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Planning and Design of the Studio Lighting Equipment

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In order to do any type of television production, some sort of a facility designed for production is required. This facility is called the Television Studio.

A properly designed television studio is a necessity to do any sort of production—even very limited production. The more planning and thought that is put into the studio, the better the results. An improperly designed studio will hamper all production capability and will be very uneconomical to use. The heart of any production studio is the lighting equipment that is designed into the studio. Both the type and quantity of fixtures as well as the lighting control (dimming) system should be designed for maximum flexibility in your particular studio.

If you are building a new studio from the ground up, then you have the advantage, with proper planning, to design-in exactly what you think you will need. This is, of course, the ideal situation. However, in many circumstances, a newly constructed studio is out of the question and instead you are renovating an existing structure. Even though physical parameters are pretty much fixed by the architecture of the existing building, you still can, with proper planning, increase the flexibility of your existing facility.

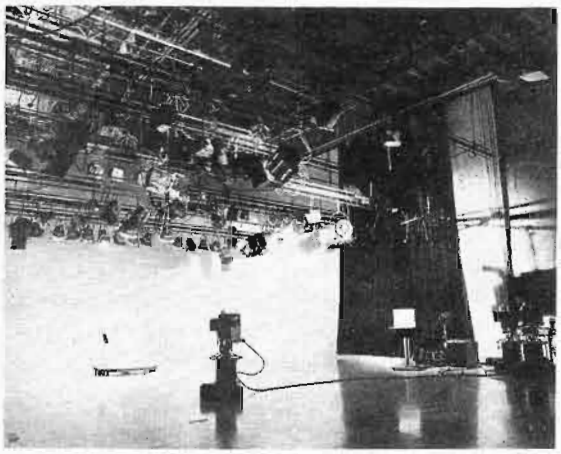

Fig. 1. Production studio-cathedral teleproduction (courtesy of Kliegl Bros).

Size

The size of the studio will determine how complex a production you can create. Generally speaking, the larger the studio, the more flexibility. However, there are practical limitations to this.

In new studio construction, one of the most popular sizes is a 50 X 70 ft. studio. This 3,500 sq. ft. area will allow the average TV station to do any type of production programming that is required. A more common size, especially among existing installations, is a 40 X 60 ft. studio. This 2,400 sq. ft. studio will normally take care of the majority of productions that are encountered in local markets.

Since most facilities have more than one studio, it should be planned that at least one studio is at least 2,400 sq. ft. with a smaller studio at least 1,200 sq. ft. A typical facility, for example, will have a production studio 40 X 60 ft. and a news studio 30 X 40 ft. In this way, there is the advantage that news and local shows can be done in the smaller studio with semi-permanent sets with the larger studio being reserved for special productions, such as commercials, etc.

Height

The height at which the lights are hung, commonly referred to as "grid" height, is also an extremely important facility parameter. A low grid height can completely destroy the flexibility of a large studio. Ideally, the grid height should be a *minimum* of 14 to 16 ft. for a studio up to 2,400 sq. ft. and 18 to 20 ft. for a larger studio. A low ceiling will not allow the lighting equipment to be effectively utilized since a low grid height will not allow for long, wide angle shots.

Electric Pause

The amount of electrical power that is required for the lighting equipment in the studio is determined by two things: the square footage of the studio and the foot candle levels required by the cameras. Using an illumination level of 250 fc, 60 watts per square foot of studio net production area is required. Net production area is defined as the usable area within the cyclorama curtains. By simple mathematics, it can be shown that 60 watts/per square foot equals approximately one 1 kw circuit per every 16 sq. ft. (1,000 watts divided by 60 watts/sq. ft. $\cong$ 16 sq. ft./circuit.)

The table, shown in Fig. 2, will give the approximate power service in kilowatts for various size studios and footcandle levels. These power requirements do not include the power required for the cyclorama lights. For cyclorama lighting, utilizing the new hi-efficient type of fixture, add in an additional 250 watts/linear foot of cyclorama for overhead lighting only. As an example, for a 3,500 sq. ft. studio with a net production area of approximately 3,000 sq. ft., a power level of 180 kilowatts is required. (Not including cyclorama loads.) For a 100 ft. cyclorama, add 25 kw to the 180 kw.

The most desirable ac power service for studio purposes is 3-phase, 4-wire 120/208 v ac 60 cycles. This type of power service is available in most areas and is normally the most economical power service that can be provided for the studio. Since there are three phases, each carrying equal loads, each phase is only required to carry one-third of your total connected load. In the above example, the 180 kw service required for the 50 X 70 ft. studio would be 1,500 amps total. By using a 3 phase, 4-wire power feed, each of the phases would only have to carry 500 amps. This will keep the size of feed wire down and, therefore, cost to a minimum.

Another very common power feed that is available in older facilities is single phase, 3-wire service more commonly known as 120/240. This type of service uses 3 wires each of which carry one half of the total load. In the above example, the 180 kw load will be broken down into two feeders of 750 amps each, plus 750 amps neutral.

It is most desirable to have a separate service provided for the studio lighting loads. In this way, there will be no fluctuation in your electrical equipment when the heavy loads of the lighting equipment are turned on.

It should be noted that in all cases such services as electrical power and air conditioning should be sized so as to take into account ultimate requirements. It is very costly to increase these services at a later date.

SERVICE POWER IN KILOWATTS (KW) FOR NET PRODUCTION AREA (NPA) AND REQUIRED FOOTCANDLE (fc) LEVEL

NPA (ft^2)	50 fc	100 fc	200 fc	300 fc	400 fc	500 fc
500	7	14	27	40	54	67
1000	14	27	53	80	106	134
1500	20	40	80	120	160	200
2000	27	54	107	160	213	267
2500	34	67	134	200	266	334
3000	40	80	160	240	320	400
3500	47	94	187	280	372	467
4000	54	106	213	320	426	534
4500	60	120	240	360	480	600
5000	67	134	267	400	532	667
6000	80	160	320	480	640	800
7000	94	187	374	560	745	934

Fig. 2. Power requirements for typical television studios (courtesy of Sylvania).

Air Conditioning

Since almost all of the electrical power used for lighting is converted to heat, sufficient air conditioning must be available to keep the studio within a reasonable temperature range that will not adversely affect other studio equipment or personnel. Due to the inefficiencies of lamps, either quartz, iodine or standard incandescent, all power applied must be considered as heat.

It takes approximately .14 tons of air conditioning for every 1 kw (1,000 watts) of lighting. These figures may vary from one geographical location to another, but may be used generally as a starting point. For the 50 X 70 ft. studio, previously discussed, the air conditioning for the studio lighting alone would be 30 tons. It must be noted that this figure of .14 tons per kilowatt is for the lighting fixtures only and does not take into consideration any other air conditioning requirements such as electronic video equipment, talent, or general illumination.

Now that the construction details have been discussed, let us proceed to the design of the actual production facilities. The first section of the design has been aimed at the engineering staff. The remainder of the discussion is concerned with the production staff.

SUSPENSION SYSTEMS

After the studio size has been determined and power service and air-conditioning designed for the studio, it must next be determined how to use the lighting fixtures in the studio. It is imperative that all lighting fixtures, with few exceptions, be suspended from the overhead mounting system. This gives the most flexible type of studio operation since the floor is free to be used for sets, cameras, and talent only. Only specific lighting fixtures for special effects should be floor mounted through the use of lighting stands.

The simplest type of lighting suspension system is a series of pipes that are suspended from the ceiling parallel to the short walls in the studio. These pipes, which are normally spaced 4 to 6 ft. on centers, support not only the lighting fix-

tures, but can also act as a mounting point for the overhead electrical power distribution equipment. This system is also the most economical since the material requirements are limited to pipe. This pipe, normally 1½ in. ID, when painted black is an ideal hanging medium for the "C" clamp equipped fixtures. These pipes can either be fixed mounted to the ceiling through the use of threaded rods, metal strap and brackets, or can be chain hung. The advantage of having the pipes chain hung is that they can be raised somewhat, if necessary, for special productions. There are inherent limitations in the fixed pipe system. In order to have total flexibility and utilize the entire studio, short pipes perpendicular to the fixed pipes can be added if the lighting fixtures are required to be used perpendicular to the pipes. These pipes can be clamped onto any pipe in the studio on a temporary basis. Fig. 3A shows a batten plugging strip with five pigtails (circuits). The pipe is mounted in the brackets below the plugging strip.

In place of the fixed pipes and the "C" clamp mounting method for fixtures, some studios have gone to a steel channel called Unistrut. Special Unistrut mounting brackets are available which will allow the fixtures to be quickly mounted on these channels.

Another very common type of suspension system is the fixed grid, where pipes are mounted from the ceiling in rows perpendicular to each other in a grid configuration. In this type of suspension system, the pipes are normally on 4 to 5 ft. centers, giving a cross hatch grid with squares approximately 16 to 25 sq. ft. Since earlier calculations call for a circuit every 16 sq. ft., it can be seen how this grid system fits nicely into the studio. This will allow maximum flexibility since the fixtures can be mounted in any direction. Again, this grid acts as a mounting device for the electrical distribution equipment.

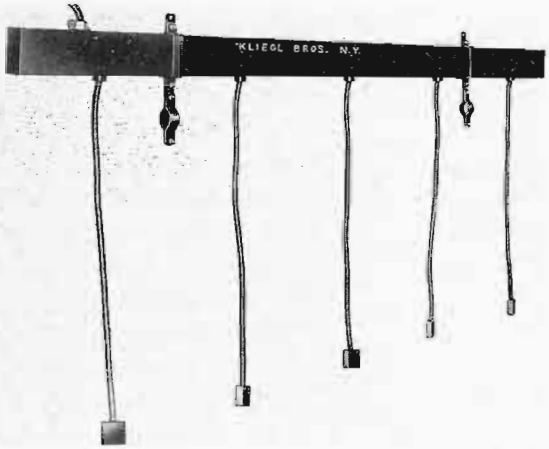

Fig. 3A. Plugging strip (bottom) and pipe mounts below strip (courtesy of Kliegl Bros.).

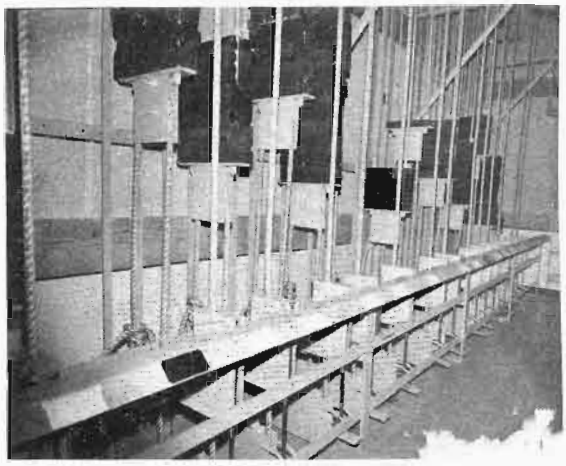

Fig. 3B. Counterweight system at the Indiana University TV studio, Bloomington, Indiana (courtesy of Tiffin Scenic Studios).

By far and away, the most flexible, and unfortunately, the most expensive type of suspension system is that utilizing movable pipes. This type of system will allow the fixtures and power distribution equipment to be lowered to just above the studio floor for service and maintenance.

There are two ways in which to make the fixture pipes and plugging strip distribution (battens) movable. The most common and inexpensive method is through the use of a counterweighted system. This type of system utilizes a block and tackle method to raise and lower battens. Fig. 3B shows a typical counterweight arrangement as installed at the Indiana University TV facility in Bloomington, Indiana. This type of system uses lead counterweights to offset the forces required to raise and lower the lighting battens. This type of system costs from $700.00 to $2,500.00 per batten. A "batten" can either be a single pipe or a set of two or more inline pipes. A typical 40 X 60 ft. studio would have at least seven such "battens" (seven pairs of pipes). The cost range will depend upon the capacity of the "system" as well as the degree of safety to be incorporated. One of the main disadvantages of a counterweight system is the amount of studio floor space required for counterweight hardware. Approximately 4 ft. along one of the longer studio walls is lost due to the required hardware. This will obviously cut down on the studio's net production area.

Another method of raising and lowering the batten is through the use of an electric winch with a grooved drum. This type of system costs from $1,500.00 to $5,000.00 per batten including limit switches. Fig. 4 shows a view of the winches in a loft just below the acoustic ceiling at the Indiana University TV facility. This system has the advantage of not taking up any floor space whatsoever since all of the operating mechanisms are mounted overhead. Fig. 5 shows

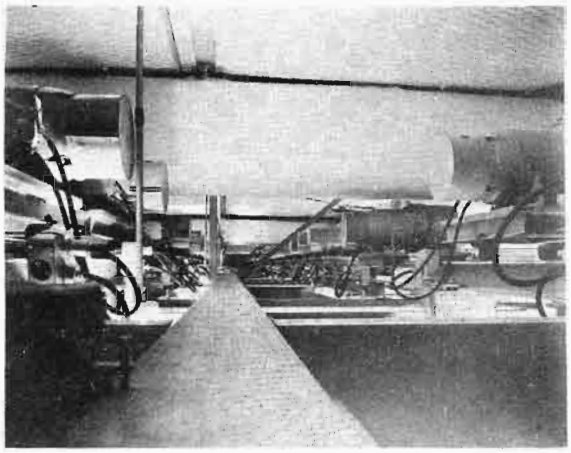

Fig. 4. Lifting motors for suspension system Indiana University Studio (courtesy of Tiffin Scenic Studios).

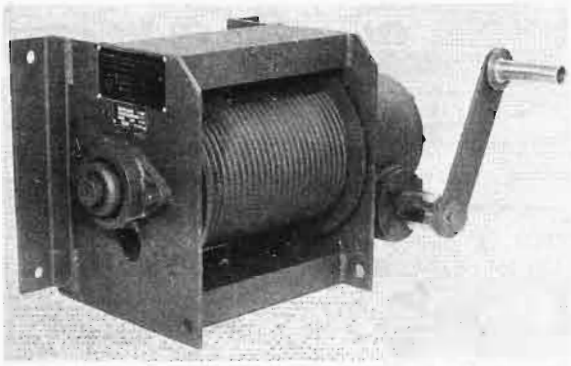

Fig. 5. Hand winch at the studio of Indiana University (courtesy of Tiffin Scenic Studios).

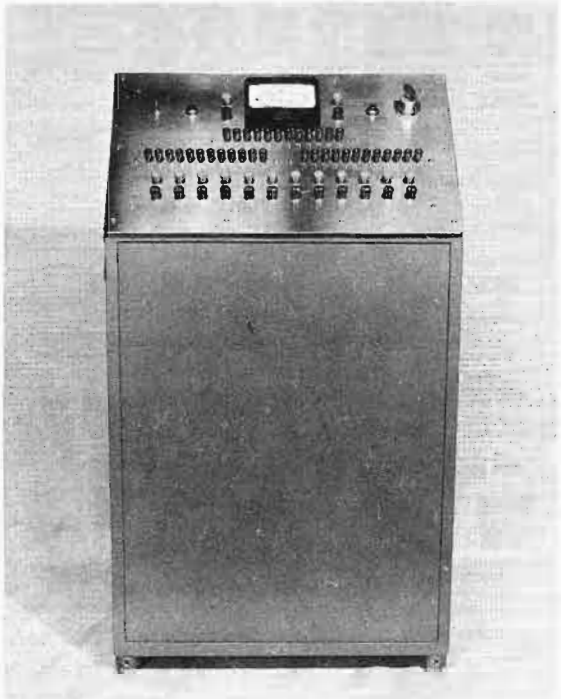

Fig. 6. Motor control to console for motorized suspension system (courtesy of Tiffin Scenic Studios).

a modified hand winch which can be used with a reversible drill motor. The motorized system and the motorized batten can be remotely operated from the control room through the use of a control panel. A typical panel is shown in Fig. 6.

Please note that before any type of suspension system is decided upon, it is imperative that the architect and building engineer be consulted as to roof loading factors for safety. It would be a very good idea at this design stage to call in a professional rigger for his advice.

Another very important part of your suspension system is the cyclorama curtain. A cyclorama curtain is a fabric that is either on a movable track or permanently put into position to act as a background. By the use of special cyclorama lights and color media the color of this curtain can be changed to provide various colored backgrounds. It is advised that the initial installation includes a single or double cyclorama rail around the entire studio perimeter. The track only costs approximately $5.00 per foot for a single rail and $10.00 per foot for a double "concentric run." For most installations, a single track is normally sufficient.

The cyclorama curtain itself is a seamless flameproof muslin, which will cost approximately $25.00 per linear horizontal foot, up to 18 ft. high. A seamless and flameproof sharkstooth faced material will run approximately $20.00 per horizontal linear foot, up to 30 ft. high. If a show type velour drapery, pleated for 75 percent fullness is desired, the approximate price per linear horizontal foot up to 18 ft. high is $40.00. It is suggested that at least half of the studio be equipped with a cyclorama curtain to start with. The velour drapes could, of course, always be added at a later date.

STUDIO LAYOUT

Once the studio size has been determined, it is necessary to properly layout the plugging strips that makes up the lighting electrical power distribution. It is important that the distribution system be layed out in such a way that power can be easily distributed to all parts of the studio. Fig. 7 shows the electrical power distribution for a typical 40 X 60 ft. studio. As can be seen, the electrical power is distributed through the use of plugging strips 16 ft. long with 11 circuits in each strip. These plugging strips, which are on 8-ft. centers with 3 ft. pigtails, will allow a fixture to be mounted in any position, on any pipe in the studio, and receive its power from the plugging strip. Between each plugging strip is a pipe for mounting additional fixtures. Since each fixture also has a 36 in. pigtail, there

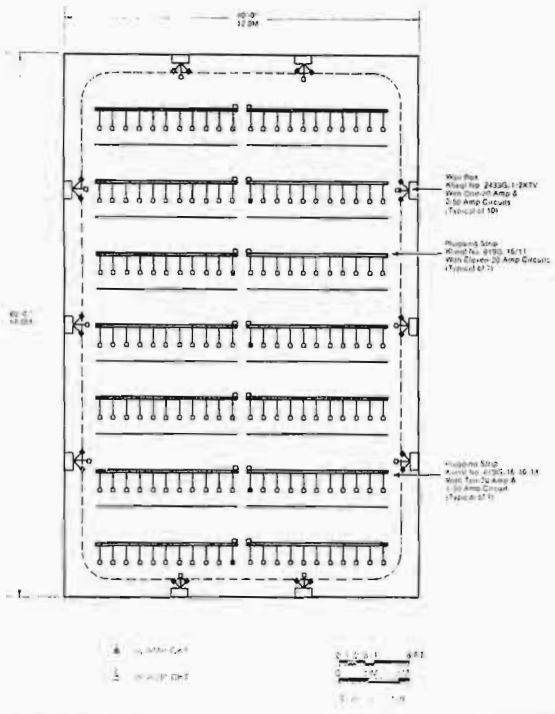

Fig. 7. Layout of a 40 X 60 ft. studio (courtesy of Kliegl Bros.).

is no trouble providing power to the fixtures mounted on these pipes.

In addition to the overhead circuits which total 154 (147 rated at 20 amp and 7 rated at 50 amp), there are 30 circuits around the perimeter of the studio that are mounted 30 in. above the floor. These circuits will allow power for the stand mounted lights and other special equipment that may be required. It is important that these circuits be provided since there are many times when floor power is required.

All of these circuits shown are wired into the dimming system which will be discussed in the next section.

A typical lighting package, consisting of fixtures, distribution equipment, and dimming equipment is shown in Fig. 8. This package of equipment provides all of the necessary hardware including cyclorama lights to do production in a 40 X 60 ft. studio. Of course, larger studios would require larger packages of equipment and smaller studios would require smaller packages of equipment. The number of fixtures and dimming system size is directly proportional to the size of the studio.

40' x 60' STUDIO PACKAGE — CATALOG #94060TV

KEY AND BACK LIGHTS

Qty.	Cat. No.	Description
10	3508TV-955G	6-3/8" 750W Quartz Fresnel
10	23508TV	8 Way Barndoor
10	13508TV	Diffuser/Gel Frame
10	EHF	750W Quartz Lamp 3200°K
30	3608TV-955G	8" 1000W Quartz Fresnel
30	23608TV	8 Way Barndoor
30	13608TV	Diffuser/Gel Frame
30	CYV	1000W Quartz Lamp, 3200°K
10	3610TV-955G	10" 2000W Quartz Fresnel
10	23610TV	8 Way Barndoor
10	13610TV	Diffuser/Gel Frame
10	CYX	2000W Quartz Lamp, 3200°K

BASE AND FILL LIGHTS

40	3451TV-955G	16" Quartz Scoop
40	13451TV	Diffuser/Gel Frame
40	FHM	1000W Frosted Quartz Lamp
2	835TV	Spun Glass
20	117TV	10' Monopole Telespcopic Hanger
20	10E955GTV	10' Extension Cable

CYCLORAMA LIGHTS - 80 LINEAR FEET PLUS TWO CORNERS

4	6901TV-955G	1 Light 1 Circuit Cyc Light with Color Frame
9	6902TV-955G	2 Light 2 Circuit Cyc Light with Color Frame
22	FFT	1000W 3200°K Quartz Lamp

EFFECTS LIGHTS

2	1357/6WTV-955G	6" 1000W Wide Angle Klieglight with Pattern Holder and Set of Patterns
1	13571/6WTV-955G	6" 1000W Wide Angle Klieglight with Iris
3	FER	1000W Quartz Lamp, 3200°K

DISTRIBUTION EQUIPMENT

Qty.	Cat. No.	Description
7	619G/16/11TV	Plugging Strip, 16'long with 11-20 amp 39" (1M) pigtails terminating in 3 pin grounding connectors
7	619G/16/10/1XTV	Plugging Strip, 16' long with 10-20 amp and 1-50 amp 39" (1M) pigtails terminating in 3 pin grounding connectors
10	2433G/1/2XTV	Wall Box with 1-20 amp & 2-50 amp 18" pigtails terminating in 3 pin grounding connectors

CONTROL EQUIPMENT

1	2911TV	Dimmer Bank containing: 12-12KW SCR Dimmers 6-7KW Non-Dims
1	2910TV	Retractable Cord "Cold Patch" Patch Panel containing: 180-20 amp load cords 30-50 amp load cords 114-20 amp cold patch jacks with circuit breakers 30-50 amp cold patch jacks with circuit breakers 1-Illumination Hood with Dimmer
1	2909TV	Two Scene, Four Sub-Scene Control Console containing: 24-Plug-in Rear Illuminated Controllers (2/Scene) 24-3 position Function switches (Sub A-Off-Sub B) 4-Sub Masters 1-Split Handle Cross Fader 6-Non-Dim switches 1-Non-Dim Master 1-Key switch 1-10' Control Cable with No. 2902TV recpetacle box

Fig. 8. Bill of materials for a 40 X 60 ft. studio (courtesy of Kliegl Bros.).

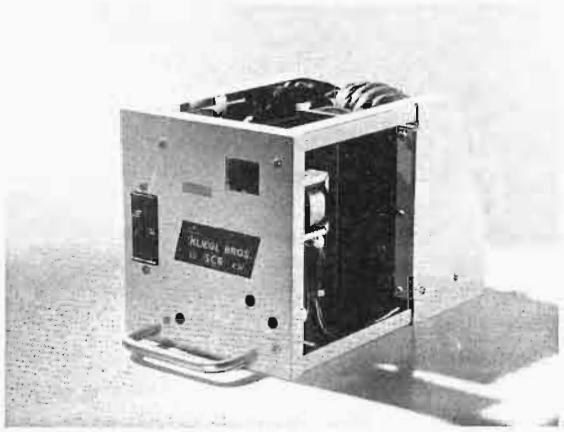

Fig. 9. A 12 kw SCR^{R}Dimmer (courtesy of Kliegl Bros.).

LIGHTING CONTROL (DIMMING) EQUIPMENT

The lighting control system is the most important tool that the lighting man has to work with. The lighting control system, commonly called the Dimming System, is the nerve center of any lighting package. The control system allows the studio production lights to be varied in intensity for the various special effects that are required. It's the dimming system that allows color blending of the cyclorama curtain background. It is the dimming system that sets the mood of the production. It is the dimming system that allows complex light changes to be easily accomplished.

The dimming system consists of three major components: The dimmerbank, the patch panel, and the control console. Each of these components has a certain job to perform.

The Dimmerbank

The dimmerbank houses the dimmer modules. The heart of any dimming system is the dimmer module. The standard dimmer module utilizes silicon controlled rectifiers (SCRs). The SCRs are currently the state of the art for light and power control. These solid state devices are very efficient, rugged and extremely reliable. Dimmer modules are available with ratings from 2,400 watts to 12,000 watts. Fig. 9 shows a typical SCR 12 kw dimmer. The dimmer has a high level filter built into it to increase the sharp rising wave form created by the SCR switching. This increased rise time, due to the filter, suppresses RF interference and reduces the lamp filament sing. It is imperative that any SCR dimmer utilized in a television studio be fully filtered. The 12 kw SCR module shown in Fig. 9 is approximately 8 X 8 X 12 in. This compact size allows for a very neat and clean installation. A magnetic amplifier dimmer, predecessor of

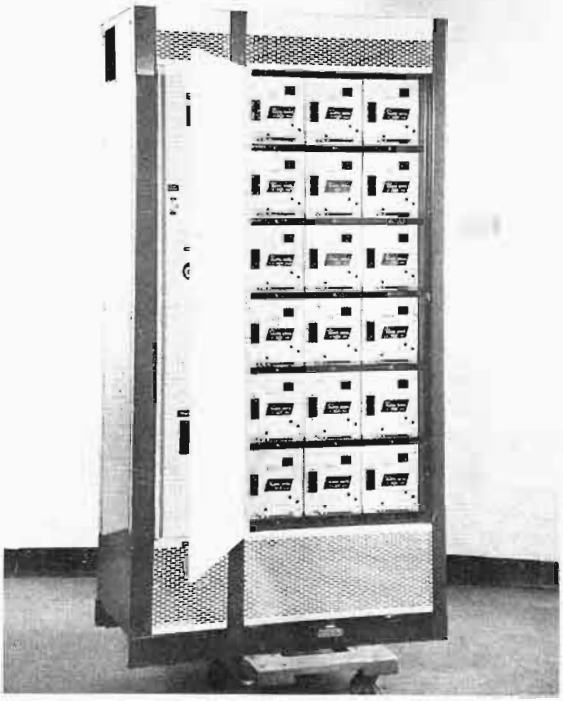

Fig. 10. SCR^{R} dimmer bank (courtesy of Kliegl Bros.).

the SCR dimmer, of this capacity would be over 2 X 2 X 3 ft.! Needless to say, all manufacturers of dimming equipment are using the SCR and similar devices today. A typical dimmerbank using 18 SCR dimmers is shown in Fig. 10.

It is important to note that the dimmerbank should *not* be placed in the studio proper due to the inherent noise created by the filter of the SCR dimmers. Ideally, the dimmerbank should be placed as close to the studio as possible, such as in the prop storage or other suitable area, where moderate temperatures are prevalent.

The Control Console

The control console is the "brain" of the dimming system. The console, upon instruction from the lighting man tell the dimmers what to do and how to behave. This is accomplished by sending a low voltage, low current (nom. 24 v @ 1 ma) signal to the dimmer to control the 120 v 100 amp. dimmer.

The most common type of control console used in television today is a two-scene preset control console with two submasters per scene and cross fading. Fig. 11 shows this type of console. "Two scene preset" means that each dimmer can be set to two separate and distinct levels and recalled or put into action by actuating the proper (Scene 1 or 2) scene master. The two submasters on each scene will allow these two individual scenes to be further broken down into four more groupings giving a further degree

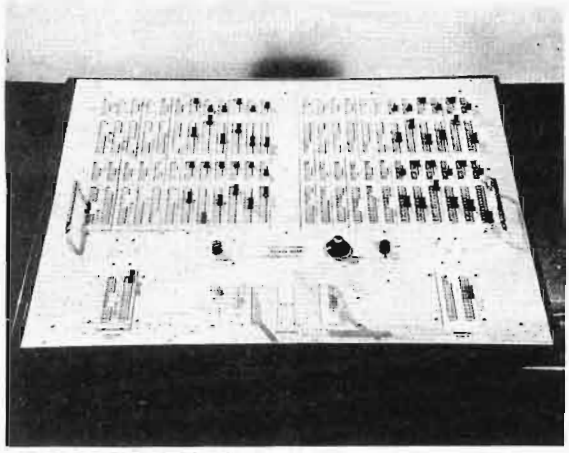

Fig. 11. Two scene preset control console (courtesy of Kliegl Bros.).

Fig. 13. Q-file in Studio 42-CBC (courtesy of the Canadian Broadcasting Corp.).

of control flexibility. For most local productions, a two-scene preset system is ideal. For more complex productions, a five-scene preset is required. This type of system will allow each dimmer to be set to five distinct levels, individually recallable for each of five sets of lighting cues.

For even more complex productions, a computerized memory system has been developed. This type of system uses an electronic memory to "memorize" your dimmer settings electronically. Fig 12 shows the Q-File system. This type of system allows a lighting man to do things that would be impossible with a conventional (manual) preset type of system. A somewhat less complex system, the Q-level, is becoming more and more popular in television. Due to the price reductions in integrated circuits and solid state devices, a memory system can be provided for less than the cost of a large manual preset system. Fig. 13 shows a Q-File console in Studio 42 at the CBC in Montreal. In either memory system, the lighting man sets his various dimmers to the desired level and merely presses a single button to completely "memorize" (record) the entire set of dimmers. By pressing another button, these settings are recalled upon demand.

Patch Panel

In order to transfer the power from the dimmerbank to the lighting fixtures in the studio, the final component of the system, the patch panel, is required. The patch panel is a switchboard which will "patch" (assign) any light in the system to any dimmer.

Fig. 14 shows an overhead style patch panel. Each lighting circuit in the studio is represented by a load cord and plug assembly in the patch panel. When the operator plugs the desired lighting circuit into a dimmer, power to that particular lighting fixture is provided. There is normally one cord per studio lighting circuit. The patch panel is normally located in the studio.

Since the patch panel is used to assign lighting fixtures to the dimmers in the system, its operation must be fast and trouble-free. One of the biggest problems in the patch panel has been the pitting of the load plugs and the dimmer receptacles during "hot" patching. The Kliegl SafPatch system, shown in Fig. 15, completely eliminates this possible source of malfunction. As can be seen by the illustration, due to the unique design of the cord and receptacles it is physically impossible to make or break a patch "hot." This automatic "cold" patching system completely eliminates any possibility or arcing

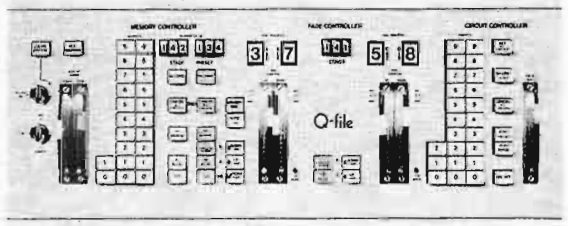

Fig. 12. Q-file memory system (courtesy of Kliegl Bros.).

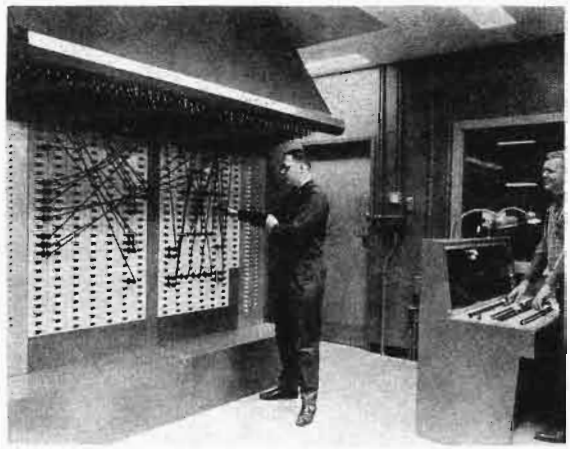

Fig. 14. Overhead batch panel (courtesy of Kliegl Bros.).

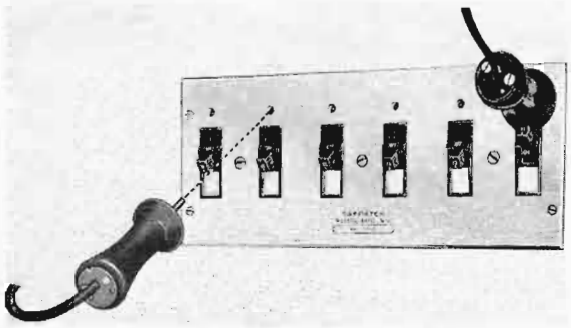

Fig. 15. Safpatch receptacle (courtesy of Kliegl Bros.).

or pitting. This fool proof system will allow even untrained personnel to operate the lighting control system without any danger of system malfunction.

Another type of control system that has been used is the dimmer per circuit system. In this system, rather than have a large number of load circuits going through a patch panel to a smaller number of dimmers, there is a dimmer provided for each lighting circuit in the studio. The thought behind this type of system is increased flexibility since each light can be individually controlled. In practice, however, this system has not proven to be feasible either practically or economically. A dimmer per circuit system will cost 2½ times as much as a conventional patch panel system. For most installations, the convention system will be by far and away the best choice.

Fig. 16 is the electrical riser diagram illustrating the inner connection wiring between the elements of the lighting system with patch panel.

The budget prices for the various elements that make up studio lighting equipment are given below. As stated earlier, the cost to equip a studio is directly proportional to its size.

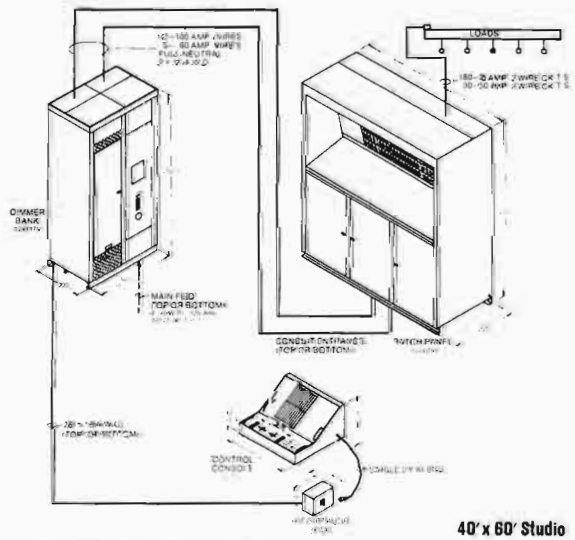

Fig. 16. An electrical riser diagram (courtesy of Kliegl Bros.).

Budget Estimates for Lighting Equipment

Studio size	30 X 40	40 X 60	50 X 70
Fixtures (inc. lamps and accessories)	$16,000	$28,000	$41,000
Electrical distribution equipment	6,000	9,000	15,000
Dimming equipment (patch panel system)	24,000	33,000	44,000
Total package	$46,000	$70,000	$100,000

LIGHTING FIXTURES

The lighting fixtures, or luminaires, are the basic tools of the lighting man. These various types of luminaires are each designed to perform specific functions. Each fixture has its own application. A misapplied fixture will cause no end of grief. The "heart" of the lighting fixture is the lamp or bulb that is used to produce the illumination.

Nowadays in television, the tungsten halogen lamp, commonly called the quartz lamp, is the only type of lamp in use. This lamp has the advantage that its initial light output when first put into service will not vary appreciably until it burns out. The more conventional incandescent lamp, conversely, will lose approximately 38 percent of its initial light by the end of its life. This output versus operating life is shown in Fig. 17.

A conventional lamp loses its light output and also its color temperature due to the blackening of the lamp envelope from the evaporating tungsten filament. The tungsten-halogen lamp has a special halogen gas added to the lamp's atmosphere to absorb this blackening, keeping the envelope clean. Due to its constant output and color temperature through its life and longer rated life, the cost per hour of operation for a tungsten halogen lamp is the same or less than that of its incandescent predecessor.

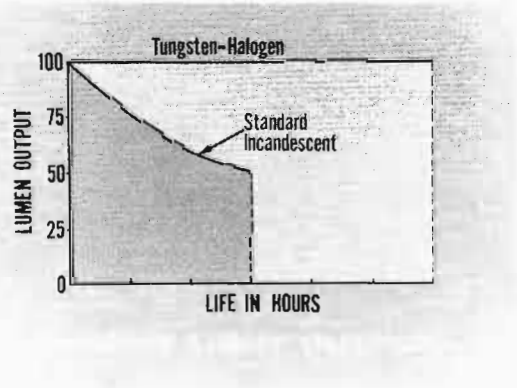

Fig. 17. Light output versus life in hours (courtesy of Sylvania Lighting Production).

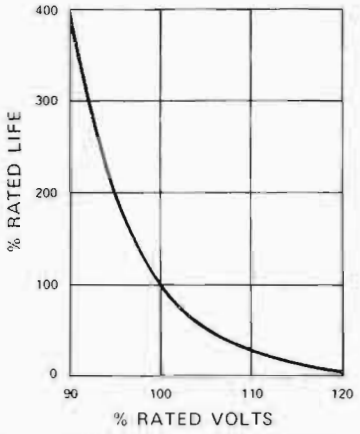

Fig. 18. Typical life variations (courtesy Sylvania Lighting Production).

It should be noted here that lamp life is a direct function of the voltage applied to the filament. If the filament voltage is higher than its rating, the lamp's life is adversely effected. If only a 5 percent overvoltage is applied, the lamp life expectancy is reduced by approximately 50 percent. Conversely, a 5 percent undervoltage will practically double lamp life. Fig. 18 illustrates lamp life versus filament voltage.

In many installations where the lamp voltage is high, complaints of short lamp life are common. The actual voltage at the fixture's socket should be measured to determine the exact voltage at the lamp before any complaints of short lamp life are sent to the lamp manufacturer.

Fresnel Spotlights

The most common type of studio fixture is the fresnel spotlight. This unit, whose output intensity can be varied by changing the relative position of the lamp to the lens, is a highly controlled directional source of light. These fixtures, when equipped with a set of barndoors, gives a smooth even soft-edged field that is easily controllable. These units, which vary in lens size from 3 to 20 in., have corresponding wattage ranges from 150 to 10,000 watts. Fig. 19 shows a 6 in. 750 w fresnel.

When the tungsten halogen lamp was first introduced, the so-called open faced or lensless fresnel was introduced. Even though this unit was more efficient than its earlier incandescent fresnel counterparts, it soon lost its favor in the studio due to lack of control.

For studio applications, 8 in. 1,000 w fresnels are commonly used as back lights with the larger 10 in. 2,000 w fresnel being used for key lights. There are, of course, applications where a larger or smaller fixture is used.

Scoop Floodlights

The scoop floodlight is the second most commonly used fixture in the television studio. The scoop, which is common as either an 18 in. 2,000 w unit or a 1,000 w 16 in. unit, acts to provide base and fill light. A properly designed scoop produces a soft diffuse light in a wide angle configuration.

Fig. 20 shows an 18 in. 2,000 w scoop. Fig. 21 shows a 16 in. 1,000 w focusing scoop. Focusing of the scoop is sometimes a great help. For added versatility, each scoop should be purchased with a diffusion/color frame holder to allow the use of light diffusion material or color media. A scoop can be used as a cyclorama light under certain conditions. It is also very desirable to be able to lower a scoop for better lighting angles. For this, a scissor hanger or pantograph is required. A pantograph is shown in Fig. 22.

Cyclorama Lights

For background lighting of the cyclorama curtain, a special type of cyclorama light is required. These units, when equipped with a color media, will transmit colored light to the cyclo-

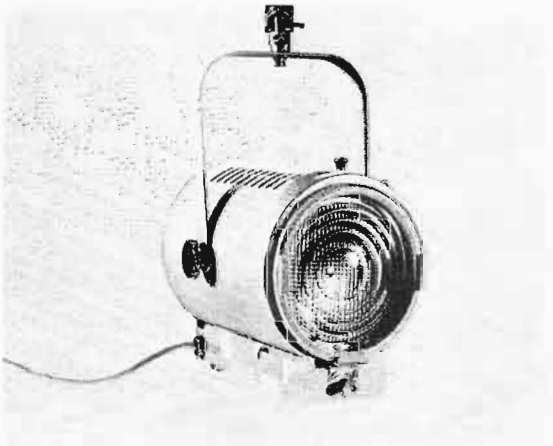

Fig. 19. A six in., 750-w Fresnel (courtesy of Kliegl Bros.).

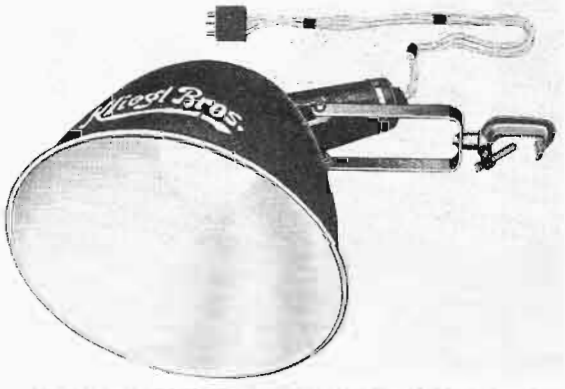

Fig. 20. An 18 in., 2000-w scoop (courtesy of Kliegl Bros.).

Fig. 21. A 16 in., 1000-w scoop (courtesy of Kliegl Bros.).

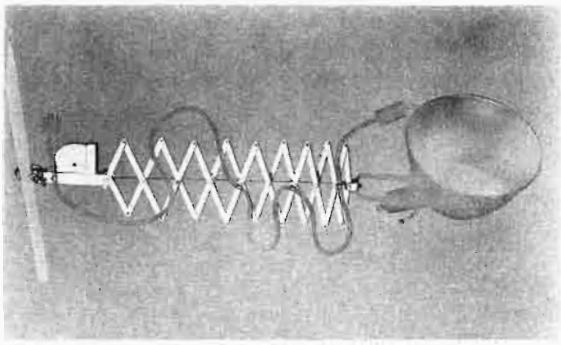

Fig. 22. A pantograph (courtesy of Kliegl Bros.).

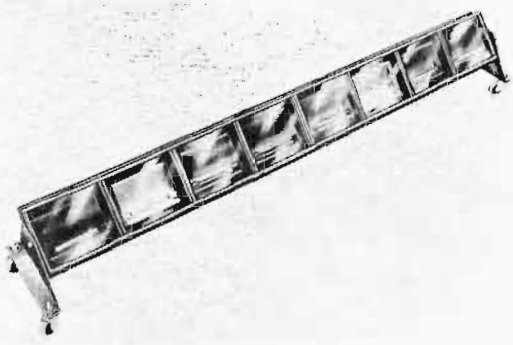

Fig. 23. An eight light strip (courtesy of Kliegl Bros.).

rama curtain. Fig. 23 shows a typical cyclorama strip light. This type of fixture is placed approximately 3 to 4 ft. from your curtain. This type of fixture, with lamps on approximately 11 in. centers, uses considerable power. A new type of cyclorama light called the "Space Cyc" has recently been designed (Fig. 24). This type of fixture does not require continuous strips of fixtures, but only one fixture spaced every 8 ft. The savings on wattage is considerable. This type of fixture will light a 20 ft. high cyclorama with fixtures overhead only on 8 ft. centers requiring only approximately 250 watts per linear foot. This is by far and away the best type cyc light available.

In most studio applications, a three-color cyclorama lighting system is desired. This will allow the cyclorama to be lighted to an infinite number of colors by blending the three primary colors. If budget is of prime concern, two color circuits can be used with a corresponding sacrifice of versatility.

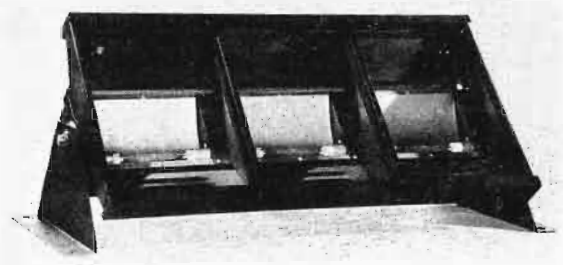

Fig. 24. Space cycle (courtesy of Kliegl Bros.).

Fig. 25. A 3½ in. Klieglight with patterns (courtesy of Kliegl Bros.).

Klieglights

A very special type of lighting fixture found in television studios is the Klieglight pattern projector. This fixture is in essence an optical projector that is used to project patterns on the background of the set area. Fig. 25 shows a 3½ in. 400 w Klieglight and an assortment of patterns. This fixture can be focused so that the pattern projected can be sharp or diffused. This type of fixture should not be used to light talent due to the characteristics of its light output. Fig. 26 shows the most popular sized fixture for studio application. This unit is a 6 in. 1,000 w wide angle unit that is ideally suited for short throws with large coverage areas. In place of the pattern feature, the units can be provided with an iris.

Follow Spots

The follow spot is a fixture that is being used less and less in television today. This is because of the person required to operate the unit. There is, however, no way to duplicate the effect of the follow spot for theatrical type productions in the studio. It is a good idea to plan to have a follow spot in the studio. Fig. 27 shows a 3,000 w dynabeam follow spot.

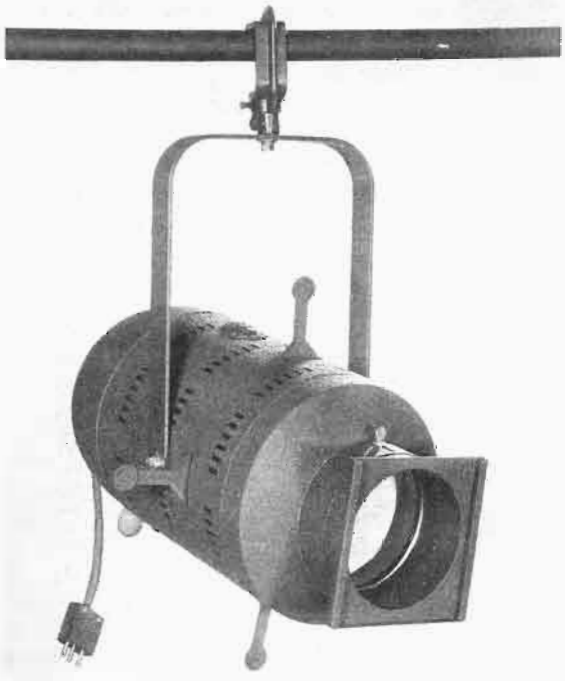

Fig. 26. A 6 in. wide angle Klieglight (courtesy of Kliegl Bros.).

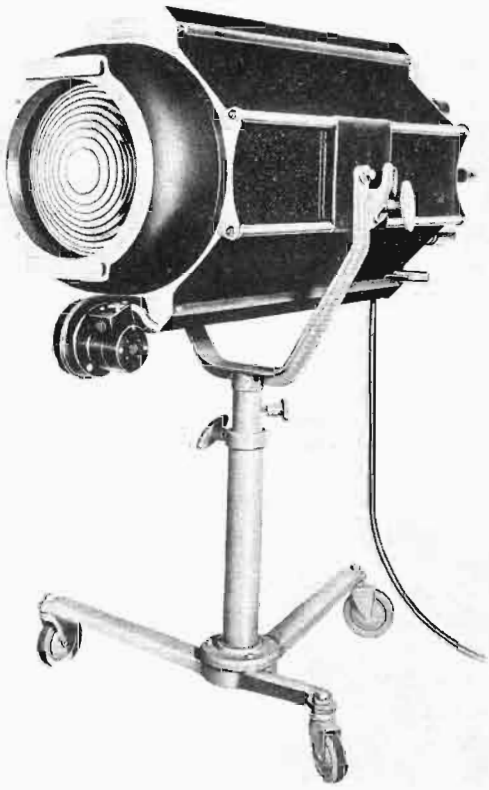

Fig. 27. A 3000-w dynabeam (courtesy of Kliegl Bros.).

FIXTURE APPLICATIONS

There are basically six special types of light that are required to light the average television set. Each one of these special lights will be discussed in detail.

Key Light

The key light or spotlight is the main apparent source of illumination on your set. It is the job of this light to make your subject or subjects stand out to the viewer. It is this light that highlights or "keys" the subject and draws attention to the subject.

A key light must have the following characteristics in order to be an effective key light:

1. *Control:* Since this is the main apparent source of illumination, output of this light must be controllable so that unwanted spill light can be avoided by the use of barn doors. The barn door is an accessory that is slipped onto the front of the spotlight that can be used to control this unwanted spill. For most television applications, a set of barn doors would have four leafs allowing the light beam to be controlled in all four directions.

2. *Soft edge:* The key light should have a soft edge. By soft edge, it is meant that the light pat-

tern of the unit does not have an abrupt cutoff but tends instead to disappear gradually around the edge of the pattern. This is important because on many sets more than one key light is used and if the units had a hard edge or a distinct cutoff, the overlap would be readily apparent.

3. *Harsh shadow:* Since it is the key light's main function to highlight the subject, the light must by definition, be a harsh light which will key and highlight certain features of the subject. Harsh shadow is a term used to describe the shadow that this light throws on the background.

4. *Focusing:* A key light must be capable of adjusting its beam from wide to narrow with a corresponding change in foot-candle level so that the exact coverage and/or intensity can be realized without the necessity of moving the fixture. The quality of the light output from the unit should not change when going from wide to narrow beam coverage. In other words, the light should still exhibit the controllable feature, soft edge feature, and harsh shadow feature no matter in what focus position the unit is used.

One of the single most important characteristics of the key light is its control. No matter how efficient a fixture may be, if the light is not completely controllable, it is almost totally useless. Take, for example, boom shadow problems. If the key light was not controllable, boom shadow could become a major problem in set lighting.

Back Light

Another very important fixture in the television studio is the back light. The back light is a fixture that is often not properly applied or overlooked completely. The main function of the back light is to separate the individual subjects from the background and give them depth and dimension. Without the use of a properly applied back light, the television picture has a very flat, dull appearance. The back light has the following characteristics:

1. *Control:* The back light must be every bit as controllable as the key light. This control is very important in keeping the back light flare out of the camera lens. The exact position of the back light and how it is used will be discussed in another section of this paper.

2. *Soft edge:* As in the key light, the back light fixture must exhibit a soft edge for the previously mentioned reasons.

3. *Harsh edge:* Again, the same note applied for shadow factor on the back light as does the key light.

4. *Focusing:* The focusing feature in many ways is more important in the back light than in the key light. This is true because of the variety of subjects that must be properly backlit. For example, a subject with dark hair must be backlit differently than a subject with light or blonde hair.

As in the case of the key light, the most universally used fixture in studios is the fresnel spotlight. As a rule, the intensity of back lighting required is half to one-third of the intensity of your key light. Therefore, the size and wattage of the back light is normally smaller than that of the key light.

Base Lighting

Base lighting is the third type of light that is required to light a television set. It is the job of the base light to establish the ambient light level that brings up the entire set area to a usable intensity for the studio cameras. The base light has the following characteristics:

1. *Noncontrollable:* Due to the fact that the base light should cover a very large area as evenly as possible, the unit should have a very large apparent source. Because of this large apparent source, the light is very uncontrollable by design. As a rule, the more uncontrollable the light, the better its quality for smoothness.

2. *Soft edge:* Since a number of base lights are normally required for set lighting, the units must exhibit a very soft edge so that these multiple lights can be easily blended.

3. *Soft shadow:* A base light must, by design and application, be a very soft source of illumination. In contrast to the key light with its harsh shadow, the base light should produce very soft shadows which do not detract from the picture and cause background shadows. The shadows cast by the base light should be undistinguishable on the background.

4. *Focusing:* The ideal base light is a unit that can have its coverage as well as intensity continuously adjustable by merely turning a small lever or crank. This allows the user maximum flexibility and ease in setting up his lighting levels.

Fill Light

A fill light is used in studio lighting to mask the "mistakes" created by the individual doing the lighting. It is the job of the fill light to cover up and fill the shadows created by the key light. In addition, the fill light can be used to improve the subject's appearance by use of soft, direct lighting. The characteristics of the fill light are identical to that of the base light and, in fact, the terms fill and base are used interchangeably. A fill light properly positioned can also serve to act as a base light and, conversely, a properly applied base light can also be used as a fill light.

Again, the most commonly used fixture for fill lighting is the scoop.

The four lights previously discused and mentioned make up the bulk of the units required to properly light a television set. As can be seen, only two basic fixtures, the fresnel spotlight and the scoop floodlight are required to light the talent on a set. In order to completely describe all of the lighting required, we must discuss set-cyclorama lighting and effect lighting.

Set Lights

Set lights are fixtures that are designed primarily to bring up the background levels to blend in with the overall set or mood. These lights are very specialized fixtures which are designed to smoothly light a wall or backdrop. Cyclorama lights, on the other hand, are lights that are designed to light a background curtain or cyc. With the use of color media, the cyclorama curtains can be "colored" through the use of these special cyclorama lights previously described. These units can be wired and controlled to produce 2, 3, or 4 individual colors on the curtain. With the use of dimmers, these colors can be blended to give any one of many possible shades and tints.

Effects Lighting

Effects lighting mainly concerns itself with shining a pattern or design on the background to add variety or interest to the picture. The light normally used for this pattern projection is a Klieglight, or ellipsoidal spotlight.

Now that the various types of studio fixtures have been discussed in detail, how are they applied?

For most basic lighting requirements, the triangular approach is used (Fig. 28). If the back light is directly behind the subject and the camera directly facing the subject, the key light is placed to one side of the subject and the base/fill light is placed an equal distance to the other side of the subject. If a line is drawn from each light toward the subject, they would intersect at the subject and form a 3-legged open triangle.

There is no steadfast rule as to which side the key light is on, that is left up to the individual doing the lighting. In some instances, the subject may be more easily lit from one side or the other.

In order to be effective, the back light should be 45°–60° above the horizon behind the subject. In this way, any unwanted shadows created by the back light will fall out of the camera area. The subject should be at least three feet from this back wall for proper separation of the light. By having the light at this high angle, direct radiation into the camera is substantially reduced.

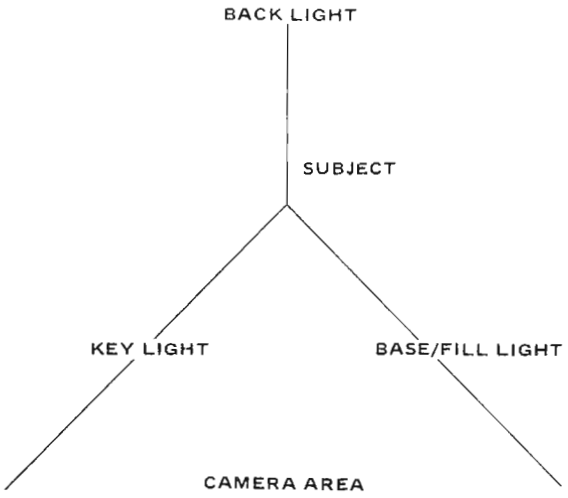

Fig. 28. A three-point light plot (courtesy of Kliegl Bros.).

The key light, on the other hand, should be 45° above the horizon. This angle was chosen for two reasons: by using 45°, the subject can look straight ahead at the camera without the direct radiation of the light into his eyes; and secondly, the light is not so high that it creates unwanted shadows under the nose and chin. The base/fill light is normally from eye level to a maximum of 30° above the horizon. This lower angle is required to ensure that the shadows created by the key light are adequately filled by this base light. In many applications, a pantograph or scissors hanger is used with the fill light so that its exact vertical height can be set upon application. Many studios use some sort of base/fill light on movable stands so that low level fill lighting can be easily accomplished.

The lighting levels that are required are set up by the particular camera that you are using. The ratio of the various lights is important to your overall picture quality. For a starting point, if your base and fill light is given a numerical value of 1, your key light could have a value anywhere from 2-3 with your back light having a value of from 1½-2. In other words, with a base light of 100 fc, the key light should be set for 300 fc and the back light for 150 fc. The exact ratio depends upon experience, subject matter, and the effects desired. It must be emphasized that these rules are only for starting purposes.

So far, the discussion has concerned the most basic type of setup which is the one camera-one subject set. As more subjects and cameras are added, so are the lighting requirements increased. Generally speaking, each subject should have his own key light and back light. In addition, there are many instances when the subject must be key lit and back lit from two separate

lights because of multiple camera angles. Again, the basic triangle method of lighting can be utilized.

SUMMARY

As can be seen, the most important thing in designing and equipping a television studio is in the preplanning and forethought that goes into the facility. It is extremely important that the equipment be matched to the requirements of the studio. Misapplied equipment is more of a hindrance than inadequate equipment. A great deal of advice and information can be gathered from both lighting manufacturers and lighting consultants that are engaged in this business.

GLOSSARY OF TERMS

Absorption Filter—A filter which transmits certain wavelengths and reflects those not transmitted. The absorbed power appears as heat raising the temperature of the filter.

American National Standards Institute (ANSI)—An independent industry-wide association that establishes standards to promote consistency and interchangeability among manufacturers. This organization was formerly known as the United States of America Standards Institute (USASI or ASI), and previous to that as the American Standards Association (ASA).

ANSI—Abbreviation for the American National Standards Institute.

Arc Light—A luminaire using a carbon arc discharge as the source of illumination.

Aspect Ratio—The width of a screened image divided by its height.

Autotransformer Dimmer—A variable voltage transformer.

Backlight—Illumination of the subject from behind to produce a highlight along its pictured edge; light is from a direction substantially parallel to a vertical plane through the optical axis of the camera or viewer.

Barndoor—Shutters of flaps, usually two or four, which are attached to the front of the luminaire in order to control the shape of the light beam.

Baselight—Uniform, diffuse illumination used to establish a sufficient ambient level of light for quality type television and film pickups at desired lens aperture.

Batten—Horizontal pipe on which luminaires or scenery can be hung.

Beam Angle—Those points of the candlepower curve where the candlepower is 50 percent of maximum candlepower define the beam of the luminaire. The included angle is defined as the beam angle. Fifty percent of maximum candlepower is the criterion used for theatrical and photographic lighting equipment; the definition varies in other applications such as floodlighting.

Beam Lumens—The amount of light (lumens) within the beam angle of a luminaire.

Blackout Switch—A master on/off switch used for controlling the overall production lighting for either stages or studios.

Brightness—See Luminance.

Broad—A wide angle floodlight.

Candela—Unit of intensity.

Candlepower—A term that is sometimes used in place of "intensity."

Chaser Lights—A linear string of lamps wired in several circuits; equally spaced lamps (generally 4 or 5 apart) are connected to the same circuit; as the circuits are sequentially energized, spots of light sppear to be chasing along the string.

Chroma—In television, a measure of color intensity; saturation.

Chroma Key—A television special effect which electronically uses a monochromatic color background to key the insertion of another background picture. Deep ultramarine blue commonly is used for the background when the foreground involves people. This process is analogous to the traveling-matte systems used in motion picture photography.

Chromaticity—The hue and saturation aspects of colored light considered together; it is independent of the brightness aspect.

Color—An encompassing term referring to the characteristics of light other than spatial and temporal inhomogeneities; principally the aspect of the hue, saturation, and brightness. Object color involves the capacity of a surface to modify the color of light.

Color Frame—A metal frame used to support color media at the front of a luminaire.

Color Media—Any colored transparent material that can be placed in front of an instrument to color the light. These are often referred to as "gels" (for gelatin); cut glass and other plastic materials are also used.

Color Temperature—The temperature of a blackbody that generates light with the closest *visual* color match to the source being specified.

Console—See Lighting Control Console.

Contrast Range—The ratio of the highest luminance divided by the lowest luminance in a scene.

Cross Connect System—A connecting system which permits studio outlets to be temporarily connected to various dimmer and non-dim circuit outputs. Also see Patch Panel and Selector Switch System.

Cross Light—Equal illumination in front of the subject from two directions at substantially equal and opposite angles with the optical axis of the camera and a horizontal plane.

Cyclorama—A vertical surface which is used to form the background for a theatrical type setting. Although it can be fabricated of a solid material, which is referred to as a "hard cyc," usually it is made of heavy cloth which is drawn taut in both the horizontal and vertical planes in order to achieve a smooth, flat surface.

Cyclorama Strip Lights (also *Cyc Strip*)—A strip light mounted horizontally at the top or bottom of a cyclorama to light it in a smooth or uniform manner.

Dichroic Filter—A filter which transmits certain wavelengths and reflects those not transmitted; the absorption is small.

Diffuse—A reflecting or transmitting media for which the reflected/transmitted light is distributed uniformly in all directions. When used in reference to light, it indicates a soft light.

Dimmer—A device used for controlling the amount of light radiated from a luminaire. Common types are: resistance, autotransformer, magnetic amplifier, silicon controlled rectifier or semiconductor, thryratron, and iris type dimmers.

Dimmer Curve—The performance characteristics of a dimmer indicated in terms of the light output of a lamp controlled by the dimmer versus the arbitrary linear scale of zero to ten associated with the dimmer control.

Dimmer Room—A room or space where remotely controlled dimmers are housed.

Edge Effect—An increased emphasis of outlines common to the image-orthicon.

Effects Machine—A scenic projector, often involving multiple slides and/or motion.

Efficacy (also *Luminous Efficacy*)—The effectiveness of a light source in converting electric power (watts) to luminous flux (lumens) expressed in lumens per watt (LPW). In the past, this concept was called luminous efficiency. Also see Lumens per Watt.

Efficiency—The ratio of a specifically designated output flux (lumens) to the flux (lumens) generated by the lamps in a luminaire; e.g., beam efficiency, field efficiency, luminaire efficiency, etc. Various utilization efficiencies involve the ratio of flux delivered to a specific location divided by the total flux generated by the lamps used.

Ellipsoidal Spotlight—A luminaire embodying a lamp, a reflector, a framing device, and a single or compound lens system, together with provisions for accommodating a pattern hold and patterns.

Eye-Light—Illumination to produce a specular reflection from the eyes (and teeth) without adding a significant increase of light on the subject.

Fader—A term sometimes applied to master dimmers controlling many dimming circuits.

Field Angle—Those points of the candlepower curve where the candlepower is 10 percent of the maximum candlepower define the field of the luminaire. The included angle is defined as the field angle.

Fill Light—Supplementary illumination to reduce shadow or contrast range.

Fixture—A name applied to luminaires.

Floodlight—A luminaire consisting of only a lamp and reflector with fixed spacing; generally, the reflector has a diffused finish and is often physically large in size.

Flux—A measure of the amount of light. The unit is the lumen.

Fly—To lift scenery or equipment above the stage floor (and usually out of view) by means of lines from the gridiron.

f-Number (also *f-Stop*)—A measure of the light-transmitting ability of a camera or projection lens; also referred to as lens speed or lens aperture. As the numerical value increases, less light is transmitted by the lens.

Focal Length—Distance between a particular point of a lens or reflector and the focal point. For simple lenses in lighting instruments, it is usually adequate to measure this distance from the center of the lens.

Focal Point—The small region where a lens or reflector concentrates all light rays received from a distinct source of light.

Focus—In addition to its optical meanings, focus is used as a verb to indicate the aiming and adjusting of a luminaire.

Follow Spot—A high power, narrow beam spotlight suited for long throws (typically 100 to 300 ft.), generally with iris, shutters, color boom, and other controls. It is designed for hand operation to follow the movement of performers.

Footcandle—A unit of illumination. 1 fc = 1 lm/ft^2.

Footlambert—A unit of luminance. A *diffuse* surface emitting one lumen per square foot has a luminance of one fL.

Fresnel Lens—A lens that acts similarly to a plano-convex lens but is thinner and lighter due to steps on the convex side. Often the flat side has a rough surface to smooth light beams by slightly diffusing the light.

Fresnel Spotlight (also *Fresnel*)—A luminaire embodying a lamp and a Fresnel lens, with or without a reflector, which has a soft beam edge. The field and beam angles can be varied by changing the spacing between the lamp and lens.

Front Lighting—Lighting from the general direction of the viewer.

Frost—One of a series of color media that is translucent but colorless, used to diffuse light.

Funnel (also *High Hat, Snoot, Top Hat*)—Metal tubes of various sizes that can be mounted on the front of spotlights to control stray light.

On certain instruments a funnel can be used to reduce beam size.

Gel—See Color Media.

Hard Light—A light that produces hard or sharply defined shadows.

High-Key Lighting—A type of lighting which, applied to a scene, is intended to produce a picture having gradations falling primarily between gray and white; dark grays and black are present but in very limited areas.

Illumination—General—synonym of lighting. Specific—the amount of light (flux) per unit area incident of a surface. The unit is either the footcandle or the lumen per square foot.

Intensity—A measure of the "strength" of a light source in a particular direction. Intensity is independent of the distance from the source. The unit is the candela. Also see Candlepower.

Inverse Square Law—An equation relating the intensity of the source to the illumination it produces at a given distance.

Iris (also *Iris Diaphragm*)—An arrangement of thin plates that form an opaque area with a circular opening in the center. The size of the circular opening is adjustable. As an example of its application, an iris diaphragm commonly is used in follow spots to vary the size of the beam.

Kelvin—A temperature scale where each degree is the same size as a degree centigrade but has its zero at -273°; i.e. -273°C = 0°K, 0°C = 273°K, 100°C = 373°K, etc. This is the unit of temperature used to designate the color temperature of a light source.

Key Light—The principal source of light which establishes the character of the actor together with the atmosphere and mood of the scene.

Lens Spotlight—A luminaire embodying a lamp and a simple lens (plano-convex or biconvex), with or without a reflector, which has variable field and beam angles obtained by changing the spacing between the lamp and the lens.

Light Center Length (LCL)—The distance between the center of an incandescent lamp filament and an arbitrary, but standard point of the lamp base.

Lighting Batten—A pipe and wireway assembly suspended by wire cables with pigtails or receptacles which serves both to physically support the luminaires and to provide electrical power.

Lighting Control Console—The assembly, usually a desk-type of housing, used to contain the controls required for adjusting the production lighting, such as dimmer, nondim, and other control functions.

Lighting Grid—A fixed structure of either aluminum or steel members, such as pipe, which is located above the studio floor for the purpose of supporting luminaires and to support the electrical outlets required.

Low Key Lighting—A type of lighting which, applied to a scene, is intended to produce a picture having graduations from middle gray to black with comparatively limited areas of light grays and white.

Lumen—A unit of (light) flux.

Lumen per Square Foot—A unit of illumination. 1 lm/ft^2 = 1 fc.

Lumens per Watt (LPW)—The number of lumens produced by a light source for each watt of electrical power supplied to the light source. E.G., if a 1,000 watt lamp produces 20,000 lumens, then $\frac{20,000}{1,000}$ = 20 lumen/watt. Also see Efficacy.

Luminaire—A complete lighting unit consisting of a lamp or lamps together with the parts designated to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Luminance—A measure of the light (flux) per unit area leaving a surface in a particular direction. The unit is the flootlambert. This quantity was formerly known as "brightness."

Luminous—An adjective to indicate the production of light, e.g., "luminous source" to distinguish from electrical sources, etc. It is sometimes used before "intensity" or "flux."

Lux—The unit of illumination used predominately in Europe; equal to one lumen per square meter. Ten lux is approximately equal to one footcandle.

Maximum overall Length (MOL)—The maximum dimension of a lamp from base to base for double ended lamps or base to extreme point of bulb for single ended lamps.

Memory System—An automatic device using controls such as punched cards or magnetic tape to control successive settings of dimmers or cross connect systems.

Nondim Circuit—A circuit supplying electrical power to a luminaire by means of a switch or a relay in order to permit an on-off function rather than a dimming function.

Nonlens Spotlight—A luminaire embodying only a lamp and a reflector which has variable field and beam angles obtained by changing the spacing between the lamp and the reflector. (Not for studio use.)

Pantograph—A hanger-type assembly having a scissor-type mechanical action which permits variable height adjustment and which is counterbalanced with tension springs and friction devices.

Par Light—A spotlight-like luminaire using a PAR lamp. The beam characteristics depend upon the PAR lamp used.

Patch Panel—A cross connect system using a plug and jack assembly.

Plugging Box—A portable box with one electrical feed and outlets for two or more branch circuits; often contains branch fuses.

Preset Control—The control, usually a potentiometer located on the lighting control console, used to program or preset the output of a dimmer, and in turn, the light output of the luminaire connected to the dimmer.

Remote Controlled Dimmer—A dimmer which requires an electrical circuit or circuits as part or all of the transmission system between the central lever and the dimmer unit.

Scene Master—A device for controlling a group of dimmers which are assigned to a specific set or scene.

Scoop—A deep floodlight with a diffuse, generally elliptical contoured reflector; the field angle commonly is less than 100°.

SCR—Abbreviation for Silicon Controlled Rectifier; a solid state semi-conductor device operating as a high-speed switch and is the basis for most modern dimmers. (Kliegl copyright)

Set Light—Separate illumination of background or set other than that provided for principal subjects or areas.

Soft Light—A well-diffused light source which produces soft or poorly defined shadows when an object is placed in between the luminaire and the light background.

Specular—Description of a mirror-like surface. When used to describe a light, it implies a hard light.

Spill Light—Stray light outside of the main beam of a luminaire; light that is misplaced or undesired within a scene.

Striplight—A luminaire with a number of lamps arranged in a line. Often each lamp is in an individual compartment. There may be a reflector behind the lamp and/or a color media in front of the lamp. Striplights are normally wired in three or four circuits.

Throw—To direct the light of an instrument in a particular direction. Also the effective distance between a luminaire and the area being lighted.

Underwriter's Laboratories (UL)—An independent testing laboratory that will test equipment to see if it meets certain safety standards when properly used.

Unit—A name applied to theatrical type luminaires, basically jargon for lighting unit.

Worklights—A general lighting system permanently installed in the studio or stage production area, which provides sufficient illumination for moving scenery and general work when the production lighting system is not in use.

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