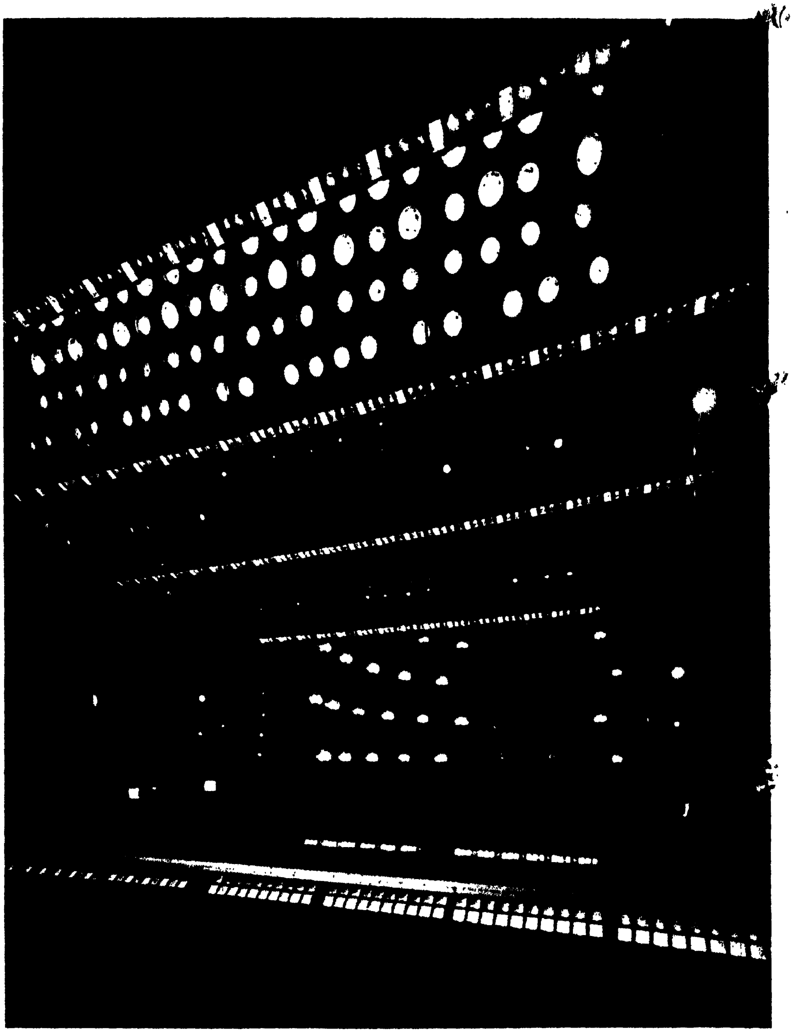
STAGE LIGHTING



Frontispiece

General View of Lighting Installation, Lisbon Opera House
(Lighting Equipment and Console Control were made in England)

THEATRE AND STAGE SERIES

STAGE LIGHTING

BY

FREDERICK BENTHAM

WITH A FOREWORD BY

ROBERT NESBITT

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FOREWORD

THE history of stage lighting is the story of development from the primitive to the complex; of the harnessing of scientific knowledge to theatrical purposes. The modern trend, most significantly, is away from the overall lighting provided by magazine battens and lengths.

It will be noted in my productions that the principal lighting is derived from high-power sources, my design being to ensure that magazine battens play only a subsidiary part. These sources, 1000–2000 watts, are rarely open floods, except for cyclorama work, but acting-area floods, pageant lanterns, and mirror spots in which concentrated beams with relatively sharp edges and without stray lights are produced.

With this equipment I can light, with high intensity, specific areas of the stage and simultaneously leave other areas dark, contrast colour with colour, and thus secure an interesting pattern of highlights and shadows, expressive control of the light rays being a considerable aid to "atmosphere."

The value of the most elaborate combination of lighting equipment can be heavily depreciated by difficulties of control. Attempts to co-ordinate a number of operators on different switchboards are not only disconcerting but also wasteful of both energy and time. It follows that a thoroughly adequate switchboard is a first essential. A modern direct-operated switchboard can be 20 ft or more long. As it is obviously unwieldy to work, and impossible to place satisfactorily, it is not surprising that expert ingenuity has been exercised to produce a thoroughly satisfactory alternative. It is, of course, the Light Console which I am pleased to be able to claim I was the first to use.

As the producer of many London Palladium and other big musical shows, I can testify to the advantages of having a lighting system literally under the operator's fingers. From his vantage point he (or she) sees the stage as the audience sees it—this is of immense practical value. Association here introduces the name of Frederick Bentham, the author of this work.

Mr. Bentham invented the Light Console after the most exacting and concentrated work. His position in the Research Department of the Strand Electric and Engineering Co., Ltd., has enabled him to take full advantage of scientific experiments carried out by him and his colleagues. It is not surprising, therefore, that he has been responsible for many new designs, including the Mirror Spots, Pageant Lanterns, and Acting Areas, which I regard as foundational and indispensable in the lighting of modern productions.

Mr. Bentham has additional qualifications to express, authoritatively, opinions on modern stage lighting. He is engineer, designer, artist. Fully conversant with the requirements of the modern stage, large or small, he is an expert with varied and exceptional knowledge. Incidentally, he has worked with me at the London Palladium when the total connected load has been 1800 amperes. Contrast this with the example furnished by him in his treatment of "Comparative Examples of Stage Layouts" in which he refers to an installation with a total of only 15 amperes.

But although Mr. Bentham is expert and pioneer alike, emphatically he is not a faddist. He has a clear perception of the complementary work of dramatists, producers, players, scenic and costume designers, and others; of the relationship of parts to the whole; and of the place of stage lighting in theatrical effectiveness. He tells what can be done with modern stage lighting, and states the basic principles that must be applied to secure the best results, taking into account, however, the human element which precludes infallibility but which is assisted to make ever nearer approaches to perfection by the latest developments in apparatus and equipment. Personal taste is reflected in specific aims and the methods by which it is sought to realize them.

Amateurs (and others) who study Mr. Bentham's book will most certainly find themselves influenced for good when they concern themselves with the lighting of any type of theatrical entertainment.

ROBERT NESBITT

AUTHOR'S PREFACE

In stage lighting we have to recognize that at the moment, in this country at any rate, there is no such person as a consulting illuminating engineer free of all commercial allegiance. Electrical engineers, lighting artists, both exist, but as separate specialists. For some years this gap was filled by Harold Ridge and F. S. Aldred, but their theatre practice is no more.

It does not seem possible to me that a man can write objectively and completely independently of his work for the firm by whom he is employed, no matter how conscientiously he may try. However, provided he frankly announces his allegiance and thereby sets the reader on his guard, his value as an author need not be imperilled.

Personally, although I began my career in the theatre as an amateur scene painter and lighting man under the late A. Gardner Davies, I have spent the past sixteen years in the demonstration and research departments of The Strand Electric and Engineering Company. This inevitably means that many of my ideas on stage apparatus have been, are, and will be incorporated in the range listed by that firm. No matter how fair I may try to be, obviously any illustrations I might give to other firms are going to be of the apparatus about which I care less or little; footlights and battens perhaps! On top of this, the placing and number of illustrations allocated to each firm can combine to make mock of any intended display of impartiality.

Rather than lead the reader astray, I therefore announce that all the photographs of stage apparatus are of Strand Electric models, except the items outside their range of manufacture.

Beyond the individual pieces of apparatus—the way they may be used, combined into installations and all the rest that makes up the art of stage lighting—these chapters are purely expressions of my own personal opinions, each of these opinions being just as capable of raising *violent* disagreement or agreement among the individuals inside that firm, as among those outside.

I should like here to acknowledge my gratitude to J. D. H. Sheridan and Stanley Earnshaw for the freedom to publish material arising from my work and for encouragement and assistance in many directions. Also, I wish to thank all those who in their various ways have helped me in the making of this book; in particular: Alfred Emmet—the loan of photographs of Gunter Heilbut's settings (Figs. 181, 182, and 186) for The Questors' Theatre; Miss Esme Church—details of the Bradford Civic Theatre; L. G. Applebee—details of the installation at the same theatre and the Haymarket, London; P. Corry—details and plan of the installation for a Grammar School; H. O. Jordan—electrical data and curves of resistance dimmers; J. Wood—the same in respect of electronic dimmers; The Technical Press—block of German dimmer regulator (Fig. 91). The Blackpool photograph (Fig. 132) is by Lancelot Vining and that of the Sadler's Wells Ballet (Fig. 155) by Edward Mandinian. Thanks are due also to the following firms for photographs of apparatus they manufacture and supply—

Lamps (Figs. 1, 3, 4, 5, and 9)—The General Electric Company, Ltd.; Black lamp (Fig. 10) and Thyratron reactor board (Figs. 98 and 99)—The British Thomson-Houston Company; Radio City, New York, control board (Fig. 100)—The General Electric, Cleveland, Ohio; Variac dimmer (Fig. 61)—Claude Lyons, Ltd.; multi-way transformer dimmer (Fig. 62)—Foster Transformers and Switchgear, Ltd.; 2-kW spotlight (Fig. 41)—Mole Richardson, Ltd.; remainder of apparatus—The Strand Electric and Engineering Company, Ltd.

FREDERICK BENTHAM

CONTENTS

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

CHAPTER XV

APPENDICES

LIST OF ILLUSTRATIONS

COLOUR PLATES

CHAPTER I

INTRODUCTORY

STAGE LIGHTING must always be considered as part of the show, sometimes a small part, purely subservient to the actor or the scenery, but at other times dominant and even overriding the actor. There is a tendency to regard the aural theatre as higher than the visual: the spoken voice first; visual effect, scenery, and lighting a poor second. This is quite a mistaken notion. Often the actor rejects the voice for mime to get his message over; in *Green Table*, for instance. Now it may well be that as stage lighting is released more and more from its bonds of mechanism, it may, at times, play the principal role.

The Purpose of Lighting

Much will depend on the character of the play. Generally, to-day, the actor is the soloist, and the lighting and scenery are the accompaniment. Lighting should enable the actor, and particularly his face, to be seen, and for this reason the first application of lighting in this book is to the Open Stage, where there is no distracting scenery to light (Chapter VIII). It is necessary immediately to qualify this by saying that there are occasions, even in the most ordinary box-set straight plays, when this rule can be broken with advantage. If the message from the lighting is sufficiently strong, it may do what the whole gamut of facial expression, if seen, could not do. Lighting with this kind of message will not only act upon the audience, but also upon the actors themselves (particularly amateurs) in such a way that they themselves will give a better performance. Bogus lighting to provide facial illumination for all occasions works against actor and audience—but beware of gloom for gloom's sake.

The correct attitude is well summed up in the hackneyed expression "the show's the thing," but do not make the mistake of regarding lighting or acting as the show.

Even in Chapter XIV on Colour Music it is not possible to treat lighting by itself. Light leaves its various sources, is reflected from various surfaces on the stage, and thence to the eyes of the audience. So far it seems to me that the interest of the stage-lighting expert evaporates once the light reaches the stage, and the journey from stage to audience is left to the architect of the theatre or hall. This does not satisfy me. It vexes me that the beautiful cyclorama can be seen properly by only part of the audience, and probably cannot be seen at all by the man at the switchboard who made it beautiful. In this book, therefore, the journey of the light to the stage will be continued to the audience and the switchboard operator.

Stage lighting must, unlike other forms of lighting, conceal more than it reveals. One piece of scenery lit by a spotlight may appear as a complete setting; one piece of scenery lit by a general flood of light from footlights and battens will certainly appear as one piece of scenery.

Acquiring Practice

The would-be stage-lighting artist, amateur or professional, is well advised not to restrict his lighting activities to the stage. One of the difficulties is to obtain sufficient practice in the art, to get the feel of lighting so that thoughts and emotions find ready expression. If the stage is regarded as the only place where any form of practice is obtained, then, usually, either the stage is kept waiting while the would-be artist fools around or he is too polite and has to curb his ideas.

We should take a poor view of the actor who had not taken the trouble to prepare his part before arriving at rehearsal. What would be said to the musician who arrived with only the faintest notion of the technique of his instrument? Yet the blunderings, even in the most exalted professional circles, when the lighting rehearsal takes place, are beyond imagination. Granted that the set is being lit for the first time, that the stage may be strange, that the switchboard is out of sight in the wings, these facts do not excuse lack of knowledge of what happens when two colours mix additively or subtractively, or of the light distribution and intensity that may reasonably be expected from a particular piece of lighting equipment.

The hoodoo that surrounds colour-mixing and the effect of colour on colour can be broken by a few simple experiments at home. The feel of plastic or directional lighting can be obtained by moving two or three 100-watt lamps in boxes from one position to another, lighting the trees and bushes in the garden. Make a practice of observing the effect of light of all kinds—the sky, the sun through the trees; go about observing all the time as the painter does; inspiration is far more likely to come from outside the theatre than from inside.

A model theatre is an unrivalled aid to proficiency; every lighting artist must have one. With its aid, unlimited practice and experiment can take place in private. Here lighting can be related to experimental sets, curtains, and cyclorama as an end in itself; not merely to the coming production at the theatre. The man whose fate it is to light an infinite series of chamber sets can seek wider horizons in his model theatre.

The accompaniment of suitable music by changes of lighting on dimmers (colour music), variations on curtains or on a suitable setting, not only helps one to think in light, to mix one's colours instinctively, but is a most satisfying pastime. Another fine exercise can be performed to a radio performance of any Shakespeare play. One is able to prepare a suitable permanent set with variations and lighting layout in advance. As the play proceeds along its course, unpredictable owing to cuts, each scene has to be set and lit on the instant.

Unlike other experts, I hold that the lighting of a model theatre should be a miniature of the full size in layout though not in the actual lanterns used. For a proscenium opening of twenty-four inches a low voltage of 6 volts from a transformer is suitable. A little skill and ingenuity can provide floods, spots and battens which, though not furnished with scale exteriors, do provide scale lighting. For dimming, 6- and 16-ohm wireless rheostats are ideal. This is not mere theory: at one time the author used to possess a model theatre whose home-made switchboard contained eighty-seven of these dimmers complete with electrical master dimming. It began as a theatre with but three dimmers!

Remember this matter is important and not to be dismissed as children's games, even by the august. The scene designer is not ashamed of his models nor the architect of his. Let's have no more: "Try an 8—make it a 4—no! What about a 3? Yes! make it a 36!"

Aided by some of my later chapters and above all the reader's own practice, he can enter the theatre or hall equipped to think in terms of light, but there will still be the snag of electricity. It is more than likely that the reader of these pages simply cannot develop an interest in three-phase, 50-cycle supplies, balancing, earthing, and all the rest; and yet at every turn lighting ideals have to be reconciled to the laws of electricity.

"A Little Electrical Knowledge . . ."

Generally authors on this kind of subject begin operations with a simplified description of the various components and processes in a direct current (D.C.) circuit, most of which lend themselves to simple description. However, alternating current (A.C.) has almost completely replaced D.C. except for a few specialized applications. Alternating current is far more convenient for practical distribution, but not, unfortunately, for simplified description. The adage about a little knowledge becomes very critical in these days of high voltage (230–400) A.C.; a mistake in the temporary connexions to a lantern may lead to a serious, even fatal shock. The days when completely unskilled amateurs could construct their own dimmers out of drain-pipes filled with washing soda are gone. There are sufficient bathroom deaths each month to point the danger.

All this is not to say that only qualified electricians can take part in the art of stage lighting; but only to stress the need for every amateur society to enrol such a man to superintend their electrical activities. There must be many such with the necessary technical experience, particularly after the War, who would be only too pleased to make their contribution. Most stage productions employ a considerable amount of temporary wiring, and it is plain common sense to ensure that it shall be carried out in a safe manner. Assuming the presence of a knowledgeable electrician, amateur or professional, in the background, no explanation of electrical terms will be attempted; the minimum will be used in a context that makes them self-explanatory.

Tradition is Strong

The story of the lighting equipment will be found to develop naturally from the lamps commercially obtainable, through the means of controlling them optically and electrically, thence to their application to particular stages and the effects thereon. The stage being a limited market, it is very seldom that we are able to begin with the effect required and work back to a special lamp. Throughout the short history of stage lighting we find this order reversed. It was impossible until comparatively recent times to project a beam of light, intensity being obtained by repetition of low-power sources. A line of these at the front edge of the stage with vertical rows behind the wings (lengths) and horizontal rows (battens) behind the overhead borders, originated in oil days and persisted in gas days, and even later in electric times. By this time footlights, battens, and lengths became hallowed by tradition. Indeed, the Russian Ballet at Covent Garden Opera House just before the War, in spite of the lavish equipment there, preferred to rely on lighting that departed very little from that tradition imposed by small-source battens and footlights, a fault that should not be repeated by the Sadler's Wells Company on the same stage. With this form of lighting the aim could only be an evenly-lighted, shadowless stage, shadows and perspective being painted on the flat scenery. Very spectacular results were obtained by this use of perspective, though, of course, the whole set could have looked "right" only from one seat—that of the Patron.

It is interesting to speculate whether the horizontal lines of flat cloths, cut cloths, borders, wings, etc., were the result of the only means of lighting or dictated by the need for an easy method of changing the scene. Be that as it may, the principal method of scene-changing with horizontal rows of scene battens and grid is basically the same to-day as then. If one is not careful, this pattern is imposed, willy-nilly, on the lighting equipment as well. About the only equipment one can be certain of finding in any theatre is a grid with its complement of scenery battens and lighting battens, plus the inevitable footlights.

What is so aggravating is the way borders, consequently battens, still appear in halls even where there is no scenery grid, or the slightest chance of flying scenery, owing to the lack of height. The excuse often put forward is that of sight lines, but this will be exposed later. In fact, a lot of the trouble has been until recently the fault of the commercial firms supplying stage-lighting equipment. Of the two principal to-day, one began life as a supplier of West End theatres, the other as a specialist in colour-lighting of cinema stages. Both have, of course, expanded their practice, but in so far as a firm can be said to have a style, you will find their origins betrayed in their work and ideas. The tendency has therefore been to regard amateur installations as a kind of reach-me-down version of the commercial stage, be it legitimate theatre or cinema. Naturally, amateurs and little theatres with little money to spend have found themselves with an installation based on the commercial irreducible minimum—magazine footlights and battens, together with a dimmer board; and even an absurdity like two battens, a footlight, and no dimmers, funds having run out. Such installations are pathetic, representing, as they do, a considerable expenditure of money. Similarly, switch and dimmer boards have been quite unsatisfactory, employing cut-down versions of the framework and shafting of larger boards. Fortunately, better days are in sight and already apparatus designed especially for the amateur is coming on the market.

The Curse of Ill-planned Halls

If the lighting apparatus of pre-War days has been unsatisfactory, what can be said of the halls in which amateurs were (and are!) expected to perform? The torments of working in such places are probably only too familiar to my readers;

but I cannot help referring to the hall in which, before turning professional, I obtained my first experience. Seating 400 on a flat floor, the acoustics and sight lines could scarcely have been worse. Not only was there no wing space whatever, but the walls angled in, reducing the available stage width up stage. No height above the proscenium was provided, and what space there was, was reduced by the interposition of a low ceiling over the last third of the stage's depth. The footlight and batten were switched on at opposite sides of the stage! Concerted action by all the amateur societies in the neighbourhood did, after many years' agitation, result in modification; but how on earth did it get like that in the first place? Reduction in height up stage, involving the rear wall, is very common, as is the occupation of valuable wing space by a pair of rooms labelled "Dressing Rooms." The stage in a modern town hall (1000 seats) completed just before the War is spoiled by a first-floor passage bracketed out from the rear stage wall. The finest new school hall I know has its large stage ruined (although equipped with front tabs) by polished oak flooring and panelling with a centre ceremonial doorway.

Heating pipes and radiators seem to be armed with high priority and these things invade the stage at the first opportunity. When a new hall is in the building, a constant vigil is necessary to ensure that the rear stage wall is free of doors, panelling, hot-water pipes, ventilation trunking, electric conduit, and so forth. Having obtained our rear wall unadorned, it can be plastered and given a finish of matt white distemper, thus becoming a cyclorama. Happy indeed is the company working in a hall with such a cyclorama rear wall!

It is surprising how many stages are ruined by antagonistic roofing over them. Leaving aside the question of flying scenery, it is important that sufficient height shall be available to get the lighting equipment out of the way. A "pitched" roof will, unless the side walls are built unusually high, cut down the scenery wings and borders at the very point where the demands of sight lines insist on extra height. This is tricky enough where the slope is across the stage, but things are made even worse when a third slope is formed by the roof from the back wall.

It seems impossible that any one should make such a mistake, and yet within twenty minutes walk of where I am writing there is a social hall with just this fault.

It is most difficult to get an architect to understand that the stage is a workshop and demands quite different standards of finish from the rest of the hall. Where, as is often the case, the stage is required for ceremonial purposes or for concerts, a suitable setting must hide the workshop. Curtains, light movable panels, and so forth can easily form a temporary background dignified enough for the Mayor, or for Brigadier X, at the prize-giving, and the like.

Stage design apart, halls are commonly spoilt for the drama by being expected to double the part of a dance hall. The flat floor is fatal; impossible sight lines and acoustics are the result. The alternative to the multi-purpose hall is usually conceived as a concert-dance hall with a separate theatre. To this in all but very exceptional instances, whether at the Civic Centre level or that of the village Community Centre, funds simply will not run. The real solution lies in one hall to serve music and the drama with properly stepped seating, and an adjoining exhibition gallery. This gallery has a flat dance floor and also acts as a venue for Arts Council exhibitions. Dancing in a fine room whose walls may be hung with pictures comprising the current exhibitions is not only possible, but a delightful way of introducing art to people who might not otherwise undertake to try it. By this means, two lofty halls with elaborate seating and the rest are avoided and more precious rehearsal time may be allocated to productions in the main hall. This matter of rehearsal time is very serious; production in the most lavishly equipped theatre can be robbed of its pleasure and effectiveness without time to rehearse on the actual stage. The absolute minimum is two rehearsal nights: the first to fit up scenery and lighting and rehearse the changes; the second for a full-dress rehearsal.

"Real" Theatres are not always Perfect

In reflecting on the shortcomings of the halls in which amateurs find themselves, they are liable to say: "If only we had a real theatre!" Too often the glamour that surrounds the professional theatres of the West End blinds us to their defects. In my opinion, we are too tolerant in this matter. The older theatres are seen through a haze of tradition; the fact that Garrick walked the boards excuses a grid that will not fly scenery without tumbling. No amount of historic association is adequate compensation for bad sight lines and acoustics. On the other hand, some find merit in a theatre simply because it is new, built in the past twenty years. The so-called *modern* theatre very often provides a stage just as cramped as that of an older theatre, and auditorium sight lines that represent very little improvement. Usually the main difference is a padded seat and doubled price in the pit and gallery. While reducing the number of circle tiers from three or four to two, the commercial theatre demands increased seating capacity and the modern deep circle is the result. Not only is the angle from the upper circle steep, but the back rows are a long way from the stage. In order to make the expensive theatre site pay, as a rule twice as many seats are required than the site can really carry if the show is to be the thing.

Where the Commercial Theatre May Fail

A concert hall where only half the orchestra could be heard properly would not pass for a moment, and yet commonly in the theatre only two-thirds of the audience get a passable view of the stage; less than one-half a good view. This high value of West End sites seems to me to provide an excellent reason for more theatres in the less expensive suburbs. Many of these theatres might be municipally owned; after all, why should the local authorities confine their activities to music and dancing? A good theatre is just as important as a public park or library. It will be found that seating for roughly 1000, a stalls floor and one circle in conjunction with a 30 ft. proscenium opening, is the limit for good sight lines. The proscenium opening is important, 30 ft. for drama, but at least 40 ft. for opera and ballet. The Sadler's Wells Ballet at the New Theatre during the War provided a fine example of the limitations imposed by a small stage. The orchestra was not too happy either, overflowing, as it did, into the stage boxes. It is commonly suggested that any State or municipally-subsidized theatre is unnecessary and that a real live theatre can be made to pay its way. To me, the fallacy of this is patently obvious: if it were so, then either greater fortunes would be made in the theatre or the theatres themselves would be better. The truth is that the site and building for a theatre, democratically designed to give everyone a good view, is so expensive as to constitute an impossible dead weight: hence the present-day cramped, overloaded site.

The final breakdown of the commercial theatre comes in those instances, seemingly on the increase, where the capital is put up and the theatre run purely as a business. Perhaps to-day men no longer have money to lose as patrons, but, whatever the reason, the habit has grown of judging results by the box office. This inevitably leads to safe building and equipment of theatres, and even to the avoidance of all risk and merely to letting the theatre to others for production. The risk is probably greater when there is a board than when control of the purse is in one man's hands. Be this as it may, while the profit motive, allied to a love of the theatre, is harmless, by itself it can be an evil thing. Not only may the selection of a play and its style of production be severely handicapped, but also a play, once launched on a suitable scale, may be severely reduced after the first week, even when it is a success. In this respect the lighting is the greatest casualty. Naturally, during the frantic rush of rehearsal a great deal of lighting equipment will be accumulated which can, subsequently, in the cool and calm of the first week, be discarded, and more efficient use made of the remainder, with consequent reduction of the hire bill. Unfortunately, this process is often carried to extremes, and once the producer is out of the way the opportunity is taken to discard still further. If the position is "discard or put the notices up," there can be but one answer, but often this is not the case. The great fire effects scene that got good notices becomes one red flood and a smoke puff. This could never happen where the true man of the theatre is responsible, for he loves his fire.

The State Can Help

Before indulging in extensive State support of theatres, it seems but fair to assist the theatre business man to the extent of at least putting him on an equal footing with his fellows in other departments of commerce. Alteration on the entertainments tax seems overdue. Other businesses are to be freed from purchase tax when scarcity is no longer here, but the theatre is evidently to retain its own purchase tax for ever. Of course there have been several relaxations to cover education, but the presence of a supplementary tax in addition to the regular income tax is indefensible. When a tax on books was proposed during the War it was vehemently resisted and, rightly, all books, whatever their type and merit, were freed of tax. Why the theatre should pay a larger proportion of tax in normal times towards the upkeep of the armed forces than the armaments industry itself, passes my comprehension.

Another aid could be the repeal of the regulations, out of date in the light of modern building technique, prohibiting the building over or under a theatre of other money-earning ventures to ease the financial burden of the site. In New York a similar regulation produced cramped commercial theatres[1] but it was revoked in 1938.

Apart from the profit motive, the trend in monopoly conditions in the commercial theatre suggests another reason for municipal competition. Granted the logic of a municipal theatre, the local pride and joy, for goodness' sake let it be properly designed, and let us make sure that the current production does not use a cyclorama because it does not require one, and not because there isn't one; that the mounting and lighting of the play are demanded by aesthetic considerations, and not by physical limitations. It will be found that needs are modest, and that after setting out to design the ideal civic theatre it will not usually resemble the Red Army Theatre, Moscow, the Paris Opera House, or Radio City Music Hall, New York.

[1] For a lament on their failings see Burris-Meyer and Cole: *Stage Scenery*, Chapter 1 (Harrap).

Theatre Design and Equipment, British Scale

It is necessary here to stress that what may appear modest by Continental standards will in Great Britain appear to be wildly extravagant. There has to be a host of new buildings of all kinds, ranging from the humble multi-purpose village hall to the large-scale spectacular opera house, be it nationally, municipally, or commercially run. In following chapters various suggestions are made for their design and equipment, but always with the British scene in view.

In a book such as this it is necessary to confine attention to theatre buildings and their equipment, leaving questions of the state of acting or writing in Great Britain severely alone. Handsome buildings do not make the theatre; nevertheless, comparison of theatres here with those abroad leads to considerable dissatisfaction, or at least to wonder at the peculiar differences in the scale of our approach to the theatre.

In London, the greatest city in the world, there are three really large stages: Covent Garden Opera House, The Coliseum, and Drury Lane. The mechanical equipment of these consists, in Covent Garden and Drury Lane, of the rather out-of-date five or six power-driven stage bridges which, rising a few feet above the stage and sinking a few feet below, do not lend themselves to the rapid striking and setting of three-dimensional scenery. If a revolve or wagon stage is used then the lifts go out of action. The Coliseum has a fine triple concentric revolving stage which has been used, as in *Golden Toy*, to give different aspects and vistas of the same solid setting. Each of these three theatres possesses a cyclorama, although at the Lane it is peculiarly shaped, and half-way up stage, owing to the sight lines and fly galleries. The scene flying grids, roughly 70 ft., are high for London, but low for stages of this size. Wing space is also cut rather fine, especially at the Lane, where the great stage is twice as deep as it is wide, a bad but common fault in the older pre-democratic theatres.

Only one of these theatres, Covent Garden, has a proper modern lighting installation conceived as a whole. This was installed in 1934 and is due for re-modelling or, as organ builders would say, "due for rebuilding." It is rather curious that models of cars, radio sets, television sets, and the like (even schemes of decoration!) can be sold on the definite assumption that these will be out of date in a few years, and yet stage dimmer boards, spotlights, and so forth, are supposed to endure for eternity. Let it be stated here and now that, at the present rate of development, lanterns may easily become obsolete (not worn out) in a decade; and some stage-boards, perhaps, in a couple of decades, provided always that they really represent modern practice at the time of installation.

The permanent lighting equipments at the Coliseum and the Lane are a hotchpotch of out-of-date veterans, both possessing as part of their stage-boards fine examples of early manufacture. Even if by the time this book is published this state of affairs has been remedied, that it existed at the time of writing is still worthy of remark. Readers, remembering some of the spectacular triumphs at these theatres, will wonder how they were achieved. The answer is, of course, by the importation of vast quantities of hired apparatus, including control boards. There can be no objection to this means except as it concerns the lighting control board. Where the rule is spectacular production for long runs, then, obviously, the fitting up of a lantern layout to suit the production gives a freshness of approach where it is most needed. It is in the control that this system must be evil: either the production staggers along with many operators on, perhaps, a dozen temporary boards; or a special board of some simple type (because of quick delivery) is put in, and the theatre collects yet another sample of the manufacturers' art. As I write I have in mind more than one theatre where the stage-board resembles the architecture of Canterbury Cathedral, with samples of all periods, except gas, in use.

Key to Lighting is in the Control

What these theatres and others of their kind want is at least a permanent control board of, say, 250 ways, preferably with variable-load A.C. dimmers to which any lighting layout can be connected in the certainty that the installation will become an expressive whole. Such a board alone might cost anything between ten or fifteen thousand pounds. Pause to recover!—to suggest such an expenditure for the board needs great courage. Yet sums of this order are spent on equipping concert halls and certain cinemas with organs. These instruments receive only very occasional use as an accessory; a stage-board, however, is continually in use, for without it there would be no light, no show!

Thus, we find that there are two remote lighting-control systems, both of which were invented in the early 1930's and which offer the key—a centralized control, without which, all agree, there can be no progress. These systems are the Electronic Preset and my own Light Console. After several years these are still poorly represented in this country, the former by an installation in the Odeon Alhambra cinema, the latter by a partial installation in the London Palladium, and three in the provinces. The value of these two systems, the one for presetting and the other for playing upon the lighting, is generally admitted; the sole obstacle is cost. Yet other countries can buy: there are several "Presets" in America; the National Opera, Lisbon, the National Opera, Ankara, and others have very large and complete light consoles, with permanent lighting equipment on a similar scale.

The Shakespeare Memorial Theatre

Repertory theatres, headed by Covent Garden and Shakespeare Memorial Theatre, Stratford-on-Avon, must have an adequate permanent lighting installation and board, for only by this means can justice be done to a rapid succession of productions. The Shakespeare Memorial Theatre is worth considering here as it is the only theatre whose planning and equipment can stand comparison with Continental examples. There are rolling stages to move solid scenery into the wings, and the two stage bridges they uncover have two decks, one above the other, with sufficient travel at least to sink out of the way modest 8 ft.-high built-up sets. The cyclorama moves up and down stage, partially enclosing the result of the mechanical happenings in the acting area. The lighting installation is very small, and, perhaps, it is not surprising, therefore, to find an ordinary Grand Master direct-operated board. After fourteen years, re-modelling is due.

Remember we have only one such theatre, and even so its mechanical equipment is overshadowed by many theatres in Europe alone where daring and adventure, rather than caution, are evident. Even the Scandinavian countries, with their small populations, often put us to shame; for example, the new theatre at Malmö, Sweden. It is often argued that there is no merit in mere size, and that these elaborate mechanical conceptions as at the Pigalle, Paris, scarcely get used. There is a duty to give engineers and dreamers rein and with them adventure into the unknown. The world is the better for Paxton's Crystal Palace, even though for most of its life it was forlorn and faded; every now and then these conceptions come into their own, as did the great revolving stage idle for so many years at the Coliseum, or the Royal Albert Hall, when once in a while a mass-gathering justifies the existence of a hall that is so unsuited to everyday concert-going. The theatre provides an opportunity for engineers to escape from the bonds of mere efficiency and to savour the joys given at one time to architects alone. If other buildings were erected on the same rigid basis of efficiency, relating seating capacity to box office, then certainly the dome of St. Paul's would never have been built and the contents of the National Gallery would have been sold long since in America.

As this chapter goes to press there is progress to report which includes a new lighting installation at Drury Lane. See Appendix VII.

CHAPTER II

LAMPS

THE electric lamp is a device for turning electric power into light. So much is obvious; but what is not so often realized is that the electric lamps so far devised do this very inefficiently. Almost all the power supplied to an electric motor is turned into motion or that to an electric fire is turned into heat. In the electric lamp less than 2 per cent of the power is converted to light; the rest mainly becomes heat.

The presence of this heat provides the explanation of the bulky lamphouses and large lamp bulbs used in the theatre. It is amazing how many theatre people seem to think this bulk the result of carelessness or oversight on the part of the designer. "If only you can produce the light of a 1000-watt spot from a small lantern the size of a 100-watt spot, then you will have got something!" Such things are possible to-day, but they bring a host of limitations which nullify any advantage that may have been gained: short life of lamp, one burning position, and so on.

The decision as to which lamp to employ for a particular purpose, weighing the pros and cons, is obviously fundamental for the designer of stage-lighting equipment. What is not so obvious is the importance of this matter to the buyer and user of the equipment. If funds will only permit replacement of a lamp once every 1000 hours, then it is absurd to buy a lantern requiring a high-efficiency lamp with an official life of 100 hours, however tempting the demonstration may be. For this reason more space will be devoted to lamps and their characteristics than is usual in such non-technical chapters as these.

Electricity

To begin with, the few technical terms to be used must be fully understood. The one without which it is impossible to think in stage lighting is *watts*. Lamps, lanterns, and dimmers are all referred to as so many watts, so it is just as well to understand the expression. Briefly, the watt is the term covering the power consumed in an electric circuit at any moment. A 1000-watt fire or lamp consumes ten times the power of a 100-watt lamp; and if a circuit consuming 1000 watts is kept alive for one hour, then the result is a power consumption of one Board of Trade Unit. The Unit—one thousand watts for one hour (one kilowatt-hour)—is what registers on the Supply Company's meter and has to be paid for.

The power (watts) in a circuit is the product of electricity of certain pressure (volts) flowing at a certain rate (amperes). Of these latter terms the pressure in volts is very important; when ordering lamps and dimmers the result is a deadlock until the voltage can be given. Usual voltages for lighting purposes are 200, 210, 220, 230, 240, and 250; of these, 230 and 240 are the commonest—230 being the official standard. Even voltages of 100 and 110 are not uncommon.

It may be wondered what useful purpose all these voltages serve in this small country; the answer is that they are far from useful, being, in fact, a legacy from the innumerable small supply undertakings of the early days. Just as the main line railways had to standardize on one track and loading gauge, so we are faced with the need for similar standardization of supply companies' voltage; this will be 230 ultimately. Much lower voltages are common for special purposes, such as 12 or 6 for car lighting. The lower the voltage the higher the current in amperes however, and it is the amperes that dictate the size of the wiring and its accessories. A 100-watt 6-volt lamp will need a much heavier flex than a 100-watt 200-volt lamp, the former taking a current of nearly 17 amperes, the latter of only half an ampere.

This effect being so marked, even with such small wattages, it is not surprising that where large loads are to be fed from a power station at a distance, every opportunity is taken to raise the voltage and thereby reduce the amperes and the size of the cables. This transforming of electricity from one voltage to another, like its generation, requires motion, the motion being supplied by an electric motor rotating a dynamo. Such an arrangement is costly, cumbersome, and incidentally noisy, so the motion is nowadays actually applied to the electricity itself. That very roughly indeed is the object of the alternating current that has now almost completely supplanted direct current, except for special purposes.

Direct current (D.C.) can be described as giving a continuous flow from the positive terminal to the negative, whereas in alternating current (A.C.) the direction of flow is reversed generally 50 times a second (50 cycles) in so accurate a manner that it can be used to drive a clock without an escapement motion. Static devices are now easily possible to convert high-voltage low current to low-voltage high current whenever required, such devices being known as *transformers*.

As is well known, some metals, such as silver or copper, conduct electricity well and are known as *conductors*. A wire of a good conductor will offer resistance to the passage of the electricity if it is of insufficient diameter to carry the requisite amperes. The energy absorbed, which depends on the length of the wire, is converted into heat. Where this is done intentionally, *resistance* wires of low conductivity, such as iron or nickel-copper, are used to keep the length of wire short. Materials such as rubber, paper, porcelain and bakelite do not conduct electricity at all and are known as *insulators*.

An electric circuit must always consist of a complete loop so that the current can return to the battery or dynamo whence it came.

Vacuum Lamps

The source of light in the common lamp is a resistance in the shape of a filament of fine tungsten wire heated to white heat, a state of affairs where 94 per cent of the energy emitted is heat and the remainder light. To prevent the oxygen in the air necessary to combustion from reaching the filament, it is enclosed in a glass bulb from which the air has been exhausted (the vacuum lamp). In the course of time the filament running at this high temperature gradually evaporates and is deposited on the bulb. This becomes noticeable as blackening on the bulb; simultaneously the thinner filament will carry less current and give less and less light until the filament fails altogether.

Gas-filled Lamps

The higher the temperature at which the filament is run the better the efficiency of the lamp and the whiter the light emitted. To slow down the evaporation of the filament and to enable it to run at the higher temperatures the bulb is filled with an inert gas (argon and nitrogen) which provides some obstruction to the molecules wishing to leave the filament. These gas-filled lamps are easily recognized by their whiter light; they convert 92 per cent of the energy emitted into light. This matter of filament temperature is naturally related to the thickness of the filament and benefits lamps of a high wattage as compared with those of a low wattage. Thus, a lamp of 1000 watts will not give ten times the light of a 100-watt lamp, as one would suppose from the power used, but fourteen times the light owing to its greater efficiency; and a whiter light into the bargain.

Efficiency, therefore, is not merely a matter for the engineer, but of direct concern in the guise of quality and colour of light to the stage-lighting expert. Such efficiency is expressed as *lumens* (a unit of light) per watt (L/W). Without going into the lumen and its relations employed by the illuminating engineer, it is easy to see that a lamp with an efficiency of 19 L/W is a lamp plus when compared to one giving 12 L/W only; these being the efficiency figures for a 1000-watt and a 100-watt lamp respectively. All lamps, gas-filled or vacuum, suffer a diminution of light output with age, their light changing from white to yellow. The makers, therefore, give a life figure in hours during which the deterioration is not pronounced; in the case of domestic lamps or general service lamps this life is 1000 hours. It is possible to operate a lamp beyond this period, maybe for years, but to do so is not a matter for self-congratulation. Such a lamp is giving a travesty of white light and used behind blue filters practically no light may be emitted for the power expended. Lamps in the blue circuits are the most critical, but the practice of waiting for a lamp to fail before replacing it, is shortsighted in extreme. There are many installations all over the country where new apparatus is contemplated when all that is required is a good clean and a new set of lamps.

More light may be obtained from lamps for special purposes by running the filaments at a higher temperature and rating them as short life, sometimes as low as fifty hours or less. Combined with this is an increase of efficiency obtained by bunching the filament close together so that it becomes almost a solid source of light. The bulb may also be shaped in such a way that optical lenses and reflectors can be brought close to the filament. The bulb, particularly at the point where it is cemented to the lamp cap, is vulnerable to heat, a condition aggravated when the lamp is suspended cap up. To keep this part as cool as possible, a long neck and mica baffles are needed in the larger wattage lamps (Fig. 1). If, then, a lamp is designed without a long neck in order to be compact, then it follows that there must be a prohibition on burning with the cap up (Fig. 3). Similarly, a lamp with a narrow tubular bulb (Fig. 4) can only be burnt vertically cap down, otherwise a blister will form on the part of the glass wall nearest and over the filament.

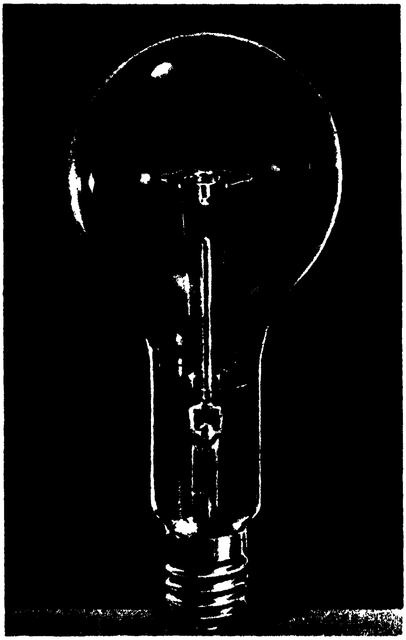


FIG. 1. 500-WATT GENERAL SERVICE LAMP WITH G.E.S. CAP

Lamp Caps

The lamp cap serves two purposes: firstly, to supply current, very often considerable, to the filament; and secondly, to provide a rigid fixing for the lamp. For the latter reason even small lamps on the stage are not fitted with the bayonet cap-holder common in the home; the spring contacts of this holder allow too much wobble. A range of screw holders is used allowing the lamp to be firmly screwed home. These holders are known as Edison Screw and are made in various sizes: Miniature Edison Screw (M.E.S.), used in pocket torches; Small Edison Screw (S.E.S.); Edison Screw (E.S.) for lamps of 100 watts or so; and Goliath Edison Screw (G.E.S.) for lamps of 500 watts and over. Even these caps are not sufficiently accurate for apparatus where the exact location of the filament, relative to the optical system, is all important. Here prefocus types of cap and holders are used, familiar to some in home cinema projectors. Three types only are used in the theatre: Medium Prefocus, equivalent to E.S.; Large Prefocus, equivalent to G.E.S.; and Bipost. The first two may be fitted to any projection lamp in exchange for its standard cap at a slight extra charge, but the last-named needs a special lamp assembly altogether. The Bipost (Fig. 5) is of a size which I suspect owes its origin to the large wattage lamps—3000 or 5000 watts and 110-volt supplies common in film studios. Such lamps need very large currents in amperes and supplying them through the lamp cap was a problem. The Bipost cap resembles a large two-pin plug, and though it can be supplied for wattages as low as 500 it is rather an anachronism below 2000 watts, both on the score of size and price!

Operating Voltage

As the filament temperature is so critical, if the lamp is to enjoy its rated life and efficiency, it follows that the pressure in volts applied to the lamp is very important. Every lamp is manufactured to work on one voltage only. Volts higher than this will increase the light output but decrease the life, and conversely a lower voltage will decrease the light but prolong the life. (See Fig. 2.) This is generally understood, but it is not commonly understood how little voltage variation is needed to play havoc with the lamp. Five per cent increase in volts decreases the lamp life 40 per cent, and 5 per cent decrease in volts reduces the light output by 15 per cent. Putting a 240-volt lamp on 200-volt mains means over 40 per cent loss of light. The cheerful person who merely knows his supply voltage as "200 and something — can't remember exactly," is very liable to come unstuck. This voltage question makes touring of equipment very unsatisfactory. Two sets of lamps are carried; 110 volt and 230 or 240; and these have to cope with the half a dozen or so voltages encountered. Some towns do get literally a brighter performance than others.

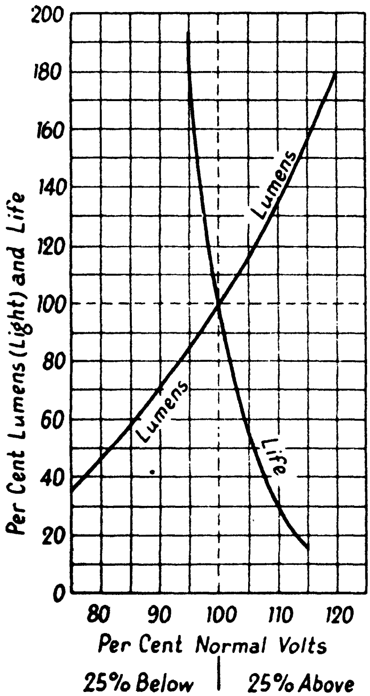


Fig. 2. Relation Between Volts and Lamp Light and Life

Types of Lamps

We shall now consider particular types of lamps in some detail; all these are commonly used in stage-lighting apparatus. The efficiency figures in lumens per watt (L/W) are for the 200–250-volt range unless otherwise stated.

General Lighting Service Lamps (Fig. 1), usually abbreviated to G/S lamps. This is the largest and most familiar class, since it includes the ordinary domestic lamps. However, only the 200-, 300-, 500-, 1000-, and 1500-watt sizes are used in stage lighting. The 200 and 1500 are seldom employed, both being in their way rather cumbersome. These lamps have a wreath-shaped filament and may burn in any position. For stage work it is usually as well to specify "angle burning" lamps; in these the filament is shaped and supported in a way that enables it better to withstand the shocks of a stage career. There is no extra charge, and the life of both filaments is 1000 hours. The efficiency of the 500- and 1000-watt lamps is 17 and 19 lumens per watt, respectively. For general lighting service below 200 watts the theatre enjoys a special class of its own. These are manufactured by the G.E.C. and Ediswan firms for certain, perhaps by some of the others as well.

THEATRE BATTEN LAMPS (sometimes known as Samoiloff lamps). These are made in 60-, 100-, and 150-watt sizes, E.S. caps. The filament centres are all the same distance from the lamp caps, and the bulbs are the same size as that of the domestic 100-watt G/S lamp. The lamps are rather more expensive than the corresponding domestic lamp, but the interchangeability between the three sizes may make this worth while. In any case, the normal bulb size of the 150-watt lamp is unwieldy for stage purposes. The filament is wreath-shaped and may be burnt in any position. Efficiency is about 11 lumens per watt for the 60-watt and 13 L/W for the 150-watt, and the life of all is 1000 hours.

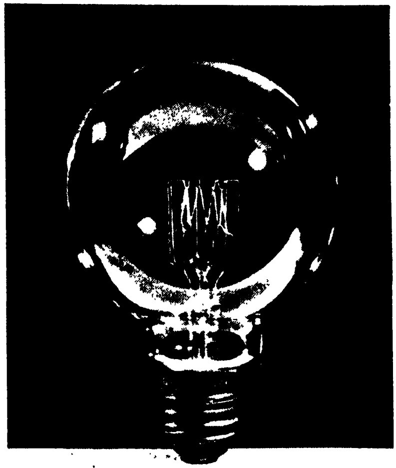


FIG. 3. 1000-WATT B.1 PROJECTOR LAMP

Where, for one reason or another, it is desired to use the standard G/S lamp for these wattages, the lamps should be recapped E.S.

PROJECTOR LAMPS. ROUND BULB CLASS B.1 (Fig. 3). Made in 100-, 250-, 500-, and 1000-watt sizes, the first two have an E.S. cap, the others a G.E.S. or Large Prefocus cap. The 100-watt lamp is seldom used on the stage. All the lamps have a "bunch" filament, and the filament centres (also bulb sizes) are the same in the 500-watt and 1000-watt lamps, making them interchangeable. The filament, as its title implies, is a bunched, compact source of light; while the bulb is almost devoid of a neck, making it very handy in shape. To balance these advantages, the life is 800 hours, and the lamp may not be burnt with the cap within 45° of vertical over the bulb. Efficiency of the 500-watt is 14.5 L/W and, of the 1000-watt 16 L/W; less than the corresponding efficiencies of the G/S lamps.

Fig. 4. 1000-watt A.1 Projector Lamp

Projector Lamps, Round Bulb Class B.2. The bunch filament is also fitted in the standard G/S bulb. This enables the lamp to burn in any position, but, of course, the large bulb with neck is an inconvenience.

Projector Lamps Tubular Bulb Class A.1 (Fig. 4). These are made in 100-, 250-, 500-, 1000-, and 1500-watt sizes. The cap arrangements correspond to those of the B.1 round bulb lamps; but only in the 1000-watt size do the filament centres make the lamps of the two classes readily interchangeable. For this reason and their fragile filament construction, the 100-, 250-, and 500-watt sizes are seldom used in theatre work; of the two remaining, the 1000-watt is the more popular. A grid filament is mounted in a tubular bulb, making a very compact source with a pronounced light distribution from the two faces of the grid as compared to the four edges. The filament is run at a higher temperature than the previous lamp classes, giving an efficiency of 22 lumens per watt in the 1000-watt size. On the debit side of the account is found a life of 50 hours and an absolute veto on any burning position except vertical cap down. Between ourselves, a slight tilt of 20° either side of the vertical seems all right. When tilted too much, the tubular bulb develops a blister.

At this point it is as well to mention that the filament formations in various makes of projector lamps, particularly A.1 tubulars, differ somewhat. For example, some filaments are slightly smaller in area and more nearly square than others. A compact regular filament with unobtrusive supports is very valuable. See pages 40 and 51.

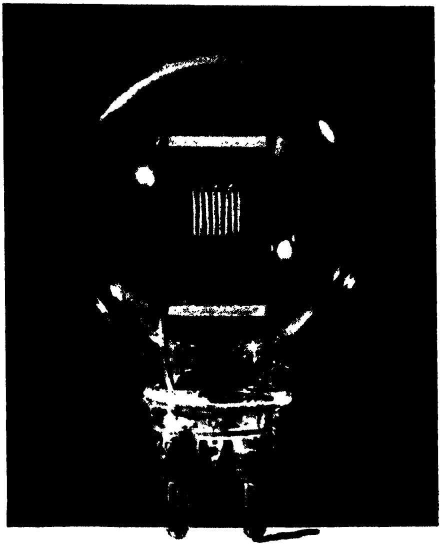


FIG. 5. 2000-WATT BIPOST LAMP

PROJECTOR LAMPS CINEMA STUDIO CLASS. These are made in 1000-, 2000-, 3000-, and 5000-watt sizes; but only the 2000-watt has found its way on to the stage. An almost square grid filament is fitted in a round bulb so that the lamp can be burnt at any angle, between vertical cap down and horizontal. The efficiency is 24 lumens per watt and the approximate life 100 hours. A G.E.S. cap is standard, but a Large Prefocus could be fitted. An almost similar lamp is obtainable known as the Bipost (Fig. 5); the filament is more or less the same, but its supports and bulb design are of the quite different construction demanded by the Bipost cap. The price of a 1000-watt Bipost lamp is twice that of the corresponding B.1 or A.1 projector lamp, which is rather a solemn thought.

PROJECTOR LAMPS, LOW VOLTAGE. The commonest is the A.1 tubular lamp, known as the "30-volt., 30-amp." The cap is G.E.S. or Large Prefocus, and the filament centre renders it interchangeable with other 1000-watt projector lamps. The filament is beautifully compact and gives an almost solid square of light. The result of the low voltage is higher current, thicker filament, and increased permissible filament temperature, and so it is not surprising to find an efficiency of 28.5 lumens per watt; its life is 50 hours burning vertical, cap up. The 30-volt, 250-watt A.1 Tubular E.S. or Medium Prefocus cap is a very good source, with an efficiency of 25 lumens per watt. It is more or less interchangeable with the mains voltage 250-watt lamps whose efficiency is 17 L/W. The life of both is 50 hours.

Another most useful low-voltage lamp is the 24-volt, 240-watt Round Bulb Projector (Aircraft Landing Lamp), fitted with a Medium Prefocus cap. This lamp, which has an efficiency of 24 lumens per watt and a life of 50 hours, is a very neat source of light that can be tilted. The range of 12-volt car lamps also has possibilities, the 36-watt V filament and the 60- and 100-watt line filaments being commonly used. In the latter two sizes the S.E.S. cap should be ordered in place of the standard Small Bayonet, otherwise there will be lampholder troubles. Fig. 6 shows a spotlight 3 in. (*A*) × 5 in. (*B*), using a 36-watt car lamp.

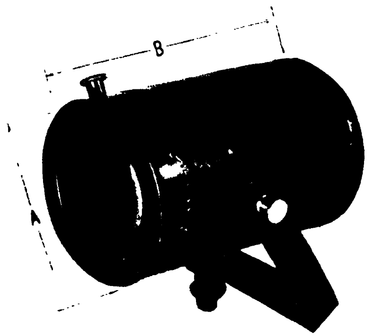


Fig. 6. Low-voltage Spotlight

All the lamps described above as having a life of 50 hours were quoted as 100 hours until recently. This new "Average Objective Life," as it is called, is a sorry form of progress especially as it brings no increased light to compensate. Only in exceptional circumstances, scene projection perhaps, can we of the theatre tolerate a life of 50 hours. Yet there are many occasions when we must use an A.1 projector lamp not so much for its intrinsic brilliance as for the tubular bulb which allows lens and mirror to be brought close to the filament to collect more light. There are two possible solutions: either to fit a small resistance in circuit to under-run lamps 5 per cent, or to use 250-volt A.1 lamps on 230 volts. This will extend life to 100 hours at the cost of 15 per cent lumens.

Non-filament Lamps. So far we have considered the commonest classes of lamps—those employing an incandescent filament as light source; we must now touch on two other forms of lamp. One is the carbon arc, which may be said to have had a glorious past—it was the first electric light; and the other is the discharge lamp, holding the key to the future. Both these lamps have at present only limited application to the theatre, especially the amateur theatre, and will not be treated in detail.

The Carbon Arc

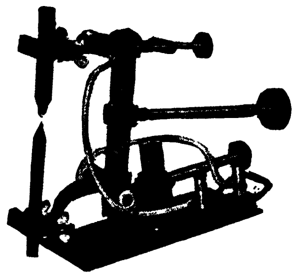


Fig. 7. Carbon Arc Lamp

The carbon arc consists of two sticks of carbon, one connected to the positive terminal and the other to the negative of the supply. These sticks are brought together to touch for a moment and then moved a short distance apart; thereupon an electric flame or arc is formed between the carbons. Why it should do so we need not go into in these pages, but the result is to form an intense white-hot crater on the positive carbon. Being exposed to the air, the carbon actually burns away, the positive with the crater faster than the negative. To compensate for this and to keep the light centre constant as the carbons are fed (usually by hand-operated knob), the positive carbon is larger in diameter than the negative (Fig. 7).

The carbon arc is one of the specialist applications where direct current is advantageous; it can, however, be operated on alternating current. The A.C. arc consists of two identical carbons, and the light source is the tips of both carbons and a ball of gas between the two. The A.C. arc is not as directional as the D.C. and is therefore not so efficient for use with elaborate optical systems as the latter. The arc *must* be wired in series with a resistance or choke as a current-limiting device. The technical reader will note, in the possibility of the efficient inductor instead of a resistance on A.C., a compensation for loss of efficiency in the non-directional A.C. arc itself.

Amateurs are very unlikely to require the services of an arc projector, and even in the professional theatre their application is restricted to the powerful following spots beloved of

FIG. 8. MIRROR ARC "FOLLOWING" SPOTLIGHT

music-hall stars and some others. At one time, more and more current was used in an attempt to get more light, but nowadays the tendency is to use more elaborate optical systems, thereby making better use of the light. Such modern systems are easily recognizable from the clear-cut circles of light projected on to the stage. An example of the latest type of F.O.H. following spot is shown in Fig. 8.

Some skill is required of the operator to keep the carbons burning nicely, especially on A.C.; sometimes, as in film projectors, automatic motor-driven feeds are fitted.

Discharge Lamps

Except for a few specialist applications these have not been used on the stage, and I do not think that there will be any general application there for a few years at any rate. Nevertheless, the filament lamp has been exploited very nearly to the limit, and it is from the discharge type of lamp that future developments are likely to come. It is of interest, therefore, briefly to survey their record.

The first general application took the form of the tubes used for signs generically described as Neon lighting. In these a high-voltage current (6000 or so) jumps from an electrode at one end of the tube to the other, the tube being filled with a gas which is rendered luminescent by the discharge. Depending on the gas, a few crude colours are produced: neon gives red, mercury vapour blue, and so on. Later improvements were brought about, mainly in conjunction with the mercury vapour filling, by coating the inside of the tube with powders, which, owing to the phenomena of fluorescence, give a fine range of beautiful colours. So far the effects of the tubes tend to be spoilt by the too liberal hand with which all the colours are crammed on one façade. The use of two colours only (a beautiful blue-green and a blue) as a vast illuminated arch under the Eiffel Tower for the exhibition of 1937 was an object lesson in restraint and artistry. The important factor of this form of lighting is that the inefficient filter method of colour production essential to filament lamps is not employed; the light is either coloured itself or converted to the colour required. Simultaneously with these fluorescent colour developments, another form of discharge lamp put in an appearance. These lamps employ high-pressure mercury vapour and are fitted with means for automatically heating the electrodes before the discharge strikes up. This preheating enables normal lighting voltages of 200 or so to be employed and are, therefore, known as hot cathode (the electrode) lamps. To the general public they were soon recognizable as street lighting of "that ghastly colour," but pleasant to drive under. Although the light is not pleasing aesthetically, it happens that much of it is emitted from parts of the spectrum near the green to which the eye is most sensitive. Another lamp, using sodium instead of mercury vapour, gives off a yellow monochromatic light which is (to me at any rate) even more unsatisfactory aesthetically. All these developments are the outlying pickets of a new era in illuminating engineering; for by variation of voltage, type of gas, pressure of gas, shape of tube, added to change of colour due in part or wholly to fluorescence, it is impossible to doubt that the next few years will be interesting indeed.

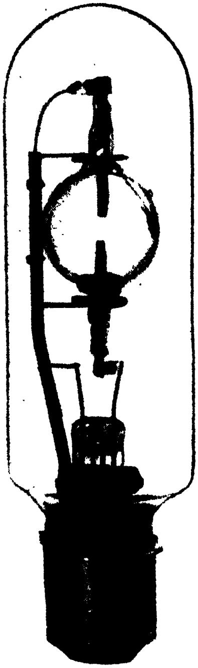


FIG. 9. 500-WATT E.H.P. MERCURY DISCHARGE LAMP WITH LARGE PREFOCUS CAP

Apart from anything else, a striking advance is made in efficiency: the discharge lamp more nearly approaches cold light, consequently, 30–40 lumens per watt are usual. Its life greatly exceeds that of the corresponding filament lamp.

In addition to the two types mentioned already there are the 4 ft. and 5 ft. fluorescent tubes and, most interesting, the extra high-pressure projector lamps, one of which is shown in Fig. 9. It has a wattage of 500 and an efficiency of 50 L/W.

So far two main difficulties prevent the common use of discharge lamps on the stage: dimming and the colour of the light from the projector lamps. Electrical dimming is possible with the sign-type mercury-vapour fluorescent tube, well enough for ballroom and similar decorative lighting, but not enough for the exacting demands of the stage. The extra high voltage is another drawback. The projector-type lamps cannot be dimmed, and the colour of the light, though an improvement on the early street-lighting lamps, is not sufficiently white.

The reversal of A.C. current fifty times a second gives discharge lamps a dark period which at 25 cycles appears as a bad flicker, not noticed at 50 cycles. It is, however, noticed when the light is used on objects in motion. Thus an artist swinging a fluorescent Indian club will not give the appearance of continuous motion but rather of several stationary clubs, the number depending on the speed. This, the stroboscopic effect, is familiar on the cinema screen, where wheels may stand still or even go backwards. The theatre, with its flair for seizing anything for effect, made deliberate use of this property years ago, though in those days the source of light employed motor-driven flicker wheels. A little thought shows the possibilities as an effect, but the matter is referred to here more as a warning of what to expect. When the effect is not required (it might well make havoc of a juggling act from the audience's point of view), the electrician should be instructed to feed his lamps from at least *two phases*.

The discharge lamps at present used on the stage for special effects are: the 400-watt tubular mercury-vapour street-lighting lamp, G.E.S. cap; the 125-watt and 80-watt mercury-vapour lamp with Pearl bulb and three-pin B.C. holder, the last two lamps being also available with black glass ultra-violet filter bulbs (Fig. 10). The 400-watt lamp is used for ageing and corpse effects, and sometimes in conjunction with the normal lighting of the cyclorama for daylight effects, provided no dimming has to take place.

All these lamps operate off 200–260 volts A.C., but *must* be supplied from a circuit with a suitable choke. The three-pin B.C. holder prevents insertion of the lamp in an ordinary non-choked lighting circuit. The lamps take three minutes or so to attain full brightness, and when switched off require to cool somewhat before they will strike up again. It follows that great care must be taken to ensure that any circuit of these lamps will not be accidentally broken or switched off, that plugs will not come apart, and so forth. If this does

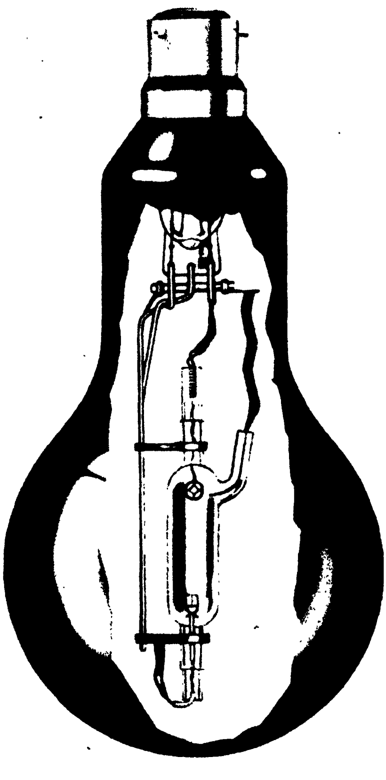


FIG. 10. PHANTOM VIEW OF 125-WATT ULTRA-VIOLET BULB DISCHARGE LAMP

happen, the lamp can be switched on again, but it will not light until it—not the stage—is ready.

It has been found possible to dim normal mains voltage fluorescent tubes in the 40-watt 2-ft. size. Though experimental as yet, there are possibilities for theatre work. The shape and low power of the tube make it unsuitable for use in compact high-power directional fittings, and this limits its application to situations where magazine equipment has been used—battens and footlights; in other words, to accessory equipment. A likely avenue to explore is cyclorama lighting, particularly close-range ground-row where the rapid spread is valuable. Colours are at present limited, but probably that is only a matter of time. More serious is the higher initial cost which may discourage theatre users, although the greater efficiency of the lamp and the absence of colour filters will reduce the watts required for the same light output as from comparable magazine filament-lamp equipment.

Note for D.C. Mains

When the electric supply is direct current, it will not be possible to use static transformers, and this will prevent the use of low-voltage lamps as an economical proposition. Further, discharge lamps would require a rotary convertor, which is an unpleasant complication, so they must be counted out.

On a D.C. supply, the carbon arc is far better behaved than on A.C.; given careful attention, it could be used where an extra bright source is required. It can be used with a special heat-resisting glass filter to provide ultra-violet radiation. Filament lamps of the same voltage as the supply (G/S, A.1, B.1, and B.2, etc.) behave equally well on D.C. or A.C.

CHAPTER III

LIGHTING APPARATUS

It is customary to divide stage-lighting apparatus into four main classes: magazine equipment (footlights and battens); floodlights; spotlights; optical lanterns (effects projectors). This division is deceptive and will not be adopted here. There is very little difference between some spotlights and a narrow-angle flood, while a magazine batten is but a collective expression for a lot of baby floodlights joined together. The real clue to the light distribution and utility of a lantern for a particular purpose (its characteristics) is given by the optical system.

Using the optical system for classification we get the following groups of apparatus, beginning with the simplest—

1. Lamp non-adjustable in relation to reflector, giving fixed light distribution; floodlights and magazine equipment.

2. Lamp adjustable relative to lens and/or reflector, giving variable light distribution: focus-lanterns and soft-edge spots.

3. Precision optical systems: spotlights and effects projectors.

The first thing that is required for all three classes is a method of describing the light distribution. Some lanterns spread their light all over the place; others give such a narrow beam that even at a distance they will only just cover a man; some give a definite beam with clear-cut edges; others fade away gradually at the edges. A simple description of what may be expected is given as the beam angle and the cut-off angle.

If we put a lamp in a simple black box with one side open, then light will emerge and can be directed on to a backcloth; it will, however, be cut off at the points where the box edges obstruct or cut off the filament from the backcloth; beyond these edges there is no light. We have achieved primitive control of the light, and the angle, with the lamp as its apex, between which the light is cut off is appropriately called the "cut-off angle" (Fig. 11).

The next step is to place a suitable reflector behind the lamp and redirect the light, which would otherwise be absorbed, forward as a beam. We may then have two lots of

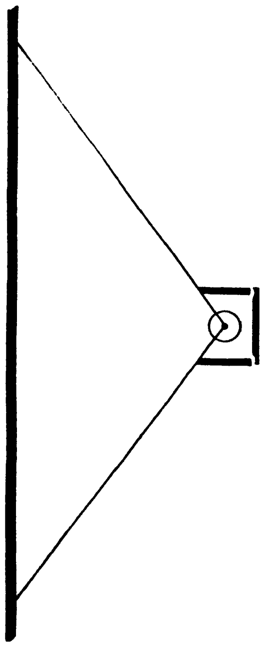


FIG. 11. CUT-OFF ANGLE FROM LAMP AND HOUSING

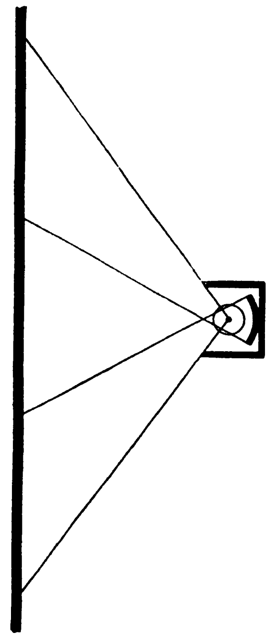


FIG. 12. BEAM ANGLE AND CUT-OFF ANGLE FROM LAMP AND REFLECTOR

light on our backcloth: the direct light from the lamp (the cut-off angle) and a further patch of brighter light perhaps in the centre, thrown by the reflected beam. The angle which this beam makes to the lamp is known as the "beam angle" (Fig. 12).

These methods are somewhat rough and ready, but are in common use among illuminating engineers and will be found of great practical use. Beam angle 100°, or beam angle variable between 10° and 40°, tells us at once what to expect, especially when combined with the cut-off angle. A lantern with a beam angle and cut-off angle of 30° has clear-cut edges; whereas beam angle 30° and cut-off angle 100° indicate a general flood of light getting stronger in the centre.

These angles when stated by the manufacturers are not obtained by guesswork; to the eye the beam angle may merge imperceptibly into the cut-off angle, but a photometer is used and the intensity measured. The official definitions are as follows—

CUT-OFF ANGLE. *This is the angle of the direct light from the lamp and is determined by the edges of the lantern or by special devices such as spill rings.*

BEAM ANGLE. *This is defined in the case of a symmetric lantern as the total angular width between the limits at which the illumination produced on a surface normal to the axis of the beam is one-tenth of the maximum.*

We see that beyond the edges of the cut-off angle should be absolute darkness. In badly designed lanterns this is not achieved; ghost light and stray light may be present. The former is light reflected internally which passes through the front lens or aperture of the lantern and appears as a low intensity phantom somewhere on the stage, a ring of light from a reflector edge or lampholder, and so on. Stray light, however, leaks direct from the lamphouse via ill-fitting access doors and badly baffled ventilation apertures. When buying a lantern such defects as these should be looked for, as they can be extremely annoying. Apart from the chance that stray light may illuminate something unwanted, it may draw the attention of the audience to the position of the lantern in use—the hallmark of bad lighting.

It is now necessary to consider in detail what we may legitimately expect from our three classes of equipment—the floodlights, the focus lanterns, and the precision optical projectors.

Reflection

The basic principle common to floodlights is reflection. Returning to our simple box floodlight, if instead of a black interior it is painted matt white, we now have a simple reflector, such a reflector being of the diffusing type. Reflecting surfaces range from white blotting paper to the silvered glass mirror. Probably these two so dissimilar surfaces reflect exactly the same amount of light, but in the first a beam of light striking the surface is scattered in all directions (Fig. 13), and in the second redirected at an angle corresponding to that of the incident beams (Fig. 14). This latter type of reflection is known as "regular" or "specular" reflection. To describe a surface we need to know both the total reflection factor and the proportion specularly reflected. Taking a few

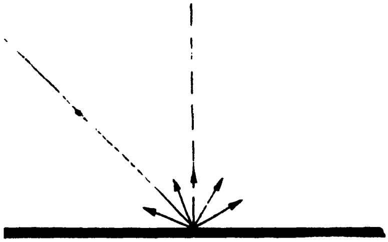


Fig. 13. Diffuse Reflection

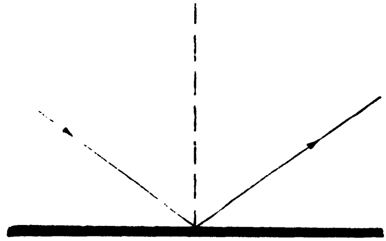


Fig. 14. Specular Reflection

of the commoner reflector materials, the comparison will be something like this—

Material	Total Reflection Factor	Proportion Specularly Reflected
	per cent	per cent
Silver-backed mirror glass	80-85	80–85
Surface silver on brass	85	85
Stainless steel	57–60	50
Chromium plate	60–65	55–60
Anodized aluminium	84	83
White blotting paper	80	0

So much for flat reflectors; but most reflectors used in stage lanterns are formed in curves of various sorts. There are two reasons for this: the first is that by curving the reflector a large angle of light will be collected from the lamp without too great a reflector diameter; the second is that by variation of the curved surface the light can be redistributed to give the required beam angle. It might be thought that the second reason was only important for a lantern giving a narrow beam and that for a wide-angle beam the diffusing reflector is best. Such is seldom the case in practice, and Fig. 15 shows how

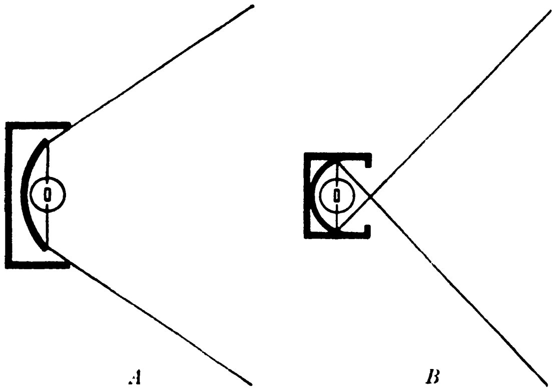


FIG. 15. USE OF CROSSING BEAM TO REDUCE FLOODLIGHT APERTURE

by shaping the reflector so that the beam crosses, more light is passed without requiring an unduly large colour frame and filter.

Reflectors often conform to three mathematical forms and are known as *spherical*, *parabolic*, and *elliptical*. With these

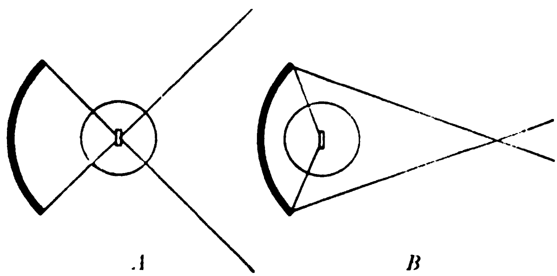


FIG. 16. SPHERICAL REFLECTOR

On the left its distance from the lamp filament equals its radius.

types the lamp can be so positioned that the spherical reflects the light back through the filament (Fig. 16); the parabolic collects the light and redirects it as a parallel beam (Fig. 17); the elliptical brings the light to a second focus (Fig. 18). Variation is also possible by moving the lamp relative to the reflector. Bringing the lamp nearer the spherical (Fig. 16) causes the beam to cross farther out instead of at the

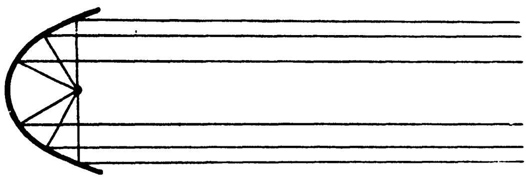


FIG. 17. PARABOLIC REFLECTOR

filament, even ultimately to become a parallel beam. Owing to the size of the light source these results cannot be achieved

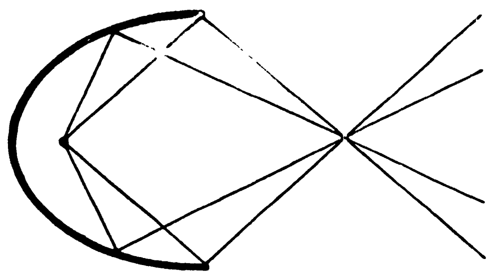


FIG. 18. ELLIPTICAL REFLECTOR

exactly in practice; observe what happens to the parallel beam in Fig. 19. The amount of light collected from the filament

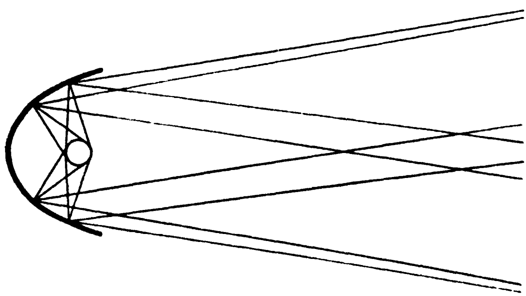


FIG. 19. EFFECT OF LARGE LIGHT SOURCE IN REFLECTOR

and used is known as the "solid angle." Because collection is in three dimensions, the amount of light gained by the good solid angle as against the bad one is considerable; the second of the two diagrams (Fig. 20) collects four times the light of the first.

Assuming we are using silvered glass as the best reflector, what will the light look like when it impinges on a white surface? As the lamp filament, assuming an A.1 lamp, is in grid formation, all reflections will contain this formation in some degree. We shall see various magnifications of this grid, at best distorted to look like streaks (termed "filament striation"). This striation may be removed by using a less regular reflecting surface than silvered glass, or glass with an uneven surface may be used instead of plate. Glasses of this type

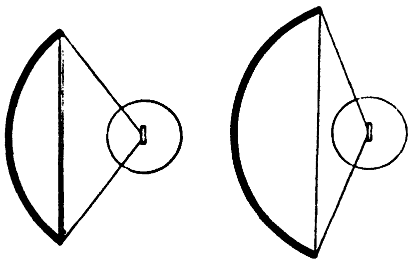


FIG. 20. SOLID ANGLE: RIGHT REFLECTOR COLLECTS FOUR TIMES LIGHT OF LEFT

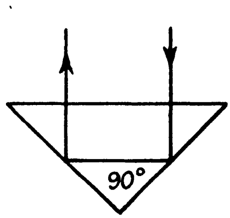


FIG. 21. PRISMATIC REFLECTION

commonly silvered are Cathedral with a slightly rough rolled surface, or Sunray with a hammered surface, giving the effect of innumerable little ball lenses. There are many glasses intermediate to these which can be used; Cathedral is most suitable for narrow beams, Sunray for wide.

Another form of reflector relies not on silvering but on complete internal prismatic reflection (Fig. 21). When built up individually, as in a lighthouse lantern, this system is ideal, and there is nothing to deteriorate; commercially produced as small moulded reflectors, some of their efficiency is lost due to the limitations of the moulding process.

A lot of nonsense is talked about the fragility of reflectors. With properly designed fixings there is nothing to this; after all, there are glass lamps inside and these are just as fragile as any reflector. At the time of writing, glass affords more subtlety in choosing the right degree of striation break-up and has magnificent reflection factors into the bargain. Glass reflectors require resilvering every two to three years when used at close range to high-wattage lamps in concentrating optical systems. The process is simple and cheap; in any event, metal reflectors would require resurfacing or plating after the same period. The future of metal reflectors may be bound up in development of anodized aluminium rather than in plating.

The aluminium is of a quality known as super pure. This is polished, electro-brightened, and anodized by some proprietary process. Good reflectors of this kind are already available for many of the spotlight projectors described in the following pages. They appear to be more durable than glass at close range to large-wattage lamps. Application to medium- and wide-angle floods raises the problem of a striation break-up surface, not solved to my satisfaction at the time of writing.

A new 150-watt lamp with a moulded bulb, the inside of which has an aluminium reflection surface, has become available. The front part of the bulb is formed as a diffuser and the result is a very efficient soft-edge medium-angle beam. In the United States, where these lamps have been obtainable for some time in a variety of beam angles, they have become the rage for footlights and magazine battens. It is very difficult to say how far we in this country will take to scrapping our reflector when the lamp fails. The initial cost of a reflector-lamp batten will be less than that of an orthodox one because there are no expensive reflectors, and there is more light; on the other hand, to replace a lamp is four times as costly at present.

General Stage Floods

These are made in three sizes for—

A. 60–150-watt lamps;
B. 300–500-watt lamps;
C. 1000-watt lamps.

The last-named is definitely a flood for the large stage. If well designed, each size should be able to take without alteration either of two reflectors, giving a medium angle of 50°

beam and a wide-angle 100° beam. The cut-off angle will be constant round about 100°. All floods will be fitted with tilting

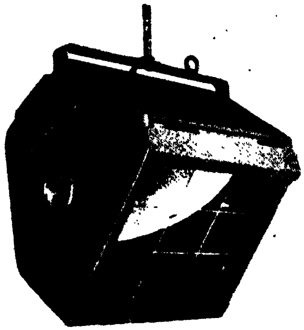


FIG. 22. 150-WATT BABY FLOOD

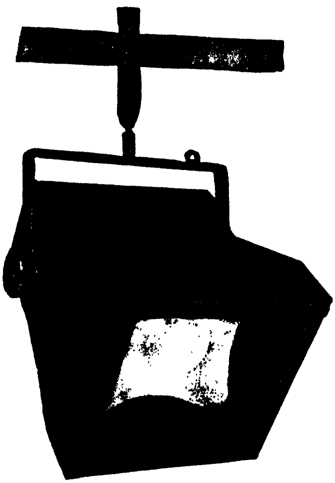


FIG. 23. 500-WATT FLOOD WITH BARREL CLAMP

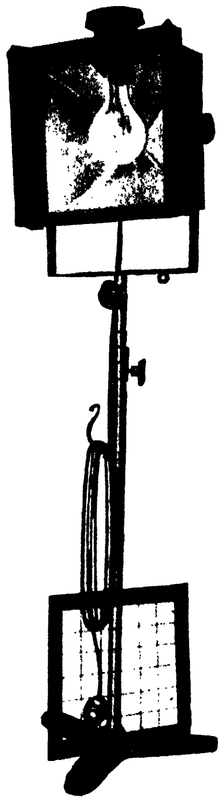


FIG 24
1000-WATT FLOOD ON TELESCOPIC STAND

fork and locking wheels. The fork can be used for suspension with or without special clamp or inserted in a telescopic stand. Colour frames, runners, and proper ventilation and robust construction are important (Figs. 22, 23 and 24).

The purpose of the alternative light distribution given by the two reflectors is to add to the flexibility and efficiency of the unit. For close-range work, lighting backings and so on, the wide-angle reflector is needed; but for acting-area lighting from battens it will be an advantage to have a more localized beam not likely to strike the backcloth or cyclorama. In extreme cases it may be necessary to reduce the cut-off angle to more nearly that of the 50° reflector; special hoods or funnels are then inserted in the colour runners (Fig. 25).

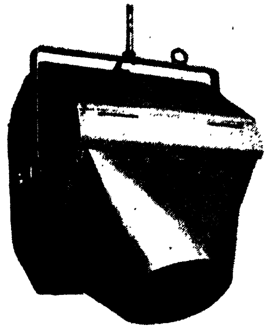


FIG. 25 150-WATT FLOOD WITH HOOD

All sizes of floods are commonly mounted on a barrel as a flood batten, each flood being independently adjustable. The baby flood and its reflector are often made up into magazine equipment.

Magazine Equipment

In this equipment (Fig. 26) the individual baby floods become compartments in one housing. The lamps have been

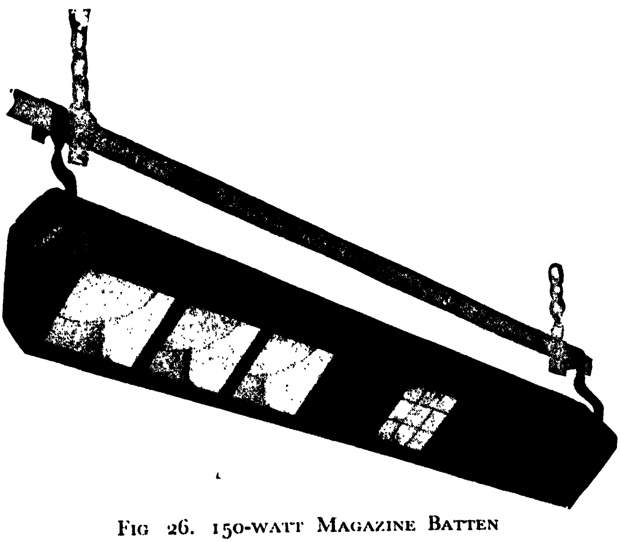


FIG 26. 150-WATT MAGAZINE BATTEN

mounted at various centres from 6 in. upwards; 9 in. is a good figure since it gives opportunity to employ a large reflector.

There are two main types of housing used: one for throwing light upwards, as footlight or ground row, and the other for throwing light downwards, as battens. The same medium-angle and wide-angle reflectors are common to both, but the variation in housing is needed to cope with ventilation in the two

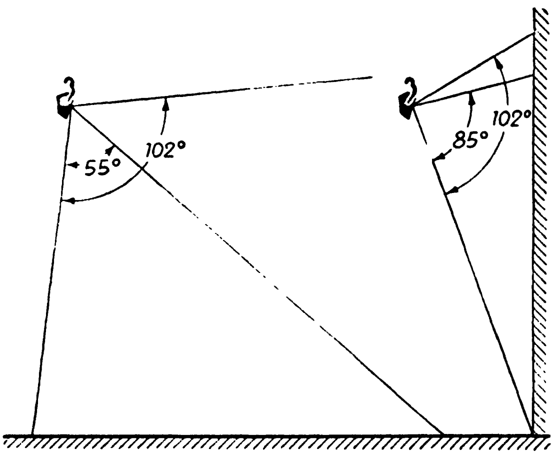


FIG. 27. BATTEN LIGHT DISTRIBUTION: *Left*, MEDIUM-ANGLE REFLECTORS *Right*, WIDE-ANGLE FOR CYCLORAMA

burning positions. Ventilation producing a current of air between the colour medium and the lamp is very important.

For standard batten work the medium-angle reflector is used, the direct light from the lamp lighting at close range the adjacent border, while the main beam is projected on the actors below (Fig. 27 *left*). For cyclorama work, the wide-angle reflector is required to give even illumination and mixing of colours (Fig. 27 *right*). The footlight seldom requires anything but the wide-angle reflector since it will have to light actors down stage at close range; nor is it desirable that it should project light at a distance on the up-stage scenery and cyclorama. The cut-off angle is particularly important in a footlight, as no light must stray on to the pelmet or proscenium border.

The job of ground-row or bottom lighting to a cyclorama or a backcloth can be carried out by the same unit. Large cycloramas are catered for by two rows carried one above the other. Castors are often fitted to a ground row to make it easily removable; the term "trucks" is usually applied to these units.

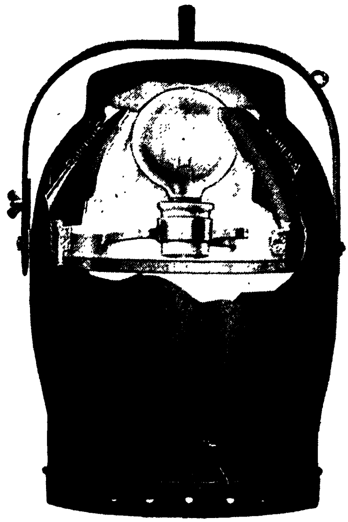


Fig. 28. Phantom View of 1000-watt Acting-area Flood

Acting-area Floods

The vertical acting-area flood (Fig. 28) is popular in spectacular productions. These lanterns utilize a 1000-watt B.1 lamp in a large-diameter concentrating reflector, beam angles of 26° or 45° being usual. The front of the lantern is fitted with spill rings or some other means to intercept the direct light of the lamp; the cut-off angle thus becomes the same as that of the beam (Fig. 29). These lanterns are often used massed together as battens or hung singly or in pairs between 6 ft. sections of

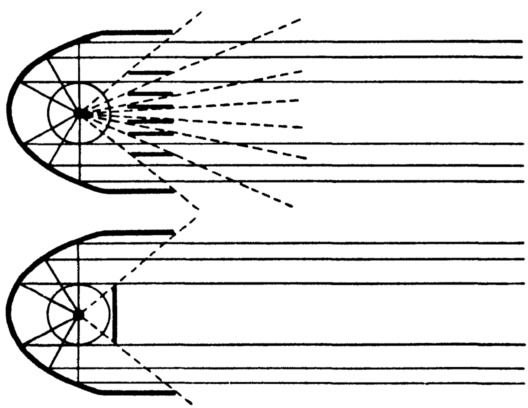


Fig. 29. Spill Rings and Baffle to Cut off Direct Light from Lamp

magazine batten. A great reduction in lantern size was made by using a B.1 instead of a G/S lamp.

Cyclorama Floods

The cylindrical German pattern taking a 1000-watt tubular line filament lamp has largely been ousted from this country

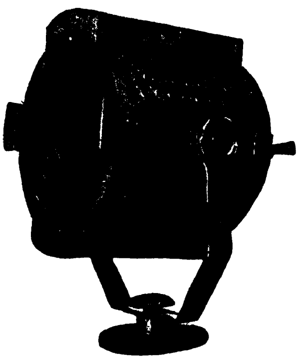


Fig. 30. 1000-watt Parallel-beam Lantern with Spill Rings

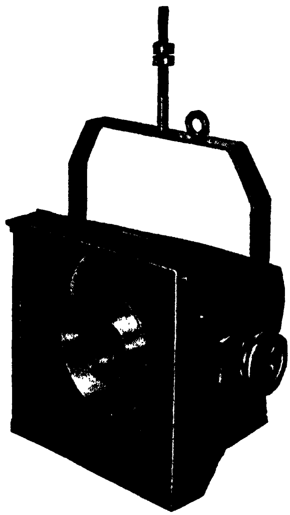


Fig. 31. Low-voltage Parallel-beam Lantern (Built-in Transformer)

by the British circular flood, taking a 500-watt G/S lamp (illustrated in the *Frontispiece*). Whatever the relative merits, there can be no doubt that for the flat type of cyclorama common here, the latter is more efficient. However, both these lanterns are considerably more expensive than the corresponding general stage flood, so economics will probably put them out of court.

Whenever space permits a reasonable throw, floods should be used in preference to low-wattage magazine battens for cyclorama work. First, a 500-watt or 1000-watt G/S lamp will give 25 per cent more and bluer light for the watts expended; secondly, the thicker filaments give perfectly smooth changes of light from the dimmers. These results are never quite certain on commercial dimmers working low-wattage lamps.

Parallel-beam Lanterns

This narrow-beam lantern might be classed as a *spot* except that the beam angle is scarcely adjustable. The lantern takes a 1000-watt lamp, and by means of a 10-in. diameter parabolic reflector and spill rings produces an almost parallel beam (Fig. 30). It is useful for giving the effect of the sun's rays streaming through a window, and the like. On small stages it would be inclined to dwarf all the other lighting. This lantern is also valuable for spotting in pageants, outdoor

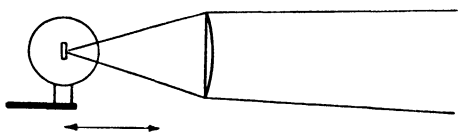


FIG. 32. ACTION OF LENS AT FOCAL LENGTH FROM LAMP

or in large buildings like the Royal Albert Hall, London; hence it is invariably referred to as a pageant lantern.

A smaller version, taking a 36-watt low-voltage car lamp complete with built-in transformer, is made. This is suitable for small-stage work (Fig. 31).

Refraction

Whenever a light ray passes from one translucent material to another its path is bent or refracted: from air to water, air to glass, or even one kind of glass to another. The amount of the refraction depends not only on the material, but also on the angle at which the ray strikes the material. By giving a suitable shape to a block of glass, that extremely valuable device for light control, the lens, is obtained. Some of these shapes are complex, but, fortunately, in general stage lighting a few simple types, comparatively crude lenses, are all that are required.

The diagram shows a simple plano-convex lens which is shaped to converge the parallel light rays from the sun to a point, this point being known as the "focus" and its distance from the lens the latter's "focal length." In reverse, if a lamp filament is placed at the focus of the lens, its spreading rays are

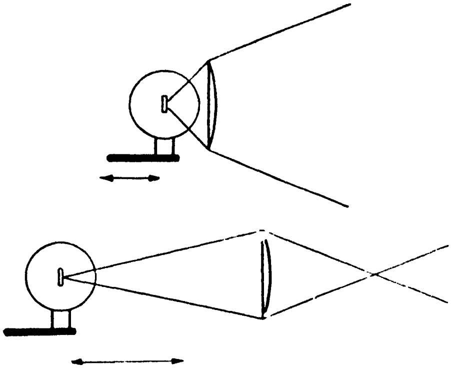


FIG. 33. SPREAD BEAMS BY VARIATION OF LENS POSITION

converged into a parallel beam (Fig. 32). If the lamp is moved either side of the focus, the beams will spread (Fig. 33) in one instance "beyond the focus" by crossing first. It is worth while to consider this action carefully, even if not technically, as the easy appearance of the following diagrams

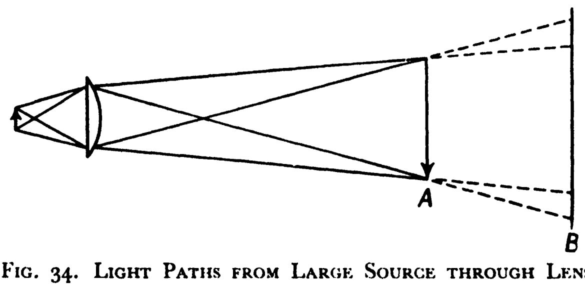


FIG. 34. LIGHT PATHS FROM LARGE SOURCE THROUGH LENS

may lead one to expect results which do not occur in practice. As mentioned under "Reflection," the replacement of a theoretical point source by a body of considerable size, such as the lamp filament, is not lightly to be disregarded. The placing of a lamp filament, represented by a vertical arrow, the correct focal distance behind the lens does not obtain, as Fig. 32 might suggest, a simple conversion of diverging rays into parallel rays. The filament can be considered as a number of points of light all redirected by the lens. In practice only the extremes need be shown and the result is an almost parallel beam with a crossing beam, both of which coincide on a screen and give an inverted enlarged image of the filament, in the diagram Fig. 34 at *A*. If the screen is moved farther

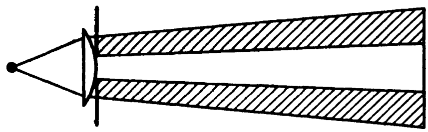


FIG. 35. LENS APERTURE REDUCTION: INCORRECT VERSION

away to *B*, the various images no longer coincide and the filament image becomes fogged or "out of focus"; this can be corrected by moving the lamp relative to the lens. The reverse, of course, applies, and unwanted filament images are removed by bringing the lamp nearer to the lens, the circle of light thrown being increased in size.

These alternative light paths through a lens or off a mirror explain why an iris diaphragm fitted to the front of a lens

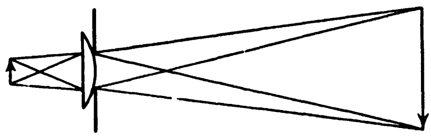


FIG. 36. LENS APERTURE REDUCTION: TRUE VERSION

does not produce the result that many expect—a smaller beam (Fig. 35). All the time light from other angles passes through the lens and produces the same-size circle but of less intensity, as some light is prevented from reaching the screen (Fig. 36). A good practical test is to place a red colour filter over half the lens and a blue over the other half. The result on the screen is magenta, with only the slightest shading to the component colours towards the edges of the image. The alternative light paths may not appear in the simple diagrams that follow, but they must never be forgotten.

The focal length and magnification of a lens depends on the curvature of its surfaces, and it can be designed to focus sharply the lamp filament eight inches or twenty inches behind it. In the case of a 6-in. diameter lens, the former will be known as a 6 in. × 8 in. (the diameter is given first) and will be thick with a pronounced curve; the latter will be a 6 in. × 20 in. and almost a flat piece of glass. The more acute the curve of the lens, the more difficult it is to control the light paths, and distortion and coloration result. The bending of the light in passing from air to glass does not affect all its wavelengths equally (see page 142). There is also waste of light through absorption by the thick glass.

These various troubles are overcome by combining two or more lenses; thus two 6 in. × 10 in. make a 6 in. × 5 in. Sometimes two different glasses, crown and flint, are combined so that the colour separation of the first can be corrected by the second; the lens (known as achromatic) is usually too expensive and, fortunately, unnecessary in most instances for the stage. For the more precise optical work, as the projection of lantern slides, compound lens are used, but are, nevertheless, crude when compared with, say, a cinema projector lens.

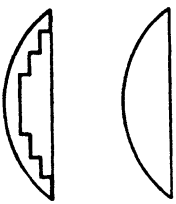


FIG. 37.
STEP LENS AND PLANO CONVEX COMPARED

Lens thickness is sometimes corrected by forming the back of the lens into a series of steps (Fig. 37). This type of lens is known as a "step," or "Fresnel" lens, after its inventor. For stage purposes, the lenses are usually moulded in heat-resisting glass, and cost no more than the corresponding lens in ordinary glass. The slight lack of definition in these lenses is ideal for focus-lantern work, and prevents the filament image being too clearly seen in the small spot position.

Focus Lanterns

This lantern must be the commonest type in the theatre to-day, though it is usually referred to under the misnomer "spotlight" or "spot." Wattages of 250, 500, and 1000 are common.

As all lanterns are basically the same, a description of the 1000-watt will serve for all. In this lantern the lamp is carried on a movable tray behind a 6 in. × 10 in. plano-convex or a 6 in. × 9 in. step lens. At the focus point a slightly diverging beam is produced and a crude image of the lamp filament is projected. It follows that the filament of the lamp (commonly a B.1) should be nicely adjusted to centre on the lens, if a prefocus holder is not fitted. Behind the lamp is a small spherical reflector (usually of metal) to redirect lamp rays, which would otherwise be wasted, back through the filament (Fig. 39). When the lantern is adjusted, this second weaker filament image can easily be seen, and should be set so as to fill the gaps between the direct filament image. As the tray carrying the lamp and reflector is moved forward towards the lens, the unpleasant filament image enlarges, is then seen merely as striation, and finally it vanishes, leaving a pool of light with clear edges. The beam angle is variable from 11°

FIG. 38. 1000-WATT FOCUS LANTERN (SPOTLIGHT)

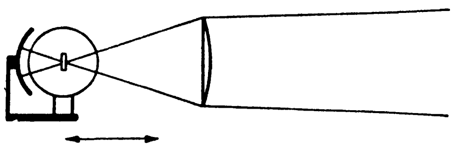


FIG. 39. FOCUS LANTERN OPTICAL SYSTEM

to 42°, filament striation (which a No. 31 Light Frost filter will remove) being present up to about 20°. The cut-off angle is the same as that of the beam.

This type of lantern does not give a clear-cut small spot; its results are more that of a medium- to narrow-angle adjustable flood with defined edges. For clear-cut spotting, a supplementary lens attachment is fitted, known as a "spotting

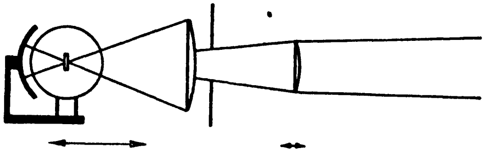


Fig. 40. Focus Lantern and Spotting Attachment

attachment." The main lens now becomes the condenser and the extra one the objective (Fig. 40). The objective focuses not the lamp filament but the edges of an adjustable diaphragm in the attachment. As the diagram shows, much light is lost in the process, so that where any real intensity is required a precision spotlight is advised.

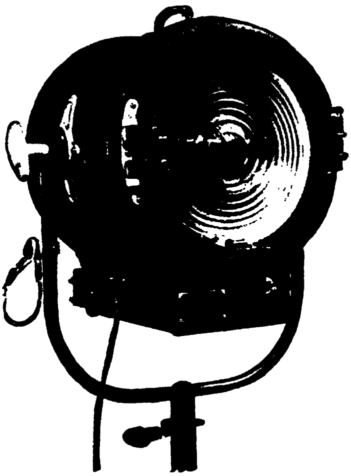


Fig. 41. 2-kW Soft-edge Spot with Fresnel Lens Plate

Exactly the same focus-lantern optical system is used in what are, for want of a better term, usually described as Soft-edge Spots. In this type of lantern the collection and re-direction of as much light as possible is the principal aim. Both lens and reflector are increased in diameter in order to collect a very large solid angle, and for the same reason the focus of the lens aided by its step construction has been reduced. At least a 10-in. diameter lens is usual (Fig. 41). The large illuminated lens is inclined to give slight ghost light, and in any case the beam has a softer edge than the standard focus lantern. Both of these factors restrict application somewhat, but for special purposes on large stages the high intensity is valuable. The lamps usually employed are 2000-watt cinema studio class. The beam angle is variable between 10° and 45°.

Precision Optical Projectors

So far the lanterns described have depended (with exception of the spotting attachment) on magnified images of the lamp filament, which, of course, has meant a series of circular pools of light. The class of lanterns now to be described give complete control over the shape of the beam. This is done by bringing the filament image to a focus at a position surrounded by a variable gate, the gate being further focused by an objective lens.

The best-known example of this principle is used in the slide lantern. Fig. 42 shows a very short focus condenser

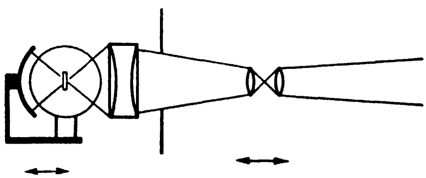


FIG. 42. OPTICAL SYSTEM FOR SLIDE PROJECTION

consisting of two plano-convex lenses ball to ball, focusing the filament light upon the gate where the lantern slide is inserted. This slide is then focused by an objective lens and thereby projected on the screen. The objective is a compound lens, since a slide is very sensitive to distortion. By using objectives of different focal lengths, variation in picture size and length of projection throw can be obtained.

The Optical Effects projector used for projecting clouds, flames, even scenery, on the stage employs this system. In many instances the slide is a moving disc or some such contraption. When a cloud effect is projected from the side of the stage a 3-in. focus objective may be used, whereas if projected from the gallery in a theatre, perhaps 20-in. focus will be required.

For spotlighting, a less high degree of definition is needed and there is no fragile slide to spoil in the heat; steps can be taken to collect and focus more light. Reflectors may be more satisfactory for this purpose than condenser lenses, and the result is the Stelmar spot or the Mirror spot. The Stelmar was the first precision high-intensity spotlight to be used—in the English theatre, at any rate. Reflectors collect the light from the front of the lamp, supplemented by a spherical reflector at the rear, and direct this light on to a variable gate which is focused in its turn (Fig. 43). Some lanterns

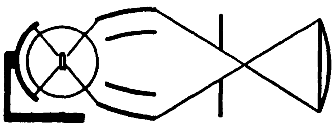


FIG. 43. STELMAR SPOTLIGHT OPTICAL SYSTEM

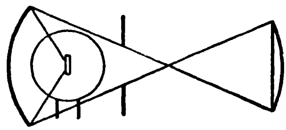


FIG. 44. MIRROR SPOTLIGHT OPTICAL SYSTEM

employing this system are to be found on long front-of-house throws from the roof of the Memorial Theatre, Stratford-on-Avon and the Covent Garden Opera House.

A shorter lantern is obtained in the mirror spot, the light being collected by a large diameter mirror at the back of the lamp and redirected to the gate which is focused by the objective (Fig. 44). Increase of light intensity of the order of three times or more is obtained when the same lamp is used in the mirror spot instead of in the simple focus-lantern optical system. Mirror spots can take A.1 or B.1 1000-watt lamps. A special model is obtainable for A.1 tubular lamps only in which advantage is taken of the tubular bulb to bring the reflector closer to the lamp filament, thus further improving the solid angle of light collected. A baby mirror spot for the small stage is to be available shortly.

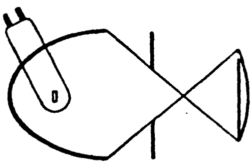


FIG. 45. AMERICAN ELLIPTICAL REFLECTOR SPOTLIGHT

In conjunction with a special tubular lamp burning cap upwards, the Americans have been able to carry this system to its logical conclusion by enclosing the lamp in the reflector (Fig. 45). Lacking the lamps over here, we can only sigh enviously.

Beam angles in the mirror spot are variable between 3° and 19°. For wider spreads up to 30° on short throws, a short-focus double-objective lens is used. The size of spot is obtained by adjustments at the gate, which consists of four independently moving shutters or a variable iris diaphragm for circular spots. By moving the lamp or reflector, more light can be passed through the gate when set for small apertures. Most regular- or irregular-shaped objects can be exactly picked out with the mirror spot. It is the ideal front-of-house spotlight, as the

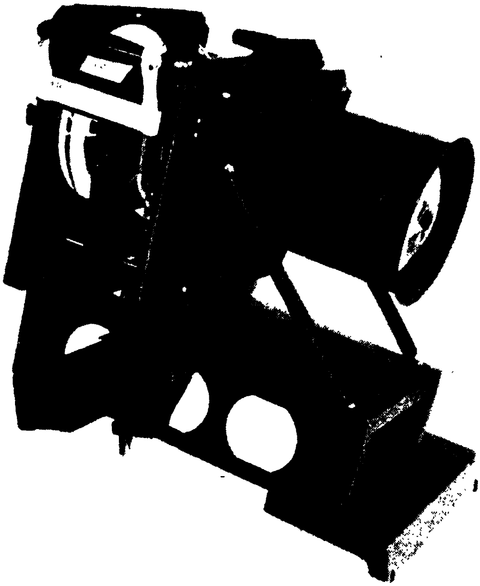


FIG. 46. 1000-WATT SKELETON MIRROR SPOT

light can be adjusted to cut off along the footlight and upstage to miss the cyclorama. When numbers of these mirror spots are installed in a special housing, usually on the circle front as at the London Coliseum and Palladium, then opportunity is taken to simplify construction by omitting the individual housings to each lantern. Fig. 46 shows one of these skeleton mirror spots; the lens, gate, lamp, and mirror can be clearly seen.

All precision optical projectors need most careful adjustment and centring of the various parts of the optical system unless (as should always be done) prefocus lampholders are fitted.

Remote Colour Change

When lanterns are placed in positions inaccessible during the performance, then obviously some means of changing the colour filters remotely is of great value. Such lanterns as the front-of-house spots on the circle front or in the roof and perhaps banks of acting-area floods on the stage for spectacular

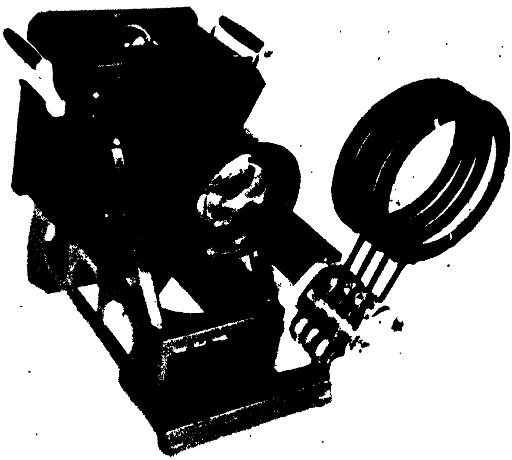


FIG. 47. SOLENOID-OPERATED REMOTE COLOUR-FILTER CHANGE

productions, and so on, require such control. Tracker wire can be used, but, undoubtedly, electric methods are to be preferred, the lantern and its colour-change mechanism being merely attached to a flexible lead. Four colours are commonly fitted, though a lot can be done with two; even one, a colour and white, is not to be despised. One method is the electro-magnetic in which a solenoid coil is energized, thereby attracting a plunger and drawing up the colour semaphore-wise (Fig. 47).

Another method, especially useful where large colour frames have to be moved or colour frames rendered independent of gravity, employs a fractional horse-power motor drive. The colour-filter frames are connected to move into position by energizing a small electro-magnet which holds in the required gear. The gear is sprung to move the filter out when the magnet is de-energized. For this system five switches, one per filter coil and one for the motor, are needed. The motor takes two to three seconds to move the filter, and

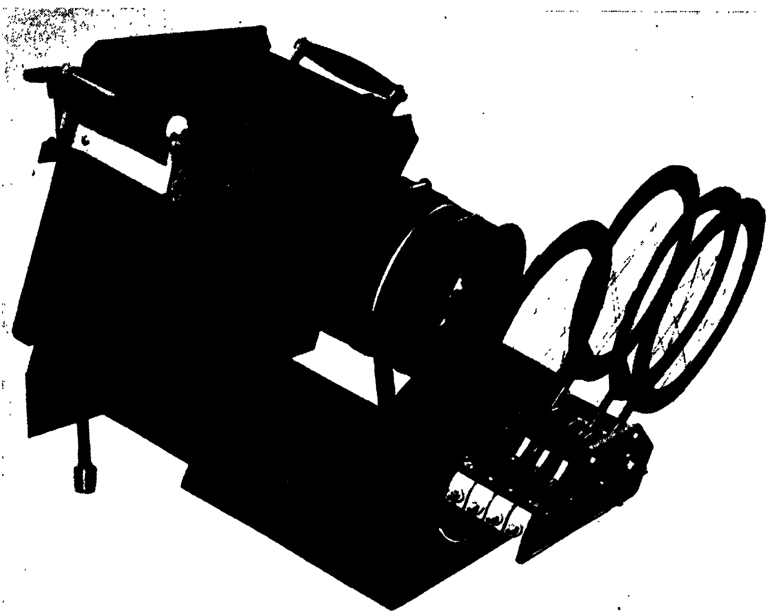


FIG. 48. MOTOR FILTER CHANGE WITH SOLENOID-OPERATED GEAR SELECTION

the colours can be used in any order or in combination (Fig. 48).

Colour change by a motor-driven wheel is unsatisfactory, since to change from one colour to another may involve passing through undesired ones, and the very important combination of colours is impossible.

A great increase in the use of colour-change attachments in the theatre is likely. Banks of spotlights on the circle front are already fitted, and there is a movement to extend their use to the rows and rows of acting areas hanging over the stage in spectacular productions. In these shows expense is outweighed by the "stunt" value of the lanterns, the success of which depends very much on the control granted by the switchboard. It is rather futile to have a hundred or so lanterns, each with four colours and white, if the operator is in great difficulties when he tries to work 400 or so switches, and also tries to perform his other duties at the dimmers.

It would seem that electric remote colour change will tend to cost more than the price of two lanterns, in which case it appears to me that the Amateur and the Little theatres will always vote for two lanterns in place of one and four colours. However, it is not essential to employ such nicely finished devices; in many halls and theatres a little ingenuity brings colour-change facilities to hand, albeit the methods may be crude. The 1000-watt focus lantern in Fig. 38 can have the springs in the front runners removed, making it possible to drop a metal colour frame into the front and back runners respectively. The frames will require to be weighted slightly, and their runners must be extended to act as guides in the withdrawn position. Tracker wires from these frames pass over pulleys fixed above the lanterns. Provided no ambitious run involving long lengths of wire and many corners is attempted, this device can be satisfactory. No elaborate control is needed: a loop and two hooks—colour in, colour out—suffice. If the proscenium cannot be pierced, cords can be brought down each side wall and operated by obliging stewards. Even though no subtle colour-changing cues are possible, the fact that the colours can be changed, between the acts for instance, is a great advantage. By careful selection of filters, white and three colours can be obtained from the two frames.

Another form of filter colour change, known as the revolving batten, is sometimes used in super-cinemas. A revival of an old device, it consists of a framework carrying four alternative sets of colour filters and rotating about the batten. The batten is wired in the usual way with compartments giving four colours, and one set of filters is reserved for normal working; the others change the whole batten to blue, to pink, or to amber. The intention, to obtain a high intensity of each single colour, is partly frustrated by the need to keep the batten and its revolving attachment near the normal in size and, consequently, a small reflector has to be used. All-over colour, however intense, is always dull, and better results can be obtained from the acting-area floods common on battens in the theatre. The revolving batten has its counterpart in a revolving length which stands in the wings and is unequal to the task of projecting light across the 50-ft. or 60-ft. proscenium opening of the super-cinema. Revolving battens give a fine "stunt" effect when all are set turning

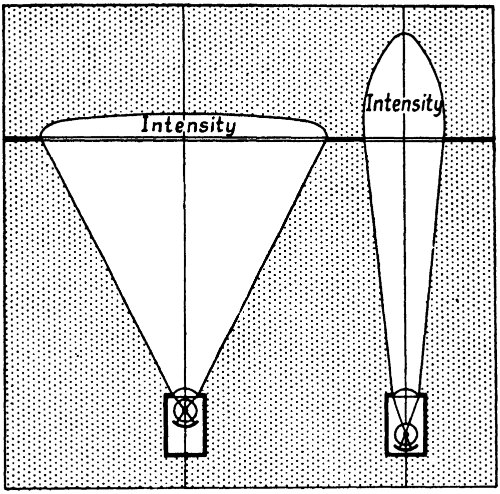


FIG. 49. EFFECT OF BEAM SPREAD ON INTENSITY

continuously, but it is an effect for occasional use; think what the expenditure on the battens might have done to the dimmer board.

Comparison of Lanterns

The light coverage of particular lanterns at various distances can be read from the chart in Appendix II, but it is necessary to be quite clear about the kind of distribution and relative intensity to be expected from the types of lanterns. To make Fig. 50, a focus lantern, mirror spot, soft-edge spot and parallel-beam lantern were directed at a screen, as shown in Fig. 49. Only one lamp, a 1000-watt B.1 projector, was used, and all lanterns were exactly the same distance

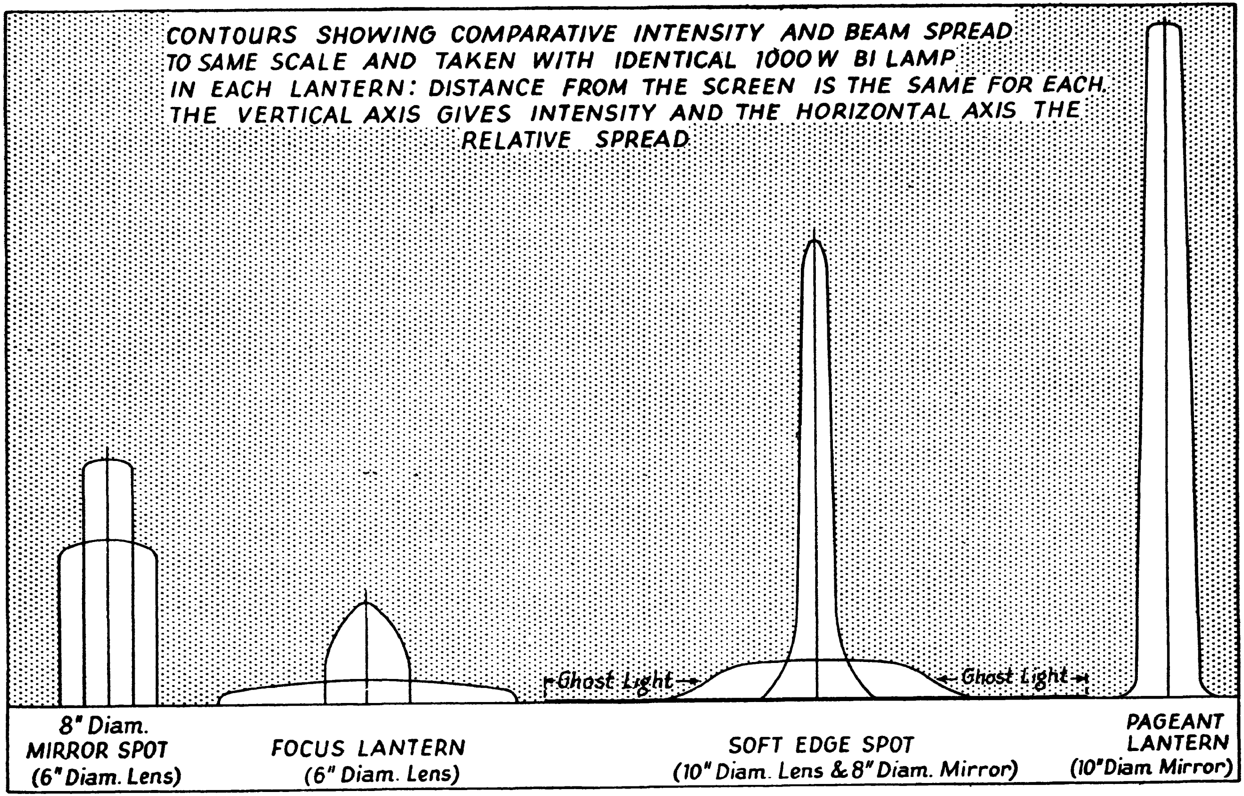


Fig. 50. Comparative Light Characteristics of Spotlights

from the screen. The intensity at regular intervals across the screen was measured by a photometer and plotted; the result was a series of comparative contours of intensity for each optical system which were independent of lamp type. Each lantern was set to its maximum and minimum beam.

The gradual falling-off of intensity in the focus lantern shows clearly against the sharp gate cut-off of the mirror spot. The higher intensity of the latter also appears. Both the soft-edge spot and the parallel-beam lantern show great intensity; the former with the drawback of slight ghost, the latter at the sacrifice of an adjustable beam. All the lanterns could be made to give more light by fitting an A.1 tubular projector lamp. This would show to most effect in the mirror spot, as the mirror could be brought close to the filament. On the other hand, the soft-edge spot is the only one that would take a 2000-watt lamp, the large diameter lens and lamphouse to correspond being of suitable size to accommodate the large bulb and its heat.

With the characteristics of each lantern in mind we can consider the practical application to a scene with a centre doorway. The doorway can be lit from a focus lantern, but the circle of its beam will not correspond to the shape of the doorway, and the lantern will require to be frosted to make this less obvious. A mirror spot can, however, pick out the door exactly, the shutters being shaped, even if the lantern throws from a distorted angle. The soft-edge spot will give the same result as the focus lantern, with many times the intensity, but with slight stray over the rest of the scene, or if the lantern hangs close to a border this will catch the stray light. Lastly, the parallel-beam lantern can be used for the sun's rays coming through the door, or to light the door if it happens to be in the Royal Albert Hall.

CHAPTER IV

DIMMERS

WHEN a dimmer is referred to in the theatre this is always taken to mean a device inserted in the electrical circuit; however, we cannot overlook the possibility of variable shutters in front of the light source. The electrical method (which is by far the more usual) involves the reduction of the normal line voltage applied to the lamp or lamps. So far, this is commonly done by inserting a variable resistance in series with the lamp to vary the voltage between that of the mains (200–250) and 32, at which point the filament is just glowing and may be switched off as the final step.

Liquid Dimmers

The resistance itself may be liquid or metallic. The former has become deservedly rare in professional circles, but it still appeals to the amateur on account of its simple construction (Fig. 51). It is the only dimmer that an amateur can easily make—a drainpipe, a fixed metal plate at the bottom, a moving metal plate at the end of a flex, and a solution of washing soda; the wattage controlled varies with the amount of soda. A little ingenuity can provide a quite useful winch or lever control for the moving electrode.

When liquid dimmers are used, there is a great tendency for the surroundings of the pots themselves to become damp, and they should never be mounted on or over the stage. The least that can be done is to put them under the stage and partition them off so that only the electrical expert has access. The electrodes can, of course, be operated from the stage above by cords or tracker wire, but care must be taken to attach these wires with porcelain insulators. The simplicity of construction of the liquid dimmer is more than outweighed by the extreme care that must be taken in installation and maintenance. In these days of 230 volts A.C., possibly 3-phase (which means 400 volts is present), a pot-board installed by the unknowing can be very dangerous indeed. There is a further drawback, though not a life-and-death matter, which has to do with boiling. When the current is passed through a solution of washing soda (the electrolyte), the electrical energy absorbed by this resistance is turned into heat, and the solution may even boil. If the two electrodes are separated a little, to give a slight reduction in the light of that circuit, jumping of the movable electrode (even when quite heavy) may take place, and the light flickers. For similar reasons the two electrodes must always be short-circuited by a switch when in contact (the full-on position). There are other drawbacks, such as evaporation and so on, and in these days there are so many efficient and reasonably-priced metallic dimmers that I really think the amateur had better avoid liquid dimmers, unless, of course, some enthusiast is prepared to dedicate his life (metaphorically) to the beastly things. The operator of a pot-board and the operator of a metallic board stand in somewhat the same relationship as the driver of a steam locomotive and that of an electric one.

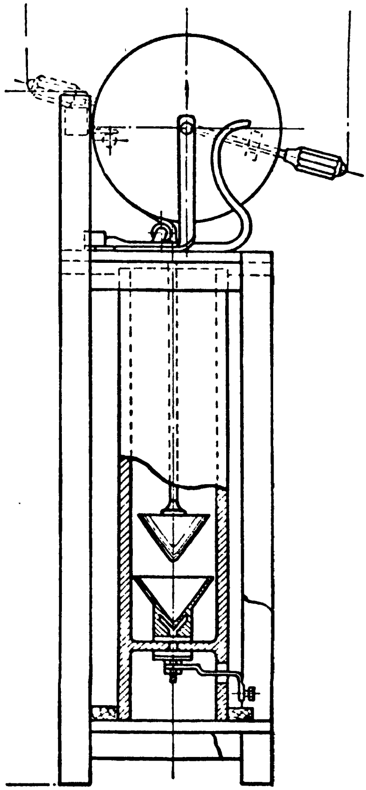


Fig. 51. Sectional View of Liquid Dimmer

Slider Dimmers

The simplest form of metallic dimmer is known as "the slider." This consists of a former, such as a vitreous-enamelled tube or rectangular slate, on which nickel-copper resistance wire is wound. A sliding contact (the slider) bridges the gap between the wound surface and the square rod on which it moves. A terminal is fitted on one end of the resistance wire and another on the rod. Thus, by moving the slider backwards and forward, more or less resistance is tapped off. The resistance wire is clamped by a band at each end. When the slider is at the end that includes the terminal, all resistance is cut out; similarly, a dead spot can be arranged at the other end. As a matter of fact, this simple form of sliding resistance, although common in electrical engineering, is seldom met in stage lighting, the principal reason being the excessive length of tube that would be required to accommodate the resistance wire necessary to cope with the great voltage range needed to dim a lamp properly. This is obviated by mounting two tubes side by side and causing the slider to bridge the gap between them, thus connecting various lengths of both tubes in series, both terminals being on the resistance coils. These double sliders provide a useful facility which is made use of when such dimmers are destined to tour. By fitting a movable plug to give the series arrangement described, or a parallel connexion of the coils, the dimmer can be used on the low-voltage (100) high-current range as well as on the more usual high-voltage low-current range. For normal use this plug is, needless to say, a waste of money.

The slider contact direct on the wire is not an ideal electrical arrangement, and the problem of a good contact which is not too free and not too stiff is still, to my mind, far from perfectly solved. This is a matter which the prospective purchaser should keep well in mind and insist on practical trial, both with the dimmer cold and after it has been slightly on check with its load for ten minutes. As with the liquid dimmer, the energy absorbed by the resistance is turned into heat and the wire expands; unless very nicely wound, the slider may squeak or even stick. A too-loose slider is a pest; when the dimmer is mounted vertically, it is not unknown for the slider to shake down half an inch or more. Owing to the contact arrangements it is not convenient to operate these dimmers through a panel (see Figs. 72 to 74), and therefore they carry their own guards, one of which has been removed in Fig. 52.

A final word on the subject. Very often the slider contact is carried on a lead screw or worm drive, operated from a handle. Such a device imposes a slow-speed dimmer travel and is not the slightest use for stage purposes.

Slider dimmers are manufactured for various wattages from 60 to 3000; but the writer would put the limits as 250 to 2000 and prefers to keep to 500 and 1000 sizes whenever possible. In the small sizes the wire is too fine to be completely satisfactory for direct contact, while the large wattage dimmers are far too cumbersome. A slider dimmer varies in its dimensions according to its wattage.

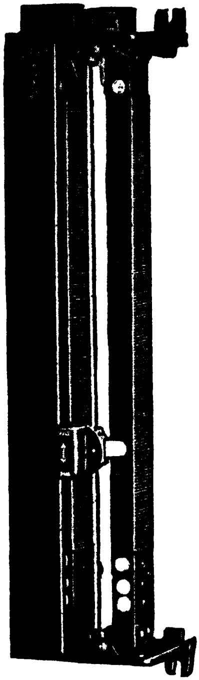


FIG. 52. SLIDER DIMMER WITH ONE COVER REMOVED

From these remarks it may be gathered that the author is not enamoured of slider dimmers, and this, I must confess, is so. The slider was early in the field as a smooth and flickerless dimmer, but should have been supplanted long since by the multi-contact dimmer. Its survival is due to the fact that it is the only dimmer that is compact and complete with operating knob, fixing lugs, and cover. The multi-contact dimmer has hitherto needed an elaborate supporting framework and shafting for the operating lever, and so on, making it expensive in comparison to the slider type. As I shall try and show later, this need not be.

Multi-contact Dimmer

Broadly speaking, each turn of the wire in a slider dimmer is a contact, but here the expression "contact" is used more strictly. The contact is solely concerned with the good conduction of electricity, and the resistance wire is connected to that contact.

Multi-contact dimmers take various forms; most of them use stud contacts, which may be mounted in a complete circle or as two segments of a circle mounted side by side (Fig. 53). The actual resistance wire is coiled or wound on formers; tappings are taken from appropriate points on the resistances to the contacts. In the circular dimmer the wiper arm bridges studs which are directly opposite each other on the circumference. In the segmental (rectangular) dimmer the wiper arm bridges the gap between the two parallel rows

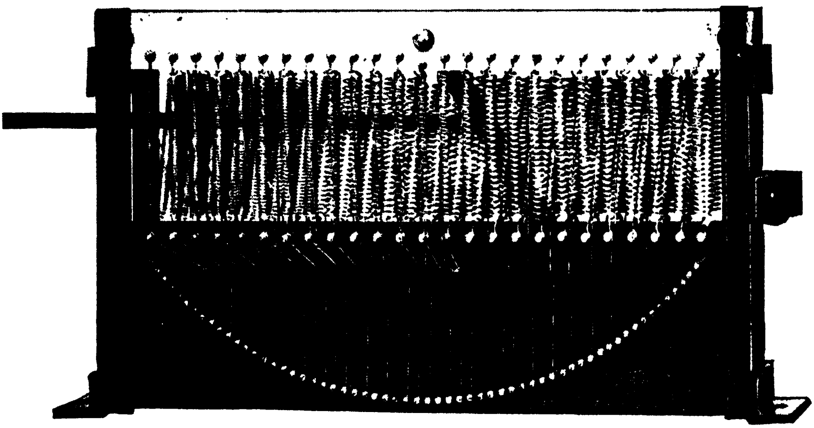


FIG. 53. OPEN-COIL STUD-CONTACT DIMMER

of contacts, rather in the same way as the pairs of windings are bridged in the slider dimmer. The dimmer assembly complete with wiper arm, contacts, and resistances is known as a "dimmer plate." Eighty or a hundred contacts are usual; the latter number should be adopted.

The dimmer with the resistance wound on formers as elements (Fig. 54) has much to commend it when compared with open-coil type. The smaller gauges of wire used on most dimmers need this support, and furthermore tappings can be taken off at any point instead of being limited to the top and bottom of a coil. This last, combined with the fact that clearances need not be so great, much reduces the overall size of the element dimmer.

When 100 contacts are used it means that the light of the lamp or lamps must be reduced in 100 imperceptible light steps from full-on to a point where it can be switched off without detection. For finest results, needless to say, a dimmer should be wound exactly for one load only at one voltage. The selection of the resistance to give the voltage drop between each contact is not a simple matter. It might be supposed that on a 230-volt circuit 100 steps dropping 2 volts at a time would be suitable. Unfortunately, as will have been gathered from

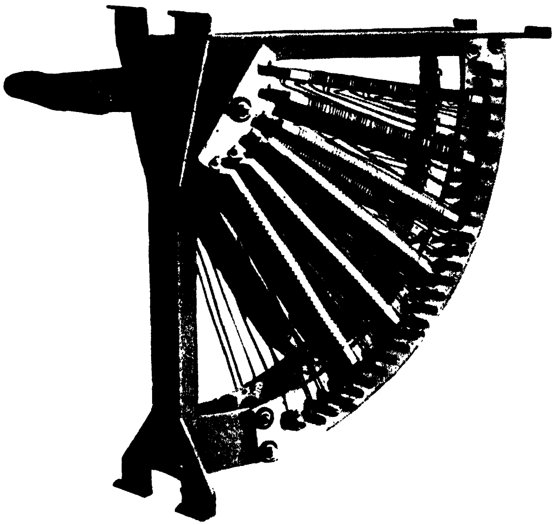


FIG. 54. ELEMENT-TYPE RESISTANCE DIMMER

Chapter II, the relationship to light output is not straightforward. A 25 per cent reduction in volts gives roughly a 60 per cent reduction in light (see Fig. 55); therefore our 2-volt steps will give a pronounced jump in the top part of the dimmer travel and too little change later on. It is obviously desirable to be able to relate the travel of the dimmer handle to the amount of light emitted by the lamp; ideally 50 per cent dimmer travel should give 50 per cent light (see Fig. 56). By adjusting the voltage steps between each contact this can be done, but would need a much greater number of contacts than the 100 that are economical, otherwise there would be some bad flickering. Some sort of compromise is needed, and Fig. 57 represents the results from a well-arranged standard dimmer. This curve will give reasonable results even on the smaller wattage theatre batten lamps.

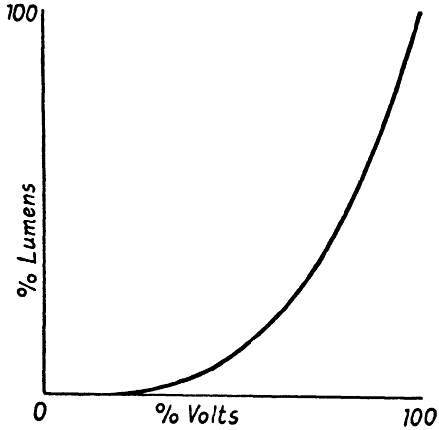


FIG. 55. RELATION BETWEEN VOLTS AND LAMP LIGHT

Messrs. Ridge & Aldred did devise a dimmer giving a curve nearer a straight line for cyclorama work (dotted line in Fig.

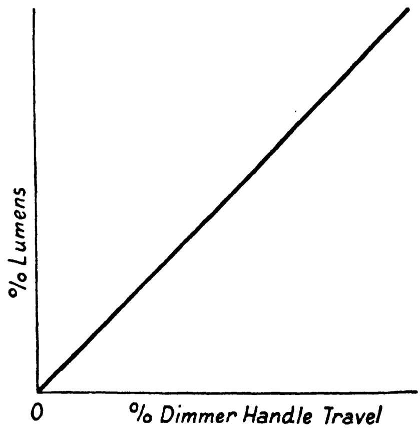


FIG. 56. IDEAL RELATION OF DIMMER TRAVEL TO LIGHT

57), but this tends to give a flicker for lamps of less than 500 watts.

The question of light jumps or flicker is more critical to the small hall and theatre. There are two reasons for this: first, the smaller wattage lamps are more susceptible to flicker whereas the thicker filaments of the bigger wattages have a slight time-lag before responding in temperature to voltage variation; secondly, the smaller the hall the closer the audience are to the stage and the less is the number of lamps comprising a particular batten. A good, but very exacting,

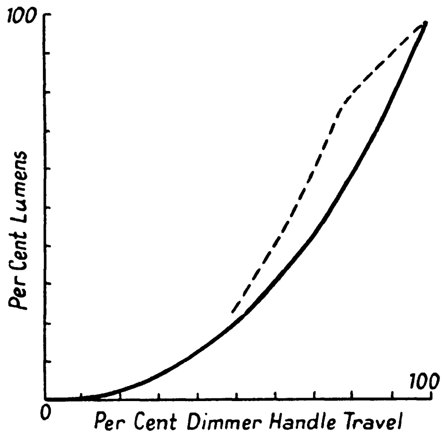


FIG. 57. NORMAL COMPROMISE DIMMER CURVE

test is to bring in slowly from blackout a row of 100-watt blue lamps at the bottom of a cyclorama.

It is possible for dimmers to be wound to allow a variation of wattage of ± $33\frac{1}{3}$ per cent, common ones being: 750-watt, ± giving a wattage range of 500–1000 watts; and 1500 watts, ± giving 1000 watts to 2000 watts. This arrangement really means a compromise winding, but is quite effective provided lamps below 250 watts are not used (Fig. 58).

In these chapters the expression " + or —" will not be used, the limits of variation being given, e.g. a 750-watt + or — will be described as a "500/1000-watt dimmer" and a 1500 + or — as "1/2000-watt." As the volts dropped at each contact depend in a resistance dimmer on the current forming the load, a 500/1000-watt dimmer, though dimming both 500 watts or 1000 watts properly, will not dim them on the same dimmer handle travel. The heavier the current the more obstruction offered by the resistance; the position of the dimmer handle for 50 per cent light will differ in each case. Or put another way: if we have one 500-watt lamp on check at some intermediate position, the addition of another 500-watt lamp to the dimmer will cause a reduction of the light from the first lamp. As has been said, on a 230-volt supply the lamp volts need not be reduced below 32 before the wiper

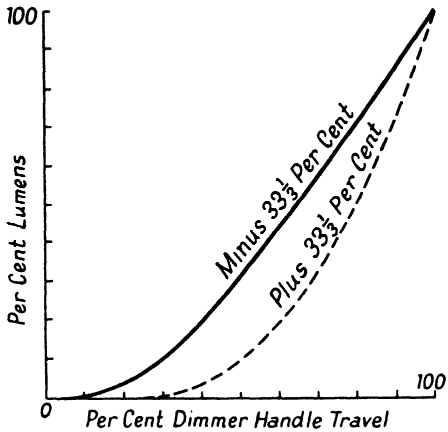


FIG. 58. CURVES FOR RESISTANCE DIMMER WOUND TO GIVE LOAD VARIATION

arm passes on to the dead contacts forming the "off" position; this is just as well, as Fig. 55 shows. (A warning here: make sure that the 100-contact dimmer has all these devoted to resistance steps; the contacts for the full "on" and "off" positions must be additional.)

It will be obvious that a slider dimmer cannot provide the careful matching of dimmer travel to lamp light possible on the contact dimmer plate; the most that can be done is to wind the slider formers in sections with, perhaps, four different gauges of resistance wire. The segmental dimmer plate can be operated as in Fig. 54 by a handle fitted to an extension of the wiper arm beyond the pivot. This is not possible with the circular dimmer plate, which is therefore unsuitable for use in the unit-type dimmer board described in Chapter V.

Heat Losses

All resistance dimmers convert into heat the energy they absorb in order to dim the lamp or lamps; their surroundings must therefore be well ventilated. However, the process is not so wasteful as it sounds; for example, when the lamp volts are reduced 50 per cent it does not mean that the same amount of power is consumed by the combination of lamp

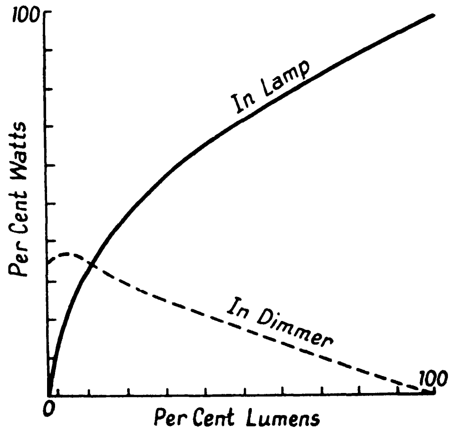


FIG. 59. RELATION OF LIGHT TO WATTS ABSORBED IN LAMP AND RESISTANCE DIMMER

and dimmer as when the lamp is full on. Introducing resistance in a circuit not only reduces the voltage to the lamp but, of course, the current in the circuit as well. Fig. 59 shows the relationship of reduction of lamp light to watts (power) in the circuit. The heavy curve shows the amount of power dissipated by the lamp itself for the corresponding reduction in light. For example, when the dimmer is reducing the light in the lamp (lumens) by 50 per cent, the power in the lamp (watts) has been reduced to 72 per cent, and 17 per cent is dissipated by the dimmer, making 89 per cent watts in the circuit. At 25 per cent lumens the lamp watts are reduced to nearly 52 per cent, and the dimmer is responsible for 27 per cent, so the total watts in the circuit are reduced to 79 per cent.

Reactance and Transformer Dimmers

So far the dimmers described, whether liquid or metallic, have depended on the introduction of more or less resistance in the lamp circuit for their operation. The now widespread use of alternating current allows the use of reactance-type dimmers, which although they employ voltage reduction for dimming, the voltage reduction is independent of the amount of current in the circuit. Whereas the resistance dimmer set at a position to reduce the voltage 50 per cent will require the load (wattage) for which it was designed in order to do this, the reactance dimmer, when set at the 50 per cent position, will give 50 per cent of the mains voltage whether loaded lightly or heavily. In some types, the 50 per cent is there even when not loaded at all and, of course, the same applies to any intermediate position to which the dimmer may be set.

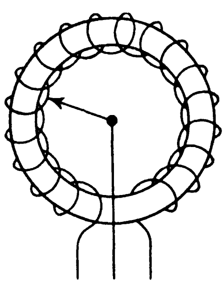


FIG. 60. SCHEMATIC DIAGRAM OF VARIABLE AUTO-TRANSFORMER

Such reactance dimmers take many forms, but the commonest is the multi-tapped auto-transformer. This usually consists of a core of laminated iron in the shape of a ring. Round this ring is wound enamelled (insulated) wire in tight formation; a contact path along the wire, either inside or outside the ring, is cleared by removing the enamel. Along this path a wiper contact passes. On connecting the two ends of the winding to the mains, any voltage between zero and that of the mains can be tapped off by the wiper (Fig. 60). As the number of turns is above 200 and the wiper rotates through almost 360°, extremely smooth lighting control is obtained. So reliable are the results that the dial can be calibrated in volts. Where, however, the lighting is to be dimmed out at a slow rate, it will be necessary to move the wiper slower at the beginning of the travel than at the end, due to the relationship of voltage to light—the curve being shown in Fig. 55.

One of the neatest and best known of the variable-tapped auto-transformers is the Variac, a photo of which is shown at Fig. 61. Another form, the Gresham, in which contact is made via a commutator instead of direct on the wire, is shown in Fig. 92. It is important to remember that when a transformer dimmer is described—for example, as 7 kW—it means that any load up to that figure can be regulated.

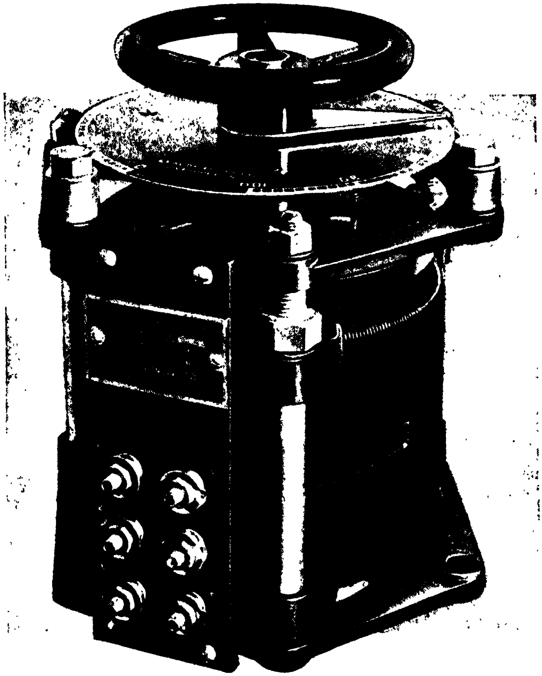


FIG. 61. 2000-WATT VARIAC AUTO-TRANSFORMER DIMMER

Further, most transformers can be overloaded 50 per cent for short periods, so that a 7-kW transformer can be employed on a 10·5-kW load for a few seconds at a time.

Some designs provide a number of separate wiper contacts to tap off several dimmer circuits from a single transformer winding and assembly. Development on these lines may reduce the cost, and space occupied, per dimmer way.

It will have been noted that contact in some transformer dimmers is made on to the wire as in a slider dimmer. However, the reasons which make this bad practice in resistance dimmers do not apply here, as there is no question of energy being dissipated as heat. Unless the auto-transformer is badly overloaded, the winding remains comparatively cool, and, therefore, perfectly tight. The loading of auto-transformers is usually given in kVA; it is impossible to give a simple explanation of the difference between a kVA and a kW, so in the present context the expressions can best be considered as interchangeable.

The collection of current from turns of wire or contact studs is known as commutation. This is comparatively easy on resistance dimmers, the brush (as it is called) passing on to the next stud before it leaves another, thereby preventing any risk of flicker. The brush is usually made of carbon, as this gives a good contact, slides easily, and takes any wear. On the transformer type of dimmer, a special brush has to be used to avoid short-circuiting the adjacent turns or contacts, for if this were done the particular turn or turns would make a closed circuit of negligible resistance and the current would rise until either the brush or winding burns out. By using a long thin carbon brush, which offers sufficient resistance to the short-circuiting current but more or less insignificant resistance to the lighting load, the troubles are overcome on loads up to about 7000 watts. A transformer as in Fig. 62, with a flat commutator, can carry twelve slider brushes, each tapping off the required voltage for twelve circuits, provided no circuit exceeds 2000 watts. Such a unit provides, electrically, the ideal basis for a flexible board (see page 104) though, of course, it requires some sort of interlocking system for mastering.

From the preceding it can be gathered that, although resistances can easily be employed as dimmers on A.C., there are transformers which can use the effects of this current to provide dimming without the heat losses of the former. More important, these dimmers act through voltage regulation, and the half light and other intermediate positions of the dimmer are independent of the lamp load. Why, then, are reactance dimmers so uncommon in the theatre? The answer is to be found in their cost. It is not merely a matter of twice but four or five times the price of the resistance dimmer for the same wattage. Economy in working is of little value compared with the variable load factor and this is of vital importance only on the stage plug circuits and for master dimming. So long as it is possible to purchase several resistances for the price of one transformer, progress is bound to be slow. At the moment the multi-slider transformer seems to offer the best chances

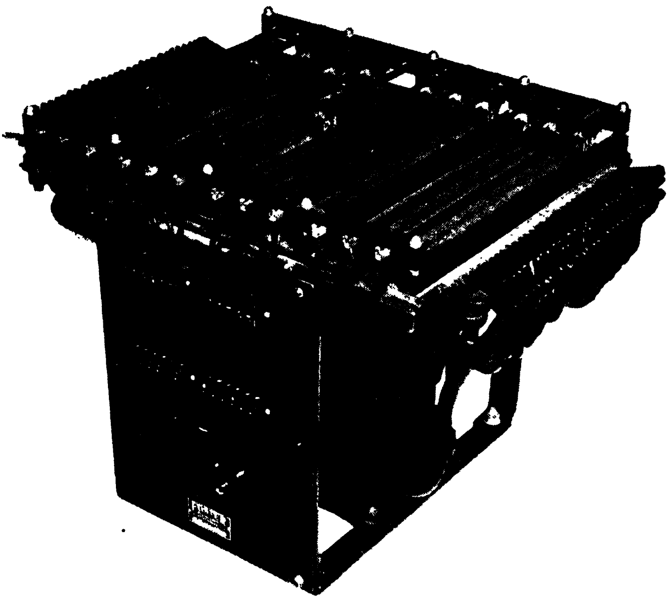


FIG. 62. TWELVE 2000-WATT DIMMERS ON ONE AUTO-TRANSFORMER

of price reduction, the cost of the transformer and its expensive tappings being in effect spread over twelve dimmers.

Difficulties really arise in commutation for loads of 10 kW or more. The carbon brush can no longer cope with the lighting and short-circuiting current; therefore, resort has to be made to a split brush bridged by resistances. Thus, we may find on large load transformers a framework with a resistance arrangement. Naturally, there have been attempts to break away from the need for commutation for large-load voltage regulation. One of these is known as the moving-coil voltage regulator in which a closed coil is moved over a transformer.

This coil has no electrical connexion with the transformer, but, magnetically, it is very much in touch. As the coil is moved, the voltage on the output terminals varies, the input volts remaining constant. That this happens can be accepted, but "the how" is not capable of simple explanation, and the

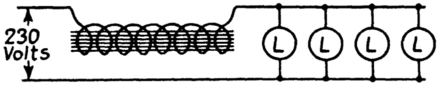


FIG. 63. CHOKE DIMMER CIRCUIT

technical reader will have to follow up for himself. There is another device which works by removing the laminated iron core, the backbone of any A.C. device to step voltage up or down. If a coil of wire is wound round such a core, as we have seen in the auto transformer, there can be a drop from 200 to 0 volts over the length. If, then, this device (known as a choke) is connected in series with a lamp or lamps (Fig. 63), there

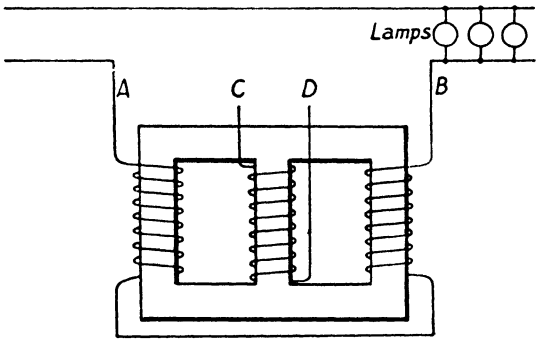


FIG. 64. D.C. SATURABLE CHOKE DIMMER

will be no light. The core can be removed and with it the choking effect; the volts will then rise, and with them the light of the lamp, until only the impedance of the empty coil of wire remains between the lamp and full brightness.

The mechanical removal of the core may be awkward. The same effect can be obtained by negativing the magnetic effect of the core with a special winding to which a greater or lesser amount of D.C. is applied. Fig. 64 conveys this idea. Normally, the volts from *A* to *B* will drop from 230 to 0; consequently, there is no light in the lamps. As more D.C. is applied to terminals *C* and *D* less voltage is dropped between *A* and *B*, and the lamps increase in brightness. The D.C. current required is but a fraction of the current in the lamp circuit, and may be supplied through an orthodox dimmer from a rectifier (to convert A.C. to D.C.) or through an electronic circuit employing a gas-filled triode valve (Thyratron). The latter merely requires a small potentiometer controlling the valve grid, radio fashion. The valve acts as rectifier and

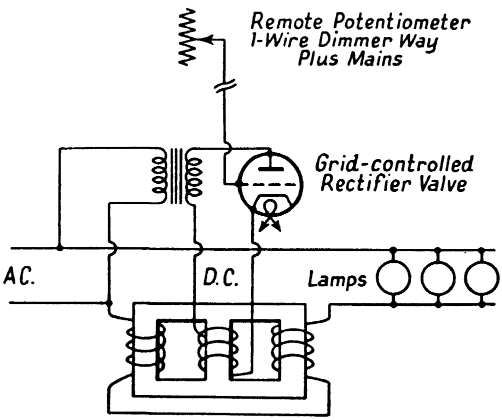


FIG. 65 SCHEMATIC DIAGRAM: VALVE-CONTROLLED CHOKE DIMMER

passes more or less D.C. into the saturating winding of the choke (Fig. 65).

A matching circuit can be added so that the amount of load connected to the choke can adjust the saturating D.C. supplied by the valve and the choke is rendered capable of dimming satisfactorily a wider range of loads, its own regulation being poor. This circuit is a complication and what with the large current-carrying choke (reactor) and the valves, it becomes an expensive form of dimmer, which has nevertheless attained considerable popularity in America.

One other disadvantage remains, namely that the desaturated full-on position of choke or transformer still carries a slight voltage drop of about 5 per cent of the mains. This means that lamps on the stage have to be of a lower voltage than the rest of the building. Provided the mains are 230 or so, this does not cause much difficulty in this country *at present* because lamps are obtainable in a large range of standard voltages. In America, however, there is only one standard voltage, and consequently the theatre main must be boosted by a special transformer to compensate for the drop; this is an addition to the equipment already costly (by our standards).

Electronic Dimmers

The larger sizes of gas-filled triode developed during the war now make it feasible to omit the choke and use the valve itself to dim the lighting. The crucial matter has been the current to be carried by the valve and in the systems already mentioned it is very small. For direct valve dimming we in this country are especially favoured by our high mains voltages, which mean that we have only to cater for an amperage half that which the Americans and most other countries have to face for the same wattage. Notwithstanding this fact, the first full-size direct valve dimmer board to receive public demonstration is that devised by George Izenour for Yale University Theatre.

Although the effect of the valve when connected to the lamps is that of a dimmer it is actually an ultra-high speed switch or relay without any moving parts. As stated earlier, A.C. current reverses its direction of flow fifty times a second—a complete cycle of change from maximum positive volts through zero volts to maximum negative volts. This type of valve is designed to provide a unidirectional path and deals with one half of the cycle only. The control applied to its grid determines at what point in the cycle (i.e. at what voltage) an arc is able to strike up between cathode and anode and the valve becomes a conductor. The arc is extinguished as the cycle passes through zero and the process repeated each 1/50th of a second, the lamps being fed with intermittent D.C. of that value until we alter the grid-control potentiometer.

As the function of the grid is to prevent the arc striking, its voltage can be considerably lower than that which is passed by the valve when the arc has struck. For example, a voltage of -10 will prevent the arc from striking at any time in the cycle, the lamps therefore remaining blacked out. Similarly the amount of current used in the grid circuit is minute (0·0002 amp max.) compared to that in the lamp circuit when the valve is conducting.

At the time of going to press the Strand Electric and Engineering Company are constructing experimental electronic boards using an arrangement of three thyratron valves fed from three-phase mains which will give a full-on voltage equal to the normal single-phase voltage used for lighting; a booster transformer or special voltage lamps are not therefore required.

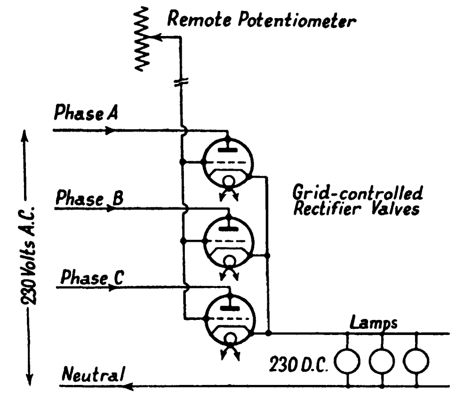


FIG. 66. SCHEMATIC DIAGRAM: DIRECT VALVE DIMMER

The three-valve combination will control up to 4000 watts on mains of the 200–250 range.

The grids of the three valves are in effect connected to one potentiometer similar to a radio volume control; as this is turned so the lamps are regulated from full on to a suitable intensity at which to black out (Fig. 66). The response of the valves to the changes on their grids is so fast that switching can be carried out in the valve itself without any need for contactor switches. The potentiometers lend themselves to the construction of a compact panel to be placed in some convenient position remote from the valve bank and giving a good view of the stage. This aspect is treated in Chapter VI.

The three-valve combination rectifies the three-phase A.C. which means that the lamps on the stage will be fed with D.C. This arrangement eliminates the bugbear of having to balance a stage over three phases. Such a balance usually only exists on paper (see Chapter XV) and is neither satisfactory from the supply authority's point of view or from the user's; for the latter has to be very careful if the risk of a 230-volt accident is not to be replaced by an even less attractive 400-volt one.

When the valve is used as a dimmer in this way the light-dimming curve will be as in Fig. 67 unless compensation is made in the grid-control potentiometer. Far more important

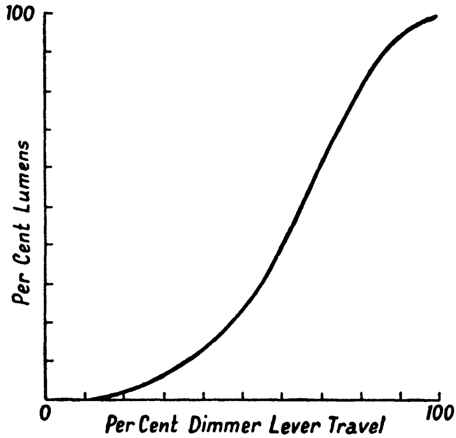


FIG. 67. LIGHT CURVE FOR DIRECT VALVE DIMMER

is the fact that the valve gives its voltage output at all positions irrespective of load. Loads can be added and subtracted at check positions absolutely freely. 4 kW, 1 kW, 25 watts or just the voltmeter, the result remains steady.

A direct valve electronic system may be cheaper than any system except resistances. Assembled as a stage-board with masters it will probably be a third more costly than an orthodox Grand Master board (see following chapter) and be far preferable for size and control facilities. The drawbacks at the time of writing are that it has as yet received no long-term trial in a theatre and it would therefore be extremely reckless to prophesy what the life of the valves will be. In the applications where great experience has been obtained these valves have always operated on high-voltage low current; theatre conditions reverse this to low-voltage high current.

The threat of virtual replacement of all the dimmers every few years is bound to sound disagreeable to the theatre owner; however he must remember that the system offers remote control at a low initial cost for the first time—an escape from cumbrous direct-operated boards he has been compelled to install hitherto.

Shutter Dimmers

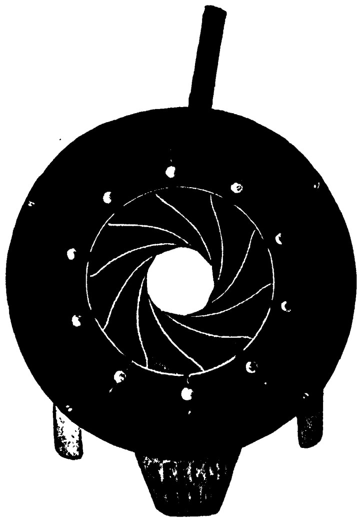


FIG. 68. IRIS-DIAPHRAGM DIMMER

One of the commonest types of shutter dimmers is the iris diaphragm attachment (Fig. 68), fitted to the front of a focus lantern; as the aperture is gradually closed, the light is dimmed and the size of the spot beam reduced. When a lens is used to focus an image sharply (e.g. the slide in an effects projector) the iris acts as a dimmer only, for reasons explained on pages 48 and 49.

The Germans use shutters in front of their large 3000-watt cyclorama floods to avoid the change of colour emitted from the lamp filament as the voltage is reduced. Behind a blue filter the red-orange glow of the dimmed filament will prevent a true blue being obtained at low intensities with the filters in common use on the stage, or so the theory goes. Producers outside Germany have considered themselves lucky to get a cyclorama, and are, therefore, not, as yet, so sensitive.

Shutters are likely to come into their own when discharge lamps are used for cyclorama lighting in the theatre. These will have to be operated by a system of remote control. This is a distant prospect; an earlier arrival will probably be the extra-high-pressure mercury lamp for scene and effects projection, the dimming shutters being operated by hand.

Note for D.C. Mains

Liquid and metallic resistance dimmers can be used on D.C. as well as on A.C. The latter, however, require the addition of a quick-break spring contact at the point where the wiper arm runs off the resistance contact studs on to the "off" studs. This is essential, as D.C. arcs badly; unless a

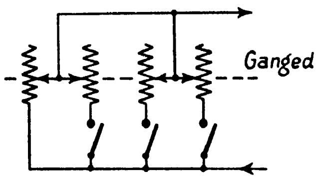


FIG. 69. MASTER DIMMER CIRCUIT FOR D.C.

circuit is broken instantaneously, such arcing burns away the stud contacts.

The transformer dimmer will not work on D.C.; any attempt to make it merely results in a blown fuse. Except for the tolerance of one-third + or −, variable load dimmers on D.C. have to consist of several plates with switches to connect them in parallel, all the wiper arms being mechanically connected to the operating lever. The correct number of plates has to be switched in to suit the load to be dimmed (Fig. 69). Of course, the liquid dimmer is a proposition on D.C., and by adding more or less washing soda the electrolyte can be matched to the requirements of the particular show.

CHAPTER V

STAGE SWITCHBOARDS (DIRECT-OPERATED)

THE expression "stage switchboard" is rather a misnomer. The switches are least important, pride of place going to the dimmers. *Dimmer board* is thus a better term. Very often the non-committal expression "stage-board" is used, and

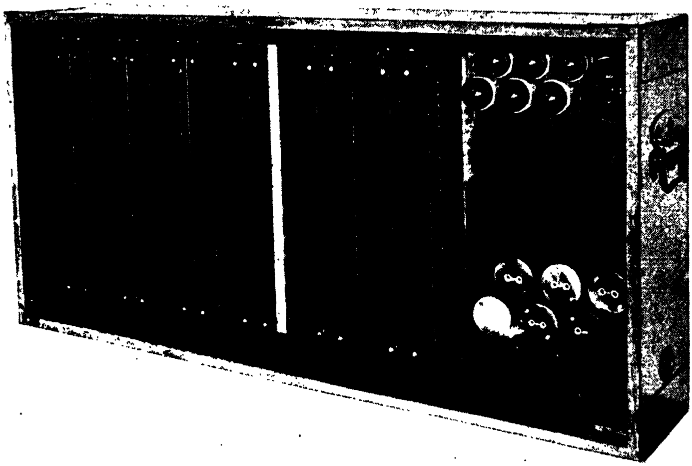


FIG. 70. 6-WAY PORTABLE SLIDER BOARD

this is adopted here. Stage-boards are either direct-operated or remote-controlled: the former has the dimmers mounted immediately behind the operating levers; the latter will work dimmers at a distance by tracker wires or purely electrical means. Remote control is expensive—a fact which prevents its use by amateurs or little theatres; we shall, therefore, consider direct operation first.

Direct-operated boards may use either slider dimmers or contact dimmers. Fig. 70 shows some slider dimmers mounted to make a stage-board, in this case a portable one. Each dimmer feeds a plug socket to which the temporary connexions are brought. In the example shown there are six dimmers, and one of the first problems that besets the operator is the difficulty of moving several dimmer knobs at once.

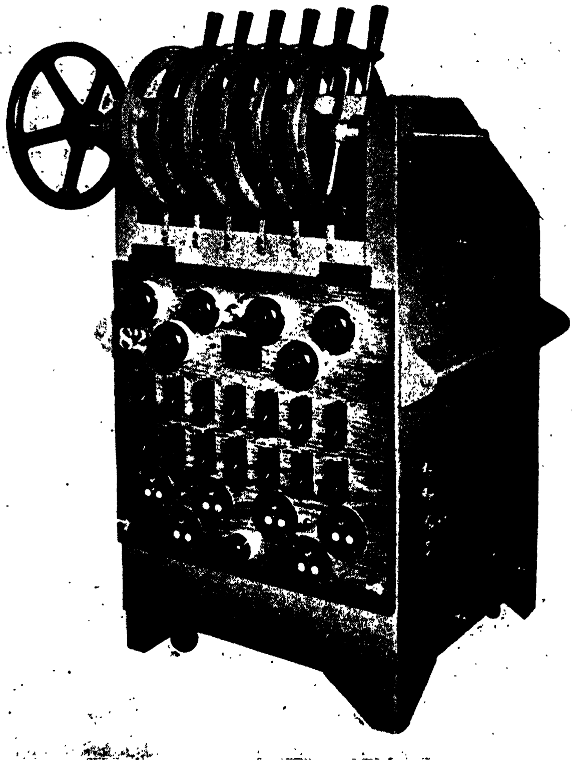


FIG. 71. 6-WAY PORTABLE INTERLOCKING SLIDER BOARD

Sometimes a rod is kept handy for this purpose, but pushing several stiff slider knobs by means of a rod under them is by no means easy, especially if in the midst of those to be moved there are one or two to remain stationary. Fig. 71, also of a portable board, shows an attempt to overcome these difficulties. Each of the slider dimmer knobs is made off to an endless tracker wire, which passing over pulleys is fixed to a grooved wheel carrying the operating handle. The handles and wheels are mounted on a shaft to which they may be screwed down for master operation by a wheel at the end of

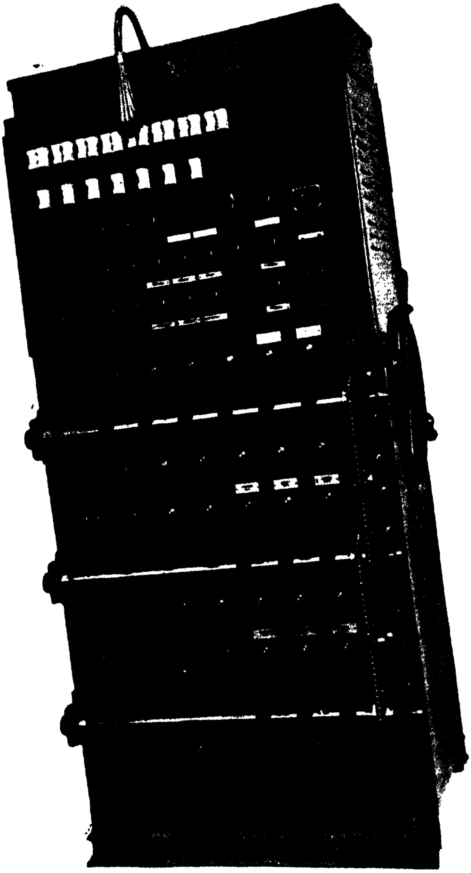


FIG. 72. 21-WAY SCREW-DOWN BRACKET HANDLE BOARD WITH CAPSTAN MASTER

the shaft. Needless to say, however effective the arrangement, it is costly and removes the original reason for using slider dimmers—cheapness.

Mechanical Interlocking

Having dismissed the slider dimmer we shall now consider the contact dimmer stage-board. Hitherto this has proved

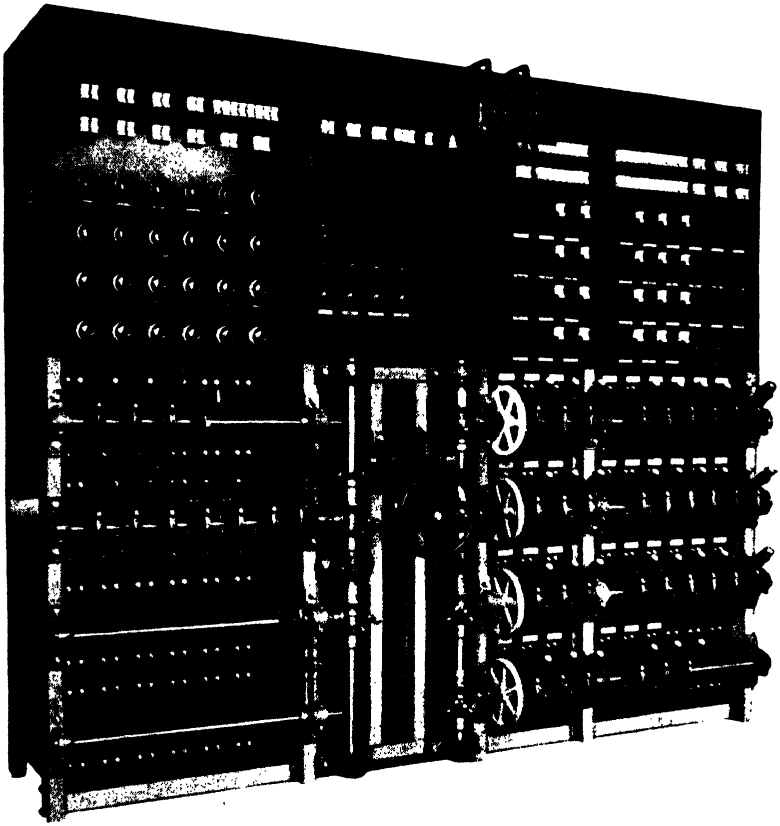


FIG. 73. 60-WAY BOARD WITH SPLINE GEAR GRAND MASTER CROSS CONTROL AND SELF-RELEASE HANDLES

bulky, expensive, and generally unsuitable for the smaller stages; but before describing how they might be improved, it will be well to examine practice up to now.

The contact dimmer has always been built into what may be termed "mechanical interlocking boards" (as shown in Figs. 72, 73 and 74). The dimmers are mounted in tiers on a built-up frame, usually of angle and channel iron, each tier of dimmers being connected by links to a row of handles pivoted on a shaft. Handles may be operated singly or locked on to their shaft for operation by a master control at the end of the shaft. In the cheaper boards the handles *screw down* to their shaft; but refinements, in the shape of *self-release*

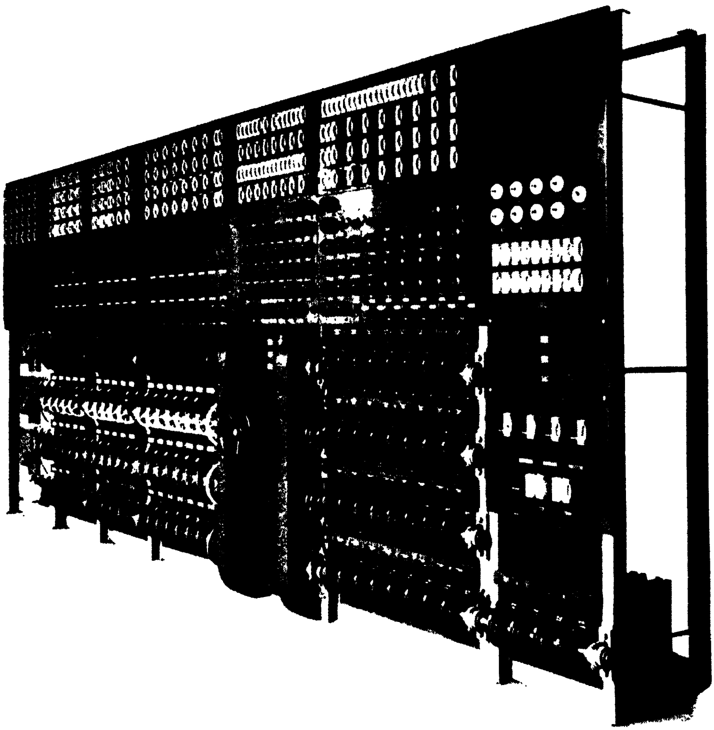


FIG. 74. 100-WAY BOARD WITH ELECTRO-MAGNETIC CLUTCH GRAND MASTER CROSS CONTROL

handles which slip at the end of travel, are available. Similarly, the master wheels may have an alternative slow-motion worm drive or often a large-diameter capstan wheel which gives better control of movement than a small wheel. Shafts are sometimes chained together permanently or at the will of the operator for collective working.

The larger boards have four tiers. The extremely large boards have their shafts in each tier split into two sections. The various sections will then be provided with gearing so that the shafts can be driven from a Grand Master worm wheel located in the centre of the board. In the professional theatre, shafts are often allocated to individual colour groups. However, the sort of installations considered in this book will not lend themselves to this practice. The dimmer operating links work through slots in a sheet-metal panel, thus keeping the "live" dimmers out of reach.

The horizontal distance between the dimmer handles is governed by the width of the dimmers behind the panel, and usually works out for a resistance at 4½ in. Sometimes reactance dimmers are included for the stage plugs, and these may alter the centres. The vertical centres between dimmers vary according to type, from 13 in. to 18 in. It is unusual to be able to load an individual dimmer plate higher than 5760 watts, and, therefore, large loads, mainly encountered on the cyclorama, will need several dimmers ganged together to work from one lever. These outsize loads may considerably increase the overall size of a board, it being quite possible for a mere 60-way board to be as long as a 100-way for some such reason as this. The limitation on the dimmer is current, which means that 110-volt supplies can be troublesome in large theatres.

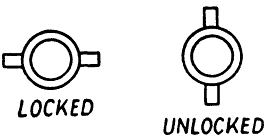


FIG. 75. EXAMPLE OF DIMMER HANDLE

Dimmer handles must give a clear indication whether they are locked on or not. An egg-shaped or a tommy-bar type of handle is ideal for the purpose (Fig. 75). A slipping type of self-release handle is preferable to the trip catch pattern, as with the latter the operator is constantly finding himself with a completely unlocked board. The slip self-release cannot clear the shaft altogether, since it requires friction to push itself against the slip lever. It might be wondered if the device is really worth the extra charge, but any one who has actually tried to turn a large number of dimmers, with their slips out of action, is not left in doubt. The braking effect of a couple of dozen handles is considerable, and the slipping "gadget" renders this quite tolerable.

All dimmer handles must have scales and a pointer so that their position may be plotted; 0 to 10, representing 0 to 100 per cent, is the obvious arrangement, but queer scales, reading 0 to 30, are not unknown! It may be necessary to provide some sort of lighting to the scales so that they can be read in the murky gloom back stage. Instead of a lamp to each scale, the possibility of fluorescent scales might be explored. Pilot lamps are often included near the dimmer handle, and are wired either to light up when the switch is "on," or connected in parallel with the lighting load to show the amount of "dim." The first arrangement is useless—the switch handle should tell its own tale; the second is only of value to show whether stage plugs have been connected or not. As the pilot lamp is 10 watts, a 1/2000-watt dimmer will not check it unless connected to a proper load. However, by the time the dimmer handle has been moved and the pilot lamp has told its sorry tale, it is usually too late for the man on the board to do anything about it. It would seem, therefore, that there are many objects on which money could be more usefully employed.

Clear labelling of the dimmers is essential. The circuit names should be short and snappy, and not a descriptive essay. A bold abbreviation such as "BATT. I" is preferable to "Batten 1" in the smaller letters needed to fit the same label. When coloured labels are used, they must be bright light colours, otherwise the black engraving will not show; a suitable red, for instance, will be nearly an orange. The dimmer watts *must* always be included on the label.

Grand Master Control

Up to the early 1930's Grand Master control was a rarity on boards in Great Britain, but now there are well over a hundred boards so equipped. The commonest arrangement is the four-tier example shown in Fig. 73, where, to the right of the master wheel, are the four shafts for the four-colour equipment, and to the left two sets of independents (spots, floods, etc.). The colour shafts must always be on the same side of the master wheel; a three-tier arrangement, with two

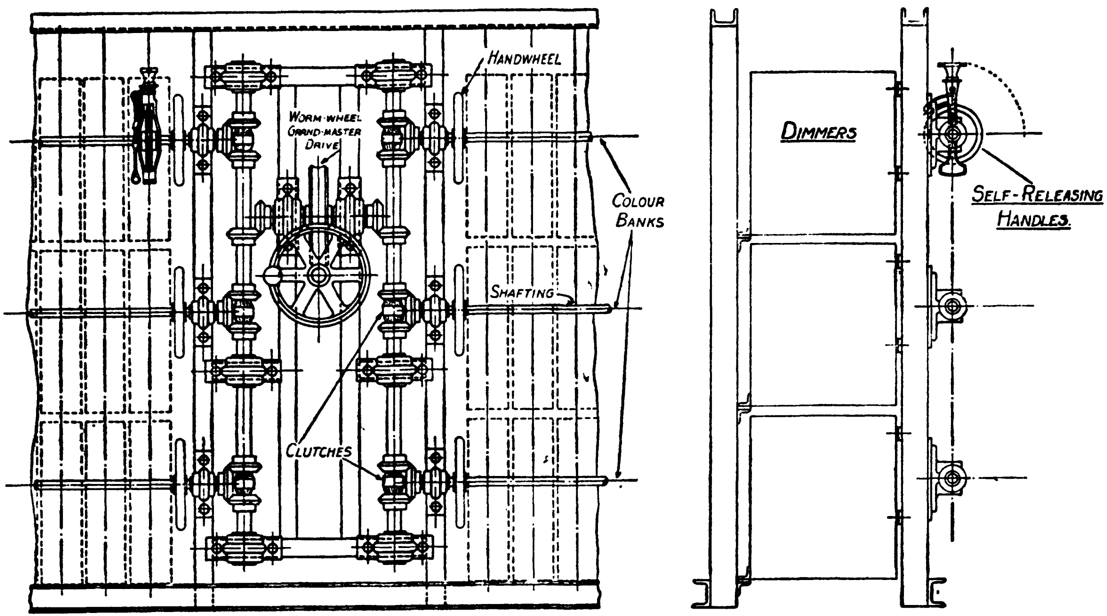


Fig. 76. Layout of Grand Master Cross Control with Spline Engaged Clutches and Slip Self-release Dimmer Handles

colours and an independent shaft each side, is awkward to work. The various shafts can be connected to move "up," "down," or "stop," depending on the position of the gearing, the arrangement being known as a cross control (Fig. 76).

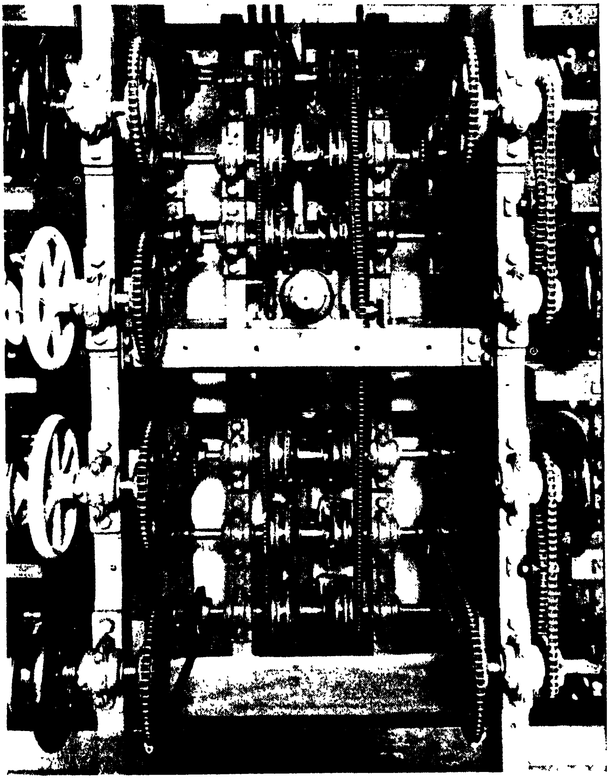


FIG. 77. ELECTRO-MAGNETIC CLUTCH GRAND MASTER WITH COVERS REMOVED

Thus the red shaft will go up, the blue down, and the others remain stationary, for one movement of the master wheel. The actual connexion of shafts to wheel is done in various ways; open gearing with its coarse teeth has been replaced by the fine-tooth, spline-action, "constant mesh," and so on. The aim is to connect and disconnect with as little gear crashing as possible. For this, undoubtedly, the electrical clutch is the best, but it has to transmit far more power than the Mansell clutch for driving single dimmers, described in Chapter VI. The photograph (Fig. 77) shows the form used for the fantastically large board in the Opera House, Blackpool. The operator is able to connect his shafting with ease from a small switch panel instead of moving half a dozen or more gear levers.

It is not always necessary to use cross gearing, particularly in the style of installation where the magazine equipment is in the minority. Division of anything other than magazine battens over colour shafts is a questionable practice; the colour dimmers of the cyclorama are far better considered as a unit by themselves rather than split up over different shafts. Hence at the Birmingham Repertory Theatre, or Toynbee Hall, London, all the shafts are permanently geared through a quick worm to a slow-motion master. This is a considerably cheaper arrangement than the cross control, and for these examples almost as effective.

American Interlocking

On the majority of American stage-boards the mechanical interlocking is carried out on a different system from that in Great Britain. In the British type of board dimmers may be locked to move with the shaft wherever their handles may be situated. On moving the master wheel, dimmers at 50 per cent travel will start moving along with those at 100 per cent; the 50 per cent ones will get to the off position first and slip, particularly if self-release is fitted. Additional dimmers can be locked on and the master wheel rotated indefinitely.

The American system provides, instead of wheels, master levers which travel only the same distance as the individual dimmer levers. Dimmer handles can be set to lock on, whatever their positions, but are collected by a single slot in the shaft. Thus, as the master handle is moved, it first collects the 100 per cent dimmers, then the 50 per cent, whereupon the two dimmers proceed to "off" in unison. The system may be somewhat easier to construct but it has bad visual effects on the lighting during a fade-out. The British system tends to leave behind to the last the circuits with dimmers at full, but as these would, probably, be the lamps most prominent in the balance of the lighting, this is all to the good. The American system reduces the light to all-over nonentity in a general fade. The truth is that both systems are a compromise and that the correct fade should be proportional, but this cannot be done mechanically.

Cross Control on Single Shaft

It is natural to yearn for some method of sending groups of dimmers up and down irrespective of shaft divisions. This facility has been curiously neglected in Great Britain, the normal locking arrangement showing little advance on the Moy board at Drury Lane Theatre installed in 1902 and still in use. On the Continent there are installations which combine this facility with mechanical trips giving pre-set dimmer positions. These delights tended to be overlooked in the change from liquid dimmers to resistances. It is possible that the change of dimming method became synonymous with improved control. It cannot be too emphatically stated that the change from arc lamp to filament lamp, or filament lamp to discharge lamp, means nothing to the theatre, unless each gives at least the facilities of its predecessor. Electrical efficiency takes a back seat every time. So it is that we *may* see accepted some form of reactance dimmer which, because it is a new variable load dimmer, will become the last word, although it may be difficult to manipulate a number of these. Likewise a remote control board should not be accepted unless it does *at least* all that a Grand Master direct-operated board does.

Whatever the reasons for neglect of mechanical "gadgets," there can be no doubt that they have missed their opportunity. Improvement is more likely to come from electrical devices.

Switching

In most British boards the circuit switches and fuses are mounted on panels of insulating material carried on the frame, over the top tier of dimmers. The switches are then, as far as possible, fixed in rows and at centres to correspond with their dimmers. Switches are either of the bakelite tumbler type or the back-of-board type operated through a slot from a lever in front. In either case there is no unshielded live metal on the front of the board, and all wiring and connexions are behind the panel, which is then known as "dead front."

There is a type of board, originated in the United States of America, with a completely flat sheet-metal front, which makes a neat-looking job. However, the shafts just described are there all the same, though concealed behind the sheet-metal face, where cleaning is all the more likely to be overlooked. In these boards it is usual to find each circuit switch mounted adjacent to its dimmer. This may have the drawback of increasing the vertical centres of the all-important dimmer handles. It is not essential to mount switches and dimmers together. There are many examples of separate switchboards and dimmer regulators, particularly where overhead clearance is restricted.

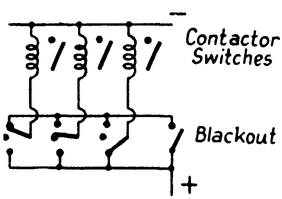


FIG. 78. CIRCUIT FOR MASTERING OF BLACKOUT CONTACTORS

The circuit switches in both kinds of board were originally single-way switches, the work of which was to render the particular circuit dead. Recently, several, and sometimes all, of the switches have been of the three-position or two-way-and-off type. When the switch is in the "down" position, the circuit is connected to the busbar fed by the master blackout switch; in the "up" position it is connected to a permanently live busbar.

The master blackout may be a mechanically operated switch on the back of the board, or remote from the stage and operated by an electro-magnet, only the small magnet coil-switch being on the board. This arrangement is desirable where the blackout switch is of any size owing to noise of operation. In the professional theatres that employ the colour shaft grouping there will be a separate master blackout contactor switch to each colour, these in their turn being connectable by two-way-and-off switches to a master blackout switch or a live busbar (Fig. 78). The cyclorama is often given its own blackout contactor—a wise provision, especially if its dimmers have to be spread over the colour shafts.

Experiments in Switching

Two-way-and-off switching seems to be obvious both for individual circuits and the master blackouts; but there have been curious experiments to make the colour blackout of the dip plugs and some other circuits transferable. This might appropriately be dealt with in the later section "Flexible Boards," but for the fact that the object is not to economize in order to make one dimmer serve several circuits. At the Savoy Theatre (1929) the board was fitted with four-way selector switches which enabled the spotting and fly plug circuits to be transferred from their home-colour blackout busbar to the others. These switches were not dead front, and were only applicable to the D.C. supply at the Savoy. Subsequently, in 1938, the same thing was attempted on certain of the plug circuits in the large installation at the Gaumont State, Kilburn. A kind of telephone jack board was constructed with weighted leads, but on the giant scale required of the loads and high voltage. The result was a large contraption which the Middlesex County Council insisted must go in a fireproof room under the stage. In addition, the door to the room had to have a trip switch which cut off the main while any one was in the room changing over the plugs, so the device was a suitable subject for curiosity corner.

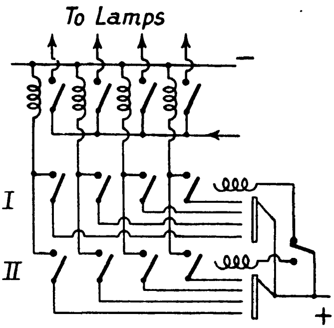


FIG. 79. CIRCUIT FOR ONE-SCENE SWITCHING PRE-SET

A neater way of obtaining the same result is to substitute small-size contactor switches in each dimmer circuit in place of the large contactors to the colour busbars. It then becomes possible to provide a series of miniature switches to the contactor coils which can be fed with main from multi-contact switches (Fig. 79). This, the early pre-set board, is of American origin, but there are many good examples by Major in Great Britain. The truth, however, is that these schemes do not get at the root of the matter, which is dimmer pre-setting (considered in Chapter VI).

Mechanical v. Electrical Interlocking

The mechanical interlocking board has many faults and limitations. These are—

(1) All the shafts, bearings, operating levers, gearing, etc., render an elaborate framework and skilled fitting

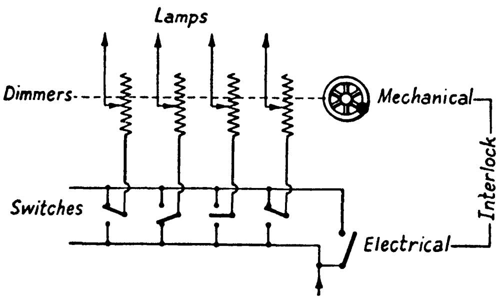


FIG. 80. MECHANICAL AND ELECTRICAL INTERLOCKING

essential. Even the simplest form of board will, therefore, cost at least three times as much as the actual contact dimmers themselves;

(2) Access to the dimmers, owing to the barrier provided by the shafts, must be behind the board, thereby adding 1 ft. 6 in. to depth of the board space;

(3) Master dimming is not proportional;

(4) Mechanical interlocking is quite illogical on an electrical switchboard.

Consider the last point in greater detail. Fig. 80 shows a typical stage-board circuit as used hitherto. The circuit switches, which are two-way-and-off pattern, can be made to connect the various lighting circuits so that they are fed direct from the mains or from a large master blackout switch. In short, the switches can be *electrically* interlocked. The dimmers, however, are mechanically interlocked by a shaft (the dotted line) as already described. Fig. 81 shows the dimmers arranged so that by operation of two-way switches they can be connected to a large master dimmer. In other words, both the circuit switches and the dimmers are electrically interlocked, and no mechanical gear is required. In the mechanical interlock, a general dim by operation of the master wheel will bring all the individual dimmer handles down; in the electrical interlock, only the master dimmer handle will move, just as operation of the master blackout switch leaves the individual switches "on."

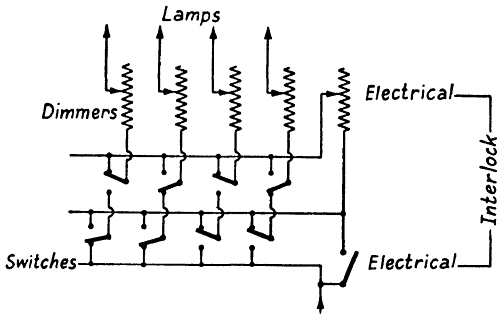


FIG. 81. ALL-ELECTRICAL INTERLOCKING

The proportional dimming obtained by the electrical master method gives proper balanced lighting at all times. For example, in a scene where the cyclorama is lit by 50 per cent blue and the acting area by spotlights at 100 per cent, a slow dim (check) will, on the mechanical board, give a completely black cyclorama at a turn of the wheel while the spots are still at 50 per cent; half a turn on the electrical master dimmer will bring the cyclorama to 25 per cent and the spots to 50 per cent, the lighting remaining properly balanced. Examples in colour mixing provide confirmation. A bright-grey cyclorama, made up of blue 100 per cent, green 80 per cent, and red 50 per cent, will, with half a turn of the mechanical master, change to blue 50 per cent, green 30 per cent, and red 0 per cent—from grey to dull blue-green. A master dimmer, when moved 50 per cent, will reduce blue to 50 per cent, green to 40 per cent, and red to 25 per cent, giving the correct change from bright grey to dull grey. With an orange cyclorama, red 100 per cent, green 50 per cent, the former will make a change from bright orange to dull red, and the latter a change from bright orange to dull orange.

General dimming-out of lighting has been considered, but the electrical master also scores in the reverse process. It is frequently required to bring in at one movement several individual dimmers to various check positions—75 per cent, 50 per cent, 40 per cent, and so on, to give a balanced effect. This is a most difficult operation on the mechanical boards because, as the master wheel is turned, the various dimmers have, in their turn, to be unlocked at the proper positions. When the electrical master method is used, the job is easy: the various dimmers are set to the positions required while the master dimmer is "off," and all that is needed at cue is to turn up the master dimmer.

Neither system by itself will perform all required lighting manoeuvres, but, in the balance, the electrical master wins easily. It may be asked why such a completely logical system has not been standardized, and remarked that after all, no one carried out master blackouts by mechanically interlocking the switches! The Cambridge Festival Theatre had such a system years ago, and it has cropped up from time to time in various small theatres (mainly amateur), notably with the Cambridge A.D.C. in 1936. That it has lacked general acceptance is largely due to the stage-lighting manufacturers' policy of designing their gear mainly for the professional theatre and cinema; thus the amateur and the smaller theatres have had to put up with makeshifts. Much valuable space on small stages has been occupied by gross stage-boards giving limited facilities out of all proportion to their large bulk and cost. The standardization of the electrical master board has depended, therefore, on its standardization in the professional theatres.

The main reason for adoption of the mechanical interlocking system there years ago and its use until now was the great difficulty of designing a master dimmer to cope with the large diversity of loads that may be connected to it. Such a dimmer at one moment will be called on to dim 20 kW, and shortly after merely 4 kW, and so on. It was only after the introduction, just before the Second Great War, of reliable dimmers of the reactance type employing voltage regulation, that electrical master dimming on a large scale was possible. As a result, new design *all electric* boards should appear increasingly in the professional theatre. Such voltage regulators, as previously explained, are expensive when compared with the corresponding resistance dimmer; this may well keep them out of the amateur theatre. However, as load diversity is not

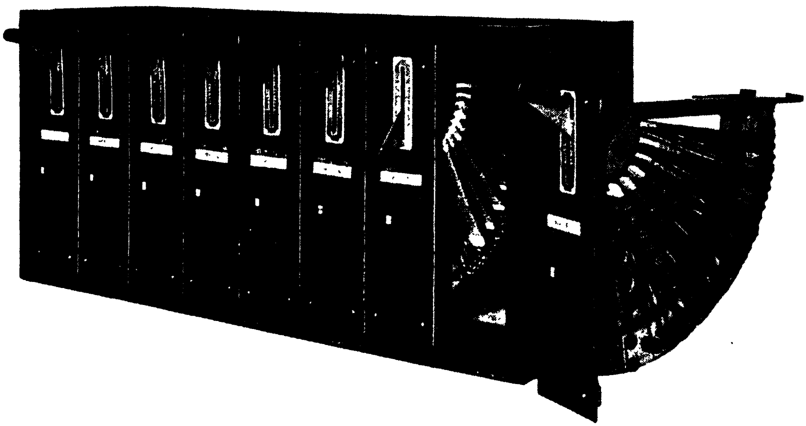


FIG. 82. 7-WAY AND MASTER UNIT DIMMER BOARD

usually so marked there, resistance master dimmers can be used successfully by an intelligent operator. Diversity is limited, but no one will use the master for two or three dimmers which can easily be moved by hand.

A Project for Unit Dimmer Boards

I now describe a unit system of dimmer boards for amateur stages and small theatres. This system, which is based on electrical mastering, would have to be produced on a large scale. Its prime essential is the reduction of cost by ensuring repetition of a few unit parts, which are—

A. *Standard Dimmer Unit* (Fig. 82). This is arranged so that any winding can be fitted up to 3000 watts. Carried as part of the dimmer is a panel through which the operating handle (an extension of the wiper arm) projects. A 15-amp. circuit fuse, a two-way switch wired in series with the dimmer, a scale giving dimmer positions and circuit label, are mounted on the dimmer panel.

B. *Standard Master Dimmer Unit.* This has the same dimensions as the dimmer above, but the winding can be made to take a total load of 6 kW with the variation necessary in a master dimmer.

C. *Unit Frame* (Fig. 82). This is of light metal construction and is arranged to take eight standard dimmers. The frame is complete with a wiring trough along the lower rear edge. The sides are fitted with perforated metal guards. Dimmers are inserted in the frame like so many books in a shelf, fixed and wired from the front. The only space behind the board that is needed is two or three inches clearance for ventilation.

D. *Base Unit.* A 12-in. plinth with vent holes to obviate placing the above unit direct on the floor.

E. *Neutral Box.* These are eight-way and arranged to take either fuse or links as the supply arrangements may demand. These boxes can be mounted on the end of the standard frame or on the wall adjacent to it.

F. *Plugging Unit.* This is not an essential part of the board, but its use enables one set of seven dimmers to serve fourteen lighting circuits (Fig. 87).

The photographs give a good idea of the various parts, both separately and assembled to form a complete board. The aim has been to avoid the expense of boards specially designed and built for each particular stage; also to allow extension from time to time as funds permit. The minimum frame possible provides for eight ways, that is seven circuit dimmers and a master (Fig. 83). The next stage is two eight-way frames on top of each other, providing fourteen circuit dimmers and two masters; then three, one on top of the other; followed by four eight-way unit frames (two pairs side by side) giving twenty-eight circuit dimmers and four masters. The masters are placed adjacent to one another to allow of easy collective operation. Six unit frames in pairs side by side will give forty-two ways and six masters, though reactance mastering should be adopted, funds permitting. Unfortunately as far as the purchaser of stage apparatus is concerned the unit board idea will not be much use unless some manufacturer puts it into production in a large way. However, the electro-interlock (i.e. electrical not mechanical mastering) with its proportional dim advantages can be applied with a little ingenuity to existing dimmers.

Contact dimmers (element type) can be mounted vertically and their arms extended to give direct handle operation as in

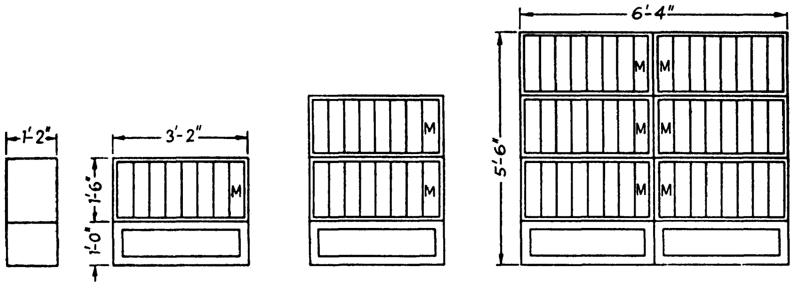


FIG. 83. ASSEMBLIES OF UNIT BOARDS FOR 7, 14, AND 42 WAYS

Fig. 82, instead of the link operation of Fig. 76. Several of these could be mounted on a light metal frame with a slotted metal front panel and the two-way switches carried on a syndanyo panel above, mastering to be by either a larger dimmer or a Variac. A less expensive set up can be arranged using slider dimmers.

With electronic dimmers master dimming automatically becomes electric and proportional, and the control units lend themselves very readily to a unit arrangement similar to the above; but on a more compact scale since the dimmer levers have only to operate small potentiometers and can therefore be mounted at one-inch centres.

Flexible Boards

Although the ideal arrangement is to have a separate dimmer for every stage-lighting circuit, as in the professional theatre, this method is rather expensive for amateurs. In many theatres a number of dimmers, representing considerable financial outlay, remain idle, and sometimes a theatre hires two or three portable boards to control spot battens while the dimmers on the elaborate permanent board locked up to battens and other items are unused.

For reasons of finance dimmers must work for their living. This aim is attained by making electrical provision: first, that lighting circuits are not rigidly connected to any dimmer; secondly, that more than one circuit can be connected to a

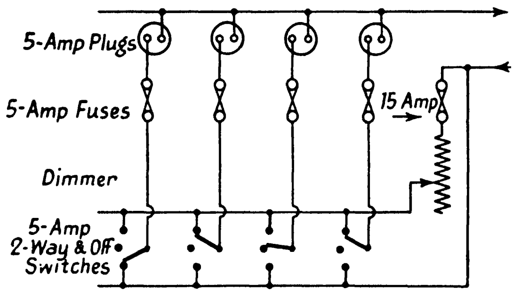


FIG. 84. CIRCUIT FOR 7-WAY (4 SHOWN) BOARD WITH SINGLE DIMMER

dimmer; and, thirdly, that circuits to remain "full on" receive their current direct from the main, and not through a dimmer.

The simplest of flexible boards is shown in Fig. 84. Such a board might serve installations in examples *A* and *B*, Chapter XI. The seven lighting circuits can be switched direct to the mains or on to the dimmer. This arrangement is by no means as limited as it would appear to be at first sight. For example, the saturated hue colour-mixing cycle (Appendix IV, Schedule A) can easily be carried out on three cyclorama circuits, the circuits being switched on to the dimmer as required for raising or checking and on to the mains to be held "full on." The cycle is often reproduced automatically by a single motor-driven dimmer and drum for exhibitions and shop-window colour effects.

With such a board most things, except the checking of a variety of lamps to different intensities to balance the illumination, can be done. Even if the dimmer cannot be purchased, provision can be made for the switching and plugging of this circuit, so that a dimmer can be hired and easily connected.

The dimmer used this way will have to be rather a makeshift. Ideally, it should be of the reactance type in order to cope with the load diversity, though it would be foolish to purchase such a thing since, for the price of one, five or six resistance dimmers could be obtained and the lighting be properly balanced. A liquid dimmer with its electrolyte mixed

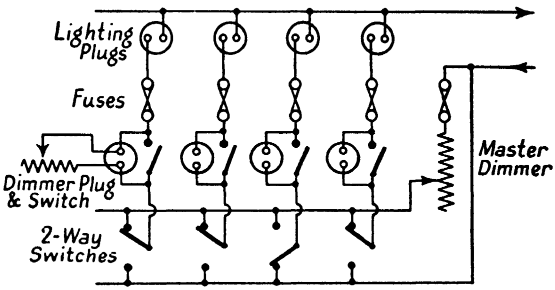


FIG. 85. CIRCUIT FOR BOARD WITH MASTER DIMMER, AND PLUGS TO INSERT INDIVIDUAL DIMMERS

to suit a particular production is suitable but inconvenient, and so for this example I suggest a slider of 1/2000 watts. This dimmer could be overloaded 50 per cent provided it is not left on check in an intermediate position. A prominent warning as to its proper use is needed if it is not to be burnt out at frequent intervals. A silent blackout could be obtained on A.C. from a 60-amp Wylex switch (see Chapter XV). The next stage of development can be to add a repeat of Fig. 84, making two groups of seven switch circuits, enabling at least fourteen lighting circuits to be controlled; more, if the outgoing board circuits terminate in plugs. This board can be easily constructed and wired by amateur labour.

The circuit in Fig. 85 has the advantage that additional dimmers, perhaps hired for the occasion, can be plugged into individual circuits. Thus a lamp at, say, half-check and a lamp at full can be dimmed simultaneously on the master dimmer. Fig. 86 shows a 10-way board of this type. When several dimmers and a master can be purchased, considerable advance is possible, and the circuit of Fig. 87 is the result.

When planning a flexible board, one is conscious of the advantage of using reactance dimmers, but unless there is a vast development in reactance dimmers, a board for twenty-four lighting circuits with twelve 2-kW reactance dimmer ways and an interplugging panel would be an anomaly, as the same outlay (maybe less) could give all twenty-four circuits their own resistance dimmer, thus making a perfect, straight board. In American books on stage lighting there is a tendency to belittle the straight board and to find strange merit beyond financial in the flexible board. To me, there seems to be no justification for this attitude. I strongly recommend that a flexible board should be adopted only where funds will not secure a dimmer for each lighting way, and even then as many dimmers as possible, rather than one or two expensive ones, should be purchased. A flexible board is always rather personal to its operator and difficult for a deputy to take over at short notice. Also, an unskilled operator without electrical knowledge cannot be trusted to do the right thing with the apparatus, and it can be positively dangerous when the lighting is spread over two or more phases. On the other hand, a properly constructed straight board ought not to need an electrician to work it.

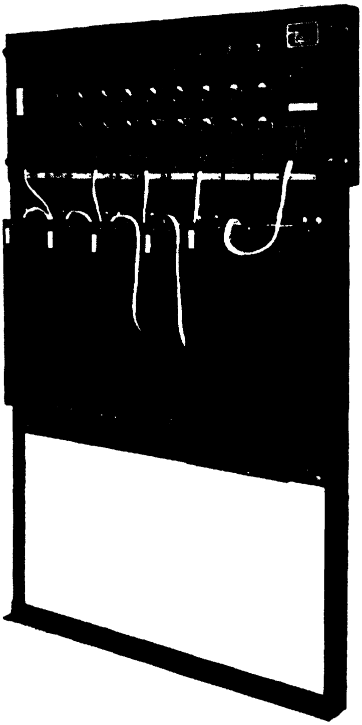


FIG. 86. 10-WAY FLEXIBLE BOARD WITH FOUR INDIVIDUAL AND ONE MASTER DIMMER

In order to obtain complete flexibility, a cross plugging board is sometimes used; the Royal College of Music, Parry

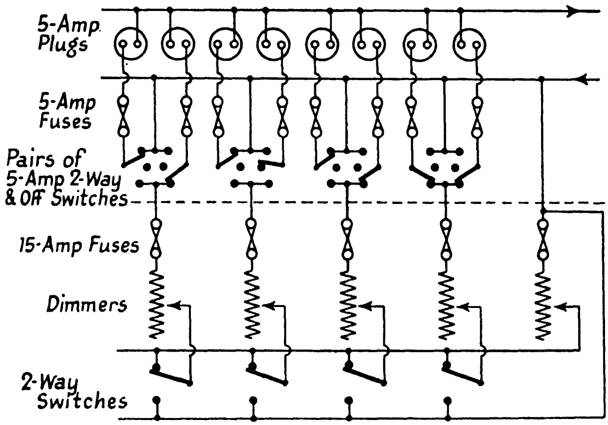


FIG. 87. FLEXIBLE BOARD CIRCUIT TO ALLOW TWO CIRCUITS PER DIMMER

Opera Theatre, provides an early and elaborate example. For this arrangement there is a series of horizontal busbars, one per dimmer, and a series of vertical busbars for the lighting circuits (Fig. 88) insulated from each other. Each lighting busbar has a plug which can be pushed through a hole in the lighting bar and make contact with the dimmer bar. There can be only one plug to each lighting circuit because if the same lighting circuit were plugged into two separate dimmer circuits, the two dimmers would run together; and if the two dimmers were reactance type, the *least* that would result would be a blown fuse.

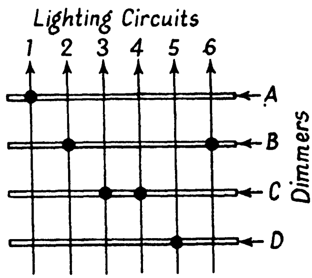


FIG. 88. INTERPLUGGING PANEL LAYOUT

It is sometimes suggested that the movable plug might be replaced by a series of interlocking switches. If there are eight dimmers and twenty lighting circuits, there will be 160 switches in twenty interlocked groups of eight. If the dimmers are, say, slides of a multi-way transformer dimmer (Fig. 62) as they certainly ought to be, the result will be more expensive than the corresponding straight board, and for what? It has even been seriously suggested that the switches for the above arrangement should be contactors going to a push-button panel!

In one British example of a reactance dimmer flexible board, at Glyndebourne Opera House, the nucleus is a 24-way Bordoni transformer, operating a hundred lighting circuits. Interesting though it is, to my mind the board could have been constructed on the straight system mainly of resistances and, in consequence, have been much easier to work.

Dimmer Reduction

The problem of the large installation is difficult. At present the practice is to install a dimmer for every one of more than a hundred lighting circuits and for really large stages there may be two or three hundred for which to plan. Economics usually will only permit the simplest form of control because of the high expenditure on the dimmers themselves, and so we find several operators working two or more simple boards. In the West End it is commonplace to find at least two large house boards on a production and portables as well. It is just these large installations which should have the finest control in order to exploit to the full their potentialities. The flexible systems so far described do not lend themselves because an operator could never keep track of two hundred lighting circuits on a board where these may be grouped in any combination on any of one hundred dimmers, some held on the mains and so on. At rehearsal he would be particularly liable to lose his way and would be in continual difficulties in remembering where he last plugged a lantern.

Some application of the flexible principle is essential to reduce outlay on dimmers so I suggest the circuit Fig. 89. Here is shown an 8-way acting-area flood bar, but there are four dimmers instead of the orthodox eight. Each lamp can be switched to "off" or to either of two dimmers. Lanterns can be dimmed individually, grouped as odds and evens, inner and outer, the end lanterns cut off and so on. Assuming the lanterns are 1000 watt, then the dimmers will be 1000/2000 watt.

The operator always knows his lantern must be on one of two dimmers and is unlikely to be confused. This system though suitable for direct-operated boards would, by cutting the outlay on dimmers in a large theatre by a half or a third, permit remote control of the dimmers on the systems described in Chapter VI. So that groupings can be changed rapidly, a pre-set switching system should be used. The change-over switches in Fig. 89 become pairs of single-pole contactors, the coils of which are operated remotely by miniature two-way-

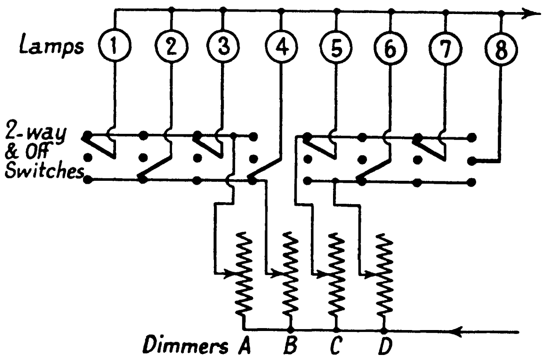


FIG. 89. CIRCUIT FOR EIGHT LAMPS TO SHARE FOUR DIMMERS

and-off switches energized in a similar manner to the single-pole switches in Fig. 79. Then it is possible to set up perhaps six groupings in advance to be brought in, singly or in combination, by putting down one or more pre-set masters at the remote control panel. Switching is inexpensive compared to dimming. Therefore, using low-voltage pre-set action and making the selection contactors act also as blackouts, eight circuits on four dimmers with six adjustable pre-set selections will be very much cheaper than the straight set of eight dimmers, if, as is intended, the dimmers are remote controlled.

Placing the Stage-board

Undoubtedly, the place for the stage-board is in the auditorium, where the operator can see the stage as the audience sees it. When remote-control systems are used, this is easy.

It has even been done with direct-operated boards when the number of dimmers has been small, as, for examples, in the orchestra pit at the Rudolf Steiner Hall, London, or in the film projection room at the back of the circle in some cinemas. Telephonic communication between board operator and the men on the stage is essential to F.O.H. positions. Amateurs, however, are advised to place their boards so that the stage can be easily visited during intervals, and more important, during rehearsals. In their case, and different from the professional theatre, it may well be that the switchboard operator

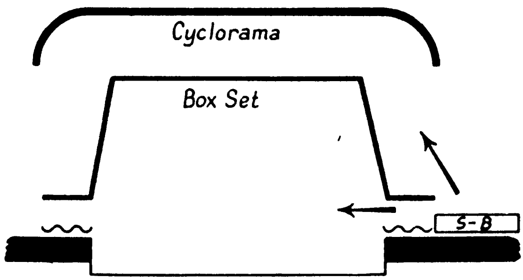


Fig. 90. Plan of Proscenium Position for Stage-board

is the only one who is really *au fait* with the installation and its adjustment. A direct-operated board should never be placed far away from the stage as the wiring between it and the stage will be costly.

When an auditorium position is out of the question, the best place for the board is against the proscenium wall. On small stages this will be difficult to achieve unless the board is of a type that does not require rear space. For amateur work it is better to have the board on stage-floor level, not on a perch. In the position recommended (Fig. 90) a view of the "down stage" is possible through the first wing and a view of at least some part of the cyclorama can be obtained, whatever the setting. Though the tendency is to put the stage-board on the same side as the stage manager, I cannot see any justification for this practice. Any signals between the board and the stage manager are better given by lights and buzzers. On a small stage to have both the board man and the stage manager trying to peep through the same restricted space is a drawback. These two must occupy opposite sides of the stage. The stage manager should have first refusal of the side nearer the dressing-rooms, but insistence on the nearness of the stage-board to the supply authorities' main will probably be the outcome of financial considerations. Should the size of the board not allow the proscenium wall position, a site in the wings will be required, in which case the board must be on the same side as the stage manager as all kinds of signals may be necessary, since the acting area will be out of sight when box sets are used.

CHAPTER VI

REMOTE-CONTROL STAGE-BOARDS

ALL who take an interest in the theatre should follow the subject of this chapter, for the future of stage lighting is tied to the discovery of some means to enable the complete installation to be played upon by an artist. All forms of remote control are of necessity more expensive than the corresponding direct-operated board. We have to employ the same dimmers, switches, and fuses which carry the heavy currents commonplace to-day; and to this we have to add a miniature switchboard of some sort, and the mechanism (robot operator, if you like) which enables the remote-control panel to move the various parts of the full-size board. The remote-control board may be likened to the player-piano, since the latter is a normal piano plus a lot of additional mechanism: so much is plain common sense.

There are two reasons that govern whether remote control should be adopted in preference to direct operation: (*a*) the size of the lighting installation; and (*b*) the amount of artistic expression required from the installation. The financial brake I do not include; it is always with us. It is obvious that as soon as the number of dimmer ways exceeds sixty, then the direct-operated board becomes more and more cumbersome until at 100 ways the situation is impossible. The barrier to stage-lighting development presented by several operators waltzing round a switchboard 15 ft. or more in length without a view of the stage, must be obvious to all. Reason (*b*) is more subtle and very difficult to bring home to people who have not actually tried their hand at switchboard operation. It is, however, a fact that even with quite a small direct-operated board of thirty dimmer ways, the operator is conscious of limits imposed by his machine; the limit is not on account of the small amount of lighting apparatus on the stage, but in his inability to use it to the full. Furthermore even a small board of thirty dimmer ways is not small enough to be placed with a full view of the stage, as the audience sees it.

Tracker-wire Control

A short general history of remote control in the theatre is instructive. I know not and care not where the first authentic

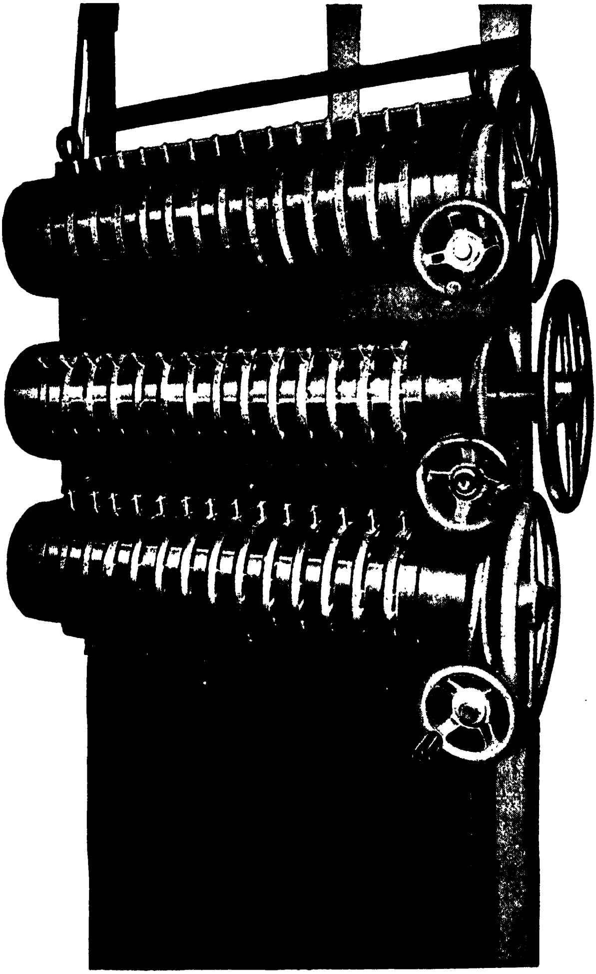


FIG. 91. GERMAN 42-WAY REMOTE CONTROL DIMMER REGULATOR

use of remote control is recorded, but the general application undoubtedly comes from Germany. This is natural enough, since for a long time Germany led the world in the large-scale stage installation, and of course the lighting was correspondingly elaborate. These large installations had to use some means, other than direct operation, to keep down the size of the control unit, and mechanical remote control was adopted. The dimmers, at one time resistances but latterly (as at the Paris Opera) auto-transformers, were situated in the basement and moved by tracker wire from a compact lever unit. This unit resembled somewhat the ordinary direct-operated dimmer handles with their interlock on the shaft for master operation; but being no longer governed by the physical centres of the dimmers, the levers could be placed at much closer horizontal centres—two and three-eighths inches as against four and a half (Fig. 91). The control was very often placed on a perch on one side of the stage, which position, owing to the geography of a German stage setting, gave a pretty good view. It has sometimes retreated beneath the footlights where the operators become puppets acting under the instructions of the lighting director, who alone gets a view of the stage through a prompter's hood, periscope, or camera obscura.

The fact that the main addition to the mechanism usual to a direct-operated board is a length of tracker wire between the handle and the dimmer, might suggest that this form of remote control is inexpensive, but this is not so. There are hundreds of these tracker wires running very often for considerable distances and turning various corners in the process. Very careful installation is needed. This and their servicing needs skilled craftsmen. A few installations of German manufacture are to be found in this country. These mainly date from 1924 when, under the aegis of the G.E.C., a drive was undertaken to equip a number of theatres with Schwarbe Hasait cycloramas and their lighting equipment, including the famous cloud machine.

The Magnetic Clutch

By the time British firms had seriously to consider manufacture of remote control there had been several electrical developments which tended to oust the mechanical tracker wire. The principal of these, as far as England was concerned, was the invention by M. Mansell of an electromagnetic clutch for dimmer control in 1930 (Fig. 92). Using this clutch, it became possible to drive a number of dimmers up or down from a uni-directional shaft, a small current being switched to up-clutch coils and down-clutch coils as required. The energizing switch could, of course, be remote from the clutch. I

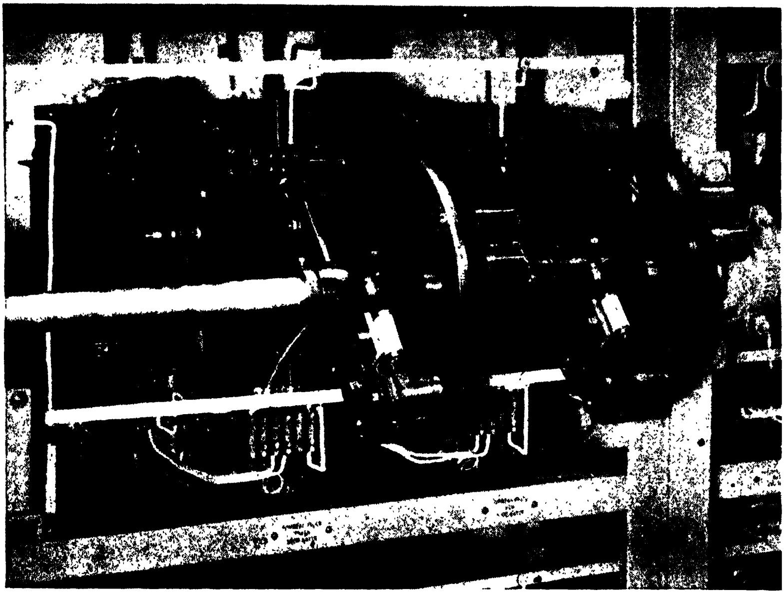


Fig. 92. Electromagnetic Clutch Driving Auto-transformer Dimmers Up and Down from Uni-directional Shaft

may add the clutch is very responsive and the dimmer may be stopped or reversed on the instant, in a way quite impossible in the form of electric remote control previously available, which employed fractional h.p. motors each driving its own dimmer through a lead screw.

Covent Garden Opera House

The first opportunity to use the clutch for stage work came when it was decided in 1934 to equip (at short notice, of course) the Covent Garden Opera House stage with an entirely new lighting installation and cyclorama (Fig. 93).

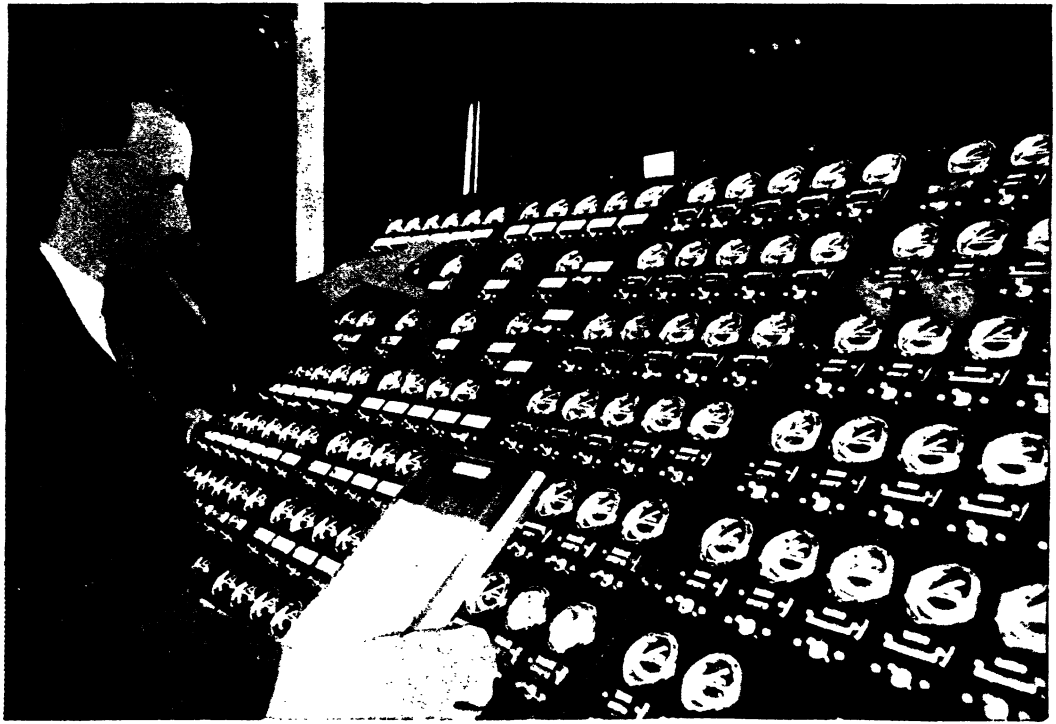


FIG. 93. 130-WAY REMOTE DIMMER CONTROL PANEL (COVENT GARDEN OPERA)

The time factor had considerable influence on the design of the dimmer control, and an arrangement of electro-magnetic clutches driven from a hand-operated shaft was the result. Each dimmer circuit has a miniature two-way-and-off switch which can be set to take the dimmer up or down, or not to move at all. There is a dial above each switch which continuously records the position of the dimmer (Fig. 94). The board is divided approximately into halves. One half controls all the colour circuits—battens, cyclorama, etc.—and the other half the independents—spotlights, acting-area, floods, etc. Motion is given to the dimmers, locked on, by means of a hand-driven shaft to each half. Although the dimmer bank is in the basement and the control is on a perch, the driving shaft is extended to capstan wheels with quick- or slow-motion gearing under the control panel. Personally I consider this hand drive rather inconvenient and feel that a motor could have been substituted, but particular concern was felt for slow-speed dimmer operation. Opera frequently demands very slow-speed dimmer checks and at that time there was no experience to go on. The circuit switches and master blackout switches are, as was usual with the German tracker-wire predecessors to this control, mounted on a separate direct-operated switchboard farther along the perch.

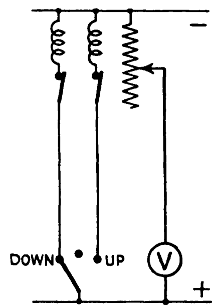


FIG. 94. SCHEMATIC CIRCUIT, COVENT GARDEN OPERA CONTROL

The indicator dials giving the position of each dimmer are fed from a miniature resistance coupled to the dimmer arm, making it possible to read the position even in a blackout, when the dimmer proper is not alive. At first sight the Covent Garden control appears ideal: we have the equivalent to a direct-operated grand master, but so much reduced in scale that it can be operated from a stool; the position of each dimmer can be read at a glance; and, unlike most direct-operated boards, dimmers can be locked on to travel up or down on the same shaft (batten 1 red can go up and batten 2 red down at the same time). However, there are certain snags which tend to make this board, for all its compactness, slow to operate. Apart from the fact that no circuit switching or blackouts take place from the panel, locking and unlocking the dimmers by the two-way-and-off switches is a very slow business. For example, suppose we have just checked twenty-four dimmers and we now wish to move one; it is necessary to place all twenty-four switches in the centre neutral position to unlock them before we can lock on and move the new dimmer. With the direct-operated board, one has merely to walk over and push the dimmer up, a quicker job, whatever

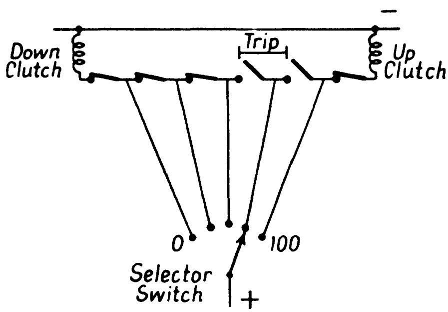


FIG. 95. LIMIT-SWITCH CIRCUIT FOR REMOTE DIMMER DRIVE

the length of the board. There are 130 or so two-way-and-off switches, and some group masters have been provided to enable certain groups of switches to be rendered dead without moving their individual dollies, but this arrangement is very limited in application. The slow changes in opera give plenty of opportunity for resetting the switches, nor has anything rapid been attempted for ballet; so that, up to the present, it has done all that has been asked of it.

Follow-up Mechanisms

There have been many attempts to provide remote control with miniature levers, each of these levers being electrically coupled to a dimmer which follows or hunts with it. The most obvious way to do this is to provide a series of limit switches along the path of each dimmer: the remote lever when placed at, say, 70 per cent, so connects the limit switches that the clutches will drive the dimmer to the 70 per cent limit and stop (Fig. 95). By varying the speed of the driving shaft, we can make the dimmer take up its position almost as rapidly as we move the lever, or quite slowly.

If there is to be any finesse in the lighting, then the limit switches ought to be arranged to allow at least 10 per cent steps, i.e. 0 per cent, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100. This will require twelve limit switches to each dimmer, which is somewhat extravagant; but worse still eleven wires, making 1320 wires on a 120-way board for the dimmer control alone. A better method has been put forward, whereby the up clutch or down is energized on the closure of a sensitive polarized

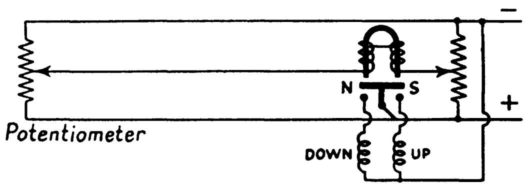


FIG. 96. WHEATSTONE BRIDGE CIRCUIT FOR REMOTE DIMMER DRIVE

relay, coupled to a Wheatstone bridge circuit (Fig. 96). In this circuit movement of the remote lever puts the bridge circuit out of balance, which in turn causes the polarized relay to close according to the direction of the out-of-balance current; the clutch then moves the dimmer until balance is restored. This method requires only a reasonable number of wires, the number of intermediate positions selectable depending not on additional wires but on the sensitivity of the polarized relay.

Assuming 120 levers, using either of the above systems arranged as a miniature dimmer board, it is not sufficient to rest there. A means has to be provided for simultaneous movement of large groups of dimmers in rapid succession. One method will be for normal work to keep the shaft motor revolving fast, and the dimmers then follow any particular movement of the remote levers as rapidly as they can (say four seconds). For a large change the motor could be stopped, the levers reset to new positions, and the motor restarted. There are drawbacks to such a system, for unlike the Covent Garden dials our remote levers only register dimmer position while the dimmers are free rapidly to follow up; so that in stopping the motor or in running it very slowly, we are left for a time without an idea of the actual dimmer positions. Suppose the manoeuvre is being carried out at dress rehearsal. The change has been under way a little time only, and if the producer suddenly says: "Stop there. I prefer that effect. Plot it." We are sunk! Perhaps twenty dimmers left their

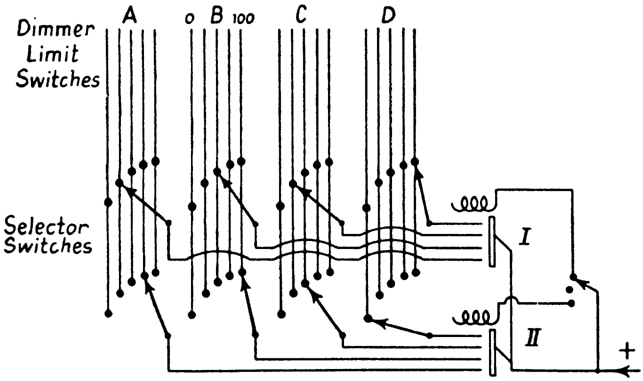


FIG. 97. ONE-SCENE PRE-SET CIRCUIT FOR USE WITH FIG. 95

last position plotted as 2, 8, 2, 10, 7, and so on, to travel to their new lever positions 6, 0, 10, 0, 3, and so on; the producer now wants us to plot with the journey incomplete. Unless we visit the dimmer room to look at the dimmers, there is no means of knowing their exact position. Of course, voltmeter dials could be fitted, but the expense on top of the bridge system would be fearsome.

Pre-set Boards

Partly to get over this difficulty the pre-set board has been developed, and each dimmer is provided with two levers, very often as many as eight. By means of a master selector switch the dimmers are transferred from the positions indicated by Scene 1 levers in use to those pre-set on Scene 2 levers (Fig. 97). We do not get the hiatus when one set of levers is being reset to new positions while the motor is stopped. With the multi-scene pre-set we cannot, however, avoid it between the fulfilment of a change from one scene pre-set to another.

The rows of duplicate switches to each dimmer are known as scene pre-sets, though no one in fact is crazy enough to think that one change serves a scene. The number of lighting changes in a play is usually so considerable that the most that can be done is to take advantage of a lull to set the scene pre-sets for some of the more hectic changes to follow. Productions with several hundred lighting cues are not uncommon. Pre-setting of a kind has been in existence some years now, the earliest form being the provision of eight scene pre-set of the lighting circuit switches on or off. This was of little value and was followed later, in 1930, by the pre-setting of dimmers up and down without intermediate positions: the Major system at the Trocadero, Elephant and Castle; lastly, position pre-set (Newton patent) in 1933 by the same firm at the Regal, Edmonton.

There have also been regulators designed to pre-set *speed* of dimmer change, but not the position of the dimmer. A famous example was the hydraulic control installed in 1926 at the Parry Opera Theatre of The Royal College of Music. It is still working. The author also fell for pre-set dimmer speed in the first Light Console and, like the College of Music, some very slow ones (twenty minutes or so) were provided, but investigation showed these to be of stunt showman value only.

The Electronic Board

So far we have considered remote control in which a remote lever is moved to a position, and by electro-mechanical means the dimmer takes up a similar position, after a greater or lesser time lag. There is a parallel in the automatic lift: the button for the fifth floor is pressed and in due course the lift goes down or up, depending on its location, until the fifth floor is reached. Another method, all-electric in operation, based on the gas-filled triode valve or Thyratron, must now be investigated. This dimmer circuit was described under D.C. saturable chokes in Chapter IV. Built up as a dimmer board (Fig. 98), it presents a series of miniature levers on a remote panel similar to those already described for the follow-up systems, but in this case the levers operate small potentiometers (radio size) on the back of the panel, which in turn

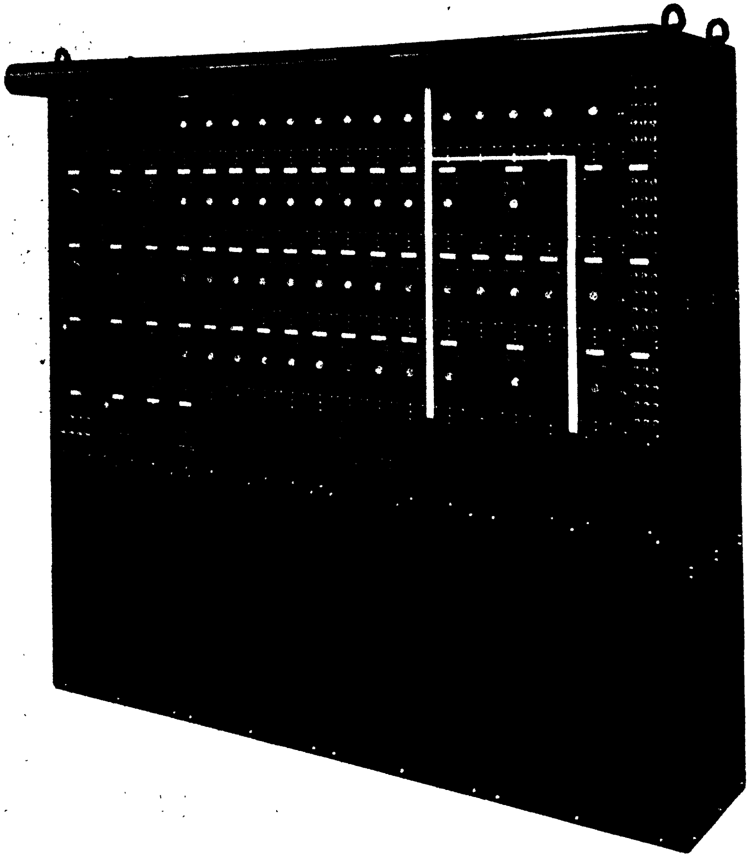


FIG. 98. 52-WAY 1-SCENE PRE-SET PANEL FOR ELECTRONIC DIMMER BANK (ODEON ALHAMBRA, LONDON, 1938)

regulate the grids of the Thyratron valves on the remote dimmer bank. The dimmers are saturable chokes (reactors) receiving the D.C. from the valves. There are, unlike the other systems described, no moving parts (Fig. 99). The remote lever in effect directly controls the amount of light given by the lamps of that circuit. If the lever is moved slowly from "Full"

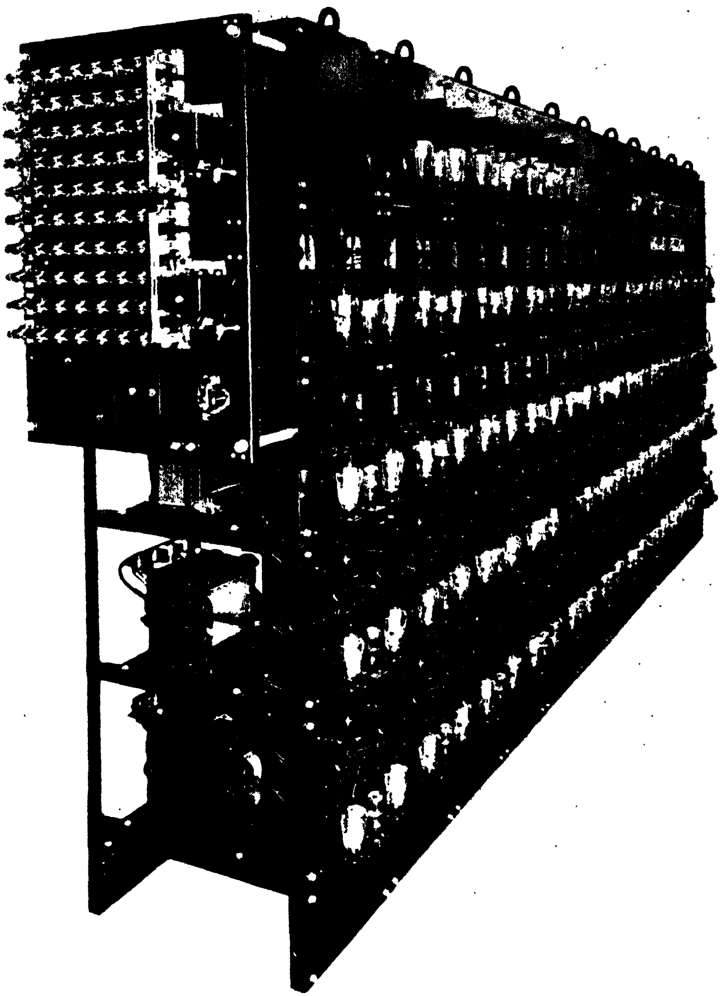


FIG. 99. ELECTRONIC DIMMER BANK USING THYRATRON VALVES AND SATURABLE REACTORS

to "o" the light will dim slowly; if the lever is moved rapidly, then the light change is rapid. The remote levers for each dimmer circuit can be repeated for a number of scene pre-sets and brought in by movement of a master fader knob. The master faders, unlike the mechanical systems, affect the individual dimmer positions proportionately; consequently a fade from Scene 1 pre-set to Scene 2 pre-set can be plotted at any time by taking note of the fader position.

The use of two levers (one pre-set) to each dimmer circuit makes the panel to control fifty-two ways, plus the necessary masters, etc., 73 in. wide × 40 in. high; from which one can see that a six-scene (or change) pre-set, for, say, 150 dimmer ways, is not going to be as small as one had hoped. In fact the very large installation at the Metropolitan Opera, New York, allows to the operator of the master faders a view of the stage only through a prompter's hood, the individual dimmer scene pre-sets being set up by assistants adjacent to him but out of view of the stage. In other large installations, such as Radio City Music Hall, New York, the Thyratron board occupies a kind of small orchestra pit, on the stalls side of the orchestra (Fig. 100). This is far from a one-man control, but it must be remembered that the stage-lighting installation at this theatre is very much larger than anything we have at present over here. Of course, the remote stage-board is not solely concerned with dimmer movement and blackouts, but increasingly has to control auxilary apparatus such as remote colour change of spots and floods, more and more of lanterns making up the installation being so equipped. The great German tracker-wire remote controls mentioned earlier in this chapter did also control (by tracker wire) the colour change of spotlights, and even acting-area and cyclorama floods hanging over the stage.

The British Thomson-Houston Company claim the following advantages for their Thyratron reactor dimmer over the resistance type—

1. The master control board is of small physical dimensions, and thus can readily be located in confined spaces or even in the orchestra pit or other front-of-stage location.

2. Master control or "ganging" is obtained electrically by operation of convenient switches. No mechanical devices such as clutches are needed.

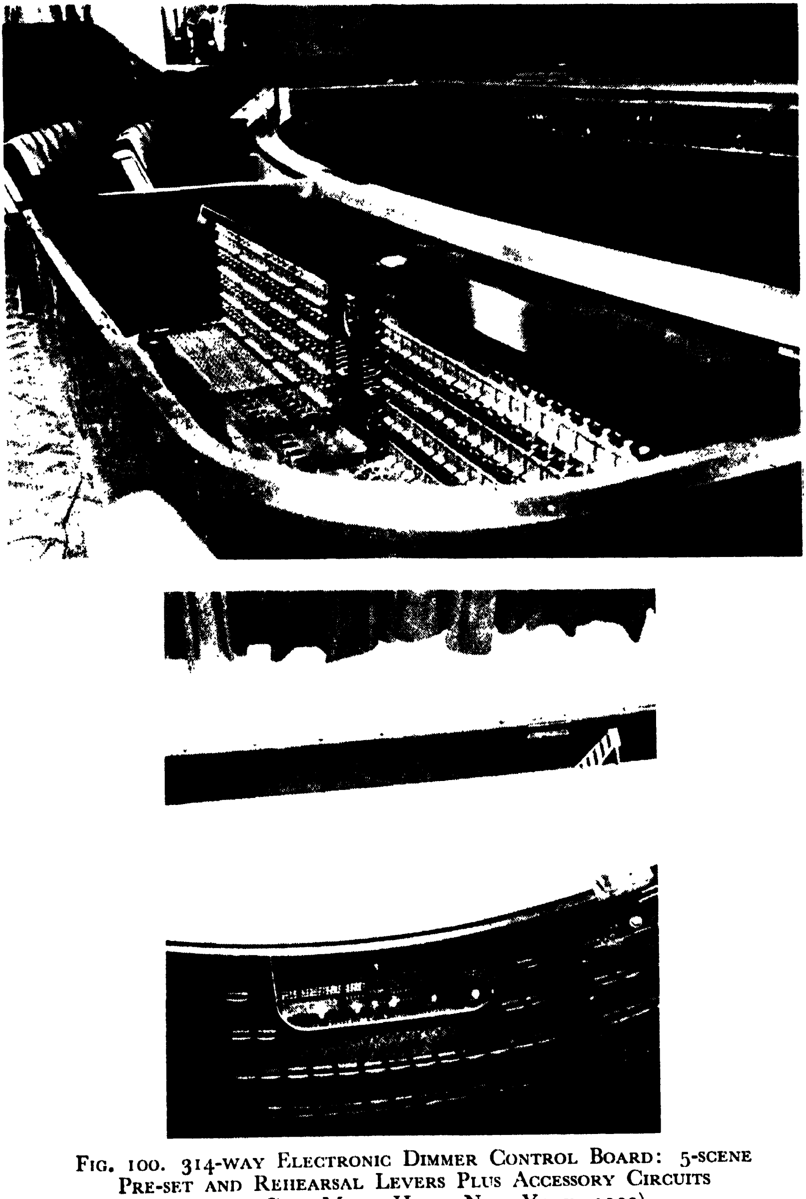


FIG. 100. 314-WAY ELECTRONIC DIMMER CONTROL BOARD: 5-SCENE PRE-SET AND REHEARSAL LEVERS PLUS ACCESSORY CIRCUITS (RADIO CITY MUSIC HALL, NEW YORK, 1933)

3. Operation of the Grand Master causes true proportional dimming, and the resultant colour of the blended light remains the same at any intensity.

4. Scene pre-setting is readily achieved. A Thyratron dimmer provides the only practical means of true pre-setting of a large number of circuits.*

5. Change of intensity control, master control, and scene changing require very small physical effort. This, combined with the compactness of the control, increases several times the number of circuits which one operator can manipulate.

6. With remote-control system, the dimming speed is under the control of the operator.

7. The dimming circuits are capable of operating from two or more points in the theatre by duplication of the elements in the master control board only.*

8. Due to the special Thyratron circuit employed, the lamp load on any circuit can be changed by a ratio of as great as 5 : 1 while maintaining full control of light intensity from "blackout" to "full bright."

9. Stepless control of light intensity is obtained, ensuring that the change in light output occurs smoothly and without flicker.

10. Ratings up to 20 kW of lighting per circuit can be provided by reactors of standard construction.

11. The reactor or dimming equipment can be located in any convenient part of the cinema to ensure lowest cost in heavy current busbars and wiring.

12. An almost negligible amount of heat is dissipated by the reactor equipment, thus giving additional freedom of choice in location. No special ventilating ducts are needed.

13. No sliding or moving contacts are used in the power circuits and no heat-dissipating resistance elements.

14. Since there are no rheostatic losses, the efficiency of the dimmer is very high.

15. If a motor-driven control is required for automatic dimming, this can be arranged for by the addition of a small unit mounted with the reactor equipment.

* Second part of Claim 4 is questionable, and Claim 7 applies to most electric Remote Control systems.

16. Apart from occasional Thyratron replacements, maintenance is negligible.

The apparatus supplied in 1938 to carry out the above claims was extremely costly compared with other controls in use. Later developments, such as the direct use of the Thyratron valve, may bring down the price and place this type of control board within the purview of most commercial theatres.

Layout of Pre-set Panel

The Odeon Alhambra panel (Fig. 98) is arranged on traditional Grand Master direct-operated board lines. The miniature levers are grouped in colour rows, each having a colour master which can be connected in turn to a Grand Master fader. The main break-away lies in the provision of pairs of dimmer levers giving the effect now in action and a pre-set one to come. For cinema work, preoccupied as it is with colour changes, this layout is quite suitable, but in lighting control for the legitimate theatre a more unorthodox layout should be adopted.

Instead of colour rows, dimmers should be grouped in families: the spotlights, the stage plugs, the magazine equipment, and the cyclorama, each of the dimmers to be connected —"off," "on group master," or held "independent"—by a switch above the dimmer lever. The group masters are in turn connected by a three-position switch to the master blackout or independent of it. Grouping by families will be opposed by the traditionalists, but on a board using proportional electric master dimming it is more than usually absurd to split units into colours. The light from the cyclorama equipment or from the footlight will almost certainly be a blend of several colour circuits and it will be inconvenient if, to lessen intensity in some area of the stage, we have to set the whole board and use the master fader.

As there is no mechanical interlocking of levers a one-scene pre-set is the minimum if one-man control is to be achieved. I think the second set of levers should be arranged as a duplicate half of the board. Thus Scene I dimmer levers are on the left, Scene II on the right, and the masters between them. I find this layout, rather than interlaced pre-sets, makes it easier to see at a glance the lighting as it is and as it is going to be. Also, it is impossible to push up several levers with the flat of the hand for a rapid change when, for example, the left-hand lever of a pair has to be picked out in each case.

A one-scene pre-set can be more adaptable when a three-position switch is fitted to each group master. In the centre positions both groups are on the cross control fader; on the left Scene I, or on the right Scene II, is held independent of it. Thus, for example, the cyclorama can be detached from the cross fader for a time, its lighting remaining static or pursuing a slow independent general fade irrespective of the more active changes going on elsewhere.

If the dimmer controls are mounted at one-inch horizontal centres and seven-inch vertical a 96-way two-scene pre-set board with masters will become a compact panel 6 ft. wide by 3 ft. high. An alternative arrangement in desk form is easily possible. (See Fig. 218, Appendix VII.)

The one-scene pre-set panel represents a great advance since it allows one man to do what would require several on a giant Grand Master direct-operated board. However, as soon as any advance is made beyond to-day's lighting towards flowing changes we are held up by the need to reset our pre-set levers. Thus we find in United States, where there has been most experience of this system, the number of pre-sets increases and with it the size of the control panel. When there are several pre-sets there is but one complete set of dimmer controls, master faders, etc.—the rehearsal system. To this are added several dimmer levers only to each way, known as the pre-sets.

The George Izenour control installed at the Yale University Theatre in 1947 is the latest and probably the finest example of the electronic multi-scene pre-set board. The rehearsal levers and masters have been formed as a compact desk for an operator seated in view of the stage. Every refinement has been added; for example, finger-tip operation of the levers, and dials showing light intensity in each individual circuit. The operator can see from the latter the exact state of light when, because a master fader or a pre-set is in circuit, the individual rehearsal levers no longer tell the truth.

The pre-sets, of which there are ten, form a separate board placed alongside (not essentially) the desk. Ingenuity can scarcely take the pre-set system farther. At the inaugural performance a play which was almost a continuous lighting change was successfully lit by two men, one at the desk and one setting up the pre-set panel.

I think the drawback will come when the system is used for a large installation instead of the present small one of 44 ways. For 220 ways there will be five times the present number of rehearsal levers and dials on the desk which will no longer be compact enough for a seated operator. The pre-set panel will have 2200 levers on it at least. I say "at least" because strictly speaking if ten pre-sets cover resetting time for forty-four dimmers, more pre-sets are needed to cover the resetting time for a row of 220 dimmers, unless more men attend to the pre-set panel, which, however, would take us farther from the one-man control, already sacrificed at the inaugural performance. And I consider absolute one-man control of paramount importance because lighting must escape from the tyranny of division into defined cues or changes if it is to advance.

Automatic Boards

Following the pre-setting of a limited number of changes it is natural to consider the possibility of recording all the changes for a production—a robot board, only requiring its cues from the stage manager, who would give these from the same single-push button. A flick on the button and the board would automatically perform the cue, be it a snap change or one of long duration. From time to time there is a vague hope expressed for something of the kind, and indeed there has been some invention in this direction. Such a board would best be described as an automatic board, and its mechanism might be comparatively crude, such as a rotating drum with adjustable pegs, or a perforated roll of paper similar to that of the pianola, or even some higher flight involving the magnetic steel tape. Examples of the first two applied to lighting do exist, an example being the drum on which the author was able to set the lighting changes for the North Cascade at

Glasgow Exhibition in 1938. There were nearly 200 changes on eighty lighting circuits, sufficient for most productions, and I do not think it would be hard to modify the apparatus to work with a magnetic dimmer bank instead of as a direct flasher. Setting up the screw pegs for each production would be somewhat laborious, but not unduly so; money permitting, the pegs might be moved magnetically in some equivalent to the London Underground train indicator storage machine.

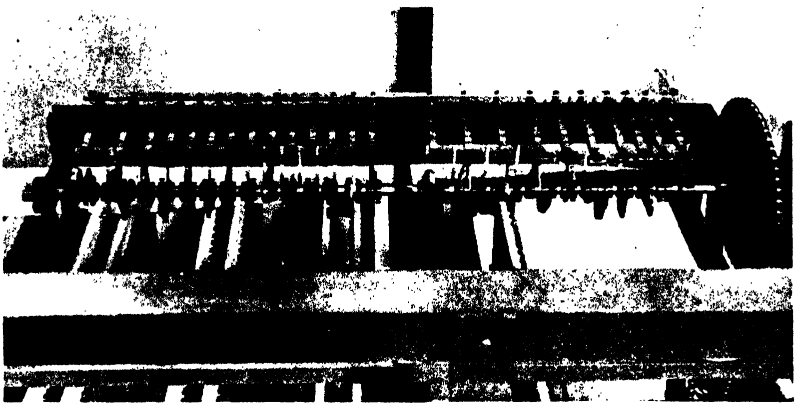


FIG. 101. ADJUSTABLE CAM-OPERATED SWITCHES FOR AUTOMATIC DIMMER CHANGES

Another adjustable dimmer drum example, smaller in size but working on dimmers, comes from the same exhibition in the Victoria Falls display. In this case a sequence from dawn to midday to sunset and night, taking about fifteen minutes, was set on adjustable cam-operated switches (Fig. 101). The lighting equipment controlled included cyclorama, effects projectors, spots, and floods. Similar dimmer equipments, in which elaborate effects could be set up to make a balanced picture, for repetition by the unskilled from a single button, were frequently supplied during the War to the services for training purposes. The lighting equipment, which included big cycloramas, differed but little, however, from that of the theatre; the money in these jobs was, unlike those for the theatre, not in short supply.

The perforated paper record is used in the electric running-sign newspapers, to make the lamp circuits forming the letters. The cutting is easy, and rapid into the bargain, as befits a newspaper. However, I am not really concerned with the engineering but with the aesthetic aspect; if someone wants such a control and is prepared to pay for it, we engineers will provide, but should we artists rejoice?

Before delving into aesthetics it had better be pointed out that the principal difficulties will be encountered at rehearsal. Even in those rare instances where a lighting plot is written out in advance, it is usually cut and altered beyond recognition before the first night and during the week following. It follows therefore, that for rehearsals we should need a normal board to carry out the producer's requests for this and that, without delay. However easily the recording system might allow alterations, the show and its lighting usually remain in a state of flux with precious little pause for thought, right up to the final curtain on the first night. If the operator has managed to get through on the normal board he is not in any need of recorded aids in the following performances when the tension eases.

However, be that as it may, I feel that there must be the same objection to employing an automatic board as there is to employing a pianola instead of a pianist in an orchestra of live musicians. The theatre is, except in very long runs, the home of live artistes. In the same way that each night the actors bring to life their roles for their audience, so do the scene shifters bring to life their scenes and the lighting staff their lighting. The inspired rendering of a dawn, or the well-turned cue conscientiously carried out by the man on the board, is a vital part of the theatre. It may be argued that most lighting plots are not very inspiring, but often far more could be made of them without transgressing the producer's intention. In the days when I used frequently to deputize at the light console in the Palladium there was one *very sweet* scene which I nevertheless managed to make really interesting to me by various subtle variations in cyc. mixtures as the final slow check took place.

The Light Console

In designing this control (Fig. 102) I made two provisos, the first that it must be sited to give the operator a good view of the stage, and secondly that the operator should be a theatre enthusiast prepared to take the trouble of training himself in the new technique.

In all the stage-boards, whether direct-operated or remote-controlled, so far described, the master controls have been accessories brought into play when more individual dimmer levers were to be moved than the operator could manage. Thus each lighting circuit had its own dimmer lever and indicator scale, circuit switch, and so on. These were provided in addition with electrical or mechanical means to enable them to be connected at will to some kind of master. In the light console the master is always used whether one lighting circuit or a hundred are to be operated. This means that only one switch is required for each lighting circuit in the theatre to lock it to the master when needed. If unlocked from the master the light in that circuit remains in the state to which it was last called by the master. It can be seen that already a great reduction in the size of the board is possible: one hundred ways requiring only one hundred switches plus a set of master dimmer, indicator, and blackout controls, instead of one hundred separate dimmers, indicator, and blackout controls, plus a set of masters.

The second great departure from stage-board practice is the decision that every control shall be operable by a single finger, and that the controls shall be arranged at 1 in. centres to enable the ten fingers to work ten different controls simultaneously, if desired. Inevitably this led to the adoption of the keys, stop keys, and console of the organ. Here in the modern organ console has evolved through the centuries the perfect means of one man to handle with complete artistic expression hundreds of tone colours. By adopting the organ console we borrow for our art, as yet in its infancy, the experience of the oldest keyed instrument extant. On the practical side, we borrow the already existing relays, bakelite mouldings, and other parts of the organ builder, without the expense

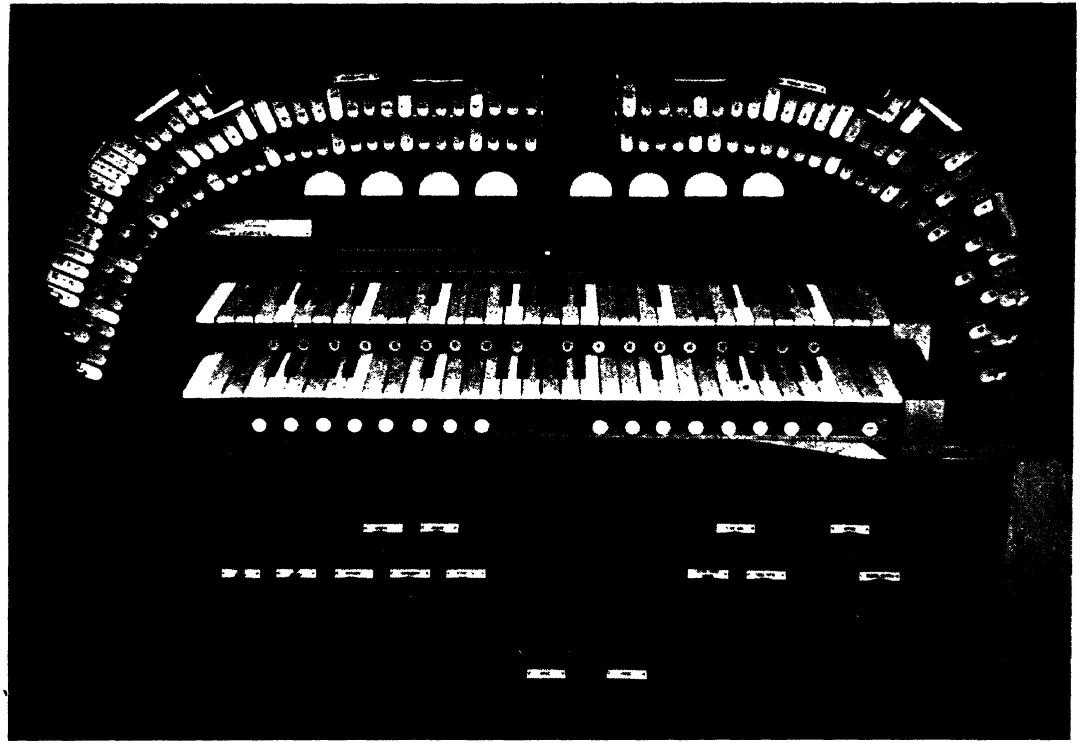


Fig. 102. Light Console for 152 Dimmer Ways and 80 Sets of Remote Colour-filter Change. London Palladium, 1949

and teething troubles associated with designing and making our own.

The single switches to lock the various lighting circuits on to the master become stop keys arranged in semicircular

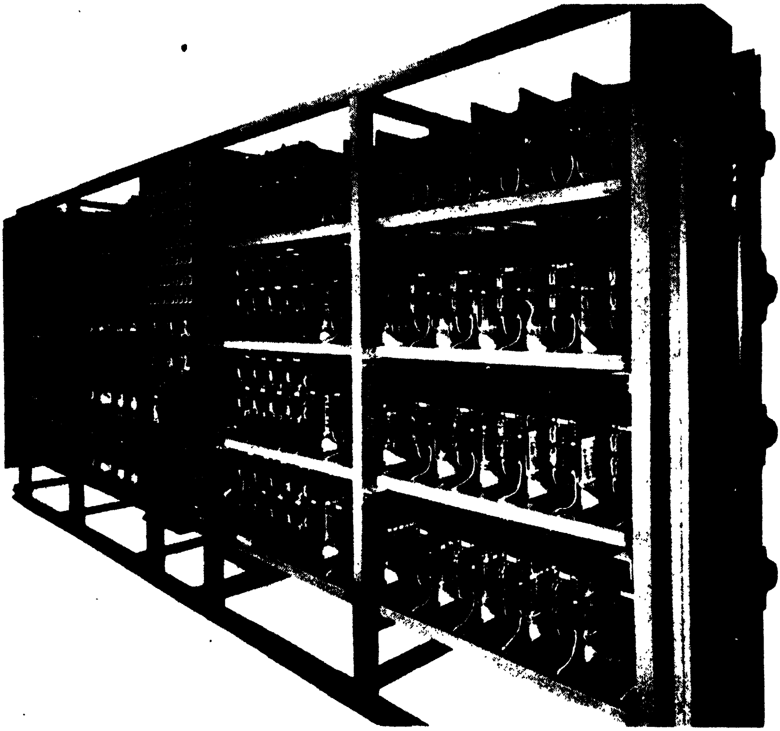


FIG. 103. LIGHT CONSOLE DIMMER BANK, CONTACTOR SWITCH SIDE

rows above the keyboards. The stop keys, mounted at 1 in. horizontal centres, are really switches, and when put "on" stay "on" in the ordinary way. Their characteristic appearance is due to the fact that the operating lever or tab (tablet) is actually the circuit label, a further saving in space. The stop tabs are coloured White, Red, Blue, Green, in rotation, and thus Batten 1 will, if four-colour, have four tabs in these colours. There is usually a group of thirty-six stops (nine of each colour) to one master.

The master comprises twelve keys (three of each colour) which, as there is usually more than one master group, form part of a keyboard, probably of thirty-six notes. The keys or notes only remain depressed as long as the finger bids them. There are two distinct touches, the first touch requiring the

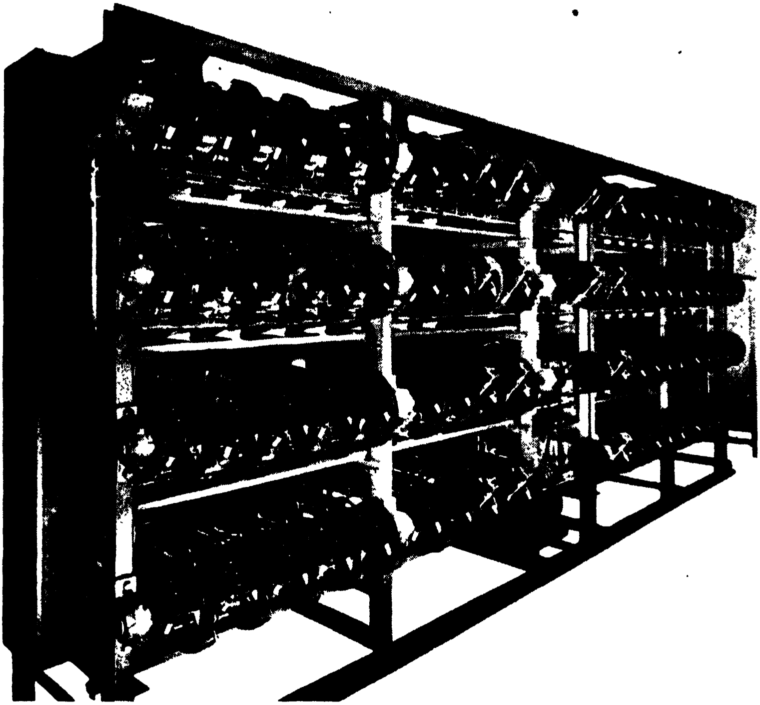


Fig. 104. Light Console Dimmer Bank, Dimmer and Clutch Drive Side

weight of the finger and the second, definite pressure from the finger. From left to right, the first four keys, White, Red, Blue, Green cause blackout contactors in series with the dimmers to break circuit at first touch, and run the dimmers down at second touch; the centre four keys bring the dimmers up at first touch and take them down at second; the right-hand four bring in short-circuiting contactors at first touch and run the dimmers up at second. These activities will take place only in lighting circuits whose stop keys are "on" and which are therefore locked to the master. We can now perform a simple operation: put down the four stop tabs for Batten 2, depress the centre keys to first touch, and the lights will raise; take the hands off the keys or put the stops "off" at any time before the manoeuvre is completed, and the dimmers will immediately stop; if the stops are put "off," the dimmers will not move until they are put "on" again, even though the dimmer keys are used for other circuits meanwhile.

The amount the dimmers are moved by the keys may be observed by watching those particular lights on the stage: if the curtain is down or the dimmer setting-up has to be done under cover of a blackout, then four dials, one per colour, mounted above the keyboard measure the amount of movement imparted. The exact position of any dimmer can always be ascertained by holding its stop key to a second touch against a heavy spring, and this will disconnect the setter indicator resistance, which normally measures the amount of movement applied to the dimmer driving shaft, and connects instead the dimmer's own indicator resistance. This second touch also, while held, unlocks any other stops of the same colour in that group which may be "on"; these are immediately restored as soon as the stop key is allowed to return to first touch—an arrangement which makes easy the jockeying into position of individual dimmers.

The speed at which the dimmer moves is governed by a balanced pedal, one to each keyboard. The pedal gives a range of speeds from sixty seconds dimmer travel to three seconds as the pedal is depressed; it retains its position when the foot is removed, a position which is shown on an indicator above the top keyboard.

This constant unlocking and locking to the master keyboards is rendered effortless by the gracious feel and touch of the stop keys; they are pleasant to work. The shape of the stop tabs and their arrangement lends itself to running the hand over or under, thereby putting "on" or "off" large numbers of stops. Also one can easily flick one "on" and another "off" with adjacent fingers and so on.

As an aid to large movement of stop keys, adjustable combination pistons are provided in the keyboard keyslips. These can be set to cause stop keys to spring on or off. If the foot is placed on the "setter" toe piston and any combination piston pressed, that piston will remember whatever combination of stops is in "on" at the time; subsequent depression of that piston without the "setter" will bring back the combination. The stop keys are fitted with small electro-magnets to pull them "on" and "off." Cancel controls are also fitted so that master groups can be unlocked clear in one movement, the operator being given a clean slate so to speak.

Foot controls (toe pistons) and other auxiliary devices enable the keyboard keys to be sustained, thereby freeing the hands for other work. The blackout contactors can be directly sustained "out," which means that a combination of lights can be blacked out from the keys and held, leaving some lights on; meanwhile dimmers can be manoeuvred to fresh positions using the self-same stop keys and keyboard. There is a general dim and general blackout which take effect irrespective of the position of the stop keys. Thus a scene can be concluded with blackout and the board cleared for action with two foot operations only—foot on blackout piston to second touch, thereby running dimmers down in addition at their fastest speed (3 secs.); a touch on the cancel piston and all is clear.

The console proper is built for the Strand Electric and Engineering Company by the John Compton Organ Company, and the author would like to acknowledge the debt he owes to the latter for the use of many of their ingenious patented devices, in particular the second-touch stop key and their clever vertical and horizontal relay which serves both keys and stops in one unit.

The whole of the action is 15-volt D.C. and the console is connected to its remote relay by means of a multi-core cable in a 1½-in. flexible metallic hose. The relay bank performs the necessary switching operations and also provides a somewhat heavier current, still of 15-volt D.C., to feed the magnetic clutch coils and the contactor switch coils, the coils taking from 0·4 amp. to 1 amp., depending on their size. The dimmer bank is a perfectly normal Strand motor-driven type with either resistance dimmers or a combination of resistance dimmers and reactance dimmers, driven from a constantly revolving shaft by pairs of electro-magnetic clutches, each fed through a micro limit switch to cut it out at the end of travel. On the back of each dimmer are pairs of electro-magnetic contactor switches, one normally closed in series with the dimmer for blackouts and one normally open in parallel for instantaneous "full on" (Fig. 105). The 15-volt D.C. action current comes from a three-phase metal rectifier and transformer unit.

As indicated earlier stop keys are arranged in groups of thirty-six each, with their twelve keys as master. Thus, a console for seventy-two lighting ways will have two masters and the keyboard will have thirty-six notes; twelve known as the left master and working thirty-six stops, twelve for the right master with another thirty-six stops, and twelve notes in the centre of the keyboard working both left and right masters together, i.e. in all seventy-two stops. Associated with the centre keys are the four indicator dials measuring shaft movement or individual dimmer position at will.

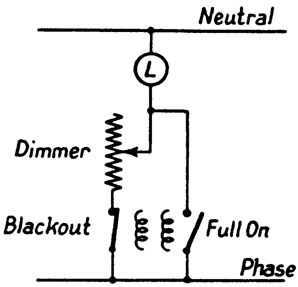


FIG. 105. SCHEMATIC CIRCUIT: LIGHT CONSOLE

The next stage is a console with two keyboards, controlling 144 stops or lighting circuits, an arrangement which would cope with all but the very largest installations of to-day. For a really great installation, we add another keyboard giving a total of 216 stops or even a fourth keyboard giving 288 stops or lighting circuits. This last is the equivalent of a four-manual cinema organ minus its pedal keyboard. Such an instrument is quite common among the larger cinemas where quite ordinary mortals are expected to play these by no means unwieldly consoles. Remembering that a light console operator does not need to use the keyboards for anything remotely resembling the rapid finger technique of a pianist or organist (there are positively no scales to play!) we can see that the largest of installations is under the control of one man in a way that no other system permits. (See Fig. 217.)

This man need not be an electrician, but certainly should be an artist, and is seated at an instrument which allows him a good view of the stage and full use of his ten fingers and two feet. Owing to its flexible cable the console is movable within the limits imposed by a wheeled platform. The light console has been far more fully described than the other remote-control systems because, unlike them, it does not resemble a direct-operated board in any way and its method is, therefore, more difficult to understand at first encounter; in any event an

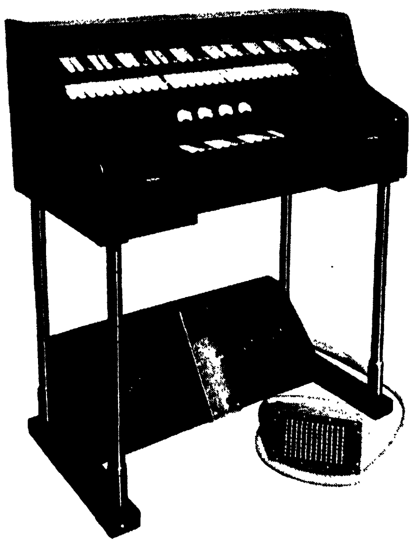


FIG. 106. 60-WAY PORTABLE LIGHT CONSOLE WITH MULTI-WAY PLUG

author is but human when he takes extra paragraphs for his own inventions.

When an installation is comparatively small, then rather less elaborate equipment is required and the Baby Light Console shown in the photograph (Fig. 106) is the result. This size of console is, owing to the absence of combination magnets on the stop keys, quite light and may be carried around. As the photographs show, it is fitted with a detachable plug to its trailing lead. As there is no combination action, a "stop switch" is fitted which can be used to hold the existing combination of stops in use while the stop keys are moved to their new positions by hand; on putting the "stop switch" off the new combination takes effect. So long as it remains "off" the stops can be moved to take effect normally.

The console principle of master- and stop-key selection

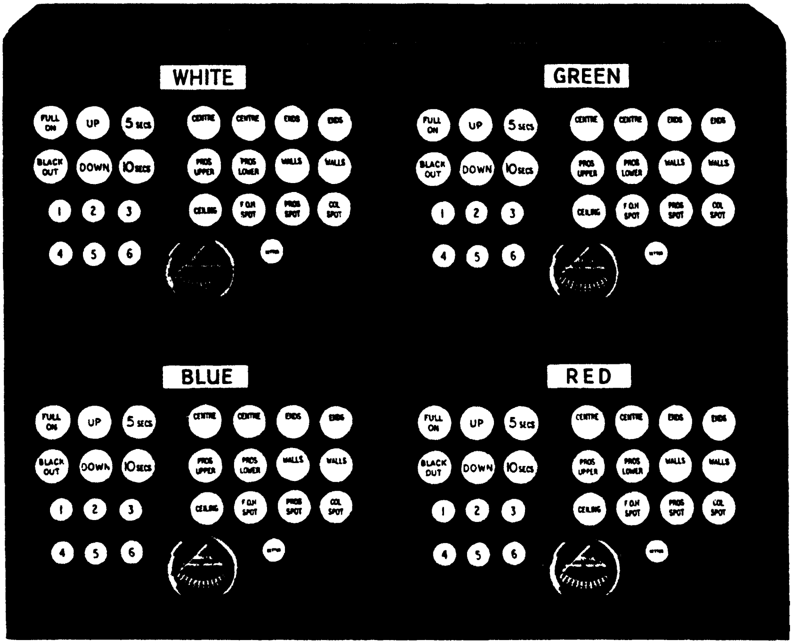


FIG. 107. 48-WAYS (SPACE FOR 80-WAYS) PORTABLE LUMINOUS CONTROL PANEL, 22 × 18 × 5 INCHES OVERALL

has appeared by request in two other guises. In the first (Fig. 107) the Compton luminous stop push was used both for "stop" selection and for masters. This is a circular push at 1¼-in. centres which when touched lights up internally and is "on." When touched again the light and the circuit go "off." The general layout results in a superficial resemblance to a direct-operated board but, more important, it provides a really lightweight portable control in which remote combination action can be used. The second variant is the Light Desk (Fig. 108) where selector switches and telephone switches are used for the masters. The job pinches in just those items where it differs from the normal console. Detachable plugs allow the desk to be used in four positions, one of which is 300 ft. from the dimmer bank.

A peculiarity of the Light Console is that, although originally designed to operate resistance or auto-transformer dimmers,

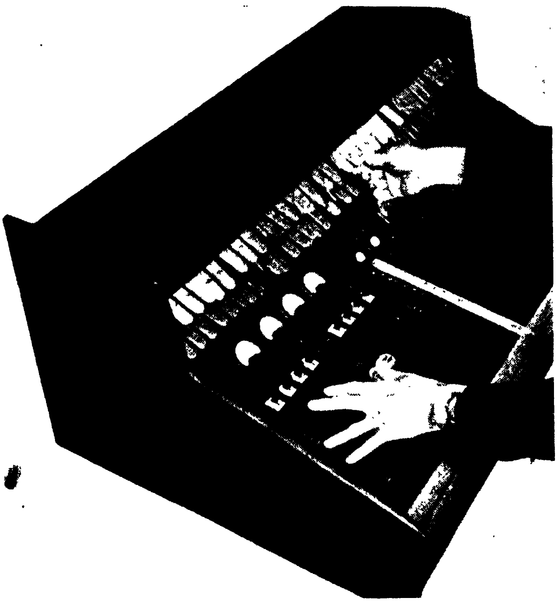


FIG. 108. 64-WAY PORTABLE LIGHT CONTROL DESK
Switches instead of keyboard masters.

the form of control remains the same if shutters for discharge lamps or direct-valve dimmers are used. To the operator they are all dimmers whatever their electrical or mechanical form.

The Light Console uses the same stop key as that used to select the circuit to dim or to blackout, to connect colour-filter change mechanism to the master keyboard for operation. The keys for this purpose can be seen as groups of five black keys in Fig. 102. These keys bring in white (filters out), filter 1, filter 2, filter 3, filter 4, separately or in combination depending on which keys are depressed while the circuit stop keys are "on." The filter changes can take effect immediately or be stored to be brought in later by pressure of one toe piston. The filter change at the lanterns can be solenoid or motor-type (Figs. 47 and 48); the result to the operator is the same. It will be noticed that this system takes up no additional space whatever.

Placing the Console

Undoubtedly the best position is a private box at the back of the circle, as at Ankara, and the worst on the side of the stage, as in the Theatre Royal, Bristol, though this console can be moved and plugged up in the stalls for rehearsals. Between these two comes a movable platform in the orchestra pit at Lisbon or at the end of the dress circle at the London Palladium. The latter position gives a rather one-sided view

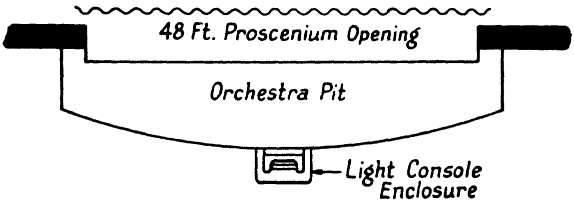


FIG. 109. PLAN: POSITION OF LIGHT CONSOLE IF FIXED

and the orchestra pit is rather close and, with some orchestras, very noisy. Members of any orchestra never have enough room and so the presence of the console is not likely to be welcomed. A small enclosure on the stalls side of the orchestra, Radio City fashion, is quite effective (Fig. 109). One advantage of a position among the orchestra is the complete immunity from would-be advisers on lighting given to the operator by the presence of a posse of aggressive bass players, as I discovered in Lisbon.

The Pre-set System and the Light Console Compared

The Light Console with its facility for continuous lighting change (playing upon the lighting) represents a system which is diametrically opposed to the multi-scene pre-set board; therefore it is very necessary to weigh the pros and cons of each system.

For lighting present-day style, particularly of straight plays, where the individual intensities of lanterns are worked out laboriously on the dimmers during rehearsal and plotted for subsequent reproduction by an electrician, the pre-set board offers considerable attraction. All that is necessary is to set a number of pre-sets during each lull and upon signal from the stage manager operate the master fader. It is assumed, of course, that sufficient scene pre-sets have been installed and that the necessary lull can be relied upon to turn up.

In contrast the Light Console should have a very high standard of operator to whom it is not a matter of working the dimmers to plotted positions, but a question of painting the stage with light in a similar way for each performance.

The console once mastered literally puts the lighting installation under the fingers, and one finds that after a time the desired effects appear on the stage without consciously exerting oneself to operate anything: a pale-blue cyc.—a little more light on the table—no sooner thought of than done, using the console controls as instinctively as a good driver uses his car.

Not only does this system mean speed at rehearsal but it means that the lighting can be a live thing. Sometimes the lighting changes will, for dramatic effect, be required to draw attention to themselves, but at other times the operator will have been moving this dimmer, and that throughout the entire show without the audience being consciously aware of his activities; the contribution will have been made none the less.

For opera, ballet, and other spectacular productions the value of this live lighting, divorced from mere changes, is obvious but I believe the future of all lighting lies in this direction and that my Light Console is not just another dimmer board but the herald of the revolution in lighting technique so often prophesied.

CHAPTER VII

COLOUR

THAT white light is the sensation of viewing several coloured lights simultaneously, and that coloured light is something *less than* white light must be firmly fixed in the mind. A spotlight with a blue filter is a spotlight minus, not a spotlight plus.

If white light is passed through a narrow slit and thence through a prism (Fig. 110) refraction takes place and a band of coloured light, the spectrum, appears (Plate IA). Seven prominent colours are seen: Red, Orange, Yellow, Green, Blue-green,* Blue, and Violet. In fact there are hundreds of different hues making up the apparently continuous band. The spectrum band is a series of images of the slit side by side, each one in a slightly different hue. What we see as a wide red band is a number of very narrow bands of differing reds.

The reason for this behaviour on the part of the prism is that light is a small section of the great range of radiation, part of which are known as "wireless waves." Light waves are very much shorter than these and each variation in wavelength gives the eye a sensation of strong colour. The more different wavelengths (colours) seen at one time, the nearer to the sensation of white we get.

The red waves are relatively long, the violet short, and the intermediate colours form steps between these extremes. Each wavelength is refracted by the prism to a different extent, hence the series of coloured images of the slit forming the continuous spectrum.

This sorting of the wavelengths by passing them from glass to air is not the only method. White light can be passed through a very fine mesh or grating and a spectrum produced. This method is known as "diffraction" and has the advantage that, unlike the prismatic spectrum, the colours are spaced without distortion according to their band widths.

Both prisms or diffraction gratings may be made into an

* See page 159.

instrument known as a *spectroscope*, looking like a small telescope. With its aid one can instantly see the spectrum.

Beyond the visible colours there is radiation which is invisible; at the red end the infra-red wavelengths; at the blue end, the ultra-violet. Both these ranges, though invisible to the human eye, can be photographed; furthermore, the ultra-violet can be converted by chemical action into visible longer waves, the phenomena of fluorescence. Ultra-violet is not one wavelength but a whole series, and in its shorter wavelengths is extremely dangerous to the eye. Fortunately,

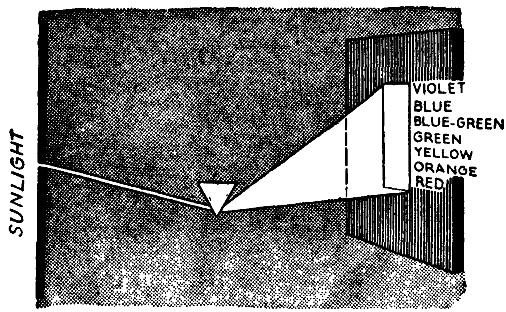


Fig. 110. Schematic Diagram showing Production of Spectrum Using Prism

these dangerous wavelengths are not required for stage effects and can be stopped by a sheet of ordinary glass.

Colour Filters

The simplest method of obtaining colour is to suppress the unwanted colours. Dyed gelatine mediums do precisely this, filtering away the colours not needed, the energy of which colours is promptly turned to heat by the filter. A good green filter inserted in front of the spectroscope blacks out the ends of the spectrum, leaving only the broad green band (Plate Ib). A very pale green filter may pass a little of all colours, but the green is strong and dominant (Plate Ic). Colours absorbed by a filter represent so much wasted light; accordingly filters designed for the stage aim at suppressing the minimum number of wavebands. A red will probably be allowed to pass a little orange as well (Plate ID); certainly an orange will pass red, orange, yellow, and green (Plate IE).

For the rest of this chapter it is necessary for the reader to have a chart of colour filter samples beside him for reference. It is not possible to print the colours satisfactorily; in any case this would not allow the testing of colours superimposed. Colour cards giving the samples can be obtained from stage suppliers. The Strand Electric range of colours and reference numbers have now been adopted by the principal firms as the British standard for the stage. This means that a producer

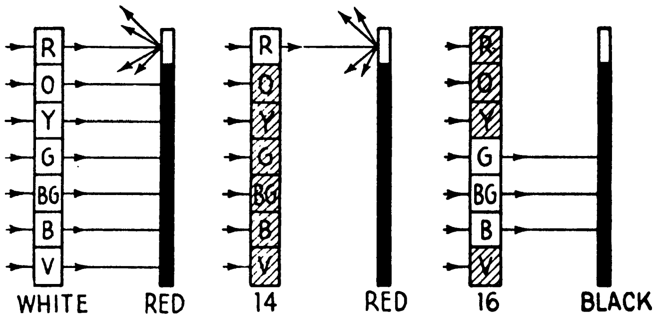


FIG. 111. EFFECT OF WHITE, RED, AND BLUE-GREEN LIGHT ON RED PIGMENT

no longer calls for a 32, expecting blue, and sees red. (See Appendix III.)

Pigments

Just as a gelatine filter is suppressing some colours of the spectrum, so a painted or dyed object may be doing the same. A pillar-box is red not by conversion of white light into red, but by absorbing all colours except the red, which is then diffusely reflected into the eye. It follows from this that the pillar-box must either be lit by white light or red light. A blue-green (No. 16) light, produced by removing all spectrum colours except blue-green and its neighbours, will not contain any light that can be reflected by the pillar-box, with the result that it appears black (Fig. 111). Unless such results are deliberately required, as in trick effects such as the Samoiloff

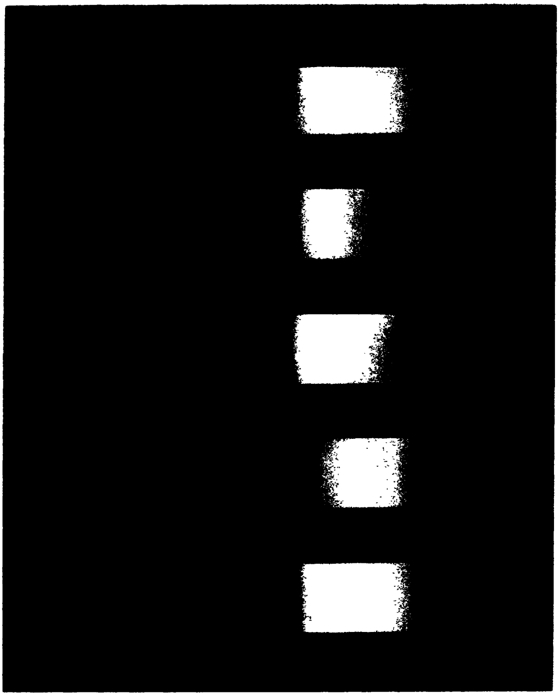
A. Spectrum of White Light

B. Spectrum of Green Filter

C. Spectrum of Pale Green Filter

D. Spectrum of Red Filter

E. Spectrum of Orange Filter



A

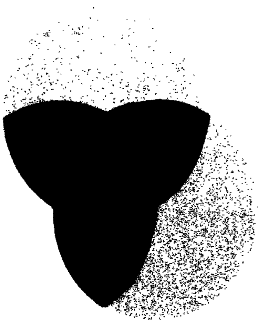
B

C

D

E

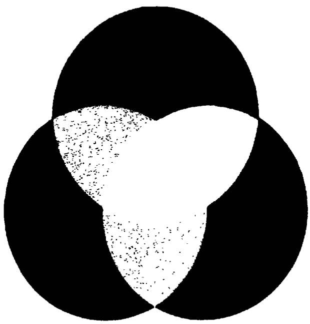
Plate I



A

Subtractive Primaries (Pigments)

Check by superimposing circles of filters No. 13 Magenta, No. 16 Blue-green and No. 1 Yellow, and holding up to the light.



B

Additive Primaries (Light)

Check by superimposing three sharp-focused spotlight circles with filters No. 6 Red, No. 39 Green and No. 20 Blue.

Plate II

(see page 297), we must always ensure that the colours which the dresses or scenery reflect are always present in the light illuminating them. In passing it must be remarked that the eye cannot see the colour of our pillar-box at very low intensities even if the light is white. In bright starlight the pillar-box appears black; this, the Purkinje effect as it is called, can be observed sometimes when the red cyc. dimmer is on its bottom stud, the rest of the stage being blacked out.

Subtractive Mixing

There are at the time of writing forty-three standard gelatine or Cinemoid filters available in the colour chart. About a third are saturated colours which absorb some part of the spectrum completely. The others are the paler colours which merely require a decreased brightness in some parts of the spectrum. No. 36 Lavender (Surprise Pink) reduces the green region slightly, thus stressing any reds and blues it is used on. No. 3 Straw reduces the blue region, thereby giving the light a warmer tone.

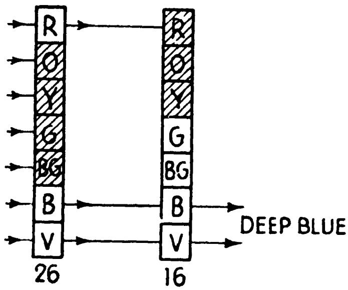


Fig. 112. Transmission of White Light Through Mauve and Blue-green Filters

Forty-three colours may seem a great number, but it will soon be found that very often resort is made to the colour chart and it is found wanting. Any one who is particular about his colours, as lighting artists should be, will be far from satisfied with the greens available, to quote but one example. However, the solution is easy: filters may be combined in the one frame. In so doing we subtract the parts of the spectrum not common to both. To give a simple instance: a 26 Mauve passing red and blue may be combined with a 16 Blue-green passing blue and green; the light resulting is a blue, the colour common to both filters (Fig. 112). This is subtractive colour-mixing and follows on similar lines to the mixing of pigments. Plotting this mixture it is better to write down 26 — 16, as we shall require the plus sign for additive mixture later on.

We can, as with pigments, go on combining colours, but the more we do so the more colours will be subtracted, until we obtain black. The joy of these colour combinations is that experiments are easy to do at home without keeping the stage waiting. It is also a chance to express one's tastes in colour; after all, few artists are content to use colour neat as they buy it in tubes.

Some of my favourite subtractive mixtures are—

55 Orange – 11 or 12 Rose = Blood Orange	
10 Pink – 4 Amber = Sunset (or Flame)	
8 Salmon – 2 Amber = Flame	
19 Blue – 1 Yellow	Compare these Greens
16 Blue-green – 24 Green	
50 Yellow – 17 Steel	
54 Pink – 17 Steel	Compare these Greys with No. 60
36 Pink – 50 Yellow	
36 Pink – 17 Steel	Compare these with No. 36 Surprise Pink or Lavender
36 Pink – 3 Straw	

Broken Colour

Subtractive mixing also leads on to a most important effect that I cannot recollect having seen in the theatre other than accidentally or in my own work. This technique I call "broken" colour and consists of placing two or more filters behind each other in such a way that the colour can be seen separately and combined. A circle can be removed from the centre of one filter or triangular filters combined. Some of these are shown in the accompanying Fig. 113; a sheet of No. 2 Amber with triangles of Nos. 4 and 10 imposed and placed in front of a focus lantern give a broken beam of four colours. This method is valuable in many applications, and the whole question will come up again in Chapters XII, XIII, and XIV, when lighting methods and effects are considered.

Additive Mixing

Thus far the subtraction of colour by mixing two or more filters, or by the projection of coloured light on to a different colour pigment, has been considered. Now the result of adding two coloured lights must be investigated.

If a Red (No. 6) circle of light and a Green (No. 39) circle of light from another spotlight are allowed to overlap, the result is found to be yellow. If the colours are Red (No. 6)

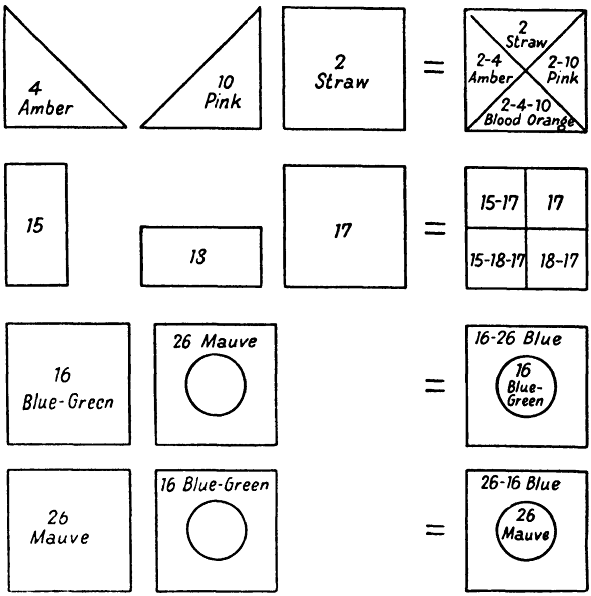


FIG. 113. BROKEN COLOUR: SUBTRACTIVE COMBINATION OF FILTERS FOR TINTING

and Blue-green (No. 16) the result is white. From these results it is quite obvious that the laws of subtractive or pigment mixing do not apply; indeed it would be strange if they did, since we are doing what involves the exact opposite to that process. For centuries colour-mixing has been synonymous for mixing of pigments; add yellow to blue to get green; the three primaries are red, yellow, and blue (Plate IIA). This is now shown to be based on a false idea: colours have hitherto been subtracted. Take the seven principal colours of the spectrum as pigments, mix them together, and the result is black. Do the same thing with coloured light. The result is white. What, then, are the primary colours?

Experiment in mixing coloured light shows that there are three colours which cannot be produced by mixing, and they are Red, Green, and Deep Blue (Plate IIB). Mixing these three in varying proportions we can get a match for any other saturated colour in the spectrum and, what is more, colours such as mauve and magenta outside the spectrum, as follows—

Adding green to red = light red, orange, yellow.
Adding green to blue = medium blue, light blue, blue-green
Adding red to blue = violet, mauve, magenta.

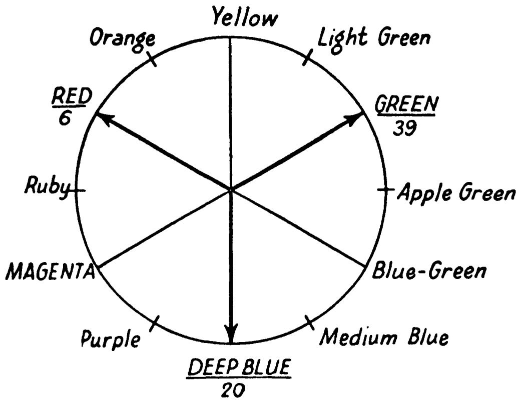


FIG. 114. COLOUR WHEEL: PAIRS OF COLOURS OPPOSITE EACH OTHER ARE COMPLEMENTARY

For stage purposes, filters covering rather a wide band of the spectrum are used to avoid wastage of light: No. 6 Red, No. 39 Green, and No. 20 Blue. As indicated in Chapter II, there is not a great deal of blue in the spectrum by the gas-filled lamp; to assist this colour at least double wattage has to be employed. The colour wheel (Fig. 114) is a guide as to what may be expected when the three primary colours are mixed on dimmers. The colours midway between the primaries are known as the *secondaries*, and a little thought will show these to be the primary colours for pigments.

When red, green, and blue are mixed together, the result is as near white as the slightly deficient blue will permit. This fact gives a clue to the method of obtaining tints of the various saturated colours: merely add some of the remaining colour to suit. Thus, to light blue (100 per cent blue; 50 per cent green) add a little red to get pale blue; to magenta (red 100 per cent, blue 100 per cent) some green to produce rose pink.

With three dimmers we can go round the wheel producing the intermediate colours as Appendix IV (page 336).

A triangle (Fig. 115) is often used instead of the wheel. Each of the three perpendiculars represents 100 per cent of the colour at its apexes and 0 per cent where it meets the opposite side. Its point of intersection represents white, i.e. an equal mixture of each primary at intensity one-third.

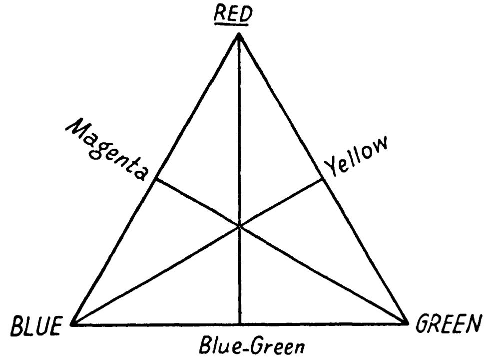


FIG. 115. COLOUR TRIANGLE: PRIMARIES AT THE APEXES

Half-way along the triangle sides come the secondaries—equal mixture of the two primaries at half intensity. In this way any colour (saturated or otherwise) can be shown as a point somewhere in the triangle, all colours being of the same intensity. For stage purposes it is usually pleasing to obtain all the intensity possible, the dimmers being put full up. That the resulting blue-green is twice as intense as the green or blue by itself is accepted without a qualm. For this reason I prefer the colour wheel to the triangle in theatre work.

Complementary Colours

If equal amounts of any two colours opposite to each other on the wheel or triangle are mixed the result is white. Any such pairs of colours, red and blue-green, yellow and blue, green and magenta, are known as *complementary*. Further reflection will indicate that if either of these pairs is a pigment, as yellow light on blue paint, the result is black. Any pair of complementary colours can be used, but it must be remembered that except in a few instances the stage filters are very impure; No. 1 Yellow actually passes a little blue, so it cannot be expected to behave according to the book. The colours that are reasonably pure are: No. 14 Red, No. 6 Red, No. 39 Green, No. 16 Blue-green, No. 20 Blue, No. 26 Mauve. During the War some of these colours went badly off the rails, and in any case I can only vouch for the Strand Electric colours. Any one who wants to go at all deeply into colour experiments, for their sake as apart from stage applications, is advised to use the more expensive but very accurate Wratten photographic filters (see page 156).

A warning on sensation matches: the eye can easily be tricked. A No. 19 Blue can be made to look like a No. 20 by adding a little red; a No. 6 Red can be matched to a No. 14 Red by adding a little blue; both will pass muster until the blue is used to turn red pigment black or the red to turn blue pigment into black. The slight addition of red in the first instance and blue in the second will entirely upset the result.

An extreme example of the perils of sensation matching when used to light pigments is given by sodium lighting. Most people have seen the sodium discharge lighting used on some streets; it is a lamp which emits its light in a narrow yellow spectrum line. This means only yellow objects will reflect under it, the rest appear grey and black. Now suppose for some peculiar reason we have to imitate this light on the stage: by mixing red and green a perfect sensation match is obtained, but as soon as this light is thrown on to coloured objects not only the yellows will appear but the reds and greens. As a matter of fact, our stage amber filters will not be much help either, since all of them pass red and some a fair amount of green, in addition to the yellow.

Contrast

The perception of colour depends very much on the presence of contrasting colours. A stage lit evenly all over in red soon loses its redness and is interpreted as a kind of fatiguing pink. The same red seen as a small contrasting patch on a blue stage will seem to be an entirely different colour. Colour that is to appear rich or vivid must be confined to small patches and high lights. There may be instances in moonlight effects or the Samoiloff complementary colour stunts when the lack of colour contrasts may be valuable. There can be no rules in this matter: it is the weighing of how much of a colour to use and what contrasts to use that make stage lighting a field for the artist. Colour-mixing additive and subtractive requires but common sense and practice, but the application of the colours when mixed is quite another thing.

A Theory of Colour Vision

Deceptions like presenting red and green to the eye for yellow (two very different wavelengths offered as a third) and getting away with it, lead to much speculation on the nature of colour vision. In sound, no two notes can be found in the octave, the simultaneous sounding of which the ear will accept for a third note.

There have been many theories to explain colour vision of more or less complexity. As none of the theories really tie up with any physiological findings, we may as well choose the one that is simplest and accounts for the phenomena we encounter.

The colour theory of Thomas Young (who lived in the early nineteenth century) supposes that there are three sets of colour-sensitive equipment (nerves, if you like) associated with the eye. The first is sensitive to the wavelengths in the red region of the spectrum; the second is sensitive to the green region; and the third to the blue. None of these is exactly sensitive to their own region only but tend to overlap, reacting more and more weakly as the wavelengths get into the domain of their neighbours. Thus, a yellow light stimulates the red and green nerves to some extent, sending a message to the brain the same as if red and green light had been employed. Yellow and its complement blue stimulate all three sets, giving white.

The theory also accounts for colour fatigue, a striking demonstration of which can be given on a cyclorama. Put the red and green dimmers to full, the result is a yellow. Do this again but give the eye a minute of green cyclorama first, the result is an orange. Repeat, but giving the eye a minute of red—the result is a light green. This different colour for an identical mixture, suggests that one colour-registering apparatus of the eye or brain gets tired by use, whereas the other two come fresh to the job. Probably not tired in a physical sense, but rather in the way that a full-up stage seems bright after a half-checked stage but soon loses some of its initial effect on the eye.

Colour fatigue suggests a way in which the colour of a stage may be emphasized or not—a blue footlight on the act drop if a very red-appearing stage is required to follow, a red footlight if the red, as for the Samoiloff trick, is not to draw much attention to itself.

Cyclorama Colour-mixing

A system such as the three primary colours in which any colour can be mixed up from the switchboard is very valuable, but it should not be assumed that its use follows automatically. If the cyclorama is to appear dark-blue or light-blue for a number of weeks it is obviously rather wasteful to leave a red circuit idle, the green on half, only the blue being used full up. This will be especially so if the equipment is being hired or toured for a production that needs limited sky effects.

Even for repertory theatres it is worth while to consider the season's likely programme and to discover how many plays will demand a red cyclorama and how many a green. I think it can be assumed that such colours are useful at the bottom of the cyclorama in the ground row, but a green or red top cyclorama must be rare.

The commonest colours for the top cyclorama are dark blue, various blues up to light blue, greys, blue greens, ambers, mauves, and pinks. All these can be obtained by another combination of mixing colours, one which will ensure that the commonest colours utilize as much of the available watts as possible.

The advantages and drawbacks of the two can be seen in the two-three colour-mixing schedules A and B (Appendix IV and V). Schedule A gives the mixing proportions for the three primaries No. 6 Red, No. 39 Green, and No. 20 Deep Blue. Schedule B gives the proportions for No. 5A Orange, No. 16 Blue-green, and No. 20 Deep Blue. In each case double wattage is assumed for the blue.

The schedules show diagrammatically the approximate positions to place the three dimmer handles to obtain the colours in the last column. Thus in Schedule A red is given by the red dimmer at 100, green at 0, and blue at 0; orange is red at 100, green at 33⅓, and blue at 0; light blue is red at 0, green at 66⅔, and blue at 100. Compare this last mixture with orange at 0, blue-green at 100, and blue at 100, producing the same colour in Schedule B. When it is remembered that a dimmer handle position of 66⅔ is roughly one-third light, it is easy to understand the advantage of the latter. Then, again, compare No. 16 blue-green by itself with the blue-green of Schedule A, and it will be noted that the commercial mediums never give a really satisfactory match, however hard one tries to secure it.

The numbers of filters against some of the names in the last column of both schedules are given only as a rough indication of the colour I have in mind. Obviously with such coarse steps as thirds and halves no exact matching can be attempted, and in any event the characteristics of the different makes of dimmer vary enormously. However, on a normal dimmer a slight movement of the levers either side of the positions indicated will soon bring in the colours desired. It will be noticed that for the tints the required dilution is obtained by not taking any dimmer lower than 50 per cent; a still paler series of tints will result if the dimmers are not taken lower than 75 per cent.

When a mixed colour of lower intensity than its component colour is required intensities have to be lowered proportionately: with a master dimmer this result is automatic, but lacking this, the dimmer positions have to be adjusted in proportion by hand; for example, amber red 100, green 66⅔ become, for half intensity, red 50, green 33⅓. After a little practice the movement of the dimmers proportionately becomes instinctive.

Fluorescence

So far colours in this chapter have been obtained by filtering out the unwanted colour wavelengths or by presenting two wavelengths to create in the eye a sensation of a third colour the wavelength of which is not present. In the phenomena of

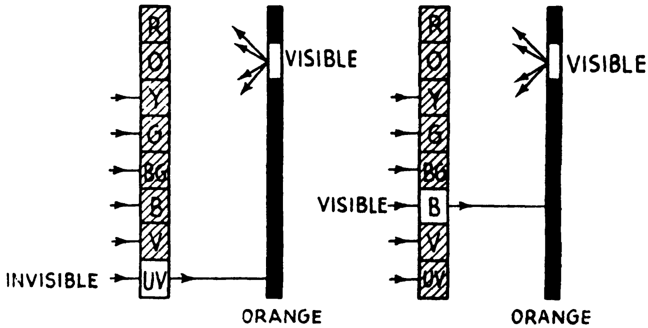


FIG. 116. FLUORESCENCE: ULTRA-VIOLET OR BLUE FILTERS PRODUCE ORANGE

fluorescence is a method of changing the light of one wavelength into another *longer* wavelength. This effect is usually taken to concern the conversion of invisible ultra-violet rays into visible light, but is equally applicable to the conversion of (say) blue light into orange colour (Fig. 116). Certain substances will fluoresce in varying colours when lit by the near ultra-violet (U.V.) rays immediately beyond the visible spectrum; others when lit by the dangerous very short ultra-violet rays beyond. These latter rays can be stopped by a sheet of clear glass and, as they are dangerous, we shall use glass to filter any of our sources of U.V. and confine our effects to those produced by the near ultra-violet.

The usual source of U.V. nowadays is the so-called "black lamp" (Fig. 10), a discharge lamp which gets its name from its black glass bulb. This black glass bulb serves two purposes: being glass it filters off the dangerous short wave U.V.; being black it filters off nearly all visible light. This lamp, usually fitted in a 150-watt baby flood, is a good and convenient source of light.

Fluorescent chemicals are usually supplied in solution as paints, dyes, and make-up for stage purposes. Quite a number of colours are available, all of which appear of great depth and intensity under the U.V. The two in commonest use are, probably, the Invisible Green and the Invisible Blue. Both these colours have great beauty under the U.V., although invisible under white light: they are applied as a colourless liquid. Some other colours are visible under white light but gain in depth under U.V. or are transformed from a garish horror into something sublime. Some colours have a slight afterglow when the activating light is extinguished. More important still, some colours are rather expensive and some colours exceedingly so.

The principal use of fluorescence on the stage is for trick effects but, apart from this, fluorescent powders are valuable, coated to discharge-lamp bulbs and tubes, as a means of providing pleasing colours. The stage applications are considered in Chapter XIII. Fluorescence is not limited to special chemical paints: many things fluoresce to a greater or lesser degree when given the chance—the teeth (real, not artificial), the skin, and the eyeball, for example. The fluorescence of the latter gives a slightly hazy feeling to the person under U.V. light and leads him to believe that his eyes are being burned; this the experts say is not correct, provided the black glass bulb to the lamp is intact. Out of the 220 colours in the British Colour Council's chart, several fluoresce slightly—two numbers very strongly.

Filter Materials

The actual colour filters can take the following forms: (A) lacquer or lamp dip; (B) china spray; (C) dyed gelatine sheets; (D) dyed plastic sheet; (E) coloured glass. A, B, and E are available where simple lampholders and bare lamps are required. The lamp lacquer or lamp dip is a liquid supplied in many of the colours of the gelatine colour chart. The lamps which are dipped into the liquid while burning must be vacuum lamps; gas-filled lamps develop too much heat and burn the lacquer rapidly. Gas-filled lamps up to 100 watts are supplied coated with a coloured china spray in a few pastel shades. Natural-colour glass-bulb lamps are also available in the lower wattages, but very little light is emitted. In all these coloured lamps the colours are poor, particularly in the blues.

Dyed gelatine is supplied in a convenient cheap commercial form by most stage-lighting suppliers. It is ideal for rehearsal work or for productions designed for two or three performances only. For longer runs or for cyclorama three-colour lighting where the same colours may be used, if only intermittently, for many months the more durable plastic materials are to be recommended. One of the great drawbacks of gelatine, apart from its general fragility, is its characteristic of absorbing the moisture of its surroundings. If left unused in a lantern for a few nights it goes limp and soiled; any store not kept at an even dry temperature is just as bad. For accurate colour experiments the fine range of scientific gelatine Wratten filters supplied by Kodak is well worth the greatly increased cost which prohibits their use on the stage.

There are several plastic sheet filters on the market; all of these are stronger mechanically than gelatine and are more or less impervious to moisture. The plastic filters known as Cinemoid have been designed for the stage in as complete a range of colours as the gelatines, and are fireproof. This is very important as only these will pass the Licensing Authorities. The supplier's specification must be examined and the material tested with a lighted match. To be correct, it will produce a gas which extinguishes the flame as fast as you try to light up. These plastic materials have rather complicated names concealed under a trade name, such as Cinemoid. Unsuitable materials are on the market which actually drop burning material on to the floor when the test is performed. At present plastics are more expensive than gelatine, but where any degree of permanence is required, the money is well spent.

The development of plastics has tended to remove the glass-filter problem to a great extent. Glass is ideal as a permanent filter, but unfortunately the colours are limited and cannot be obtained to do just what is required for the stage. Blues are still bad and all colours absorb far more light than the dyed filters. The fact that the German Schwarbe system of cyclorama lighting used glass filters in seven colours instead of three, is an indication of the difficulties of glass.

As an ultra-violet filter, glass is supreme, and takes the form either of a black glass bulb for small discharge lamp or of a moulded heat-resisting plate filter to be used in front of long-throw arc projectors.

Accurate Colour Definition

There is disconcerting vagueness about colour nomenclature: how can there be certainty that the other person's idea of the same colour is not different? Painters have their own set of names, textile workers theirs, and so on. Several attempts have been made to ensure the certainty that our pink can be recognized as such at the other side of the world if need be.

The most obvious way is to provide a chart of numbered samples, as, for examples, the Strand stage filter chart or the Leichner numbers for grease paints. A fine example of this kind of thing is the British Colour Council chart, consisting of 220 coloured ribbons, each of a different colour, and each presenting both a glossy surface and a matt surface. This chart, incidentally, gives the lie to those who suggest that we can get along with fifty colours only; there are 220 in this chart, and yet one is far from the limit of one's powers of colour recognition. Along with the chart goes a dictionary made up of nearly 600 alternative names for the ribbons hitherto current; thus Nude can be looked up and established as ribbon No. BCC 11, or Kingfisher Blue as No. 164, and so on.

More satisfactory is some kind of matching instrument to enable any colour to be described. An early system, still in general use, was invented by Joseph Lovibond for matching the colour of samples of beer. This instrument, known as the Tintometer, employs the subtractive primaries in glass slides or wedges of varying density. The sample to be matched is viewed side by side with the standard glass slides through an eye piece; a combination of glass slides is adjusted until a match is obtained, and the result can be read off as something like this. Turquoise Blue BCC No. 118 = Y 2.2, B 4.7, Brightness 1.5; or Cardinal BCC No. 186 = R 28, Y 3. There are other instruments, some of which employ purely electrical matching methods—an elaboration of the photometer light cell, which when placed in the light will register the intensity of the light as so many foot candles. The results of these systems can be tied up internationally to what are known as C.I.E. units.

By now readers with memories of an early section of this chapter may be somewhat uneasy. If the eye cannot tell the difference between a mixture of red plus green and yellow alone, any system of colour identification based on matching must surely be more than somewhat unreliable. This is perfectly true, but is not quite so important for paints and textiles receiving light, as for filters transmitting light. Of course, if the Samoiloff effect is being carried out, it is just as important that the costume red dye shall reflect red only as it is that the red filter shall only transmit it.

Fortunately, there is an optical instrument—it is expensive—known as a Spectrophotometer, which can provide an accurate record of exactly what wavelengths and how much of them, is transmitted. Roughly, the light transmitted is split up into the spectrum, many narrow vertical sections selected, and each compared for intensity side by side with the same section of the spectrum of the unfiltered light source. The comparison can be visual or electrical, and the narrower the width of the sections the more there will be, the more ratio figures obtained, and the greater the accuracy. The result can be accurately plotted, as shown in Fig. 117, and is then known as a spectrophotometric absorption curve. Along the horizontal axis are the wavelengths from 720 to 400 millimicrons; a millimicron is represented as mμ and is 0·000001 millimetre—rather interesting when it is recalled that a wavelength of 6 metres is known as ultra-short in radio. Sometimes the wavelengths are given in microns (μ) or Ångstrom units (Å); the only difference in dealing with the visible spectrum is the number of noughts; red of 700 mμ is the same wavelength as 0·7 μ or 7000 Å.

The position of the principal colour bands of the spectrum is also indicated along the horizontal axis. The exact boundaries between the principal colour bands, where, for instance, the red is no longer a red and must be described as orange, is difficult to determine exactly. It all depends on what is meant by "orange." Likewise, the blue-green band is apt to be ignored, the blue and green bands being by that much enlarged. This is a pity, since blue-green is the complement of red, and it is important to counter the effect of the unfortunate compound name, which suggests a mixture, and not a spectrum colour band in its own right. The vertical axis gives density of the wedge or transmission percentage. Thus, a perfectly clear filter would merely show a narrow black line along the horizontal axis, the black line representing the slight absorption that results from transmission through even a good transparent medium. The curves of Fig. 117 are easy to understand once it is firmly fixed in the mind that the vertical axis is plotted logarithmically: observe carefully where 50 per cent transmission comes. It will be noticed that a blue filter, such as No. 20, not only absorbs all the reds, orange, yellow, and green as one would expect, but also that it is not by any means a perfect transmitter of its dominant hue, blue.

It is interesting to compare the curves of the saturated hues in Fig. 117 with the tints in Fig. 118; the former blot out sections of the spectrum, whereas the latter act in a more subtle way. It is easy to see why Nos. 17 and 36, in spite of the fact that they are very pale, do give such different results. The curves have purposely been drawn to the same scale as those in the Wratten booklet for comparative purposes, though Wratten curves go beyond the visual spectrum at 400, since this ultra-violet region is important photographically.

The production of colour in a stage lantern is hardly efficient: only 2 per cent of the electric energy becomes light, and of this 7 per cent or so is transmitted by the red filter, 18 per cent by the green, and 3 per cent or 4 per cent by the blue. However, the red letter-box is just as inefficient with sunlight, but if the colour obtained gives satisfaction there is no need to worry.

Far more efficient methods of producing coloured light are

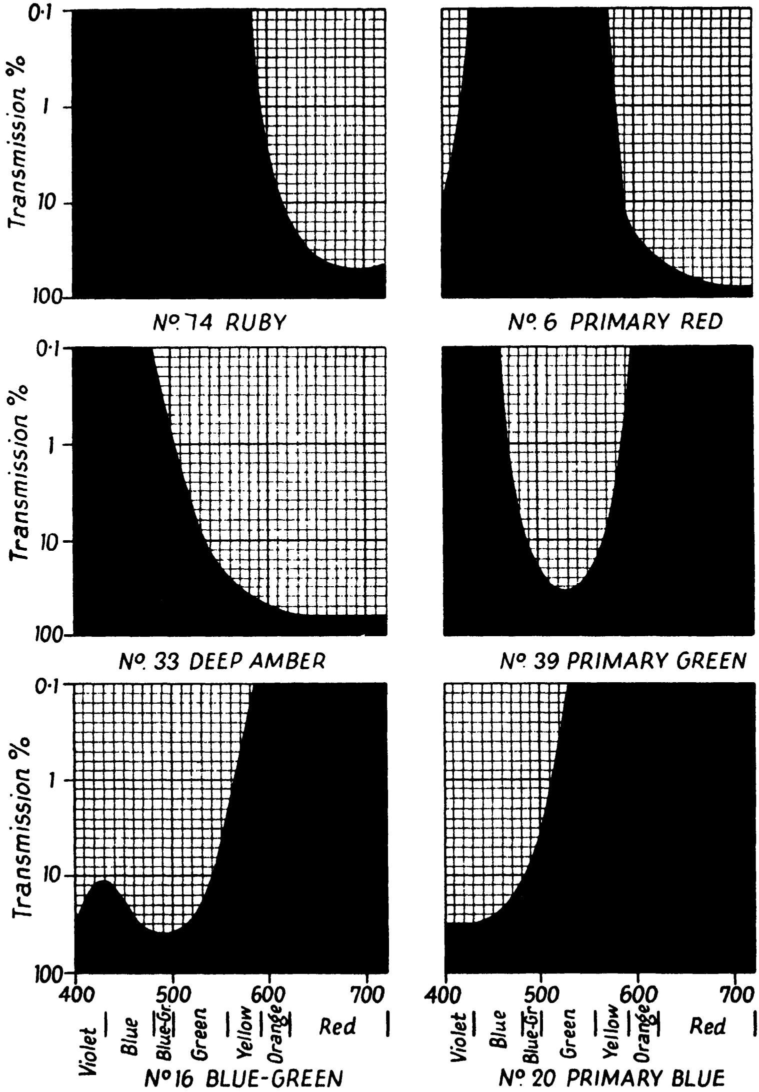


FIG. 117. SPECTROPHOTOMETRIC TRANSMISSION CURVES FOR SATURATED HUE FILTERS

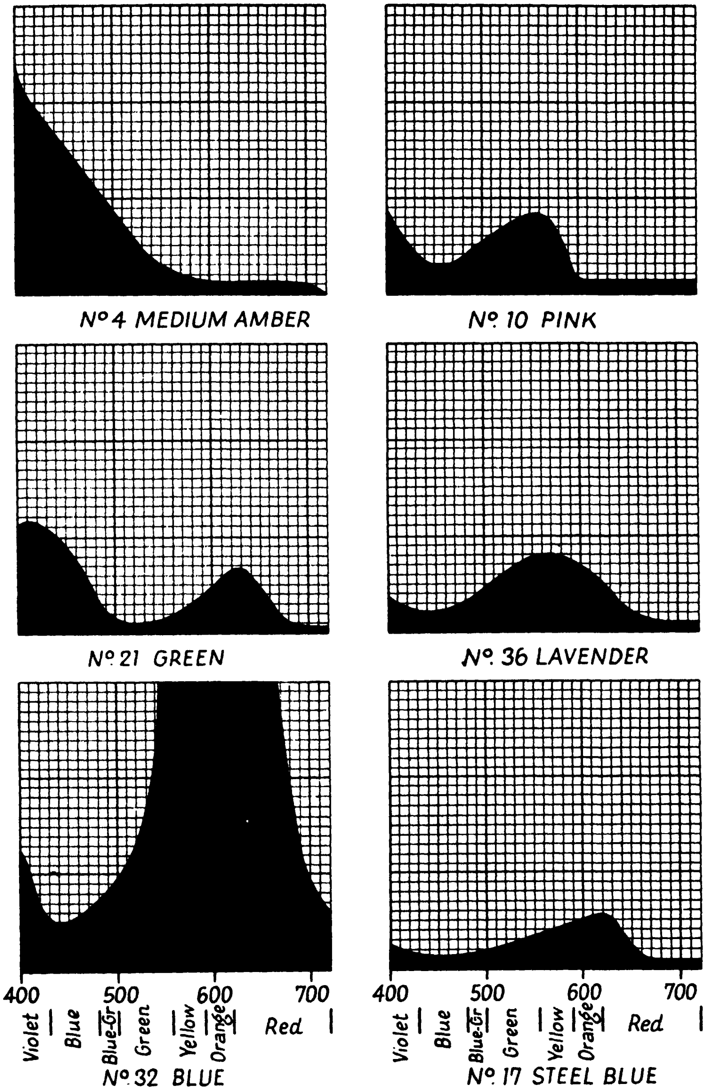


Fig. 118. Transmission Curves for Tints

available in discharge lamps, where, first, a greater percentage of electrical energy is converted to light, and, secondly, the light may be coloured at source or converted to colour by fluorescent powders coated on the lamp. The results are generally either crude or somewhat peculiar. Lamps described as daylight often look like daylight seen indirectly (as from the train in Piccadilly Tube Station), but the light is somewhat "phoney" when directed on coloured objects. Vegetarian dishes can look decidedly fishy under discharge lighting of so-called "approximately north daylight" or

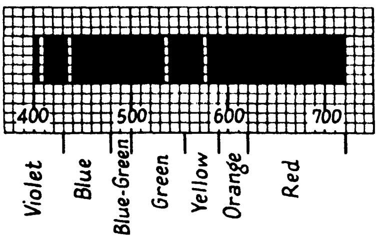


FIG. 119. SPECTRUM OF MERCURY DISCHARGE LAMP

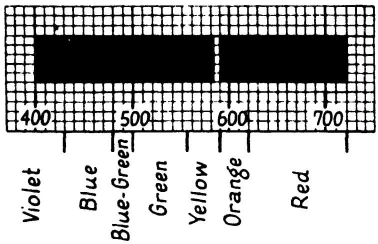


FIG. 120. SPECTRUM OF SODIUM DISCHARGE LAMP

warm white "resembling direct sunlight." As usual, publicity is ahead of the facts, though it is merely a matter of time before these lamps become what they are claimed to be. The difficulty is the fact that discharge lamps do not emit their light as a continuous spectrum, but in a number of well-defined lines. For example, the principal lines of a mercury-vapour discharge lamps spectrum are seen in Fig. 119, and an extraordinary spectrum of the sodium lamp in Fig. 120. The sodium is a good example of the peril of rating efficiency too high. It is, as explained in Chapter II, probably the most efficient lamp manufactured, but few derive any aesthetic pleasure from its monochromatic light.

Effect of Light on Scenery and Costumes

The appearance of any pigment to the eye is influenced by the nature of the pigmented material. Thus a glossy or varnished plane surface will show its true colour only when viewed from the direction of the light illuminating it. At some angles the conditions of Fig. 123 may apply to a greater or lesser degree and prevent the reflection of any colour except that of the spotlight beam itself. On the other hand a matt surface will behave as Fig. 122 both as regards light reflection and colour reflection. Conditions are usually far more complicated, and a set of art silk drapes will behave differently round the folds and perhaps the visual result will be further influenced by deep shadows in the folds. This uneven reflection is what gives life to the material.

Art silk stretched tight, as a cyclorama, would be impossible to light from a batten in the normal overhead position. From the Stalls a series of blobs of light, the direct reflection of the batten compartments, would be seen; whereas in the Circle there would be very little reflected light of any kind and the material would appear drab and unexciting. A casement cloth with a matt surface will be far more satisfactory.

If the curtain hangs in folds these defects are remedied to some extent but the light will still show a reluctance to get down or up the curtain. To obtain even distribution and the life and sparkle absent from the casement cloth, the art silk has to be crushed. The house tabs in Fig. 205 are an example of this effect. A plain matt material can be made to glitter by lighting in different colours from different directions, particularly if the material is translucent and can be lit front and back (Fig. 200).

Materials can be interesting when they are selective to light, reflecting light from one direction, absorbing that from another. Velvets and velours are best in this respect, their deep pile being very sensitive to direction. Lit along the pile even black velvet can be made to reflect; light thrown up the pile is completely absorbed. Thus a curtain which can easily be seen under the light of a batten will become jet black under the footlights. This property makes velvets very useful as a background where it is desired to throw the actors into relief since the spill of lighting thrown on them may make little impression where it strikes the curtains.

In general, materials used for costumes are less critical in behaviour because they are of necessity broken up and no flat surfaces presented.

Effect of Light on Make-up

Stage grease paints and make-up do, of course, behave as ordinary pigments under lighting, and the fact that the heavier colours will spoil the make-up is well recognized. The use of make-up to give the face form and colour can be nullified if the stage illuminant is different from that in the dressing room, and unless care is taken to see that the lighting helps the make-up. The debt of lighting to make-up is just as great; for no matter how much a face may be lit, it cannot be "seen" unless the eye can pick out broad indications, which at a distance it interprets as detail. So much is obvious, but there is a trap set for the unwary, not in coloured light but in white light or almost white light.

A colour such as No. 36 will only just be detectable in the beam of light but will bring into prominence reds and blues in a way that may throw the whole make-up out of balance. Vigilance should not be relaxed because the lighting man says he uses the palest of colours only.

In certain large theatres a queer situation arose out of the search for more and more light. It is now common to use high-intensity following arcs, the light of which is so white as to be almost steel blue; in consequence, the players, if they are not to look like corpses, must use a heavy warm, almost red, make-up. Now the gain in the illumination from this form of arc is at the end of the spectrum least kind to the red, so that the very thing the lantern was put in to light, the face, receives least benefit from the increased intensity. Of course, there is a super-beam, which cleaves the darkness of the auditorium, and also a clear-cut circle of light on the stage, so everyone, from artist to audience, is satisfied.

CHAPTER VIII

THE OPEN STAGE

THE design of a lighting system for the open stage makes an excellent introduction to the assembly of a number of pieces of lighting equipment to make a coherent and expressive whole. The open stage may be found in halls of great architectural merit or in those with no such merits; in churches and cathedrals; in the open air.

In a beautiful hall, with an open platform, it is a great pity to erect a temporary proscenium opening and "fit-up" stage complete with scenery. It seems to me that inspiration should be derived from the atmosphere of the hall and the play chosen to accord. The hall may be one of the many in schools and colleges, and with good fortune a production may be given in a hall of great historical background. The atmosphere of such a hall amply compensates for the difficulties that are encountered in trying to find somewhere to put the lights. Almost certainly the place will be lofty and overhead lighting impossible even if desirable. On no account should floods be hung on long wires over the platform, and footlights should not be used, even though they could be put on the floor with ease.

The Setting

First, however, consider the setting. Some sort of setting there must be, no matter how splendid the oak panelling, and so forth, if only for the reason that the doors are certain to be in the wrong place, a big central door being usual. These defects can be remedied by the use of built-up screens; just one large screen in front of this door will make a big difference. Entrances will now be possible from either side of the stage. Further arrangements readily suggest themselves but, generally, it is wise to avoid an arrangement which aims at masking the wings in the manner of the proscenium stage. The properties used should be simple and easily moved in a blackout. If the large back screen is split in the centre, the two sections can be opened to reveal a set piece or more elaborate property. The screens would be moved under cover of a blackout. Suspended curtains are never satisfactory on open stages; the inevitable straight line of the top is too hard. Screens can be given an elegant profile.

Canvas-covered screens need careful painting if they are not to look tawdry and cheap against the substantial materials of the hall. The contrast between a flat wash of buff distemper and oak panelling is too striking. One way to give body to the colour is to create a broken surface by stippling or spattering a lighter colour on top of a darker one. A good neutral material for covering screens is unpainted hessian. This can be further enlivened by stencilling a simple pattern on it, using dye as colour. Another and better method is to fold the hessian in large vertical flat box pleats, care being taken to avoid a fussy curtain-like line top and bottom, the material, pleats and all, being taken right over the edge of the frame and tacked on the back. The result is well worth the extra trouble, as the shadows and colourings caught by the pleats, even when not directly lit, give great quality to the surface. This, however, can be applied only to large-scale screens, as a material like hessian will take only large pleats. Further, small pleats would merely be fussy, which is a reason why they are not suggested for canvas coverings. The question of scale is important, since the screens bridge the gap between the small detail costumes and the just-lit abyss of the hall beyond.

Lighting

The aim must be to provide a pool of light on the acting area, the natural diffusion of this from the platform floor being all that is required to light the background or screens. As a pool of light is to be formed, the sources will be focus lanterns and soft-edge spots entirely. On the open stage it is unnecessary to bring the actors into relief by side lighting. The fact that all the lighting is directed on them will do this automatically; there is no competing cyclorama, and so on. On no account should any architectural features of the hall be picked out or floodlit during the show. However tempting the forest of organ pipes and the apse behind them they should be left alone. Nothing should be done to cut down the lanterns for the production itself.

All the light must come from lanterns against the side walls in the body of the hall, and the centre line of the beams should make an angle of roughly 55° with the front of the platform

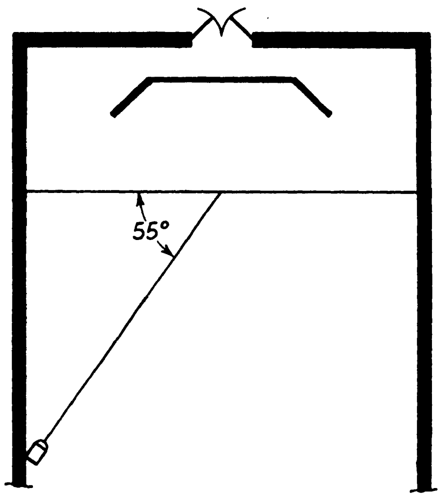


FIG. 121. PLAN OF PROJECTION ANGLE AND SCREEN FOR CENTRE DOOR

(Fig. 121). Long throws from galleries at the rear of hall, however tempting and no matter how "super" the lanterns, will give results that are too flat. Convenient ledges in the side walls may be splendid, provided the centre line of the beam will not have to be depressed through a greater angle than 35°. Should the play require the wearing of wide-brimmed hats, supplementary focus lanterns will be needed, below the main lanterns but slightly above the level of the players' faces. An alternative help to facial lighting is to cover the stage with a light drugget and to make sure that the pools of light begin well down-stage of the players: the diffusion from this has a softening effect on facial shadows (Fig. 122). A highly-polished stage floor should be avoided. The lantern beams with such a floor will be specularly reflected and appear as unwelcome blobs of light on the surroundings (Fig. 123).

Where window ledges, or something of the sort are available the lanterns should be left unscreened; to drape curtains

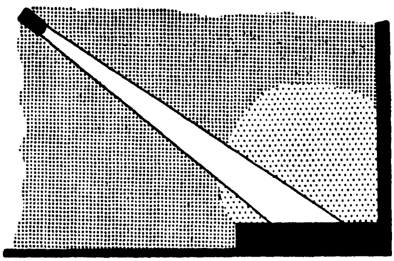


FIG. 122. SECTION: DIFFUSE REFLECTION FROM STAGE FLOOR

round them will make them the more prominent, assuming that the lanterns are reasonably neat, well designed, and, further, that light emerges from the proper place only and not from innumerable badly-baffled ventilation holes. If, however, the lanterns have to have a temporary support relying on the floor only, this will be best provided by a tall pair of steps, or

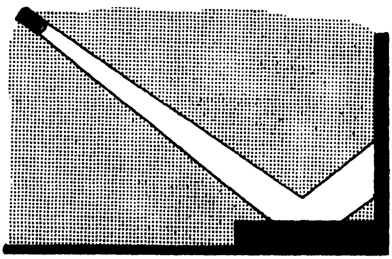


FIG. 123. SECTION: SPECULAR REFLECTION FROM STAGE FLOOR

even a short ladder leaning at an angle to the wall, brackets or short flange-plate stands being used to fix the lanterns.

Masking will be essential, and should take the form of a tall screen designed to echo those on the stage.

Lighting changes will be simple in nature and the best arrangement, where masking screens are used, will be to place the dimmers under the group of lamps they control. There will then be a couple of lighting men, one to each side of the hall, and they will take their cues direct from the action on the stage. They can also use the steps to change the colours of the lanterns mounted on them; also to re-focus and redirect the lanterns between scenes.

The usual portable board behind one of the stage screens will be adopted when lanterns are mounted in inaccessible positions (the hoped-for window ledges). In open-stage productions there is seldom work for the lighting man on the stage, and so, whenever the electrical arrangements will allow, a position in the hall is better. The lighting effects will be stylized; heavy colours will give wonderful results, and should be the rule. White and slightly-tinted lighting effects should be avoided; they are too hard and revealing to allow the spectacle to be at one with the hall. As can be imagined, the productions I have in mind are in costume. As a general rule, costume is essential where scenery is absent, whatever the type of stage. The costume and the lighting set the whole picture, and both must have something real to say.

An object lesson in lighting of this type were the recitals given by the dancer "La Meri" in front of black unlit curtains. The elaborate national costumes in a pool of rich colouring made a magnificent picture. The heavy colours I have in mind are No. 33 Deep Amber, No. 8 Salmon, No. 5 Orange, even No. 13 Magenta, the lightest being No. 4 Medium Amber. Such colourings should be used even where the action is supposed to take place by day. Sufficient intensity is the great secret in the use of heavy colours. A stage lit in heavy amber but of low intensity will be filled with heavy foreboding; the same ambers of high intensity will be exhilarating.

The truth is, that though the filters are the same, the colours, being drab and rich respectively, will be different.

Indoor Example

See Fig. 124.

Open platform hall, distance from *A* to background screen does not exceed 50 ft.

Equipment required: four 1000-watt focus lanterns; four 1000-watt dimmers mounted as a switchboard.

The lanterns are mounted in pairs at *A* and *B* in a way that complies with the conditions already given. Lanterns *A*1 and *B*1 are directed to cover the whole acting area, the beams being crossed. *A*2 and *B*2 are localized according to the needs of the action, probably to form a more intense pool of

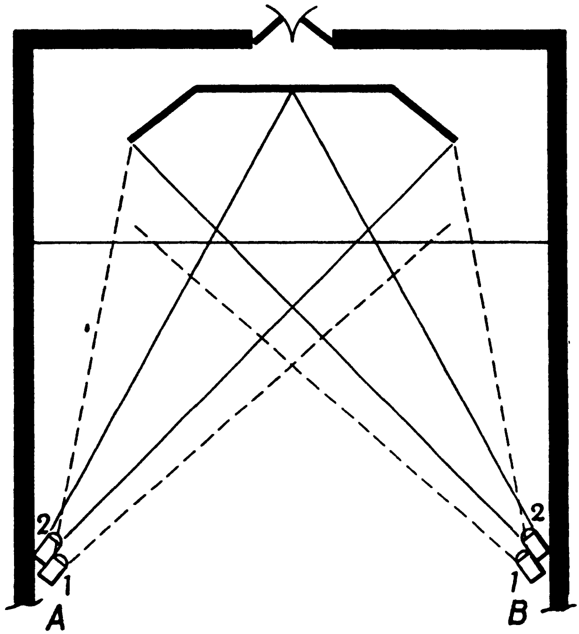


FIG. 124. PLAN FOR INDOOR EXAMPLE OF OPEN STAGE LIGHTING

light in the centre of the acting area. All lanterns will have light frosts; suggested colours might be No. 4 in *A*1, No. 33 in *B*1, No. 33 in *A*2, No. 8 in *B*2. A great deal of variety is obtained by use of the dimmers on this combination. If night scenes are required, *B*1 is changed to No. 32 and the other lanterns brought in slightly on the dimmers, *B*1 being more or less full on. The slight introduction of the other colours will give variety of balance under the dominant blue and also help the make-up. If the lanterns are inaccessible, an extra lantern will be necessary; though a simple colour change as described on page 58 can usually be adopted.

Never "follow" a character with a pin or any other kind of spotlight.

When the scale is larger than the above, the number of lanterns should not be greatly increased; four each side would be a maximum. The aim must always be broad, stylized effects, relying on a few sources; thus the next step would be to substitute more powerful lanterns. Three or four 2-kW soft-edge spots each side will cope with almost anything.

Although I have stressed the use of much colour, there should not be much colour change in the sense that this might be used on the proscenium stage, even supposing the production to be a dance drama. Dramatic effect will rely on movement of the dimmers, bringing one direction of light or another into prominence.

Churches

Frequently the hall will be a church and the play will be at one with its surroundings. All that has been stated so far in this chapter applies with equal weight to production in a church. Large numbers of churches afford plenty of concealment for the lighting equipment; the pillars between the nave and aisles, for instance. The stage is usually built up in front of the chancel steps, though sometimes advantage can be taken of the natural stage provided by the chancel. The claims of the West End, as at Lichfield Cathedral in 1946, are worth considering.

Once again, no curtains should be used, a simple set of screens being built for masking purposes. With lighting such as already described, elaborate masking will be quite unnecessary; characters will exit behind the screens, thereafter to take advantage of the gloom. Too often floodlights are used, and, in consequence, long lines of masking curtains litter the church to enable the players to take cover. The producer who knows his business will not tolerate such amateurish makeshifts. If concealment of lighting units is easier in a church, one of the difficulties that may beset the lighting expert will be the much longer throws encountered. It may, therefore, be necessary to employ a parallel-beam lantern, such as the 1000-watt pageant, in place of the lanterns already suggested for indoor work. It will then be hoped that the nave will have a triforium in order to give the lanterns height.

Church work, with tremendous distances from the source of supply to the dimmer board and from thence to the units themselves, tends to be prodigal of cable. This fault it shares with open-air productions; in fact the two have much in common. Tough rubber-sheathed cable can be hired at reasonable rates. Triforium positions and the like confirm the advantage of bringing lanterns into two groups, and, whenever possible, placing the dimmers near to the group controlled. In this instance, as switchboards do not sail through the air with ease, they may be placed vertically below the lanterns each side of the nave. To run six lanterns as separate circuits right back to some position in the chancel wastes a lot of cable.

Cables must not run on the floor in the path of the public. Where to hang cables clear is impossible, that part of the aisle or elsewhere will have to be shut. Incidentally, it is not fair to the players who have to traverse the murky darkness off-stage to expect them to negotiate earthbound cables.

In a stone church the colours previously described with wood panelling in mind should be lightened somewhat. Nativity and other religious mystery plays include visions and characters such as the Madonna whom it is sometimes desired to bring out in a special way. On no account should the Madonna be picked out with a spotlight and followed. Quite apart from the great difficulty in doing this properly, the result is bound to be reminiscent of the music hall. The best method is to throw a pool of No. 36 Lavender on a part of the stage to be reserved for the Madonna, angels, and the like. The use of the heavier colours on the rest of the stage, ambers and so on, will help to stress the contrast. When the angel appears to the shepherds, the contrast will be between the almost White No. 36 and the bluey night effect. In this instance only would this spotlight be brought up on a dimmer and taken out after the vision. In day scenes, when the amber lighting is the main basis, the No. 36 spotlight should be left on, and the special characters should walk into its pool. This colour will give a particularly fine effect on the blue robes worn by the Madonna. Any attempt to provide golden glory for heavenly choirs will inevitably savour of the revue chorus; the same pool of light should serve them. Restraint is by far the best plan, and this applies to all visions. It is possible to perform the most startling illusions with the aid of gauzes, ultra-violet rays, projected scenery, and so on, but such conjuring tricks will be out of place in plays the merit of which will lie in simplicity and sincerity of presentation.

Open-air Theatres

Although the professional open-air theatres, such as Regent's Park, tend to steal the limelight, amateurs have, nevertheless, succumbed to the attraction of such performances. These will probably take place in the grounds of private house, and have the advantage of being on a smaller scale, at any rate, as far as the audience is concerned, thus avoiding the problems of voice amplification. The main difference, from the lighting point of view, between an open stage indoors and outdoors lies in the possibilities that are opened up by the lighting of the trees and bushes which form the setting.

The acting area will, in the main, be lit along the same broad lines already indicated for indoors; the concealment will be trees if the right venue has been chosen. Colours will be much lighter than in the previous examples; in fact, plain white lighting will be the basis, and colours used sparingly.

A marked characteristic of open-air lighting is the need to light the trees and so on which form the background; otherwise the general effect will be one of gloom, no matter how much light is thrown on the acting area. Whereas indoors the surroundings are comparatively near the acting area and, further, are of materials that readily pick up the light scattered by the stage floor, dust in the air, and so on, in the open air on a dark night no such aids exist.

As for most purposes, trees and bushes are less distracting when lit from the front, it follows that it will be more economical if some of those lanterns used for the acting area also illuminate the background, though at less intensity.

Lanterns which are to be placed in trees and similar inaccessible positions must be outdoor models; otherwise there will be the complication of building weather protection round them. These lanterns will have to be sought among outdoor units used for floodlighting buildings. Three such are shown:

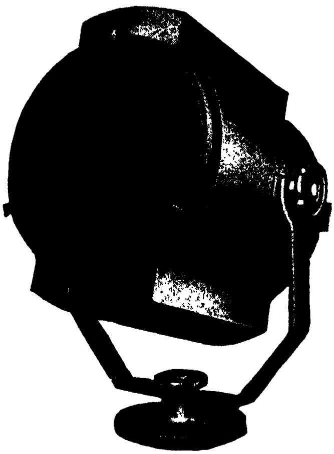


FIG. 125. 1000-WATT PARALLEL-BEAM LANTERN: WEATHERPROOF MODEL

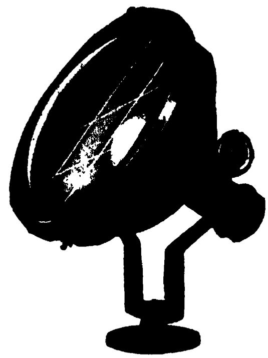


FIG. 126. 1000-WATT MEDIUM-ANGLE OUTDOOR FLOOD

the outdoor edition of the 1000-watt pageant (Fig. 125) which, incidentally, as its name implies, began its career outdoors (The Tower of London Pageant, 1935); the medium-angle 1000-watt floodlight (Fig. 126), and another version of the same lantern (Fig. 127) focusable with a 1000-watt B.1 lamp, or even 2 kW provided no colours are used.

When colours are used in these lanterns, coloured glass can be fitted in frames internally or cinemoid in square frames carried by external runners made up as a special attachment. Thus, we have lanterns giving beam-angles of 11°–17° and 20°–45° adjustable and 54° fixed. The outdoor pageant, like the indoor pageant, is fitted with spill rings so as to make the cut-off and beam angles the same; in the present instance, it may be desirable to remove the rings from some of the lanterns to allow the cut-off to be increased to 70° and thus to relieve the surrounding gloom (Fig. 128). For positions where the lanterns can be set up before the show and struck again at the end, or even during the show in the event of rain, the whole range of indoor lanterns is available.

As lanterns are used on either side of the audience making the 55° angle, already described for indoors, it may be necessary to make up simple visors of zinc to fit the side of the lanterns nearest the audience to prevent the cut-off angle making itself

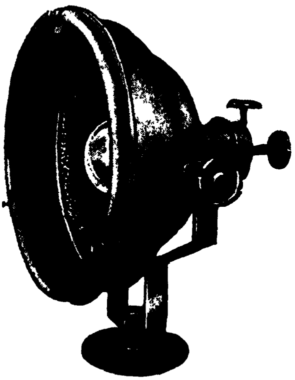


FIG. 127. 1000-WATT FOCUSABLE OUTDOOR FLOOD

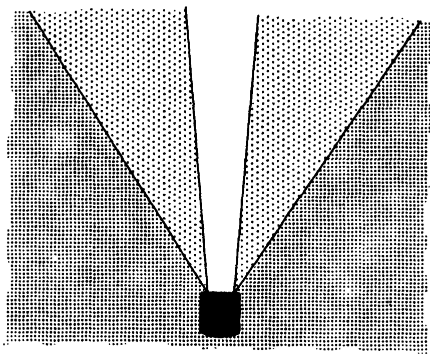


FIG. 128. EFFECT OF REMOVING LANTERN SPILL RINGS

objectionable in the corner of someone's eye. This particular trouble is unlikely to occur with the pageant lantern. Beams of lanterns will, in general, be crossed, i.e. a lantern will light the farther side of the stage, the aim in open-stage work being to make the on-stage side of the player the brighter.

Background Effects

Where funds are limited it is advisable to avoid lanterns being specially allotted to the trees that form the setting. What money there is should go first to the acting area, and the spill from the types described must look after the setting. In most cases, the interest of the play will be best served by such restraint, as, for example, *As you Like It* and *Twelfth Night.* However, where magic and fairyland are in question, the enchantment of lighting among the trees and bushes can be given full rein. The lighting expert who really wants to show his prowess had better see that *The Tempest* or *A Midsummer Night's Dream* are on the bills. Even in such plays only slight resort should be made to colour filters, the natural colours of the foliage being given a chance to express themselves. Pools of magenta, vivid green, red, deep blues, and so on, are liable to become a Brock's benefit. As will be apparent in later chapters, I am all for an orgy of colour, on occasions, but such occasions are rare, and never occur when a realistic setting is used. Use should be made of lighting from different angles, and only after the possible variations have been tried should colour be applied.

So far only lighting of foliage from the front has been considered; the effect of such lighting is familiar to all those who have undertaken night-driving. However, if the front lighting is restricted to the acting area, it becomes possible to pick out the foliage by floodlights lying on their backs and shining up vertically into the heart of the tree. Where the trees are tall, a narrow-angle flood, or even spotlight, will give better results. The closer and more bushy foliage can be lit from the rear, the transparency of the leaves giving an ethereal effect (Fig. 129).

Often, with a little care, the number of lanterns can be reduced by simple ruses. For example, if a mirror spot is used to project a vertical beam into a tall tree, it can also be made to flood other trees sideways at lower intensity, by merely leaving the lamp access door open. Distant trees can be included in the picture by use of long-range lanterns, such as pageants, instead of yards and yards of cable terminating in a wide-angle flood.

When the need for colour arises, it is advisable to avoid great contrast and to use a series of tones of one colour; for example, white and ambers Nos. 2, 4, and 33, and, perhaps, a warm pink like No. 8. It is better to pick out or to apply the high-lights, always using the white or lighter colours against a general ground of the deeper ones. For a night effect a series of blues Nos. 40, 18, 32, and 19 may be used, the Nos. 40 and 18 being the high-lights, and for dawn No. 10

FIG. 129. STAGE AND LIGHTING OF NATURAL BACKGROUND AT OPEN-AIR THEATRE, REGENT'S PARK

minus No. 4 from Actors' Right Front. It is always well to consider the possible artistic gain from leaving some of the setting dark rather than flooding everything with light of some sort.

Elaborate movements of dimmers and variations of lighting are not essential in the open air; the field of vision is so wide, and there is such depth in the live scenery, that the eye can roam and thus obtain most of the variety it needs. It was interesting to compare the satisfaction from the permanent Forest of Arden setting at Regent's Park with that on the stage of the New Theatre some years ago. At the New a fine glade set by Molly McArthur in the style of Watteau was used throughout; nevertheless, the setting palled after a time—a defect that was not noticeable when *As You Like It* was at Regent's Park.

Open-air Example

See Fig. 130.

Three 1000-watt medium-angle outdoor floods.

Three 1000-watt narrow-angle pageant lanterns outdoor type with spill rings.

Four 500-watt medium floods (indoor type).
One 1000-watt focus lantern (indoor type). } Optional for background.

One 7-way 1000-watt slider dimmer board.

The six units for acting-area lighting are formed into Group A (Actors' Right): two pageants and one flood; and Group B (Actors' Left): one pageant and two floods. The pageants will have Nos. 50 to 54 filters and be directed to cover, perhaps, Left Centre, Centre, and Right Centre; one flood on either side will be white, and the extra one No. 8 Pink. Only seven dimmers are needed, since at least the two white floods can be unplugged when the background lighting is in use. Night effects can be got by checking the pageants low and using the background units in blues. Where there are no such units, the Group B acting-area floods will be No. 33 and No. 18 respectively, the two full on giving warm white.

All lanterns and the switchboard must be carefully earthed, as wet or damp ground is a good conductor. Whenever possible, the dimmer board and main isolating switch should be placed under cover. If a shed or tent is used, the switchboard should be covered with a waterproof sheet when not in

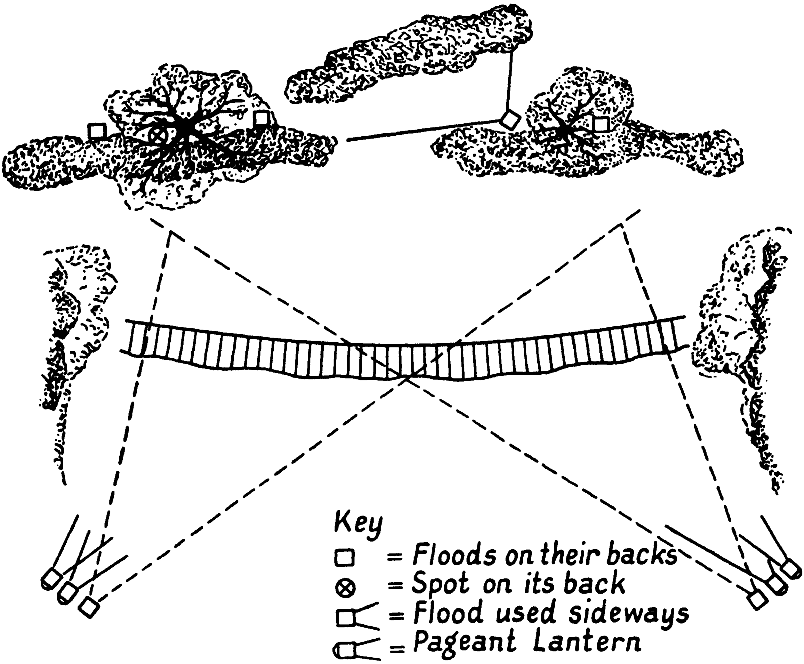


FIG. 130. PLAN FOR OUTDOOR EXAMPLE OF OPEN-STAGE LIGHTING

use. Tough rubber-sheathed cable (cab tyre) should always be used.

The Stage of the Future

Invariably, when designers consider the stage of the future they assume an open stage; the answer to any riddle now solved by a proscenium is the magical properties of lighting. To my mind, however, there should be no greater hurry to discard the invention of the proscenium opening than the wheel in transport; the age of an invention does not condemn it. The removal of the proscenium severely reduces the positions in which lighting equipment can be concealed, and, in consequence, its removal does not correspond to the release of lighting from its bondage. At the same time, as the proscenium is removed, the seating in the auditorium is brought farther round the stage; in some schemes completely round the stage as in a circus.

Even in Great Britain a lot of experience has been gained. Apart from the smaller-scale examples already considered in this chapter, there have been numerous large-scale productions in buildings such as the Royal Albert Hall, Olympia, and Earl's Court in London, and their counterparts in the provinces. One obvious form of open stage is the circus ring, but, in general, the tendency, both indoors and outdoors, is to reserve one end of the building for some almost recognizable stage, with a cyclorama and/or scenic background. The forestage is so large that it comes right out into the audience as an arena (Fig. 131). This was the technique of the Pageant of Empire in the Wembley Stadium in 1923, the Pageant of Parliament at the Royal Albert Hall, and many other subsequent examples.

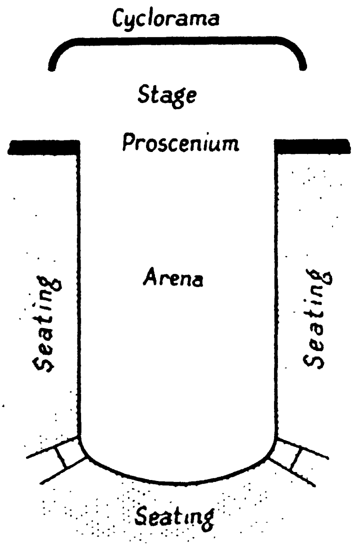


FIG. 131. PLAN OF ARENA STAGE

Often a normal stage with scenery and tabs is combined with the arena-type of forestage. The Grosses Schauspielhaus at Berlin provided a famous example at one time, and the Ice Rink, Blackpool, provides an example less famous, but none the less interesting (Fig. 132). The Blackpool arena is used for ice carnival; the photograph gives an idea of the difficulty of lighting this form of stage, especially in a building of normal height. Any hopes of an uninterrupted cyclorama ceiling, spanning auditorium and stage, vanish in a maze of lanterns or apertures through which the lanterns shine. Even

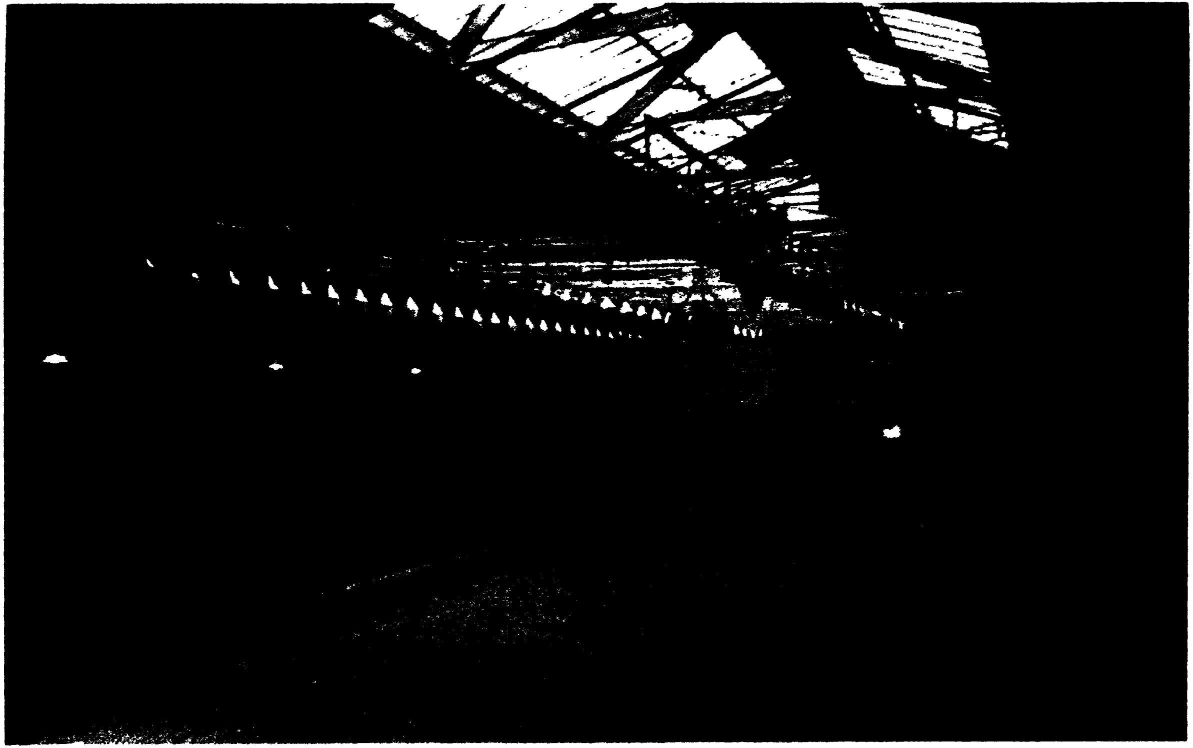


FIG. 132. FLOODLIGHTING FOR ARENA STAGE: ICE CARNIVAL AT SOUTH SHORE ICE RINK, BLACKPOOL

an array of lanterns such as this can provide lighting more or less from overhead only; most other angles are impossible because the lanterns would certainly trouble the eyes of some of the audience opposite. When it is remembered that on the proscenium stage actors and scenery can be lighted from all angles, it is not difficult to see that lighting from a few comparatively steep overhead angles, to say the least, is restricted. Added to this, on the normal stage the players can be presented as lighted against a light background (the normal), or against a dark background at will; the arena stage is restricted to the latter, since the audience must remain dark.

While I feel that the arena stage is unlikely to progress, except for specialist productions, it seems to me that considerable advance might be made by designing every theatre or hall in future so that a forestage can be used when required. This matter is discussed further in Chapters IX and X. Another important step would concern the decoration and lighting of the auditorium, which, so far, have been used merely for decorative effects. The auditorium during the intervals is lighted as itself, charming or otherwise. By careful design, variations on the lighting installation could in sufficiently neutral architecture, change the mood of the auditorium to suit the play, and, if necessary, modulate from one mood to another between scenes and acts, thereby preserving the atmosphere of the drama, instead of splitting the play into a series of blackouts or glimpses of nondescript lighting on the house tabs. The lighting artist should be able to play upon the auditorium in just the same way as he can upon the stage.

CHAPTER IX

THE PROSCENIUM STAGE AND ITS LIGHTING INSTALLATION

IT cannot be too strongly stressed that a grid for flying scenery does not make a theatre. In fact, to be of any use it must have considerable height and is, therefore, very expensive. Nor is it easy to make good use of flying facilities without skilled labour. On the list of priorities it can be placed very low indeed. There are examples among civic centres where a grid flying space is provided, but the auditorium has a flat floor. The money spent on the grid would have been far better spent in making some provision for the audience to see that stage properly. We can legitimately consider this matter further, for there is no point in lighting a stage unless the light after striking the actors and setting can be reflected into the eyes of all the audience.

It is, unfortunately, seldom that the ideal of a hall dedicated solely to dramatic performances can be achieved. It may have to spend most of its time as an assembly hall or classroom, or play many parts as a ballroom, concert hall, theatre, and so on. There will be a conflict between the roles which will demand a flat floor and those which demand a stepped or raked floor; invariably the flat floor has won so far. Thus the drama is handicapped by bad sight lines and acoustics. An attempt is made to remedy this by increasing the height of the stage floor, and in this way the evil multi-purpose hall has come into existence. When in addition the stage floor is raked and the rear wall is covered with lovely oak panelling, perhaps garnished with gilt radiators and a centre door, it is a case of "Abandon hope . . . ." The odd thing is, given a few simple provisions, potentially the sight lines are better than most commercial theatres with their two or three tiers. The hall I have in mind may have seating for anything from 200 to 1000; above this number a hall constructed on multi-purpose lines becomes too much of a wilderness for the drama, although not for ballet, which usually derives benefit from a large proscenium.

Above 1000 seats resort must be made to separate halls, a large-scale concert hall and a smaller-scale theatre, as at Wolverhampton. Two hundred to one thousand seats will give us a lot of ground to cover.

Sight Lines and Seating

In any auditorium seating over 100 people the rear seats will require raising. Assuming the seating area to be roughly a rectangle (the front corners will, of course, be angled) about twice as deep as it is wide, then half the seats should be raised. Of the raised group the rear half might be provided with

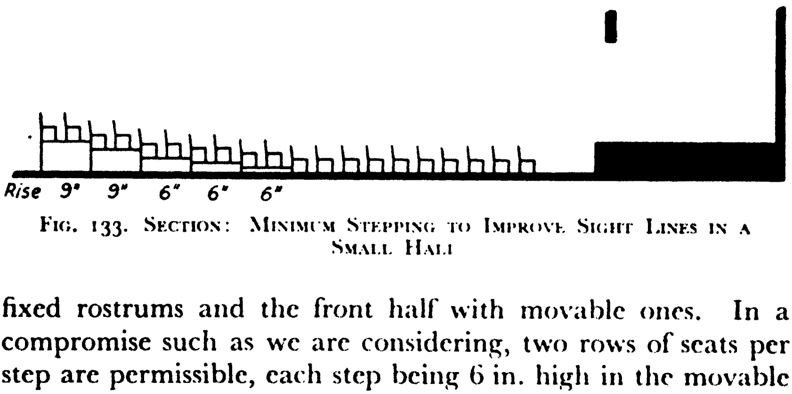


FIG. 133. SECTION: MINIMUM STEPPING TO IMPROVE SIGHT LINES IN A SMALL HALL

fixed rostrums and the front half with movable ones. In a compromise such as we are considering, two rows of seats per step are permissible, each step being 6 in. high in the movable sections and 9 in. in the fixed. For example, a hall with twenty rows of seats will have ten rows raised; six on three steps rising 6 in. at a time, and four on two steps rising 9 in., the total rise being 3 ft only for (say) 300 seats (15 in a row) less the front corners (Fig. 133). A 3-ft rise does not demand a stepped gangway; merely a little ingenuity in arranging the steps for access. In this example, maybe the whole set of rostrums could be removable, though the writer is in favour of a fixed nucleus inside of which the removable ones can be stored. The flexibility imparted even to a hall used solely as a private theatre by having a good portion of flat floor available on occasion, will well repay the extra trouble of making removable rostrums. Where money is very tight it will be surprising what a difference will be made by this slight stepping, though it is far short of the ideal. To see the show comes before cushions and soft seats.

Enough has been said to show that restriction to a flat floor is inexcusable even in a multi-purpose hall. A 1000-seater (see Fig. 134) will possess a small straight balcony—no horse-shoes, please—under which is the permanent stepped section (black in the figure) with the more elaborate access needed owing to its height of (say) 5–6 ft. In front of the permanent section are the removable steps (white) to be stored

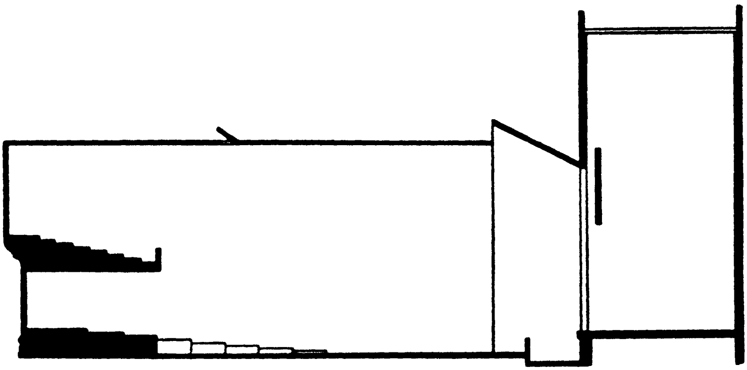


FIG. 134. SECTION: MINIMUM STEPPING FOR PASSABLE SIGHT LINES IN A LARGE HALL

in the former when not in use. Thus, three-quarters of the stalls floor can be cleared for dancing, etc., the fixed seating and steps being available for sitting out and watching the cabaret; it is not pleasant dancing under a balcony, anyway. The balcony above becomes available as a base from which temporary lighting stunts can be projected on to the dancers.

But enough of such things! Having ensured that there is no legitimate excuse for the flat-floored purgatories at present existing all over the place, let us get back to the drama. When *every* member of the audience has been provided with a seat where he can both hear and see the major part of the stage, including the backcloth, then is the time to start thinking of a grid and elaborate machinery for flying scenery. If we could see but two-thirds of the screen in a cinema we would stay away, and yet the drama is staged all over the country with this millstone around its neck. The stage forms a complete picture, and even if it contains one actor and no scenery, it should all be seen.

Stage Layout

Having made provision for the audience to see the stage, it is necessary to consider its design and the layout of the masking that will be essential even for an empty stage. The stage floor must be level and about 3 ft above the lowest point of the stalls floor. The rear wall must be flat, finished with Keene's cement painted matt white, and should extend as far into the wings and above the stage as possible. This wall becomes an elementary, but none the less effective, cyclorama. It follows from the sight lines that a pitched roof is not suitable for the stage, since this will give the greatest height to the cyclorama in the centre where it is least wanted.

The proscenium opening should not be made too large as it will either be costly to fill with setting or will have to be masked with the almost equally costly false proscenium, often seen in the theatre. Width is better obtained by a forestage in front of the proscenium opening, of which more anon. For a hall which may be required for orchestral concerts a large proscenium opening is desirable; this can surely be arranged by making the proscenium sides as sliding doors, capable of decreasing the opening by a further third, and a pelmet dropped in. The forestage will also be useful in concerts.

The stage itself ought to be roughly as deep as the proscenium is wide in the smaller examples. Greater width will make up for lack of depth, but not *vice versa*. There should be plenty of wing space on both sides, level with the stage floor; a depth of one-half of the proscenium opening to each side.

The ratio of the height of the proscenium to the width ought to be such as to make a nicely proportioned opening, such as 2 to 3. Height is taken to mean to the underside of the pelmet or proscenium border. About 10 ft is the minimum height; usually the scenery on the smaller stages will be about 18 in. higher than the opening. Thus, 10 ft 6 in. × 16 ft opening, 12-ft scenery flats; 12 ft 6 in. × 20 ft opening, 14-ft flats. On a larger scale, 16 ft × 30 ft opening will call for 18-ft flats—big stuff, in fact. Needless to say, these figures are rough guides only, and the information is to be obtained from setting out the various sight lines, as in the examples given later in Chapter XI. Even though the vast majority of productions, at any rate on the smaller stages, will rely on the simpler scenery obtaining its effect from suggestion, it will be as well to arrange our stage so that a realistic box set can be put on if we

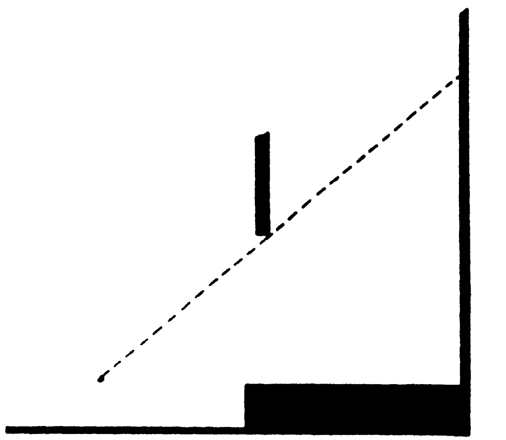


FIG. 135. SECTION OF STAGE WITH NO BORDERS, IDEAL SIGHT LINES

wish. Simplification should be dictated by artistic or, alas! financial considerations, and not because the confounded stage will not take the scenery.

Stage Masking

The next step is to consider the minimum masking necessary to clothe the stage. For this condition an empty stage, but not a naked stage, is the great test. With our white cyclorama back wall we have to consider right wings, left wings, and overhead. This last is the most vexed question of all, although it usually concerns only the front half of the seating. Ideally, the vertical sight line from the front row should see nothing but cyclorama beyond the proscenium opening (Fig. 135) a state of affairs not likely to be realized. The next thing would be a single deep border (Fig. 136), still Utopian in the present context. Probably we shall be lucky to get away with three (Fig. 137). Leaving questions of aesthetics on one side for

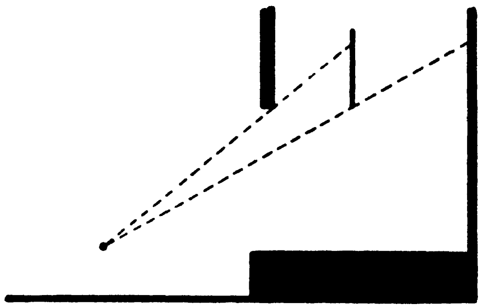


FIG. 136. SECTION OF STAGE WITH ONE BORDER TO REDUCE HEIGHT OVER STAGE

the moment, these three borders will immediately complicate the lighting installation. It is such methods of masking that have been responsible for the rows and rows of lighting battens from which the theatre is only just being emancipated. Obviously we shall need a batten of some sort behind the

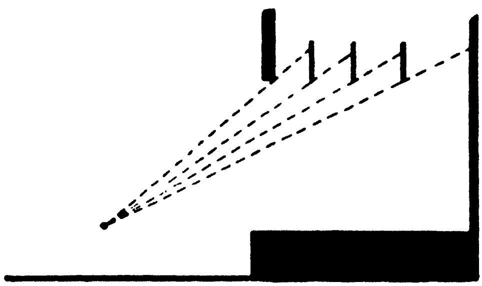


FIG. 137. SECTION WITH THREE BORDERS TO MASK INSUFFICIENT HEIGHT

proscenium opening for the acting area and also behind the up-stage border for the cyclorama. Such lighting will leave borders Nos. 2 and 3 quite dark and cause a ghastly shadow to be thrown by No. 1 into the bargain (Fig. 138). Even if we can afford lighting equipment for Nos. 2 and 3, balancing the lighting intensities is going to be a troublesome business. And all this merely so the traditional masking borders can be used. These borders will not look right in the exterior sets and in interiors, which form the majority of settings, they will ruin every set no matter how good.

The solution is to provide a white ceiling extending over

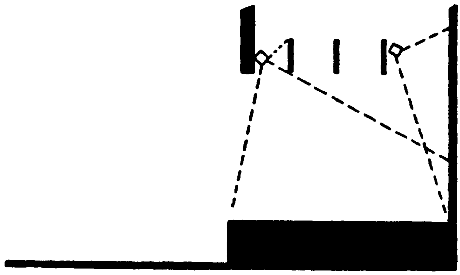


FIG. 138. SECTION: LIGHTING DIFFICULTIES WITH THREE BORDERS

roughly two-thirds the acting area (Fig. 139). The cyclorama lighting can now be mounted over the up-stage edge of the ceiling and the acting-area batten under the down-stage edge behind the proscenium. On the smaller stages, sets will almost always be regular in shape, since there will be little space to spare. The curtains, flats, and so on can be fixed to the off-

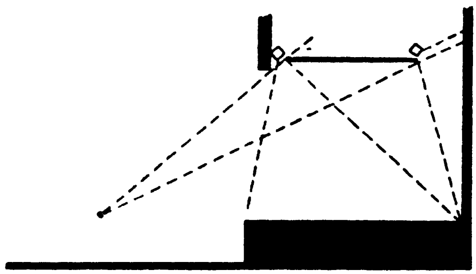


FIG. 139. SECTION: CEILING MASKING INSTEAD OF BORDERS

stage edge of the ceiling. In most cases it will be an advantage to run a track along this edge, the track carrying a number of standard curtain widths which can be opened or rolled up for insertion of doors and windows. The ceiling should be constructed of three-ply wood on a suitable frame and fixed rigidly, thus helping to support any flats put against it.

Schools and many others may find it an advantage to make the ceiling into a permanent setting by the addition of two columns at the up-stage corners of the ceiling (Fig. 140). With curtains along the sides and the plain cyclorama at the back this set can, if properly proportioned, look handsome enough for prize-givings and the many other occasions when the drama will not hold sway. If the architect is inclined to

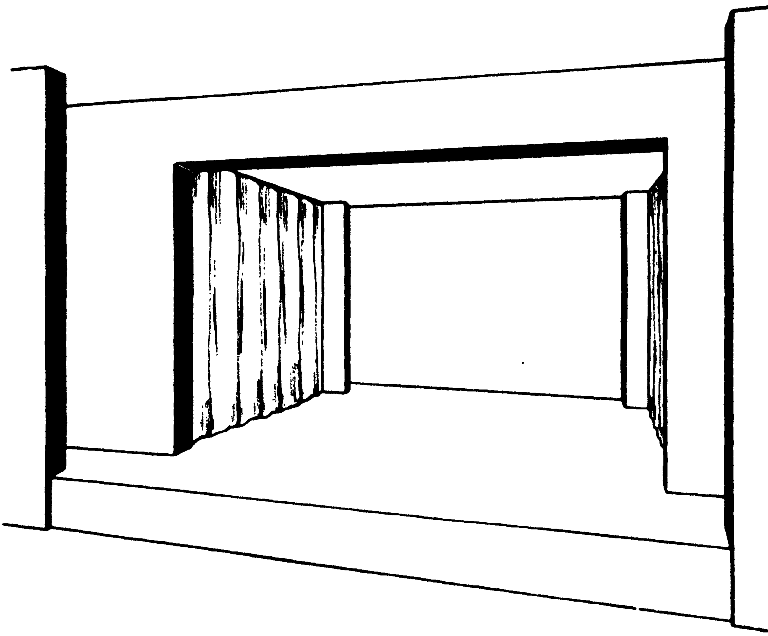


FIG. 140. PERMANENT CEILING WITH SIDE CURTAINS AND CYCLORAMA REAR WALL

quibble at a plain back wall in such a prominent position in his hall, let him examine the treatment of the lecture theatres in the R.I.B.A. building, London. When such a permanent setting is provided, there is no reason why a hard plaster ceiling should not be used. Whether of plaster or plywood, I imagine the acoustics will benefit from its presence. Placing flats along the edges of the ceiling will enable a box set of the utmost realism to be provided. Yet again, with some curtains and a few simple pieces of scenery all Shakespeare can be staged with a due regard for the duty to provide excitement for the eye as well as the ear. In serving the needs of the lighting we have abolished that great bugbear of amateur stagecraft—rigging the ceiling.

All this is very well for interiors, but what of exteriors! Here a convention has to be adopted. Some such is in any case unavoidable owing to the restrictions of a small stage, and no

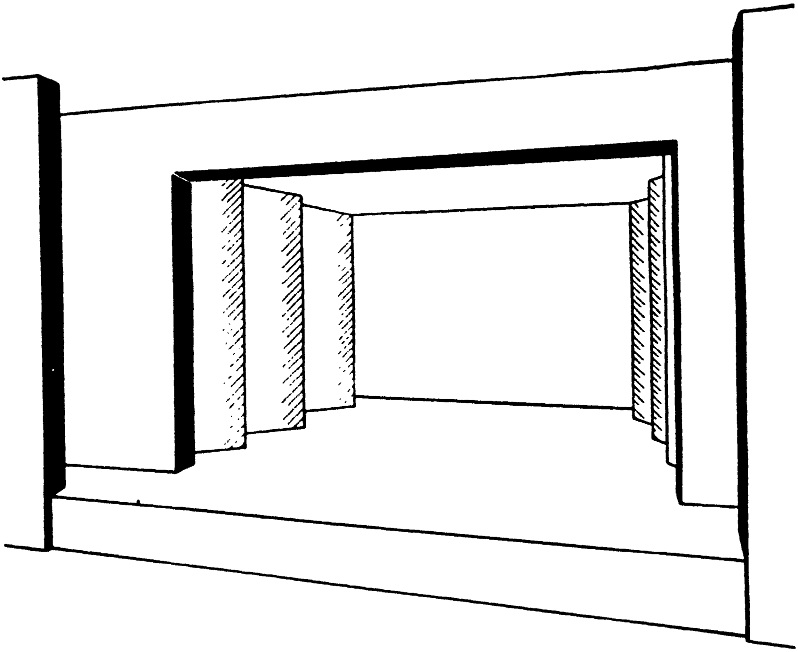


FIG. 141. AS FIG. 140 BUT SET WITH SIDE WINGS
Note. Fore-stage entrances through permanent wings instead of doors.

attempt should be made to employ realism except up stage beyond the ceiling. There a painted ground row and profile trees can be set. These will be found to dress the whole stage in spite of the neutral ceiling and masking used down stage. For exterior scenes, curtain wings or, better still, flats nearly parallel to the proscenium (Fig. 141) will be more effective than the boxing in, used for interiors. Where flats are used they must not be painted or shaped as trees and what-not; the essence of success is to set the picture in front of the cyclorama and the masking will not draw attention to itself. The pieces used in front of the cyclorama may be painted in any style one pleases.

These principles can equally well be applied to medium-sized stages, i.e. about 14 ft high by 20 ft wide by 20 ft deep. For these stages it may be advantageous, if height permits, to make the ceiling fold and hang vertically as a border. The down-stage lighting batten and the pelmet are to be capable of movement to allow greater flexibility in scenery height. Unless the stage is deep it is better to carry out height adjustment from a pelmet in front of the house tabs rather than from a proscenium border up stage of the tabs. Such a proscenium border tends to bring No. 1 batten too far up stage; on a shallow stage every inch counts. Variation in stage height is essential for all but the smallest stages. Cottages 16 ft high can only be tolerable in very large theatres. It will be best for the pelmet to be raised out of view for the tall sets and dropped in for the others. Other movable ceiling arrangements are suggested under Examples D and H, Chapter XI, in which part of the ceiling pivots to form a border.

Lighting in Section

Having arranged to let the audience have a good view of the stage and at the same time made sure that the stage shall present a seemly picture, we can now concentrate on the lighting. First (but only just) comes the lighting of the actor; and secondly, the lighting of the set. As far as possible the apparatus for these two functions should be kept entirely distinct from one another. Some sort of compromise is inevitable, especially on the small stage. We shall find that the best place to light an actor to reveal his features and yet provide some, but not excessive, modelling is from the auditorium. It is not done by using footlights, thereby spraying the background with the same light; nor yet by battens immediately overhead with consequent disastrous results from the modelling point of view.

Focus lanterns or mirror spots out in the front of house near the side walls will light the actors, at any rate down stage. The beams will be crossed so that combined with a suitable downward angle they will not hit the cyclorama when it is in use. The framing shutters of mirror spots in this position would be very valuable, since the light could be accurately fitted to the acting area. With focus lanterns, a part of the circle is liable to appear where unwanted, unless the lantern is focused down, with consequent defects in the area covered. As the number of F.O.H. spots is increased, so some will be placed in the ceiling on the theatre centre line. This position is difficult to define owing to the great variations of ceiling or beam heights. Generally speaking, a steeper angle of throw than 35° being inadvisable, a retreat further from the stage may be unavoidable and so will a more costly lantern to compensate for increased length of throw (Fig. 142). A

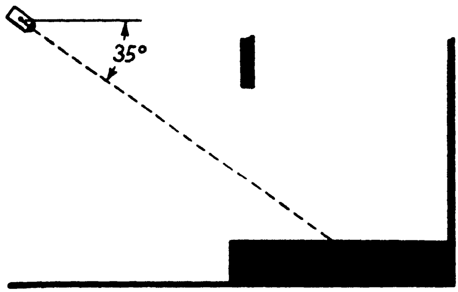


Fig. 142. Section: Front of House Spot-lighting Angle

focus lantern may be used here with more success than at the side; nevertheless the mirror spot is the real auditorium lantern.

At the next position immediately behind and over the proscenium opening, known as No. 1 Batten, the lighting units will serve both the actors up to centre stage and be required to light the setting down stage of the cyclorama. No. 1 Batten will therefore be a mixture of focus lanterns and floods. The focus lanterns will be less powerful than those in the F.O.H., since they have less distance to throw, e.g. 1000-watt focus lanterns in the auditorium, then 500-watt ditto on No. 1 Batten. The floods will vary in wattage according to the size of the stage, the minimum being 100- or 150-watt and the maximum 500-watt. To bridge the gap between the rather cumbersome 500-watt size with a 300-watt lamp and the baby 150-watt, a double unit of the latter can be used. Where the stage is sufficiently large, 6-ft lengths of magazine batten (the compartments of which are virtually the same baby floods) can be substituted with advantage, the focus lanterns hanging between the lengths. This is not done on small stages as the directional possibilities of the individual baby floods are useful in overcoming shadow problems, especially when combined with the hood attachment.

Medium-angle reflectors should be fitted to the baby floods or magazine lengths. This will enable the main beam to be kept clear of the cyclorama, only the direct light of the lamps spilling thereon. This question of direct light on the cyclorama is very important, even where a play demands interiors only. There may be windows in the rear wall of the set and these have an unpleasant way of appearing as patches of light on the cyclorama, when acting as a backing. Night scenes with lighted interior are especially troublesome. This is where a No. 1 Batten with the individually swivelled baby floods will be very valuable, particularly on small stages where these troubles are very much aggravated. The primary aim of the floods on this batten is to light any part of the setting down stage of the cyclorama; with this they combine the duty of providing a general wash of light behind the accents of the focus lanterns. It is from these floods that any pronounced colouring for night effect, etc., will come. The focus lanterns may be spaced out at regular intervals across the stage, but where there are only two then these will be the extreme ends of the batten, i.e. about level with the sides of the proscenium opening. On the larger stages the height may require additional focus lanterns lower down, just behind the proscenium on adjustable brackets, in order that some better lighting angles may be available. These lanterns are usually known as *perches* and they can be considered as extensions of No. 1 Batten.

No. 2 Batten will hang or be carried over the up-stage edge of the fixed ceiling, and is devoted to the cyclorama only. In the smaller stages triple baby flood units will be used, working up as expense permits and size demands through a magazine batten to a bank of 500-watt floods. It is here on the cyclorama that three-colour mixing comes into its own, and therefore there will be three circuits, and floods or battens will be fitted with wide-angle reflectors.

So far we have considered basic stage equipment, and now some of the possible refinements can be investigated. One of the first of these is the provision of three-colour lighting at the bottom of the cyclorama, in its simplest and cheapest form a length of 2 in. × 1 in. wiring trough with E.S. holders, the lamps being of the coloured-china sprayed type 60- or 100-watt. No very exciting colour-mixing will come out of this arrangement, but it will be better than nothing. The real thing to use is a magazine ground row; or footlight, as nowadays careful design has combined these two duties in the same unit. It is very important that the ground row

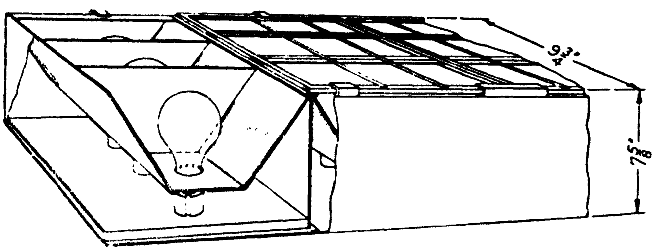


Fig. 143. Parallel Compartment Magazine Equipment for Close-range Ground Row

should not be closer to the cyclorama than thirty-four inches to its front edge. This not only prevents spottiness at the bottom, but also gives the reflector some chance, however small, to throw its light up and at the cyclorama. To cope with very close ranges a unit with parallel compartments (Fig. 143) can be used, but the result is bound to be rather a makeshift.

When there are three dimmers to the top and three to the bottom, then I suggest No. 5A Deep Amber, No. 16 Blue-green, and No. 20 Blue should be used at the top instead of the orthodox No. 6 Red, No. 36 Green, and No. 20 Blue, which, however, would be retained at the bottom. The reasons for this were discussed under "Cyclorama Colour-mixing" in Chapter VII.

The question of concealment is important, particularly when an empty stage effect is required. Ideally, the ground row ought to be mounted out of sight below stage level in a pit covered on occasion by removable sections of the floor. Alternatively, a ground row in 6-ft lengths can be movable and placed on the stage floor, thus making it available for other purposes. Where money is important it is undesirable that this equipment should be reserved for one job. The portable sections of ground row can be used to light door or window backings to interior sets, or even as a footlight. When a pit cannot be provided, the ground row can be concealed by an inclined plane. This is merely a long narrow plywood flat, one edge of which rests on the floor down stage of the lighting ground row and the other is propped up so that the plane

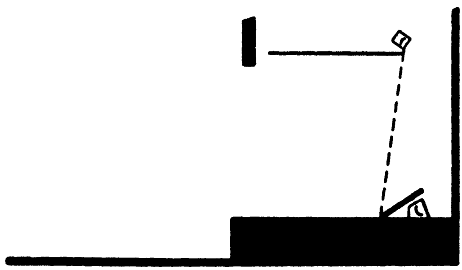


FIG. 144. SECTION: INCLINED PLANE TO MASK LIGHTING

makes an angle of 35° or less with the stage (Fig. 144). This inclined plane is painted matt white and will automatically pick up the top cyclorama lighting in a shade of the original colour. The effect is most satisfying and overcomes the need for a painted wall row or a line of hills or what-not, in circumstances where something neutral is required.

On the medium-sized stages some vertical acting-area floods carried on a No. 2 Batten half-way up stage will be useful; these floods will be 150- or 500-watt depending on the scale. After fairly considerable equipment has been acquired it will be time to contemplate a footlight. I hope I have made it clear that its priority is very low. A footlight is a very useful piece of apparatus, but it is expensive and, unlike focus lanterns, floods, and dimmers, we can do without it. Its duties are, except in West End leg shows, very subtle, and far more shows are ruined by the over-use of it than by the lack of it. Its main object is to soften the facial shadows caused by overhead units or front-of-house units throwing at too steep an angle. It is invariably too bright, and this causes actors' shadows on the back of interior sets, plus scenery shadows when the cyclo-

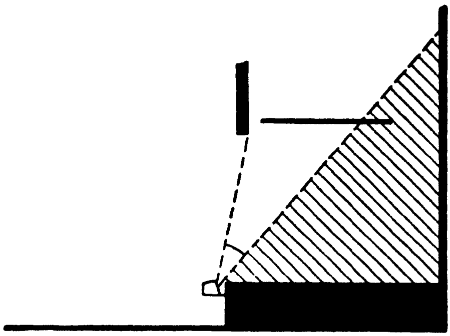


Fig. 145. Section: Footlight, Rising Shadow Theory

rama is used. In theory this is overcome by mounting the footlight so that a rising shadow is thrown by the edge of the footlight ramp (Fig. 145). This shadow embraces the cyclorama, but it also causes a bad shadow line on the side walls of a box set and on curtains, etc., set about centre stage.

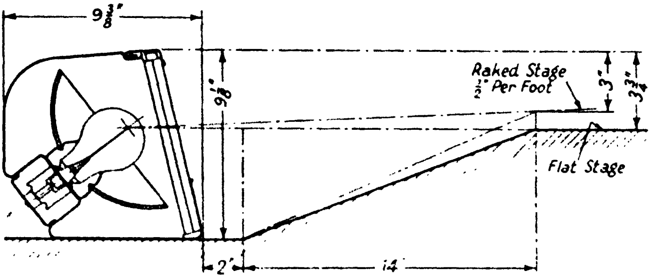


Fig. 146. Section: Usual Mounting of Footlight

Usually the kinds of stage we are discussing are not deep enough to give the rising-shadow theory a chance, and it will be better to mount the footlight as Fig. 146. Any woodwork or ramp between the up-stage edge of the footlight and the stage floor must be black.

The length of the footlight should only be 75 per cent of the total width of the proscenium opening; compartments will have 60-watt lamps and wide angle, or even no reflectors in many instances; it can be wired for two or three circuits. As explained earlier, the footlight can very often double the part of ground row. For small stages where some footlight correction is absolutely necessary due to enforced high mounting of the auditorium focus lanterns, a cheap remedy will be the opal architectural strip-lamp in 3 ft or 4 ft lengths. A single line of these can be mounted in a simple metal hood and carried from brackets along the front of the stage. The lamps will be wired with a dimmer as a single circuit. A touch of this light

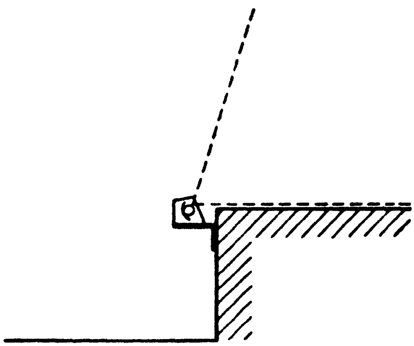


FIG. 147. SECTION: FOOTLIGHT BRACKETS TO SAVE STAGE SPACE

brought in on the dimmer will be quite sufficient for most purposes, no colour filters being required. This type of lamp, owing to its shape, will not throw shadows of verticals such as actors on the cyclorama.

When a forestage is used, footlights must be able to vanish and leave a clean stage front. There are various methods of doing this, ranging from elaborate mechanical lifts or rotating devices to striking by hand. But remember the priority of the footlights when considering costs; its position in the stage-lighting installation is similar to the cushions on the seating—a refinement that must come after the essentials. Many lighting installations lead one to suppose that the proud owners are in the habit of providing cushions before the seats or the building. On small stages where floor space is valuable the footlight can be carried on removable brackets over the front edge of the stage without a ramp (Fig. 147).

Lighting in Plan

To assess exactly how many lanterns ought to be used in the F.O.H., No. 1 Batten, for cyclorama and so on, it is necessary to consider the installation from the plan view. The vertical aspect must always come first, otherwise a diagram showing the acting-area plan is liable to be covered perfectly by the circles thrown by the various lanterns, when in practice the angle at which the circles of light are projected may be of little use for their primary purpose—facial illumination. Considering the coverage of focus lanterns, spotlights, and

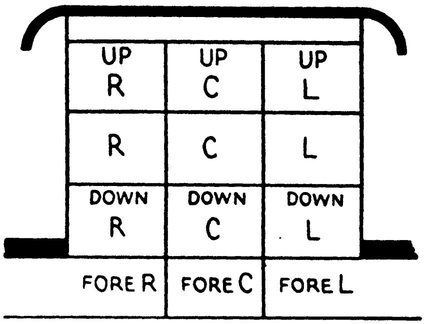


FIG. 148. THE PLAN: STAGE AREAS

narrow-angle acting-area floods in detail, the stage will fall into distinct areas: down stage, centre stage, and up stage; these are each subdivided into Left, Centre, and Right. The left and right is from the actor's point of view facing the audience, known as Actor's Left and Actor's Right. Using these terms, we get Left Centre (L.C.), Down Right (D.R.), Up Centre (U.C.), and so on (Fig. 148).

It would be convenient if we could locate our lighting according to this formula; if this were possible we should have a further narrow division beyond the up-stage area, best labelled "No Man's Land," where the lighting for cyclorama and its scenery falls. On a small stage the best that can be aimed at for lighting is down stage and up stage. Thus, if we have the minimum gear, two spots in the auditorium will cross their beams and light Down Left and Down Right, overlapping in the centre. The two spots on No. 1 Batten attend to Up Left and Up Right in the same way. The next step is to add a centre spot in the auditorium, giving Centre, Down Left, and Down Right, the last two crossing beams as before. If No. 1 Batten can be treated in the same way, then this auditorium spot would become Down Centre. The next additions are designed to give a change of colour to these areas, beginning with the most important "Down Centre." Thus we find one focus lamp left and right, but two in the centre. The change of colour referred to here is, of course, one that takes place on dimmers during a scene and is, therefore, not possible by mechanical means, however elaborate.

This system is applied until we have two spotlights for each of the stage areas and some unattached ones as well. Very often the centre and up-stage areas will receive assistance from vertical acting areas in a second batten over centre stage. However, this will be vertical light and, in any case, when interiors are in question, the ceiling will prevent the use of battens other than No. 1. This is a good reason for concentrating one's main acting-area lighting forces there and in the auditorium. A full spot batten will have spots, two to each of the centre and up-stage areas (i.e. twelve spots). The lighting artist will not earmark his spots rigidly for these areas, but he will always bear in mind that a proportion of his spots will be confined to semi-flooding duties; the fewer spots there are the higher the proportion.

Naturally, if there are a dozen spots in No. 1 Batten and perch spots into the bargain, the scene lighting will be a fabric of spotting carefully built up and balanced. This should not be attempted on a small stage, even if the number of spots were available, as actors moving about the stage tend to intercept at such close ranges beams intended for other areas. Broad effects are better; not only do they require simpler equipment, but the idea behind them is far more likely to get over. The wonderful mosaic built up over several days, using vast numbers of spots, all at individual check positions, is only really appreciated by the producer who carried it out. Perches are useful in throwing the characters into relief, but can be used only on stages with height. On small stages, actors will have to use the "No Man's Land" in front of the cyclorama;

frequently spotlights placed high in the wings, or at the ends of the cyclorama batten, will do very well to light this region, since the actor will not walk on sideways and will therefore be facing the spot on the opposite side (Fig. 149). Larger stages will have spots on the end of the cyclorama batten and No. 2 Batten for this purpose. Backings to doorways will be lit by baby floods hanging over the door: a common fault is to use a flood from the side, which projects a distracting shadow of the actor making his entry.

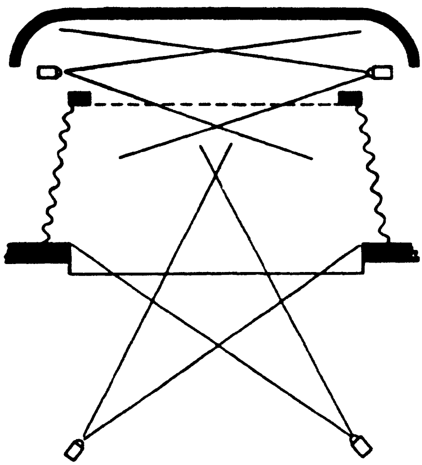


FIG. 149. PLAN: LIGHTING THE UP-STAGE AREAS CLEAR OF THE CYCLORAMA

Where a forestage is used, this becomes another area to be lighted, and we get Fore Left, Fore Centre, and Fore Right, though it may be necessary to make do with two lanterns.

Examples of installations of various sizes, based on the principles described above, are given in Chapter XI. Special lighting methods and effects lighting are treated in Chapters XII and XIII.

Note on Crossing Beams

Practically throughout the chapter reference is made to the crossing of beams from spotlights or focus lanterns: the left spotlights light the right-hand side of the stage. While writing

I had in mind the small stage with limited height and space. In these circumstances there are two main problems: how to get the light to spread quickly, and what to do about the shadows on scenery and cyclorama. However much you increase the blue lighting of your cyclorama in, for example, a day exterior, you can never swamp direct light that may be

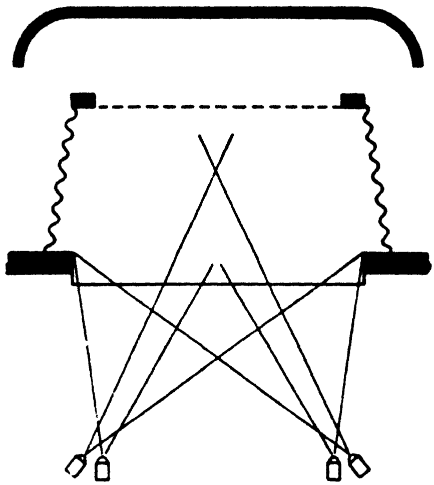


FIG. 150. PLAN: LIGHTING THE DOWN-STAGE CORNERS

thrown from a spotlight. The result may be an unpleasant circle of light, but certainly will be actors' shadows.

By crossing the beams, the shadows are projected to the sides of the stage where, even in a box set, they are not so noticeable. As the stage increases in size, so there is more liberty in this matter. Usually the crossed beam lights the actor from the more important "on stage" aspect. Sometimes when important action takes place in the down-stage corners of the stage it will be necessary to take steps to counter the too directional effect of the crossed beam. A supplementary, less powerful spot is used, as shown in Fig. 150.

CHAPTER X

THE MUNICIPAL THEATRE

THIS chapter describes the design and equipment of moderate-sized democratic theatres to set the standard for their area. Because such theatres have not arisen so far, it is assumed that they will have to be municipally built. For the smaller civic groupings the one theatre will have to serve opera, ballet, the play, and music in one auditorium. Larger groupings will be able to split the various activities among specialized auditoria; one seating 600 for straight plays; another of 1000 seats or over for opera, ballet, and other spectacles; a separate concert hall may also be possible. I will concentrate on a single 1000-seater theatre of the widest application with adequate equipment; a venture on a scale that could reasonably be expected to be launched in many London suburbs and provincial cities.

The theatre intended here is not the elaborate building that should rightly be expected as a National Theatre, nor is it a cut-price home for the drama. The quality of design, building, and materials employed throughout must be honest, without any suggestion of the plaster-palace standards of the local cinema. The theatre should have an air of permanence, and be built with the idea of passing on to the coming generation an example of fine building. The stage is excepted, and the maximum flexibility for remodelling, even complete rebuilding, is the rule beyond the proscenium.

The Auditorium

This is to be a democratic theatre where every one (including the lighting operator!) has a view of most of the stage, a view that includes the setting as well as the players. To achieve this and yet avoid making the auditorium too vast, it will be necessary to limit the seating capacity to one thousand at the most, one tier being the limit; this, the dress circle in most existing theatres, gives the best view of the stage. Above this the sight lines are strained, and little, if any, of the cyclorama can be seen (Fig. 151). The stalls floor usually requires

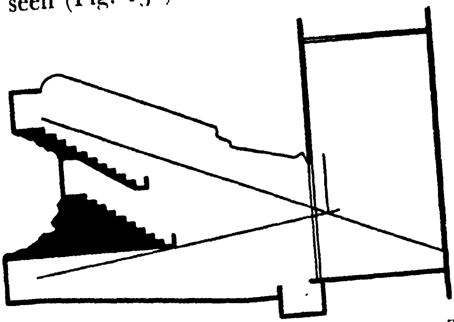


FIG. 151. SECTION: SIGHT LINES IN A MODERN LONDON THEATRE

a greater rake than is normally given; the stepping at the London Coliseum is a great improvement on most theatres.

It follows that to obtain a view of the stage free from obstruction, at least the rear part of the stalls must be stepped, and the

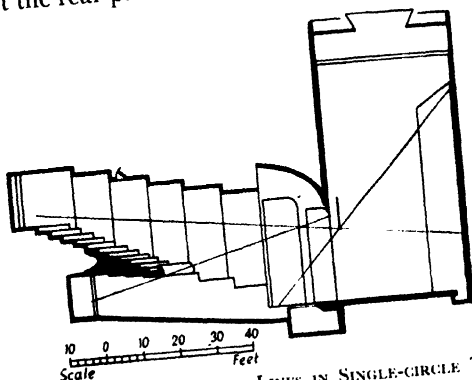


FIG. 152. SECTION: GOOD SIGHT LINES IN SINGLE-CIRCLE THEATRE

front half be given the maximum permitted slope of 1 in 10. To step the stalls under the circle will place the latter rather too high, if the rear stalls are not to be shut in. Some authorities have a regulation that prevents steps on the stalls floor; if all the floor is stepped, there is no logic in this: therefore the regulation must go. Fig. 152 is a general compromise.

Instead of the one tier, by the sacrifice of some seats, the single-stepped floor, made famous at Bayreuth, can be adopted (Fig. 153). A *fan-shaped* stepped auditorium of this sort will

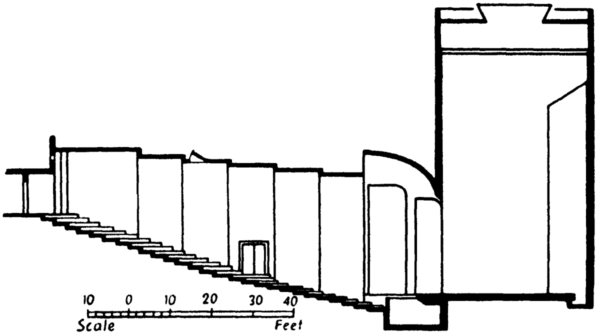


FIG. 153. SECTION: ONE-STEPPED FLOOR FOR IDEAL SIGHT LINES

give perfect sight lines: it will also go a long way towards ensuring good acoustics, since the player will speak at each member of the audience, and not over the heads of half of them. With the seating limited to 1000, the rear seats, though

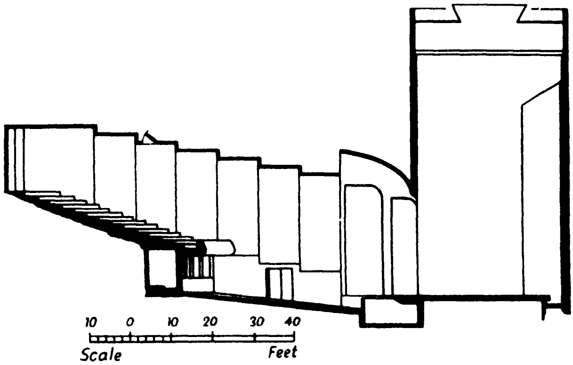


FIG. 154. SECTION: STADIUM ALTERNATIVE TO FIG. 153

no further distant for vision than those at the back of a modern upper circle, may appear to be farther off. This is an optical effect caused by the unbroken rows and rows of seats that stretch away to the stage. This illusion can be prevented by raising the rear half of the seats as shown in Fig. 154, the auditorium now being of the stadium type of many cinemas.

The sight lines of the seats at the rear of the raised section miss the stalls seats, but take in the orchestra or forestage. The stadium plan gives those who like the front row of the circle a chance still to enjoy its pleasures.

Between the raised section and the stalls private boxes may be placed, as in the Liverpool Philharmonic Hall. One of these boxes can be reserved for the lighting control. Under the raised section is a really spacious bar serving drinks of *all* types, hard or soft, hot or cold. To this social centre I would like to see most of the audience adjourn after the play for mental and physical refreshment. Lack of somewhere to go to talk over the play is apparent outside the London West End Theatre district.

The municipal theatre might have a resident repertory company season as well as visiting companies of all kinds. The theatre would also be used for local amateur activities. In cases where funds are inadequate to provide a fine theatre and a fine concert hall, the theatre can cater for both. The adjustable proscenium and large forestage will make this possible, but the theatre will not be used for dances or exhibitions, a separate hall being essential for these purposes. The provision of separate halls is not extravagant, and in a well-run centre there will be more than enough bookings for both.

The Forestage

The shape of the stage is governed by the sight lines, and once the principle that all shall see has been adopted, a deep stage is out of the question unless a large proscenium is used. As the theatre in mind has to cater for straight plays as well as opera and ballet, the proscenium opening must compromise and be of medium size. Adopting an opening variable between 30 ft and 40 ft wide, a stage depth of 30 ft from proscenium wall to cyclorama pit will give good results. There are two extremes to avoid: a drawing room comedy "lost" on a large stage with masking curtains or tormentors, and a full *corps de ballet* giving Fokine's *Scheherazade* on a stage barely 30 ft wide. The gain to ballet of a large-scale stage is well shown in the photograph of *The Sleeping Beauty* at Covent Garden (Fig. 155).

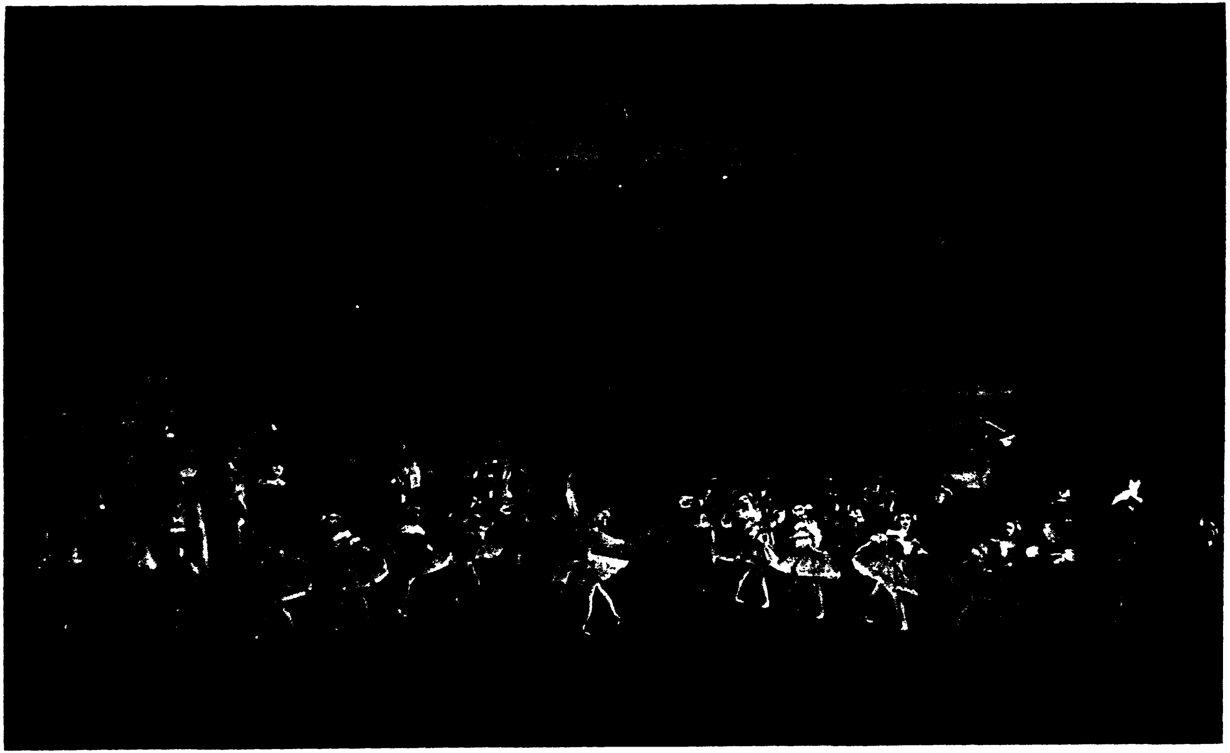


Fig. 155. Ballet on a Large Stage: "The Sleeping Beauty" at Covent Garden Opera House

Even a 40-ft opening is scarcely large enough where many movements or large crowd scenes are involved. A stage ought to be able to mount a pageant or a procession. For these and many other reasons I show on the plan (Fig. 156) a fore-stage which will bring the stage width up to 50 ft. Experiment

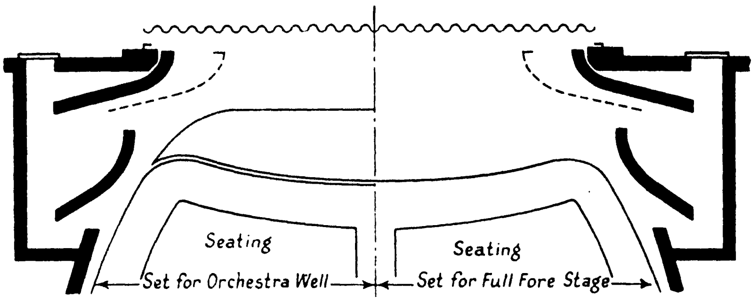


FIG. 156. PLAN: ADJUSTABLE PROSCENIUM AND FORESTAGE

with the forestage is important, for not much has been done outside little or amateur theatres. Only one of the larger theatres, namely Stratford-on-Avon Memorial Theatre, has a permanent forestage. When a forestage is used in other theatres, owing to the lack of entrances it is seldom possible to do more than arrange a false proscenium behind the opening (Fig. 157). This does not give an increase in intimacy

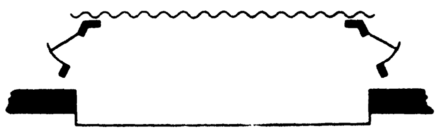


FIG. 157. PLAN: POOR SUBSTITUTE FOR A FORESTAGE

between audience and stage, but creates a great barrier of two prosceniums.

A wide forestage with several entrances, as shown in Fig. 156, allows crowds to rush on and off stage from the direction of but not among the audience.

The forestage is level with the stage and 12 ft deep in front of the proscenium, the part forming the forestage wings and 6 ft of its depth being permanent, with the front portion as an electric lift. When this descends an orchestra pit to hold sixty players for opera or ballet is revealed. This section can also be set as steps; straight plays using box sets can be badly handicapped if separated from the audience by 12 ft of flat stage floor.

To enable the forestage to present neutral but expressive surroundings, the ceiling over it is contrived as a plain white cyclorama cove on which three-colour lighting of exciting intensity can be projected. The auditorium edge of this cove will allow the provision of a lighting bridge over the first rows of seats. It is important to provide neutral entrances which will

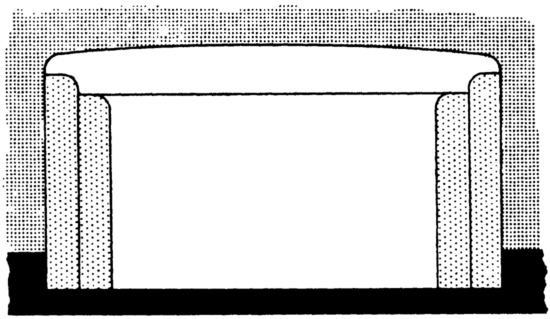


FIG. 158. ADJUSTABLE PROSCENIUM SET FOR LARGE OPENING

serve interiors and exteriors alike; doorways, even when not fitted with doors, are quite unsuitable. The entrances must be behind wings, which will be as high as the proscenium opening, but as there is a cyclorama overhead, they will not reach the roof (Fig. 158). The proportions of these wings, also their acoustical shape, will need to be carefully considered. If the inner wings can move on a track 5 ft on and off stage, the inner position with a pelmet dropped in will avoid the feeling of a box set, on a stage too big for it (Fig. 159). The wings allow the concealment of side lighting—previously a problem on a forestage.

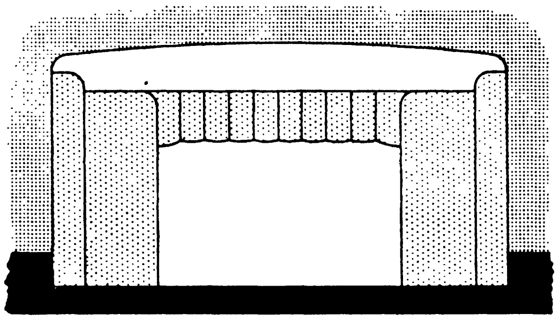
The Stage

The stage proper will be flat, and provided there is plenty of wing space, bridges and a revolve will not be necessary;

there will, however, be the usual traps, carpet cut, etc. The best stage covering for general purposes is black lino, which can be washed but not polished owing to troubles caused by specular reflection. A canvas drugget will be used occasionally.

Nowadays, revolving discs, wagon stages, and other rapid scene-changing devices can easily be erected when needed on top of the normal stage floor. Burris-Meyer and Cole give interesting descriptions of the various methods possible.

There is a school of thought which considers that the mechanical stage has had its day. The theatre has or will



Pros. Opening 30x 18 Ft.

FIG. 159. ADJUSTABLE PROSCENIUM SET FOR AVERAGE OPENING

soon grow out of the realistic or naturalistic setting, in which it cannot compete with cinema or television. Settings will be simple—a playground for light; to strike them will require no machinery. But this is just what they do in fact need. The simple inclined plane across the stage or the great flight of steps cannot be simple mechanically. Lightly constructed of many pieces easy to remove, it can neither stand the actor without creaking in a maddening manner, nor stand the destructive directional lighting poured on it.

As a general rule the less scenery there is the more solid becomes what does remain, and machinery to strike it or to change its aspect becomes essential.

A full counterweight system and some hemp lines should be fitted to carry scenery and lighting apparatus. The grid should be sufficiently high, at least 60 ft, to enable scenery to be flown clear of the cyclorama. A cyclorama with curved ends should be permanent on the back wall. Its height must be such that only one border, 14 ft up stage of, and of the same height as, the proscenium, is required. A cinema screen, if fitted, may be flown on the counterweight system, but the talking picture horns must be carried on a tower, to be wheeled right off the stage into a special storage recess when not in use; when flown, the horns block too many lines. A pit is needed for the cyclorama bottom lighting and permanent perch platforms, 16 ft high, are required on either side of the proscenium opening to carry apparatus for projecting scenery on the cyclorama.

On any such stage, where a large opening may have to be reduced from 40 ft to 30 ft or even less, for plays which were first produced in the smaller theatres, it is convenient to make the stage manager's desk portable. No great ingenuity is needed to form this as a shallow desk, complete with signal and buzzer controls, clock and telephone. Three yards of flexible metallic hose enable this desk to be sited to give the best view of the stage for the large or the small opening. Its flexibility also allows a variety of false prosceniums, tormentors, etc., to be used for masking at this point, according to the needs of the play. The desk must be high enough to use standing.

Rehearsal Room and Sound Effects

As the auditorium will not be particularly high, a large room can be contrived in the roof behind the light bridge. This room, though officially for rehearsals, may be the subject of several interesting experiments. Fitted with microphones, it could house an orchestra in productions where the forestage and a live orchestra are needed. It would thus function as a special sound studio from which choirs and so on could be heard, either through the sound-reproduction system or direct through doors into the F.O.H. cyclorama cove, which would then become a sound duct.

The theatre will have an amplifier sound system for records and other effects, the control desk of which might well be in the same box as the lighting control. The purpose of this system is *not* to reinforce the human voices on the stage which, through bad acoustics and faulty elocution, cannot make themselves heard. If the theatre has to double the part of a concert hall, a concert organ will be necessary, and I imagine this might speak from behind the forestage screens from one side or both, depending on the size of the instrument.

The Cyclorama

It is now no longer necessary to describe and advocate a cyclorama, but it is desirable to consider carefully the form

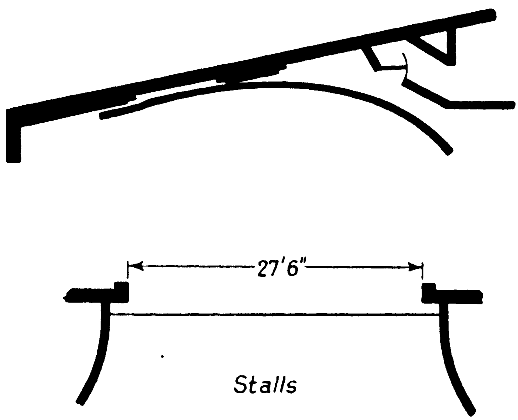


FIG. 160. PLAN: ASYMMETRIC CYCLORAMA, WESTMINSTER THEATRE STAGE

best suited to a particular theatre. In the little theatre, or the multi-purpose hall, the problem resolves itself readily: the cheapest or nothing. For most stages this means a white plastered back wall to the stage, which can be very good. The area of this flat cyclorama should be as large as possible, and it need not be symmetrical; if for any reason there is more cyclorama on the players' right, in some sets it may be possible to employ it to the full. The cyclorama at the Westminster Theatre (Fig. 160) comes to mind as a successful asymmetric example; obviously less masking scenery is needed on the actors' left. If the rear-stage wall permits direct plastering, so much the better, but not all walls allow this, and an expanded metal screen on a framework has to be built, cemented, and plastered, in which case the cyclorama may be shaped with advantage either as a gradual curve (Fig. 161) or as a flat main portion with curved ends, of which there are many examples in this book (Fig. 177). These curved ends are not difficult to light and they do not occupy so much of the stage floor area; yet there may be plans, as at the Westminster Theatre, where the slow curve is appropriate. In vertical section the cyclorama should not be curved.

A free cloth cyclorama is not successful on a small stage, since there is not sufficient volume and weight of material present to

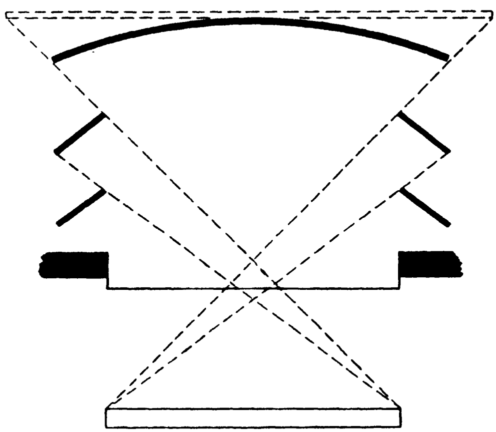


FIG. 161. PLAN: ADVANTAGE OF CURVED CYCLORAMA WHEN WING SPACE IS LIMITED

ensure correct hanging. A rigid cloth cyclorama may be stretched by lacing on a frame, cinema-screen fashion. Materials in great width without seams are available; jointed materials must hang with the seams horizontal.

When the cyclorama for a larger stage, such as that of the municipal theatre under consideration, is studied, it is not easy to decide which form to adopt for the best; the aim of minimum masking scenery (ideally none) is difficult to reconcile with minimum stage obstruction (ideally none).

The problem has been solved in several of the great Continental theatres: by the giant skydome of the Schauspielhaus, Dresden, and the moving dome at Charlottenburg, or the great cyclorama at the Paris Opera, which can be raised into the flys well clear of the stage. This book, however, is written for

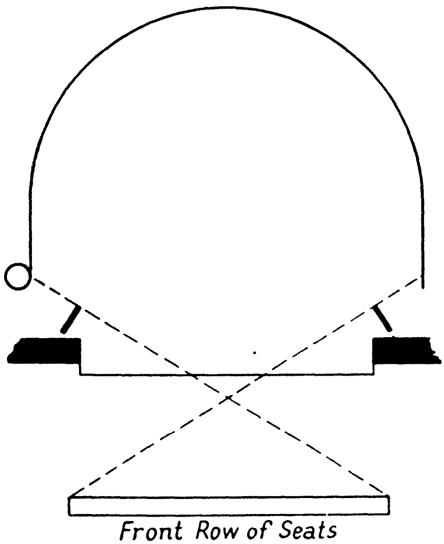


FIG. 162. PLAN: COMPLETE MASKING BY CURVED CYCLORAMA CLOTH

Britain, and as I indicated in Chapter I, it is a waste of time to consider these solutions.

A cloth cyclorama suspended from a semi-circular track high in the flys can be made to mask a stage completely (as

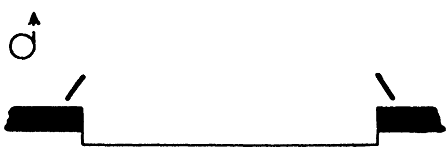


FIG. 163. PLAN: STAGE UNOBSTRUCTED WHEN CYCLORAMA CLOTH IS ROLLED UP

Fig. 162); if the cyclorama is rolled up as in Fig. 163, the condition of a clear stage is also realized. There have been, and are, several examples; ranging from, perhaps, the smallest example at the Cambridge A.D.C. to that at the Covent

Garden Opera House; many have seen this cyclorama unrolling in the Sadlers Wells ballet *Adam Zero*. When it is properly maintained and is large enough to enable the weight of the material to make it stable, the results *can be* really good. Nevertheless, the results are seldom good. Creases appear readily, even in photographs of settings when one would imagine extra care would be exercised in bringing the cyclorama into play.

The cloth cyclorama in the form described only partly solves the stage obstruction problem: it is a case of all cyclorama

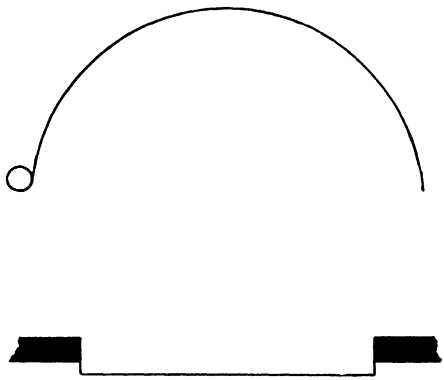


FIG. 164. PLAN: CYCLORAMA CLOTH SET NOT TO OBSTRUCT DOWN-STAGE WINGS

or nothing. For the very common set, which requires cyclorama up stage only, the all important down-stage wings have to be obstructed. To get Fig. 164, in addition to Fig. 162, a much more complicated roller installation, of which there are no examples in this country, is needed.

A deep curved cyclorama, with a no-man's-land between it and the acting area, is often coveted, but the no-man's-land is a complication in a democratic theatre. In the plans of the theatre I have drawn for this chapter the complication does not arise, but in the vast majority of theatres, with their acute sight lines from the upper tiers, the stage floor of the no-man's-land can be difficult to fill with scenery (Fig. 165). The problem resembles borders upside down, and to fit a curved area up stage with line upon line of painted ground rows that do not look like a makeshift is well nigh impossible, at any rate for an artist with a conscience. Thus, although a moderate

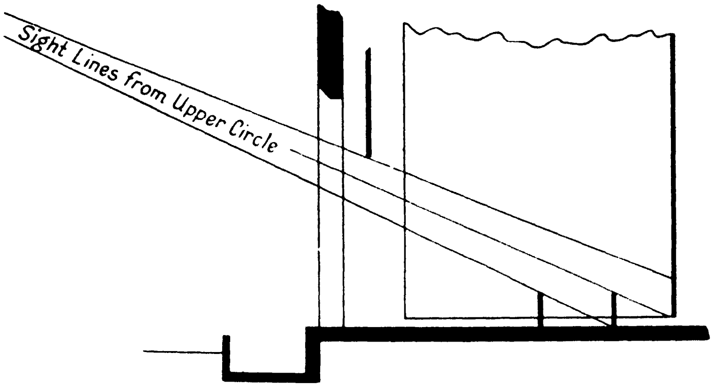


FIG. 165. SECTION: ACUTE SIGHT LINES IN A LONDON THEATRE

distance between the rear of a set and the cyclorama is important, the variation with a fixed cyclorama between a shallow set and a deep set may provide awkward areas of floor. The deck of a ship seen *Treasure Island* fashion provides an example

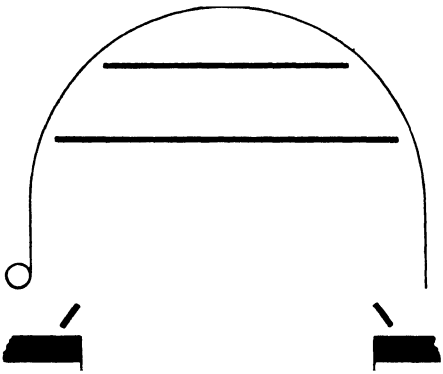


FIG. 166. PLAN: FLOOR-MASKING PROBLEM WITH DEEP CYCLORAMA

of a difficult shallow set. With the curved cyclorama of Fig. 166, how is the floor to represent sea?

An interesting and not too expensive solution is provided by the cyclorama at the Shakespeare Memorial Theatre, Stratford-on-Avon (Fig. 167). Here the cyclorama, with its top lighting (together weighing 33 tons), moves up and down stage on a track. In its up-stage position it is available as a backing to

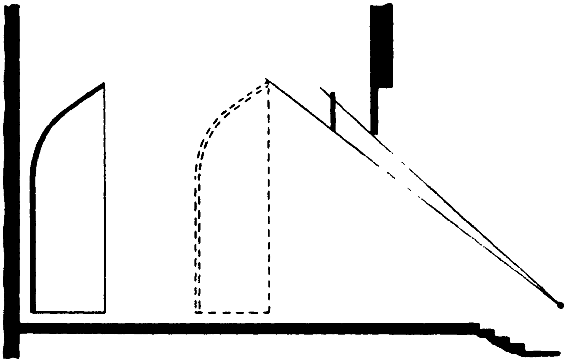


FIG. 167. SECTION: MOVABLE CYCLORAMA, MEMORIAL THEATRE, STRATFORD-ON-AVON
Sight line from front row of stalls.

deep sets and also it leaves the acting area clear of obstruction, —a specially important point in this theatre owing to the sliding stages. In the down-stage position it provides reasonably complete enclosure of the acting area. The movement is given by hand operation of an endless chain. As the Stratford proscenium opening is only 30 ft, the cyclorama for the municipal theatre under discussion, with a 40-ft opening, would be considerably more bulky. The curve in the vertical section reduces the cyclorama height needed, but is apt to cause lighting troubles; the bottom lighting fades away nicely on the vertical but picks up again at the top as the cyclorama curves. A cylindrical cyclorama is a better arrangement from the lighting point of view, but would have to be taken up much higher to give the same sight line (Fig. 168). This lighting trouble is much aggravated in small cycloramas, and it is axiomatic never to curve a small cyclorama (under 20 ft high) in the vertical plane.

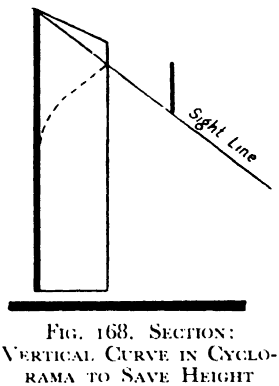


FIG. 168. SECTION: VERTICAL CURVE IN CYCLORAMA TO SAVE HEIGHT

However, as the auditorium sight lines are helpful, the stage is comparatively shallow, and wing space is available, on the whole I think a fixed cyclorama, shaped as in Figs. 177 and 178, will give the best results for this municipal theatre. There will be little obstruction of the stage, and the cyclorama will mask with little scenery. A show that requires a complete cyclorama will have to have its own cloth. A passage behind the cyclorama must be provided. It is not necessary to stand the cyclorama away from the rear wall, thereby building a section to the expensive scenery tower which can never be used. It is, however, desirable that the passage should be reasonable in size and part of the stage fire risk, thus obviating the need for doors at each end. Such a passage was contrived at the Saville Theatre, London, in spite of the cramped site, by excavating beneath the pavement of the street outside.

Cyclorama Finish

It is usual to finish the cyclorama in hard plaster with a smooth surface to be painted with a matt paint. A large-scale cyclorama might gain from a coarse finish which would in its interstices give a far more lively effect, the result of lighting with two colours giving the equivalent of the spattering with one colour upon another practised by scene painters: specks of colour are mixed together by the time they reach the eye but the result is seen as richer colour with more body. As far as I know, no cyclorama has been so finished. It might, of course, collect dust rather quicker than the orthodox. On the Continent there are cycloramas constructed throughout of well-seasoned wood; the acoustic effect is, presumably, better than that obtained from hard plaster. This kind of cyclorama is often flown clear of the stage, but a high grid and special flying lines are needed.

Various special cycloramas have been constructed for particular productions; curtain cycloramas hanging in folds have often been used in preference to the orthodox cyclorama with its strong suggestion of realism. Mr. Robert Nesbitt's cyclorama of vertical triangular flutes for *Up and Doing*, at the Saville Theatre, gave some fine effects for the type of show in which novelty of setting must be the keynote (Fig. 169).

Cyclorama Colour

Often, particularly in Italy, a light but pronounced blue paint is used. It is not intended to be lit by white light, in which event the effect would be grey, but by blue and other coloured lights. The idea is that the majority of cyclorama effects required are blue, and that the scatter of white light

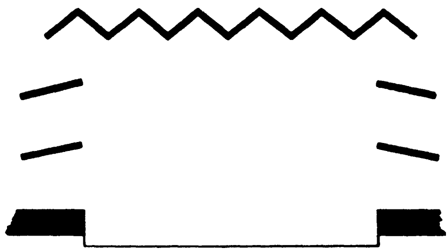


FIG. 169. PLAN: SHAPED CYCLORAMA FOR DIRECTIONAL LIGHTING

from the acting area striking the cyclorama is far less obtrusive than it would be with a white cyclorama. However, the general opinion, and my own, is that a matt white of the highest reflection factor should be used; the nearest it approaches magnesium carbonate the better, as the light needs every help in reflection. Commercial blue paints are unlikely to reflect 100 per cent blue light. The construction of a cyclorama needs great care in order to avoid rust marks, oil marks, and damp patches, which creep through subsequent layers of paint.

The cyclorama should be frequently repainted, the work being carried out in one operation without allowing one section to dry before the whole is completed. How frequently the cyclorama must be painted depends on many factors—whether smoking is permitted or not, whether there is an air washer, and so on—but, on the whole, I think it should be done at least once a year.

Cyclorama Lighting

The main lighting of the cyclorama must come from the top. As evenness of illumination is important, wide angle reflectors will be used, and, in addition, the equipment must not hang too close, thus helping the light to get down the cyclorama. (Examples of suitable distances are given in Chapter XI.) A rough general guide to wattage is 5 or 6 watts per square foot of cyclorama surface for the blue circuit using Cinemoid No. 20, and 2·5 to 3 watts for the other cinemoid colours. The same wattage will apply to gelatine and, presumably, filters of the kind cemented between clear glass. Coloured-glass filters will need double or treble this wattage. The bottom lighting wattage is additional to the figures given.

Common sense is required in calculating the area of a large cyclorama such as that in Fig. 162; naturally, there can be a trailing off of the intensity in the down-stage portions and at the top, as these areas are more for masking than effect.

Stage Lighting Installation

The lighting installation for this particular theatre is given in full in Fig. 177, and even though readers will usually have to be satisfied with something simple such as Figs. 172 or 179, the layout in this plan is of interest since it is the logical development of present-day tendencies in lighting. At first sight 138 dimmer and lighting circuits may seem a large number; actually I have chosen a moderate course for a stage of this size, and it is quite possible to imagine expansion to 180 dimmer ways. On the other hand, a modified installation of 100 ways is perfectly feasible, especially if the special forestage arrangements are not included.

Particular interest centres round the forestage and the auditorium lighting bridge. The forestage becomes more than just a platform stuck out into the audience. It is a permanent setting, forming a neutral link between the scenery of the stage and the decoration of the auditorium. With the aid of its lighting the mood of the play can be sustained during intervals and scene changes. When not required, this permanent set vanishes under a pall of darkness. It will be noticed that its somewhat austere façade may be at variance with out-and-out farce. A gaily coloured pelmet and banners could be hung over the inner screens to prevent a too sobering effect during intervals. Other ways of achieving gaiety by means of decorative lighting, or floral decoration, or even optically projected patterns, suggest themselves.

The auditorium lighting bridge and the forestage wings solve a particular problem of theatre lighting: the illumination of the players in the all-important down-stage area. In the ordinary theatre the first overhead batten must hang behind the proscenium, and by the time the proscenium wall, the fire curtain, house tabs, proscenium border, or false proscenium have been allowed for, at least 7 ft has been occupied. Even then, No. 1 Batten cannot light to good effect players who are vertically under it. For most theatres this all-important part of the stage has to rely on the footlight and circle front spots, all flattening front lighting. In the theatre design under consideration, this lighting can be supplemented by the bridge out in the auditorium, in effect placing No. 1 spot batten over the front edge of the forestage or orchestra rail. Further, the lighting is not restricted to overhead, considerable side lighting being brought to bear on the forestage and down-stage areas from the forestage wings. In this way a full range of flexible and expressive lighting is available anywhere on the forestage and stage proper. A full-length play could, in fact, be presented without raising the house tabs.

Beginning in the auditorium, and mounted in the roof well back from the stage, are long-range narrow-beam mirror spots to provide general facial lighting in the fore-, down-, and centre-stage areas. Over the front rows of stalls a lighting bridge is concealed in the ceiling and extends the full width. This bridge carries medium-angle mirror spots, and acting-area floods; at the extreme ends are plug points for pageant lanterns and 2000-watt soft-edge spots, for modelling and effects lighting in the fore- and down-stage areas. Any special side lighting is by acting-area floods (used sideways) or soft-edge spots can be plugged up behind the permanent wings. A footlight, which can vanish, leaving a flat stage, comes 4 ft in front of the house tabs. Behind the proscenium opening hang a magazine or flood batten and a spot batten. Preferably, these are carried adjacent to a counterweighted bridge to move vertically on rigid guides according to the height of the setting. The bridge should be used to give access to the spots, and not to carry the lanterns. Both flood and spot battens are to hang on separate counterweight lines, the former passing through the bridge, and the latter just up stage of the batten but capable of being clamped to the bridge (Fig. 170). This arrangement gives the utmost flexibility: a rigid arrangement is to be avoided at this important point on the stage. For example, in some of the smaller sets, it will be an advantage to fly the bridge right clear and to drop the battens inside the set.

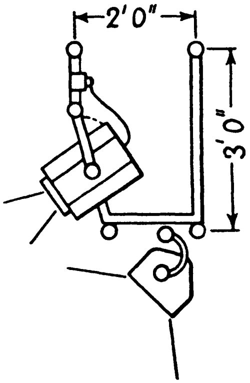


FIG. 170. SECTION: LIGHTING BRIDGE

The great advantage of a bridge both here and in the auditorium is the ease with which the lanterns can be focused and the colours changed. One of the great difficulties, unless fantastic batteries of spots are installed, is to get really exciting masses of white light for daylight. With a bridge, one can do justice to three contrasting scenes. If there is no bridge, the least that can be done is to provide a tower wagon instead of a ladder for access to the spots.

There will be perches, or boomerangs, on each side of the proscenium opening, carried by a light flat frame moving on and off stage on a track. A vertical cat ladder on each frame gives access to the lanterns and the bridge above. Reproduction of the photograph of the Opera House, Lisbon, gives an idea of this adjustable bridge perch frame, though the perches could, with advantage, have been two-dimensional instead of three, the aim being to occupy as little stage-floor space as possible. (See *Frontispiece*.)

This adjustable proscenium of lighting equipment made up by the bridge and moveable perches is important. There is a suggestion that a rapidly adjustable false proscenium, with perhaps a push-button motor drive, might be used in the theatre, but unless the lighting equipment moves as rapidly the device will be of little use. The false proscenium opening is reduced in size to correspond to a small-sized scene, and the lighting must move with it, or, as Fig. 171 shows, the lighting cannot get inside the scene—a remark that applies equally to the vertical section as to the plan.

Off stage behind the proscenium wall, on either side of the opening, are rigid platforms for scenery projection, the projection rays passing along the back of the wings (see page 286, Fig. 195). These positions will give better results than those over the proscenium on a shallow stage of this size. The

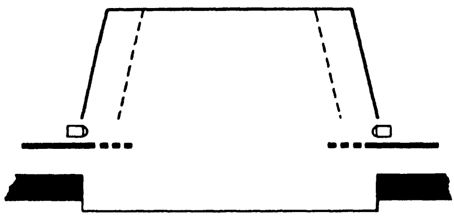


FIG. 171. PLAN: DEFECTS OF ADJUSTABLE PROSCENIUM AND FIXED LIGHTING

proscenium position from which to cover the whole visible cyclorama is difficult; essential masking on the sides and overhead are bound to intervene.

Seven to eight foot up stage of No. 1 Batten will hang No. 2 Batten. This should contain lanterns to throw a general diffused light, but still with the greatest intensity at actor level (see Fig. 27); also lanterns to throw a narrow beam clear of the setting. On a stage of this size this is usually done by hanging narrow-angle acting areas between 6 ft lengths of medium-angle magazine batten. This makes it awkward to change a lantern position and therefore it is preferable to give up an extra set of lines for the *floods to hang on a separate barrel.* To provide a change of colour, the acting areas hang in pairs. On this batten there will be four pairs of acting-area floods; strictly, there should be eight dimmers, but a satisfactory compromise can be obtained with four (see Fig. 89). However, in this theatre, where productions will be changed so often, it will be convenient to have individual dimmers.

No. 3 Batten, seven or eight feet farther up stage, is of similar type. There are six acting areas instead of eight. The object of this arrangement is to bring the pools and beams of light from the acting-area floods between those of No. 2 Batten in front and the batten behind.

No. 4 Batten ought to be seven or eight feet up stage of No. 3 Batten. It is, however, important to see that this batten, which is the cyclorama batten, hangs at least 8 ft, preferably 10 or 12 ft, from the cyclorama.

For a cyclorama of this size fifty-two 1000-watt floods in two rows will make the best arrangement. To ensure ample intensity there will be four colours arranged: No. 5A Orange, No. 16 Blue-green, and No. 32 Medium Blue, each 10,000 watts; No. 20 Deep Blue 22,000 watts. The 5A and 16 are wired each to pairs of dimmers left and right, the 32 and 20 to pairs centre and ends. These two rows of lanterns are mounted on two barrels carried from the same counterweight lines. The eight acting-area floods which are spaced and wired to correspond to No. 2 Batten, although really part of No. 4 Batten, are better carried on a separate bar hanging from the adjacent pair of lines. This will give greater flexibility, and the spaces on the acting-area barrel will be handy if special lanterns are needed for lighting the scenery just in front of the cyclorama. Some cloud-effect projectors could be carried here, with advantage, though they need not be the permanent property of the theatre.

The rest of the equipment, ground rows, and stage plugs are perfectly straightforward. If a pit is not provided for the former they should be mounted in pairs on 12-ft trucks with castors, making them easy to strike. They plug into special dip plugs on either side of the stage. An additional refinement is the provision of eight dimmers (centre and ends) instead of four. Separate sets of stage plugs and dimmers are to be provided for up and down stage to facilitate the setting and adjustment of lighting for a deep scene while a shallow one is in use down stage.

Plugs are fitted in the flys to feed special lanterns that may be hung from "spot" lines for special effects. These plugs can also be used for pageants or soft-edge spots. The former are frequently hung high in pairs in a frame, and used to project across stage to represent the sun's rays or moonlight. This can be effective when thrown backwards, giving back-lighting of characters and scenery.

Side Lighting

Usually the only place where side lighting can be mounted, to be readily accessible and yet leave the stage floor clear, is down stage at the perch positions. The all-important side lighting might be more imaginatively used if it were easier to place. There is need for light two-dimensional frames moving on and off stage in slots (similar to the grooves in which the old scenery wings were held). With the on-stage edge as a vertical pipe to which lanterns could be clamped and with a light ladder incorporated for access (as already described for the perches) results would be more satisfactory than obtained from the present rigidly fixed "boomerangs" in the wings. The demand for a conglomeration of lanterns on stands or three-dimensional towers cluttering up the entrances might be lessened.

Higher up, lighting bridges running up and down stage, one to each side, are wanted. These bridges could be placed to secure the best lighting angles and would avoid encroaching on the scenery fly galleries to connect, suspend, or place side-lighting units. They would be infinitely more convenient than the present makeshifts of inaccessible lanterns in hanging frames or fixed to the end of the battens. Direct access from the proscenium bridge to the side bridges will enable the same staff to man both.

I must stress that only on a stage such as this, with a lot of permanent equipment, is it permissible to parallel the dip plugs for temporary lanterns on the floor and in the flys; even then they must be *separately switched at the board.* Normally it is essential to provide *a separate set of dimmers to each dip point and each fly point.* This does not preclude the use of pairs of plugs to each point, as in Example J, Chapter XI.

CHAPTER XI

COMPARATIVE EXAMPLES OF STAGE LAYOUTS

All the plans in this chapter are drawn *to the same scale* ($\frac{1}{16}$ in.: 1 ft) and in spite of the fact that no really large stage is shown, there is a remarkable variation in size from Example "A" to Example "I." Each one of these stages may on occasion have to mount the same play!

Scale as regards physical dimensions is obvious to most people; scale in lighting is less obvious but equally important. While, in view of the enormous lighting intensities we try to convey in daylight scene, it is desirable to employ the highest intensities we can, it is possible to use quite small wattages, provided *all* the lighting is in scale. The word "all" is important; even the house lighting must be in scale. In comparing the following installations, the scale should be kept in mind. It will be noticed that it is not necessarily tied to the size of the stage.

The apparatus must be regarded as mobile, particularly in the earlier examples, and shifted round to suit a particular production. For example, the floods behind the proscenium might, on occasion, be grouped to one side of the stage instead of being equally spaced.

In the early examples the minimum current required is given; whenever new mains are being installed, considerable margin must be allowed for future extension or for the use of additional dimmer boards and equipment hired for special productions.

Examples "A" to "G" have been designed to show a series of installations for stages increasing in size, Example "A" being very small indeed. As far as I am aware, only Example "C" (The Questors', Ealing) actually exists, though, of course, there may be installations that are similar.

Example "H" has been given to me by P. Corry, and shows what can be done when little money is available. It is of particular interest, since Mr. Corry has had considerable first-hand experience as an amateur producer and actor, in addition to his activity as a supplier of lighting and stage equipment.

Examples "I" and "J" are from L. G. Applebee, who must have been responsible for more installations than any one else in this country, including the largest, that at Covent Garden Opera House. Incidentally, the total load of the Haymarket Theatre is two-thirds that of the top cyclorama (150 kW) at the Opera House.

SUMMARY OF COMPARATIVE EXAMPLES

	Total Load watts	Lighting Circuits	Dimmers
A	3,300	10	5
B	6,700	10	5
C	9,750	20	10
D	16,500	30	21
E	26,040	28	28
F	60,860	47	47
G	321,000	182	138
H	13,900	16	14
I	29,000	31	30
J	97,200	90	78

Example "A"—Small Stage, Minimum

This is an absolute minimum installation, planned on a small scale as a nucleus for a very small stage or a travelling fit-up which is likely to encounter extreme limitation on current, the total required being under 15 amps at 230 volts.

The stage in the following diagram (Fig. 172) is based on the plan shown on page 40 in *Community Centres*, published by H.M. Stationery Office, which utilizes standard huts as a temporary measure. I have drawn what I think the maximum possible proscenium opening, 16 ft by 9 ft, and provided a door on both sides of the stage. Without this extra door the stage would be quite unworkable; as it is, extensive use of scenery and furniture would be out of the question, though the ceiling masking and white rear wall will be some compensation. The proscenium, stage lighting, and switchboard might well be removable, leaving a completely open platform for concerts.

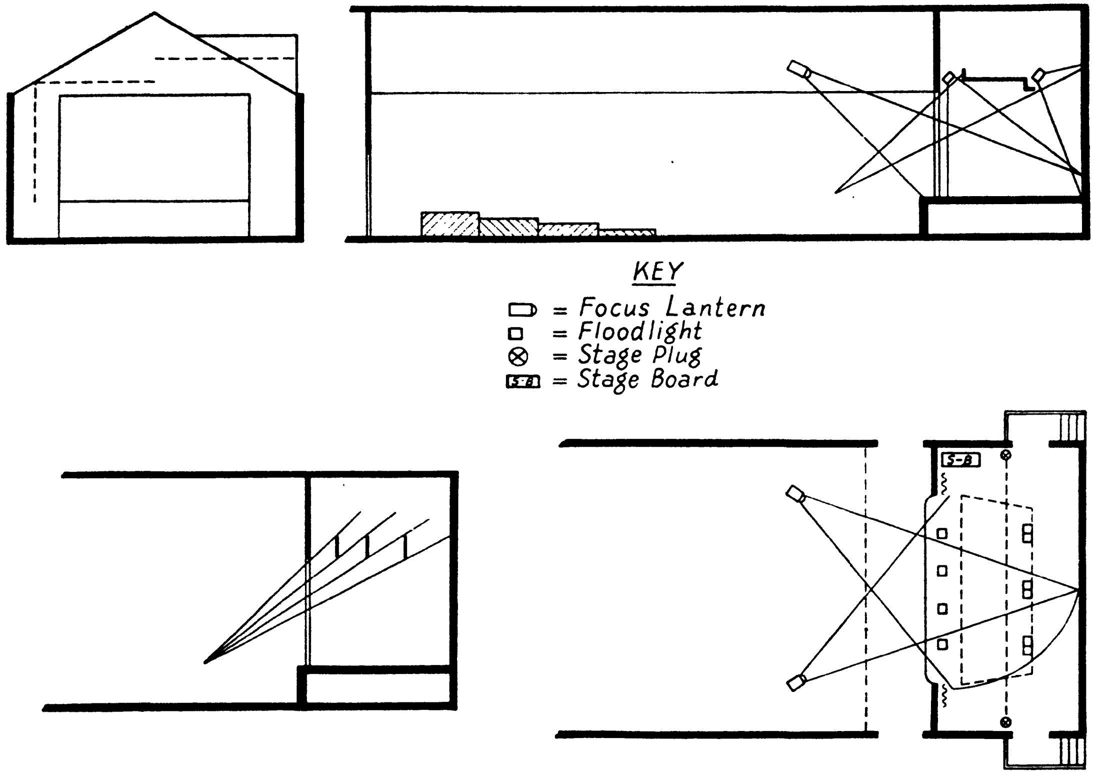


Fig. 172. Example "A": Fitup Stage and Seating in Temporary Hut

			watts
FRONT OF HOUSE			
Two 500-watt focus lanterns . . . (6 in. diameter lens and simple hand colour change from gangway, if possible.)	2 circuits	500-watt	1000
NO. 1 BATTEN			
Four 100-watt medium-angle baby floods . (Wired 1 and 3 one circuit, 2 and 4 the other.)	2 circuits	200-watt	400
CYCLORAMA BATTEN			
Three 150-watt wide-angle twin baby floods	2 circuits	450-watt	900
STAGE PLUGS			
Four 5-amp B.S. three-pin, two each side of stage	4 circuits	250-watt	1000
Total:	10 circuits	Total	3300

STAGE-BOARD

One 10-way board with four dimmers and a 3000-watt master (see Fig. 86). Minimum mains 15 amp.

ACCESSORIES

Set of four funnel attachments for floods on No. 1 batten.

One 150-watt baby flood with alternative wide- and medium-angle reflectors and a funnel attachment.

One 250-watt baby spot for general stage duties.

Example "B"—Medium Stage, Minimum

This is another minimum equipment for a stage with ceiling masking similar to that in Example "A," but larger in scale. With such an installation much interesting work can be done, and it forms a fine nucleus on which to build. In cost it can easily compete with that well-known white elephant minimum —two magazine battens, a magazine footlight, and no dimmers!

			watts
FRONT OF HOUSE			
Two 1000-watt focus lanterns . . . (With simple hand colour change from gangway if possible.)	2 circuits	1000-watt	2000
NO. 1 BATTEN			
Six 150-watt medium-angle baby floods .	2 circuits	450-watt	900
CYCLORAMA BATTEN			
Six 300-watt wide-angle floods . . .	2 circuits	900-watt	1800
STAGE PLUGS			
Four 5-amp B.S. three-pin, two each side of stage	4 circuits	500-watt	2000
Total:	10 circuits	Total	6700

STAGE-BOARD

One 10-way board with four dimmers and a 4500-watt master. Minimum mains 30 amp.

ACCESSORIES

Set of six funnel attachments for floods on No. 1 batten.

Two 150-watt baby floods with alternative wide- and medium-angle reflectors and funnel attachments.

Two 250-watt baby spots for general stage duties.

Example " C "—The Questors' Theatre

The plan on the opposite page is of an amateur theatre which has employed the ceiling masking, advocated in these pages, for the past twelve years or so. The theatre is that of the Questors' in Ealing, Middlesex, a flourishing company whose productions have always been ambitious and varied. The activities of this company are of great interest, since from the beginning money has been very tight, and the conversion of an improbable mission hall into an attractive theatre was the work of their own hands. Needless to say, the scenery is designed, painted, and built by members of the company, which is just as it should be.

For present purposes I have based my example on the Questors' installation as it was round about 1939, and have put forward the commercial equipment obtainable to-day. Items marked with an asterisk * were in fact constructed by the amateurs, including the flexible switchboard with its liquid dimmers.

			watts
FRONT OF HOUSE			
Two 500-watt focus lanterns (Left and Right) . . . . (Fitted with mechanical colour change.)	2 circuits	500-watt	1500
One 500-watt focus lantern (Centre) .	1 circuit	500-watt	
NO. 1 BATTEN			
Four 100-watt medium-angle baby floods	2 circuits,	200-watt	1150
Three 2500-watt baby spots (focus lanterns)	3 circuits,	250-watt	
(The baby spots are at the centre and ends of the batten.)			
c/f	8 circuits		2650

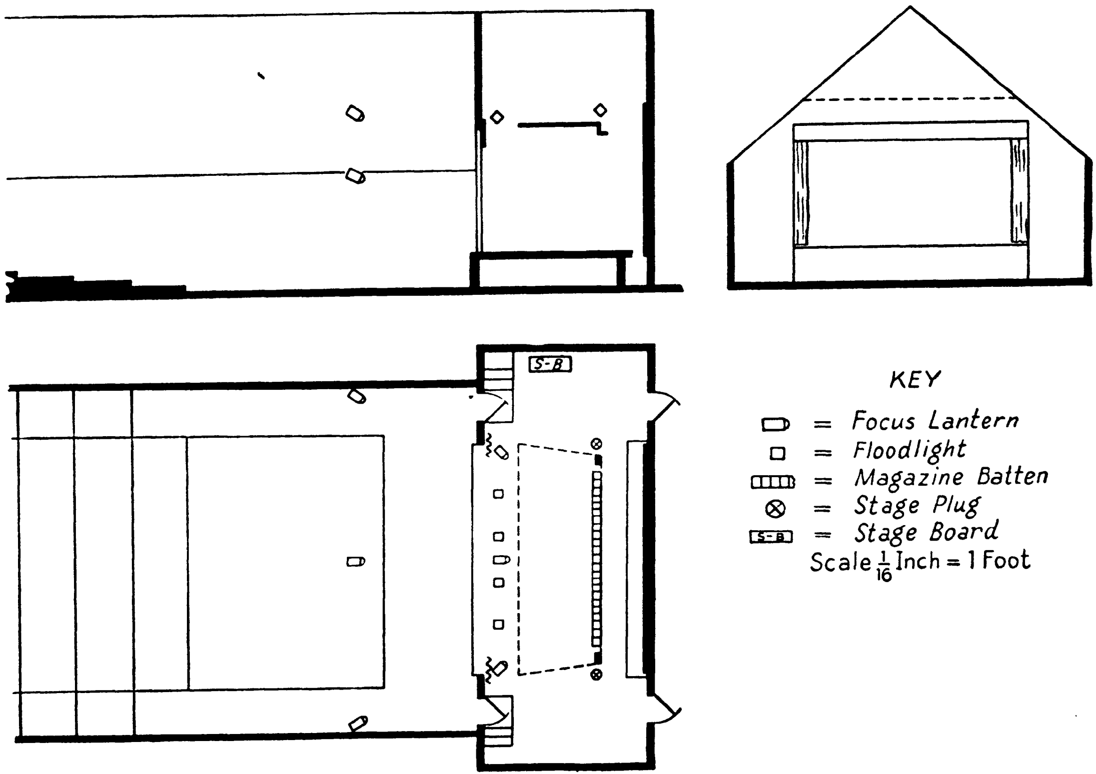


FIG. 173. EXAMPLE "C": LIGHTING LAYOUT: THE QUESTORS' THEATRE, EALING

			watts
	b/f	8 circuits	2650
Cyclorama Top*			
15-ft, 150-watt wide-angle magazine batten	1 circuit 1500-watt		3000
	2 circuits 750-watt		
(The colours would be No. 5A Orange, No. 16 Blue-green, and No. 20 Blue for the double circuit.)			
Cyclorama Pit*			
15-ft parallel-type magazine equipment			
Blue 60-watt.	1 circuit 900-watt		2100
Red and Green 40-watt	2 circuits 600-watt		
(Owing to the close range, this special equipment (see Fig. 143) is put forward.)			
Stage Plugs			
Four 5-amp (two Left, two Right) .	4 circuits 500-watt		2000
Total:	18 circuits	Total	9750

Stage-board* (Flexible Type)

One 20-way (2 spare) board with eight slider dimmers and two 4000-watt masters. Minimum mains 40-amp. The dimmers are wound; one 1500-watt, three 500–1000-watt, and four 250–500-watt.

Accessories*

Set of four funnel attachments for the floods on No. 1 batten.

One 150-watt baby flood with medium-angle reflector and funnel attachment.

One 150-watt baby flood with wide-angle reflector.

One 250-watt baby focus lantern.

One 500-watt focus lantern.

Example "D"—A Little Theatre

Although this stage is larger than Example "C" the lighting is still small in scale. The number of units has, however, been increased to give the lighting facilities of a fully-equipped theatre. Owing to the increased depth of stage, opportunity has been taken to introduce another lighting batten by pivoting the ceiling. Such a device allows the use of curtain traverses at half-stage. This theatre is planned to be economical of space, but at the same time to allow a considerable amount of movement for the dance.

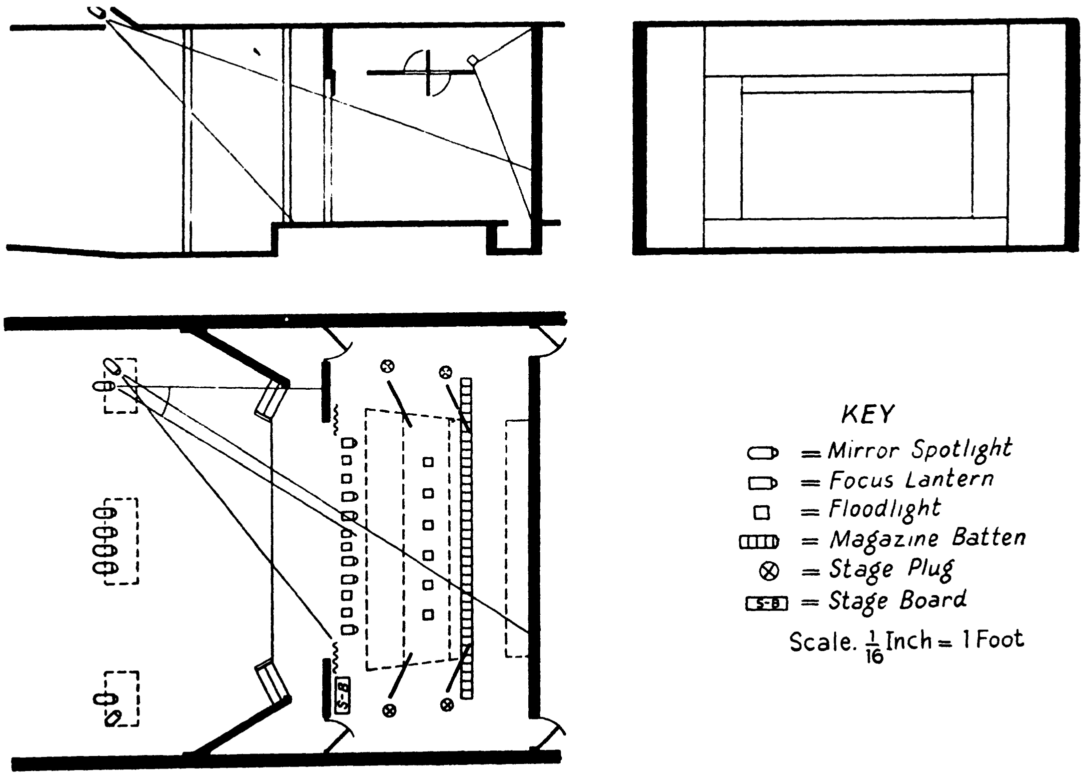


FIG. 174. EXAMPLE "D": PLAN AND LIGHTING LAYOUT FOR LITTLE THEATRE IN PART OF AN EXISTING BUILDING

		watts
Front of House		
Four 250-watt mirror spots (Left and Right)	4 circuits 250-watt	2000
Four 250-watt mirror spots (Centre) .	4 circuits 250-watt	
(The left and right spots at least to have some kind of remote colour change.)		
No. 1 Batten		
Six 250-watt focus lanterns . . .	6 circuits 250-watt	2400
Six 150-watt medium-angle baby floods	2 circuits 450-watt	
No. 2 Batten		
Six 150-watt medium-angle baby floods	2 circuits 450-watt	900
(Funnel attachments to be fitted when required as acting areas.)		
Cyclorama Top		
27-ft, 150-watt wide-angle magazine batten	2 dimmers 1350-watt	5400
	1 dimmer 2700-watt	
Cyclorama Pit		
18-ft wide-angle magazine ground row		
Blue (150-watt)	1 dimmer 1200-watt	2800
Red and Green (100-watt) . . .	2 dimmers 800-watt	
(By means of extension leads under the stage, this ground row can be used as a footlight when required.)		
Stage Plugs		
Three 5-amp (Left)	3 circuits 500-watt	3000
Three 5-amp (Right)	3 circuits 500-watt	
	Total: 30 circuits	Total 16,500

Stage-board

A 30-way frame to take twenty slider dimmers, one transformer master dimmer, and a 24-way interplugging panel. Remote-controlled contactor switch for master blackout. Minimum main 70 amp.

Six dimmers are wound especially for the cyclorama and permanently connected thereto, in order to get the best colour-mixing and freedom from all flicker on these sensitive lamps. This item, 8200 watts, could go on one phase if a balance is required. The remaining fourteen dimmers for the flexible section of the board will comprise nine 250–500-watt and five 500–1000-watt. (Circuit, see Fig. 87.)

The transformer master will be an expensive though ideal arrangement; an alternative is to use a resistance master of four 4-kW plates wired as Fig. 69.

Example "E"—School Community Centre

This plan is based on the plan for a school community centre stage given in *Community Centres*, published by H.M. Stationery Office. The position of one of the doors in the back

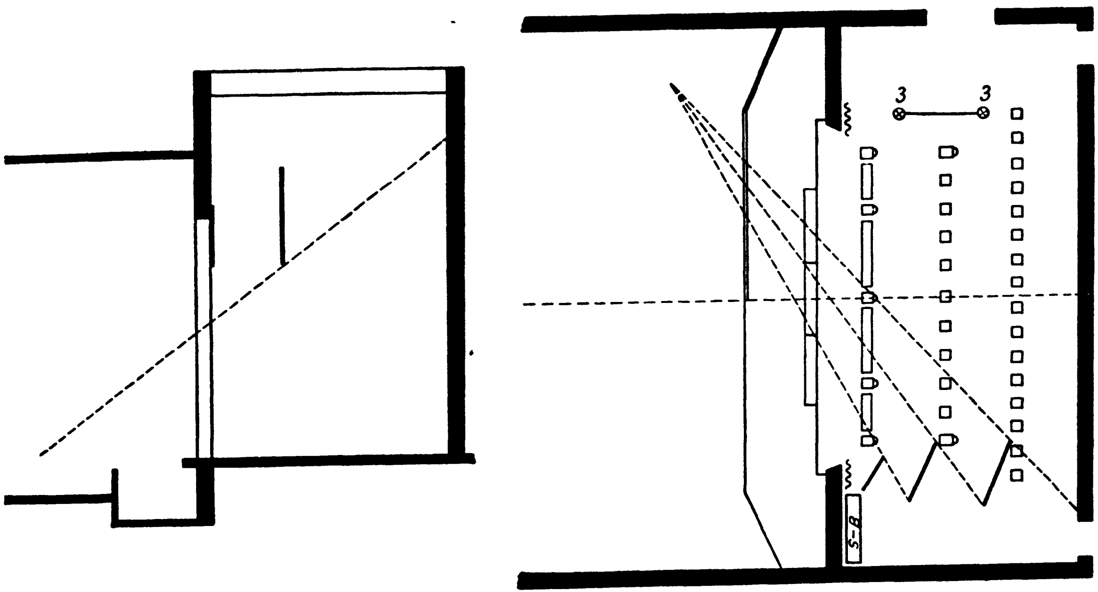


Fig. 175. Example "E": Lighting Layout for School Stage Used as a Community Centre

wall has been altered to allow the use of a flat cyclorama. The size and proportions of the stage are a great advance on the previous examples. Both the Arts Council and the National Council of Social Service advocate stages of similar dimensions in their schemes. This size is large enough for most normal productions and is at the same time not so large that amateurs will find themselves forced to make large-scale, therefore expensive, scenery.

The stage is not sufficiently high to allow flying of scenery, but it will permit the flying of a ceiling piece out of the way when borders are required. To do anything more than this would, in any case, require quite an amount of expensive equipment, difficult for amateurs to handle. A fire curtain, which might be evaded in a hall like this for occasional use as a theatre, would certainly be needed were provision for flying scenery to be made.

The lighting in this Example and Example "F" following are intended for direct comparison; being a small and a full installation, respectively, for the same-size stage.

			watts
FRONT OF HOUSE			
Three 1000-watt focus lanterns (Concealed in auditorium ceiling.)	3 dimmers	1000-watt	3000
FOOTLIGHT			
Three 6-ft lengths of 60-watt wide-angle magazine (To be carried from removable brackets over front edge of stage. Wiring from dimmers to run to plugs on the front of stage and up stage so that the footlight can be used as cyclorama bottom lighting.)	3 dimmers	480-watt	1440
NO. 1 BATTEN			
Two 6-ft and two 3-ft lengths of medium-angle 100-watt magazine	3 dimmers	800-watt	4900
Five 500-watt focus lanterns (between the above)	5 dimmers	500-watt	
NO. 2 BATTEN			
Eight 150-watt medium-angle floods	2 dimmers	600-watt	2700
Two 500-watt focus lanterns	2 dimmers	500-watt	
One 500-watt medium-angle flood (The two focus lanterns will usually be fixed at each end of the batten; the 500-watt flood will be used at any position. All floods can be fitted with funnel attachments when the cyclorama is in use.)	1 dimmer	500-watt	
c/f	19 dimmers		12,040

			watts
	b/f	19 dimmers	12,040
Cyclorama Top			
Sixteen 500-watt wide-angle floods	.	2 dimmers 2000-watt 1 dimmer 4000-watt	8000

(This arrangement using high-efficiency lamps, offers the most inexpensive method of lighting a cyclorama of this size, where space allows a reasonable throw for the lanterns.)

Stage Plugs			
Left: six 5-amp (pairs in parallel)	.	3 dimmers 500–1000-watt	6000
Right: six 5-amp (pairs in parallel)	.	3 dimmers 500–1000-watt	

(The pairs of plugs above are separately switched at the board.)

		Total: 28 dimmers	Total 26,040

Stage-board

30-way (2 spare) bracket-handle interlocking board with capstan masters (see Fig. 72).

Suspension for Hanging Equipment

All overhead battens are carried from winch suspensions and are fitted with flexible tails to enable the equipment to be lowered within 4 ft of the stage floor for cleaning and adjustment.

Accessories

Apart from lanterns hired for particular productions or carried by visiting companies, this stage ought to possess the following—

One 1000-watt focus lantern on telescopic stand.

One 500-watt focus lantern.

Four 500-watt wide-angle floods on telescopic stands.

Three 150-watt baby floods with alternative reflectors and funnels.

Example "F"—Theatre for an Arts Centre

The plan is of similar dimensions to Example "E," but is based on that put forward by the Arts Council for an Arts Centre. The stage is to be equipped with fire curtain and grid for flying scenery. A 40-ft scenery tower is proposed; this dimension should be from stage floor to grid. There will be additional height to the roof and lantern above the grid.

The lighting installation for such a stage should be somewhat lavish, since there will be touring ballet to light in addition to the drama.

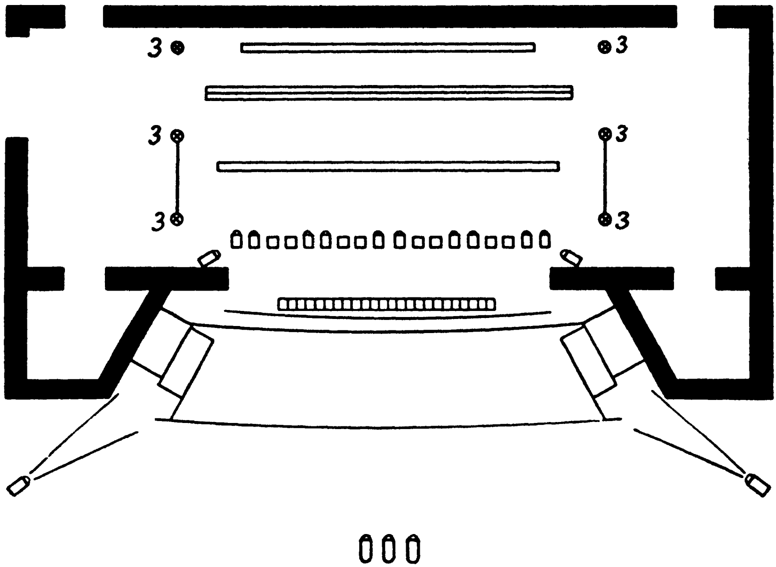


Fig. 176. Example "F": Plan: Lighting Layout for Arts Council Community Centre Stage

Plug points shown joined share dimmers but are separately switched.

		watts
Front of House		
Three 1000-watt mirror spots (Centre).	3 dimmers 1000-watt	5000
Two 1000-watt focus lanterns (Left and Right)	2 dimmers 1000-watt	
(The centre spots to be concealed in the ceiling; the others could be carried by removable brackets on the side walls.)		
Footlight		
18 ft of wide-angle 60-watt magazine	1 dimmer 480-watt	1440
	4 dimmers 240-watt	
(Wired one circuit complete across the stage, one half-left, one half-right, one centre, and one ends. Footlight to be arranged to disappear, leaving the stage flat.)		
Perches		
Two 1000-watt focus lanterns	2 dimmers 1000-watt	2000
(One each side of the proscenium arch.)		
No. 1 Batten		
Ten 1000-watt focus lanterns	10 dimmers 1000-watt	14,000
Eight 500-watt medium-angle floods	4 dimmers 1000-watt	
(The floods are wired in pairs *A* and *B* Left, *C* and *D* Right. For ballet, four extra floods would be substituted for some of the spots, thus making the batten three-colour.)		
c/f	26 dimmers	22,440

		watts
b/f	26 dimmers	22,440
No. 2 Batten		
28 ft of medium-angle 100-watt magazine	3 dimmers 1200-watt	3600
Cyclorama Top		
60 ft of wide-angle 150-watt magazine in two rows . .	2 dimmers 3000-watt 1 dimmer 6000-watt	12,000
Cyclorama Ground Row		
Four 6-ft lengths of wide-angle magazine Blue 150-watt . . . Red and Green 60-watt . . (Movable lengths on castors.)	 1 dimmer 1500-watt 2 dimmers 660-watt	2820
Stage Plugs		
Left: six 15-amp plugs (pairs in parallel)	2 dimmers 500–1000-watt 1 dimmer 1000–2000-watt	8000
Right: six 15-amp plugs (pairs in parallel)	2 dimmers 500–1000-watt 1 dimmer 1000–2000-watt	
Fly Plugs		
Left: six 15-amp plugs (pairs in parallel)	2 dimmers 500–1000-watt 1 dimmer 1000–2000-watt	8000
Right: six 15-amp plugs (pairs in parallel)	2 dimmers 500–1000-watt 1 dimmer 1000–2000-watt	
Independents		
One plug each side of stage and flys, four in all, switched only .		4000
	Total: 47 dimmers	Total 60,860

Stage-board

50-way (3 spare) Grand Master self-release interlocking board, two-way-and-off circuit switches. Blackouts by remote-operated contactor switches. Board to be carried on a perch platform. Special effects connection point for additional portable dimmer board when required. (The plugs which share dimmers are separately switched at the board.)

Suspension of Hanging Equipment

If, as is probable, the stage is equipped with counterweight flying gear, then the overhead lighting battens will be carried from this.

Example "G"—Municipal Theatre

This installation is for the theatre discussed in Chapter X, and is intended to light full ballet, opera, and other spectacular

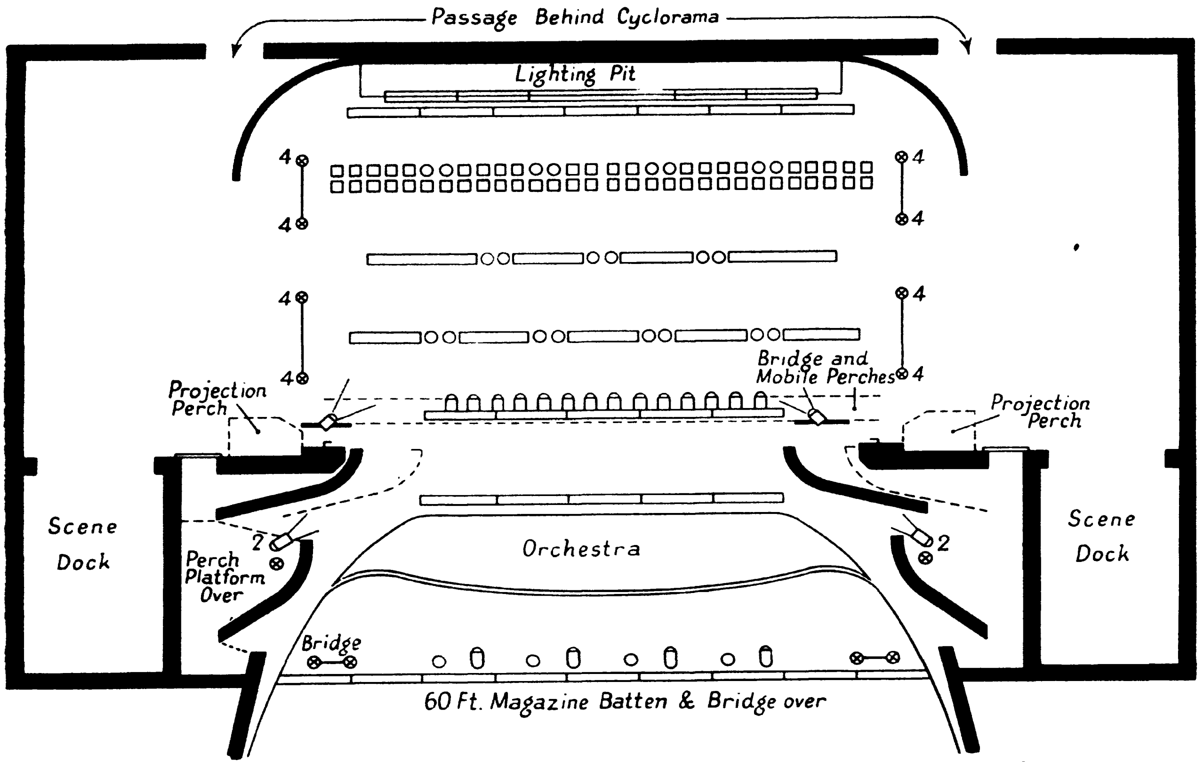


FIG. 177. EXAMPLE "G": PLAN: LIGHTING LAYOUT FOR AUTHOR'S MUNICIPAL THEATRE DESIGN

Plug points shown joined share dimmers but are separately switched at the board.

productions, in addition to the drama. There are to be a 30–40 ft adjustable proscenium opening, a forestage with

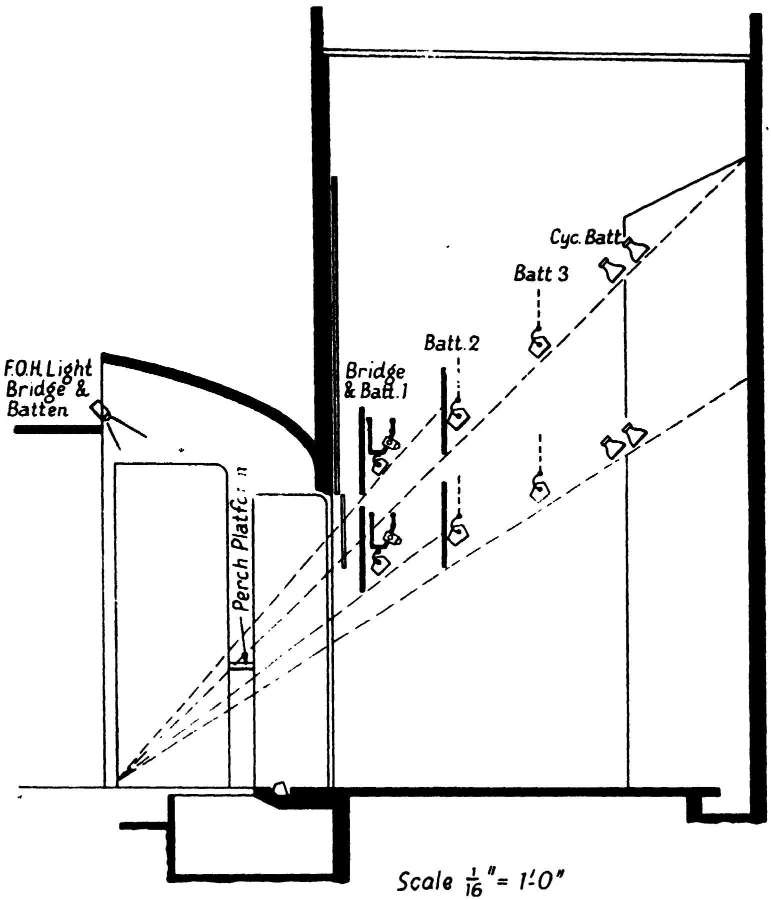


FIG. 178. SECTION: LIGHTING FOR AUTHOR'S MUNICIPAL THEATRE DESIGN

auditorium lighting bridge, and a stage 33 ft deep from the setting line, with at least a sixty-foot high grid. To give everyone a good view, the auditorium is either of stadium type or it consists of stalls and one circle only. The lighting installation, except for the forestage features and cyclorama, does not differ much from those in first-rank commercial theatres in London and the Provinces.

Front of House		*watts*
Auditorium Ceiling		
Six 1000-watt mirror spots .	6 dimmers 1000-watt	10,000
Ends of Circle Front		
Four 1000-watt mirror spots .	4 dimmers 1000-watt	
(All the above have remote colour change, 4 filters and white.)		
Forestage Perches*		
Four 1000-watt 26° acting-area floods.	4 dimmers 1000-watt	8000
Four plug points, pairs in parallel	2 dimmers 1000–2000-watt	
(The acting-area floods are used horizontally as a kind of wider-angle pageant lantern and have remote colour change.)		
Forestage Bridge*		
Four 1000-watt 26° acting-area floods	4 dimmers 1000-watt	12,000
Four 1000-watt mirror spots .	4 dimmers 1000-watt	
Four plug points, pairs in parallel	2 dimmers 1000–2000-watt	
(The acting-area floods have remote colour change.)		
Auditorium Cyclorama Cove*		
60 ft of wide-angle 150-watt magazine	2 dimmers 3000-watt	12,000
	1 dimmer 6000-watt	
(In a theatre without the special forestage and auditorium lighting bridge items marked * would be omitted. However, the auditorium ceiling spots ought then to be increased to ten, and space found for a pair of 1000-watt focus lanterns in side walls at, roughly, the ends of the orchestra.)		
Footlight		
30 ft of wide-angle 100-watt magazine	3 dimmers 600-watt	4200
	6 dimmers 400-watt	
(Wired three-colour left, centre and right. To disappear on an electric lift.)		
Perches		
Four 1000-watt focus lanterns .	4 dimmers 1000-watt	8000
Two 2000-watt soft-edge spots .	2 dimmers 2000-watt	
(Mounted on a light movable frame with ladder to move on and off stage; this frame can also carry the tormentor masking.)		
No. 1 Batten		
30-ft medium-angle 150-watt magazine	4 dimmers 900-watt	20,000
(Ends)	4 dimmers 600-watt	
Fourteen 1000-watt focus lanterns	14 dimmers 1000-watt	
(The magazine batten and spot batten are suspended on separate but adjacent lines so that they can be used independently. The perches and battens might be combined with a counter-weighted bridge, the whole somewhat as Fig. 178, rendering access for adjustment and colour change easy.)		
	c/f 66 dimmers	74,200

		watts
b/f	66 dimmers	74,200
No. 2 Batten		
30-ft medium-angle 150-watt magazine	4 dimmers 1500-watt	14,000
Eight 1000-watt acting-area floods (50°)	4 dimmers 1000–2000-watt	
(Floods are wired in pairs centre and ends, and hang between lengths of batten or preferably on a separate bar.)		
No. 3 Batten		
30-ft medium-angle 150-watt magazine	4 dimmers 1500 watt	12,000
Six 1000-watt acting-area floods (50°)	6 dimmers 1000-watt	
Cyclorama Top (No. 4 Batten)		
Fifty-two 1000-watt wide-angle floods	2 dimmers 11,000 watt 6 dimmers 5000-watt	52,000
Eight 1000-watt acting-area floods (28°)	4 dimmers 1000–2000-watt	8000
(The cyclorama is intended for four-colour mixing (see page 224.))		
Cyclorama Bottom		
36-ft wide-angle 150-watt double magazine ground row . .	4 dimmers 3600-watt	14,400
(If not in a pit, then in 12-ft lengths mounted on castors; and special plug points to feed them.)		
No. 5 Batten		
42-ft wide-angle 150-watt magazine	4 dimmers 2100-watt	8400
(Mainly for circumstances in which very close range lighting of the cyclorama is unavoidable.)		
Stage Plugs		
Down Left: 8 plugs	4 transformers	64,000
Down Right: 8 plugs . .	4 transformers	
Up Left: 8 plugs . . .	4 transformers	
Up Right: 8 plugs	4 transformers	
(The transformer dimmers can control any load up to 4000; plugs are separately switched at the board.)		
Fly Plugs		
Down Left: 8 plugs	4 transformers	64,000
Down Right: 8 plugs . .	4 transformers	
Up Left: 8 plugs . . .	4 transformers	
Up Right: 8 plugs	4 transformers	
(Plugs are separately switched at the board.)		
Independents		
Eight plugs variously situated. Switched only		8000
Float Spots		
Two plug points in footlight ramp	2 dimmers 500–1000-watt	2000
	Total: 138 dimmers + 14 spare. Total	321,000

Stage-board

For a stage of this size a remote control is essential: a Light Console, with control for 152-dimmer ways and accessories, situated in the auditorium, would enable most productions to be lighted without delay at the dress rehearsal.

Front-of-house Arc Spots

A theatre such as this should have two or three mirror arc spotlights in a room at the back of the circle to follow artistes in certain classes of production.

Accessories

These will be numerous, mainly acquired for particular productions. Touring companies will bring their special equipment, which should be connected to the transformer-controlled stage plugs instead of their portable boards. The fine array of hanging equipment will render a lot of fitting up unnecessary. Personally, in such a theatre I would like to see most productions re-lighted, apart from special effects, in terms of the theatre's own equipment. Unless this is done, all productions tend to get lighting on the lowest level—the minimum amount that can be carried and fitted up in the other theatres of the tour.

Example "H"—Grammar School Stage

The ceiling-border arrangement is of particular interest. As can be seen in the section, borders Nos. 2 and 3 are pivoted at their bottom edges so that by slackening the lines to the top edges the borders take up a position parallel to the stage floor, thus forming the all-important ceiling piece.

		watts
Front of House		
Two 1000-watt focus lanterns .	1 dimmer 1000–2000-watt	2000
(The lanterns are concealed in a central ventilator in the ceiling and are separately switched.)		
Footlight (Removable)		
Three 6-ft lengths of 100-watt wide-angle magazine . .	3 dimmers 800-watt	2400
No. 1 Batten		
Two 6-ft lengths of 150-watt medium-angle magazine . .	2 dimmers 750-watt 1 dimmer 900-watt	3900
Three 500-watt focus lanterns .	3 dimmers 500-watt	
Cyclorama Top		
18-ft 150-watt wide-angle magazine batten	3 dimmers 1200-watt	3600
c/f	13 dimmers	11,900

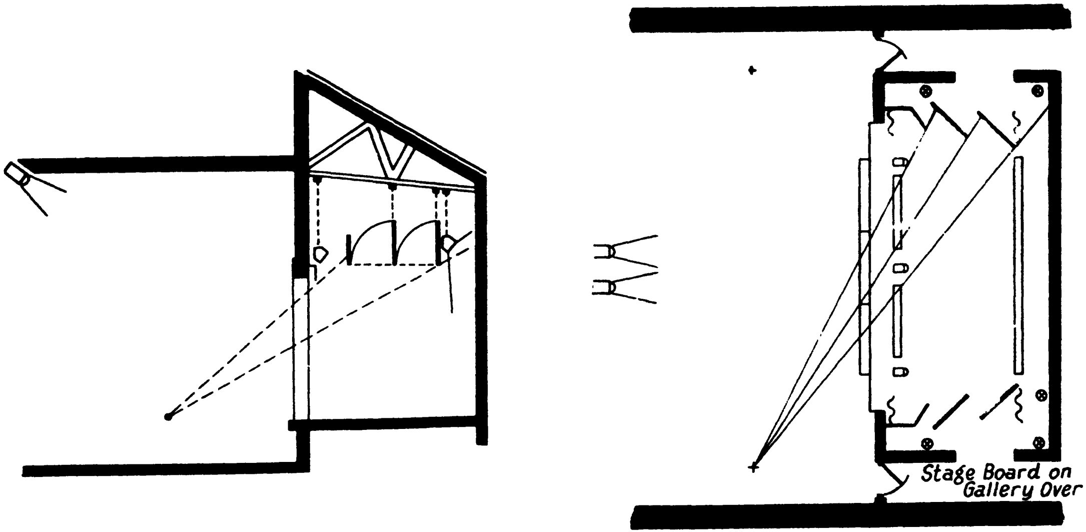


Fig. 179. Example "H": Lighting Layout Installed in a Grammar School

	b/f	13 dimmers	*watts*
CYCLORAMA BOTTOM			11,900

The footlight can be moved up stage and plugged into the same set of dimmers in this position. This dual purpose provides the reason for 100-watt lamps when 60 watts would give better balance as a footlight.

STAGE PLUGS

Two 10-amp up stage . .	1 dimmer 500–1000-watt	2000
Two 10-amp down stage . .	1 switch only	
	Total: 14 dimmers	Total 13,900

STAGE-BOARD

Fourteen-way bracket-handle type with space for four additional dimmers and switches. Two-way-and-off switches to all circuits. Shafts ganged together to operate from master capstan wheel: a back-of-board master blackout switch. The board is situated on a gallery down stage actor's left.

Example "I"—Bradford Civic Playhouse

This is a fine example of the little theatre. It should be noted that, as a result of practical experience, there are few flooding circuits in the basic equipment, except for the footlight and, of course, the cyclorama. Originally, there was a

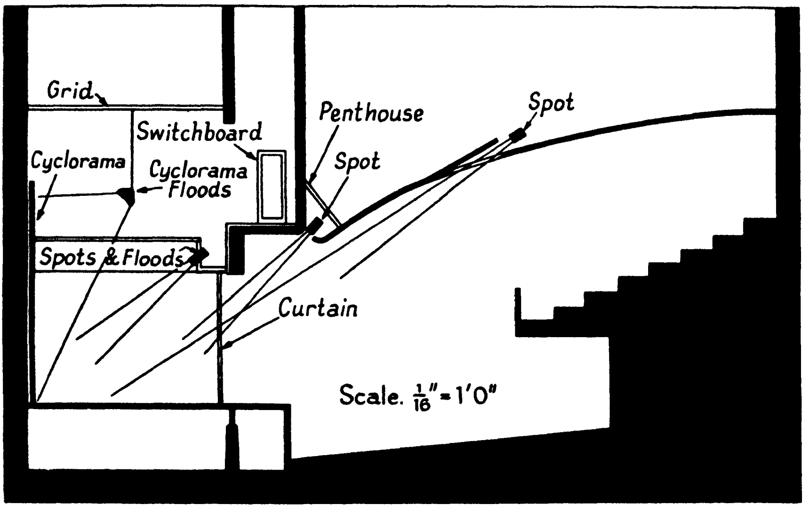


FIG. 180. EXAMPLE "I": SECTIONAL VIEW OF LIGHTING AT BRADFORD CIVIC PLAYHOUSE

three-circuit magazine batten hanging under the bridge, but this was removed, and the circuits used for focus lanterns. I must subscribe to one criticism—that of the word "Civic" in the name of the theatre, which implies credit for a fine achievement in a quarter where none is, in fact, due. The retort to this might be: His Majesty's Theatre, The Queen's Theatre, The State Cinema!

		watts
Front of House		
(Roof left and right.)		
Two 1000-watt focus lanterns	2 dimmers 1000-watt	
(Door openings at balcony ends.)		
Two 1000-watt focus lanterns	2 dimmers 1000-watt	8500
(Roof over front stalls.)		
Three 1000-watt focus lanterns	3 dimmers 1000-watt	
Three 500-watt focus lanterns	3 dimmers 500-watt	
Footlight (Removable)		
60-watt three-colour magazine	3 dimmers 500-watt	1500
(Three 6-ft lengths without reflectors. Proscenium opening is 23 ft wide.)		
Bridge		
Six 500-watt medium-angle floods	3 dimmers 1000-watt	5000
Four 500-watt focus lanterns	4 dimmers 500-watt	
Cyclorama Top		
Sixteen 500-watt wide-angle floods	4 dimmers 2000-watt	11,000
Cyclorama Bottom		
Set of plugs	3 dimmers 500–1000-watt	
Stage Plugs		
Backstage (Left and Right)	2 dimmers 500–1000-watt	3000
Flys	1 switched only 1000-watt	
Auditorium	1 dimmer 2700-watt	
	Total 30 dimmers	Total 29,000

Stage-board

Thirty-way screw-down handle type with scales, ganged into two sections for operation from slow motion and quick wheels. All circuits have two-way-and-off switches, and the blackout switch is back-of-board type. The board is situated over the proscenium opening. This position is similar to that in the Cambridge A.D.C., a theatre of more or less the same size; in both cases there is not enough room for the board in the wings.

Example "J"—The Haymarket Theatre, London

This installation was completed in 1948, and shows how far the layout can be simplified for a theatre that specializes in one type of production. As mainly box sets with ceilings are used, battens No. 2 and No. 3 need only be hired when required. Meantime, these dimmers are fitted on the board and wired to the flys, where they can be connected to any special equipment that may be needed. For similar reasons the stage plugs do not conform to the usual three-colour arrangement, and merely consist of a pair of plugs in parallel in each trap. Another set of independent plugs is switched only and mounted in different traps. There are rather more of these than is usual, and they are used for connecting up property lighting fittings, fires, etc.

		watts
FRONT OF HOUSE		
(Centre Upper Circle.)		
Eight 1000-watt mirror spots .	8 dimmers 1000-watt	8000
FOOTLIGHT		
100-watt three-colour (Left, Centre, and Right) . .	9 dimmers 600-watt	5400
PERCHES		
Six 1000-watt focus lanterns .	6 dimmers 1000-watt	6000
(Three each side of the proscenium opening.)		
No. 1 BATTEN		
24 ft of medium-angle 150-watt magazine		
Left and Right	6 dimmers 450-watt	16,950
Centre	3 dimmers 750-watt	
Twelve 1000-watt focus lanterns .	12 dimmers 1000-watt	
No. 2 and No. 3 BATTENS (Wired to points in flys only)		
	6 dimmers 1000–2000-watt	12,000
No. 4 BATTEN		
30 ft of medium-angle 150-watt magazine		
Left and Right	6 dimmers 600-watt	5850
Centre	3 dimmers 750-watt	
STAGE PLUGS		
Pairs of plugs in parallel;		
P. 1, 2, 3, 4, and 5 . .	5 dimmers 1000–2000-watt	22,000
OP. 1, 2, 3, 4, and 5 . .	5 dimmers 1000–2000-watt	
Back	1 dimmer 1000–2000-watt	
Independents as above but switched only		11,000
	c/f 70 dimmers	87,200

		watts
	b/f 70 dimmers	87,200
Fly Plugs		
Left, Up and Down	2 dimmers 1000–2000-watt	8000
Right, Up and Down	2 dimmers 1000–2000-watt	
Chandelier plugs, Left and Right, switched only		2000
Spares	2 dimmers	
Auditorium	2 dimmers	
	Total: 78 dimmers	Total 97,200

Stage-board

Seventy-eight-way (2 spare) Grand Master interlocking board with permanently coupled shafts and self-release handles. Two-way-and-off switches to each circuit and remote contactor switch blackouts. Board is carried on a perch platform actor's left.

There are, in addition, two 60-amp and one 30-amp special effects points for connexion of portable boards.

CHAPTER XII

LIGHTING METHODS

ASSUMING the stage is equipped with one of the basic installations of the previous chapter, how do we set about using it for a particular production? Well, to begin with, the lighting must be considered in the very early days before a decision is reached as to the possibility and manner of mounting the play on our stage. Just as it is absurd to take on a play which cannot be cast, so we must make sure that the stage and its lighting equipment can play their roles. The principal snag from the setting viewpoint is not so much the actual scenery as the furniture and properties. The incubus of a piano or a settee is obvious, but humble objects such as chairs and, above all, fragile crockery can take up a lot of room. *Hamlet*, with sixteen or more scenes, may be much easier to put on the small stage than a modern drawing-room play with but one change of scene. Similarly, the most exacting lighting arrangements may be required for the realistic single-box set, simply because the audience are on their home ground: anything may have happened to shadows, colours, and so on in remote Elsinore, but not in present-day London.

A certain amount of modification is possible in the basic lighting installation for a particular production; it should by no means be the rule that apparatus must be used from the position it is found. If the play demands it, by all means take down all the spotlights and use them, throwing backwards from up stage to down. In halls or theatres employing a regular electrician, his character can be analysed from his reactions to the evacuation of lanterns from their favourite haunts. The permanent installation may be supplemented by special equipment hired for the particular production, though of course economics will insist on this being kept to the minimum. Anyway, make sure the mains will take the extra load and that there is something to which connexion can be made.

At this stage it will be as well to decide who is actually going to "do" the lighting. Very often the producer reserves this for himself, being the only department in which another artist does not intervene between him and the audience and in which he can truly say, "Alone I did it." This, in my opinion, is a bad tradition, as bad as the producer playing a leading part in his own production. The producer must co-ordinate and direct the work of artists in every department: acting, music, scenery, and lighting. "Artist" is the operative word; the electrician could design the lighting if he were not, as so often seems to be the case, merely a technician. The lighting, like the setting, requires a designer, and the roles could very logically be combined in one man. Yet how few scene designers train themselves to light their own sets! This is partly, I imagine, on account of the electricity bugbear. A scene designer does not need exhaustive knowledge of the mechanics of the craft; he can safely leave such things to the scene builders and stage carpenters. Likewise, he can leave electricity to the electrician, but he must know how to paint —with light.

The play decided on, the lighting artist, whether doubling the role of scenic artist or not, goes away to study his part and consult with himself, or another, on the relationship of the setting to the lighting. He must also attend many rehearsals, so that the location of the various business and groupings will be clear long before lighting rehearsal. At all times he is *under the direction of the producer* but, like the actors, as an artist with liberty to interpret. During this time he has decided what lanterns will be used and where, also the colour filters and the possible changes. Some of these things may have been tested on the model setting in his model theatre.

When the time comes to put the play on, the lighting artist will have to decide whether to work the dimmer board himself or not. Personally, I am strongly of the view that he should; it is only by actually working a board that real contact with the lighting can be established. In local centres and amateur theatres this is usually possible, provided always that, if he is not an electrician himself, his work should be examined, from this point of view, by one who is. There will be some of the larger town halls and professional theatres where the electrician will sternly discourage such amateur operators of the switchboard. This attitude springs from a variety of reasons, most of them illogical and on that account impossible to combat. I do hope that wardens in charge of places where amateurs are to play will not lay on an ample supply of cold water in the shape of a "Now when I was at the Lane" type of electrician.

Apart from back-stage friction, by no means the invariable rule, the switchboard design and position may make it advisable that the lighting artist directs from the front of house where the effects can be seen.

The Scenery and Lighting Rehearsal

No one who has not got an actual job of work to do attends this. The scenery is fitted up and lanterns coloured and focused on the positions required. Specific effects and changes are tried and plotted; but I do not favour going through the scenes over and over again, trying to fit in the changes without the actors. Some of this is inevitable in the professional theatre, where to the stage staff this is just another play; but to the amateur to whom it is "the play" the scenery and lighting are registered in their proper context. Amateurs are a team rather than the collection of specialist departments that seems unavoidable in the larger professional theatres.

Nor should lighting be reduced to so many cues, carried out on signals from the stage manager. To do this, is to reduce the job to the level of opening and shutting the doors at each Tube station. The switchboard operator must take part in the play, and only where the stage simply cannot be seen should the signal method be adopted.

Lighting Plot

Plotting will be peculiar to each man, some taking down in detail, others relying principally on excellent memories. The actors have to memorize their parts and business so why not others? Anyway, the plot—particularly a complicated one for a large flexible board—should be arranged that its layout strikes the eye. It must not consist of line upon line of close writing, a solid page. The most obvious way is to put the cue line, action, or signal boldly in the left-hand column. Vertical columns are given to the principal groups of apparatus across the page: Front-of-House Spots, Spot Batten, Cyclorama. Good abbreviations are preferable for the above—F.O.H., SPOTS, CYC., and so on; make sure, however, that the names used in the plot correspond to the labelling on the board. If the board calls the Cyclorama batten "No. 3 Batten," then "No. 3 Batt." it is.

Where there are invisible manoeuvres, such as the plugging up of dimmers on flexible boards, which are required to be done before a cue takes place, these should be noted on a line to themselves between the last cue and the one to come. The left-hand column bears a dash which draws attention more effectively than the word "Prepare."

Lighting Methods

In order to cover as much ground as possible I shall not consider lighting effects in relation to a particular play or scene. Readers are referred to Chapters VIII and IX of Peter Goffin's book, *Stage Lighting*,* for an excellent description of the lighting of a specific play, from the producer's angle. For my general remarks and hints I shall begin with realism, because such effects are more commonly called for and because as we proceed it will become apparent that the boundary between realism and impressionism and any other of the *isms* is even less clear in the lighting than in the *décor*.

It cannot be too often stressed that the lighting for any scene must be dominated by an idea. The approach must not be: a spot on the arm-chair for Bill and Susan's big scene; a spot on the table so that they can see Jimmy's business with the wineglass; pick out the doorway; and so on. Last of all, the sun is put in as a sop to realism, the sky being strengthened by additional floods because of the shadows on the backing, and in consequence is quite out of tone with the rest. There is a type of setting that corresponds to this lighting, the type where doors and windows are scattered about to satisfy the play's

* Published by Muller.

Fig. 181. Night Interior Using Permanent Ceiling and Cyclorama, Bernard Shaw's "Arms and the Man," Act I, at the Questors' Theatre

Fig. 182. Day Exterior Using Permanent Ceiling and Cyclorama, Bernard Shaw's "Arms and the Man," Act II, at the Questors' Theatre

demand for entrances without any conceivable architectural relationship. Mercifully, such a setting is comparatively rare, but such lighting is all too common. The excuse offered is usually: "You must have some conventions on the stage."

This is very true, but one must be consistent; if all that is required is a number of conventional pools of light for the actors to act in, then the lighting must be quite honest and no half-hearted token sources offered. I believe that lighting does not best serve the actors by ensuring, first of all, that their faces can be seen. To take an obvious example: if the characters in the play are suffering from the heat, then obviously the actors will have less work to do if the moment the curtain rises the impression given is one of heat.

The idea must click immediately the curtain rises: "It is a lovely day! The sun is streaming through the window; it is good to be alive!" or "The sun is blazing through the window—one can scarcely breathe," or "It's jolly cold outside, but my! it is cosy in here." Write down the idea behind the lighting for the scene as a single sentence, and this will automatically colour all our subsequent activities, even if we have to pick out Aunt Jessica's pin-cushion with a 1000-watt spot.

Exteriors Daylight

The first point to watch will be the need for a certain amount of general flooding. Unless the site is some leafy glade things will never look right if the light is a mosaic of pools and patches. The worst condition is, of course, noon when the sun is high in the heavens. Fortunately, the sky will have to be full up, which will help counter shadows thrown thereon. This is where the medium-angle beams of floods or magazine equipment can be directed to maximum effect on the acting area and clear of the sky. If there is still too much stray light, then the funnel attachments will cut this out.

Any tinting of the acting area might come from Nos. 51 or 52 at the strongest; generally it is a question of all up—reds, blues, any circuits that are going.

It must be remembered that electric light is already very yellow compared to sunlight and, provided there is plenty of light, white is usually safest with, perhaps, No. 50 where the actual sun's rays are supposed to be visible. As the intensity available becomes less and less, then the white becomes dull and light tinting is needed to create interest.

The most satisfactory noonday effect the writer ever achieved was at the Lisbon Opera, where the scenery and acting area were lit in white. The two bridges which appear in the photograph (*Frontispiece*) enabled most of the colour filters to be removed between the acts. The cyclorama was lit in a medium blue which, by contrast, warmed the white lighting. Apart from the great installation, an unhappy note is struck in this example by the reference to blue sky. Too often the sky in these latitudes is not blue but more a blue-grey, even on the finest of days. This raises a difficulty: anything like a grey or No. 18 light blue will suggest coldness and will not sufficiently warm the white lighting of the acting area. I am of the opinion that in many instances we shall have to stretch a point in favour of a real blue, such as a No. 32 (or equivalent mixture). This blue can be toned into warm white at the bottom of the cyclorama by the ground row. The first essential is not realism in matching, but that the sky shall look attractive —it is a lovely day. White lighting on blue painted cloths is a wash-out; the blue always looks like grey paint. Light amber or yellow effects should never be used in flood over the cyclorama unless it is wished to convey that the day is unpleasant.

The sky often gains from something to break its flat expanse, and for this purpose a few *stationary* fleecy clouds are invaluable; their production, not difficult, is considered in the next chapter. Once a few white clouds are on the sky, more freedom in the application of colour is possible.

Early sunlit morning is best suggested by general diffuse lighting (somewhat cold) from the battens, with directional warm lighting superimposed *from one side*. The earlier the hour the more coloured the directional light; and, of course, the nearer winter, the more the colouring and directional effect will be noticed, the sun being low in the sky. The deepest-coloured sunlight is seen on cold winter mornings.

Cold mornings without sunlight must be as diffuse as possible; anything resembling directional light or shadows must be avoided: probably more footlight correction than usual will be needed. A pleasant time can be had with Nos. 17, 60, 55, and 56 and other combinations such as Nos. 17–3, 17–55.

Sunrise and sunset are real fun for the lighting expert. As so often is the case, these more obvious effects are not the difficult ones. A noonday sky will give far more trouble than a big sunset display. If a play contains both sunrise and sunset, even if they occur in different settings, it is as well to differentiate. Usually, if given half a chance, I like to assume the sun is rising off stage. This means that a lamp (2000-watt soft-edge spot for large stage) on the perch is focused to cover the acting

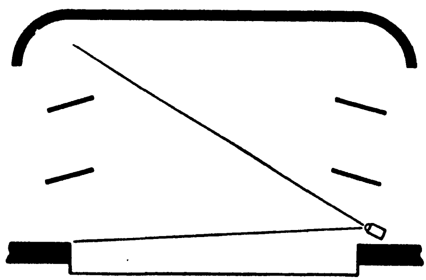


FIG. 183. PLAN: DIRECTIONAL LIGHT FOR DAWN EFFECT

area from one side (Fig. 183). The stage, at first flooded from overhead and slightly from the float in cold light, gradually has this dramatic light brought up across it (No. 10–33); the cyclorama top is given a slight blush of reddish pink with a cold ground row. As the scene proceeds, so the general lighting increases, overpowering this coloured source which is then removed. It is one of the few opportunities of using strong colour on the acting area in a straight play. Sunset is assumed to take place behind the cyclorama ground row, that is, in full view of the audience. The most striking clear sky sunsets are possible using red, green, and blue in the ground row and Nos. 5A, 16, and 20 in the top.

For cloudy sky sunsets it will be necessary to use projected clouds and even a sunburst flood (see following chapter). The difficulty is that as the cyclorama is perfectly flat it does not provide any break-up for the light. In changing effects such as these, it is very important to keep the cycle of change smooth.

A 1000- or 2000-watt lamp for the sunrise will need very careful dimmer operation. The thick filament takes some appreciable time to warm up; when creeping the dimmer in, one is likely to overdo it and the light will come either with a rush as too much light, or so slowly as to miss the cue. Lighting changes must always flow, and any suggestion of bringing up the sun in a couple of minutes at the behest of a cue must be avoided.

Exteriors Night

The most tricky provision on a small stage is that of an inky black sky. It is achieved, not by the absence of light, but by

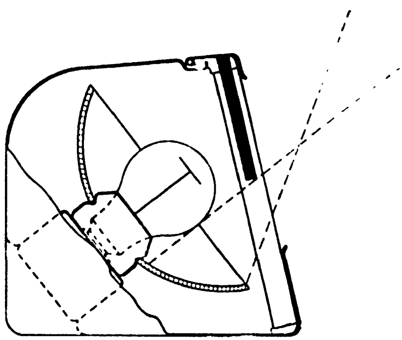


FIG. 184. SECTION: MASKING THE FOOTLIGHTS FOR NIGHT SCENES

the provision of very-low intensity No. 20 Blue, the dimmer on the bottom stud or two. It will be most noticeable how much blacker the sky becomes with this addition of light. Some sort of contrast colour on the foreground, as might be provided by a street lamp, or camp fire, is a help. Where such a course is not possible, then there will be no alternative but to step up the amount of diffuse blue on the foreground, the point being that it is impossible to convey the darkness of the sky without some sort of intensity comparison. A few stars or a storm cloud are a great help in this direction.

A common fault in night scenes is excessive blueness; the theory seems to be that intensity matters not, so long as the colour No. 20 is right. What so often happens is that some footlight in light colours, introduced to bring out the faces, throws shadows on the sky, which then have to be removed by applying more blue. Very often the footlight is fitted with concentrating reflectors which aggravate this effect, and these could be removed altogether from the compartments used for night effects; or the top two-thirds of these colour frames can be blanked out with mask (Fig. 184).

Moonlight effects are best conveyed by directional rays superimposed on the setting. For large theatres, either the 1000-watt pageant lantern or 2000-watt soft-edge spot is commonly used; sometimes hung in pairs in special frames from the flys. Smaller stages will find a 1000-watt or 500-watt

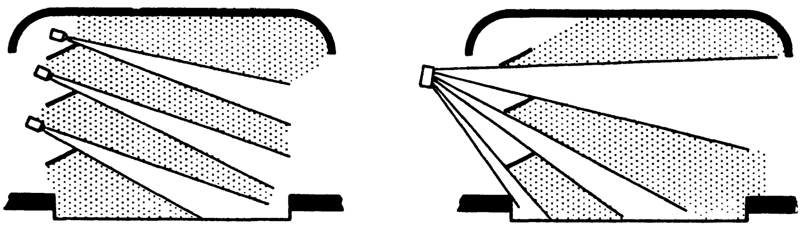


FIG. 185. PLAN: IMITATION OF MOONLIGHT BY SPOTS (LEFT) IN PREFERENCE TO SINGLE FLOOD (RIGHT)

focus lantern (with No. 31 Frost) very suitable. A flood cannot be used, nor can a spot be wide-focused as the shadows will then radiate from this source. The only true solution where large coverages are required, is several lanterns each giving parallel beams. For example: if our setting has a series of wings stage right, each wing will have its moonray lantern instead of a single flood well off stage, throwing the shadows of the wings in widely conflicting directions (Fig. 185).

The colour of moonlight needs some thought, and it can be stated here and now that the No. 16 Blue-green, labelled "Moonlight Blue" in some colour charts, does not in the slightest degree resemble moonlight. Direct moonlight is, under normal conditions, a very low intensity cold white, and its characteristics are the hard shadows giving stark black and white lighting. This white would be best imitated by one, or at the most two, steels No. 17, were it not for the Purkinje effect alluded to in Chapter VII, page 145. This effect intervenes at these low intensities to put colour perception, except the blue, almost (completely, in starlight) out of action. From this it can be seen that the best moonlight effects will be obtained from black and white scenery, costumes, and make-up, lighted through double No. 17 Steel-blue filters. If this is not done, then reds and colours show up in such a way under this light that the brain automatically says this is not moonlight but cold daylight.

Such a complete change of pigments for one act or scene will seldom be possible, and we are faced with the job of spoiling colour with our filters as far as possible, without conveying the effect of a riotously blue stage. The thing to avoid is any contrast that will emphasize the blue. A No. 40 Blue, or better still 40–50, will be effective enough to suppress most colour and at the same time will not look particularly blue, unless deliberately contrasted with amber to red lighting. Thus, if the scene is the moonlit village with the glowing lights behind the windows, the temptation to make these orange must be restrained; they must be steel-blue, or at the most natural white. The way that orange windows will immediately turn the moonlit scene into a Christmas card ought to be a worthy lesson. The camp fire must err on the cold side for similar reasons; fires are always too red on the stage, anyway. The problem of showing the moon in person is treated in Chapter XIII.

Interiors Daylight

I shall assume the presence of a ceiling; there is really no excuse for leaving this out when any attempt at realism is intended. Even a curtain set is vastly improved, used with ceiling instead of borders. The presence of a ceiling means that all the lighting will have to come from behind the proscenium arch or proscenium border. As before, it is essential to decide the dominant idea behind the lighting; decide where the natural lighting of the room is coming from.

As the majority of the lighting is coming from the direction of the audience it will be necessary to avoid any suggestion that the imaginary source lighting is coming from the back of the stage; side windows are obviously the best compromise. Beams of light through windows are, as with exteriors, put in with concentrating lanterns, not medium- or wide-angle floods. The lighting of backings behind windows needs to be very carefully carried out. For up-stage backings, the cyclorama will be best with, perhaps, a painted ground row (Fig. 186). Side windows will require their own backings, and considerable care will be required to make the lighting of these tone in with the main backing. So seldom can a number of backings be made to look right with one another that, if at all possible, some natural reason should be provided which will permit the light to stream in, without the audience being able to see out—lace or muslin curtains, for example. The wall of the set opposite the window providing the illumination will need some auxiliary lighting. Where No. 1 Batten consists of baby floods, these can be angled to get this result. For daylight effects it is essential that the ceiling should be lighted, though not in any strength. The footlight is sometimes used for this purpose; but on the whole better results will be obtained by a baby flood flooding upwards from a perch position. On a large stage this will be replaced by a flooded and frosted spot. Unless the walls and the ceiling opposite the window are lighted subtly in this way, the lighting will never look right. When there is supposed to be snow on the ground outside, then this light must be stronger, and it will be noticed that at once the eye interprets this peculiar light as snow. Such suggestion is often more successful than all the snow backcloths and snow effects.

Having got our idea placed, we can now turn to the focusing and placing of the spotlights for the actors' benefit. For day scenes pools of light must be avoided and our focus lanterns adjusted in flooding terms, well frosted. As this goes on, we shall be influenced by the effect lighting already dealt with; incidentally, this will probably need strengthening as more and more acting-area lighting comes on.

To some folk this method will be heresy. "Light the acting area first, put in the background afterwards" is the cry. This teaching comes from the doctrine that the actor instead of the show is all-important. Modern stage lighting is not the

Fig. 186. Day Interior Using Permanent Ceiling and Cyclorama: Bernard Shaw's "Arms and the Man," Act III, at the Questors' Theatre

lighting of actors with focus lanterns instead of magazine battens. It is impossible to convey an idea if this is to come from lighting superimposed on mere actor illumination. The couple on the sofa must not be lighted from just any lantern on the spot batten: it must be the spot which quarrels in direction least with the supposed source of illumination.

Interiors Night

It is usually possible to place artificial light sources in such a way that excuse is given for the lighting. The actual sources must be low in power, about 15 watts, unless heavily shaded and/or tinted. The modern type of tubular fitting gives trouble, as very low wattages are not supplied; pairs of lamps can be connected in series. Anyway, whatever is done, glare must be removed or this will rivet the gaze to the exclusion of all else. By contrast the rest of the lighting will appear dim.

An attempt should always be made, though it is seldom possible, to light the actors from the fittings supposed to be providing the illumination. A character seated somewhat behind a table lamp may quite well receive good illumination from this lamp. A higher wattage than usual is used and the side of the shade towards the audience toned down by fitting some neutral filters (Nos. 55, 56, and 60) inside it. In the same way firelight should always come from the fire in preference to an elaborate fake-up from perches and spot batten.

Much trouble is caused by the habit of using baby float spots for fireglow; baby floods will automatically spread all over the place in the way that a sheet of flame really does light up the room. The floods are just as easily concealed as the spots. Where the tradition of using a spotlight with a 3-in. diameter lens to represent a sheet of flame came from is a mystery. In the same tradition is the use of red for fireglow. Never use a No. 6 Red (sometimes known as "Fire Red") for fire or flame effects. Broken colour should be used: variations in 10–4, 10–5, and the like. Where the light of the fire has to be augmented be very careful never to allow the spots on the spot batten to dominate, as the direction of fireglow will be wrong; an acting-area flood for this purpose is just crazy.

The lighting to represent artificial light can be much warmer than that for daylight, and more localized. As a general rule, daylight should be floods supplemented by focus lanterns; artificial light, focus lanterns supplemented by floods. Keep the top of the set and ceiling dark (see Fig. 181). Double 51 or 52 are useful for direct light, 3–36 and 2–36 for parts of the set not intended to receive direct light.

The footlight should be at low intensity and arranged to build up slightly where the pools of light thrown by the spots are. By this means correction can be provided just where required. Where there is no footlight the effect may be got by bracketing a baby flood from the front of the stage. A room lit by oil lamps at table height will never look right if all the light comes from above in the No. 1 spot batten. F.O.H. spots with a low mounting at the sides of the hall can provide ideal facial correction. In larger theatres these spots are mounted among the stage boxes or where these boxes would be!

It is a great mistake to consider each circuit in a magazine footlight or batten as dedicated to the use of a single colour. Juggling with the colour filters of a circuit can be very profitable. Filters can be graded compartment by compartment to build up across the stage. In the footlight, lamps can be omitted altogether where some object, a table with a white cloth, for example, will draw too much attention if floodlit at close range by its nearest compartment. Dimmers are never too critical to permit some latitude, except when the footlight or batten is very short. Another device for a small stage is to omit one or two of the normal low-wattage (60 or 100) lamps and insert a 150-watt lamp where extra brightness is required. The whole can then be checked in proportion by the dimmer as required. Always aim to avoid the two extremes completely, even flat lighting, and, on the other hand, a lot of detached pools of light. A very great deal of practice and a great number of spots would be needed to build up lighting by spots alone.

When realism is not in question, then night interiors can be suggested with quite heavy colours. To take an extreme example: a play performed without scenery before black drapes could revel in No. 8 Pink, 7–2, or 7–3, the change in colour being the only way to point the time of day.

A particular trial in interiors is the way the pattern of the window frames gets projected on the nocturnal backings. In an attempt to overcome this, the backing is flooded with more and more blue to the complete detriment of realism. Covering the windows with grey gauze and using a black backing is one solution when it is supposed to be a dark night outside or the window is not required to be prominent. The gauze is, in any event, helpful even where the backing has to be lit.

Very often the room lights have to be extinguished leaving the room in darkness except for the fire. Inevitably the lighting on the backings, adjusted to tone in with the room lighting, will now appear too bright. The proper way to carry out this cue is to reduce the backing lighting as the room lights go off. This may appear strange, but unless it is done the reverse effect—that of the backings jumping up—will probably be given.

The local authority will seldom permit real candles, oil lamps, and what-not; but property fittings for self-contained battery or mains can be hired. So can property coal, electric, gas, or log fires. Some of these are very good imitations; some are very awful; it behoves us to choose and reserve our props well in advance.

Candles are easier imitated by small battery-operated torch bulbs to which wisps of paper are stuck. A lamp commonly used is known as a "two by one lamp" from its dimensions in inches; there are divers ways of making this tolerable. Electric candle lamps are all right so long as they are concealed by shades or shields.

Suggestion

Slavish imitation for the benefit of so-called "realism" is all very well, but it is a cause for pleasure when we come up against something that cannot be treated with any attempt at realism on our small stage. A life spent in lighting eternal box sets would be real purgatory for the lighting artist. Every now and then the company ought to give its scenic and lighting men a chance to show off: put on *The Rumour*, *The Adding Machine*, or something of that type. Once realism is discarded it is often surprising how little scenery and lighting is needed to get the idea over. For example, the Thames Embankment can be evoked by a simple silhouette of a parapet carrying a lighted lamp standard with its characteristic dolphin base.

An exacting test is the inclusion of one scene demanding suggestion among a number of straightforward sets. The cathedral scene in *The Witch* is a case in point. We have to suggest a cathedral on our 18 ft by 14 ft stage. Obviously the stage is opened up into the wings as much as possible; all is dark except for light striking a significant column in the foreground. This need to keep everything as dark as possible may lead us astray; we must suggest the distant vistas to be found in a cathedral, however dark. The placing of a faint blue lamp directly seen here and there may give just this effect; something —one cannot tell what and at what distance—is to be seen. Incidentally, the lamp acts as an effective blinder for the dubious surroundings off stage. The projected suggestion, at very low intensity, of a distant window is another approach.

The light of stained-glass windows in the wings off-stage can be suggested by jazz gelatine filters in focus lanterns without their lenses. Jazz gelatine varies very much over the sheet and must in consequence be carefully selected.

Lighting for the Dance

Since facial expression is of secondary importance, the main lighting may well come from the side. Such lighting brings the dancers into relief against the *décor*. Even when front lighting is attempted, it should come from the sides of the auditorium, as modelling is all-important. The lighting of the *Ballet Jooss* is a model of what can be done with slender resources. At the other extreme, the mass of lighting concentrated on one dancer, La Meri, at the Savoy Theatre before the War, did show how very valuable intensity can be to give really exciting colour. All Robert Nesbitt productions are a tribute to intensity and punch of light. Without this punch even the richest colours appear insipid.

Interesting results can be obtained by projecting beams of light from high in the up-stage wings across to the down-stage opposite. This back-to-front effect gilds the dancers in a delightful manner (Fig. 187).

Far more ought to be done to keep the lighting in motion during the ballet; that this is not done is probably attributable to present-day control boards. Grinding out just a few changes by the operator in his blind position is sufficiently discouraging to prevent more ambitious demands. Lighting changes in ballet have to be tied not only to the action, but also to the music; inevitably this means an instrument to play the light before we can get very far. These rhythmic changes are not

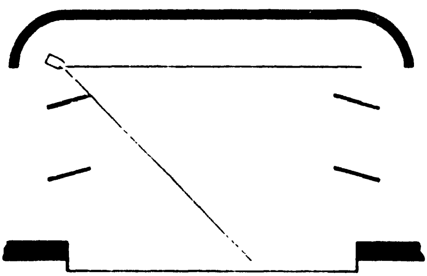


FIG. 187. PLAN: DIRECTIONAL LIGHTING FROM UP STAGE

particularly required in classical ballet, but in symphonic ballet they are essential. (See pages 317 and 318.)

The lighting of the stage floor in ballet is important. A black stage-covering tends to isolate the feet and make them too prominent. Unless the décor carries its own floor cloth then a medium floor is preferable for most works.

Shadows

The dance frequently offers opportunity for the use of enlarged shadows on the background. Shadows of actors and scenery can be very effective, particularly when the lanterns are fitted with contrasting colour filters. The lanterns may be concealed in the footlight ramp or mounted in the wings to throw distorted shadows on the cyclorama. If, as in Fig. 188, two lanterns—one 6 and one 39—are employed, then the general light where the two mix will be amber, but the shadows will be red and green. Shadows thrown by a multiplicity of coloured sources can be very vivid. For really hard definition, focus lanterns with the lenses omitted are used. The setting shown in Fig. 207 is of interest, apart from the shadow effect, since it was built for lighting demonstrations; it is described in Chapter XIV.

Broken colour is particularly recommended for shadow effects. Considerable variation in definition of shadow is possible, depending upon whether the object whose shadow is thrown is closer to the lanterns or to the cyclorama. The

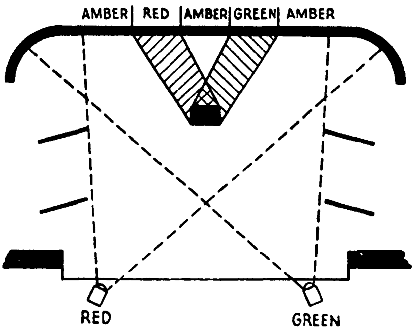


FIG. 188. PLAN: COLOURED SHADOWS ON CYCLORAMA

latter gives the sharper, but not necessarily the more interesting, shadows.

Psychological Lighting

This chapter, indeed the whole book, must of necessity seem over preoccupied with material means and prosaic effects rather than with the spirit in lighting. I have chosen to concentrate on realism in lighting, rather against my will, because an effect like a fine sunny day brings a mental picture and response to all of us. Lighting to convey how one feels just before a major surgical operation, to portray despair, terror; or, on the other hand, joy and happiness, can only spring from genius; it cannot be taught. The technique is the same as that brought to bear on flickering flames and the reflection of snow outside the window and other trivialities; but what to do and why, one cannot explain.

It will not matter whether one is lighting a realistic fine-day scene or a group of actors without any scenery, the lighting should underline the action on the stage. The fine day should be lit so that it sets off the mood of the play: unless it does this it will be mere illumination, however closely it counterfeits nature.

Too often psychological lighting is so self-conscious that it means acting in murky pools of deep colour: Red for blood and war, magenta for passion, purple for the regal mind, blue for romance, apple green for youth, and so on. This lighting is constantly fiddled on the dimmers, first this actor then that picked out in a shaft of light and the audience are made aware of only one message—special lighting effects by ——!

Except in spectacle where the lighting movement and colour may often be more than half the show, the approach must be subtle and restrained. Moods are pointed by colours but slightly removed from the normal (the broken colour and the subtractive mixing of pale filters is invaluable for this).

Emphasis of a character or an area of action should be by a slight increase of intensity rather than by a shaft of light stabbing the murky gloom. Above all, movement of dimmers can be so slow that the audience are made aware of a shift in emphasis without, so to speak, seeing it. There is no earthly reason why a dimmer should not take minutes in its travel instead of seconds. To take a crude example, suppose an act begins in a mood of despair and ends in a frenzy of enthusiasm, the lighting might make its contribution by trebling the overall intensity of the stage during the thirty minutes the act lasts. The audience will not see a change of lighting lasting thirty minutes but it will feel it.

A similar slow change in which the lighting is imperceptibly reduced can bring a sense of oppression, or a change from general lighting to particular can allow a character to dominate the scene. The slower the change the more the character will dominate because the reason will not be visually apparent. The selfsame lighting change which, if done quickly and perceived, would suggest a flippant "enter the villain, Ha!" can strike a mortal chill.

General slow decreases in lighting over a scene during an act are not so important because the first bright impression of a scene tends automatically to create less effect as the act progresses; but this does suggest the converse of this—the piling on of lighting—may often be common sense to keep interest, especially where the action on the stage is static. We find an aural equivalent in speech or music where it is seldom advisable to keep going at the same volume level, however interesting the content.

Personally I rate direction and intensity of lighting far higher than colour in the art of expression. Put crudely, an all-over flat change of colour as from battens and footlights is nearly meaningless. There must be colour contrast and this is obtainable only by the use of directional light. On the other hand, using white lighting we can go very far by variation in direction and intensity, as black and white photography shows.

Consider only a cylindrical column with a plain cap. Lit all over evenly the result is uninteresting, but as directional light is brought up on one side so the column gains interest. So far the change has been from dull to interesting but if the column is lit equally from both sides only, then a reaction of strangeness is produced. This kind of light is never met in nature. Lighting the column from the base upwards so that it tails off into darkness will bring to the most obtuse a sense of something wrong. Take a photograph of Buckingham Palace floodlit as it is from the ground, print it with a light instead of night sky and the incongruity of shadow direction might well be terrifying. It would have to be a clean building like the Palace because London usually provides a substitute for the day shadows under cornices and ledges where rain cannot wash the grime away.

Taking this into consideration, there are two approaches to lighting a naturalistic scene as in *Outward Bound* or *Thunder Rock*. Either the lighting can be normal in intensity but directed from slightly abnormal angles, too low down or too high up, giving the audience a vague sense of something wrong; or the scene can be lit in a perfectly normal matter-of-fact way which would give point to the unawareness of the passengers that they are no longer alive. The lighting approach to kill the play would be that of ghostly gloom.

The producer must thoroughly brief his lighting artist as to the way he sees the play and the latter must accept this or resign; otherwise they will be working at cross purposes even if they are lighting the same scene with nothing more abstract than the glow of the setting sun.

Much can be learnt from both Harold Ridge and Norman Marshall (see Bibliography) on the work that was done at the Cambridge Festival Theatre in 1926.

Finish in Lighting

Apart from artistic considerations, the lighting of a scene should always present a finished look. A glow near wing or border must not be allowed to betray a lantern. Scenery and curtains must be properly backed so that light from behind does not show. Unwanted shadows cannot be completely eliminated, but the more obvious must. Shadows from borders across the scene, projections of window frames on to backings, shadows of actors waiting for their entrance in the wings—these are the result of negligence. Above all, the equipment should be kept properly cleaned, and maintained so that it always gives good results.

There is another detail wherein only the actor can help. Amateurs are inclined subconsciously to move their heads out of the glare of a spotlight. Consequently the body may be beautifully lit while the all-important face is not. Actors must be encouraged to seek the limelight for then, after some practice, we can be sure that even when a spotlight is accidentally knocked slightly out of position they will be able to make the best of the situation.

CHAPTER XIII

SPECIAL EFFECTS

In addition to the general lighting effects so far described there is a range of special effects involving some particularized usage of equipment. These special effects are almost in the nature of illusions or tricks and need great restraint in their application if they are not to degenerate into distracting stunts. I think the orthodox pre-war productions of Wagner's *The Ring* at Covent Garden probably presented a greater concentration of such effects than any other productions in the theatre. A brief run through the plot may indicate the possibilities in this direction: it is to be hoped the snares also.

The cycle begins with an orgy of optical effects projectors giving an underwater view of the Rhine. A later scene gives amid a display of projected clouds on the cyclorama an example of projected scenery: the distant view of the newly-built Valhalla. At this stage in the proceedings the two giants run off with Freia, the guardian of the magic apple-tree, whereupon the gods lose their immortality and grow old and withered—under the influence of mercury-vapour discharge lamps. After a visit to the gloomy depths of Nibelheim, things are put right (more or less) and the gods regain their youth. The opera ends with a thunderstorm and the optical projection of a rainbow bridge (a tricky piece of work) to enable the gods to cross the valley into their new home, Valhalla. The opera runs continuously without an interval; all changes have to take place as laid down by the music. The opera is a lighting-effects man's paradise—or would be, if it were not for the heavy hand of tradition.

The other three operas of *The Ring*—*Valkyrie*, *Siegfried*, and *The Twilight of the Gods*—pursue their way to the accompaniment of clouds, flames, floods, and other items in the catalogue. Such is the realistic approach, brought up to date as far as tradition will allow. There have been some who have had the temerity to suggest that the operas might be much improved if not a single cloud, flame, or drop of water were to appear;

to say nothing of the sparks from the forge and other side dishes.

The less exalted will run into temptation over the production of Shakespeare—*Macbeth*, *The Tempest*, and *Midsummer Night's Dream*. I am inclined to think that every now and again a good old orgy of effects with all the tricks might be fun for all concerned; *The Tempest*, perhaps. For junior school productions there is certainly a lot to be said for overdoing such things. More abandon is likely the farther away the classroom and the nearer the atmosphere approaches the fifth of November.

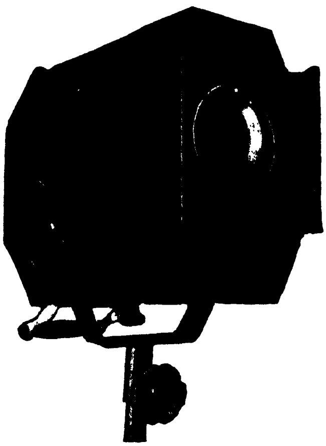


FIG. 189. 1000-WATT OPTICAL EFFECTS PROJECTOR

For less melodramatic productions, the difficulty will be to blend the special effect into the general background. A moving cloud can be an appalling distraction; even a stationary one can catch the eye. On the other side, let it be admitted that a flat, clear sky can equally well strike a discordant note. Anyway, there is one restraining brake for one's enthusiasm—the expense of the more realistic effects, even to hire.

Optical Projection

The best-known special effects are those employing an optical projector (see Fig. 189) and are accordingly known as "optical effects." The projector—usually a 1000-watt with an A.1 tubular lamp—is common to all, the lenses and slide attachments being varied according to effect and throw. The effects include clouds (still or moving), flames, sea waves, scenery slides, and others, most of which are treated in detail below. (Less expensive makeshifts are described where possible.)

Fundamental to all optical effects projection is the need for a rigid fixing; any movement or vibration at the lantern is amplified by the projection throw. In the theatre a perch platform either side of the proscenium is often used. A pair of steps in an unfrequented part of the stage is another device. At Covent Garden a series of rigid perches and a bridge over the proscenium is available. On the small stage, hanging is often the best method, but of course care must be taken that the lantern will not be hit by scenery and set swinging. The steps method is the best where the floor is rigid (only the "on-stage" floor should be sprung) as an operator can get at the lantern and if need be stay there to make changes during the scene. A telescopic stand fully extended may not be used unless strutted to something rigid. The aim should always be to project the slide or effect from the front on to the screen or cyclorama. Back projection on to a translucent screen takes up too much precious stage depth and has other drawbacks as well: the joins between one strip of material and another will show; the lantern lens is apt to appear as a flare spot; and more light is absorbed by transmission through a material than by reflection from a surface like hard plaster.

Distortion and Focus

Considerable patience and artistry are needed to get the best from an optical effect. It is not a matter of hiring an effect labelled "Wave," connecting it up, focusing, and there you are! Distortion due to the angle at which the effect strikes the cyclorama, masking and choice of lens, clarity or otherwise of focus and tinting, can be used to obtain a fine range of results personal to the operator instead of the stereotyped effect in the box.

It is of prime importance to see that all the lenses and reflectors are thoroughly clean and polished. Next, if the lamp is not fitted with a pre-focus holder, it and its reflector must be adjusted so that the light emerges fairly and squarely from the condenser. The actual rays emerging from it can be seen as a guide. The lamp tray is moved away or towards the condenser, depending on the objective lens combination and the size of slide used. The tray should always be moved backward and forward whenever an effect is set up to see if the light can be improved.

Moving effects consist of a rectangular or circular box with a turntable attachment which, fitting in the lantern runners, enables the effect to be rotated. Stationary slides may either be carried in the orthodox changing slide carrier or in individual metal carriers; either type is actually fitted into a turntable attachment. Use of the turntable device enables the picture to be levelled up when projected at an acute angle from the side of the stage. The effect attachment or the turntable attachment has runners to carry the objective lens. On the stage itself short-focus lenses will be used and are as follows—

Narrow Angle, gives 9 ft wide picture at 10 ft.

Wide Angle, gives 12 ft wide picture at 10 ft.

Extra-wide Angle, gives 18 ft wide picture at 10 ft.

Long-focus lenses, such as 6 in. giving 5 ft at 10 ft, may sometimes be required on the stage. Front-of-House throws requiring 12-in. or 14-in. focus lenses will need an auxiliary support to the lens tube.

Masking and Tinting

Masks to fit the picture to the scene may be inserted at two points in the optical systems: in the effects runners (Fig. 190 at *B*), or in the lantern runners (Fig. 190 at *C*). When the mask is at *B* it can be hard- or soft-focused along with the subject on the effects slide. At *C*, the slide and mask can be focused independently, the slide soft, the mask hard, or vice versa.

The cutting of masks to counter distortion due to angle of throw and shape of cyclorama receiving the projection, needs much patience. Experimental masks can be cut in post-card by trial and error, and where permanence is needed the successful one repeated in metal. Black election slides on which white lines can be scratched can be useful. Such a slide drawn out with some equally spaced numbered lines of latitude and longitude can be projected first and will give a good guide as to the compensation to be allowed for.

Where the masking edges are not to show, the out-of-focus effect is assisted if the edges of the mask are irregular as in Fig. 191. Another valuable material which can be used for masking or making designs on mica slides is Photopak (obtainable from photographic suppliers); this dries brown in colour but is opaque to light. For softening edges and clouding out parts of slides, moist soap can be smeared on lens or slide.

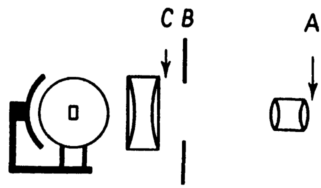


FIG. 190. POSITIONS FOR TINTING IN PROJECTION OPTICAL SYSTEM

Tinting filters can be placed at *A*, *B*, or *C*; but if *A* is to be used, then an auxiliary colour runner should be ordered with the objective lens, as this is not supplied as a matter of course. Positions *B* and *C* give an all-over tint or a tint that can be definitely localized to part of the slide by cutting the filter. Position *A* in front of the objective lens is more subtle in action: by partially covering the lens with the filter, an effect

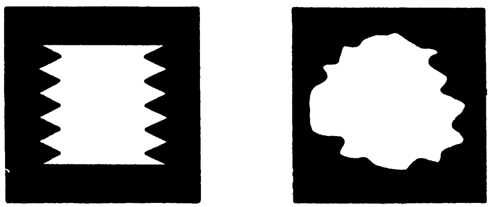


FIG. 191. IRREGULAR MASKS FOR POOR DEFINITION

of white merging to colour can be obtained in the picture. The result gives the effect of relief to quite a flat picture and, used with moulded glass slides, the results can be very interesting.

For most theatre work clockwork is preferred as a motor to drive moving effects. Except in the very fast effects there is no noise and steady motion is obtained; also the clockwork motor is cheaper and weighs less. Speed regulation is obtained by a device consisting of rotating wind vanes (Fig. 192).

The air offers resistance to these vanes, and by turning them from flat-on to edge-on, considerable increase of speed is obtained. For still faster speeds the vanes may be removed altogether. Slow effects, such as clouds, run for several hours; but where the lantern is inaccessible and there is a risk that the motor will run down before the scene is reached, the clock motor can

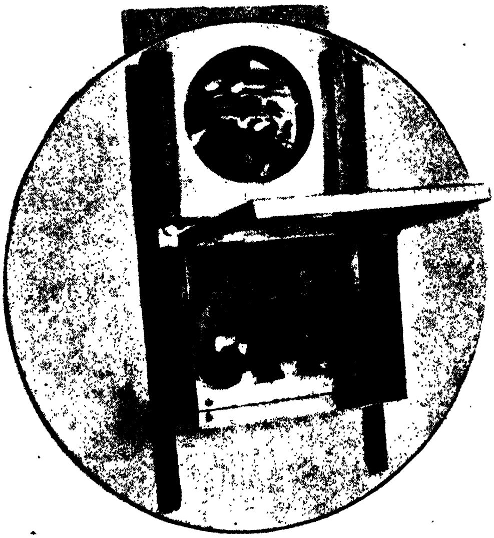


FIG. 192. EFFECTS DISC SHOWING SPEED REGULATION VANES FOR CLOCKWORK MOTOR

be fitted with an electro-magnetic stop and start-operated remotely from a switch and 3·5-volt dry battery. Another method is an inch or so of fine cotton tied to one of the vanes; the cotton is tied to a string which, when pulled from below, will break it and leave the vane shaft free to revolve.

Great improvement is taking place in electric motor drives, the previous noisy contraptions being replaced by neat units with considerable advantages over clockwork.

Cloud Effects

There are two main types of moving cloud effects; both consist of a circular mica disc in an aluminium case 19½ in.

in diameter (Fig. 193). The types are known as "storm cloud" (dark clouds on a light background); and "fleecy" (white clouds on a black background). The discs are hand-painted and there are several gradations in these types, storm discs varying from very heavy to quite light. The effect must *never be sharply focused* and a tinting filter such as No. 17, 40, or 60 is almost essential. As the background is light, care must be taken that the edges of the projected disc do not show; projecting from the side, well out of focus, this should not cause trouble. The distortion caused by acute angular projection greatly improves the effect. Running very slowly the denser storm clouds, tinted with filters such as 55, 56, and 60 in combination, make a very good mist or fog effect, especially when thrown on to gauze. Storm clouds are very suitable for night skies and, with much patience, by cutting a circle of the required distorted shape in the tinting filters, an effect of clouds passing over the moon can be reproduced. This tinting filter goes at *C* in Fig. 190.

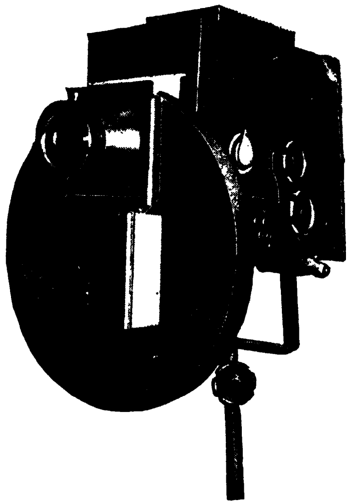


FIG. 193. CLOUD EFFECTS DISC WITH WIDE-ANGLE LENS AND ARC LANTERN

White fleecy clouds are much improved by superimposing the projection from two sets of effects. Not only is more variety obtained thereby, but the clouds become more light and wispy. This type of cloud can be more sharply focused than the storm, but sharp focusing is to be avoided, nevertheless. Tinting with No. 17 may be necessary to prevent the clouds appearing too warm against a blue sky. Very slow speeds are needed, and the effect must not be too bright in contrast to the sky.

Because moving clouds can be very distracting, stationary slides very often give far better effects. Such still effects must not be obtained by stopping a moving disc, which may be burned thereby, but by using special mica slides. The slides can be hired or the more venturesome may like to buy the mica and make their own with Photopak. The mica must be free of any grease, however slight, before beginning operations; and a cover piece of clear mica bound on to the slide to preserve the surface. If complex colour tints are required, as for sunset clouds, it is better not to colour the slide but to fit tinting filters to the front of the objective lens. This method provides more lasting colours, greater depth, and the possibility of variation from scene to scene or show to show, using the same slide. The colour frame may be fitted with several overlaid shaped pieces of colour, as in Fig. 113. The result can be the most magnificent display of broken colours upon the cloud. Incidentally, the storm cloud giving, as it does, the impression of the sun behind the cloud is more suitable as the basic sunset lighting. Using these simple methods the operator can out-Turner Turner.

The setting sun with its radiating shafts of light can be produced by laying a 500-watt flood on its back close to the cyclorama. A complete No. 33 Deep Amber filter is inserted, together with two-thirds of a No. 11 Pink, and on top of this are laid a number of metal strips 1 in. wide. The resulting arrangement of strips can be cut out of a sheet or soldered to two spacing pieces. Whether the result of these activities is a masterpiece or a distracting eyesore will not depend on any instructions I can give here, but on the operator being enough of an artist to follow up my indications.

Where expense is all-important, a simple cloud can be contrived with the aid of a baby flood. The front of the flood is fitted with a sheet of card or stout brown paper; a small portion of this is cut out as a curved slit so that a leak of light is emitted. The lamp in the flood must be clear with a wreath-shaped filament, the image of the filament greatly influencing the shape of light leak or cloud. With a great deal of patience, careful choice of the angle of projection, and suitable tinting, a cloud which might have come from an optical projector can be produced at no cost. This result is not produced in five minutes!

Stars

It is hardly possible to suggest an Arabian Nights sky without stars. In the best circles these are produced by small 15-watt daylight blue lamps mounted behind minute holes in the plaster cyclorama. Each lamp is fitted with an individual thermal flasher, which gives a quick flicker without extinguishing the lamp. Very few such stars are needed. Five or six are worth while, and thirty, as at Stratford-on-Avon, opulent.

Where this cannot be done or where a sky alive with stars is needed, then star slides in optical projectors must be used. The slide is merely a piece of zinc in which one can punch *minute* holes to taste. These holes must be confined to the centre of the slide and a medium-angle lens used, otherwise distortion will produce stars like footballs. A tint of No. 17 or 40 will give whiteness and correct coloration.

Star slides plus a few of the flickering lamp type can look very convincing. In neither case should any real constellations be imitated. For purely decorative effects in spectacular productions, small torch bulbs sewn on to a cloth make a braver, if unreal, show.

Flames and Smoke

This effect relies on similar principles to those that are applied to clouds, with one important exception: a break-up glass is fitted to the case between the disc and the lens runners. This glass is a very slightly rolled cathedral, the object of which is to produce a swirling motion in the flames. Careful focusing is necessary to produce this motion without making the glass or the flame disc too sharp. Flames run faster than clouds and must be put on with the disc running downwards to counter the reversal of the lens. Discs are painted in colour with more or less smoke predominating; the colour can always be removed for complete smoke by suitable subtractive filters (16–8). This arrangement running very slowly has a variety of imaginative applications beyond smoke and flames.

Flames should never be thrown as a flood all over the stage, as the lack of intensity and conflicting directions imparted by the varying planes of the scenery will make the effect unrecognizable. Flame effects are better used concentrated on a small section of the scenery or cyclorama. By means of an adjustable lever shutter they can be made to spread from little beginnings. Once again they must be concentrated so as to appear intense, otherwise the effect is meaningless.

The disc rotating without the objective lens can give the effect of reflected flame on a window from a fire off stage. The same effect may be obtained by waving a bunch of ribbons in front of a flood or spot off stage, but is difficult to keep up for long.

A full-scale fire, such as the final act of Galsworthy's *The Roof*, will require many effects projectors for even a medium stage, and the expense may put this system out of court. The solution may be to rely on floods, not effects projectors. Where floods are used, the fire has literally to be played upon the dimmer board. There must be at least two sets of floods at each fire point, one of which is held steady while the other is brought in and out unevenly on the dimmer. All such floods have broken colour in them with the lighter colours in the flickering ones. Combined with real smoke from smoke boxes and puffs (see below), the results can be very exciting; above all, suitable high intensity is there.

Another flame device for those with little faith in their powers as virtuosos of the dimmer board is the revolving drum flame. In this a motor-driven drum with flame-coloured apertures revolves round a 500-watt lamp. Put close to the backcloth and mixed with steady floods the result can be very realistic. In fact, these drums, working in property beacons on the roof of Shell-Mex House, actually brought out the Fire Brigade when lit up for the first time as part of the Coronation decorations.

Smoke is produced by slow-burning smoke powder in an electrically-heated pan; the white smoke is supposed not to tickle the throat. The gadget can be hired and plugged into D.C. or A.C. mains. Smoke puffs ready fused and fired electrically are valuable in getting a concentration of smoke quickly. A flash-box fitted with a pair of terminals is also used; a piece of fuse wire is put across the terminals and covered with special powder. There is quite a variety of things in the firework line, but all have one thing in common: they may not travel in a passenger train.

For a really convincing blaze the silk flame is best. In this effect, painted silks are mounted over a blower concealed in a trap, the silk being lighted by spotlights from beneath. The flame is strikingly real, but should not be used close to actors as the breeze on their clothes will give the game away. The *Wandering Jew* at the stake in his last scene looks more cold than hot. Such executions are better off stage, as in *Saint Joan.*

Snow Effect

This is similar in operation to a cloud effect except that the mica disc is covered with metal foil, punctured with minute holes. The effect should not be used with wide-angle lenses unless it cannot be avoided. A tint of No. 17 is advisable to remove the warmth from the effect; if a wide-angle lens is used, a tint of No. 40 will counteract some of the coloration due to this lens. The effect can be used all over the stage, but the results are better if a gauze can be hung down stage. Two effects superimposed on one another are many times more effective than one. Where this is impossible, a single effect can be improved by inserting a coarse metal break-up gauze between objective lens and disc. Snow is one of the easier effects to use.

Rain

This effect consists of a disc with ruled lines and a break-up glass in front. As the disc must, of necessity, be black except for the rain scratches, there is very little light to play with. The rain must never be flooded all over the stage or used with a wide-angle lens. Best results will be obtained by locating the rain on part of the cyclorama or front gauze, the rest of the cyclorama being occupied with heavy storm clouds. Tinting with No. 17 or 40 is essential. This is a very difficult effect to use, and very often better results will be obtained by suggestion. Heavy clouds, and/or the sunburst effect (described under "Clouds") with broken Nos. 17 and 40, used from high on one side of the cyclorama, may look very impressive.

Waves

This is the one effect that is sufficiently obvious that it excites comment even when seen by itself. It consists of a rectangular box (Fig. 194) in which is fitted a stationary slide of the sea as seen from the stern of a ship. Suspended between the slide and the lens are three very slightly muffled glasses which are moved up and down in turn by a clockwork motor. The effect of these glasses is to give a rolling motion to the waves so real that many people find it difficult to believe a film is not used. The most impressive use of this effect is in *Treasure Island*, where the sea is seen over the bulwarks of the "Hispaniola." When properly done, the lanterns are rocked on special stands which give a moving horizon to the sea, and consequently the impression of the ship rolling. There are very few opportunities for this kind of thing, with the possible exception of *The Tempest.*

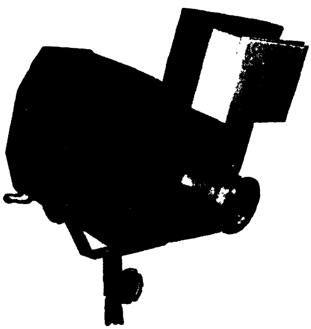


FIG. 194. WAVE EFFECT ON 1000-WATT LAMP PROJECTOR

The wave effect can be used to give small waves breaking on the shore in the distance. In such circumstances the effect (one is enough) is projected from the side on to a ground row. The shore is painted in white or near white, the sea in darker tones. The distorting glasses of the effect cause appreciable movement in the edges of the effect and the lantern can be finely adjusted so that this movement brings the sea on its down stroke over the white shore. Most realistic impressions of the waves beating against the cliffs can be obtained. The wave effect must be kept well below the horizon, otherwise there will be too much motion in the far distance.

Water Ripple

There are two forms, one of which resembles the wave in shape and is used to represent the track of the moon on the water. The other, which is much simpler and does not need an optical lantern, merits fuller description. It consists in the smaller size of a 60-watt striplite lamp with a long line filament; in front of this revolves by clockwork a small drum in which a series of irregular horizontal slots is cut. The device is fitted into a narrow box, which can be placed close to the bottom of a ground row. The result is just the right amount of water motion required to put life into an otherwise dead piece of painted water.

Other Optical Effects

These include a running water disc which by means of its turntable front can be a running river or waterfall; underwater effects, which seldom get a part except in *The Ring* and pantomime; sandstorms which have two discs running in opposite directions and are delightfully murky; a panorama effect showing trees, telegraph poles, and scenery rushing by in a manner that only suits burlesque. The Aurora Borealis also looms larger in the catalogue than the number of plays requiring this effect would seem to justify.

Lightning

A lot of fuss is usually made when this effect occurs—carbon sticks, flashing discharge lamps, and so forth. The writer is of the opinion that for most lightning cues flashing an ordinary batten, with No. 17 or 40 in it, is quite adequate. The switch of the circuit to be flashed should preferably be shunted by a push-button switch of the momentary contact type. Rocking a quick-break switch rapidly is quite impossible. An essential is that the lamps should be low wattage, not more than 150-watt, so that they will respond quickly to the push; also that the push should be kept in motion giving a flicker.

Where fork lightning must be seen, an optical effects projector and attachment are used. The attachment consists of a slide and a hand-operated disc with flicker slots. The lantern must pivot easily in its stand and the turntable front must be slack so that subsequent flashes can be rapidly placed at differing angles on different parts of the cyclorama. Considerable rehearsal must be given to this device!

Projected Scenery

Although very elaborate and expensive apparatus is used for this purpose on the Continent, it is possible, particularly on

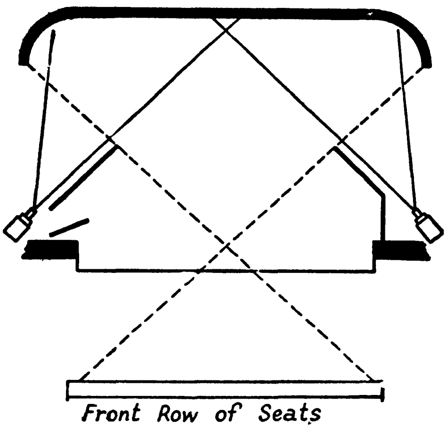


FIG. 195. PLAN: SCENE PROJECTION ANGLES TO CLEAR MASKING SCENERY AND REDUCE DISTORTION

the smaller stages, to obtain more or less adequate results from the ordinary effects projector with a 4 in. × 3½ in. slide. The production of *Julius Caesar* in modern dress early in the War, at the Embassy Theatre, transferred quite successfully to His Majesty's Theatre. All backgrounds were projected, and the transfer from a small stage to a large was compensated by a change of lamp: 1000-watt A.1 for Embassy; 30-volt 30-amp for His Majesty's. Two lanterns were employed on perch platforms, one of either side of the proscenium opening. Similar methods were used for *War and Peace* at the Phoenix Theatre.

To be successful, the essential masking scenery must be planned to allow for passage of the projection rays at a kind angle (Fig. 195). Unless this is done, not only is the distortion of the slide very difficult to correct, but also the lens can be made to focus only one part of the picture sharply. Close-range work is impossible except in the most nebulous

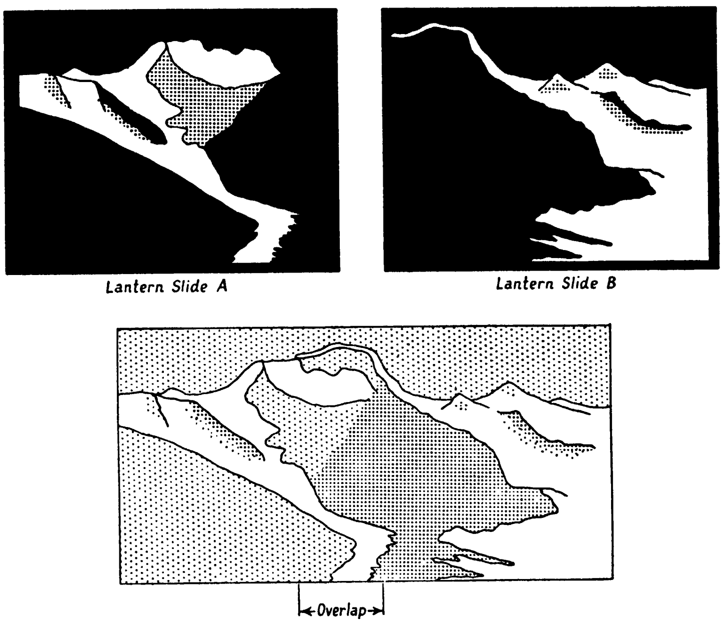


FIG. 196. SPLITTING A MOUNTAIN PICTURE ON TO TWO PROJECTORS

of designs, as wide-angle lenses will curve straight lines, except in the centre portion of the slide.

The lighting of the acting area must be kept absolutely clear of the backcloth, and footlights are out of the question. Slight tinting of the projected picture by use of the top lighting often enhances the effect.

Where two lanterns have to be used to obtain sufficient coverage, the problem of the join crops up. It is a tricky though not impossible business to make this happen behind a central column belonging to the permanent set. It is better not to rely on the projected slide for the sky, this part being blanked off with Photopak (Fig. 196). The busy part of the slides are comparatively easy to join; but where there comes an overlap or separation of plain sky the join shows very badly. The mountains, as in *Peer Gynt*, lend themselves to the omission of the sky (Fig. 197). Here the cyclorama blue at full will provide the sky, the projected slide being merely a black and white mountain pattern. In addition, the cyclorama lighting can always be tilted upwards to keep the lower part of the cyclorama comparatively dark for the projector.

Projected scenery will be at its best when no attempt is made to provide a cheap or easily changed substitute for painted scenery. As in all forms of art, the matter expressed must arise naturally from the medium used. I prefer to forget all about accepted scenery and allow the designs to evolve from the hints that the lantern will throw out if given half a chance. The following is an example of what I mean—

Slides can be made from the hundreds of moulded or patterned clear glass. Such glass can be obtained from suppliers such as Messrs. Hetley, Soho Square, London. This glass may be slightly rolled, as in cathedral glass, ribbed in various ways, or even patterned. If a piece of ribbed glass, for example, is inserted in the slide carrier and focused, a series of vertical shaded columns appears. Now place a green filter half across the objective lens and notice how the columns are now tinted on one side with green, on the other with white. The columns can be cut off as required by placing a suitable cut-out metal stencil in the slide carrier, or even by blanking out part of the moulded glass slide with paint, Photopak, or paper.

For some years I used to demonstrate a forest scene on gauzes to Wagner's *Forest Murmurs*. This scene began life as a singularly revolting piece of figured glass of fancy scrolls and thistles like pineapples. By blanking out the centre and such parts as were necessary, fitting a two-thirds 16 filter in front of the objective, and applying just the right amount of focus, tree wings with entwining boughs overhead were produced. The whole result was completely satisfying and right; yet this glass as figured glass was one of the most frightful creations I have seen. A projection such as this on to two gauzes, one 10 ft up stage of the other, might easily provide "a wood near

FIG. 197. CONTINENTAL G.K.P. PROJECTION OF MOUNTAIN BACKGROUND

Athens" (Fig. 198), as Basil Dean showed at Drury Lane in 1924.

One of the good results of basing one's designs on these glasses is that the temptation to realism can more easily be avoided. The more realistic the slides are, the more the detachment from the actor is stressed. Try a coloured photograph of

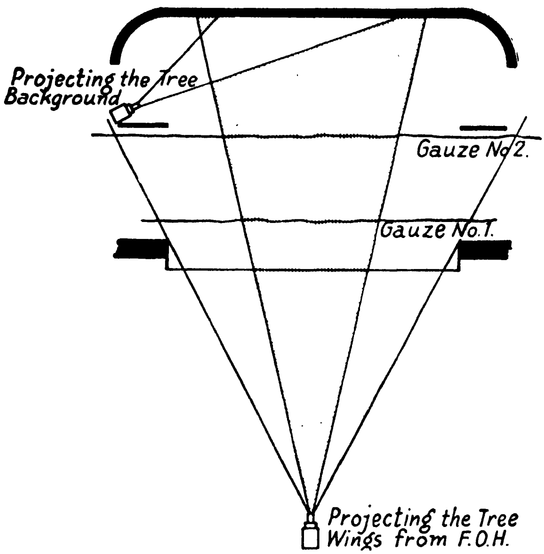


FIG. 198. PLAN: THREE-DIMENSIONAL FOREST PROJECTION USING GAUZES

Venice as a background to the *Merchant of Venice*, and it will be found that the result always stands apart from the foreground.

Another excellent result is the depth in the moulded glass projections and the way that difficulties of colouring are avoided.

The heat on a lantern slide, which may be in use for half an hour or more, is considerable, so much so that heat-resisting glass or mica slides have to be used. It is not surprising that paints and dyes fade. A blower improves matters, but is a noisy complication best avoided. Tinting by filters on the objective lens is lasting and the colours can be changed if required. It behoves us to use this method as much as possible.

On the Continent the projection equipment is basically the same as in this country but far finer results are obtained, mainly due to the careful design of the lenses and their high quality. The apparatus used costs more than ten times the equivalent article here. Probably the most famous is the G.K.P. system, but there are others. Slides are $5\frac{1}{4}$ in. × $7\frac{3}{16}$ in., used in conjunction with specially designed large-aperture lenses and motor-fed arcs or projector lamps, some as large as 5000-watt. The size and shape of many continental stages permits the projected image to be reasonably remote from the acting area and consequently the risk of spill light from one to the other is lessened.

We have to face the fact that, if scene and optical projection is to be improved in this country, then good quality precision optical systems and lenses must be used. Furthermore greater care must be taken to collect as much light as possible from the light sources. Unfortunately as more light is collected so is more heat. Chance Bros., Ltd. make a heat-absorbing glass (O.N. 20) which in 2-mm thickness transmits only 14 per cent heat for the loss of 12 per cent light. When used in a concentrated beam of light, such as that from a 2-kW lamp or from a 1-kW with a large-diameter mirror, the glass must be used in strips to prevent cracking. The protection of the slide is considerable and may make a blower unnecessary in most cases.

A possible avenue to explore is the use of EHP Mercury projector lamps for such effects as clouds where colour is not important. Concentrations of light in the region to which the eye is most sensitive can be built up with considerably less heat radiation than would result from a corresponding intensity using a filament lamp.

Once a good light source and objective lens is used the slide distortion through angle of projection is easily corrected by photographing the artist's design at the same angle; everything being scaled down. Photographic lantern slides must have their high lights cleared down to the glass, as the coating may transmit only 50 per cent of the light for whites. It may be preferable to get the artist to re-draw his design direct on the slide, using the distorted photograph as a guide.

The Linnebach lantern is a type of projector which uses neither lenses nor condensers. A large slide 3 ft square or more is placed in front of a source of light such as an arc or a 1000-watt A.1 tubular projector lamp in a black housing. The black and white or coloured design on the slide is thrown shadow fashion on the cyclorama. Projection is limited but the system has the advantage of a wide spread at short throw.

The slide and light source need not be part of the same lantern; it is possible to have a large framework 6 ft square or so of wood and cinemoid built in the wings or behind a translucent screen. The shadow of this is projected by one or more lanterns with or without lenses depending on the degree of definition required. The lanterns can be moved about in the

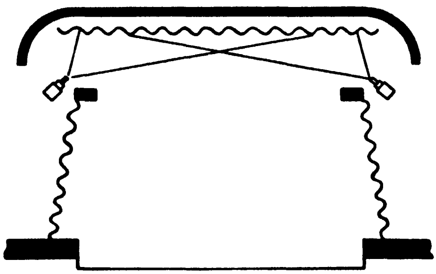


FIG. 199. PLAN: PROJECTION OF PATTERNS ON PLAIN CURTAINS

wings, faded in and out, singly or in combination and thus different aspects are projected. The term "Penumbrascope" has been applied to recent manifestations of this principle which differs little from Figs. 188 and 207 except that the object of which shadows are thrown is out of sight instead of in view on the stage.

Projected Curtain Patterns

Another use for figured glasses (above) is for curtain patterns. Most amateurs rely very much on hessian, and every now and then comes the feeling that although the plain material can be beautifully lighted, the period really demands a patterned hanging. Hessian can have two figured glasses projected, one from each side of the stage, in slightly differing light colours. Or if the pattern is not to be too recognizable, then different glasses are used. The resulting effect is extraordinarily rich and does not betray its origin. Furthermore, the curtain will stand a fair amount of spill light. The patterned light must come from the sides and pick up the folds, not flatly from the front as is frequently done in the cinema. The self-same curtain can appear in another act as a plain and completely different material (Fig. 199).

Visions and Picture Effects

Reference has been made to theatrical gauze (mosquito netting) as a surface for projection of optical effects. This gauze has the facility of appearing solid when lighted from the front and of vanishing altogether when scenery or actors are lighted behind it. The secret of success in these vision effects is that the fogging front lighting must be so placed that it does not pass through the gauze to light the regions beyond; similarly no light on the vision must be allowed to strike the gauze. A common mistake is to use a magazine batten and footlight to fog the gauze; naturally this light penetrates and no end of difficulty is experienced in getting the vision to disappear. Except on large stages it is essential to use narrow beam floods and focus lanterns both for the gauze and vision.

Properly done, the gauze and vision will, in their turn, vanish absolutely. The best general purpose colour for gauze is grey, and this can always be painted with a design. Sometimes gauzes are used one behind the other, the second being a few feet up stage of the other. The second should be white to make up for transmission through the first; a different size mesh is needed unless watermark effects are intended. Gauzes may be hung in folds, though these will not vanish altogether. Ethereal effects are obtained by side-lighting the folds of one gauze behind the other with, perhaps, a blue-lit cyclorama in the background. The effects in Figs. 200, 201, and 206 are produced from the same gauze setting with different lighting.

By using a slightly fogged tight gauze down stage of the actors a two-dimensional effect can be produced. The eye is deceived into considering everything beyond the gauze as on its plane. It is as well to remember that though a vision may be perfectly "disappeared" when still, an actor taking up his

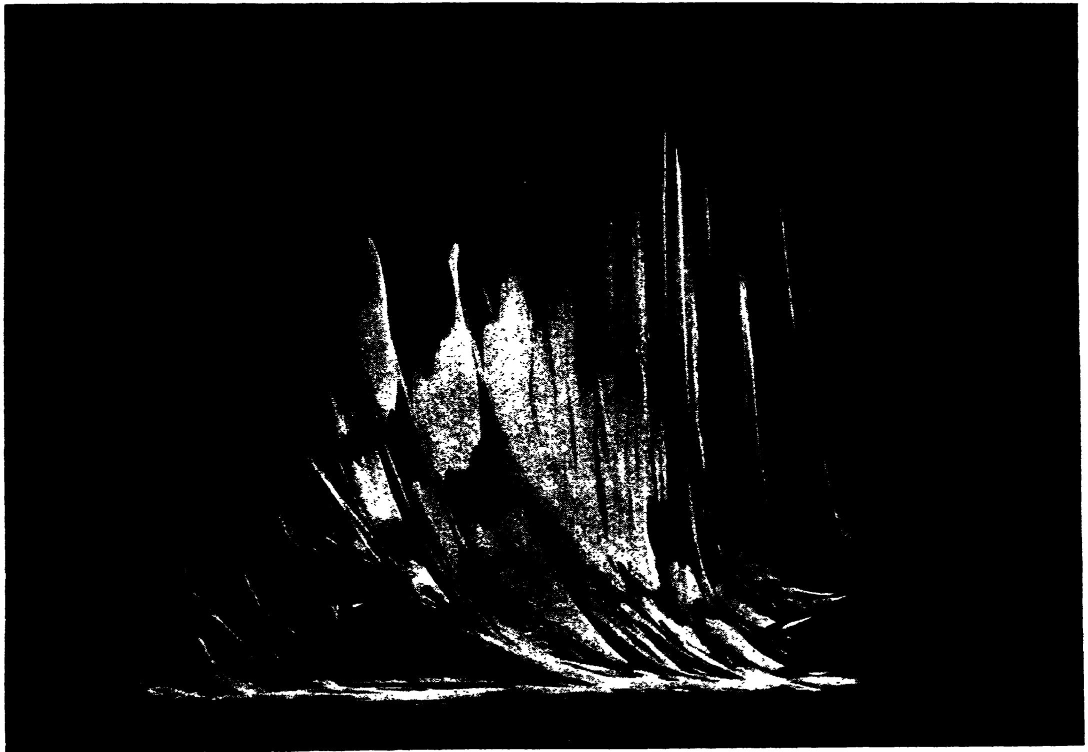


FIG. 200. GREY GAUZE WITH ARCHED CUT-CLOTH BEHIND (SEE ALSO FIGS. 201 AND 206), FRONT AND REAR TOP LIGHTING

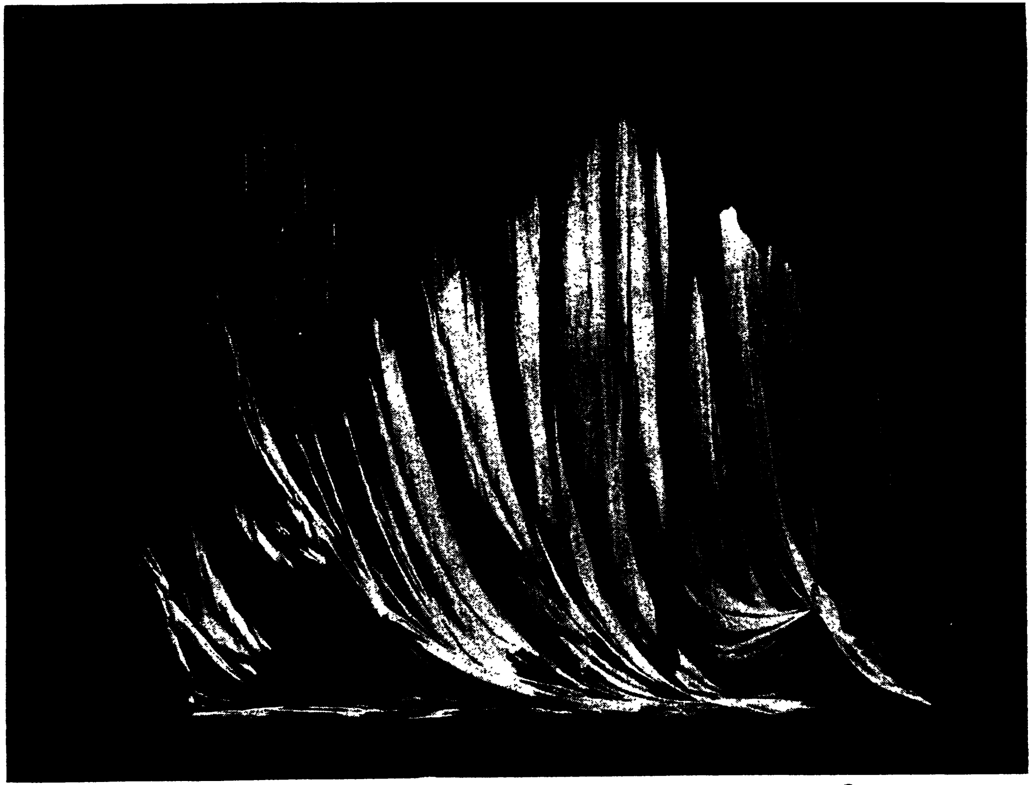


Fig. 201. Grey Gauze (as Figs. 200 and 206), Rear Top Lighting Only

position may by his movement betray his presence. To be absolutely safe, a black velvet curtain should hang behind the gauze until the revelation is to take place.

Fluorescent Effects

Visions, ghosts, and the like can easily be produced with the aid of the invisible ultra-violet rays on fluorescent paints and make-up. However, such effects more easily become, by their close resemblance to the accepted ghost, a burlesque rather than a horror. The spectre with his head tucked underneath his arm and a rapier through his chest (possible under U.V.) is far less likely to terrify than a normal being, slightly abnormal in a way that the mind can only feel but not recognize.

When illusions are contemplated, the stage must not be flooded with a high level of ultra-violet, as this may bring into prominence the natural, if low intensity, fluorescence of many materials. The skeleton that dances, throwing away his bones, one by one, until he vanishes, will require a black-draped stage and black tights to which the fluorescent bones are hooked. One 125-watt lamp in the footlight for a small stage and two for a large will be ample. The skeleton's routine must be arranged so that under no circumstance does a limb from which the bones have been removed pass in front of those that remain.

Another illusion is the reverse of the preceding effect: in this the scenery is treated but the actor is not. For *Golden Toy* at the Coliseum before the War, the setting included a great fluorescent archway flooded by lamps in the footlight and overhead, and backed by a black velvet sky.

In this instance Lupino Lane ran on stage in a pool of ordinary spotlighting, climbed up a fluorescent rope, hanging from the arch, out of the pool of light and thereupon vanished. The Indian Rope Trick!

Fluorescence need not be restricted to the supernatural; as a decorative effect it can be very striking. The treated surfaces, appearing as actual coloured light producers, not reflectors, give extraordinary rich luminous colours. For these decorative effects the higher the ultra-violet intensity the better—three or four lamps in the footlights and U.V. floods overhead.

When treating scenery and costumes, the best effects are obtained on white materials. The surface requires to be slightly absorbent but not too much so; blanket-like materials will eat up the precious liquid. The other extreme, a polished surface, must also be avoided, as there will be nothing to key the liquid and it will rub off. Doping on a large scale is an unpleasant and tricky business which amateurs are well advised to entrust to firms specializing in this work.

An interesting application is the use of a fluorescent screen for optical effects projection. A 125-watt black lamp is used in place of the usual projector lamp; the invisible light passes through the slide and is focused by the objective lens. The light remains invisible until it strikes the fluorescent screen; there are no rays to betray the source of the projection. So far this form of projection has been confined to exhibition work.

The Samoiloff Effect

This relies on the use of complementary colours and is so called after its inventor. As we discussed in Chapter VII, a lantern fitted with a blue-green filter does not transmit any light wavelengths that can be reflected from a red surface; it therefore appears black. Under the red light there will be little colour contrast, and so the reflected colour will be interpreted as a reddish white. Now, suppose an actor is made up in red and wears a coat of black and blue-green stripes: under the red light he will appear as a white man in a black coat; under blue-green light as a black man in a striped coat.

Any pair of complementary colours can be taken from the colour wheel in Fig. 114, but the filters and pigments must be perfect. There are other factors to consider. For example, at first sight yellow and blue complementaries may seem to be more pleasing, the yellow being more nearly white, but under the blue light the black effect does not get a sufficiently strong contrast. Powdering on top of make-up must be in the same colour as the grease-paint; there is a lot to be said for liquid make-ups.

Of course, the colour change need not be sudden; the changes from winter to spring or summer are easily performed on dimmers. The backcloth must be painted with black tree trunks, red flowers, green leaves, and so forth. Beginning under blue-green light, the scene appears in black and white, colours being spoiled either by absence of their colour in the light or by absence of contrast. As red is gradually added to the blue-green, these defects are remedied and spring arrives!

Adrian Samoiloff did not discover complementary colours: his title to inventor rests on his being the first in Great Britain to get their "stunt" value exploited on the stage. His first production was *Round in Fifty* in 1922 at the London Hippodrome, and was, apart from the effects, notable as representing the beginning of magazine battens in this country, in order to obtain the necessary colour purity.

CHAPTER XIV

COLOUR MUSIC: LIGHT AS AN ART

So far stage lighting has been discussed as an accompaniment to normal theatrical activities. Sometimes it is given quite a minor role, merely to illuminate actors and scenery; occasionally it gets a big part, and even the actors play a secondary role for a moment or two, then some feel that stage lighting is capable of such powerful expression that it cannot always be expected to remain the slave of the theatre. Just as the piano can forsake accompaniment for solo work, alone or with orchestra, so one day we may expect solo lighting.

As a matter of fact, solo lighting is no longer a novelty, and it is the object of this chapter to trace the two lines of development: the one based on special instruments which are often analogous to musical instruments, the other, based on the growth of the stage lighting installation into an expressive medium. I also wish to show that the practice of this art of light ("Colour Music" as it is usually called) is not restricted to expensive and elaborate instruments; any one with access to a stage or model theatre with more than one dimmer can derive benefit and enjoyment from the training it gives. Indeed, many people do practise this art without being aware of it, largely because the title "Colour Music" is rather unfortunate. "Colour Music" suggests a preoccupation with Colour to the neglect of Form, and with Music to the extent of preferring aural analogies to the all-important visual appeal.

History

The historian of Colour Music is Adrian Klein, and the third edition of his book gives a complete survey of what was done to 1937, various theories and inventions being described in detail. This being so, I shall content myself with but the briefest outline of pre-1937 happenings, and devote this chapter mainly to post-1937.

The first man actively to do something towards providing a visual counterpart to music seems to have been Father Castel, who wrote on the subject and constructed an instrument, or, at any rate, a model, which was finished in 1734. Altogether, his was a considerable contribution at a time when all the dice were loaded against him. Writings and musings intervene, and the next important event was a private concert, given in the old St. James's Hall, in 1895 by Professor A. Wallace Rimington. Over a thousand people attended by invitation. Two public performances followed, and the music was provided by piano, organ, and an orchestra. The programme included Wagner's *Rienzi* Overture, two Chopin preludes, and the Bach-Gounod *Ave Maria.* The instrument was taken on tour, but Rimington, like all exponents in this art, seems to have suffered from sensationalism and showmanship, which get between the serious experimenter and his public. Professor Rimington wrote a book on Colour Music, and since then there has been considerable sporadic activity, mainly in America.

The first full score to carry a part for colour organ was Scriabin's *Prometheus* (*The Poem of Fire*), but as colour organs are rare, it has probably received fewer than half a dozen performances with this part played. It seems to be generally agreed that the colour does nothing whatever for the music and vice versa! My own reactions in 1937, when I gave a performance (perhaps the first in this country) of the colour part, were entirely in accord with this verdict. Scriabin, of course, suffered more than a handicap in the fact that he was composing for an instrument which did not exist, and, therefore, had to rely entirely on theory without a single practical experiment to go on. Mr. Klein himself has spent much time in practical experiment in the art, and had constructed, in 1921, an elaborate spectrum projector operated from a keyboard. Eventually, in 1933, a recital was given on this instrument, accompanied by the organist, as an interlude in the normal week's programme at the Finsbury Park Astoria.

Other important events in the history of colour music were the two recitals given by Thomas Wilfred, at the Queen's Hall in 1925, but these can more conveniently be referred to in detail later in this chapter. Another name has to be mentioned, that of Mary Hallock Greenewalt, who seems to practise extensively in America, but whose work is quite unknown in this country.

The Music-colour Analogy

Many experimenters have been attracted by analogy to music, some having stretched analogy so far as to try to make a keyboard for visual wavelengths equivalent to the piano-keyboard for sound wavelengths. Others admit the impossibility of this, but still try to build, somewhat vaguely, on musical rather than visual foundations, such things as chords, keys, and so on receiving first place instead of form. Some of the experimenters concern themselves too much with inventing new theories instead of basing practice on the results of trial and error. All are inclined to rate colour alone too high.

The first difficulty the analogists had to cope with was the absence of any equivalent to the musical octave in light. Various compromises have been arrived at; in a common one, the spectrum is taken to extend over one octave and the exact colour to be ascribed to each note varies among inventors, but we may take it that *C* will be some kind of saturated red and that the other notes will run, in order, to *B*, which is a violet. This colour octave consists of saturated hues, and the remaining octaves, to provide the equivalent of a piano or organ keyboard, are repeats of the same colours, brighter towards the treble and darker towards the bass. This, although providing an interesting keyboard, is a big departure from truth, a musical equivalent being a single-octave organ keyboard with the swell shutters progressively opened for each octave from bass to treble.

However the single octave provides all kinds of other difficulties. The spacing allocation of colours to twelve keys in the octave cannot be analogous to the musical principle of equal temperament because, roughly, four of the keys would be red, and all the other colours of the spectrum would have only eight to share. Assume that the problem is settled, strike two of the colour notes—red and green—and the result is equivalent to the single yellow note between them—a result with absolutely no counterpart in the musical octave. Strike a chord in the light octave, and the result is effects which may be a washy white or a dubious pink, and so on; the corresponding effect in music is a rich sound compounded of the notes of the chord.

To overcome this chord trouble the analogists put forward various arrangements for showing the colours that make up the chord as patches of colour side by side. The moment this is done the all-important factor of form is in question and it is no longer possible to concentrate on pure colour. If the patches are horizontal, there may, at times, be suggestions of natural phenomena, such as the horizon between sea and sky. If vertical, then there will be architectural associations. Then, again, how can the colour patches be the same size, since optical illusion always makes a red patch look smaller than an equal blue one viewed simultaneously? A good example of this illusion is the French tricolor with its vertical bands of red, white, and blue, which have to be in the proportion 37, 33, and 30 to appear equal to the eye.

To the analogist any kind of suggestion other than that given by the colour itself is anathema, and he gets into great difficulties. How can there be reconciliation of the fact that a gradual change via all the intermediate colours is a most pleasing method of changing from red to yellow, whereas in music sliding from one note to another can be excruciating, except in rare instances? The reverse is equally troublesome; the detached notes of music are seen as a tiring flicker.

Translating Instruments

It is not only the most incorrigible analogists who expect one man to play the piano or organ, the instrument translating into light the music. I have so often been asked to do this that the matter must be disposed of here and now. We have seen that there is no direct analogy to the musical octave, and that, therefore, either the instrument would have to translate into different terms the music being played on it, or a separate keyboard be fitted so that the musician could play both parts. The first idea is to expect mechanism to paint a picture, which,

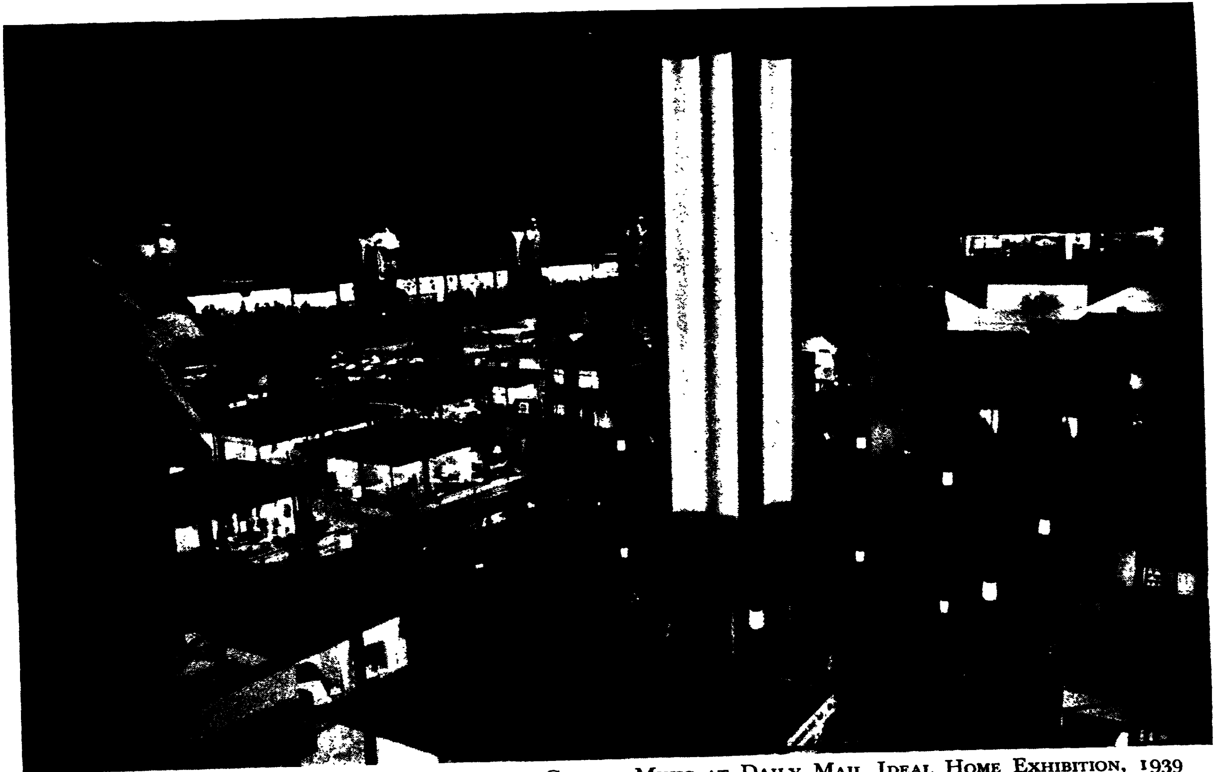


FIG. 202. 70-FT HIGH ILLUMINATED TOWER FOR COLOUR MUSIC AT DAILY MAIL IDEAL HOME EXHIBITION, 1939
Organ and light consoles are at the edge of the Pool to the left of the tower.

even if it is to be painted in light, is still absurd; the second overrates the powers of the musician. Playing the piano or organ is a full-time job, and so is playing a light score. It would be quite easy to plan and build, say, a four-manual organ—"choir," "great," "swell," and "colour"—but no man could play it.

Whatever light instrument or colour organ is evolved, the question of duets between the light organist and the sound organist at different instruments, which may perhaps look alike (Fig. 202), will arise. Further, the music must not be limited to organ or piano; the orchestra has far more to offer the colour organist.

The Visual Approach

Purposely discarding all question of analogy and special instruments, some visual equivalent to the emotional effect of the music can be sought. Since the stage or theatrical type of installation is already expressive to a certain degree, this equipment is ready for experiment, and may as well be used. The mixing of coloured light with dimmers upon a cyclorama can be made to correspond to change in music. Six dimmers and the three primary colours, top and bottom, would easily interpret, albeit without frills, Elgar's *Chanson du Matin* and *Chanson du Soir*. There is quite a deal of sunrise and sunset music, and, apart from colour, the gradual crescendo of light or diminuendo gives an overall pattern to the rendering which is important. Other compositions, perhaps similar to Herbert Dawson's organ record of Easthope Martin's *Evensong*, with a crescendo in the middle, can be tried. The six circuits will be found to be expressive, especially in music of a cool meditative kind which is not at variance with the sky so readily evoked by a cyclorama.

The next stage is to try the complicated layout required by a white or grey curtain: at least top, bottom, and side lighting to bring out the folds. If the curtain is muslin, backed at a distance of six or seven feet by a black curtain, a set of lighting at the rear can also be used (Fig. 203). The more lighting equipment, the more expressive, but also the more difficult for the novice; cyclorama and simple curtain lighting must be mastered first. The curtain lends itself to Wagner Preludes—Act I of *Lohengrin* and the *Parsifal* preludes—and a great deal of music. So far these colour-music experiments could quite easily be performed on any stage-boards, provided there is some view of the stage and the installation is not too large. The results are satisfying to the player, and quite entertaining as an interlude or a curtain raiser in a theatre or cinema programme.

The cinema has given this form of colour lighting, as with its organ, a bad name through sheer incompetence on the part of performers. Even where a musician has been in

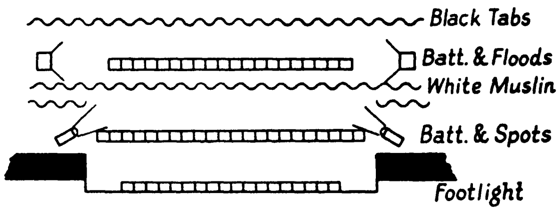


FIG. 203. PLAN: LIGHTING FOR WHITE MUSLIN CURTAIN

charge of the organ, the lighting of his interlude has been left to any one to work, even in many instances to some sort of automatic or semi-automatic dimmer. The operator who needs a machine to do the mixing of colours he has not bothered to learn will have no contribution to make to this art. The auditorium of a cinema, such as that at the Davis, Croydon, or New Victoria, London, has too much character of its own to allow anything more than pretty or decorative effects, but plain curtains on the stage do permit considerable range, as has been seen. The organist should, of course, be out of sight until the end of the number; the last hopes of this were removed when the cinema owner was persuaded to part with extra £ s. d. for an illuminated console. With an organist jabbing out at any stop key to give his console a colour, with a man on the limelight picking out the keyboards in another colour, and with a third man manipulating the footlight and batten, colour music is more than beyond reach. Yet there are hundreds of cinemas which could stage such interludes without any additional equipment, and with merely a few gramophone records for accompaniment. Owing to this abuse of lighting installations it would be difficult to get the public to take a real interest in colour music in the cinema: transplant the display to the theatre, the exhibition, or the public gardens, announce it properly, and they attend.

That this is so was proved by a curtain raiser of colour music put on at the Princes Theatre, Bristol, in 1934. The display lasted, roughly, fifteen minutes, and took place on a simple grey curtain, down stage of the set for *Ten Minute Alibi*. Thanks to the imagination of the manager and of L. G. Applebee, who designed the installation, I was able to enjoy the experience of trying a lighting solo on a theatre audience. Because it was properly featured, the "show" gained considerable applause, and had to be repeated for the whole week instead of for the first two nights as intended. Yet the equipment used (and certainly the hired curtain!) had nothing that could not be found in any up-to-date cinema. In 1933 a similar interlude was presented during matinees in the temporary theatre at Radiolympia, to be followed later by the first of colour music interludes given occasionally on the cyclorama in The Questors' Theatre, Ealing.

No special switchboard was used for any of these items, that at the Princes being a Grand Master of seventy ways, of which a dozen or so were brought into play, that at Radiolympia a 24-way temporary liquid dimmer board, and that at Ealing a home-made flexible board with liquid dimmers. Rather more space has been given to these humble experiments than they would seem to warrant, but it is desirable to counter, again and again, any impression that Figs. 202 and 207 might give as to the need for elaborate equipment. I can only quote experiments for which I personally was responsible, but there can be little doubt that, lost among the orgy of colour lighting in the cinema, there may have been other serious experiments. This book is mainly restricted to experiments and practice in Great Britain, but both on the Continent and in America there were also developments, two of which, the Clavilux and the Paris fountains, are very important.

The Clavilux

The most original contribution from America is that of Thomas Wilfred, who experiments under the auspices of the General Electric Company over there. His recitals in Queen's Hall, London, on a portable model of his instrument, created considerable attention and much favourable comment; nevertheless, his ideas were not taken up here. Briefly, the instrument was based on optical distortion of lamp filaments, and he could literally paint the screen with moving and dissolving abstract shapes. The results rather resembled the beautiful growing effects of the water bath slide into which dyes are dropped (sometimes seen in panto), but, of course, with the great difference that the effects were at all times absolutely under the control of the operator at his keyboard, and could grow and diminish at his will. It is strange that nothing more of Wilfred's work has been seen or heard of in this country.

Fountains: Paris, 1937

Illuminated fountains provide a fine field of experiment, especially when the jet arrangement under the control of the operator is variable. At the 1937 Paris International Exposition, apart from the various automatic-change water displays, there were two big displays. One consisted of jets arranged over a considerable stretch of the Seine and controlled from a panel in a boat. The other, known as the Théâtre de l'Eau, consisted of a jet arrangement on three barges, the control desk being in a restaurant on the opposite bank of the river. Only the wealthy patrons of the restaurant got music with their fountain, the general public outside taking it silent. The general effect varied between a liquid Crystal Palace and a pine forest; tall jets could be sent up or a water mist spread over the barges. To run up three tall jets, changing colour to full white when at their fullest extent, to hold them a moment and then to cut the lights and jets, the water crashing down in the darkness—this combination of lighting, variable in colour and direction, plus the variable jets of water, is thrilling indeed.

The Seine display was more diffused, but had the advantage that all could hear the music from loud-speakers which floated on the river. Special compositions were commissioned, and smoke and fireworks sometimes accompanied the water and light.

At the British Empire Exhibition at Glasgow the following year there were many illuminated fountain displays and cascades, but all were dumb and automatic: there was not the slightest hint that anything had been learnt at Paris. The World's Fair, at New York in 1939, carried on, albeit rather extravagantly, where Paris left off. Is it too much to hope that the 1951 Festival of Britain in London will see something more

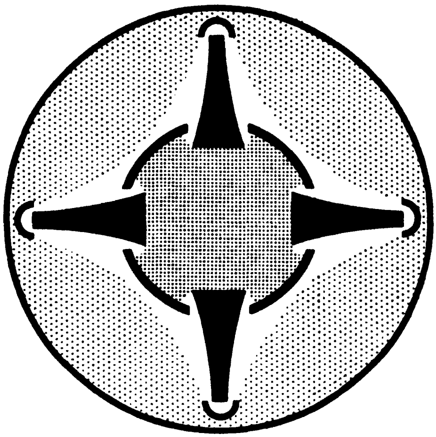


FIG. 204. PLAN OF TOWER IN FIG. 202
White areas represent lighting.

than mere pretty automatic fountain changes? The apparatus exists—we only need the imagination!

The Kaleidakon

In 1939 a display of colour music was staged as the central feature of the *Daily Mail* Ideal Home Exhibition, at Earl's Court, *at the request of* the organizers. A 70-ft tower stood in the pool (Fig. 202), and the lighting was played from a Strand Light Console, the music coming from a Compton electrophonic pipeless organ with a similar console. The tower was shaped as Fig. 204 on plan, and was split vertically into three divisions. Thus, the stops at the console read: Top Inner and Outer; Centre Inner and Outer; Bottom

Inner and Outer. Each of these groups was in the three primary colours with double blue, duplexed on both manuals, providing thirty-six stops at the console. The manual keys were divided to bring in the left circuits, right circuits, or both together. This amounted to seventy-two dimmer ways individually controlled, and many of these consisted of several dimmer plates ganged together, as the loads were heavy. The total on the tower was 230 kW or 1000 amps, a load which, if desired, could be flashed as rapidly as the fingers could move the keys. The combined sound and light was christened the Kaleidakon (not by me) and had a month's run—three twenty-minute recitals daily. The device suffered from two handicaps. The first was my serious illness which made it impossible for me to play or even to see the combination, yet at that time I was the only person who could claim to be a virtuoso of the console. The second was the fact that between the recitals an automatic drum unit was made to operate a cycle of colour change on the tower. I had fully intended that this device should break down at the first possible moment, never to function again. Needless to say, the fact that the attractions of colour were paraded at all times greatly lessened the impact of the recitals. An equivalent setback would have been given the organist if continuous organ music records had been relayed between shows. At Paris no such errors in showmanship were made; the fountains of the Seine and Théâtre de l'Eau remained dark and silent until the appointed hour. The organist was Quentin Maclean, and the double task of supervising the installation and playing the console fell to Bernard Bear. He later shared the task with Paul Weston, whose speciality was "hot numbers"! A signature tune *Home Sweet Home* had to be played, and this, plus the ordinary exhibition lighting which remained on, made any subtle approach out of the question.

The Light Console Society

Following the completion of the first demonstration model of the Light Console in 1936 colour-music experiments took place almost continuously up to the outbreak of the Second

Great War. Most of these experiments were items in the regular stage-lighting demonstrations to customers, parties of students, and so on. More important were the colour music recitals given to the same audience, known as the Light Console Society, at intervals for two years. Here it is necessary to record appreciation of the Strand Electric directors' attitude

FIG. 205. DEMONSTRATION THEATRE (1939) DESIGNED BY THE AUTHOR FOR THE STRAND ELECTRIC AND ENGINEERING COMPANY

in allowing full use of the company's demonstration theatre (Fig. 205) out of business hours, and in meeting the Society's expenses.

Playing to the same audience each time overcame the novelty factor. Almost any one could stand and, perhaps, enjoy one show, however peculiar, from curiosity; to attend regularly was quite a different matter. New items were not the rule, the more successful going into the repertory for repetition at subsequent recitals. After a while there were invaluable discussions with an audience that had developed a critical faculty towards the new art. Some works were written down in a light notation, and the rudiments of a colour music library founded. This *single volume* was blown up three years later. The console was recovered from the ruins of the theatre, and has been used as a stage-board in the London Palladium ever since. A list of the music, gramophone records set to light, is given in Appendix VI. White muslin curtains, gauzes, black curtains, cyclorama realistic sets, and three-dimensional abstract settings were all used as a basis on which to perform the lighting variations. Occasionally, collaboration with dancers was tried, as, for instance, with Lydia Sokolova and her pupils. In March, 1937, the Scriabin *Poem of Fire* was attempted.

Lisbon, 1941

The export of a complete stage installation to the National Opera S'Carlos, Lisbon (*Frontispiece*), with console control, provided an opportunity to give colour-music recitals to invited audiences of six to eight hundred persons at a time. Although the scenery available was slight, being merely a set of white translucent curtains, neutral masking flats for the wings, and an inclined plane for the cyclorama base, all the lighting equipment of a modern opera house could be brought to play upon it. Added to this were the great advantages of a wide proscenium opening, a permanent white cyclorama, and a delightful auditorium, old but beautifully restored. The console was placed in the centre of the orchestra, and the music came from gramophone records, so the show was the lighting, and nothing else. Altogether, this was a most enjoyable experience for me, with the exception of one uncomfortable occasion when my usual set of the *Unfinished Symphony*, conducted by Sir Henry Wood, got replaced at the last moment by a version by Weingartner. A further experiment tried during a choral and orchestral concert was to change the lighting on the rear curtain between pieces to suggest their mood. The lighting remained static during the actual playing.

Settings for Colour Music

It will now be clear that without waiting for the invention of special apparatus any one who has access to a stage installation can take up the art of colour music, and in so doing will not only gain, and perhaps give, pleasure, but also obtain a new insight into the visual and emotional effects of light and colour. Whether the stage installation is part of a model theatre or a giant "affair" with light console will not affect the basic principles. In many ways the beginner will find the limitations of the former an advantage; the vexed problem of when to flash in rhythm does not crop up, simply because the board will not allow him such refinements.

Earlier, simple lighting on plain white muslin curtains or cyclorama was considered. The next stage is to try a setting suggestive of the theme or prevailing mood of the particular music and to play the lighting as variations on this theme. A beginning can be made with the muslin curtain. If this is made very full, with a chain along the bottom, and lowered to drag the stage floor by two or three feet, it can be draped in a variety of ways. By throwing the chain about the floor the curtain can take up expressive folds that are quite different from the usual regular folds or draping. Something similar can be done to gauzes, with the further advantage that the folds of the front gauze can conflict with those of the rear gauze, and even with those of the backing curtain. Any set or combination of folds can be revealed at the will of the lighting operator. Fig. 206 shows two gauzes and a cut-cloth backed by black velour curtains, lighted by spots under traps in the stage: other views are given in Chapter XIII, Figs. 200 and 201. Only the lighting is changed for the three views. The setting is one used for all movements, except the last, both in the Stravinsky *Firebird* and the Moussorgsky-Ravel *Pictures from an Exhibition* suites. Curiously, both these had the same setting, five absolutely plain columns against the cyclorama and its inclined plane, for their final movements, *Berceuse and Apotheosis* and the *Great Gate of Kiev*, respectively.

Another form of setting is shown in Fig. 207. This is particularly suitable for shadow work in front of the cyclorama, broken colours being used in most of the shadow lanterns. The advantage of this set is that it is built from the shapes in Fig. 208; as they are geometric they can be arranged to give a variety of three-dimensional formations. A turntable, or

Fig. 206. Grey Gauze (as Figs. 200 and 201) Rear Bottom Lighting

Fig. 207. Three-dimensional Shadow Setting and Cyclorama Background for Colour Music Played on the Light Console in the Foreground

revolving disc stage, is convenient to vary the aspect slightly; for example, in each movement of Tchaikovsky's *Fifth Symphony* (the ballet *Les Présages*). The shapes are painted black one side and grey or buff the other.

Realism of a not too flagrant kind can often be employed, as for Mendelssohn's *Fingal's Cave* overture, Rimsky Korsakov's *Scheherazade*, and, to a lesser degree, for Wagner's *Flying Dutchman* overture. Generally, however, abstract setting is to be preferred, and comes more naturally to player and audience. The reverse seems to apply to film colour music, the abstract sequences of Walt Disney's *Fantasia* being the least satisfactory

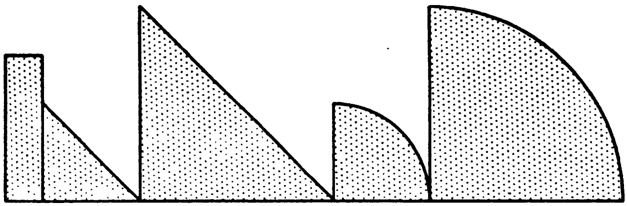


FIG. 208. COMPONENTS OF THE AUTHOR'S UNIT SETTING USED IN FIG. 207

and the majority of the music resolving itself easily into figures, leaves, animals, and so forth.

Expressive Powers of Lighting

It is now necessary to consider the expressive powers of the lighting, and in the more elaborate settings, direction is more important than colour. On the plain cyclorama, colour is all there is, but otherwise form becomes more and more important. The lighting is placed to give the fullest expression of the directional variations of the setting, and it will be found (fortunately) that there is no need to provide every colour from every direction. Great care must be taken that as a crescendo is built up, adding lantern after lantern, colour upon colour, it does not result in flat lighting, nondescript in colour. Some powerful directional lantern in white must be kept, as with the organist's chorus reed, to top the climax: the general mass of lighting full up from everywhere is able, thereby, to have form.

The colour filters depend more on the composer of the music than on where the composition is supposed to be set. The colourful East of Rimsky Korsakov and Delius are by no stretch of imagination the same thing. What colour level to employ must depend on one's feeling for the composer, unfortunately influenced more than a little by the fact that one knows his nationality.

The lanterns being coloured up, the playing has to be attempted. Movement of the lighting almost always takes place but must not be regarded as an end in itself or as inevitable; it may well be that some composition is better served by static lighting or a slow crescendo only. The emotions, not pre-conceived theories, are the best guide. If a piece of music makes you feel ill, the lighting should reveal this. Similarly something that seems to be funny may be underlined so that the audience actually responds with laughter; but the music should not be guyed.

Outright laughter at musical humour is rare, but combine light and music from the light console and spontaneous laughter are usual. I shall not forget the thrill of trying a humorous accompaniment to the jazz classic *Twelfth Street Rag* and finding that the audience thought it as funny as I did. Hot rhythm, putting in the beat, the breaks, and whatnot, has universal appeal, even in the august precincts of the Lisbon Opera House. Walton's *Façade* suite is an obvious subject for this kind of treatment.

Music that does not give emotional or dramatic leads had better not be attempted—in early days of the art, at any rate. Bach, Haydn, Mozart, and Beethoven should be left alone; there are plenty of others—one day, perhaps, there will be our own composers. The emotions are easily interpreted in colour and direction, but are really beyond explanation in a short chapter. The truth is that if the intended colour musician, after hearing *Valse Triste* a few times, has not the faintest idea where and with what colour to begin, he had better retire from colour music, and, I am afraid, stage lighting as well. Of course, the accompaniment will not come right first time; even simple pieces will require much rehearsal until they suddenly connect, the lighting is composed, and future repetition will bring scarcely any detectable change.

It is important that the lighting should develop an overall shape as the changes follow one another; merely to chase the music will bring no satisfaction. The light composition must get somewhere; in the movement of a symphony the various lighting themes will return again and again, just as do their musical counterparts.

The decision has to be made whether a particular piece of music is to be closely followed or followed in intention only. Close accompaniment, hanging on to the various entries, and even applying rhythm and beat, will not worry most people, for this requires an instrument such as the light console. To flash or not to flash? As a matter of fact, leaving dimmer movement for flashing need not be emphatic. The dimmers can be rocked up and down on the clutches or the circuits flashed to full-on or blackout while the dimmers are at some intermediate position. For instance, with the lights held by the dimmers at 80 per cent, flashing to full-on will not be so bold as when the dimmers are 0 per cent. Compositions such as Gigout's *Organ Toccata* will all be flashing of various kinds, the rapid toccata being played continuously on the battens and footlights while the slow theme is put in by the other hand on side floods. Both are made more or less emphatic by movement of the dimmers over which they are being flashed.

Colour Music and the Ballet

There are limits to the extent to which lighting can pursue the dance rhythms in music, and as the art of the ballet is ready to hand, a little co-operation would appear to provide the solution. Of course, there is the obstacle of reconciling the views of the dancers who see everything in terms of the dance. And the light organist? No! I do not think he will be difficult; he has not had time to develop a tradition.

The symphonic ballets of Massine come to mind as most needing the aid of light which is played. Of these, the obvious one for treatment is *Choreatium* to Brahms's Symphony No. 4. To me the music of this symphony is a blend of the danceable and the opposite. Every now and then the music soars away from the puny figures on the stage, and all the "elevation" in the world cannot follow it; here light takes over in realms of which it is master. In such a manner the dance and light would be able to assist each other where they are not at ease.

It is not only symphonic ballet which would gain from lighting that is played, not worked, but, once again, there should be no fidgeting and lighting should not be kept on the move purely for the sake of movement; there are many ballets where static lighting "full-up white" has a bigger contribution to make than all the colours and movement.

It is important, in suggesting what might be done with light in ballet, not to neglect what has, in fact, been done, and at a time when light was by no means as tractable as now. A woman, Loie Fuller, seems to have been the first to realize the potentialities of light in this connexion. What is far more important, she succeeded in putting her theories into practice, and toured the world, bringing to the public something that represented real pioneering. Dancing in muslins and gauzes illuminated in moving colour from arc spots, often lighting upwards through traps in the stage floor; shadow effects; projected effects—she used them all. If, as often happens, we find the new effect of which we are proud has been done years ago, it is likely that Loie Fuller and her electricians were responsible for its creation.

Instrumental Colour

In the past there have been, as described earlier, many attempts to associate colour with particular musical notes or keys. After playing for some years, I do find in close fitting a heavily orchestrated piece, for example Siegfried's *Funeral March*, that certain colour correspondences with timbre appear. As it is customary to talk of colour in instrumentation, I append my notes for comparison with those of others. The list may be of interest since it brings out my feeling that colour cannot be disassociated from form, even when considered as vaguely as this.

The brass seems to occupy the red to yellow part of the spectrum; the strings, green to blue; the woodwind, violet and the mixtures of red and blue outside the spectrum. Thus, a tuba is a flood of deep orange, a horn deep amber, a trombone amber, and a trumpet a shaft of amber or yellow. The Bach-Handel trumpet becomes a thin shaft of intense yellow. The violas and violins are floods of various greens, with the addition of blue and white to give texture. They become whiter as they soar. Solo violin is a shaft of colour, the cello is a flood of blue-green. The woodwind is localized, red for oboe, mauve to violet for clarinet, and blue for flute.

That too much reliance cannot be placed on the above is shown by the fact that, played with the orchestra, a piano will probably appear as one tone colour only, whereas by itself it might evoke the whole gamut.

In conclusion, I must stress the need for *intensity*, in reserve for climaxes maybe, but it must be there. Colours and light low in tone give the visual equivalent of listening to music with cotton wool in the ears.

The Future

It is sometimes argued that an art of mobile light ought to arise without musical accompaniment. I tried this on the Light Console Society, and the result was uncomfortable. Even in the silent cinema, where the realistic nature of the films made no great demand on the audience, to take the vision cold was an ordeal. No doubt in time there will be more original composition, with light accompaniment in view, and we shall no longer be compelled to practise on music that was never intended for such treatment. One would be rash to prophesy the lines on which future development of this art will take place; with the growth of television the need for visual accompaniment to music will become acute. Therefore once we have colour television, colour music is bound to follow, first as a novel stunt but later more seriously, and ultimately it will take its place alongside aural music and the visual arts.

CHAPTER XV

THE ELECTRICAL INSTALLATION

THIS chapter is the only chapter in this book that requires of its readers some technical knowledge of electricity and its installation in buildings. Those to whom it is Greek, should, after reading the chapter, hand it over to someone who understands the technicalities, probably to the wiring contractor or the electrician. However, the uninitiated are not advised to skip this chapter, as there is much in it of general interest.

Modern electrical supplies must be taken seriously; the danger of shock (often fatal) and fire is considerable. Even though a kind dispensation will exempt the private membership theatre club from many exacting regulations, readers are advised to obtain a guarantee from the wiring contractor that the permanent wiring (as much as possible should be permanent) is carried out in accordance with the latest edition of the I.E.E. regulations and the L.C.C. regulations. Furthermore, all temporary wiring for particular productions should be under the supervision of someone who really *knows* what he does.

Electrical Supply

It is probable that this will be 400 volts three-phase four-wire, and, of course, all lighting will have to be treated as single-phase two-wire supplies. Whenever possible, the stages of schools, and other places where unskilled persons are likely to be much in evidence, should be fed from one phase. The supply company may have its own ideas, but as anything but a paper balance is impossible in theatre lighting, the safety factor warrants some latitude in this matter. Where the stage load is small (40 amp), it can be balanced against that of the auditorium and the rest of the building. Larger stage loads will have to be balanced on three phases; the stage floor on Phase A, the hanging equipment on Phase B, and the rest of the building on Phase C. Stage installations that approach the professional theatre in scale will have to be balanced over three phases.

It is essential that the whole of the stage floor plugs shall be on one phase; many trailing leads will have to be plugged up and lanterns shifted in a hurry and, perhaps, in the dark. This means that the hanging equipment and any stage lanterns out in the auditorium (F.O.H.) must be balanced over Phases B and C, which, in itself, provides a clue when three-phase balancing is advisable, for, usually, it is only the lavishly equipped stages that provide a load of twice that of the stage floor for the hanging and F.O.H. equipment. It is safer not to interlace the phases in the hanging equipment, Phase B being hanging equipment down stage and F.O.H. lighting; Phase C all up-stage hanging equipment. It is highly desirable that a multiple earthed neutral system be used.

Stage Wiring

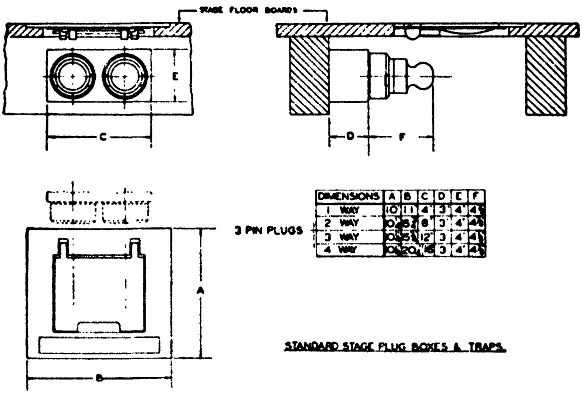
This does not differ from standard practice, except that in many ways it is simpler, concealment of the conduits and trunking on the stage side of the proscenium being unnecessary in most cases. No wiring can be run on or in the back wall of the stage. It is a good idea to use a system of troughing with removable lids (such as that made by Power Centre, Ltd.) for stage wiring, since this will permit the inevitable alterations in stage layout from time to time. The larger installations will have a separate intake the stage side of the proscenium arch.

Fusing

All stage-lighting circuit fuses must be mounted on, or adjacent to, the stage board. It is preferable for the phase fuses to be mounted on the front of the board itself by the dimmer handles or, at any rate, in some easily spotted relationship to the dimmers. Neutral links or fuses can be mounted either at one end of the board or on the wall. When neutral fuses are needed, they should be loaded somewhat in excess of the corresponding phase fuses. However, it is to be hoped that the neutral fuse will soon be obsolete. Good quality fuses are essential, since "dead short" circuits are not uncommon on the stage. On remote-controlled dimmer banks and contactor panels there is a risk of fuses shaking out of their holders; a fuse such as the Slydlock avoids this trouble. See also Figs. 213 and 214.

Plugs and Sockets

On small stages all individual pieces of lighting apparatus should be connected by plugs and sockets near the apparatus



DIMENSIONS	A	B	C	D	E	F
1 WAY	10	11	4	3	4	[illegible]
2 WAY	[illegible]	[illegible]	8	3	4	[illegible]
3 WAY	[illegible]	[illegible]	12	3	4	[illegible]
4 WAY	[illegible]	[illegible]	16	3	4	[illegible]

FIG. 209. A METHOD OF MOUNTING STAGE PLUGS AND TRAPS

concerned. One size, either 5-amp or 15-amp B.S. three-pin, should be adopted throughout, thus making all apparatus interchangeable. Even the stage floor plugs (known as dips) should conform to this size. The outsize plugs beloved of the professional theatre have nothing to recommend them.

Dip plugs consist of two or more plug sockets mounted on a box underneath a trap in the stage floor; the plugs are mounted as in Fig. 209 to prevent dust collecting. For circuit identification colours are often used; a definite sequence should always be employed, as, for example, if plugs were mounted in fours (known as four-colour dips) paralleled up and down stage, the order reading Down stage to Up would be white, red, blue, green. The access traps in the stage floor must be robust and free-moving; when closed, there should be slots for the cables. The small plug sockets, each with its individual sprung brass lid, are not the slightest use on the stage. Contrary to the I.E.E. regulations, even on D.C., plug sockets must not be switched other than at the stage board: L.C.C. regulation 83 J provides for this exception. If metal access traps are used, care should be taken to see that they are not earthed or connected to any metal part of the electrical system; the wooden stage floor can insulate them. To earth the traps would spoil the all-over safety factor provided by the wooden stage floor.

Hanging Battens

The floods, spots, and other pieces of lighting equipment seldom hang singly, but are usually grouped into what are known as battens. Battens may consist of a single unit of magazine equipment, running the whole width of the stage, or of a bar carrying a mixture of individual floods and focus lanterns, commonly known as a spot batten. Even magazine battens are seldom unbroken, but split into sections with spots or acting-area floods in between.

On small stages (Chapter XI, Examples *A*, *B*, *C*, and *D*) a batten will hang immediately behind the proscenium opening and another six or eight feet from the back wall. The simplest of fixings is all that is called for; it is not necessary to fit a means of raising and lowering the lighting battens on this size of stage, access being easy with the aid of a pair of steps. A length of slotted angle-iron bracketed from the proscenium will allow lanterns to be bolted in various positions. In this case the plugs feeding the equipment can be mounted on the strip of troughing or conduit carrying the wiring. The actual batten will be as long as the proscenium opening.

On larger stages a framework or grid should be built up by means of three or four 1½ gas barrels or R.S.J.s, running up and down stage. To these, pulleys can be fitted both for lighting and scenery suspension, the suspension wires being made off to winches on the side of the stage. In this case the various lanterns are clamped to a 1½ gas barrel, which may be internally wired in Rockbestos heat-resisting cable; at the outlets

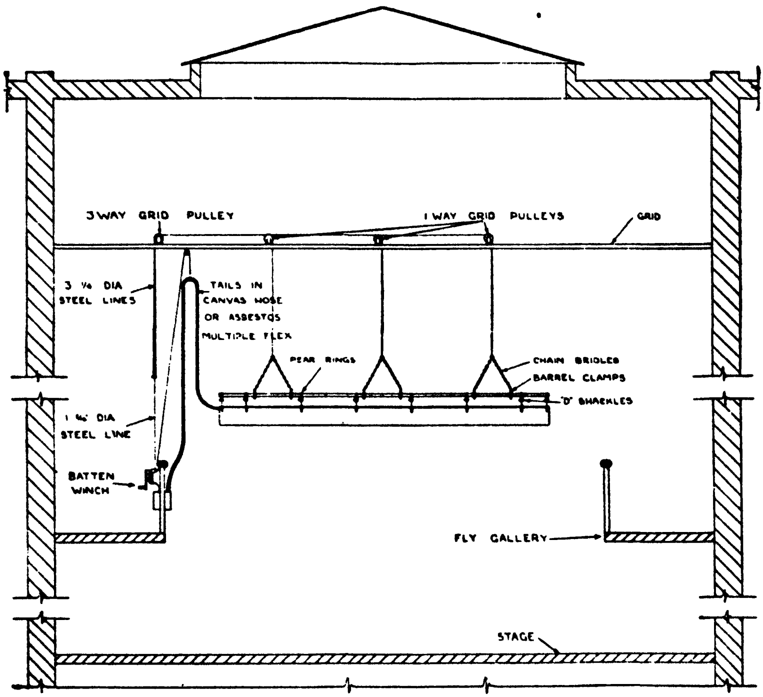


FIG. 210. A METHOD OF HANGING A LIGHTING BATTEN

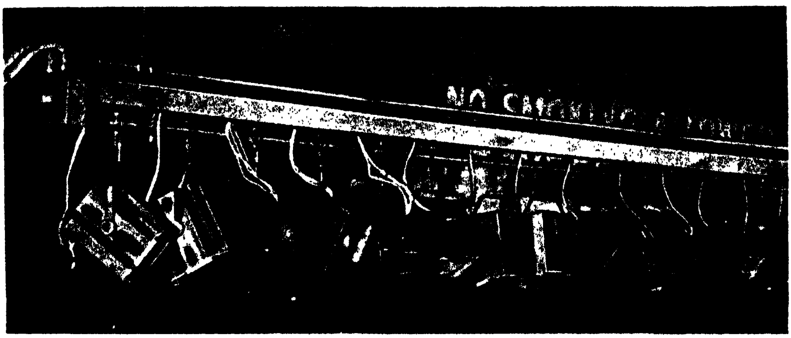


FIG. 211. PART OF SPOT AND FLOOD BATTEN

Using trunking for the wiring as there are more than 14 circuits which can be got into a 1½-inch gas barrel.

15-amp. connector plugs are fitted to join up to the lanterns. The Rockbestos wiring terminates at one end of the barrel (depending on the position of the switchboard) in a connector box. From this connector box special stage multi-core asbestos-covered cable runs in canvas hose to a connector box on the stage wall, and thence in conduit or troughing to the stage-board (Fig. 210).

It is worth while to observe the extra complication in wiring that is necessitated in making the hanging lighting or battens movable. Where expense is important, it is well to avoid movement, especially as small stages are usually limited for height and must have as much as possible for their scenery. Where there are many circuits, troughing has to be carried along the top of the gas barrel (Fig. 211). Magazine battens have their own wiring troughs built in as part of their construction, (Fig. 212). Owing to their special character, they do not need to be fed via plugs interchangeable with the rest of the apparatus.

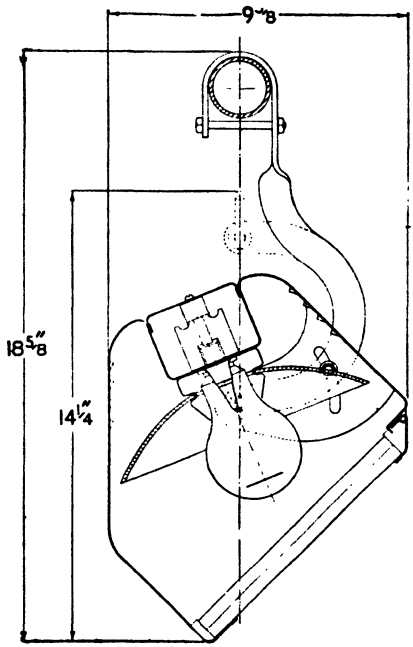


Fig. 212. Section of 150-watt Magazine Batten showing Wiring Trough

Where the stage has a scenery grid (Chapter XI, Examples *F* and *G*) with counterweight lines, the lighting battens are fixed to the barrels of the counterweight sets. It is better not to clamp the lanterns direct to the scenery barrel, but to give them their own barrel, which is, in turn, attached to the scenery barrel. Apart from the question of an internally-wired barrel, this arrangement is far more flexible, since it renders the transfer of the lighting batten up or down stage easier, in cases where brailing is not possible.

Dimmer Board

All dimmers must be wired in the phase or live side. The regular practice in the past of putting them in the neutral is inexcusable. Switches (not always fitted to stage-boards) are usually left on, and working takes place on the dimmers; if, then, the dimmer is in the neutral, a stage hand may receive an indication by the extinction of his lamp that its plug socket is dead, when in reality it is fully alive. Fusing is as Fig. 213 for single circuits and Fig. 214 for more than one circuit to a dimmer.

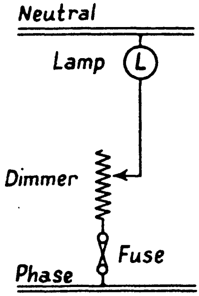


FIG. 213. FUSING FOR SINGLE CIRCUIT

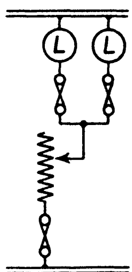


FIG. 214. FUSING FOR DOUBLE CIRCUIT

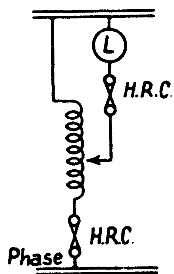


FIG. 215. FUSING FOR TRANSFORMER DIMMER

Where auto-transformer dimmers are used, it is also essential to see that the return side of the lamp circuit is connected to the neutral, otherwise the "lights out" position of the auto-transformer will correspond to phase on both pins of the plug. Also, fuses should be inserted between the winding and the phase line, and not between it and the neutral (Fig. 215). The use of auto-transformers for *any purpose* is prohibited in the L.C.C. and some areas; and special application for permission for each installation has to be made. A double-wound transformer is too expensive and bulky in size.

Although deliberate short-circuiting of resistance dimmers is common in stage work, it is, of course, impossible to do this with auto-transformers. The principal delay in their application to lighting has been caused by the need to avoid short-circuiting even one turn of the winding. This has led to the designing of all sorts of patent brushes to the wiper arms, the commonest being a long thin carbon brush; another is a split brush joined by a resistance.

The smaller dimmer boards may be fed from an ironclad switch fuse on the adjacent wall; the larger ones will be fed through a sub-main board somewhere out of earshot of the auditorium. This sub-main board is usually supplied by the manufacturers of the stage-board as a complete unit, with busbars, fuses, and contactor switches appropriate to the scheme. In a large layout this unit might include also the electrical master dimmers remote-controlled from the board above.

As indicated in Chapter V, installations where expense is an important factor may have two or three times more lighting circuits than there are dimmers. In such cases not only will the stage end of all circuits finish in plug sockets, but also the switchboard end will consist of male plugs. Whether all these plugs and sockets will be 5- or 15-amp two-pin plugs will depend on the size of stage; but in most schools and amateur stages circuit loads of over 500 watts are uncommon and the top limit would be 1000 watts. It is obviously wasteful where money is "tight" to fit 15-amp plugs on a board containing, say, five 500-watt dimmers and one 1000-watt. Whenever possible, inter-plugging flexible boards should be on one phase only, but where two or more have to be used, the plugging panels must be designed and placed so that plugs are only interchangeable between members of the same phase group.

Some boards are made so that the dimmers can be removed from the front, thus obviating the need for rear access space (18 in.). Occasionally, the smaller boards are mounted on roller tracks to pull forward for access to the dimmers.

Switches

On the stage and the stage-board, switches must be as silent in action as possible; on A.C., slow break can be used. Two-way-and-off switches must be of a type that can be changed over rapidly from one way to another to avoid flicker. The intermediate "off" position is of comparatively little importance. The Wylex is an interesting switch for the blackouts on the smaller boards. This is a slow-break A.C. switch of remarkably small dimensions—a 30-amp double-pole $2\frac{1}{4} \times 2\frac{1}{4} \times 1\frac{1}{8}$ in. deep and a 60-amp D.P. $2\frac{1}{4} \times 3\frac{1}{8} \times 1\frac{1}{8}$ in. deep. Being slow-break, the switch is silent in operation and is, therefore, valuable on the stage.

Cables

Flexible cables must be three-core, and those used on the stage floor must be surrounded by a heavy covering. Workshop flex is not really suitable; a special variety, known as Stage Flex (Cargo Flex) is available, or heavy C.T.S. is often used. Twisted (maroon) flex common to domestic installations is not permitted. The flexible cables are most vulnerable on the stage and should, therefore, be of the finest quality possible.

For connecting movable battens a special multi-core flexible, obtainable in sizes up to 25-core, is used. The component wires are either 70/0·0076 or 110/0·0076, and are numbered for identification. The whole is in an outer protective casing of asbestos braiding.

Stage Pilot Lighting

This falls into two groups, the "maintained lighting" and the "working lights." The former remains "on" during the show, and on a small stage will probably consist of only four points, all heavily shielded (the transformer lamp units of war-time blackout memory are excellent). Two are fixed well clear of the stage on each of the two stage-side walls, one for the stage manager's corner and one for the stage switchboard. The "working lights" are for scene changing, and on a small stage will consist of a couple of lamps in conical metal shades hanging over the middle of the stage.

The larger stages will need more extensive working lighting. Where magazine battens are installed, often some of the compartments are reserved for this purpose, or, better still, an extra lamp holder is fitted in some white compartments. These circuits are fed from a separate switch fuse on the main intake board, local switches being placed in convenient positions; those for the stage working lights (or batten pilots) in the stage manager's corner. In this corner the dis-board for all stage-maintained lighting is aptly placed; switches *in series* with the local switches would enable the stage manager to douse all offending lights during dark scenes.

The main aim of the lighting described in this paragraph is twofold; first, to provide some light for working during the day, without going to the stage-board; second, to enable scene shifters and actors to move during the between-scenes period, when the actual stage lighting may be blacked out preparatory to being reset for the next scene. There is nothing more annoying to the operator of a flexible board than cries of "Lights" when he is in the midst of a complicated bit of plugging. Buildings to which the public are admitted will have to provide "Secondary Maintained" lighting points, some of which will have to be on the stage. Whether these points are "wax nightlights" or "battery points" will depend on the scale of the enterprise; they really ought to be fitted, even when the theatre is beyond the reach of the regulations. The dislike of an audience for sudden darkness is not dependent on whether they are the public within the meaning of the act.

Auditorium Decorative Lighting

This is best controlled from dimmers on the stage-board. Independent dimmers are pleasant, but where there are probably more deserving claims on the cash, a simple change-over switch will allow one of the stage-board electrical master dimmers to double this part. Auditorium lighting must be fed independently of the stage blackout. If the blackout switch is also the board isolator, the live auditorium dimmer must be prominently marked and the frame painted, preferably red.

Signals

Some signals are essential, but nothing elaborate need be attempted. The system is best fed off a small 12-volt transformer; buzzers and a small lamp are required for each position. The lamps are switched from miniature switches in the stage manager's corner to the opposite side of the stage: where there is a large stage, stage manager to Left stage, Right stage, Stage-board, Orchestra, and so on. A buzzer to some salient position in the auditorium, with a return buzzer to the stage manager, is handy in getting the production under way at the beginning and after the intervals. There are times when, for amateurs at any rate, it is tactful to postpone curtain rise for a minute or two. A simple battery telephone is a good investment between these two points.

The circuit, Fig. 216, is commonly used in the theatre where acknowledgment of the signal is required. Many of the points have buzzers, and the cue board of a West End theatre

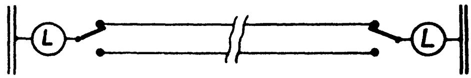


FIG. 216. CIRCUIT FOR REPLY AND CALL SIGNAL LAMPS

may become quite large. Nevertheless, the practice must always be to use the cue board only when it is absolutely necessary, the staff taking their cues in preference from what they can see. They ought never to degenerate into mere automata responding to the stage manager's lamps and buzzers.

Auditorium Spotlights

When these are fixed, for example, on the front of the circles, in small groups of three or so, it is customary to surround them with perforated or expanded metal cases, generally painted gilt. I have even seen single lanterns with a tray underneath. The object of such accessories is obscure; perhaps they are intended to interpose their own graceful lines between the eyes of the audience and the lanterns within, or, maybe, the spotlights are considered liable to explode into many fragments of broken glass. This practice is nonsensical and aggravates rather than ameliorates the eyesore. Many lanterns reasonably neat in appearance are obtainable.

An obvious precaution is to see that a heat-resisting lens is employed; usually these are standard, but confirmation should be sought; the next thing is to make sure they cannot fall out, whatever happens. For the actual suspension of the lantern, the provision of a lantern fixing, as unlikely to collapse as the ceiling or anything else over the audience's heads, is an elementary matter.

These remarks do not rule out the provision of fibrous plaster housings for concealment of lanterns. Such housing would naturally be planned as an integral part of the decorative scheme when new work was contemplated. These housings have the merit of being silent in action. The heating and cooling of a sheet-metal box containing twelve 1-kW spots can be very noisy. Ventilation is important, as the heat given off can be objectionable, optically and physically, to the occupants of the circle.

Contractors' Label

It would be handy to place a label prominently on or near the stage-board. This label would bear the name, address, and 'phone number of the contractor and supply authority, also other useful details in large letters:

Supply. 230-volt A.C. 50-cycles.

Batten plug sockets are 5-amp B.S. three-pin.

Stage plug sockets are 15-amp B.S. three-pin.

This would prevent a lot of confusion when additional apparatus was purchased or hired.

Maintenance

The permanent wiring installation will have to be examined and tested regularly once a year. In addition, the lanterns, lamps, flexes, fuses, dimmers, etc., should be examined at frequent intervals. Apart from safety, this practice helps to prevent lamps going out for any reason during the show. All apparatus, the invisible as well as the visible parts, must be kept clean. This is frequently neglected, even in the case of reflectors and lenses where the need for cleaning is obvious. A film of dust will change the characteristics of a reflector and lens, reducing the light transmitted and also acting as a diffuser.

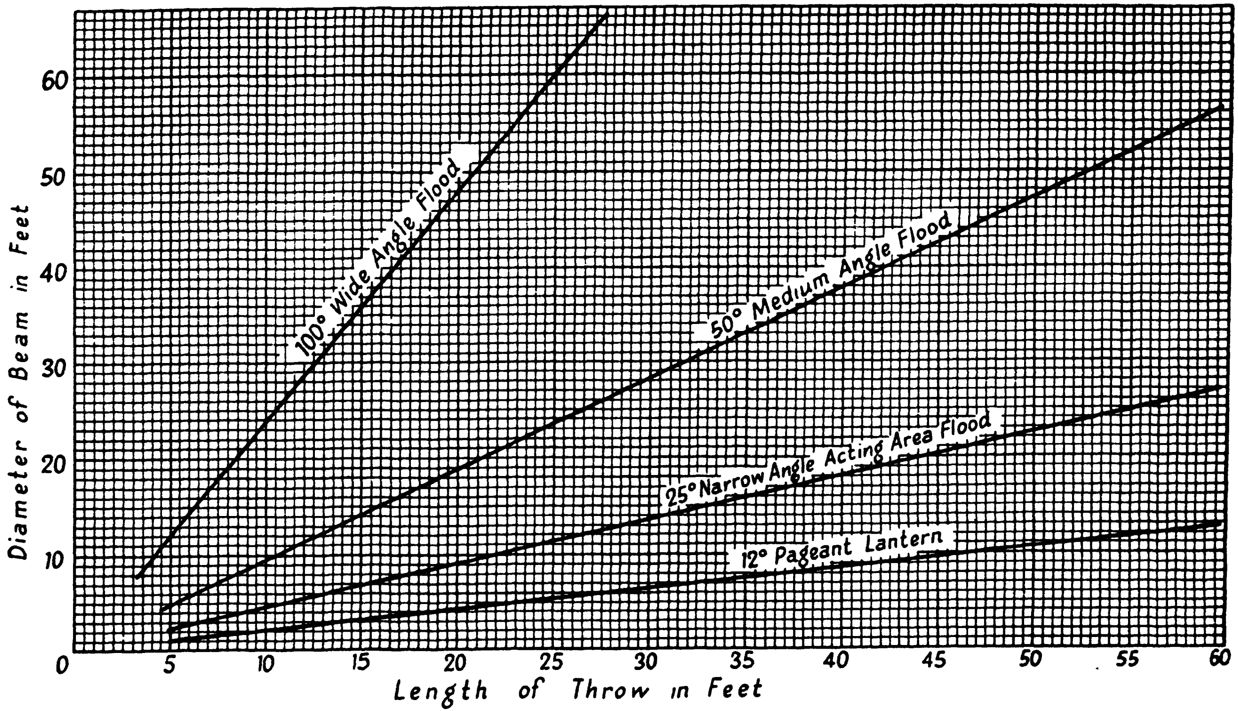
It is a commonplace to see the house staff hard at work every day polishing the brass in front of the house, while inside the theatre the lighting apparatus gets attention only once in six months. It is impossible to overstress the inconsistency of this. The installation of elaborate high-efficiency equipment is pointless unless it is properly looked after and used. The apparatus, like the artists, must be at concert pitch. Equipment which is uneconomic to maintain and clean is better not purchased.

All reflectors, lamp bulbs, and colour filters should be dusted and polished once a month. Once every six months at least the lamps and reflectors must be removed and washed in soap and water, dried, and polished.

The silvering on reflectors in the higher-power mirror spotlights should be examined. Depending on the amount of use, they may require re-silvering every two to three years.

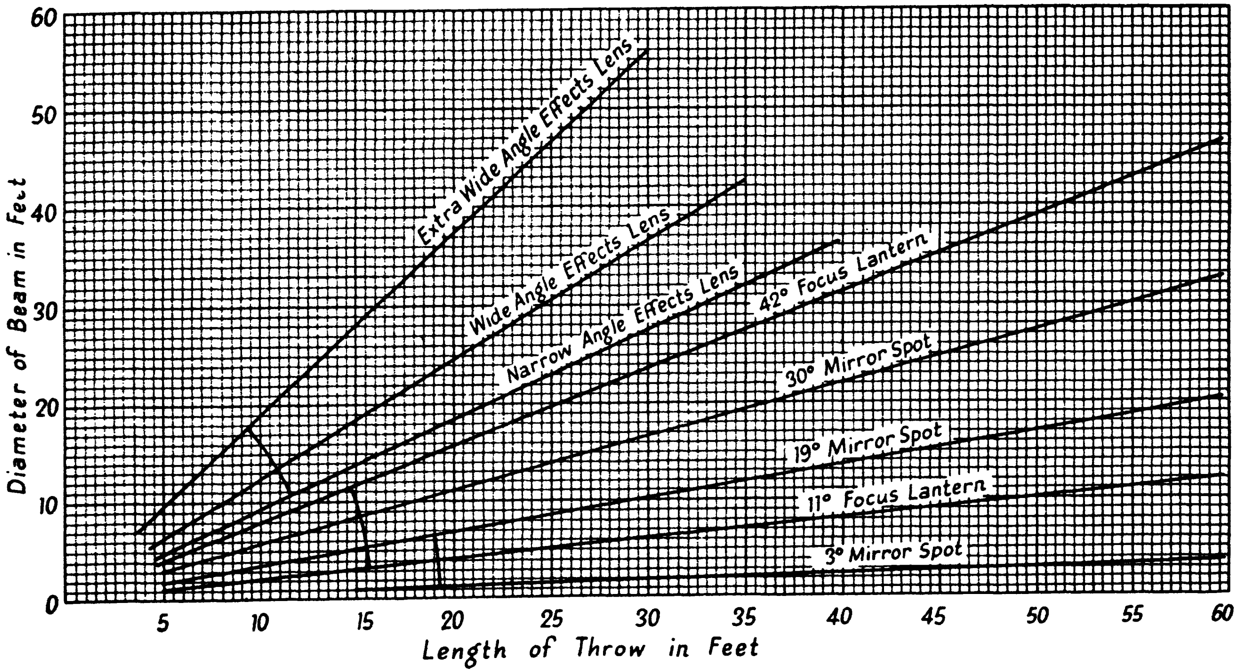
APPENDIX I

Coverage of Fixed Beam Floods



APPENDIX II

Coverage of Focus Lanterns and Spotlights



APPENDIX III

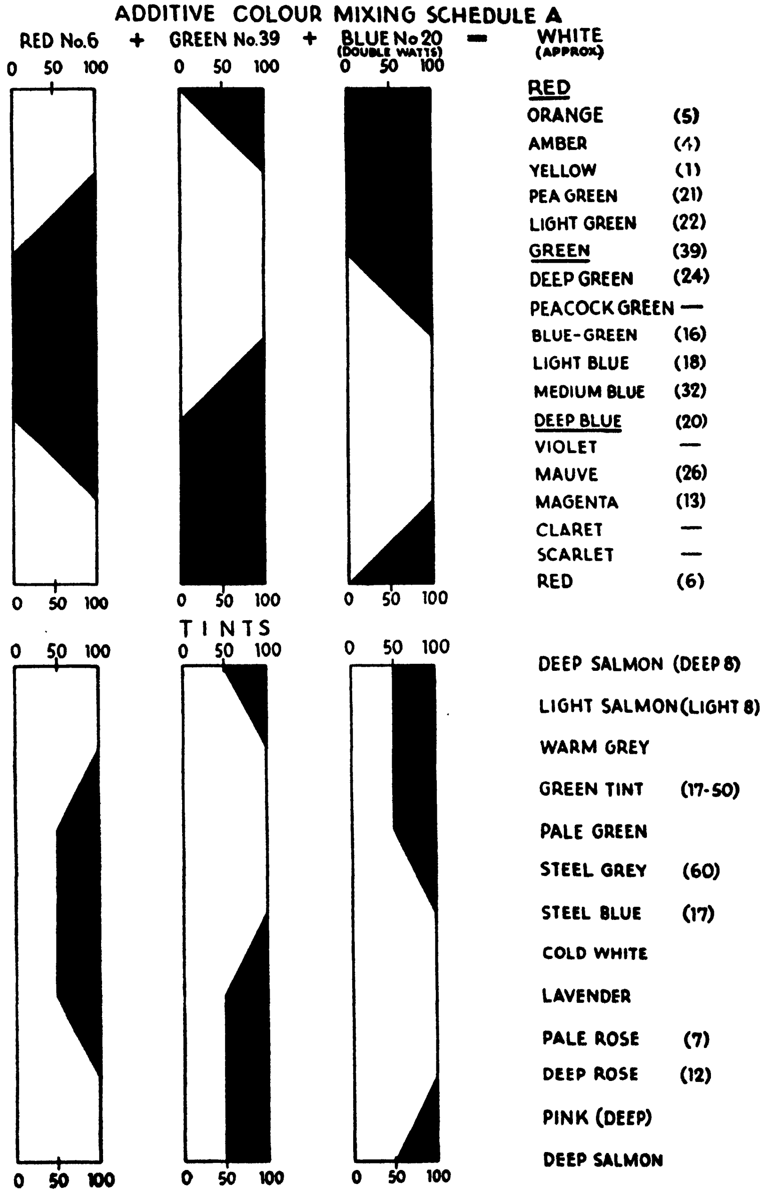
List of Standard Stage Filters (Strand Electric) in Colour Order, as in the Chart, and Numerical Order for Reference

WHITE	Clear	30
	Light Frost	31
	Heavy	29
YELLOW	Pale Yellow	50
	Yellow	1
AMBER	Straw	3
	Light Amber	2
	Medium Amber	4
	Deep Amber	33
	Salmon (Amber-pink)	8
ORANGE	Orange	5
	Deep Orange	5A
PINK	Gold Tint	51
	Pale Gold	52
	Pale Salmon	53
	Middle Salmon	9
	Light Rose	7
	Pale Rose	54
	Lavender (Surprise Pink)	36
	Middle Rose	10
	Dark Pink	11
	Deep Rose	12
	Magenta	13
RED	Red (Primary)	6
	Ruby	14
	Mauve	26
	Purple	25
BLUE	Steel Blue	17
	Pale Blue	40
	Light Blue	18
	Medium Blue	32
	Dark Blue	19
	Deep Blue (Primary)	20
	Peacock Blue	15
	Blue-green	16
GREEN	Pea Green	21
	Moss Green	22
	Light Green	23
	Primary Green	39
	Dark Green	24
NEUTRAL	Chocolate Tint	55
	Pale Chocolate	56
	Pale Grey	60

1.	Yellow
2.	Light Amber
3.	Straw
4.	Medium Amber
5.	Orange
5A.	Deep Orange
6.	Red (Primary)
7.	Light Rose
8.	Salmon (Amber-pink)
9.	Middle Salmon
10.	Middle Rose
11.	Dark Pink
12.	Deep Rose
13.	Magenta
14.	Ruby
15.	Peacock Blue
16.	Blue-green
17.	Steel Blue
18.	Light Blue
19.	Dark Blue
20.	Deep Blue (Primary)
21.	Pea Green
22.	Moss Green
23.	Light Green
24.	Dark Green
25.	Purple
26.	Mauve
29.	Heavy Frost
30.	Clear
31.	Light Frost
32.	Medium Blue
33.	Deep Amber
36.	Lavender (Surprise Pink)
39.	Primary Green
40.	Pale Blue
50.	Pale Yellow
51.	Gold Tint
52.	Pale Gold
53.	Pale Salmon
54.	Pale Rose
55.	Chocolate Tint
56.	Pale Chocolate
60.	Pale Grey

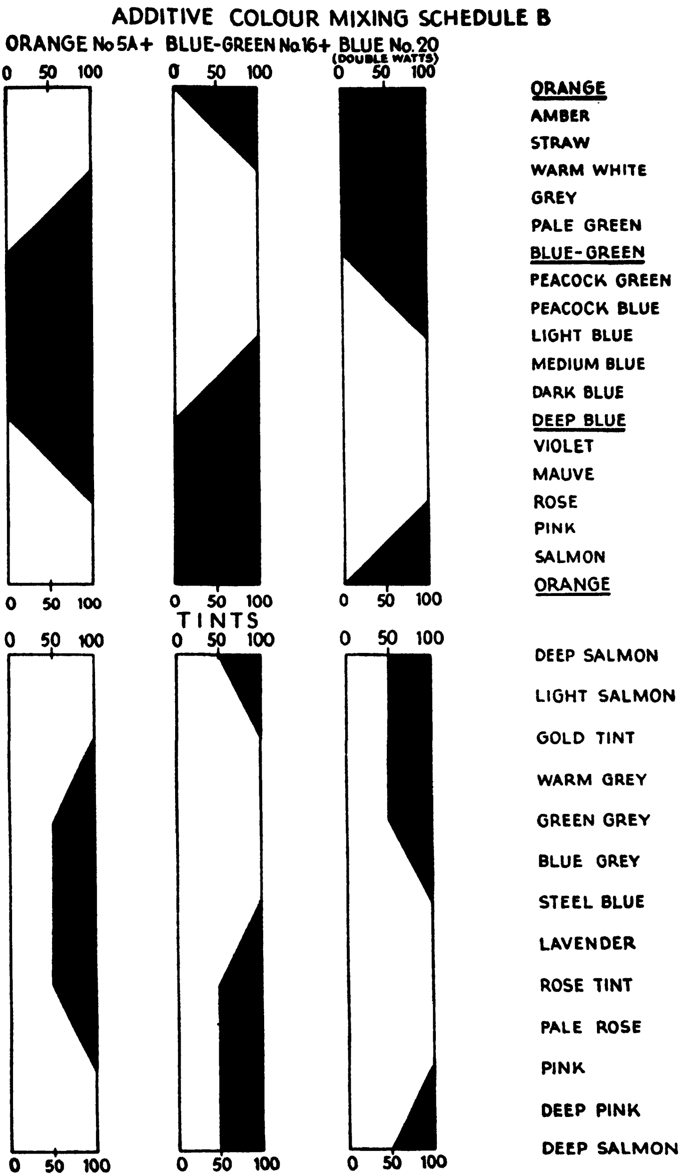
APPENDIX IV

Three-Colour Mixing Chart using Red, Green, and Blue



APPENDIX V

Three-colour Mixing Chart Using Orange, Blue-green, and Blue



APPENDIX VI

List of Music performed during 1936 and 1937 before The Light Console Society in the Strand Electric Demonstration Theatre

BACH	Toccata and Fugue in D Minor
BOELLMAN	"Prière à Notre-Dame"† / "Toccata" } "Gothic Suite"
BORODIN	Overture: "Prince Igor"
BRAHMS	Symphony No. 3, Second Movement
ERIC COATES	"The Three Bears"
DEBUSSY	"En Bateau"†
DELIUS	"On Hearing the First Cuckoo in Spring"*† "Walk to the Paradise Garden"†
ELGAR	Fugue from "Second Organ Sonata"† "Chanson du Matin"† "Enigma" Variations, 1, 9, 12, and 13
GIGOUT	"Toccata"
GRIEG	"Death of Ase"† / "The Morning Song"† } "Peer Gynt" Suite
HANDEL	Air from "The Water Music"
HOLST	"Saturn," from "The Planets" Suite†
MACDOWELL	"A.D. 1620"†
EASTHOPE MARTIN	"Evensong"†
MASCAGNI	Intermezzo: "Cavelleria Rusticana"†
MENDELSSOHN	Overture: "Fingal's Cave" Nocturne: "Midsummer Night's Dream"†
MOUSSOURGSKY-RAVEL	"Pictures from an Exhibition" Suite. (Complete)
MOZART	"Fantasia in F Minor"
QUILTER	"Where the Rainbow Ends" Selection
RHEINBERGER	"Vision"†
RIMSKY-KORSAKOV	"Scheherazade" Suite, First and Second Movements
ROSSE	"Merchant of Venice," Prelude I†
ROSSINI	Overture: "L'Italiana in Algeri"
SCHUBERT	"Unfinished Symphony," First Movement
CYRIL SCOTT	"Lotus Land"*†
SCRIABIN	"Prometheus" (Poem of Fire)

*** In these items the solo lighting was assisted by a dancer.**

† Items marked thus could have been played (maybe in a simplified version) on an orthodox type of stage-board.

Sibelius . . .	. "Valse Triste"†
Stravinsky .	. "The Firebird Suite" (Complete)
Tchaikovsky .	. "The Swan Lake," Scene† Symphony No. 4, First Movement Symphony No. 5, First Movement Symphony No. 6, First Movement
Vaughan Williams	. "The London Symphony"(Complete)
Verdi . . .	. "La Traviata," Prelude Act I† "La Traviata," Prelude Act III†
Wagner . . .	. Overture: "The Flying Dutchman" Overture: "Rienzi" "Lohengrin," Prelude Act I† "Lohengrin," Prelude Act III "Parsifal," Good Friday Music† "Siegfried, Forest Murmurs"† "Siegfried's Funeral March" "Dawn" and "Siegfried's Journey to the Rhine."
Hot Rhythm .	. Sundry jazz works, such as "Bugle Call Rag," "Twelfth Street Rag," "Sophisticated Lady," etc.

† Items marked thus could have been played (maybe in a simplified version) on an orthodox type of stage-board.

APPENDIX VII

Recent Progress

SINCE the main body of this book was set up there has been some development mainly on the lines already indicated.

Money and a fine site is at last available for a National theatre and it is to be hoped that it will make a fundamental

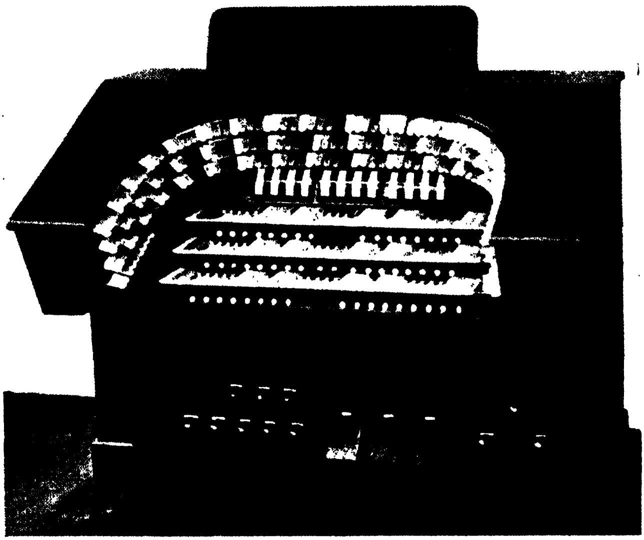


FIG. 217. 216-WAY LIGHT CONSOLE FOR DRURY LANE THEATRE

contribution to theatre planning and equipment and not be just another theatre building only superficially up to date. If it only solves the problem of how to give each of the audience a good view of and good contact with, the stage for ten shillings or less it will have been justified.

Apart from planning activity both at the National and Municipal levels, many commercial theatres are purchasing apparatus long overdue. Drury Lane Theatre is installing a 216-way Light Console (Fig. 217) to control a layout which consists largely of plug outlets to which the variable requirements of this theatre can be connected. At the London Palladium the old partial Console installation of 1941 has been replaced by a new complete one (Fig. 102). There is a large semi-permanent lighting layout which is adjustable through use of plug connexions throughout. Most of the outlet points

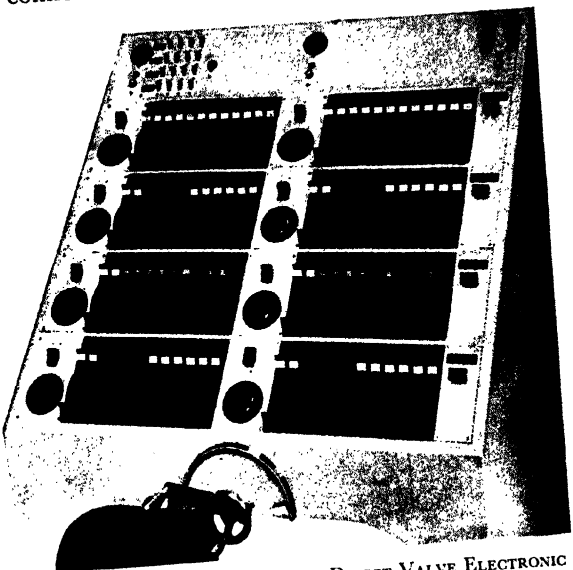


FIG. 218. 48-WAY ONE PRE-SET PANEL FOR DIRECT VALVE ELECTRONIC DIMMERS

consist of a pair of plugs to allow rapid connexion of one or two lanterns to each dimmer.

The Strand direct-valve Electronic dimmer (see pages 78–81) has now been constructed and is at present operated from a One-scene Pre-set panel (Fig. 218) similar in layout to that described on pages 125–127. This apparatus has come out of all its electrical tests with success. The first big installation will be at the New Theatre, London. The 144-way One Pre-set panel is to be behind a window in a room at the back of the pit.

All this improvement in apparatus is well enough but there is a great need to improve the status and pay of the men who look after and use it. Work in theatre lighting does seem to be a dead-end job unlikely to attract the ambitious.

GLOSSARY OF STAGE AND TECHNICAL TERMS

In general this list is restricted to items not clearly explained by their context in the book; to these are added some of the more notable terms peculiar to the theatre. For missing items the Index should be used.

ACTING AREA. The part of the stage on which the actors move or speak. Also short for Acting Area Flood (A.A.), a lantern which provides vertical lighting of this area, not to be confused with Acting Area Lighting which should apply to *any* lighting specifically for this area.

ACTOR'S LEFT OR RIGHT. Also known as Stage Left, Stage Right, it assumes that the actor is facing the audience. His Right is the latter's Left. Lanterns and spotlights on a batten are numbered from his left.

ANODE. See *Cathode*.

APRON STAGE. An extension of the stage to the auditorium side of the proscenium opening.

ARC. From "arc lamp," a high-power light source burning carbons. The term is usually coupled with Front-of-House (F.O.H.) to refer to the spotlight projectors at the back of the auditorium used for picking out and following Music Hall artists and others.

AUTOS. Spotlights or focus lanterns on the circle front or in the roof of the auditorium, the colour filters of which can be changed remotely by electric means. Sometimes known as Pre-set Spots. Both these terms are incorrect but likely to remain.

BACKCLOTH. See *Cloth*

BACKING. A cloth or flat (*q.v.*) placed behind windows, doors and other openings in the scenery.

BARREL. Usually a 1½-in. gas pipe hanging horizontally for carrying scenery or lanterns, or used vertically as a support to which lanterns can be clamped.

BATTEN. Metal barrel or wooden bar from which scenery or lanterns can hang. Loosely applied to the barrel and lighting equipment, e.g. spot batten, flood batten.

BLACKOUT. No light. Used as a verb to indicate the switching out of lights, properly a group of lights. Dead blackout (D.B.O.) is the most important lighting cue required and must be attainable by *one* switch.

BOARD. An all-embracing term to cover the control point for many lighting circuits. The principal stage-lighting control where the switches, dimmers, and fuses are located is best called Stage-board; but Switch-board, Control-board, and Dimmer-board are frequently used.

Boomerang. Vertical barrel carrying spotlights at the sides of the stage behind the wings.

Border. A strip of canvas or curtain used to prevent the regions above the stage beyond the scenery being seen.

Box Set. Also known as a Chamber set, the staple form of interior setting to-day—a room with the proscenium opening as the "fourth wall."

Bracket Handles. A simple dimmer control handle which screws down to its shaft for collective operation.

Brail. To draw a lighting batten or piece of hanging scenery up or down stage out of its normal vertical position.

Bridge. A large rectangular section of the stage floor formed as a lift to travel some distance above or below the normal stage level. May be power- or manually-driven and lessens the need for large rostrums. A Lighting Bridge is a narrow gallery 20 in. or so deep suspended over stage or forestage. Lanterns fixed to the bridge are accessible during rehearsal or performance.

Busbar. A metal conductor to which many electrical circuits sharing a common supply may be connected.

Cathode. An electrode in a discharge lamp or radio valve designed to emit electrons. An Anode is an electrode designed to receive the electrons. As the direction of the current in a discharge lamp is reversed 50 times per second, both electrodes are designed to emit electrons and are therefore known as cathodes, e.g. hot cathode lamp.

Chamber Set. See *Box Set.*

Check. To alter lighting intensity on dimmers; the reverse is to "bring in," but "dim in" and "dim out" are not unknown and surely descriptive enough to justify the contradiction.

Circuit. Any complete path from source of electrical supply and back, but more specifically in stage work, a lamp or lamps, plug socket or sockets which are connected to a switch on the stageboard. A dimmer circuit is better referred to as a Way (*q.v.*).

Cloth. A large area of painted canvas with a wood batten top and bottom, but otherwise hanging free. Up stage we have a Backcloth, down stage a Front cloth, and between them are Drop cloths, or a Cut cloth of arches or trees.

Colour-change Lanterns. Another expression for Autos (*q.v.*).

Colour Master. See *Group Master.*

Console. The key desk from which an organ is played, now extended to cover a compact desk for remote control of lighting—particularly the author's Light Console.

Contactor. A switch carrying a large current which is operated by an electro-magnet requiring a small current.

Counterweight System. The modern method of flying scenery in which the apparatus can be loaded so that hanging scenery is exactly balanced.

Cue. This is the signal given by the Stage Manager (or taken directly from the action on the stage) to carry out a plotted change of lighting. The change may be slow or fast.

CYCLORAMA. Properly applied to a plain cylindrical background or sky dome completely bounding the stage behind the proscenium, but now applied to almost any plain cloth or background up stage on which an extra flood of light is directed. Cyc. is a common abbreviation.

DIRECT OPERATED. Apparatus such as a stage-board where the operating handles and dimmers are mounted on the same framework and mechanically connected.

DISC STAGE. A revolving stage sufficiently shallow to be laid on top of a normal stage. The orthodox type of revolve with under-stage mechanism is nowadays required only when power-operated bridges and lifts form part of the unit.

EARTH. This can accidentally form the return path to the generator, the connection being provided by the unfortunate person holding the metal which has become alive. To prevent this, all metal-cased electrical apparatus is now connected by a third wire (green) known as the earth wire; hence three-core flexible leads. If the metal case then becomes accidentally connected to the live wiring a large overload current will flow back to the generator via the earth wire, blow the circuit fuse, and thus disconnect the apparatus.

EFFECT. Variously applied to apparatus for a specific optical result, such as a wave or cloud effect, or to a particular stage picture painted with light—a dawn effect, fine day effect.

ELECTRODE. See *Cathode*.

ELECTROMAGNET. A device which forms a magnet only as long as an electric current flows through its coil.

ELECTRONIC. Any application of electric thermionic valves outside radio work.

FIT-UP. A portable proscenium and other equipment to convert an open platform into a temporary stage.

FLAT. A rectangular piece of scenery constructed of canvas stretched on a wooden frame consisting of two stiles (the uprights) and horizontal rails between. There are various elaborations for doors and windows.

FLEX. Not any loose cable but a cable whose conductor is made up of fine strands to withstand twisting without breaking. Must be of the finest quality with heavy insulation for stage work.

FLOAT. A traditional name for footlights, origin uncertain.

FLOOD. Used to cover any lantern which gives a *fixed* beam of light.

FLYS. The upper part of the stage where scenery can be suspended out of sight (flyed). Also refers more particularly to the gallery at the side of the stage where the ropes and controls for this scenery are placed.

FOCUS LANTERN. A lantern with a simple lens optical system providing a beam which can be focused to give a flood of light between 10° and 45°.

The edges are not sufficiently defined to justify the term "spotlight" by which it is, however, commonly known.

F.O.H. See *House*.

Foot-candle. A unit of light intensity which is meaningless unless factors of glare, colour, contrast, etc., are stated. The sun gives as much as 10,000 ft candles at mid-day, the full moon only .02, the average house or office lighting gives 5–10, yet all can be pleasing, or not, depending on the other factors.

Forestage. See *Apron Stage*.

Frost. A diffusing filter. No. 31 Light Frost is an essential to avoid striation in a focus lantern when focused down.

Fuse. A safety device consisting of a link or piece of wire which will melt and cut off the current if a circuit is overloaded or develops a fault. It is important to use the correct fuse wire to suit the circuit because, if too large, some other part of the circuit must burn out instead, probably with disastrous results.

Gelatine. This material dyed has been commonly used as colour filters, which are consequently often referred to as gelatines even though to-day they may be of plastic material.

Grand Master. The master control capable of affecting all dimmers. It can be mechanical or electrical. It is a term loosely applied to a mechanical direct-operated stage-board when so equipped.

Gridiron or Grid. The framework above the stage from which the scenery and lighting are suspended.

Grid Valve. The gate in an electric (thermionic) valve through which current born on a stream of electrons has to pass to get from cathode to anode. By varying the small electric charge on the grid the gate can be, so to speak, opened or closed; there are no moving parts. See also *Heater*.

Ground Row. Originally a piece of painted scenery representing hills or the like placed as foreground to a backcloth; now covers magazine lighting equipment placed on the stage floor, as for example the bottom lighting to a cyclorama.

Group Master or Colour Master. Dimmer controls may be subdivided for mastering on a stage-board into either colours or families (e.g. the spotlights or the floods); in either case the groups may be identified by colouring the controls in a distinctive manner.

Heater. The cathode of an electric valve has to be directly or indirectly heated in order that it may freely emit electrons. The filaments for this purpose remain on the whole time a valve is in or ready for use. On a 120-way direct-valve electronic board this might amount to approximately 10,000 watts all the time the board is switched on; whether the dimmers are used or not will make no difference. There are, however, no further losses when a dimmer is on check.

Hemp Line. Originally scenery was hung from hemp lines made off to the fly-rail. Although replaced for most purposes by counter-weighted lines (*q.v.*) some hemp lines should be retained; for items which are detached when set on the stage they may be more convenient.

House. A general term for a theatre. The Front of House, or F.O.H., means in stage lighting only the auditorium.

Impedance. On alternating current the reversal of motion in, for example, a coil, tends to induce a current (back E.M.F.) in opposition to the main. Impedance is the resistance of the wire plus this effect.

Independents. A term applied to spotlights whose dimmers do not belong to a colour shaft. The dimmer handles are painted black. Nowadays when the bulk of the board may consist of Independents the expression has little meaning. It is also applied to stage plugs without dimmers.

Intake. The room where the Supply Authority's mains enter the building. In this room are housed the meters and the main fuse and switchgear to *distribute* the power to the various areas of the building. Local to these areas are dis-boards containing smaller fuses for the various lamps, plugs, etc. Fuses are mounted on the dimmer- and switch-board so that it functions as a dis-board for the stage.

Lantern. The haystack-shaped glass skylight which must be fitted in the roof of any stage fitted with a safety curtain. Its object is to allow escape of smoke and the high pressure caused by the expansion of air in a fire.

Legs. Strips of curtain hanging at the sides of the stage to prevent a view of the wings. They correspond to the overhead borders (See *Border*).

Length. A row of lamps or section of magazine equipment which is hung from the back of a flat to illuminate a backing. In the days of all-over flat lighting, lengths were placed behind the proscenium and each scenery wing as a vertical continuation to each overhead batten (See *Batten*).

Lighting Bridge. See *Bridge*.

Lime. An expression for the powerful following spots in the F.O.H. (*q.v.*). The source of light, now an electric arc, used to be a gas jet impinging on a lozenge of lime.

Live. An electric circuit consists of feed and return to the generator (two wires). The Live wire is usually red and it is important that all switches and fuses should be in this lead, otherwise lamps and apparatus cannot be rendered dead (safe) because the earth may form an alternative return path. "Line" and "Phase" are sometimes used instead of "Live."

Mirror. Almost invariably used in stage lighting for a curved reflector to collect and redirect light. A Mirror Spot is a lantern whose light output is principally the result of collection by a reflector.

Moon Box. A shallow square box with a large circular aperture the white interior of which is illuminated by lamps concealed in the corners. This device is hung behind a cut-out-moon in a backcloth.

Neutral. When used in an electrical context it refers to the return wires of an A.C. installation. This return wire (black) is usually at Earth potential but should nevertheless be treated with respect and insulated in the same way as the Live wire (*q.v*).

OBJECTIVE. The final lens or combination of lenses used to focus a lantern slide (or equivalent) sharply.

OPEN STAGE. Any stage without a proscenium and/or front tabs (curtains).

OPTICAL EFFECT. In stage lighting this is a device which when fitted to an effects projector with objective lens can produce a moving effect such as clouds, flames, waves, or even dissolving colour patterns.

PANORAMA. At one time a painted cloth which could be unwound from one side of the stage and rewound on the other to give a changing view. It still appears in pantomime, and in vertical form to indicate descent to Nibelheim in *Rhinegold.* Nowadays "panorama" is often a cloth cyclorama.

PERCHES. Originally shelf-like platforms on the stage side of the proscenium wall. The term is often applied to spotlights in that position whether there are perch platforms or not.

PHASE. Alternating-current supply for loads of 60 amps or more is often conveyed by a four-wire system. Three wires represent the live phases and the fourth is the common neutral return. The alternating-current cycle in each phase is equally out of step. All this has only nuisance value in stage lighting; indeed we have to treat each phase with its neutral as a separate supply and as far as possible confine that phase to a particular part of the stage. When the voltage between any phase and neutral is 230 volts, between phase and phase it will be 400.

PHOTOMETER. An instrument used to measure light intensity. It registers in foot-candles (*q.v.*) or, more up to date, in lumens-per-square-foot. To compare the distribution between one type of lantern and other (I used it to make Figs. 49 and 50) it is useful. Otherwise, for reasons given under "Foot-candle," I do not consider it should appear on the stage. There results should be judged by eye.

PLAN. A drawing showing a horizontal cut taken through, for example, a building. Unless otherwise stated (first-floor plan, roof plan, etc.) it is the one a few feet above the actual ground or stage floor so that all the window and door openings in the walls show on it.

PRE-SET. A term for some types of stage-board (see Chap. VI), but also used by some people to describe the remote colour-change spots on the circle fronts (see *Autos*). This is difficult to justify as the switching for them is rarely of the pre-set type and if the term is to cover the fact that the spots are set before the show and cannot be moved thereafter, then this would apply equally to the spot batten.

PROFILE. Rigid but flat scenery, the edges of which are cut out in the shape of trees, etc. It is constructed of thin plywood faced with scrim, but substitutes such as cardboard are not unknown.

PROJECTOR. Any lantern capable of projecting a strictly localized beam of light.

RAKE. The slope of the stage floor from front to back found in older theatres. Causes difficulties with present-day three-dimensional scenery and the rake *must* be added to the auditorium floor instead.

RECTIFIER. A device for converting alternating current to direct current.

RELAY. Strictly an electromagnetic switch which requires a minute current to work it. It is used to supply the larger current for the coil of a contactor switch or magnetic clutch and thereby avoid a long run of heavy wire between remote-control point and the latter.

ROSTRUM. A movable platform to provide a raised area of the stage. The larger ones are constructed of a strong folding frame with a separate top so that they are easy to strike and take up little space.

SCIOPTICON (SCIOP.). An American term, for optical effects projector, which seems to be here to stay.

SECTION. A view of a building or stage showing a vertical cut through it. Lines are sometimes drawn on the Plan (*q.v.*) view marked A–A, B–B and particular sections drawn for each position. If, however, the section is located on the centre line of the plan, or some other obvious position such as the proscenium, it is not necessary to specify beyond the word section.

SETTING LINE. The line on the stage side of the proscenium to which the setting may be brought and from which its dimensions are taken.

SIGHT LINES. Imaginary lines from the eyes of each member of the audience to the stage. These lines are straight and cannot pass through or round *any* obstruction. One aim of good theatre design is to ensure the proportion of the stage common to all these lines is as large as possible.

SOLENOID. A form of electromagnet in which the core is not fixed and used to attract a moving part, but is free to be drawn up inside the coil when current passes through it. For the same current in the coil an electromagnet will exert a greater attraction (Fig. 92), but a solenoid can pull through a greater distance (Fig. 47).

TABS. Derived from "Tableaux curtains," which part in the centre and draw up in loops either side of the proscenium, but now applied to any set of stage curtains. Curtains forming part of the furnishing of a setting are drapes, but this is not always adhered to. "House tabs" is the name given to the curtain which cuts off the stage and forms part of the auditorium decorative scheme. Where, as is usually the case, this curtain is used to terminate the act it may be known as the "act drop," but the term really belongs to a painted curtain formerly used for this purpose, the house tabs merely opening and closing the show.

The house tabs and other curtains which move before the audience can be made extraordinarily expressive by their direction and speed of movement.

TAILS. The heat-resisting wiring of lanterns and other apparatus is often extended for one to three feet outside. These ends are known as tails and are used to connect up. They must not be replaced by running the ordinary wiring into the lantern, as the cable used for normal purposes does not have a heat-resisting covering.

THROW. The distance from projector or spotlight to screen or object illuminated. It is as well to specify angle of the throw in addition to its length.

TIER. A theatre with one balcony is a single-tier house; with a dress circle, upper circle and gallery all on separate balconies it is a three-tier house.

TORMENTORS. Masking flats immediately behind the proscenium.

TRAPS. Openings in the stage floor which can be uncovered when required. The traps for stage plugs are small and simple whereas a grave trap is large and a star trap complicated mechanically as well. (The latter is used to shoot demons through the stage.)

TRIPE. A general term for flexible cables. See *Flex*.

TUMBLE. A method of flying a cloth in which both the bottom and top rollers are pulled up as far as possible and the cloth kept taut by a free roller hanging in the middle. Obviously this needs half the height of the normal method which is to haul the cloth up vertically until the bottom edge is out of sight.

WAY. An expressive circuit on a stage-board with its own dimmer or with provision to insert an individual dimmer.

WINGS. The sides of the stage beyond the area used for actors or scenery. Also vertical pieces of scenery or curtain strips ("Legs") used to mask these areas.

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INDEX