MOTION PICTURE HANDBOOK

A Guide for

MANAGERS AND OPERATORS
of MOTION PICTURE THEATRES

By F. H. RICHARDSON

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AUTHOR'S NOTE.

This book is dedicated to the motion picture operator as a token of appreciation of the important part he plays in the presentation of the photoplay. That it may be helpful in hastening the day of perfect motion picture projection, is the desire of the writer, and he trusts that a careful perusal of its pages may stir the ambition and increase the ability of every reader.

F. H. RICHARDSON.

October, 1910.

PUBLISHER'S NOTE.

The remarkable vogue of the motion picture and the rapid strides it has made in public favor as an entertainment and educational factor has had its drawbacks. Chief among these has been the impossibility of securing a sufficient number of men with the necessary knowledge and experience to fill important positions.

The Moving Picture World has, in no small measure, contributed to the success of the picture and the articles in this book were written to give helpful information in regard to the many problems that may arise in connection with the duties of the manager and operator. With a few exceptions the articles have already appeared in the Moving Picture World but they have been revised and amplified and are herewith presented in compact form to comply with popular request.

Mr. Richardson has avoided technical terms and his plain language and matter-of-fact style bespeaks for this book the same degree of popularity which attaches to the Operators' Column which he still conducts in the pages of

THE MOVING PICTURE WORLD.

October, 1910.

The Source of the Light.

It is imperative that the motion picture operator should thoroughly understand the electric current and the rules which govern its action under any given circumstance likely to be met with in the line of his work. It is not enough that he know that a few certain things will produce certain results. He should know WHY these results are obtained; in other words, he should understand the force he is handling, and understand it thoroughly if he expects to obtain the best possible results. Moreover, while the one who has not an elementary knowledge of electricity may learn to handle the current with very good results under one certain set of conditions, he is likely to be practically helpless under other and different conditions, particularly should he be called to "go on the road," thus being obliged to "hitch up" on different systems of wiring, different lighting systems, and meet with a wide range of voltage. Also the man who, while able to get fair, or even good, results under conditions with which he is familiar, does not thoroughly understand the force with which he is working is not in position to improve results already obtained through the medium of intelligent experiment. He must perforce depend almost wholly on what someone else tells him without being able to form an opinion as to whether what he has heard is likely to be correct or incorrect.

Good light is of prime importance in picture projection, and the one who is able to produce and maintain a clear, silvery-white spot has mastered three-fourths of the difficulties between him and the goal of good operating.

THE CURRENT—DIRECT AND ALTERNATING.

The difference between direct and alternating current is simple, once it is understood.

Direct current flows constantly in one direction, so that one carbon of the lamp is always positive and the other negative. For reasons which will be fully explained later, the positive carbon must always be above and the negativ below when using direct current.

Alternating current, on the other hand, flows first in or direction and then in the other, this being caused by t peculiar construction of the generator (dynamo). The cı rent flows one way for a time varying from 1-25 to 1-275 a second. It then is reversed, flowing in the opposite dirı tion for the same period of time. These two periods of flo are termed a "cycle." To make this term more clear: suppose you walk across a room, then turn and walk back again. When you got back where you started from you would have completed what would correspond to a "cycle" in alternatin current. Therefore when you hear "60 cycle" current spok of it means that the current reverses its direction 120 tim per second. If it be 132 cycle the reversals are at the ra of 264 per second, etc. In a two-pole dynamo the curren flows in one direction during the time the armature makes one-half of a revolution and in the opposite during the other half, so that one complete turn of the armature completes one "cycle." Modern dynamos, however, have more than two poles (some of them a great many more), thus reducing the necessary armature speed required to produce a given current frequency. ("Frequency" means the number of cycles per second.) All dynamos, direct or alternating, are constructed to produce a certain voltage, and the machine designed to produce, for instance, 110 volts could not and would not produce 220 volts or any other pressure than that named.

With alternating current each carbon of the lamp is alternately positive and negative. This has a very decided effect on projection light, as will be explained later on. Many operators claim that as good results cannot be obtained from alternating as with direct current, but this is not true, though it is somewhat more difficult and requires more current (amperes) to produce results equal to those possible with direct current.

Alternating current is preferred by power, and many lighting companies, mainly for the reason that it can be generated at high tension (voltage) transmitted to the place where it is to be used and there transformed (reduced to ɔwer voltage) by means of a very simple arrangement, ıown as a transformer, the latter requiring very little care attention. Also this current is just as readily transformed m a low to a high voltage.

'his cannot be so readily done with direct current. For eral reasons high tension direct current is neither so irable or commercially practical as is alternating.

[NOTE.—Those who wish to learn more about this matter may do so y consulting works on electricity at their public library.]

Now the saving lies just here: high tension (high voltage) ırrent capable of performing an immense amount of work ı be transmitted over a very much smaller wire than can same amount of electrical energy at low voltage. It is JANTITY (amperes) of current flowing, not pressure, ich determines the size of wire necessary. One (1) npere at 2,000 volts becomes about ten (10) amperes after t has been transformed down to 110 volts pressure. By consulting the wire table (given later on) you will find that, while a very small wire will carry three amperes, it takes a much larger one to carry 30 amperes. Now suppose the current must be conducted one mile from the power station. If the tension is 2,000 volts the current may be brought right up to the transformer (usually located on the pole nearest to where the current is to be used) on a small wire, whereas if it were generated at 110 volts it must be carried all that listance at that voltage, thus requiring about ten times the mperage. Don't you see the immense saving in wiring cost?

All this has no direct bearing on operating or projection, ɔut is explained for the reason that the writer has heard ɔperators compelled to handle alternating current exclaim with considerable heat, "What do they generate the stuff for anyhow?" Then, too, the operator should have at least some understanding of these matters, and, as a matter-of-fact, the more general knowledge he has of electrical practice the better for him and his employer.

One question frequently propounded, and which seems to puzzle a great many operators who seek to understand alternating current is: "How is it that if the current reverses its direction so often there is flow sufficient to maintain an arc?"

This is very simple when one stops to consider the enormous speed of the electric current. This speed has been variously stated, some authorities placing it as high as that of light. With this in mind it will readily be seen that, infinitesimal as is the time required for an alternation the current will pass hundreds, if not thousands, of times entirely around a circuit many miles in length during that period. Electric speed is entirely beyond the power of the human mind to grasp and comprehend.

Careful experiment has proven that a low frequency current is most economical for power purposes, 25 to 30 cycle being best. On the other hand, the high frequency current is best for light. Current with as low frequency as above named will not do for light at all, as the illumination furnished by it is flickery and unsteady. It has been found that 60 cycle current answers fairly well for both purposes and that is the standard being adopted by practically all new commercial plants designed to furnish both light and power. Even the old plants originally furnishing very high or very low frequency current are changing their generators to 60 cycle machines, so that is the alternating current you will now most frequently meet with.

Direct current needs no detailed explanation. Being generated in the dynamo it flows out on one (the positive) wire, performs its work and returns to the dynamo via the other (negative) wire. You are not likely to have to cut into any high tension direct current systems and will almost invariably find direct current to be at a pressure of 110 volts, except where the three-wire system is used. From this sysetm (as will be explained further on) you can get either 110 or 220 volts, according to the way you "hitch up" to it.

In handling steam we use the term "pound' to denote pressure. In handling water its volume or quantity is expressed in "gallons."

Electricity has pressure just exactly as has steam in a boiler, but this pressure is expressed in "volts" instead of, as in steam, in pounds. Electric current has volume, or quantity, just as has flowing water, and this quantity is measured, or expressed, in "amperes," instead of in gallons, as is the case with water.

Fix it firmly in your mind that the term "VOLT" MEANS PRESSURE and nothing else but pressure, just exactly as pounds means pressure in a water pipe or a steam boiler, and that "AMPERES" MEANS VOLUME, OR QUANTITY, of current flowing, exactly as gallons would mean the quantity of water flowing in a water pipe.

Electric current has both pressure and volume, exactly the same as has water in a watermain, and the terms volt and ampere mean in electrical practice precisely the same thing as do pounds and gallons when applied to a water-main carrying water under pressure.

The "ohm" is the term used to express resistance to the passage of an electric current. Current in passing through a wire meets with resistance, just as a water pipe offers resistance to the flow of water through friction. This resistance is expressed in ohms.

The term "Watt" is used to measure the amount of work performed by an electric current. In other words, it means electro-motive force or horsepower. Merely for the sake of convenience the term "kilo-watt" is much used, meaning 1,000 watts. A watt is 1/746 of a horsepower.

DEFINITIONS OF TERMS.

These definitions are the clearest, simplest the writer has been able to discover after a search of many standard works on electricity. He believes that a close inspection of them will enable the average man to arrive at a pretty close understanding of what the terms really mean. At any rate they cannot be put in simpler language.

VOLT: The practical unit of electric pressure, or electromotive force. The pressure required to move one ampere against a resistance of one ohm. The electro-motive force induced in a conductor, usually an armature coil, which is cutting 100,000,000 magnetic lines (of force) per second.

AMPERE: The unit of electric current (quantity or volume). That amount of current which can be driven by a pressure of one volt, the unit of electric pressure or electromotive force, through one ohm, the unit of electric resistance. Such a rate of flow of electricity as would transmit one coulomb per second (a coulomb is defined as the unit of electrical quantity. That quantity of current which would pass in one second through a resistance of one ohm, under a pressure of one volt.). A current of such strength as would deposit .005084 grains of copper per second. The unit rate of flow per second.

[NOTE.—Some writers say that the term ampere does not represent quantity, but only indicates the strength of the current; quantity being represented in coulombs, which means the quantity passing a point in a given time (coulombs equal the amperes times and seconds). This is splitting hairs altogether too fine for the average operator. Technically the above statement is quite true, but for the operator's purpose it is well enough to say that amperes represent quantity.]

OHM (there are several standards, viz., the Board of Trade Ohm, English Ohm, British Association Ohm, Legal Ohm and the Standard Ohm): The "Legal" ohm is the standard used in the United States, and it is defined as follows: The resistance of a column of mercury (the resistance such a body of mercury would offer to current) 106 centimeters in length, having an area of cross-section of one square millimeter at 0 degrees Centigrade or 32 degrees Fahrenheit. This is now the international value of the ohm.

WATT: The unit of electrical activity or power. The number of watts is numerically equal to the amperes times the voltage. One volt times one ampere equals one watt or 1/746 horsepower. Sometimes called the "Volt-Ampere."

HOW TO MAKE CALCULATIONS.

Knowing the voltage and number of ohms resistance the number of amperes flowing may be determined by dividing the volts by the ohms; as, for instance, having 110 volts pressure and a rheostat offering 3 ohms resistance how many amperes will we get? 110 divided by 3 equals 36 2/3, the number of amperes. Knowing the voltage and number of amperes flowing, the ohms resistance offered may be determined by dividing the volts by the amperes; as, for instance, with 220 volts pressure and 40 amperes flowing how many ohms resistance have we? 220 divided by 40 equals 5½, the ohms resistance offered to current passage. Knowing the number of amperes flowing and the ohms resistance we may find the voltage by multiplying the amperes by the ohms; as, for instance, if we had 3 ohms resistance and were getting 30 amperes of current we would find the pressure by multiplying 30 by 3, which would tell us the voltage was 90

RULE OF THUMB.

The following formula, known as the "Rule of Thumb," is correct and is very convenient in aid of memory. In this formula, V equals volts, A amperes and O ohms. Remembering that it is expressed as a fraction and that the line means "divided by" and that with the upper quantity eliminated the two lower should be multiplied together, just cover up the quantity desired and what remains will equal the quantity covered up. For instance: I wish to ascertain the resistance, knowing the amperage and voltage. I place my thumb over the "O" and see that V divided by A will give it.

$$\frac{V}{O\ \ A}$$

To find the watts being consumed you simply multiply the voltage by the number of amperes flowing; as, for instance, we have 30 amperes at 110 volts. How many watts? 110 multiplied by 30 equals 3,300 watts. How many kilowatts is that? 3,300 divided by 1,000 equals 3 3/10 kilowatts. How many horsepower is it? One watt is 1/746 of a horsepower, therefore 3,300 watts would equal 3,300 divided by 746 or 4 and 158/373 horsepower.

Wiring.

INSULATION.

This is a matter of the UTMOST IMPORTANCE to which too little attention is usually paid. In too many instances current bills are excessive simply for the reason that there are unsuspected current leakages due to faulty insulation. By this it is not necessarily meant that the wire covering is faulty. Insulation, in its true sense, means keeping the current from contact with the ground, in any degree, at all points, also keeping the opposite wires of a circuit from electrical contact with each other.

We confine electricity to the wires by insulation, and the higher the pressure (voltage) the more perfect must be the insulation. If there be a small "pin-hole" in the seam of a boiler the steam will still be confined at pressure but some of it will be escaping, thus causing constant waste. If there be a slight imperfect "ground" (imperfect connection between the earth and the wire) there will be a small but constant current leakage, which will tell in the meter and therefore in the current bill. You will thus readily see the necessity for very carefully insulating your wires. Further along I will tell you how to detect grounds.

Air is a conductor of electricity, but a very poor one. It will only carry current at enormous voltage—far in excess of anything used commercially, with the single exception of wireless telegraphy. Air may, therefore, be said, so far as commercial electric current is concerned, to be an absolute non-conductor, and it follows that current cannot escape from the wires by way of the air. Certain substances, such as rubber, glass, porcelain and others, are non-conductors of electricity, and by stringing the wires through the air, allowing them to come in contact with nothing but non-conducting material, the current is confined to the wire, just as is the steam in a boiler by its steel plates and rivets. Wires are usually covered with rubber or some non-conducting composition, thus still further insuring complete insulation and consequent confinement of the current.

But if there be the very least metallic or other current-carrying connection with the earth there will be current constantly escaping from the lines, and this means waste pure and simple. It is the small "ground" (a "ground" is a current-carrying connection between the wires and the earth) that is dangerous to the pocketbook. If connection is such as to carry considerable current it will most likely manifest itself by heating, and may burn off, but the small ground is different, for you can't see it, you don't have any visible evidence that it is there; no one but the meter knows it exists, but all the same it works night and day. The power-house man may know of it through his ground detector, but he won't send any special messengers to tell you, since it is constantly adding to his "bills collectible."

Be very careful, therefore, to have your insulation PERFECT.

Supposedly, in this day of multiplicity of electrical devices, nearly every one understands what a "short circuit," familiarly known among electricians as a "short," is. Nevertheless I will explain the matter. As has been stated, the constant tendency of current is to lower its own pressure, just as steam seeks the open air for the same purpose. The positive wire of a circuit carries the full dynamo pressure, but the pressure of the negative wire is very much less. Current will therefore flow from the positive to the negative the instant any sort of current-carrying connection is established. A lamp is a limited short circuit between the positive and negative, limited because of its internal resistance which is calculated carefully to only allow a certain quantity of current passage. A projection arc lamp is a dead short circuit when the carbons are closed, but the short is controlled by the resistance device (rheostat or compensator) placed in series with it. The true "short," however, is where the two wires of the circuit become joined through contact without any such controlling device. Such a short may be by reason of the two wires coming in direct contact, in which case the fuses will blow or the wires heat and probably burn off. Fuses are supposed to, and by all means should, be small enough to blow the instant such a short is established, otherwise there is danger of the heated wires causing fire. A short may be caused by a loose wire swinging against the opposite conductor or being carelessly thrown across the two. It may be caused by some poor conductor being laid across the two wires, in which case there will be current leakage until it is removed, and this leakage will represent the same waste as would a ground. As a general proposition, however, a short shows itself immediately and whatever damage is done is almost instantaneous.

WIRING.

All wires used in inside work, and most of those used for outside as well, are covered with either rubber, gutta-percha or a fibrous covering saturated with an insulating compound. Such wires may touch DRY wood without likelihood of danger but, on general principles, should not be allowed to. Wires should never, under any circumstances, be allowed to come in contact with metal which has any kind of connection with the earth or which reaches (as the iron sheeting of an operating room) from one wire of a circuit to the other. In saying that wires should not be allowed to touch metal the writer is fully aware that modern electrical wiring allows of, in fact, in some cities, requires that wires be encased in metal tubing, both wires of a circuit being

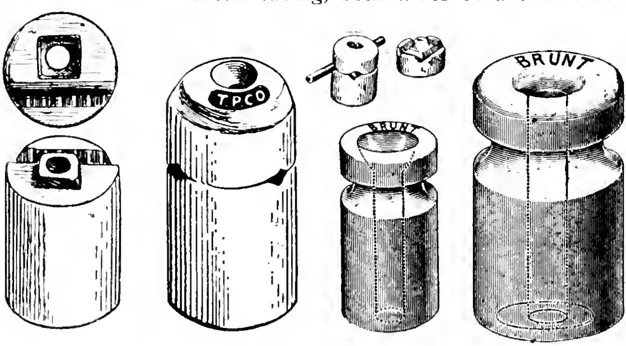

FIG 1.

placed in the same tube. There are technical reasons why this is not injurious. There are, by the close proximity of the wires to each other and to the conduit, induced currents when alternating is used but one current neutralizes the other so that, as a matter of fact, this induced current is not recorded by the meter nor does any reach the earth by way of the conduit, unless the wire insulation and conduit insulation is imperfect allowing actual contact between a raw wire and the metal of the conduit. A technical explanation of the reasons for this would be beyond even the average electrician and will therefore not be given. Suffice to say this is the fact.

In running your house or operating room circuits run the wires as directly as possible, stretch them tightly and fasten them securely to porcelain insulators, types of which are shown in Fig. 1. It is best to keep the wires of a circuit not less than 2½ inches or 3 inches apart. The insulating knobs may be fastened to the wall or ceiling either by nails or suitable screws. If nails are used cut out a circular piece of heavy leather ½ to ¾ inch in diameter and drive the nail through it first. This acts as a cushion and you can drive the nail down tight on the head of the insulator without breaking the porcelain. Allow your wires

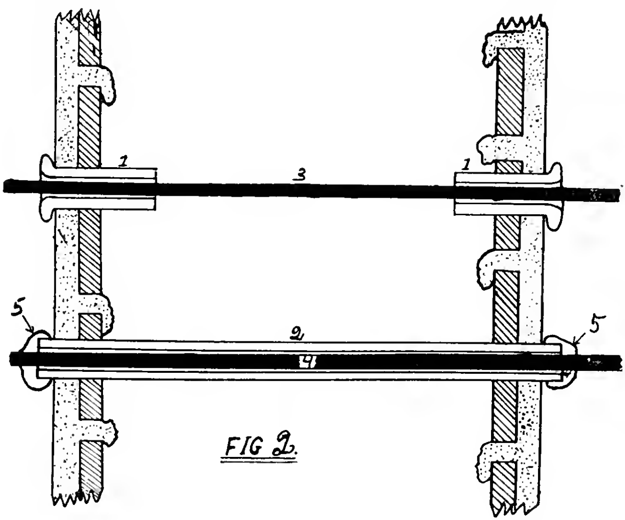

FIG 2.

1—1 Porcelain insulators.
2 Rubber tubing.
3—4 Wires.
5—5 Tape to hold tubing in place.

to come into contact with absolutely nothing but the insulators except as hereafter related. To pass wires through a wall or floor get some hard rubber insulating tubing from an electrical supply house. Bore a hole as large as the outside diameter of the tubing through the wall or floor, being certain that the tubing will go over the insulated wire. Run your wire through the hole and slip on the tubing, shoving it into the hole so that it projects slightly on either side. Pull the wire tight and fasten it, then wrap insulating tape tightly around the end of the tubing and wire on both sides of the wall to prevent its slipping out of place. Porcelain tubes may be used instead of hard rubber if desired (see Fig. 2).

If the wall be of brick take a piece of gas-pipe and file saw teeth notches around the circumference of one end. Using this as a drill you will be astonished how soon you can pierce a hole through the wall.

Bear in mind that this work is not designed to make a lineman of you but merely to give sufficient direction that you may be able to run a circuit properly should circumstances be such that it be necessary. On the road an operator is called upon to do a great many feats and frequently if he can't do them circumstances are such that they cannot be done at all. Moreover, I wish to enable the operator or manager, from the directions given, to be able to form at least an intelligent opinion as to whether their wiring is being, or has been, properly done.

Your wires should be selected by reference to the wire and lamp current consumption tables which appear a little further on. It is generally stated that "a 16 c.p. incandescent lamp consumes ½ ampere of current." This, you will see by reference to the lamp consumption table, is very wrong, applying only to 110-volt lamps.

To figure the size of wire necessary in circuits you proceed as follows: Supposing we have 110-volt current and wish to install a circuit to carry ten 16 candle-power lamps. By reference to the lamp consumption table we find that each 110-volt 16 c.p. lamp will require ½ ampere of current, or a total of five amperes. By reference to the wire table we discover that a No. 16 rubber covered wire will carry six amperes, leaving a one-ampere margin, so we select this size. A No. 18 weatherproof wire would carry the required current but the underwriter's rules forbid anything smaller than a No. 16 wire being used on inside work.

In using this table we must remember, however, that it applies for SHORT LEADS ONLY (see Table No. 3). As the length of a wire increases its total resistance increases, so that a No. 16 wire would not convey six amperes of current for a long distance without drop in voltage due to resistance. If the lead be long a larger size must be used for a portion of the distance. In other words, if your lead be a long one, it will be necessary to use, for a portion of the distance, a size of wire capable of carrying something more than the amperage indicated in the table, else there will be "drop" of voltage and your lamps will not burn up to candle power.

The following table gives the current allowance by the National Board of Fire Underwriters for various sizes copper wire, figured on a non-heating basis and, with due allowance made for long leads, it will meet every requirement of either the operator or the electrician.

TABLE NO. 1.

Browne & Sharpe Gauge.	Rubber Covered Wire. Amperes.	Weatherproof Wire. Amperes.
No. 18	3	5
No. 16	6	8
No. 14	12	16
No. 12	17	23
No. 10	24	32
No. 8	33	40
No. 6	46	65
No. 5	54	77
No. 4	65	92
No. 3	76	110
No. 2	90	131
No. 1	107	156
No. 0	127	185
No. 00	150	220
No. 000	177	262

NOTE.—The discrepancy in allowance between rubber covered and weatherproof wire is not that one will not carry just as much current as the other, but arises from the fact that the least heating will cause gradual deterioration of rubber insulation. Wire with rubber insulation is therefore rated very low in current carrying capacity.

LAMP CONSUMPTION TABLE.

This table is compiled from actual tests made with standard lamps and it will be found to be approximately correct. Used in conjunction with the wire table even the novice may figure out what size wire to use for any incandescent circuit not exceeding seventy-five feet in length.

TABLE NO. 2.

Voltage.	Candle Power.	Amperes.	Watts.
52	16	1.04	54.1
52	32	2.08	108.2
100	16	.64	64.0
100	32	1.28	128.0
110	16	.51	64.0
110	32	1.16	128.0

Where 8 c.p. lamps are used in decoration two of them equal one 16 c.p. lamp in current consumption.

Light frosted or ground glass globes reduce the illuminating power of incandescent lamps by about 12 per cent. The average life of an incandescent lamp is about 800 hours of use. Many will burn much longer and some much less, but this is the average. Old lamps are poor economy in a theater, as they burn dim and destroy the illumination.

TABLE NO. 3.

This table will be found of much use in conjunction with Table No. 1. As has been said, there is drop in voltage in long leads, due to resistance. This table gives the data in this connection so far as it will be likely to be of the least use to the theater man or operator.

Voltage			Wire No. Browne & Sharpe Gauge.
52	110	220	
292	625	1247	14
370	780	1586	13
473	1000	1957	12
602	1252	2499	11
749	1575	3175	10
940	1984	3976	9
1186	2542	5012	8
1500	3162	6355	7
1897	3997	8032	6
2387	5100	10110	5

To use this table multiply the distance in feet from the point of departure to the end of the circuit by the number of amperes

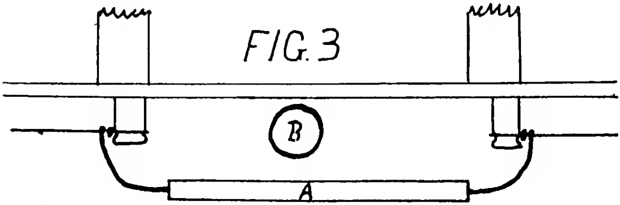

FIG. 3

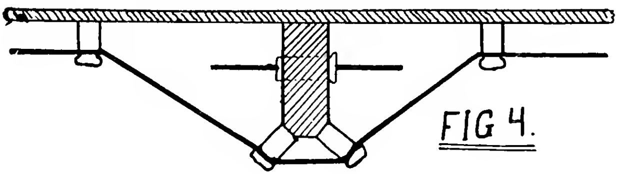

FIG 4.

you wish to use on the circuit. Look in the table under the voltage heading corresponding to the voltage of your lines and find the number nearest to the product you have obtained by the multiplication. Opposite this, in the right-hand column, will be found the size of wire necessary to carry this current with 3 per cent. loss.

In running wires along a wall it is often necessary to pass a metal pipe which the knobs will not be long enough to allow the wires to clear. This should be taken care of as per Fig. 3.

A is hard rubber insulating tubing. B is the pipe.

Another electric wire of opposite polarity may be crossed in the same manner. A joist or timber may be passed as shown in Fig. 4 or the wire may be run directly through it by insulating with porcelain, glass or hard rubber tubing.

In making a wire splice, or joint, it is of the utmost importance that it be done right, since a poorly made joint will invariably heat, with consequent loss of power and liability to eventually burn off. Fig. 5 shows some of the ways of making different joints in wire. "A" shows the right and wrong way to skin a wire. If done as at 1 you are likely to cut a slight ring around the wire and this will cause it to break very easily. "B" shows the "Western Union" joint which is most used by wiremen. Invariably use two plyers in making this joint and pull it up perfectly tight. "C" shows the proper method of tying a wire to an insulating knob. Use wire (without removing the insulation) the same size as the line you are tying. At "D" is seen the

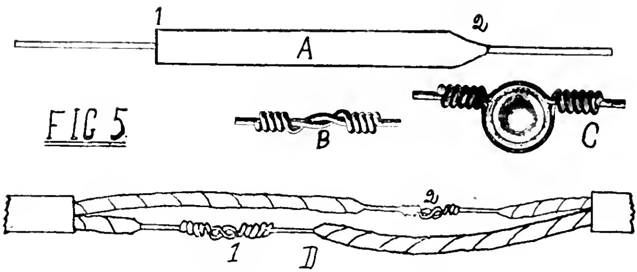

FIG 5

proper method of making a splice in a twin wire. When the joint is done 1 and 2 should be wrapped with insulating tape after which the whole length from which the outer insulation has been removed must be thoroughly taped. Twin wires (two insulated wires enclosed in one outer insulation) should be used only in metal conduits. To make a splice in a flexible cable strip the insulation from about three inches of each end. Clean the strands thoroughly and separate the wires of each end into about four equal parts two-thirds of the way back to the insulation. Now put the ends together so that the strands of each end will come between each other and wrap them down tight and solder.

Before making a wire joint always CLEAN THE WIRES PERFECTLY, scraping them until they shine. It is impossible to make good electrical contact unless the metal is perfectly clean. After making a wire joint always cover with insulating tape at least as deep as the original insulation.

To solder a joint first heat the wires with a gasoline torch and rub on a soldering compound, which may be had in stick form from electrical supply houses. Then, using solder wire, melt sufficient solder by holding the solder to the joint and playing the flame on it to thoroughly fill the splice. Care should be had not to heat the wires, especially if small ones, too hot, as it has a tendency to weaken them. Those who cannot secure soldering compound may make a flux as follows: Saturated solution of zinc chloride 5 parts, alcohol 4 parts and glycerine 1 part. A well-made joint may be used temporarily without soldering, but a permanent joint should ALWAYS BE SOLDERED.

Before leaving this branch of the subject of wiring I will tell you how to figure the resistance of wires. You probably will never need to use the rule, but for the sake of completeness I will supply the information. Electrical calculations having to do with wires are based on the "circular mil." The term really means the cross section of a circle 1-1000 of an inch in diameter. The resistance of a commercial copper wire having a length of one foot and a cross section of one mil is 10.8 ohms. This resistance increases as the length increases and decreases as the cross section increases. In other words, the longer the wire the more resistance, and the larger it is the less resistance it offers to a given current. To find the resistance any copper wire will offer you simply multiply its length in feet by 10.8 and divide the product thus obtained by the number of circular mils the wire contains. To turn this rule to practical account we must go further. To find the size wire necessary to transmit any given current a given distance with a certain percentage of loss proceed as follows: Multiply the number of amperes by the total number of feet of wire in both legs of the circuit and multiply this by 10.8. Multiply the voltage by the percentage of loss you propose to allow and divide one product by the other and the result will be the area of the required wire in circular mills.

B. & S. Gauge.

No. 16 wire has an area of 2,583 c. m.
No. 14 wire has an area of 4,107 c. m.
No. 10 wire has an area of 10,380 c. m.
No. 8 wire has an area of 16,510 c. m.
No. 6 wire has an area of 26,250 c. m.
No. 4 wire has an area of 41,740 c. m.

The above table contains all the sizes of wire likely to be used in an ordinary theater.

SWITCHES.

Those attempting to pass an examination will find it quite essential to know considerable about switches, especially the correct names of those in most common use. To this end illustrations of some of them are incorporated. Fig. 6 shows a single throw, double pole knife switch such as is almost invariably used for light circuit service switches, also for the projection arc lamp circuit. This is the switch most commonly encountered, but it comes in many forms. The "snap" switches which are enclosed in a small, round metal case and operate with a button are one form of this switch. A, Fig. 6, is arranged for link (A, Fig. 10) and B for cartridge (Fig. 9) fuses. Fig. 7, A, shows the triple pole, single throw knife switch; Fig. 7, B, the single pole, single throw knife switch, and Fig. 7, C, the double pole, double throw knife switch. Fig. 7, A, is arranged to carry cartridge fuses (Fig. 9), while Fig. 7, B and C, must have link fuses (A, Fig. 10) or plain fuse wire.

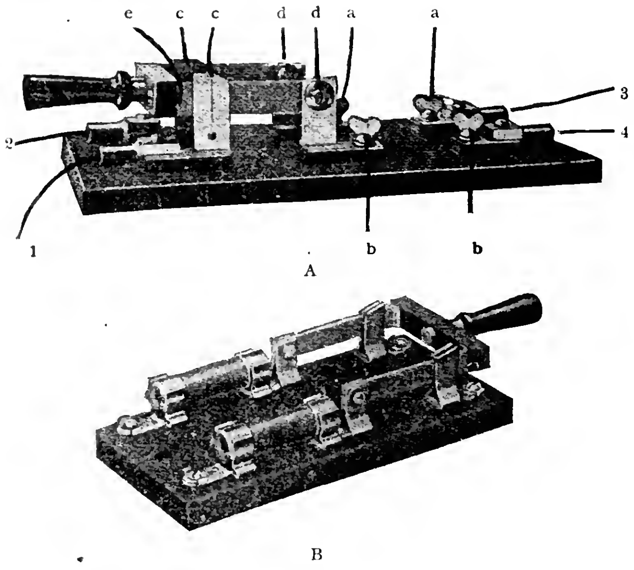

FIG. 6

Where a switch is made with two sets of contacts, as in C, Fig. 7, so that it may be thrown clear over making another contact on the other side, it is called a "double-throw" switch; otherwise it is a "single-throw."

Taking A, Fig. 6, as an example: the wires attach to binding posts 1-2-3-4, being intended, in this case, to be soldered into the lugs (called "Terminals") shown. These lugs are by no means necessary, however, as the wires may be attached directly to the switch binding posts. C-C are the switch "contacts." The fuses attach between binding posts a-a and b-b, this switch requiring the use of link fuses (A, Fig. 10) or plain fuse wire. B, Fig. 6, is arranged for cartridge fuses, such as are shown in Fig. 9. B, Fig. 6 and A, Fig. 7, shows cartridge fuses in place.

Switches should invariably be mounted on slate, porcelain or other insulating base, slate being the most common material for this purpose. It is important that contacts c-c, Fig. 1, 6, be kept clean and smooth. They will, where strong current is used, become roughened in course of time, due to arcing when the switch is opened. This may be smoothed off with a fine file, but if the contacts are charged at the time you must stand on an insulating mat or a wooden chair while doing it and avoid touching both contacts at once, or anything which will ground you, or you will get a shock. Live wires may be handled with impunity provided you are completely insulated from the ground and don't touch both wires at the same time.

A dry wooden chair insulates you for ordinary voltages. An asbestos, rubber or lineoleum mat does the same. There is no danger from an ordinary shock from lines charged up to 220 volts, though you can get a "jolt" that will make you take very decided notice. Also it is possible to be painfully burned by even that voltage, though such a thing is very unlikely to occur. The point I wish to make, however, is that you may touch and work with a "live" switch contact or wire when necessary by exercising care in keeping yourself insulated.

SWITCHES SHOULD INVARIABLY BE MOUNTED EITHER HORIZONTALLY OR SO THAT THE SWITCH HANDLE WILL HANG DOWNWARD WHEN THE SWITCH IS OPEN. This is of importance, since if mounted the other way there is always liability of the switch lever accidentally falling into place, thus closing the switch, which might cause you to get some unpleasant shocks, and even, under certain circumstances, do other and much worse damage.

The fuse end of the switch (where the fuse is attached to the switch base) should always be the "dead" end. That is to say: binding posts, 1 and 2, Fig. 6, A, should be the "live" end, and not posts 3 and 4. The "live end" means the end attached to the supply, the other end being "dead" (not charged) when the switch is open. In the case of the operating room arc lamp switch the live end would be attached to the wires coming from the main house switchboard. In the main house switch it would be the end attached to the wires entering the building.

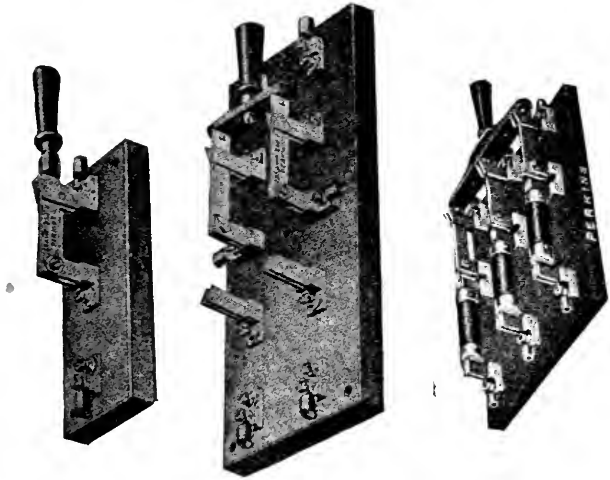

FIG. 7 B. C. A.

Contacts d-d, Fig. 6, must be kept as tight as may be without unduly binding the action of the switch. Unless these contacts are kept snug they will heat more or less, moreover the switchbars will "wabble" and won't strike contacts c-c squarely when closing. Always keep the connections between the handle crossbar (e, Fig. 6) tight. A loose, wabbly switch indicates a slovenly workman. In purchasing switches LOOK CAREFULLY TO THE LAST NAMED CONNECTIONS. In some makes of switches this joint is very poorly made and causes constant trouble, particularly in the smaller switches.

INVARIABLY OPEN A SWITCH WITH A QUICK JERK, especially if it be one carrying heavy current. This reduces the arcing. Arcing roughens and injures the contacts and the less there is of it the better.

Triple pole switches are, of course, used only on the three-wire system. A switch enclosed in a casing of sheet metal is called an "enclosed switch."

SWITCHBOARDS.

It is not designed to go deeply into this subject, but merely to give you some ideas from which you will be able to trace out ordinary switchboard connections for yourself. In most theaters where there is a switchboard it will be found arranged about as Fig. 8, A or B.

A, Fig. 8, is a two-wire board, a-a being the feeding mains,

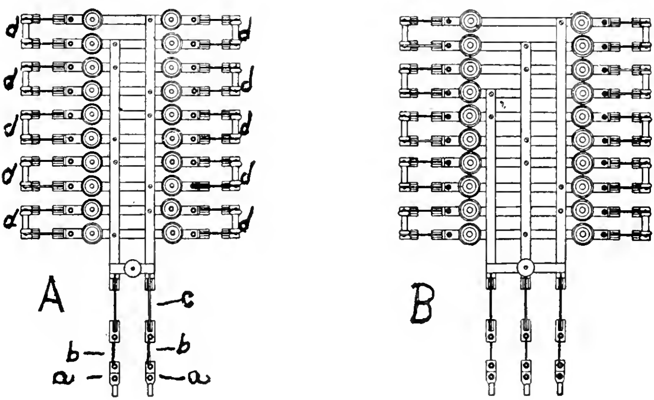

FIG. 8

b-b the fuses, c the main house switch and d-d-d-d-d-d-d-d-d-d the circuit service switches. The two rows of circles are the circuit fuses, being of the "plug" variety, (B, Fig. 10). Looking closely you will see screw heads in the face of the bars. These screws indicate the contacts, circuits being run in either direction from each contact. As to the two-wire board, I do not believe any explanation is necessary; but the three-wire board is more confusing, though it is quite simple after all. Now an examination shows us that the first circuit has contact with the right hand and neutral bars, as has also the next one, which means that these four circuits (there are two circuits to each contact, if all are working) are on one "side." The next two, however, we find to have contact with the neutral and the left hand bar, which means that they are connected with the opposite side. Thus far, if the circuits are all working and have equal number of the same candle power lamps the board is equally "balanced." The next, or top circuit, however, we find to be connected to the neutral and the right hand bar so that there are three contacts with six circuits on one side and two contacts with four circuits on the other. COUNTING THE SCREW HEADS IN EITHER OUTSIDE BAR WILL TELL YOU THE NUMBER OF CONTACTS THERE ARE ON THAT SIDE. One side of ALL circuits are connected to the neutral (center) bar. To find which side a circuit is connected to, disregard the screw heads in the center bar and find the screw connecting it to the outer bar. This will show you which side it is on. These two illustrations are given that you may study them closely. Large switchboards are very confusing, but as a matter of fact they are extremely simple. Remember that the light circuit running from a three-wire board HAS BUT TWO WIRES, NOT THREE. Remember, also, that a circuit can be, and usually is, run each way from a switchboard contact; in other words, each contact usually carries two separate and distinct circuits.

Pulling switch c kills the whole board, of course, and extinguishes every light it controls. Blowing a fuse on the two-wire board has the same effect, except that the wires will still be alive in the sense that a shock will be had if you touch them. Fuse-blowing on the three-wire board is more complicated, however. If one of the outer fuses blows the lights on the circuits connected to that side will go out, but those on the other will still burn. If the central (neutral) fuse blows out there will be no effect at all provided the board is evenly balanced—has an equal number of candle power on each side. This is by reason of the fact that under these conditions there is no current in the neutral wire at all, the lamps of the two sides burning in series with each other. If, however, there be a greater candle power on one side than on the other there is curent flowing in the neutral wire equal to the difference and if the neutral fuse blows the side having the lesser candle power will burn above candle power until the fuse is reinstalled. This is the practical effect of the blowing of a neutral fuse since the even balancing of a three-wire system is seldom accomplished, though it might be balanced evenly enough on one board to show no perceptible effect through the blowing of a neutral fuse. The reasons for the installation of three-wire systems will be explained under "Wire Systems" further on.

The main house switchboard should invariably be mounted on slate, marble or other insulating, non-combustible material and the whole board should be enclosed in a metal cabinet with a door having a substantial, easily manipulated latch. If the board is of considerable size it should be placed in charge of some competent man and none other be allowed to touch it. The fuses of all circuits, except the stage, exit and operating room arc lamp circuits should be located on the main switchboard.

The proper place for the main house switchboard is the lobby, preferably at a point from whence a view of the stage, or curtain, may be had. The writer considers it exceedingly good practice to have the main switchboard equipped with two main switches, as follows: The main house switch which pulls everything except the exit lamps and a sub-main switch which pulls all lights it is desired to extinguish to darken the auditorium, with the exception of one circuit handled by the operator as afterward explained. Darkening the auditorium by pulling half a dozen circuits one after another makes a very bad effect. This switch should not prevent the installation of all the regular circuit switches but be supplemental to them. This applies to large houses only, where there are several auditorium circuits. On large switchboards it is well to label all switches plainly, indicating just what circuit they control, thus: "Proscenium," "Ceiling Clusters," etc., etc.

EXIT LIGHT CIRCUITS.

In some cities it is required that exit lights be operated with non-explosive oil burned in suitable lamps. If electric light is allowed for exit lamps the circuit should in all cases be controlled from the box office, never from the main switchboard, and this circuit should in no case be controlled by the main house switch. There is no telling what a nervous man will do when excited. He might pull the main house switch at an alarm of fire, thus throwing everything, including the exit lights, in darkness. Tap in your exit light circuit ahead of the main house switch (i. e., between the switch and the street mains) and run it directly to a switch located in the box office, where proper fuses should be installed. Thence run the service wires to the various exit lamps. Exit lamps should be enclosed in a box with ground glass front on which the word "EXIT" has been blocked out in translucent red, the letters not less than five inches in height. These signs should be placed over all exits and the lights in them be kept burning at all times when an audience occupies the auditorium.

It is desirable that one of the auditorium circuits, preferably the ceiling lights, be controlled from the operating room, as well as from the main switchboard. This is accomplished by running the circuit service wires from the main switchboard service switch through the operating room, bringing them past a position on the wall DIRECTLY IN FRONT OF THE OPERATOR and in easy reach from operating position. Install a sub-service switch so that the operator can reach both it and the dowser at the same time. Now when the signal is given the operator to start, all the circuits except that controlled by him are pulled from the main switchboard. The operator, when ready to start, pulls the above described switch with one hand as he pulls the dowser or starts the machine with the other. The effect is to darken the house and throw the picture at one and the same instant. In stopping the order is reversed and the picture is off and the lights on simultaneously. It is NOT advisable to have all circuits handled thus, since the man at the main switchboard should be able to light the auditorium instantly, in case of alarm, which he could not do were all circuits controlled by an operating room switch, until the operator threw in his switch. The main switchboard service switch of the circuit controlled by the operator is not touched at all—is left shut at all times except when the house is closed.

STAGE SWITCHBOARDS.

Stage switchboards should all be assembled at one point, preferably just to the right of the proscenium arch—the right as you face the auditorium from the stage—and mounted on insulating, non-combustible material. Each circuit must have its own service switch, as: "1st border," "2d border," "Foots," etc., etc., and each switch should be plainly labeled with the name of the circuit it controls. NOTHING BUT ENCLOSED FUSES SHOULD BE ALLOWED ON A STAGE UNDER ANY CIRCUMSTANCES. Plug fuses (B, Fig. 10) or cartridge fuses (Fig. 9) are proper fuses for stage use. Great care should be taken to have all binding-post contacts and wire joints tight to prevent any heating, and especial care must be had that the insulation of wires, switches, etc., is perfect.

FUSES.

As has been stated, the electric current generates heat by electrical friction as it passes through the wires. A short circuit, ground or overload, might cause such large quantities of current to flow as would heat the conductor red hot, thus causing innumerable fires, or an excess of current might burn out large numbers of incandescent filaments were it not for the protection afforded by what is called the "fuse." This latter is a short piece of soft metal possessing very high conductivity (current carrying capacity), but which fuses (melts) at about the same temperature as does lead, of which metal it is largely composed. Hence, inserting a short piece of fuse wire in a circuit protects both lamps and wires from excess of current since the instant the current flow increases above the capacity of the fuse it "blows out" (melts), thus automatically breaking the circuit and stopping all flow of current until a new fuse has been installed, which cannot be done until the cause of excess has been removed. It follows, however, that the size of fuse used on any given circuit must be proportionate to the current used on that circuit. To install a six-ampere fuse on a circuit carrying but three amperes would not protect the wires except to a limited extent, the lamps practically not at all. To install a fuse of greater carrying capacity than the wires it is designed to protect would be almost as bad as installing none at all. It is not desirable, however, to put in fuses barely large enough to carry the current flow of a given circuit, since, if this is done, there is likely to be excessive and needless blowing of fuses, but it must be borne in mind that fuses ordinarily will carry about 20 per cent. overload. In the smaller fuses it is well to allow just a little leeway over even this, *but not too much.* Use common sense and judgment. The lamps and wires must be fully and adequately protected, still there is such a thing as *excess* of caution. The writer knows of nothing in this wide world not capable of being overdone. The novice will do well to proceed carefully in this matter, however, until he knows just exactly what he is doing. He would better be too safe

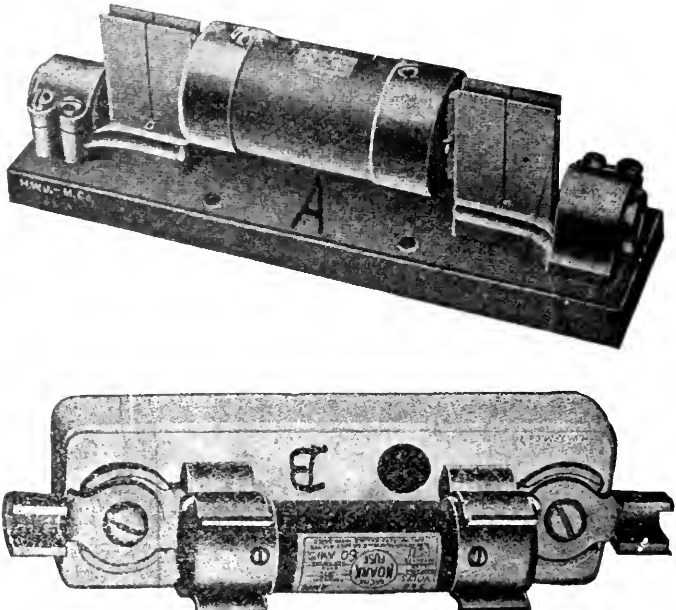

Fig 9.

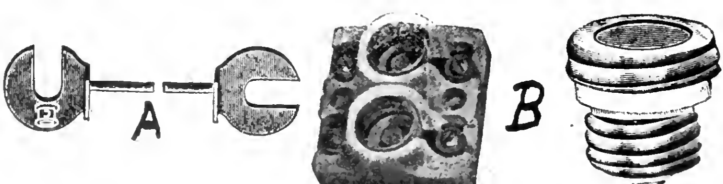

Fig. 10

than not safe enough. In time he will learn just how far he may go without encountering the danger signal. There are several types of fuses in common use besides plain fuse wire, which latter is simply attached between the binding posts the same as you would a piece of copper wire. Before going further, let me caution you on one point: *never, under any circumstances, put a piece of copper wire, or anything else but the proper size fuse, in place of a fuse that has blown out!* Have an ample supply of extra fuses at all times. When a fuse on an incandescent circuit blows out it is a pretty certain indication that something is wrong. If you install another and it blows as soon as you close the switch you may begin to hunt for a ground or short circuit at once.

Fig. 9 shows two types of what is commonly known as "cartridge" fuses. These are reliable, quickly and easily installed and emit no visible flash when they blow out. They are in every way excellent. Fig. 10, A, shows the "Link" fuse, which is installed by simply compressing the hooks under the binding post screws. This type is an excellent, inexpensive operating room fuse. Fig. 10, B, shows the "plug" fuse and receptacle, the whole being commonly known as a "plug cut-out." This form of fuse is in very general use and is most excellent for circuits of moderate capacity, say not exceeding ten amperes. For heavier current better use one of the other types, though the plugs are made to carry as much as fifty amperes. They are easily and quickly installed, and the contacts are excellent. Be sure, however, that you screw the plug in tight. There is no possibility of fire from this type, as the fuse wire is entirely enclosed by the brass, or mica, cap. Switches may be had with this type of fuse receptacle if desired. All things considered, this type is perhaps best to install on your switchboard unless you care considerably about extra fine appearance, in which case Fig. 9 style might be preferred. Plug and cartridge fuses are the only ones which should be allowed on a stage.

The operating room projection lamp circuit is a thing to itself. It is subject to heavy and frequent fluctuations of current and must be fused accordingly. There is absolutely nothing about a projection arc lamp which momentary excess of current, within reasonable limits, can in the least injure. The writer uses No. 6 wire for his operating room projection circuit and fuses with fifty ampere fuses. He has never experienced the slightest trouble through so doing. Of course, where lighter wires are used, a smaller fuse must be installed. A good rule is "fuse ten amperes over the current you pull under normal conditions." Be careful, however, that the main house fuses (fuses attached to main house switch) are equal in capacity to all circuit fuses, plus your operating fuses, else they might blow and leave everything in darkness. Link fuses (Fig. 10, A) are excellent for operating fuses, as they are cheap and easily installed.

When using plug or cartridge fuses promptly *throw them away when they blow out.* They are of no more use to you or any one else, and, if they get mixed with the good ones, it simply causes aggravation. Keep the various sizes separate and the whole lot in some handy place near the switchboard.

Be sure and have your fuse connections tight. Loose connections heat and very little heat will melt a fuse. A dirty contact is equivalent to a loose one.

WIRE SYSTEMS.

There are two wire systems in general use in incandescent lighting, viz.: the multiple arc and the three-wire. But there are two others occasionally encountered, viz.: the multiple series and series multiple. To this must be added the high potential system, which is, in practical use, a multiple arc. What is known as a series arc system is used exclusively in arc lighting and is of no interest to the operator except that he be able to know it when he sees it, so that he will let it severely alone. A projection arc lamp cannot be connected into this system under any conditions.

In the following diagrams the circle represents the dynamo and the X lamps; + indicates positive and — negative.

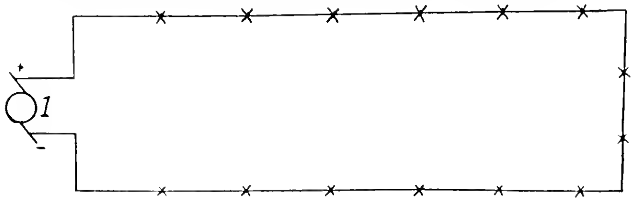

FIG 11

Fig. 11 is a diagram of the series arc system. This system carries about fifty volts pressure for each lamp in the circuit.

A twenty-lamp circuit would have about 1,000 volts pressure. Each lamp must carry the entire pressure and all the current, which latter seldom exceeds ten amperes. You cannot connect a projection arc lamp to this system under any circumstances.

Fig. 12 is a diagram of the multiple arc system of wiring, illustrating the method of connecting a projection lamp thereto. You may connect in anywhere, simply attaching one wire to one wire of the light circuit and the other wire to the opposite, being sure that the wires, switches, fuses, meters, etc., are large enough to carry your current. Before connecting ascertain the voltage of course, and arrange the amount of your rheostat resistance accordingly. In practice lamps are not usually attached between

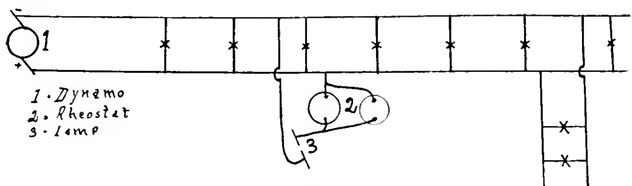

FIG 12

the main wires, as is shown in the illustration. Light circuits are run from the mains, as shown, and are called "service circuits."

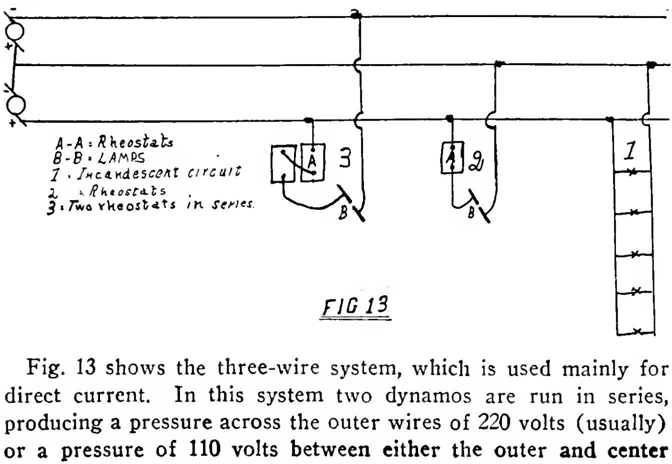

FIG 13

Fig. 13 shows the three-wire system, which is used mainly for direct current. In this system two dynamos are run in series, producing a pressure across the outer wires of 220 volts (usually) or a pressure of 110 volts between either the outer and center ("neutral") wire. As has been said, the main reason for the use of alternating current lies in the fact that it can be generated at high voltage, carried to the place desired at that pressure and there easily transformed to lower voltage. This cannot be done with direct, or at least it is not practical to do it. Direct current is to be preferred, but for this one objection and the three-wire system was evolved as a means of carrying relatively large quantities of direct current electromotive force without prohibitive wiring cost. The diagram shows two methods of attaching a projection lamp to this system. In one we attach to the two outer wires and will get the full series pressure of the two dynamos, usually (practically always) 110-volt machines, which will be 220 volts, and we must provide rheostat resistance for that pressure. The other and usual method is to attach to the center (neutral) and one outer wire, which gives us the pressure of one dynamo, usually 110 volts. Incandescent service circuits are run by attaching to one outer and the neutral wires and using 110-volt lamps. Service circuits may be attached to the two outer wires, however, by using 220-volt lamps, but it is not desirable to do so, since the high resistance lamp is not so efficient. In this system the center wire is called the neutral, and is both positive and negative. In practice the service circuits are run from both sides and kept as evenly balanced as is practical. The lamps of the circuits on the two sides burn in series. and the neutral only carries current equal to the difference in the load on the opposite sides. If the load of the opposite sides is evenly balanced there will be no current at all flowing in the neutral. It is possible, therefore, for the fuse of the neutral main to blow without affecting the lights of the system at all. As a matter of fact, however, it is seldom or never that a system is thus evenly balanced. You may cut your projection lamp in on any service circuit, which is heavy enough to carry the load by simply attaching, as instructed for Fig. 12 system. You may also attach direcly to the mains if desired.

Fig. 14 is a diagram of the multiple series system of wiring, not much in use, however. In this system a very considerable range of voltage is possible, the lamps being burned in series. Ascertain the voltage of the lamps by looking at the tag pasted on them and multiply the voltage of the lamp by the number of lamps in the series, and the product will be the total voltage carried by the mains. Thus, if you find the lamps are 110-volt and there are two in series multiply 110 by 2. If there are five 50-volt lamps in a series multiply 50 by 5 for the line voltage,

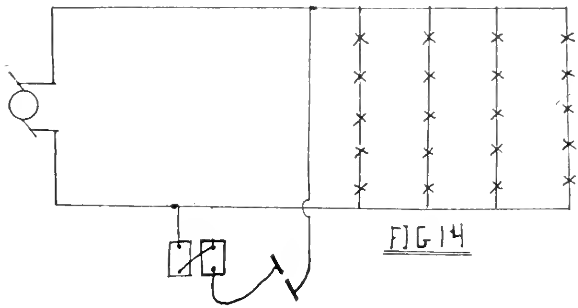

FIG 14

etc. You may attach a projection arc lamp, as shown, by providing rheostat resistance according to the line voltage.

SERIES MULTIPLE.

The series multiple system is a very bad form of wiring and is so little in use that it is hardly worth while describing. A projection arc lamp may easily be connected to it.

HIGH POTENTIAL ALTERNATING SYSTEM.

The high potential system is a two-wire system, in effect the same as the multiple arc system. It is always alternating and the mains carry pressure from 2,000 to as high as 20,000 volts, usually about 2,000, however. With the mains we have nothing at all to do, since they must be handled only by an expert electrician. Never attempt to touch, handle or meddle in any way with the mains of a high tension system, unless you hanker to reach the hereafter by a very expeditious route.

In this system there is what is called a "primary" and a "secondary" current. The current on the mains is high tension, but is, by means of a transformer (Fig. 15), reduced for commercial use, usually to 110 volts. The secondary current is taken from the secondary coils of the transformer on two-wire service circuits, which are the same as the multiple arc system (Fig. 12), and your connections are made exactly the same as directed for that system. A full explanation of the transformer will be given under the head of "Resistance Devices" further on, but for the benefit of road operators and showmen the following instructions are given:

Fig. 15 shows a transformer attached to a pole. That is where

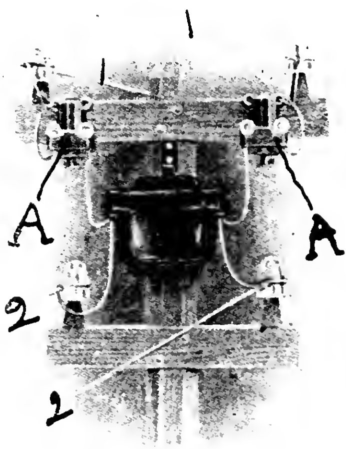

Fig. 15.

you will usually find them. 1—1 are the high tension wires, which you must, on no account, touch since they will probably be charged with a pressure of at least 2,000 volts. 2—2 are the secondary wires, carrying usually 110 volts, to which you may attach your arc lamp wires. A—A are the fuse boxes, sometimes set in the sides of the transformer and sometimes, as in this case, isolated. The fuses are carried in iron plugs, which may be pulled or screwed out. For ordinary service circuits these fuses will be very small. The reason is this: they carry high tension current, being located between the mains and the transformer. One ampere of current at 2,000 volts becomes about 10 amperes after it is reduced to 110 volts pressure, so that a three-ampere transformer fuse on a 2-000-volt system will carry what will become 30 amperes at 110 volts after passing through the transformer. In many places it will be found that the wires entering the building (ofttimes a church) where the show is to be given are not large enough to carry projection arc lamp current, and it will be necessary to run your own temporary wires to the transformer. First ascertain from the light company whether or not the transformer is large enough to carry your current plus whatever else it must take care of. This is important, since, if too small, you might burn it out and have to pay for it. Commercial transformers will stand a pretty heavy overload for two or three hours without damage, but this is easily overdone. Next, be sure that the transformer fuses are large enough to take care of your current plus the other load they must carry. These two points taken care of, you may climb the pole and attach your wires to the secondary wires (2—2, Fig. 15), just as close to the transformer as possible. If the machine is large enough to carry your load the secondary wires will not likely be smaller than No. 8 or No. 10, and either of these will carry your current for the few inches from where you attach to the transformer coils. Attach by stripping the insulation, scraping the wires perfectly clean and wrapping the well-cleaned ends of your wire around very tightly five or six times. Run your wires through your switch, fuses and rheostat to the lamp in the usual way. Of course this direction is for a temporary job, to use one or two nights only. Your wires may be supported on temporary insulators in any convenient, safe manner. If the wires running into the building are heavy enough you can attach to them just as you would to the multiple arc system (Fig. 12), but in all cases ascertain whether or not the transformer and its fuses are large enough or you may have trouble. *A high-tension transformer is a dangerous thing to fool with,* and unless you are very certain you know just what you are doing you had better let it severely alone. Sometimes, however, the operator on the road is practically forced to do these things, and the above directions may be of great assistance.

METERS.

When on the road one must frequently hitch up on wires controlled by a meter. Let me caution you that you must in all cases ascertain positively that the meter is large enough to carry your projection current plus whatever else it must take care of or it will burn out. If too small, arrange with the light company to allow you to hitch on ahead of the meter and pay a flat rate for the current used. (See Miscellaneous Section.)

Resistance Devices.

Resistance is perhaps the one most important thing to the operator, and many have been the heated arguments as to the relative merits of various types of machine made for this purpose. Generally speaking, resistance devices may be divided into four classes, viz.: rheostats, transformers, choke coils and arc rectifiers.

The rheostat is the oldest form of projection resistance, and for direct current is the only one available. Resistance is necessary from the fact that the carbons of a projection arc lamp form a dead short circuit when brought together. Means must therefore be provided to allow of but a certain limited quantity of current passing through the short thus made or the wires would burn up instantly were it not for the fuses, since the lamp would take far more current than the fuses and wires would carry. In fact, could such a condition be maintained, the only limit to current flow would be the capacity of the dynamo feeding the system. To prevent this, resistance is inserted in the circuit, and we will first consider that form known as the rheostat. Different metals possess different degrees of conductivity (current-carrying power), copper wire being the best of any metal commercially available. That is to say, a copper wire of a given size will carry a larger amount of current without heating than a wire made from any other metal combining the toughness and ductility necessary and at the same time not too costly. On the other hand, an alloy of certain other metals possesses high resistance to current, and wire made from this alloy is used in rheostats. The resistance device is to the electric circuit exactly what the valve is to the water pipe. If you wish to get a certain quantity of water from a water pipe you don't take the cap off its end—you install a valve and open it just enough to let through the desired quantity. If you wish a certain quantity of current—say forty amperes—from a wire charged at 110 volts, you cut the wire and connect in a certain length of resistance wire calculated to allow 40 amperes to pass at a pressure of 110 volts. If the pressure were suddenly raised to 220 instead of 110 volts, you would have to insert more resistance wire or you would get more current and your resistance would heat unduly. The more resistance wire of a given size you insert in a circuit at a given pressure the less current you will get, and the less resistance the more current will go through. The higher the voltage the more resistance you must have to get a given number of amperes. The rheostat is nothing more nor less than a case carrying a certain number of feet of resistance wire wound into coils to save space and mounted on insulators. Some are so arranged that a part of the coils can be cut out or cut in by moving a lever or changing a connection. In the non-adjustable rheostats there are two binding posts, one being attached to the end of the first coil and the other to the end of the last coil, the current thus being obliged to pass through the entire length of all coils in the machine. Now, if a binding post be attached to the end of the fourth coil of a rheostat containing six coils and one of the wires be attached to that post instead of the one at the end of the sixth coil, two of the coils would be "cut out," thus decreasing the resistance by one-third and correspondingly increasing the resultant current. When you see a rheostat with more than two binding posts, it is that kind of an arrangement exactly. One post is always a "permanent" and one wire must always be attached to it, but you vary the amount of current according to which post you attach the other wire. The adjustable rheostats, which have a sliding lever,

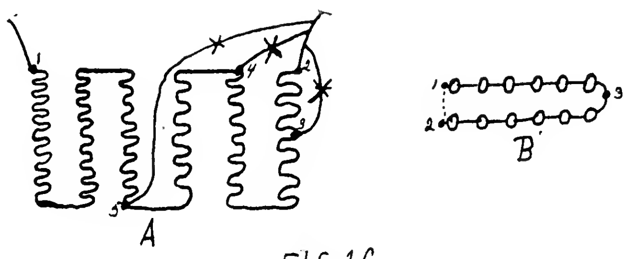

FIG 16

amount to the same thing, each contact being in effect the same as a separate binding post as above described. The coils of rheostats are connected with each other, as shown in A, Fig. 16. Taking A, Fig. 16, as an example: 1 is the permanent binding post to which one wire is always attached. 2 is the binding post at the other end, 3, 4 and 5 being intermediate posts and A and B the wires. Now, if you attach to binding posts 1 and 2, you, of course, will see that the current must pass through the entire resistance, and you will thus be cutting down your current all you can with that machine. If, however, you were to attach a wire to binding post 3, connecting it with wire B, with a switch at X, you would "cut out" half of one coil when the switch was closed, since the current seeks the line of least resistance. If you attach in the same manner to binding post 4, with a switch at X, you cut out two whole coils when the switch is closed, but cut them in again (compel the current to pass through them), when it is again opened. If you attach in the same way to binding post 5 with a switch at X, you would cut out three coils when the switch is closed. I have sketched this out to show you that you may connect your wire anywhere, even in the center of a coil and cut in or out as much resistance as you desire; also to show you the principle on which the adjustable rheostats operate. B, Fig. 16, shows a type of rheostat often encountered. In this sketch we are looking down at the top ends of the coils. You will observe that the two rows of coils are connected at one end but not at the other, binding posts being placed at 1, 2 and 3. Now, if you connect your wires at 1 and 2, it will readily be seen that the coils are all placed in series and the current must pass through them all. If connection is made at 1 and 3, you will be using just half the machine, the other half being idle. If you connect at 1 and 3 and then connect binding posts 1 and 2 together with a piece of copper wire (jumper it is called) as per the dotted line, you will have placed two halves of the rheostat in multiple and will get approximately twice the amount of current you would get by the second-named connection.

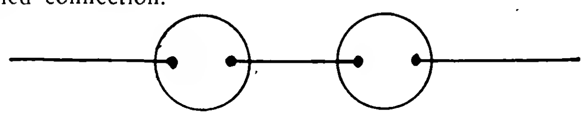

FIG 17

Right here let me explain the terms "series" and "multiple." This is something which confuses many, but which is, in reality, very simple. Series, as applied to rheostats, means that all current which reaches the lamp must first pass through all the resistance in two or more rheostats *one after the other,* Fig. 17.

I think this is simple and plain enough to require no further explanation, except to say that adding rheostats in series *reduces* the current. Multiple puzzles many, however, and I will explain it fully.

Fig. 18 is a diagram of two water pipes connected together with two valves, and the effect is precisely the same as connecting rheostats in multiple (Fig. 19). By opening both valves you get

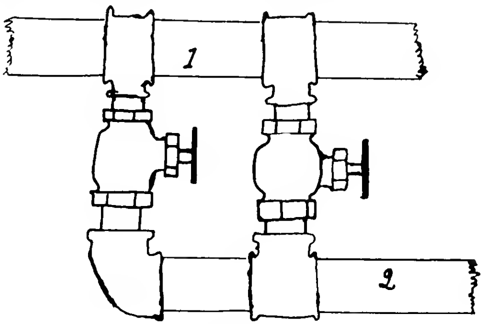

FIG 18

just double the quantity of water through into pipe No. 2 that you would with only one valve open, just as you get additional current to the capacity of each rheostat added to multiple. I

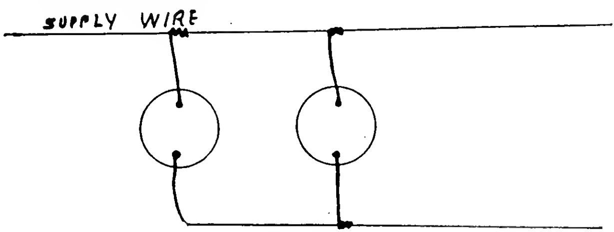

FIG 19

think a little study of Figs. 17, 18 and 19 will make this matter clear to you. It certainly ought to.

Some rheostats are composed of a number of separate "cells," each cell being in itself a complete rheostat. They are really two or more complete rheostats enclosed in one case. One of the best known of this type is the "Chicago Stage Lighting Rheostat." This type of machine is quite flexible, as the cells may, by means of "jumpers," be connected in any desired manner, both series and multiple, or each cell may be used separately.

RHEOSTATS.

In the matter of rheostats their design is almost legion, but the really good ones are limited. The writer would like to personally recommend a few he has found to be strictly first class, but in a work of this sort it is manifestly impossible. Moreover he has not tried or even seen all kinds and might do an injustice to some excellent machines with which he is not acquainted. In view of this circumstance he has concluded to confine his remarks largely to the rheostats sent out with and as a part of machine outfits.

In setting up your rheostat be sure to insulate it thoroughly. True, the coils are insulated from the frame, but this insulation is not always to be relied upon. A coil may weaken and swing out against the casing or other things may happen to produce the same effect. If the casing itself is not insulated this will mean serious current loss unless the "ground" be heavy enough to burn itself out, blow a fuse or otherwise evidence its existence. Set your rheostats on heavy asbestos board, slabs of marble, slate, glass or other non-combustible insulating material. If they be placed near a wall other than stone, brick or tile protect the wall with sheet asbestos with air space of one inch back of it. **Never set rheostats near anything inflammable,** as they are liable to become very hot, especially if overloaded—as rheostats too often are. Be sure to connect your wires tightly, setting the binding-post screws down with plyers. Don't overdo this, however, and twist the screws off. Use a little judgment and common sense. Don't let the plyers slip and mangle the screw tops—that is an evidence of carelessness.

Clean the wire thoroughly before inserting it in the binding post. A dirty connection is almost as bad as a loose one. If the wire is too small for the post (and most rheostats have binding-posts with too small a hole in them—manufacturers take notice) use a copper terminal, cut of which will be shown later. If the wires of the rheostat show red the machine is overloaded. If the coils are all in and show red the machine is too small for the work and you should install a larger one. If not all in cut them in and add another rheostat in multiple. It is very, very poor economy to overload a rheostat. It won't last very long with that sort of usage and will waste much current through excessive heating while it does last.

When using an adjustable rheostat with sliding contacts **keep the contacts clean and see to it that the contact is tight,** otherwise they will quickly become roughened by almost invisible arcing. Should this happen, remove the lever and carefully, with a fine file, smooth up the contacts and face of lever contact and fix the latter so that it will make firm connection with the contacts. Remember this: a poorly constructed rheostat is the most expensive article you can buy. By all means get a good machine. It will save you money every hour you run if you are on metered service. For motion picture work it is best to get one with which more current than is normally used may be cut in by the operator. You will occasionally get a very dense film and if the operator is able to increase his current strength in such cases it is a great help. Unless required by local law the rheostat should not be located in the operating room in Summer unless there is a hood over them connecting with a vent pipe to carry off the heat. They may be placed in a dry basement, being very sure that they are thoroughly insulated from the ground and protected from contact with anything inflammable. In Winter one rheostat may be placed in the ticket office, where it furnishes heat without extra bother or expense. Unless for mere temporary use the **best rheostat is always the cheapest** in the long run. A poorly constructed one is an abomination and makes for heavy current bills and poor light. Without good light you won't have a good show and without a good show the nickels will—well, if you don't know what they will do, experience (the fool's only teacher) will demonstrate the matter in course of time. Some rheostats are made with cast metal resistance instead of wire coils. The writer has had no actual experience with this type of resistance, but sees no reason why it should not be all right if made of proper alloy. Possibly it might even be some better on alternating current, since it ought not to have the vibration so frequently present in wire coil machines when used on alternating. These machines are, however, considerably heavier (some I have seen are excessive in weight) than the wire coil rheostats and this is very objectionable in road work. In purchasing a rheostat see to it that the machine complies fully with requirements of local law; that its coils are well separated, well insulated, well fastened to the insulators and are not loose and "flabby." See to it that the binding posts will accommodate wires the size you propose to use—and that should be No. 6 if used on motion picture lamp. If adjustable, with sliding contact, see to it that the contacts are ample in size and that the contact is such that it can be kept tight—this latter is of the utmost importance. **Don't look at the price half as closely as you do the machine.** With direct current the writer prefers connecting the rheostats on the positive wire, since this gives a somewhat lower voltage at the lamp. The effect will be the same whichever wire the resistance is on, but if you get a "jolt" (electricians' name for shock) it won't be quite so heavy. With alternating either wire is the same. How to determine which is the positive and which the negative wire will be fully explained later on. The rheostat cuts the voltage down somewhat since resistance always causes drop in voltage. The more resistance the greater the "drop." The arc itself is supposed to cause a drop of 40 volts through internal resistance. Owing to this resistance an arc cannot be sprung (started) with less than 40 volts pressure.

Fig. 20 shows the 25 ampere, adjustable rheostat put out with the Powers machine. This rheostat is well made, but does not comply with Underwriters' requirements in that it has no casing. It supplies a maximum of 25 amperes on 110 volts direct or 104 volts alternating. On the left is one binding-post to which one of the wires must always be attached. This post connects directly with the adjustment lever. The adjustment cuts out or in one coil for each contact. On the right are two binding posts. When the wire is attached to the inner one, two of the coils are dead and with all resistance cut in eight coils are working. With wire attached to outer post all ten coils are working when all resistance is cut in. The inner post is only useful when working on very low pressure current. The Powers people also put out with their machines a rheostat identical with the above except that it is non-adjustable and has casing, thus complying with Underwriters' rules.

Let me say here that when using an adjustable rheostat

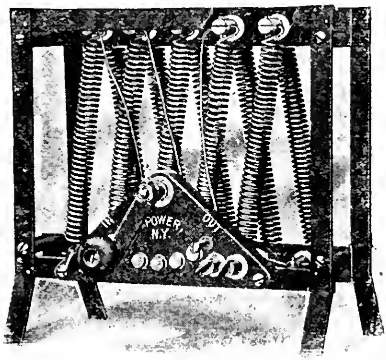

Fig. 20.

on which appear the words "in" and "out" on opposite sides of the contacts, swinging the lever, or knob, towards the "in" cuts in more resistance and reduces the current. Swinging toward the "out" has, of course, the opposite effect. Before turning current on an adjustable rheostat for the first time, set the adjustment clear around to "in," then close switch and move the lever until you get the current you want.

Fig. 21 shows two other rheostats put out with Powers machines. The smaller is well made and has a maximum capacity of 35 amperes on voltage ranging up to 120. The construction is first class, the contacts excellent and the adjustment arrangement very convenient. There are but two binding posts. Attach a wire to each is all the instruction necessary, setting the lever so that the resistance is all in before turning on current, of course. The larger machine may be used on voltage from 52 to 240. It is exceptionally well made and is quite light. The writer has found it par-excellent for road work. There are two binding-posts, one of which connects, of course, directly with the central adjustment lever post, and the other with the end of the coil opposite the post.

On this machine by side of a binding post appears "**in 52**" with an arrow, meaning that for 52 volts the lever should

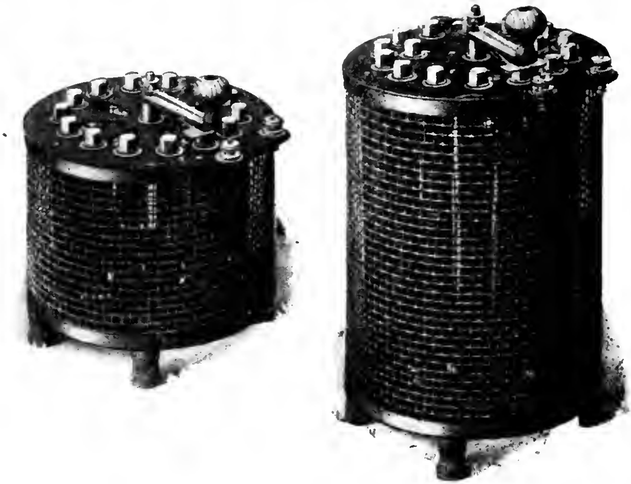

Fig. 21.

be in this position and moved in direction of arrow to cut in resistance. Be very sure not to turn on current when the lever is against the stop post on this side, as then the **resistance is all out** and it would be a dead short circuit when the lamp carbons were closed and there would be fireworks and blown fuses. For 52 volts set the lever back about five points before turning on current and then move it to suit. From the contact beside "**in 52**" the coils connect straight around the machine and the further you move the lever the more resistance you have. For 110 volts set the lever around about seven contacts, turn on current and move to suit. For 220 volts set lever clear around against stop post, opposite the "240" and move back to suit. This machine is divided into two halves which may be used singly, in series or in multiple. As the machine reaches you the two halves are connected in series by a wire jumper between the eighth and ninth contacts. To use the two halves separately on different lamps remove the jumper, set the lever against post on the 240 side. Connect one set of wires to the "**in 52**" binding post and to the eighth contact and the other set to the other post and the ninth contact. The last named half will be adjustable but not the other. To use in multiple remove the jumper, set lever against stop post on the "220 out" side. Connect one wire to both binding posts and the other to both the eighth and ninth contacts. The "220 out" side will be adjustable but not the other. There are eight coils on one side and six on the other but the wire is different gauge so that the resistance of the two sides is essentially the same. With the two contacts inside the circle you need not concern yourself. At that point two coils are cut in or out instead of one, though for what reason the writer himself is unable to understand.

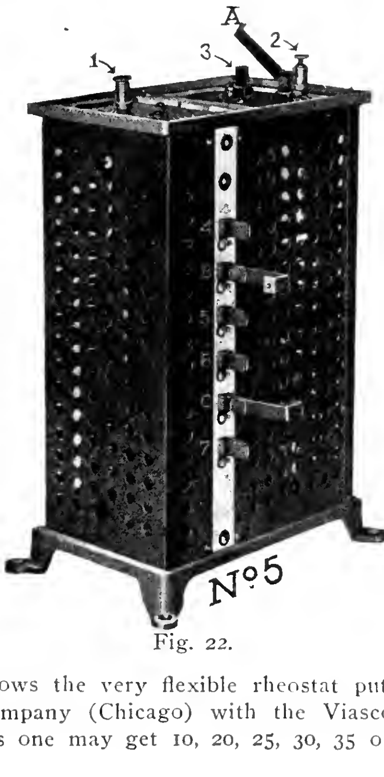

Fig. 22.

Fig. 22 shows the very flexible rheostat put out by the Viascope Company (Chicago) with the Viascope machine. On 110 volts one may get 10, 20, 25, 30, 35 or 40 amperes by manipulating three switches—an excellent arrangement for the operator. The machine complies with Underwriters' rules and may be used on any voltage from 52 to 220. The resistance wire in this machine is all in one piece, which is an advantage in some ways but makes it difficult to replace coils, should such an operation be necessary. The coils are in two rows, the rows joining at binding-post 1. By connecting one wire to post 2 and the other to post 3 the two sides are in series (switch 4 being open, of course). When using the machine thus be very sure that switch 4 cannot be closed, as that would cut out all resistance, making a dead short circuit. By connecting at posts 1 and 2 or 1 and 3, with switch 4 open, you use one side singly, the other being idle. Close switch 4 and the two sides are in multiple. Switch B cuts in five additional amperes when in lug 4 or ten amperes when in lug 5. Switch C in lug 6 adds 15 amperes, in lug 7 it adds 20 amperes.

Fig. 23 shows the two excellent rheostats put out with the Edison machines. The smaller is an adjustable, climax wire

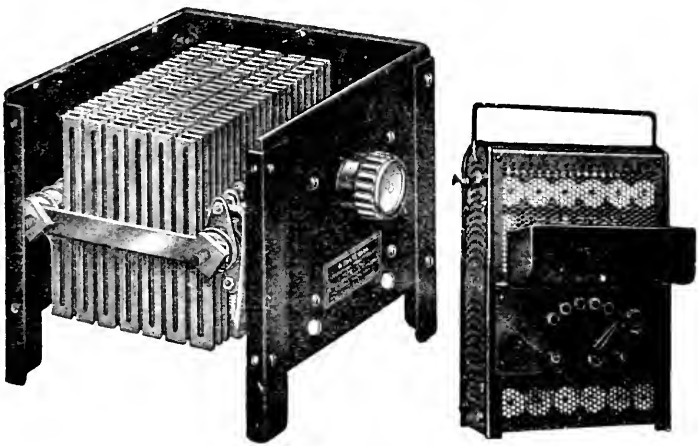

Fig. 23.

coil machine, each coil being independent and quickly removed by loosening two set screws. The coils, terminals, contacts, etc., are well insulated. The machine supplies a maximum of 25 amperes on 110 to 125 volt direct current.

May be used on alternating also. The contacts are good and the machine in every way well made, complying with Underwriters' requirements. There are but two binding posts. Attach a wire to each, set the lever to "in," turn on current and adjust to suit. The larger machine is of the cast metal gird type and the company claims for it great excellence. It gives a maximum of 40 amperes on 100 to 125 volt current. It is adjustable, with excellent contacts inside the casing and therefore well protected. The girds are well insulated. The top and bottom is covered with perforated, and the back, front and sides with solid sheet metal. No instructions are necessary. Connect the wire to either binding-post, set the knob around to "in," turn on current and adjust to suit.

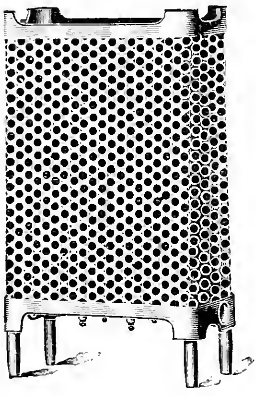

Fig. 24.

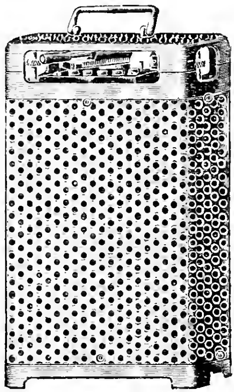

Fig. 25.

The makers of the Motiograph machine put out three rheostats with their machine. The writer has, at the request of that company, very carefully examined these devices and in justice must say that they certainly are very finely constructed machines. All comply fully with Underwriters' rules. Their "A C R Dandy" is similar to the "Universal" (Fig. 24), but non-adjustable and but 25 amperes capacity on 110 volt pressure, either direct or alternating. It has but two binding posts. Attach a wire to each. Fig. 24 shows the "Universal," which has a capacity of 45 amperes. It is in effect two separate rheostats in one case. The two cells may be used singly, in series or in multiple. By different connections you may get, on 110 volt pressure, 12, 25 or 45 amperes. There are four binding-posts located on bottom of machine. There is one cell in each end of the machine and the two binding-posts opposite each other across (the thin way) the machine belong to the same cell. By attaching your wires to either of these two sets of posts you will be using one cell singly and get a little less than 25 amperes. By attaching one wire to both posts on one side the long way of the machine and the other wire to the other two posts the two cells will be in multiple and you will draw 45 amperes. By attaching one wire to either of the four posts and the other wire to the post at opposite diagonal corner and connecting the other two posts with a jumper (piece of copper wire) the two cells will be in series and you will get about 12 amperes. All the above refers to 110 volt pressure.

Fig. 25 shows the "A C R Adjustable, Underwriters' Model." This machine has two binding posts, one of which connects, of course, directly with adjustment lever. Connect a wire to each post. Move lever clear over to "in," turn on current and adjust to suit. The contacts are excellent. Keep them clean. In case the contact spring should ever get loose remove the lever and bend the spring down a trifle. The adjustment is on a slate base, located under a heavy metal cap. The machine is quite light and the contact arrangement being so well protected it is an excellent rheostat for road work. Capacity 45 amperes on 110 volts or 25 amperes on 220 volts. All these machines are protected by perforated sheet metal casing. The coils are independent of each other and are very easily removed and replaced. The coil connection is through machine turned lugs, the coils being held in place by two set screws. As a matter of plain justice to the Motiograph people it must be said that their rheostat construction is very fine.

The rheostat put out with the Standard machine is of the metal gird type and is very light in weight. It complies fully with Underwriters' requirements. The makers claim it will supply 75 amperes, although built for normal load of but 25. This is rather a large claim, it seems to me. Has but two binding posts and is non-adjustable.

There is a rheostat put out by the Chicago Stage Lighting

Company and another of the same type put out by the Kleine Optical Company which are in such general use that they must be mentioned, though not put out with a machine outfit. These machines comply with Underwriters' rules and consist of a number of cells in one case. They are well made and in every way first class machines. Each cell is in effect a separate rheostat and the various cells may be used singly, in series or in multiple. The five-cell rheostat is an excellent machine for road work.

TRANSFORMERS.

The use of the rheostat form of resistance on alternating current is out of date. Too much power is wasted in heat, besides which they do not furnish nearly so satisfactory projection current as does a rightly constructed transformer. The "Inductors," "Economizers," "Compensarcs," etc., so widely advertised, are nothing more or less than low voltage transformers. The claims made as to current saving through their use are probably somewhat exaggerated, but that they are very much more economical than is the rheostat is beyond question. There is, however, a very decided difference in different makes of these machines and you will do well to investigate carefully before purchasing, especially as they are somewhat expensive in first cost. Their weight renders them undesirable for road work. In ordering it is well to state the number of cycles of the current it is to be used on. A good transformer used on the current cycle it is designed for is absolutely noiseless and you should be able to lay your hand on it anywhere, at any time, without feeling undue heat. Usually they are adjustable, giving about three different amperages, ranging from 30 to 50, from 35 to 55 or 40 to 60 in different machines. It is quite possible to get practically as good projection light from 60 cycle alternating current, by the use of one of these machines, as from direct current, but very close attention must be paid to setting the carbons, as will be explained further on under different heading.

The current you get from a transformer has no kind of mechanical contact with the street mains. It is not the same current as that with which they are charged, but an induced current of much lower voltage. The transformer operates as follows: Within a soft iron core (shell type, Fig. 26), made up of laminated plates of soft iron, are four coils of insulated wire, two of which are called the "primary" and two the "secondary" coils. The two latter (I am speaking now of the projection transformer, though all transformers operate in essentially the same manner) are connected directly with the projection lamp. The relative number of turns and size of wire in the primary and secondary coils

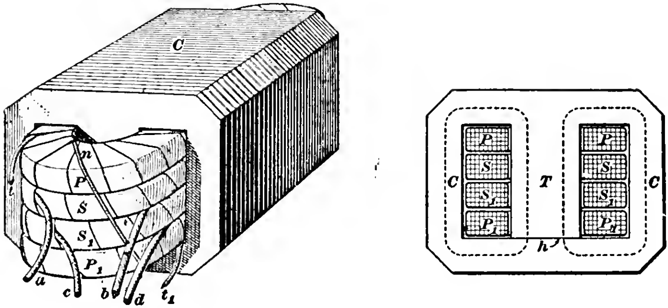

FIG. 26

will determine the pressure and amount of current you will get from a given line voltage. The secondary coils will have a less number of turns of larger wire than will the primary. Were this condition reversed the machine would then be a "step-up" transformer, furnishing current of higher voltage than that of the line. Should you connect your line wires to the wrong set of binding posts this is precisely the condition you would establish and fireworks would be due real soon. When current is switched on the primary coils the iron plates become magnetized and a current is induced in the secondary coils to which your lamp is attached. Those who wish to learn all about induced currents should consult standard electrical works at their public library.

In Fig. 26 P, P′ are the primary and S, S′ the secondary coils. Wires a, c would connect to the binding posts marked "Lamp." Shell type transformers are the kind used almost exclusively in projection work. **Transformers cannot be used on direct current** under any conditions. In making connections you will find, on most machines, two binding posts marked "**Lamp.**" Connect a wire to each post and run one (either one) to one lamp binding post and the other to the other lamp binding post. Some machines have but two other binding posts, they being marked "**Line.**" Run wires from operating room switch to these posts. That is all there is to it. Other machines have four line binding posts, connections being made to different posts for different voltages. Instructions will come with these machines for connecting.

A well built transformer, used on the current it is designed for, will last indefinitely. If at any time there is smoke or odor of burning insulation coming from the machine it indicates that one of the coils is burning, due to overloading or faulty insulation. The machine must be cut out at once and the coil removed and rewound—which is a job for the manufacturer. Do not attempt to run the machine after it begins to burn else you may injure the other coils, thus very greatly increasing the damage. Transformers should be set on insulation the same as directed for rheostats. Cuts of the various machines may be seen in the advertising columns of the Moving Picture World. They are a comparatively new thing and manufacturers are changing their designs so often that it is not advisable to run cuts of them in this matter. The Nicholas Power Company, J. H. Hallberg, New York City; Kleine Optical Company, General Electric Company, Electric Appliance Company, Bell & Howell Company, Chicago—any one or all of them will send you full information about their machines, all of which are standard, well made and efficient.

MERCURY ARC RECTIFIER.

This is a new device put out by the General Electric Company. It is too new to the trade to be well known as yet, but the company claims big things for it. This machine transforms alternating current into direct. The machine operates somewhat as follows: In the first place it is not attached directly to the street mains, but behind a transformer, working on the secondary circuit. There is a large glass bulb with two wings standing out on either side, near the bottom, to each of which the alternating wires are attached.

At the bottom is a short tube in which is a small quantity of mercury. Near it, also pointing downward, is another short tube containing mercury. By tipping the tube, or bulb, slightly an electric arc is sprung between these two bodies of mercury and this arc creates a mercury vapor which fills the whole bulb, acting as a sort of conductor for the main current which enters through the two side wings, passing down and out of the bottom mercury tube, to which is attached the positive lamp wire. As has been stated, alternating current flows first in one direction and then in the other, changing direction 120 times per second in a 60 cycle current. When the current direction is toward the left hand wing (called an anode) it enters and passes to the lamp as indicated above, but when the direction of the current is reversed it cannot flow up and out by reason of the excessive resistance. The opposite wing (anode), however, is connected to the other wire of the circuit and when the direction changes the current in that wire is then flowing toward that wing and passes through to the lamp just as it did on the other side, but it will be noted that this brings the direction of current flow through the mercury tube always in one direction. This is the principle the machine works on. There are other very important details concerning reactance which maintains the arc during the instant of time in which the direction of current movement is reversed, but this matter would be too deep for the average operator and is of little importance from the operator's point of view. The machine seems to be entirely practical and the company claims it reduces current bills. They are quite simple to operate.

MOTOR GENERATOR SETS.

Another very satisfactory method of changing A. C. to D. C. is by means of an alternating current motor driving a direct current dynamo of low voltage. The motor and dynamo may be on the same shaft, which forms a very compact outfit, or they may be separate and connected by belt.

By this method the current is transformed from A. C. to D. C. with slight loss, provided the machines be mechanically and electrically efficient. In such a set, the lower you can have the dynamo voltage the less resistance you will have to have in the lamp circuit, therefore the less amount of loss there will be. It is, of course, understood that the dynamo cannot be less than a 50-volt machine, since it requires about 45 volts to overcome the internal resistance and strike an arc.

The motor generator set merely amounts to driving a D. C. dynamo with A. C. current. Such sets are in use in many houses and give satisfaction.

Certain companies put out a D. C. "current saver," for which large claims are made. These sets amount to a D. C. dynamo of the line voltage driving a D. C. dynamo which supplies the arc, at the arc voltage, thus eliminating rheostat heat waste. The only loss is through the mechanical and electrical friction in the two machines. The motor and dynamo are both on one shaft and the outfits are very compact. They are, or should be, practically noiseless.

The Operating Room.

Before taking up lamps, carbons, lenses, machines, etc., etc., we will consider the operating room itself. In nine cases out of every ten, particularly in theaters of the "store room" variety, the operating room of the past has been miserably planned and constructed, the prevailing idea seeming to have been that any space which could not possibly be used for anything else on earth, and that was in sight of the curtain, would do for the operating room. As to size, some managers seem to have considered anything above 4 feet square by 4 deep as a sinful waste of space. The whole show, or the greater portion of it, at least, comes from the operating room, and to expect an operator to produce the best possible results on the screen when cooped up in a little 2 x 4 iron-lined cracker box is expecting just a little too much. The very least permissible operating room dimensions should be 7 feet square by 6 in the clear from floor to ceiling. The writer well knows it is often difficult to get the latter dimension, but a room that is too low to allow plenty of head room below, floor thickness and 6 feet above is not fit for a theater. A 13-foot ceiling will do it easily. In building the operating room be very sure and get the floor perfectly solid. The least vibration will produce very bad effects on the curtain, especially when the stereo picture is on. The writer has seen an operating room floor so loose that every time the operator would move, when running the stereo, the picture would jump. The walls may be built of 3 or 4-inch hollow tile, set in rich cement mortar, plastered inside and out: or they may be made of wood and fireproofed with sheet iron and asbestos, covering floor and ceiling with the fireproofing also, of course. Where studding walls are to be covered with iron and asbestos they should be first covered with rough lumber. Nailing the iron and asbestos directly to studding is very objectionable from any point of view. Cover walls, floor and ceiling completely with sheet asbestos, which should be at least ¼ inch and preferably ⅜ inch thick.

Cover this with sheet iron or steel, with joints well nailed down. This latter is very important, as otherwise the seams will buckle and open up with the heat of a fire. If the walls, floor and ceiling have been completely covered with asbestos and iron, properly put on, the room will stand a surprisingly heavy fire without material damage. Where depth is limited by reason of lack of head room below, 2 inches may be made to answer for floor thickness instead of the usual 5 to 7 inches. Cut good, sound 2 x 12 planks, sized on one side, the length you want your operating room. By length I mean from front to back. Ship-lap them ½ to ¾ inch and lay them side by side with plenty of dowel pins between. The back end may rest on a 2 x 6 lag screwed to inside of front wall. At other end, on top and flush with ends of planks lay a good, sound 2 x 4, to which fasten each plank with two ¼ x 4½-inch bolts. This completes the floor, which may be supported from below or hung from the ceiling joists with one ½ inch rod every 3 feet. The floor will be solid if you have used plenty of dowel pins and set them in tight, and will be just 2 inches thick. It may be covered with sheet metal below and painted or covered with canvas and papered. If the planks are more than 8 feet long there should be some rod hangers in center of floor. Use dry, seasoned lumber or cracks will open. In the smaller cities it is not usually required by law that operating rooms be made fireproof. Better do it anyhow, however. It may save your whole house from destruction. By thoroughly fireproofing the operating room as above it is quite possible to burn a whole reel ot film, or even two of them, and the audience hardly know of the disaster. To accomplish this, however, you must protect the lens and peep holes, which may be done with small, individual shutters for each hole, arranged to slide up and down in grooves, or hung from a hinge. The latter method is not so good, however, as the shutters will not close tightly. All must be held up by one cord which must be so arranged that the operator can reach it and instantly close all shutters. The cord should be carried directly over the machine head so that the fire will reach and sever it quickly should the operator lose his head. Another and better way is to hang a wide sheet of iron in grooves on the front of the operating room wall. This sheet should be wide enough to cover all holes and be stiffened so that it will remain perfectly flat. Hang with cord running into room, so arranged that operator can drop it instantly, or fire will sever the cord quickly. In addition to this there must be a large vent pipe from the ceiling of the operating room to the open air. This pipe should be not less than 1 and preferably 2 feet in diameter. With such an operating room the films may burn and the audience scarcely know it. Where a large vent pipe is impractical an ordinary stovepipe, with firmly riveted joints, run from near the operating room ceiling to a chimney flue will help a lot, though of course it will not carry off near all the smoke from a burning film. It helps amazingly in ventilating the room, too, in Summer. In the front wall should be a window arranged to open for ventilation. It may be covered on the outside with ornamental lattice if the bare window detracts from the appearance of the front. The door to the operating room should open outward, being held shut with a stiff spring. If a trap door is used it should be not less than 30 inches square.

FITTINGS FOR OPERATING ROOM.

Every operating room should have a small, substantial work bench, made from 2-inch lumber and equipped with a small, solid vise with anvil attachment. Repair bills may not be so heavy if you give the operator a fair show to fix things himself. But if you won't even give him a decent work bench and vise (a "work bench" made of 1-inch stuff isn't "decent") he is not very much to be blamed if he takes no great interest in trying to make repairs. Around the wall should be plenty of coat hooks or stout nails on which to hang things, and a substantial shelf should be conveniently located high enough to be out of the way. Always and invariably there must be a metal can in which to throw carbon butts and the operator who puts them anywhere else should be promptly fired, before he fires your house. It is well to locate a small shelf just under the peephole, to be used for announcement slides, oil can, cement, song slides, etc. There must, of course, be an electric fan, but its location will depend on circumstances, but under no conditions should the air current from it be allowed to strike the condenser directly, or even the lamphouse itself.

TOOLS.

The best and most satisfactory plan is for the operator to own his own kit of tools. Tools furnished by the house will usually be neither complete or satisfactory. The following list contains nothing superfluous and may be added to at will, but it constitutes a fairly good kit and costs but a few dollars; in buying tools it always pays to get the best quality obtainable: One pair "Button" plyers, 8 or 10-inch; one pair 8 or 10-inch lineman's side cutting plyers (I leave the matter of size open, as some prefer one and some the other); one pair 8 or 10-inch gas plyers; one large and one medium screw driver; one screw driver with good length of carefully tempered blade for small machine screws; one 10 or 12-inch cabinet rasp for sharpening carbons; one small riveting hammer; one claw hammer; one small cold chisel; one medium size punch; one very small punch for star and cam pins; one pair small tinner's snips; one blunt nose film shears (such as clerks use); one small gasoline torch for soldering wire joints. With this kit you will be able to do almost any ordinary job, but you will have use for them all. In addition to the above the house should furnish one 8 and one 10-inch flat file, one ⅝ round file, one 8-inch "rattail" file, a small bench vise with anvil, some soldering flux, solder wire, film cement, slide cover glass, mats and binders, and wire of various sizes likely to be needed.

Tools should be arranged neatly and conveniently on the wall, preferably over the work bench, though plyers and screw drivers should always be hung within reach of the machine. The writer has found the clamps, such as are used to fasten mental conduit to the wall, to be the neatest and best tool holders. They are very cheap and may be had in any size. Get ¾-inch ones for plyers and smaller sizes for other tools. Never, **never** leave tools lying around. When through with a tool put it back in its place instantly. It will take a second or two to do this, but "I had that screw driver a minute ago, now where in thunder is it?" is altogether too common a remark and it spells Slouchy Workman in big letters. Keep your **tools in place and don't have to** rummage all over the room every time you need something. It is cheaper by far in the long run. It is a shame, but it is a fact, so far as the observation of the writer goes—and he is frequently called to theaters to straighten things out, therefore has seen many operating rooms—that not one operating room in ten is equipped with a half-way complete set of tools and in not one in fifty are even the few tools there hung up in orderly fashion. All this means wasted energy and lessens a man's chances of Heaven (if the showman has any, anyhow) through fracturing the third commandment. I might add that it is a good plan to wrap plyer handles and screw-driver blades to within a couple of inches of their ends with insulating tape. It will save you many unpleasant shocks.

OPERATING ROOM SWITCHES.

The operating room switches must be installed in compliance with local law, which, in many cities, requires a metal cabinet with a door. **All switches should be assembled directly in front of the operator**, as he sits in operating position, except that the dissolver switch, if one be used, may be located convenient to that machine. In wiring an operating room **make the electrical connection of each machine entirely independent of every other machine.** A tremendous mistake is frequently made, where two machines are used, of installing a double throw switch attaching one machine to each end. This is very bad if the machines are to be used alternately on steady run, since it is desirable many times to have both lamps burning at once. To explain: You are running one machine, but must switch over to the other when that film runs out. Now with independent wiring your helper can start the lamp of the other machine and start that machine so as to not leave the curtain dark for an instant, but with double throw switches between you must stop your machine, throw the switch, start the lamp (perhaps with new carbons) and start the other machine all while the house is standing dark. It is surprising how many good houses have their machines wired on the foolish double throw switch plan. It is to be condemned from any and every point of view. Have your operating room incandescent lights equipped with snap switch sockets, but also have a snap switch on the wall beside the peephole with which you can put them all out. If one of the auditorium light circuits is handled by the operator, as it should be, have this switch located by the side of the peephole. Keep all switch contacts clean, smoothing them up occasionally, if necessary, with a fine file. Keep the handles and crossbars of switches tight; a loose, wobbly switch is an abomination and none but a lazy, shiftless workman will tolerate it.

Keep your operating room clean. Under no circumstances allow loose papers or trash of any kind to accumulate on the floor. Make it your invariable practice to sweep the room **thoroughly** once each day. The operator who has not enough ambition to keep his operating room at least decently clean had better quit and go into the junk business. He can then mess around all he wants to. If he doesn't leave, I would earnestly recommend that his pay be stopped. Keeping an operating room clean is so small a matter that there is absolutely no excuse on earth for failure to do so. When running it is necessary to have the operating room in darkness if you get the best results. With lights burning in the operating room you cannot nearly so readily distinguish shadows on the picture. It is harder on the eyes, too. The darker the room is, the better. In front of the lamp house, especially if the floor be ironclad, should be an insulating mat about 24 x 30 inches in size. This may be rubber, heavy linoleum or asbestos board—not sheet asbestos, but asbestos board. But whatever it is it should be well fastened down, or let into the floor flush with its surface. The writer insists on a comfortable chair with a back. He doesn't propose to sit bunched up on an uncomfortable stool. He tries to give good service, as every man should, but he demands reasonable comfort in his work as, also, every man should. Of course this item does not make much difference on a short evening run, but for long runs it does.

THE LAMP.

A good picture cannot possibly be produced without good light and the better the light is, other things being equal, the better will be the picture. Good light cannot be had with a poor, dry lamp with 2 or 3 inches of the cable ends burned to a crisp. It is astonishing how little attention many operators pay to their lamp. I have been sent for by theater managers to see what was the trouble that their light was so poor and found that I could only move the lamp adjustment screws by grasping the handle and twisting hard enough to very nearly break things. And that was all in the world that was wrong. No matter what make of lamp you use, take it entirely apart just as soon as its adjustments move the least bit stiff and proceed as follows: After removing all screws and taking the lamp entirely apart, grease all parts thoroughly with vaseline. Now wipe off the surplus grease and drop the parts into a box of good graphite. Shake (don't wipe) off the surplus and put the lamp together. If you have been using a dry lamp you will be astonished at the difference and how much more accurately you can adjust your light. A very common fault with many, in fact, almost all lamps, is the tendency of the carbon arms to "wobble" sidewise, due to the fact that the rack bars (the bars which slide up and down to adjust the carbons) being too small. With these small bars, if there be the very least play in the boxing which holds them it is magnified many times out at the ends of the carbon arms, which frequently you can swing fully ⅛ of an inch. These lamps may be all right when new, but after being used a short time the fault develops. The metal warps a trifle through heat—at least I suppose that is what causes it—and then there is lost motion. The rack bar should be flat and wide. From front to back it need not be more than ⅛ inch thick, but the other way it should be at least 1 inch wide. Exactly like a flat tongue in a wide slot so it cannot wobble sideways. In that case a little lost motion wouldn't count for much.

This fault is one that is very aggravating, especially when working with alternating, which requires very close adjustment of the carbons for the best results. With direct current the play is not usually enough to do material damage. Every few days dress off the inside of your carbon contacts. They gradually accumulate scale and get rough so that good contact with the carbon is not had. This is very bad since it adds electrical heat to the natural heat from the arc, resulting in loss of power and the weakening of the carbon arms and clamps. The bronze clamps put out with most lamps have but little strength when hot. If you are troubled with excessive breakage have a blacksmith make you a set of arms and clamps of Bessemer steel, using the old one for pattern. They will last for years. Another almost universal fault with lamps is too small a binding post hole. If your binding post won't take No. 6 wire run a drill through the old hole if there is metal enough. If not, then attach your wires by using a copper terminal, an excellent form of which is the Bell terminal, shown in Fig. 27.

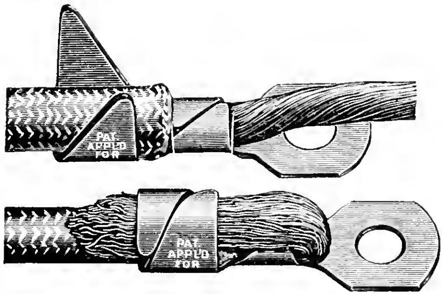

Fig. 27.

To attach a copper terminal to a flexible cable, strip the insulation from about 2 inches of the wire, cleaning it and the inside of the clip thoroughly. Now lay the wire in the clip, as shown in the top illustration, Fig. 27, leaving enough wire projecting beyond small lug to bend back and reach well into the large lug. Clench small lugs down tightly, bend wire back over and clench down large lugs, as shown in lower illustration, Fig. 27. Large lugs are intended to hold the insulation in place, but clenching them down on the raw wire ends makes just that much additional contact. To attach to lamp, remove binding post screw and put some washers on it, put it through hole in clip and screw down tightly, clamping clip to binding post. These minute directions may seem unnecessary to some of the older operators, but you would be amazed at the number of "operators" who can't, or don't, do the smallest job properly.

Unless there is an extension on the carbon arm for the purpose of removing the cable from the intense heat of the arc it is not advisable to attach your cables directly to the lamp binding posts if you are using a powerful light. The heat from the arc is so intense that the cable ends soon become charred, thus necessitating the removal of 2 or 3 inches, frequently. Also the wires are liable to burn off at any time. The reason for this is that copper, when subjected to heat, has a tendency to oxidize or scale and when the individual strands of a cable are so fine and each is subject to the action over its entire surface it does not take long to reduce the available current carrying cross section to a point where it is too small to carry the current. Electrical heating is now added to the heat of the arc and of course the whole thing soon burns off. Some manufacturers have recognized this condition and have added an extension to their carbon arms which takes care of the matter nicely. Where these are not present you may overcome the difficulty by making, from No. 8 steel wire, an arrangement like Fig. 28.

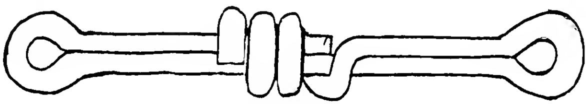

Fig. 28.

Attach one end to the binding post the same as you would a copper terminal and to the other attach the cable end, using a small stove bolt with washers and clamping the cable and wires together tightly. Make the extension of a length to suit your own individual case, but 3 inches usually is plenty long enough. If too long it will interfere with the free movement of the lamp. This kind of extension will last indefinitely. When you get a new lamp, or put in a new carbon arm, remove the lamp, put in two long carbons, clamping them firmly in place. Now squint along the two carbons and see if they line with each other sidewise. That is to say (to make myself clear), would they appear in line with each other were the lamp in place and you looking through the condenser opening? If not, carefully file your carbon arms, with ⅝ round file, until the carbons line exactly. This is of much importance, especially with alternating, if you expect to get the best results and get them all the time. Where the lamp house is not asbestos lined the writer has found it a good scheme to lay a sheet of asbestos in the bottom, letting it bend up in front as far as bottom of condenser opening. Where lamps have a backward and forward movement adjustment screw with fine thread, the writer disconnects this screw entirely and attaches a handle so that he can pull the lamp back or push it ahead. The handle must extend through back of lamp house, of course. Be very, very careful that the insulation between the carbon arms and lamp is perfect. If it is poor on both there may be current leakage which will be waste pure and simple and will keep your lamp house charged all the time. Sometimes the lamp house may be charged and and you cannot discover where it comes from. After ascertaining that none of the fine cable strands are doing the mischief brush off the top of the lower carbon arm carefully. Sometimes carbon dust or a piece of carbon will bridge the insulation enough to carry current to give you a lively shock.

THE LAMP HOUSE.

Little need be said on this subject. All lamp houses have their good and bad points and all, so far as the writer knows, lack ventilation which can be controlled by the operator, except to a very limited extent. Personally the writer prefers ample ventilation in a lamp house, but arranged so far as possible to avoid direct currents of air, though he is not sure that even these are hurtful. Lack of ample ventilation creates excessive heat in the lamp house, which in turn abnormally heats the back condenser lens, as well as the wires inside the lamp house. The hotter your lens the greater the expansion and consequent liability to breakage. Some say keep the lamp house tightly closed or you will br-r-eak your condensers—let's see! The front condenser lens gets pretty warm itself, doesn't it? It is exposed to every vagrant breeze that blows, is it not? It scarcely ever breaks, does it? It seems to me there is a moral lying around loose here somewhere. The writer firmly believes, and has proven it to his own satisfaction, that there will be little condenser breakage (provided other conditions are right, see "Condensers") if one could run with the whole back out of his lamp house. But running with closed lamp house and then opening the door, if for but a second, soon after the lamp is cut off, produces a **sudden change in temperature**, and bing! there it goes. Give the back condenser plenty of air all the time, the same as the front one has, is the rule I have adopted. Of course, there is somewhat greater liability of breaking the back lens, since that gets the hottest, but the front one gets pretty hot, too. There is not so much difference after all. I don't assert positively that I am right, but I think I am, and I'm not breaking many condensers either—maybe one in a month, maybe not so often. Keep your lamphouse clean and the rods it slides on well lubricated. Keep the screen which covers the vent holes clean. It clogs up rapidly with a fine, white ash, the residue of the water glass contained in carbon cores.

Lenses.

Hundreds of managers and operators have written the writer asking whether the high priced condensing lenses were really to any appreciable extent better than the cheaper grades. Unquestionably they are, provided you deal with a reliable firm which send you the really high-grade lenses in return for the higher price. I am sorry to say, however, that some unscrupulous firms, well knowing that the average manager or operator is qualified neither by knowledge or experience to judge the quality of a lens, ship out a cheap lens to the man who has paid for a high grade. One manager sent me a fragment of a condensing lens he had paid $2 for. I make no pretense to expertness in judging lenses, but even the novice could see it was a very poor quality of lens, probably one retailing for 75 cents. The high-class lens, being made more carefully and of better materials has, or should have, more even density, therefore withstanding the shock of expansion and contraction better. The glass does not have the greenish tinge present in the cheaper lenses and therefore yields a considerably whiter light. More than this, they are much more accurately ground and for that reason give a greater amount of light at the aperture plate for a given arc strength. To sum up: The high-grade lenses give a whiter, stronger light and do not break quite so readily, though they will break, as will any glass subjected to rapid and extreme expansion and contraction. When the condensing lens fits into a metal round, it should fit loosely, with fully 1-16 inch play. The glass expands more in diameter than does the metal round and if the fit is snug when cold the round will bind and may crack the glass when heated. If your lens is too large you can easily grind it down on a coarse grindstone. An emery wheel, unless very fine and low speed, will chip the edges badly. You cannot tell when a condenser is dirty (unless very dirty) simply by looking through it. Look through the casing vent holes when the arc is burning and if the lens looks foggy it is dirty and needs cleaning. The outside you will, of course, polish thoroughly every day before starting the run. Lenses may be cleaned by wiping with a wet cloth or breathing on them, polishing afterward with soft, dry cloth or chamois. Wood alcohol is best, however, for the purpose. Wet (not dampen, but wet) a bit of cloth with alcohol and wash the lens off with it, polishing quickly, before the alcohol evaporates, with soft, dry cloth or chamois. Keep the alcohol tightly corked, as it evaporates very rapidly. Don't keep alcohol in the operating room. In case of fire it would help things along amazingly. As to the distance the condensing lens should be from the film; the writer considers 12 inches about right, but has been unable to see that a variation of an inch either way makes any material difference, though under certain circumstances he has been able to remove a "ghost" (dark spot in center of curtain) by moving the lamp house forward or back. As to the matter of condenser breakage the writer does not feel justified in saying much more than has already been said. He has a grave suspicion (may be all wrong, though) that up to a certain degree of heat there is small danger of breakage, other things being right, but when that point is passed the danger is very largely increased. He has about come to the conclusion that this, fitting lenses too tightly in metal rounds, and very sudden changes in temperature, due to excessive heat in lamphouse, are the three causes responsible for nine-tenths of all condenser breakage. Where condensing lenses of the same focal length are used front and back the writer believes danger of breakage is materially reduced if when putting in a new lens it be placed in front, the old lens being moved to the rear next the light. He believes a lens that has been used in front for some time has become "seasoned" (I use that term for want of a better), so that it will stand the comparatively severe service next the lamp better than will a new one. This may be imagination, pure and simple, but—try it out, anyhow.

That condenser breakage is a serious item of expense in many cases is proven by the fact that the writer has received more than five hundred letters from managers and operators, during the past year alone, on this very subject.

Some believe that placing a new lens in cold water and bringing it to a boil, then allowing it to remain in the water until cold anneals the lens to a certain degree and reduces liability of breakage. Personally, the writer does not believe in it much, but it does no harm, anyhow, and may do some good.

FINDING THE FOCAL LENGTH OF LENSES AND FINDING THE SIZE LENS REQUIRED TO PROJECT A GIVEN SIZE PICTURE AT A GIVEN THROW.

Finding the focal length (commonly termed the "focus") of a lens is a very simple operation, but one very little understood by operators. To ascertain the focal length of a condenser lens, pin a sheet of blank paper on the wall opposite to, and removed at least ten feet from, a window through which comes strong light. Next, holding the lens as in Fig. 29 A, with the flat surface square with the wall, move it back and forth until the image of the window appears sharply defined on the paper. Holding the lens at point of sharpest definition, measure from its flat side to the wall, and this measurement is the focal length, or "focus," of the lens. An incandescent lamp will answer equally well for illuminant if not less than ten feet distant. Get sharp image of the lamp filament on the wall and measure as before.

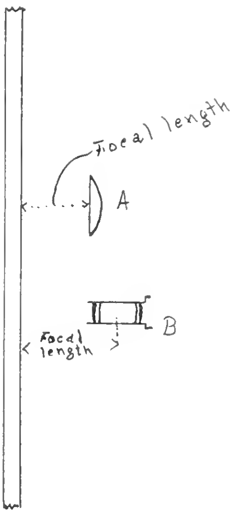

Fig. 29.

Measuring focal length of projection lenses is done in precisely the same way, except that you must first make the central point between the two lenses (see Fig. 29 B) and measure from that point. This will be the equivalent focus of the lens. The distance from the lens nearest wall to wall will be the back focus of the lens.

Finding the focal length of lens required to project a certain width of picture at a given distance is equally simple, though a dense, dark mystery to very many operators. Multiply the distance from lens to curtain, in feet, by width of picture opening (aperture opening in motion pictures and slide mat in stereo), in inches. Divide this result by desired width of picture, in feet, and result will be equivalent focus of required lens, in inches.

Example: What lens will project a 15-foot motion picture at 60 feet? Answer: 60 x $\frac{15}{16}$ (aperture plate is $\frac{15}{16}$ inch wide) equals 56¼, which divided by 15 equals 3¾, so we shall want a 3¾-inch lens. Example: What lens will project a stereo picture 15 feet wide at 60 feet? Answer: 60 x 3 (width of standard slide mat) equals 180, which divided by 15 equals 12, so we shall want a 12-inch stereo lens. This will not be absolutely accurate, since aperture plates are about 15-16 of an inch wide and mats usually exceed 3 inches by about 1-16th inch.

Moreover, the cheap lenses are not ground absolutely accurate and there will be some variation there, too. But the rule answers for all practical purposes. The same result is attained by dividing the distance by the size of the picture and multiplying by the opening. In using this rule, don't guess at distances and expect accurate results. Measure from curtain to lens with a tape line, no matter if someone has "told" you it is a certain distance. Reject any odd inches in the measurement below six and add a foot if the fraction be more than six inches. If throw is more than fifty feet, measure the aperture opening and multiply by its exact width to get accurate results, as on long throw the least variation of aperture will mean considerable on the curtain.

Before starting the day's run remove the projection lens and make sure there is no oil on its back lens. If there is, you cannot get a clear picture. When using a lens-tube, the position of the picture may often be shifted on the curtain as much as a foot, up, down or sidewise, simply by turning the tube around in the jacket. About once a month take the projection lens all apart and clean the lenses thoroughly by washing with wood alcohol and polishing carefully with a soft dry cloth or chamois. Because the projection lens looks perfectly clean and clear when you look through it is no evidence that it is so. Be very careful, however, to get the lens back just as it was, or you will have trouble galore. In

TABLE OF LENSES.

APPROXIMATE SIZE OF PICTURE OBTAINED WITH LENSES OF DIFFERENT FOCI AT GIVEN DISTANCES.

FOCUS OF LENS,

Distance between Cinematograph and Screen.	2 in.	2½ in.	2¾ in.	3 in.	3¼ in.	3½ in.	4 in.	5 in.	6 in.
	DIAMETER OF PICTURE (obtained with 1-inch mask)								
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
10 feet	5 0	4 0	3 6	3 4	3 2	3 0	2 8	2 0	1 4
12 "	6 0	4 9	4 4	4 0	3 9	3 6	3 0	2 6	1 8
15 "	7 6	6 0	5 6	5 0	4 8	4 6	3 8	3 0	2 0
20 "	10 0	8 0	7 3	6 8	6 2	5 8	5 0	4 6	3 4
25 "	12 6	10 0	9 0	8 4	7 9	7 2	6 0	5 10	3 8
30 "	15 0	12 0	11 0	10 0	9 3	8 6	7 0	5 6	4 0
35 "	17 6	14 0	12 8	11 8	10 9	10 0	8 8	6 2	4 8
40 "	20 0	16 0	14 6	13 4	12 4	11 6	9 8	7 8	5 10
45 "	22 6	18 0	16 4	15 0	14 0	13 0	11 0	9 2	7 0
50 "	25 0	20 0	18 4	16 9	15 6	14 3	11 9	10 0	7 8
75 "	37 6	30 0	27 8	25 1	23 3	21 5	17 6	15 0	11 4
100 "	49 6	40 0	37 0	33 5	31 0	28 7	23 9	20 0	15 0
150 "	73 6	60 0	55 4	50 1	46 6	42 11	35 9	30 0	22 4

EXAMPLES—A 3¼ inch lens at a distance of 45 feet gives a disc 14 feet in diameter. To produce a disc of 20 feet with a 5 inch focus lens the machine must have a throw of 100 feet.

projection work the lenses should be ground accurately enough to give clear, sharp definition, but beyond this, quality does not seem to count for very much in the motion picture lens. There is probably a difference, but the eye does not seem to be finely discerning enough to catch it. In the stereo lens, quality cuts more figure, but even here it is size that counts. A good, clear-cut stereo picture cannot be projected with what is known as a "quarter-size" lens, which is the article which usually (always, I believe, unless otherwise agreed) goes with the regular machine outfit. These lenses are a nuisance. A really good stereo picture cannot be projected with anything less than a "half-size" lens, and that is what you should by all means have. The foregoing refers only to stereo lenses of greater equivalent focus than 10 inches. Below 10 inches equivalent focus, the quarter size stereo is satisfactory. The road man should have stereo lenses for various distances and a motion picture lens jacket with lens tubes for various distances.

Be very sure to have your picture in exact focus. It may look all right to you from the operating room, still, a fraction of a turn of the adjustment screw may improve it considerably. With the stereo it is a good plan to throw a picture on the screen before the show and get someone to work the adjustment screw for you while you go down in the house and direct him. Get it so that every detail comes out sharp and clear. A scene with grass, flowers, shrubbery or trees is best for focusing. Once set, it will, of course, remain so until disturbed. It is close attention to such details as this that marks the real operator. The "Oh, that's good enough" man never gets ahead—he oughtn't to! Knowing a thing does no manner of good unless you apply your knowledge—remember that.

Once in a great while a peculiar accident will happen to a stereo lens. In some of these lenses the two pieces of glass which go together at each end are cemented together with balsam gum. Poor gum is sometimes used and it melts under heat and runs in between the two glasses, which, however, remain glued together. You may get them apart by placing in cold water and bringing to a boil. Take the lens out of the boiling water and, working very fast, with considerable force, slip the two lenses apart.

Don't try to pry them apart. Slip one off the other—they don't come apart easy even when hot. Clean the balsam off with turpentine, polishing carefully afterward. After having cleaned the lenses carefully, you may use them without cementing. Of course the really better way is to send the lens to the maker, who will clean, repolish and recement it for a dollar or two. You may have to drop the lenses in the boiling water several times, slipping them a ilttle more each time, as the balsam holds very tight. Be very sure you get the lenses together again the same way they were or you will have trouble.

Should one of the lenses of a projection lens get broken the whole set is ruined. It cannot be replaced, or, at least, it would cost more than would an entire new lens. **To test your motion picture lens for accuracy of projection**, get a piece of clear mica four or five inches long and cut it the width of a film. Now with ruler lay it off both ways for two inches near one end with straight lines about one-eighth inch apart, scratched with the knife point, forming a sort of miniature checkerboard. Put this ruled portion over the aperture plate in exactly the position the film would occupy (as regards the tracks and tension springs), close the gate and turn on the light. Now focus the scratch marks on the curtain, and if they appear clear, straight and without distortion of any kind the lens is true and accurate. In making this test be certain the lens is clean, particularly that it has no oil on its inner end. This mica strip can be used every day before the show to test the focus and get it exactly right; but you must get it in the machine in exactly the position the film will occupy. In this relation let me say that the lens sometimes gets blamed for what is really the fault of a worn aperture plate. The variation of as little as 1-64th of an inch in the distance of the film from the lens as it passes through the machine will affect the focus. Now, it frequently happens that aperture plate tracks do not wear evenly. There may be a sort of bow, or, worse yet, double bow, in the tracks where the short spring contact comes, or the pressure of the tension springs may cause the outside or inside of one or both tracks to wear faster than the other side. These things have a decided tendency to cup the film in such manner that it is impossible to get the whole picture in focus. Understand, I do not mean by the above that 1-64th inch would make any difference provided the whole picture were moved that much to or from the lens, but the cupping I refer to causes one portion of the film to be nearer the lens than another, and this will not do, even though the variation be but the amount named. The film must be perfectly flat as it passes the aperture opening.

THE SPOT.

Many operators govern their light almost entirely from the appearance of the light which shines on the gate, called the "spot." This is decidedly wrong. Aside from the length of the arc and effects produced by something wrong in the carbons the thing which should be your sole guide in regulating your light is the picture itself. Aside from the two above named things it will tell you every lamp adjustment you should make, tell you when you have made it just right, and tell you better than can anything else. Looking at a bright, brilliant spot, or sitting, as the operator must, where it strikes the eyes, is very hard on them. The writer protects the spot with a rather light (but not too light) strip of green glass. This glass, which must be made different sizes and shapes for different machines, he has a tinner bind the glass in a narrow frame of tin to which is soldered a flange, by which it is attached by two screws to the gate or cooling plate. Fig. 30 shows the idea. You must drill screw holes in the cooling plate or gate, usually, to attach it. The glass should stand out about 1½ inches and be deep enough up and down to show the whole spot, especially its top edge. This glass takes away all the glare and one may look straight at the spot as long as one likes with absolutely no eye strain at all. After you have

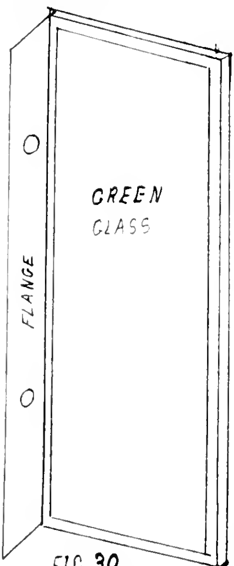

FIG 30

used it a day or two you will wonder how on earth you ever got along without it, though at first it will bother you some. Use hard solder for fastening on the flange or have it made in one piece with the frame. Some operators use a metal plate instead of the glass, but the latter is best. The shield should be set back about ⅜ of an inch from the picture opening, on the operating side, of course.

The writer has said in his hand-books and in various articles, and now repeats, that the operator who produces the best results watches his picture and not his spot, making his lamp adjustments according to what he sees on the curtain. Like all other rules, however, this must be qualified. At times it will be found impossible to get the desired result by any lamp adjustment you may make. This indicates that there is something radically wrong, and nine times in ten the trouble will be found in the arc itself. Perhaps a "mushroom" has formed on the lower carbon tip. Perhaps your carbons are not set just right. But to ascertain precisely what is wrong and intelligently remedy it without stopping, you must be able to closely examine the arc. This may be done as completely as you would examine the flame of a tallow candle, and with less eye strain. When burning a crater on a new carbon before the show starts the writer frequently opens the lamphouse door and watches the whole operation. He can gaze right into the crater and examine every detail of his carbon tips and does do it several times in the course of each day. How? Simply by the use of two pieces of glass, 5 inches long by 4 wide, one red and the other green. But the shade must be just right to get the best result. A red or green glass alone is of small practical value in examining the arc, unless it be a very weak one.

The top edge of the spot is the best guide in shortening the arc (closing the carbons). When the carbons are too far apart (too long an arc) there is usually a sort of nebula of light forms at the top of the spot. With direct current it will be orange with a purple center when it gets large, and with alternating it will be purple. With your carbons set just right this nebula (I use the term for want of a better) will form quite rapidly and the careful operator will not let it get more than ¼ inch wide, closing the carbons just so that it disappears. If closed more than that the light will usually sing, indicating that the arc is too short. Trim your lamp **little** and **often** is the only right rule. The nebula will vary somewhat with the set of the carbons, also with the size of carbon used, but if the carbons are set right it nearly always appears and forms a perfect guide for trimming the lamp. If it does not form it is usually an indication that your carbons are not set right or are not burning right. Another guide to carbon adjustment is to drill a ⅛-inch hole in the front of the lamphouse on a line with the top of the condenser and about 1½ inches to its left. Through this hole will be thrown on the wall two points of light with a purple band between. The width of the band will indicate the relative length of the arc. Still another way is to set the condenser vent-hole (if you have a condenser casing which will allow it) on top, or a little to the right of the top, and bend the forward edge of the hole in a trifle. Through the hole will be projected on the wall, magazine or film guard a multi-colored band edged with orange or white, indicating the relative length of the arc. But, after all, the top of the spot is the best guide for carbon adjustment and he who can read all that it tells will find it a great assistance in securing good light. The spot should be as small as possible and get a good, clear picture, since all light which does not enter the picture opening is wasted. But even this must be qualified. Looking through the light beam you will usually see a clear, white center edged, top and bottom, with a more or less deep strip of orange. This latter portion of the light is, of course, very poor for projection and it is possible that by using it you will not get as brilliant a picture as though only the white center were utilized. This depends on circumstances and how "orangy" the light is. Just what causes this phenomenon the writer is unable to say, but believes it to be due to (a) wrong set of carbons, (b) uneven heating of crater, (c) imperfect lenses, one alone or all combined.

The spot should be perfectly round. An oblong spot cornerwise of the gate indicates carbons out of line with each other sidewise. Oblong straight across the aperature indicates crater too low down. Move bottom tip ahead or top one back according to circumstances. The size of the spot is controlled by moving the lamp toward or away from the condenser. If the spot is edged with light, bright blue and has a sort of "puckered" appearance the lamp is too far from the condenser. This is a condition which will usually only appear when using long focus condensers. It is possible with short focus lenses, but it is not likely you will ever get the lamp that far back with them.

THE PRINCIPLES OF OPTICAL PROJECTION.

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The following brief review of the leading principles of projection is designed for the reader who, having no knowledge of the science of optics, wishes to understand the operation of projection apparatus.

With the aid of the apparatus we throw or project upon a screen an enlarged image of a transparent object (a slide or film). The process is almost the reverse of ordinary photography. For example, in photographing a scene by means of the photographic objective or lens we obtain a reduced image of that scene on the ground glass. This glass is replaced by the sensitized plate and by the use of chemicals the image is fixed thereon. Now in projection we reverse this process. From the picture made with the lens we make a transparent slide, or we use the film negatives, and by means of a condensed light we strongly illuminate these, and with an objective lens an enlarged image is projected upon the screen, and this screen image corresponds with the real objects first photographed.

From this illustration it will be seen that the first essential in projection work is the lens or objective. Just as in photography the quality and tone of the picture depend to a very great extent upon the quality and character of the lens, so in projection the objective is the factor which determines the excellence of the screen image.

The condensing lenses must be of a diameter slightly greater than the diagonal of the slide or film in use. The size most commonly used is 4½ inches in diameter.

As the condensing lenses are in close proximity to the arc or other source of light, they are, of course, subjected to considerable heat and will expand and contract accordingly as they are heated or cooled. Some arrangement should, therefore, be made for this expansion and contraction so that it will be as even as possible. We have done this in our patent ventilated mount, which provides for the circulation of air and ensures the even expansion and contraction of the condensers.

The optical principle of projection for both lantern slide and moving picture apparatus will, perhaps, be more readily understood from the diagram on this page.

At E is an electric light or other suitable illuminant the light from which is caught up by the condensing lenses or condenser C; this condenser is an arrangement of lenses so constructed as firstly, to gather up as great a volume of light as possible, and secondly, to concentrate the light which it gathers at the center or diaphragm plane of the objective when the objective is located at the proper distance from the slide or film, which distance is determined by the focal length of the objective.

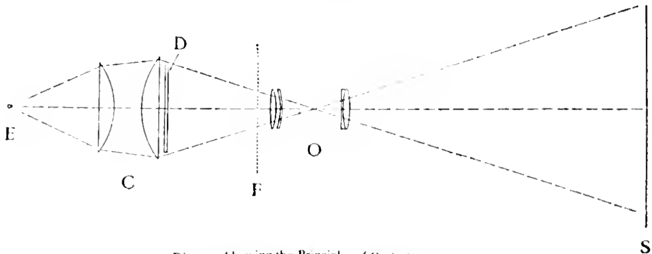


Diagram Showing the Principles of Optical Projection.

The slide or film should be placed at such a point that the entire area of the opening is fully illuminated, and it should also be placed so that the greatest number of light rays possible should pass through it. Taking into consideration the fact that the opening in the mat in the lantern slide is $2\frac{3}{4} \times 3$ inches and in the moving picture film is $\frac{11}{16} \times \frac{15}{16}$ inches, it will at once be evident that the slide must be placed at the point D in the diagram in order that its entire area be covered, and the moving picture film must be located at the point F in order that it may take in the greatest number of light rays.

Proceeding from the slide the light passes through the objective O, where the rays cross, and the object is hence reversed, and by means of the objective the object is imaged or delineated upon the screen S. The degree of sharpness and flatness of the image depends upon the optical corrections of the lens.

The relative positions of the arc, condenser, and objective must be such that an image of the light source will be formed at the diaphragm of the objective. All the light coming from the condenser is then utilized and the image on the screen is at its brightest.

Oftentimes lantern slides and films are to be used interchangeably, and approximately the same sized image is desired with both. As the opening in the slide mat is approximately three times that of the moving picture film, it is, therefore, necessary to have a lens for lantern slides approximately three times the focal length of that of the lens used for films. It is possible to match the size of the images in **one dimension only** (either width or height) as the two openings are not proportionate in size.

It is necessary, therefore, in ordering to specify whether the images are to be the same height or width.

The Selection of a Lens.

The most important consideration in projection work is the **lens,** for on its selection depend the quality and size of the image on the screen. Not the lens mounting, nor even the diameter of the lens itself, but **its equivalent focus** and **distance from the screen,** determine the size of the image.

At a given distance the greater the focal length the smaller will be the image. Shorter focus lenses, therefore, will give large images. Do not make the mistake of selecting lenses of such short focus; that the magnification will be so great that when the observer is near the screen much of the definition and perspective will be sacrificed.

Brilliant pictures of medium size are far more satisfactory.

The projection distance must be measured from the film or slide to the screen.

The tables on pages 80 and 81 show the size of image obtained with lenses of different focal lengths at varying distances. Other sizes, focal lengths and distances can be computed as follows:

Size of Image.—This can be determined by multiplying the difference between the distance from lens to screen and the focal length of the objective, by the size of the slide, and dividing the product by the focal length.

For example:

Let L be the projection distance, 40 feet (480 inches); S, the slide mat, 3 inches; F, the focus of the lens, 12 inches;

then we have the formula (in which d is the size of image).

$$d = \frac{S\,(L - F)}{F}$$

Substituting for the letters their known values we have

$$d = \frac{3\,(480 - 12)}{12} = 117 \text{ in. or } 9\tfrac{3}{4} \text{ ft.}$$

Focal Length.—To determine this factor multiply the size of the slide or film opening by the distance from the lens to screen, and divide the product by the sum of the size of the image and the size of the slide.

Thus we have the formula $F = \dfrac{S \times L}{d + S}$ and substituting their values as before

$$F = \frac{3 \times 480}{117 + 3} = \frac{1440}{120} = 12 \text{ inches.}$$

Distance from Slide to Screen.—With the other factors given we can get this by multiplying the sum of the size of the image and size of slide mat, by the focal length, and divide this product by the size of slide mat, thus:

$L = \dfrac{F\,(d + S)}{S}$, substituting values

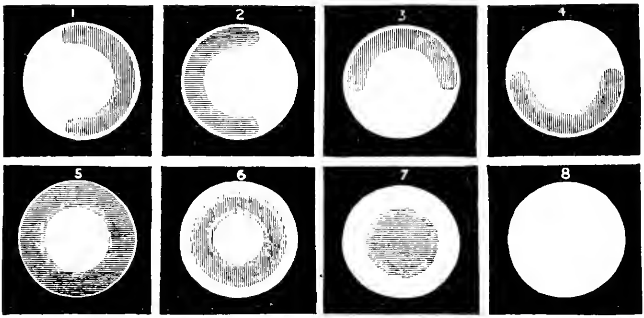
$$L = \frac{12\,(117 + 3)}{3} = 480 \text{ inches} = 40 \text{ feet.}$$

Adjustment of Light.

Successful results in projection depend largely upon the correct adjustment of the lamp, which must throw a brilliantly illuminated circle upon the screen.

After the objective is focused, as will be evidenced by a sharp, clear image on the screen, remove slide and slide holder, and examine the illuminated circle. If the light is centered and the lamp correctly adjusted this circle will be clear and entirely free from coloration or shadows.

The following diagrams illustrate the results of defective centering, showing the shadows and stating the causes. These can be speedily remedied and a little practice will soon make one adept in centering the light accurately.



In Figs. 1 and 2 the radiant, i. e., the crater, needs to be properly adjusted laterally, it is too far to the right or left.

In Figs. 3 and 4 it is too high or too low.

In Figs. 5, 6 and 7 it is too near or too far from the condenser.

Fig. 8 shows it to be in correct position, the field being entirely clear.

CONDENSER BREAKAGE.

An operator in Winnipeg, Canada, suggests a very simple and inexpensive method of preventing condensers from cracking. It is passed on for what it is worth. He places a new condenser in the kitchen oven for four or five days, allowing it to heat and cool off again and again as the fire is used. By this method of tempering he says that a condenser lasted fourteen months and was then broken only by accident while being cleaned.

Boiling the condensers has also been suggested, but the method of baking and cooling appears feasible and is based on logical reasons.

Table showing size of screen image when moving picture films are projected.

Size of Mat opening $\frac{11}{16}$ x $\frac{15}{16}$ inch

Equiv. focus Inches	15 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.	45 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.
2¼	4.8	6.4	8.0	9.6	11.3	12.9	14.5	16.1					
	6.5	8.7	11.0	13.2	15.4	17.6	19.8	22.0					
2½		5.4	6.8	8.2	9.6	10.9	12.3	13.7	16.4				
		7.4	9.3	11.2	13.1	14.9	16.8	18.7	22.4				
3		4.5	5.7	6.8	8.0	9.1	10.3	11.4	13.7	16.0			
		6.2	7.7	9.3	10.9	12.4	14.0	15.6	18.7	21.8			
3½			4.9	5.8	6.8	7.8	8.8	9.8	11.7	13.7	15.7		
			6.6	8.0	9.3	10.6	12.0	13.3	16.0	18.7	21.4		
4			4.2	5.1	6.0	6.8	7.7	8.5	10.3	12.0	13.7	15.4	
			5.8	7.0	8.1	9.3	10.5	11.6	14.0	16.3	18.7	21.0	
4½				4.5	5.3	6.2	6.8	7.7	9.1	10.6	12.2	13.7	15.4
				6.2	7.2	8.4	9.3	10.5	12.4	14.5	16.6	18.7	21.0
5					4.8	5.4	6.1	6.8	8.2	9.6	10.9	12.3	13.7
					6.5	7.4	8.4	9.3	11.2	13.0	14.9	16.8	18.7
5½					4.3	4.9	5.6	6.2	7.4	8.7	9.9	11.2	12.4
					5.9	6.7	7.6	8.4	10.2	11.9	13.6	15.3	17.0
6						4.5	5.1	5.7	6.8	8.0	9.1	10.3	11.4
						6.2	7.0	7.7	9.3	10.9	12.4	14.0	15.6
6½							4.7	5.2	6.3	7.3	8.4	9.6	10.6
							6.4	7.1	8.6	10.0	11.4	13.0	14.5
7							4.4	4.9	5.8	6.8	7.8	8.8	9.8
							6.0	6.6	8.0	9.3	10.6	12.0	13.3
7½								4.5	5.4	6.4	7.3	8.2	9.1
								6.2	7.4	8.7	10.0	11.2	12.3
8									5.1	6.0	6.8	7.7	8.5
									7.0	8.1	9.3	10.5	11.6

EXAMPLE: With a lens of 5½ inch focus at a distance of 35 ft. the screen image will be 4.3 x 5.9; at 40 ft., 4.9 x 6.7; at 45 ft., 5.6 x 7.6 etc.

Table showing size of screen image when lantern-slides are projected.

Size of Mat opening 2¾ x 3 inches

Equiv. focus Inches	15 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.	45 ft.	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.
5	8.0	10.8	13.5	16.3	19.0								
	8.8	11.8	14.9	17.8	20.8								
5½	7.3	9.8	12.3	14.8	17.3	19.8							
	7.9	10.7	13.4	16.1	18.8	21.6							
6	6.6	8.9	11.2	13.5	15.8	18.1	20.4						
	7.3	9.8	12.3	14.8	17.3	19.8	22.3						
6½	6.1	8.2	10.4	12.5	14.6	16.7	18.8						
	6.7	9.0	11.3	13.6	15.9	18.2	20.5						
7	5.7	7.6	9.6	11.6	13.5	15.5	17.5	19.4					
	6.2	8.3	10.5	12.6	14.8	16.9	19.0	21.2					
7½	5.3	7.1	8.9	10.8	12.6	14.4	16.3	18.1					
	5.8	7.8	9.8	11.8	13.8	15.8	17.8	19.8					
8		6.6	8.4	10.1	11.8	13.5	15.2	17.0	20.4				
		7.3	9.1	11.0	12.9	14.8	16.6	18.5	22.3				
8½		6.2	7.9	9.5	11.1	12.7	14.3	16.0	19.2				
		6.8	8.6	10.3	12.1	13.9	15.6	17.4	20.9				
9		5.9	7.4	8.9	10.5	12.0	13.5	15.1	18.1	21.1			
		6.4	8.1	9.8	11.4	13.1	14.8	16.4	19.8	23.1			
9½		5.6	7.0	8.5	9.9	11.4	12.8	14.2	17.1	20.0			
		6.1	7.6	9.2	10.8	12.4	14.0	15.5	18.7	21.9			
10		5.3	6.6	8.0	9.4	10.8	12.2	13.5	16.3	19.0	21.8		
		5.8	7.3	8.8	10.3	11.8	13.3	14.8	17.8	20.8	23.8		
12			5.5	6.6	7.8	8.9	10.1	11.2	13.5	15.8	18.1	20.4	
			6.0	7.3	8.5	9.8	11.0	12.3	14.8	17.3	19.8	22.3	
14				5.6	6.6	7.6	8.6	9.6	11.6	13.5	15.5	17.5	19.4
				6.2	7.3	8.3	9.4	10.5	12.6	14.8	16.9	19.0	21.2
16					5.8	6.6	7.5	8.4	10.1	11.8	13.5	15.2	17.0
					6.3	7.3	8.2	9.1	11.0	12.9	14.8	16.6	18.5
18					5.1	5.9	6.6	7.4	8.9	10.5	12.0	13.5	15.1
					5.6	6.4	7.3	8.1	9.8	11.4	13.1	14.8	16.4
20						5.3	6.0	6.6	8.0	9.4	10.8	12.2	13.5
						5.8	6.5	7.3	8.8	10.3	11.8	13.3	14.8
22							5.4	6.0	7.3	8.5	9.8	11.0	12.3
							5.9	6.6	7.9	9.3	10.7	12.0	13.4
24								5.5	6.6	7.8	8.9	10.1	11.2
								6.0	7.3	8.5	9.8	11.0	12.3

EXAMPLE: With a lens of 10-inch focus at a distance of 20 ft. the screen image will be 5.3 x 5.8; at 25 ft., 6.6 x 7.3; at 30 ft., 8.0 x 8.8; at 50 ft., 13.5 x 14.8 etc.

Carbons.

This subject is one of greatest importance since it involves the matter of light—the very foundation stone of projection. I believe it will be valuable to the operator to know what carbons are made of and how they are made and to that end a short dissertation on their manufacture will be included. Carbons are made from 6 inches to as much as 30 inches in length. They are supposed to be perfectly round and straight, but a variation of 1½ per cent of the nominal diameter is allowed in the matter of roundness and a 6-inch carbon may be 1-32 or a 16-inch one 1-16 out of true as to straightness without being rejected. Carbons are made from a mixture of three substances in varying proportions, viz.: soot obtained from the imperfect combustion of pitch, tar, naphthaline, oils or resins; retort carbon formed in process of making illuminating gas and petroleum coke obtained in process of distillation of mineral oils. Soot is the best form of carbon, retort carbon comes next and petroleum coke is poorest. The quality of the carbon depends largely on the percetage used of the above named materials. Quality is judged by breaking a carbon and examining the fracture also by the sound when struck, but this is beyond any but the expert. Some operators claim they can judge of the quality of a carbon by its color and gloss, but in this I believe they are mistaken. The expert in carbons might be able to tell something from the exterior of a carbon but hardly an operator. In manufacturing carbons the materials are first thoroughly pulverized into a dust, then purified and metalic particles removed by action of a powerful electro magnet. The binder is now added and the mass mixed to a stiff dough or paste. For binder common coal tar is most commonly used, though some makers employ a special syrup (sugar syrup, I understand it to be). After the binder is thoroughly incorporated the mass is passed between heavy rollers under great pressure and is then stamped into blocks 12 inches in diameter by about 16 inches in height. These blocks are placed in a hydraulic press in which is a steel die the size of the carbon being made. If it is to be a cored carbon a steel needle the size of the core is placed in the center of the opening. The press now forces the mass through this die under pressure of several thousand pounds per sq. inch.

As the carbon rod is leaving the die a steel wheel runs along it printing the maker's name and other marks, usually denoting quality. The rod is next cut into 36-inch lengths which are allowed to roll down a slightly inclined table to straighten them. They are then tied in large bundles and baked for several days at a temperature of about 2,700 degress F. This baking reduces the binder into a substance closely resembling very hard coke. The rods are now cut into stock length, tested as to straightness, examined for imperfections and pointed. Those to be cored have forced into their centers a stiff mass formed of a powder obtained by grinding up defective carbons which have been baked mixed with water glass. The percentage of water glass in the core is a most important matter. The more there is of it the longer arc, within certain limits, can be pulled with a given current. The carbons are thoroughly dried after coreing, but not again baked, and are then ready for use.

In purchasing carbons it is better to get as long stock as you can use in your lamphouse and considerable saving is effected if you can use 12, or even 10-inch carbons, at least for the upper. There is just so much waste to each carbon in the form of a butt, averaging, usually, three inches in length. This waste is the same with a six-inch as with a 12-inch carbon, but if your 12-inch stock is cut in two and used in the form of two 6-inch pieces there are two butts instead of one. Do you see the point? In other words, when using 6-inch carbons you waste one-half the stock in the form of butts, whereas with 12-inch carbons you waste but one-fourth. Where a house runs all day and evening too this item will amount to more dollars than you would imagine in the course of a year. In a house using strong light, running continuous 11 hours per day, there will be about 350 more 12-inch carbons used in a year if cut into 6-inch length than would be consumed by burning 12-inch stock. Where 12-inch stock is cut into 6-inch lengths the whole bundle may easily be sawed in two with an old carpenter's handsaw, provided it be done before the bundle is loosened. A coarse, low-speed emery wheel is best to sharpen carbons on, but in lieu of that a 10 or 12-inch cabinet rasp is excellent. If you are using alternating current be very careful to sharpen your carbons with a true point, being particular to get the small, flat space at the end always about the same. The point, particularly the flat space at the tip, will be your guide in setting the carbon and, as will be later explained, it is of utmost importance that you get your carbons set exactly right with alternating current. Cracks running lengthwise of the carbon are **not** faults but rather evidence that the carbon has been well and thoroughly baked. Cracks running around the diameter, however, are serious faults and any such should be promptly thrown away. In making your purchases insist on examining ends of cored carbons and reject any bundles in which are many carbons containing imperfect cores.

You cannot get a good light with a carbon that has a bad core. The core is for the purpose of holding the current central in the carbon. The soft core has a relatively higher conductivity than has the hard carbon surrounding it. This holds the current to the center of the carbon and enables you to maintain a better crater and keep it where you want it. When using direct current it will frequently happen that the lower carbon will burn to a long "needle" tip and there will be a little heap of black powder on top of the lower carbon arm. This is due to the fact that the binding material is burning out, thus leaving the carbon itself free and it drops away without being consumed. This is due to abnormal heating through higher resistance of the carbon and may be remedied to some extent by using a larger carbon, though even the ⅝ size will do it sometimes when you are using a heavy current. That it is due in considerable extent to poor carbon is proven by the fact that one carbon will not needle at all while the next one, of same size and kind, will needle for 2 or more inches. This shows there is a vast difference in the resistance of carbons—or the writer thinks it does anyhow. He may be wrong, but this is the explanation which appeals to him. The formation of glass-like beads on a carbon tip is evidence of high quality, this being the only residue of voltalized soot. It frequently happens that a thin-stemmed, mushroom-shaped tip will form on the lower carbon when using direct current. This is due to the carbons being held too closely together, thus excluding the free passage of air to the crater. Under this condition particles of voltalized carbon are carried along by the current instead of being consumed. In the arc they are converted into graphite and cling to the tip of the lower carbon. This graphite "cap" presents high resistance to combustion and remains until it falls, or is knocked off. Once started by too close contact of the carbons the mushroom grows until it is sometimes half an inch long and you will have poor light as long as it is there. It can be consumed by burning a long arc but the best way is to knock it off with a screwdriver blade and be more careful in future. The white ash which forms inside the lamphouse when using cored carbons is the residue of the water glass contained in the cores.

As to the size and kind of carbons to be used, that will depend on several things and will vary with individual cases. For alternating current it may be said that ⅝ cored above and below is the thing in practically all cases. For direct current ⅝ cored fills the bill above, but either ⅝, 9-16 or ½-inch cored or 9-16 or ½-inch solid may be best below, according to individual preference or the current strength used. If solid is used below do not get too hard a carbon or your light will have a tendency to be yellow. Try the different carbons until you get the one which gives best results, but don't decide by burning one carbon. Give each one a day's trial at least. In putting you carbons into the clamp it is necessary to use considerable pressure on the clamp, since if there is not good contact, much heat will be generated through electrical resistance due to poor contact. If the contact is very poor there may be arcing between the carbon and clamps and this will consume carbon, still further loosening the connection and unduly heating the carbon arm and clamp. Don't overdo the matter of pressure, however, as the carbon arms and clamps put out with many lamps are very weak, especially when hot. Use judgment and common sense. Some advocate using an upper carbon which has been flattened on one side with alternating current, but the writer has been unable to detect any material advantage from this practice.

SETTING THE CARBONS.

Whether you are using A. C. or D. C. (alternating current or direct current) practically all available illumination comes from the "crater," a saucer shaped depression which forms on the upper (positive) carbon tip with D. C. and on both tips with A. C. (though with the latter the craters are usually flat, rather than depressed in the center, as with D. C.). The whole endeavor in setting the carbons should be to get the crater to form of good size and face the condensing lens as squarely as possible. Setting the carbons with D. C. is comparatively easy and simple. All projection lamps are so made that the top may be set further back than the bottom (angling the lamp, this is called) so as to aid in getting the crater square with the condenser. In all lamps but the Edison, I believe, this angle may be varied within certain limits. With D. C. the lamp should be angled back just as much as possible and not get the lower carbon tip, or any part of it, between the crater and condenser.

Whether or no the lower tip is interfering is somewhat difficult to tell unless one is able to closely examine the tips by aid of the glasses before mentioned. Draw a line with the eye, when the arc is burning normally, from the lower edge of the crater to the lower edge of the lens and if such a line strikes the lower tip there is interference and loss of illumination, though if slight it may not amount to much. The greater angle you can give the lamp without this interference the greater illumination you will get from a given arc, but the amount of angle will be checked by the lower carbon arm striking the front wall of the lamphouse when the lamp is wide open, or the lower carbon doing the same thing when a new one which projects below the arm is in. This must be taken into consideration since angling beyond the point where the carbon arm interferes involves burning a shorter lower carbon with consequent greater carbon waste.

I have already spoken, I believe, of the size of carbons best to use. With A. C. it matters not at all which wire is connected to upper or lower binding post of lamp, but with D. C. the negative must be connected to the lower and the positive to the upper. There are several methods of ascertaining which is the negative and which the positive wire, but the following is simplest: Connect one wire from one binding post of operating switch to lower binding post of

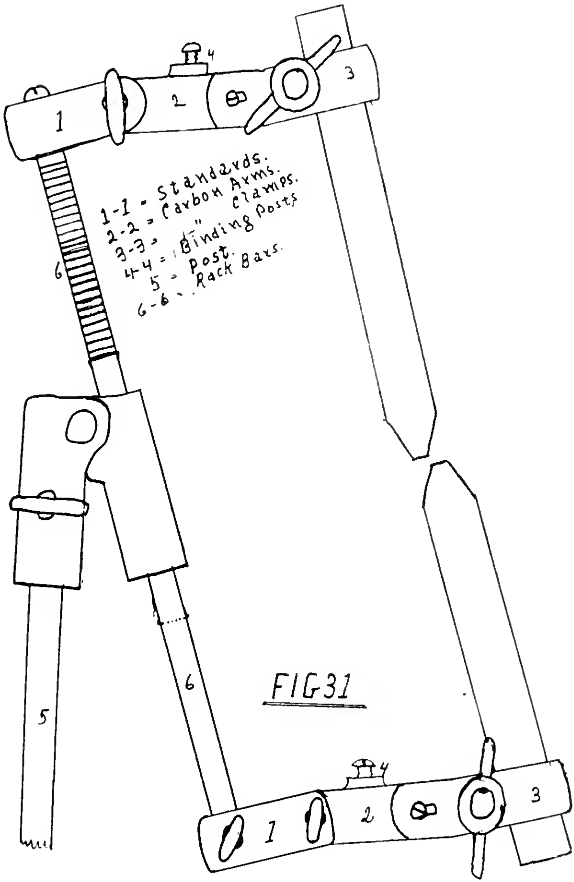


FIG 31

lamp. Connect other wire through the rheostat to upper lamp binding post. Now, first being sure the resistance is in if using an adjustable rheostat, close the switch and light the lamp. Let it burn for five minutes and shut it off. Examine the carbon tips. If the lower is burned to a round point and the upper has a saucer-like depression you are all right, but if just the opposite condition exists change the wires at the lamp and cut the rheostat in on the other wire. The latter is not necessary but the writer prefers

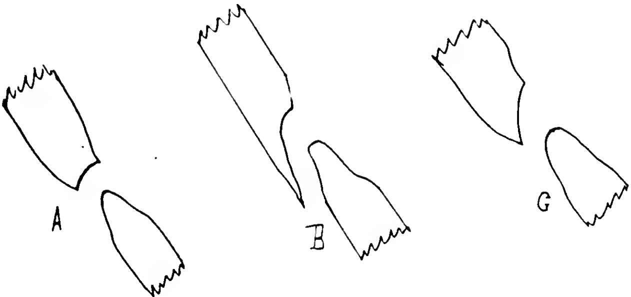


FIG 32

the rheostat on the positive wire, since he thus has a little less voltage on the lamp and this makes any shocks he may get somewhat lighter. Otherwise it makes no practical dif-

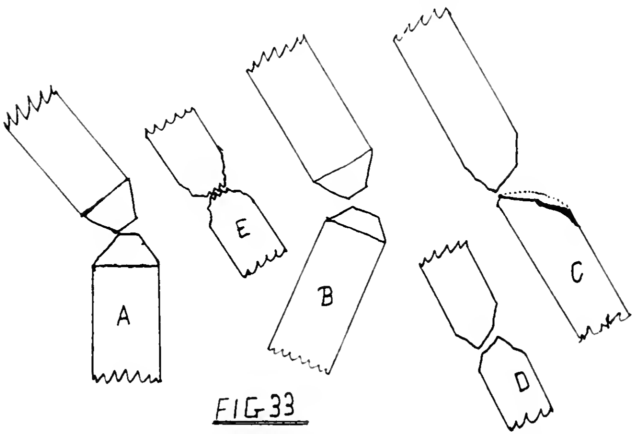


FIG 33

ference which wire it is on. Having ascertained that your carbons are in perfect line with each other sidewise (see "The Lamp") set your carbons in place as per Fig. 31. Some operators prefer setting the top carbon parallel with the lamp rack-bars and angling the lower one slightly ahead, but this is merely a matter of individual preference. We have now arrived at the **one most important thing in securing good projection light,** and that is to get the advancement of the lower carbon tip **exactly right,** since this is what will in great measure determine the position of your crater. If you set it too far back your crater will be too low down and the light will be thrown downward instead of straight ahead as it should be. If, on the other hand, you get it too far ahead a long "skirt" will form on the back edge of the upper carbon tip. This is not a good condition, since when it prevails the crater is not in the best position and moreover there is tendency of this "skirt" to break off, often fully half way up the crater. Fig 32A shows lower tip too far back. Fig. 32B, tip too far forward, Fig. 32C shows an ideal condition, and this latter condition may be at all times maintained, barring imperfections in carbons, by close attention. But let me impress upon you that it is more than anything else the exact amount of advancement of the lower carbon ahead of the upper which makes it. I am assuming, of course, that you have experimented and found what carbon, or combination of carbons, are best suited to your needs. There is little or no difference of opinion among operators as to the best set for D. C. carbons, but there is a vast difference in the matter of care to get the set exactly right so that the best possible results will be obtained.

With A. C. it is quite another story. Fig. 31 shows one method of setting A. C. carbons and Fig. 33, A and B, two more, each of which have their advocates. It is, however, significant that whereas three years ago you could hardly find an operator setting his carbons as per Fig. 31 (the D. C. set) you will find at present that nearly all the high-class men set their carbons the same for either D. C. or A. C. They have discovered, as did the writer, that while freelv granting a higher candle power for Fig. 33 sets, the crater cannot be controlled or maintained, hence steady light with these sets is an impossibility, especially with set B. (With set B, Fig. 32, the lamp itself should be set straight up and down.) I shall, therefore, confine my remarks largely to the set shown in Fig. 31, which I strongly advise all operators to use. It is precisely the same as the D. C. set, except that the top carbon should be set parallel with the lamp rackbars and the lower carbon angled forward a trifle In using this set I cannot caution you too strongly to be exceedingly careful to get your carbons set **exactly right.** "Pretty near" will not do at all. They must be exactly right.

Use the round points of the carbons as your guide in setting and find out just how far to set the lower tip ahead of the upper and then **keep it that way.** When you have it right the craters will be about as shown in Fig. 33C, which is ideal. With such a crater you will have white, steady, strong light at all times. If the upper crater burns too flat advance the lower tip just a very little. If the lower tip shows a tendency to form, as in Fig. 33D, move it back just a trifle, but remember that a little movement of the tips backward or forward may make a big difference in the form of the craters. The craters are small and 1-16-inch move of either tip makes a big change in their forms. With alternating the carbons must be **fed little at a time and often** and the arc must be comparatively short, but if too short a condition such as shown at Fig. 33E will arise. Such a condition means carbons kept too close together. The remedy is, if you get them in that shape, burn a long arc for a time. In fact whenever your crater is going wrong and you change your carbon tips, lengthen your arc for a couple of minutes until the crater form changes. With A. C. the colored glasses I have spoken of are almost an imperative necessity, since to get good results one simply **must watch the arc itself.**

Operators may argue and tell what they can do until they are weary and breathless, but one thing they cannot do, no matter what they claim, and that is get a good, steady light with alternating without looking at the arc itself when anything is wrong with the light. With A. C. use ⅝ cored carbons above and below, also you should have not less than 45 amperes to get good results, 50 to 55 if you are using rheostat resistance. Right here let me offer a criticism which applies to nearly all lamps. I have shown the importance of backward and forward movement of the carbon tips, especially with alternating current. It is of prime importance that the operator be able to accomplish this movement at any time while running and frequently the necessary movement will be not to exceed 1-16 inch. Yet important as is the matter, most lamps have absolutely no provision for tilting the carbon arms except to pound them up or down or accomplish the desired result by tapping the carbon tip itself, which is unreliable and may result in breaking the carbon off entirely. The Motiograph lamp has a screw by which the adjustment may be made, but it is not a practical arrangement, or rather it does not work well in practice—still it is much better than nothing at all. I am told there is one lamp with an excellent arrangement for this movement of the lamp arms, but I have not as yet seen it. It seems high time that lamp makers woke up to the necessity of this provision and gave us some practical method of tilting the lamp arms while running it. It is difficult to accomplish I know, but surely is not impossible. When you put in new carbons always burn a very long arc until the crater is formed.

The Film.

There are comparatively few operators who thoroughly understand the proper care of a motion picture film and, judging from conditions, very few exchange men either. It seems hardly necessary to say that the film is a strip of specially prepared celluloid which comes from the maker in 200 feet lengths. This strip is 1⅜ inches wide and of varying thicknesses, though supposedly 5-1000 of an inch of which 1-1000 is the emulsion. This thickness has recently been somewhat increased in the new non-inflammable stock. On one side of this celluloid strip is a photographic emulsion, on which appears a succession of what are nothing more or less than photographic snapshots, ¾ by 1 inch, taken at the rate of about one thousand per minute. There are 16 photographs to each linear foot of film, each taken about one-sixteenth of a second later than the next preceding. All this has been told so often that its repetition seems almost like waste of space, but the facility with which the most beautiful, as well as the poorest, examples of film develop into "rainstorms" is proof positive that, while some points concerning film may be well understood, others are not, since there is an amazing amount of ignorance or carelessness, or both together, displayed in the handling of films by both operators and inspectors. To such an extent is this carried that it amounts to nothing less than an outrage—an outrage against the owner of the film and against the public who pay their money to see a picture—not a bunch of junk. And the damage is fully nine-tenths due to just one cause and one cause only, viz., what is known as "pulling down," i. e., holding the reel stationary while revolving the reel to tighten the film roll. This, of course, causes the whole roll of film to slip on itself under considerable pressure, thus applying friction to both sides of the whole film. Now it seems to the writer that the commonest kind of horse sense ought to tell one what this will do to a film, particularly to the comparatively soft emulsion side. Look through any light ray and you will see that the air is constantly full of dust, and it does not require the wisdom of Solomon or an examination with a microscope to know that some of it is bound to adhere to the film. the more especially since celluloid, under combined influence of heat and friction of the tension springs, generates considerable static electricity.

To be sure, these particles of dust are very fine, but some of them are very hard and some particles contain metal, which is attracted by the electricity in the film. When the film slips on itself, in pulling down, these pieces become miniature plows, producing scratches coarse or fine, according to size and pressure. Of course, all dust particles are not large enough or hard enough to produce material damage, else we would have a film utterly ruined in a week of ordinary misusage, since they are present by the million. But the process is repeated many times in an ordinary day's run and then is **duplicated at the exchange itself.** What is the remedy, you ask? Well, it is very simple; but getting it applied is another matter entirely, since it involves a little more time and considerably more labor in rewinding—a job the operator cordially hates at best. Also it involves slower work by the inspector. **Rewind slowly, applying considerable tension**—at least as much as the average takeup supplies. That is all there is to it, since there would then be no reason to "pull down." One of the prolific causes of this pernicious practice is, however, too much film for the size of the reel. Reels are too small. Custom puts between 900 and 1,000 feet of film on a reel. This fills a 10-inch reel chock full with ordinary stock, and if the film happens to be a trifle thicker than ordinary it fills the reel more than full. Ten inches is too small. They should be 11 inches and no more than a thousand feet of film ever be placed on one reel. In some theaters where the work is rapid there is no time to rewind as above indicated and the operator has no choice, when running a thousand feet of film, except to pull down. With an 11-inch reel the necessity would not be present in nearly so great a degree, though with rapid rewinding either there must be no tension or else the labor is very hard. If there be no tension then the roll must be pulled down some or it will wind so loosely it will "flop." Rewinding should be done by motor in such cases and then the tension can be left on. I have dwelt on this matter, since I consider it one of vital importance—perhaps of more importance than any other one thing in the motion picture business to-day—and in time this will come to be recognized. There are other minor causes which contribute to the production of rainmarks, the principal one being the practice of holding the film flatwise between the thumb and fingers when rewinding. This does not produce deep scratches, but undoubtedly it is responsible for a multitude of very fine ones. Anything which applies friction to the surface of a film produces injury. There is at least one machine which still has idlers with a flat surface extending clear across.

This is bad. Nothing at all should touch the film in its passage through the machine except on the track. Such idlers may do slight damage when properly adjusted, but unfortunately they are not always thus and, worse yet, are not always even revolving. Idlers of this type have been discarded on most machines and should be on all. The long, deep scratches frequently seen are usually chargeable directly to the ignorance (I use plain terms), carelessness or laziness of the operator. In running new film on which the emulsion is still comparatively soft some of it is likely to deposit on the magazine fire guard rollers, particularly if they are not turning. This deposit increases rapidly, also catches particles of dust and dirt, and may form a sharp point, which plows through the emulsion, leaving a long, deep scratch. Magazine rollers should be carefully examined and cleaned every day, especially if you are on "first-run" film.

Outside the damage as above set forth there is little or nothing to injure a film either in its passage through the machine or at any other time except for wear of sprocket holes and tension spring marks. The writer asserts that, given a modern machine, in proper adjustment, he can run a film through, under ordinary show conditions (being given ample time for rewinding or given a motor for fast rewinding), 500 times and have scarcely a mark on it—not a single one that will be discernible on the curtain. To do this he would not, however, accept more than 850 to 900 feet of film on a 10-inch reel. Another thing I must mention in this connection, since it is productive of much damage to new films: some new film is quite stiff and has a decided tendency to rewind in the takeup in octagon shape, nor can this be prevented by any ordinary tension. It follows that it will do the same thing in rewinding unless heavy tension be applied to it or it is frequently pulled down. This condition is present only in new films on which the emulsion is, of course, comparatively green, soft and very easily injured. Even pulling down will not get it wound closely enough but that a thousand feet will very much overrun a 10-inch reel. There is room for display of at least ordinary intelligence, on the part of exchange men, in the stock placed on a 10-inch reel, if they care anything at all about their own property. In running new film (first run) the emulsion is often green and soft, with decided tendency to deposit on the tension springs. This matter should be **closely watched when running first run film.** If the deposit is bad it will sometimes evince its presence by a jerking of the springs, but not always. Carefully examine the surface of the tension springs **after each run** and **don't forget it.** The deposit, if allowed to remain, makes a bad tension spring mark the full length of the film.

After considerable experimenting the best preventive the writer has been able to discover is to rub the springs with an ordinary tallow candle before each run. Uusually this will prevent deposit, but not always. In removing deposit be very careful not to roughen the spring or you will then have trouble and plenty of it. Every film should have a tail piece 2 feet long, but a 3 to 4-foot leader is an imperative necessity under present conditions, since it takes from 2 to 3 feet to thread into the takeup. If the title is of ordinary length, even with a new film, by the time you have threaded, started your machine, centered your light and framed up, the audience is left to wonder what the picture is about; the title being "all in" the takeup. But this does not apparently interest the average exchange man, who seemingly is only concerned in "getting the money." I will therefore endeavor to show him where he would actually save money by putting on a leader and thus attempt to touch his heart through his pocketbook. Almost any old film will do for leader, while title is worth good money. In threading into the takeup the average operator folds the film end on itself an inch a couple of times and then thrusts it under the reel clamp. Now in rewinding what happens? I'll tell you. If the reel clamp be stiff this folded end may pull off instead of pulling out and there is something like two inches of film (title) gone. Anyhow when the film pulls off it usually whips around from once to half a dozen times, according to the carefulness (or carelessness) of the o~erator, and what is done to the title would be a shame to tell. It is safe to say each operator who runs it will amputate from 1 to 4 inches during the time it is in his possession. Now, Mr. Exchange Owner, wouldn't it be cheaper for you to have that much junk leader lost each day than have your title gradually eaten away, thus depreciating the value of the film until a new one is attached? But, say you, "operators persistently steal leaders." Yes, that's so, dear sir. **Can you blame them?** They well know that if they are fortunate enough to get a film with a leader on to-day it's a moral certainty the one they get to-morrow won't have one or will have one too short. Send out **all** films with not less than 3 feet of leader, preferably 4, and notify operators that all films will be so equipped. Just as soon as operators discover you mean what you say you will find leader stealing will stop. They will have no cause to take them.

Moreover, you can put a stop to it by charging it up at the rate of 2 or 3 cents a foot—or even more. By thus equipping your film and **keeping the leaders proper length** your titles will last just as long as ony other portion of the film. And now I come to something that will interest you, Mr. Exchange Man. Do you know how operators get leaders when you won't supply them? I'll tell you a state secret. The operator has to have a leader for his film. He proceeds to get it—how? Very simple. He runs it once without leader and then he amputates one anywhere he thinks a jump won't show in the body of the film. He has his leader and you would have to do some mighty close inspecting and comparison to catch up with it. Perhaps you don't know this is done much? Well, there are probably several things you don't know yet and this is just one of them. It serves you right, too. Equip your films as they should be and the practice will stop. You can't stop it in any other way. Film exchange men can well afford to take this matter up seriously, for lack of leaders, now that takeups have become of general use, is costing them far more dearly than they know or realize. Nine operators in every ten resort to the above scheme and they get the necessary leaders that way, too, though they wouldn't know a single thing about such a thing if you asked them—dear me, no! We have had a good many "Associations" in which film renters have played a prominent part, but the writer would suggest, humbly and in all seriousness, that an organization to teach them how to care for their own stock would be a blessing both to them and to those who use the films.

Making mends is another matter of great importance and it is a somewhat sad fact that not one operator or film exchange inspector in fifty makes a perfect patch. The operator is to be excused to some extent, since he seldom has time to do the matter rightly. But what about the exchanges? In only one exchange in all Chicago has the writer seen a film properly mended. That is a broad statement, but true. Let it be understood that film cement when properly used welds the film as much as it glues it. To properly make a patch it must have the heavy, even pressure of a clamp for 4 or 5 seconds. A properly made mend is not more than ⅛ inch wide and is nearly as strong as the original stock. To make such a patch as this, however, is usually impractical

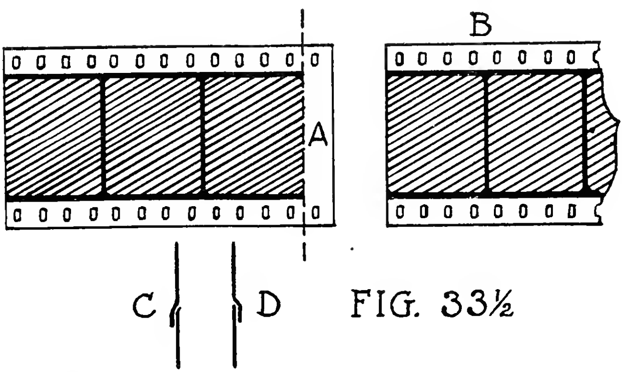


FIG. 33½

in an operating room; but there is absolutely no excuse for the exchange making any other kind.

Nor is there any excuse for operators not making a reasonably narrow, strong patch. Proceed as follows: Cut your film as per Fig. 33½, making stub end A not to exceed 3-16 inch long, and cutting end B exactly on dividing line between two pictures. Cutting the film any other way will cause a misframe. Now lay a small metal straightedge in position shown by dotted lines, Fig. 33½. With a sharp knife scrape the emulsion from the stub right up to edge of straightedge, **scraping right down into the celluloid until a rough, whitish-gray surface is produced.** Be sure to scrape well around the sprocket holes, since this is where the patch usually begins to loosen. Now turn end B over with emulsion side down and, again using straightedge, scrape back of film for a space about equal to width of stub end A. This latter proceeding is very important, since there is likely to be oil on the celluloid, but even if there is not, the patch will not adhere nearly so well if back of film is not well scraped. It takes a very sharp knife to do the scraping properly. (A bit of emery paper fastened to a block of wood makes a good substitute.)

Be sure emulsion sides of both ends are either up or down, apply your cement liberally to the stub end and, working fast, since cement evaporates rapidly, join the two ends so that the end B just covers stub A. Match the sprocket holes perfectly and press the patch together firmly, applying all the pressure you can for a few seconds, when the cement will have set and the patch is finished. Be very sure to get your sprocket holes properly matched, as they are your guide, and unless they fit together the mend will be crooked or two holes will be too small, causing a jump as the film goes through the machine. It may also cause the intermittent to climb a couple of sprocket holes, thus producing a misframe. A film mender with a pressure clamp is a fine thing if you have the time to use them—without the clamp they are merely a nuisance. They are hardly a practical appliance in an operating room. In making patches watch closely the following points: Get emulsion on same side on both ends. Scrape well and apply plenty of cement, especially around sprocket holes. Be sure the sprocket holes match perfectly There has been some argument as to whether a patch should be made as per "C," Fig. 33½, or "D," Fig. 33½. Cement may be had from any film exchange, but you should now get none but the N. I. cement, since it will answer for both N. I. and ordinary stock, whereas ordinary cement will not do on N. I. film at all.

WET FILM.

Should you by accident get the film wet, no matter how wet, it will receive no material damage if you **immediately unroll it** and stretch it in such manner that the emulsion touches nothing until it is dry. This does not apply to colored or tinted film, though even this may sometimes be saved by prompt action. But the unrolling must be done very quickly.

REMOVING EMULSION—MOISTENING DRY FILM.

When it is desired for any reason to remove the emulsion from film it may be done by soaking in warm water to which has been added sal soda (common washing soda will do). Use plenty of the soda and let the film soak for say 15 minutes, and you can then wash the emulsion off easily. It may also be removed by soaking in ordinary cold water and then scraping. Proceed as follows: Soak the film until emulsion is soft. Lay film, emulsion side up, on a flat board or table and draw it under the blade of a knife. If the knife blade is long enough and the edge straight enough the whole surface of the film will be cleaned at one wipe. Film should, so far as possible, be kept in a cool, moist place, though the matter of moisture may be overdone. If you get too much of it the emulsion will stick to the back of the film. It is a mere waste of space telling operators not to keep spare film near the ceiling of a hot operating room. They will keep it where it is most convenient. However, films not on the machine **should** be kept in a solderless metal box or cabinet located near the floor, and if fastened to the wall it should be so attached that it may be instantly lifted away and carried outside in case of fire. Where a film tank is used it is well to have the bottom covered with a coarse screen held an inch from the bottom by wooden or metal cleats. In the bottom of the tank keep some water to which has been added just a little glycerine—one part of glycerine to 33 of water is about right. This will be very beneficial to the films. Old, brittle film may be made pliable as follows: Get any metal can large enough to hold a film when unrolled loosely. The can must have a tight cover. Cover the bottom with a coarse screen, leaving an inch or two below it. Into this space place a mixture of water and glycerine as above. Unroll the film into the can and leave it in a moderately warm room for from one hour to half a day, according to condition of film. Examine frequently. Don't leave long enough to soften the emulsion too much. Another way is to give the film a bath in the aforenamed solution. To do this build a drum by nailing lattice lath around a couple of barrel heads. Place the solution in a washtub or other suitable receptacle and draw film through it, winding immediately on the drum **with emulsion side out.** The drum should be geared so as to run fast enough to throw off all surplus liquid. Be very careful in handling the film after it is wet, as the emulsion is then soft and the least scratch will play havoc with it. This operation must be done in a room where there is no dust. Sprinkle the floor well before commencing. It will perhaps be best for the novice to place the liquid in a long, shallow pan, merely drawing the film slowly through the mixture as it is wound onto the drum. The drum must be revolved until the film is dry. Glycerine absorbs moisture rapidly and that is the reason it is beneficial to a film. Don't use more than one part to 33 of water, however.

LEADERS—INSPECTING.

When you have an old film with a short title, put on a good, long leader, attaching so it is in frame with the title. Frame up on the leader and when the title comes it will have to be very short if the audience cannot catch it, provided you run slowly. Right here let me caution you to **always start your machine slowly.** If you start fast and have to frame on the title it is gone before there is any chance to read it, especially if it be a short one. Also the practice of speeding up on the last few feet of the film is bad and should not be tolerated as it is hard on both the film and the machine. When the operator has the opportunity he should invariably inspect his film before running it the first time, cementing all loose patches and making any other needed repairs. An ounce of prevention in this respect is worth several hundredweight of cure. The inspection given films in some exchanges is very largely a matter of vivid imagination. If the film isn't clear in two somewhere it is enthusiastically O. K.'d by the inspector, who is expected to "inspect" (???) a thousand feet of film in ten minutes or less. I know I am roasting the exchanges a good deal, but unfortunately it is all "coming to them"—or to some of them.

Those whom the shoe doesn't fit need not wear it. In looking over film, unwind into the tank or takeup and rewind slowly, holding film by edges with pressure enough to "cup" it. You will thus by sense of touch be able to detect all broken sprocket holes and loose patches. If more than two sprocket holes are missing in one place, cut it out. In case you should ever be caught without cement, an emergency substitute may be had in ordinary liquid glue. Proceed as you would with cement, but use the glue instead. Don't put much on, though, and give it ample time to dry. This should only be done in case of emergency, however, as it is by no manner of means good practice and makes but a very, very poor job at best.

You can measure the exact length of a film by running through a machine, counting the turns of the crank. The Power's, Edison, Motiograph, and, I believe, the Lubin, also, pass exactly one foot of film to each turn of the crank. The Viascope passes nine inches. And now let me call your attention to the fact that, at a normal speed of 60 feet per minute, 960 separate and distinct photographs must stop dead still—dead still, without a quiver or particle of vibration, each occupying precisely, to the thousandth of an inch, the exact space filled by its predecessors—each minute. It requires slight discernment to see that to accomplish a result so marvelously rapid and accurate not only the mechanism, but the film itself, must be in good condition.

FILM JUMPING.

The writer has had hundreds of letters asking why some new films apparently sway sidewise with rhythmical motion and others continually jump on the screen. The first named fault, usually attributed to lost motion in the camera, is due to the use of a rotary perforator. The last named fault lies in the perforation also. It would occupy much valuable space to enter into detailed explanation as to the exact why and wherefore and could accomplish no corresponding good. Old, dry films jump because (a) the sprocket holes are shrunken, (b) sprocket holes are worn. The first named fault may be remedied by moistening the film as before set forth. Films will jump more or less when run on a machine with worn intermittent sprocket teeth or where the star movement is too loose; also, they will jump badly when run on a finger feed machine the fingers of which are worn. The film gradually cuts a little groove in the fingers on the under side. It is hardly discernible until they are taken out and closely examined, but the effect is there just the same. Remember that with a fifteen foot picture a jump of 1-1000 of an inch becomes 180-1000 on the curtain, while 1-64 inch would become almost three inches. In other words, a fifteen foot picture magnifies the film photo 180 times its diameter, and it follows that any defect is magnified that many times also. From this you may see how absolutely accurate must be the perforation of a film to secure an absolutely steady picture. The marvel is that old films run as well as they do, the more especially when run on a wo n machine.

HOW FILM IS MADE.

In closing this subject, I believe it well to give a very brief, crude description of the way a motion picture film is made. Celluloid is a composition of camphor and pyrolyn, the latter being nothing more or less than ordinary cotton which has, by a bath of nitric and sulphuric acids mixed in nearly equal proportions, been converted into gun-cotton. But it must not be inferred from this that celluloid is in any degree whatever explosive, for it is not. A certain mixture of pyroxylin and camphor, dissolved, or partially so, in alcohol or ether, produces the crude celluloid, which may appear as lumps in the bottom of the acid tanks or in blocks in a press, according to detail of manufacture. The crude celluloid is worked by cold and then by hot steel rolls and is then subjected to prolonged, heavy pressure, after which it is dried in kilns for several days. It is now in the form of cakes, which are worked into strips 200 feet long by 22 inches wide.

A machine next coats this strip with photographic emulsion by passing it beneath a hopper filled with emulsion, in the bottom of which is a narrow slit. Another machine now splits the 22-inch strip into ribbons 1⅜ inches wide, which are then ready for sale to the film photographers, or film makers, as distinguished from film stock makers. The film stock maker only perforates such stock as is ordered perforated, since film makers usually do their own perforating. The perforating is done by a punch press, of which there are several kinds. Some are rotary, some punch two, one hole on each side, and some punch four at a time. There are exactly four perforations to each ¾ inch of film. The film is fed to the press by an intermittent movement or by a pawl and ratchet. Negative films (the ones the photographs are taken on) have a much "faster" emulsion than have the positives. Such is a rough sketch of the process of manufacture of motion picture films, and one has but to glance at the constituent parts of celluloid to understand why it is so inflammable.

SPEED.

The matter of speed is of much importance, but no rule can be laid down governing it. Speed must be left entirely to the discretion of the operator, except that with inflammable film forty feet per minute is as slow as is safe, with ordinary light. Theoretically, the machine speed should be the same as that of the camera which took the picture being projected, but in practice this is often far from true. The camera man grinds out a set speed, supposed to be sixty feet per minute, though often he varies widely from the mark. The actors act the scene as seems best to them, but ofttimes when the scene is projected it is discovered they have misjudged the speed of action necessary for best effect. Right here is where a really good operator who closely watches such details becomes of great value, helping out the scenes amazingly merely by changing speed on different scenes. Take, as an example, Pathe's "Faker's Dream." If run straight through at camera speed the film is dull and of comparatively little effect. Where the actors are moving about their speed is too great and while on the various amusement devices of the park the speed is altogether too slow. But by running about a fifty foot speed in the first instance and close to seventy-five in the other, the film creates much laughter, but it is necessary to change speed radically many times on this film. Another example is "A Ride for a Life," by Edison, I believe. If run at normal speed while the auto ride is on, the "Ride for a Life" develops into a howling farce, but if speeded up just as fast as you can run, it is excellent, but as the ride is cut three or four times in its length by other scenes, you have to slow down for each of them or the farce would be reversed. As an example the other way, we all know that the slower the Passion Play is run the more impressive it is. Forty feet per minute is best for it. The only rule for speed, except in starting the machine, which should always be done slowly, is, "Watch your subject and be governed entirely by its action." Twenty-five minutes is the extreme limit of time for 1,000 feet of film. Fifteen to twenty minutes is ordinary time for most subjects.

THE THROW.

There is a misunderstanding among most operators regarding the throw, i. e., the distance the picture is projected. Within reasonable limits the throw has very slight effect on the brilliancy of a given sized picture, provided the atmosphere be reasonably clear. It must be remembered that you are passing a certain intensity of light through the aperture plate. This light is to be distributed over a given amount of space. An open arc lamp, a candle or a lamp diffuses its rays in every direction and over a complete circle, but the light from your lamp, at least all which passes through the aperture plate, is confined to a space the size of your picture. Every bit of light which passes through the film reaches the curtain, save the amount diffused by impurities in the atmosphere, and that for a distance of even 150 feet is very slight. Of course, there is some loss, and if the throw were extended to several hundred feet it might be considerable, but very little in 100 or even 150 feet. In fact, some operators claim that a better picture is had at 100 feet than at 50 by reason of the fact that the long focus lens is a better article than is the short focus. When you increase the size of the picture, however, it is quite another story, for you are then diffusing your light over a greater area, and this counts rapidly. With a picture 8 x 10 you cover a space of 80 square feet, while a 12 x 14 picture takes up 168 square feet, or more than twice the area. You are therefore lessening your illuminating power by about one-half with the larger picture, or rather you are lessening the brilliancy in that degree.

LENS, THROW AND SIZE OF PICTURE.

We are indebted to the Selig Polyscope Company for the following table showing the height and width of a picture at given distances with lenses of various focus. Elsewhere we give other computations and any slight differences in scale may be explained by variation in size of aperture.

FOCUS IN INCHES. / *DISTANCE IN FEET.*

—	10	15	20	25	30	35	40	50	60	70	80	90	100	120	140	160
1½	4½	6¾	9¼	11½	13¾	16	18¼	22¾	27½	32	36½	40½	45¾	54¾	64	73
	6¼	9½	12½	15½	18¾	22	25	31¼	37½	41¾	50	56	62½	75¼	87¾	100
2	3½	5	6¾	8½	10¼	12	13¾	17	20½	24	27½	31	34¼	41	48	55
	4¾	7	9½	11¾	14	16½	18¾	23½	28¼	33	37½	41	47	57½	65¾	73
2½	2¾	4	5½	6¾	8¼	9½	11	13¾	16¼	19	22	24¾	27½	32¾	38½	43¾
	3¾	5½	7½	9½	11¼	13¼	15	19	22½	26¼	30	33¾	37½	45	52½	60
3	2¼	3½	4½	5¾	7	8	8¾	11½	13¾	15¾	17½	20¼	22¾	27½	32	35¼
	3¼	4¾	6¼	8	9¼	11	12½	15½	18¾	21	25	27	31¾	37½	43¾	49½
3½	2	3	4	5	5¾	6¾	7¾	9¾	11½	13¾	15¾	16½	19½	23¼	27½	31½
	2¾	4	5½	6¾	8	9½	10¾	13½	16	18¾	21½	24¼	26¾	32	37½	43¾
4	1¾	2½	3½	4¾	5¼	6	6¾	8½	10½	12	13½	15½	17	20¾	24	27½
	2¼	3½	4¾	5¾	7	8¼	9½	11½	14	16	18¾	21	23½	28	33	37½
5	1½	2	2¾	3½	4	4¾	5½	6¾	8¼	9½	11	12¼	13½	16½	19¼	22
	1¾	2¾	3¾	4¾	5½	6½	7½	9½	11¼	13	15	16½	18¾	22½	26¼	30
6	1¼	1¾	2¼	2¾	3½	4	4½	5¾	6¾	8	9¼	9¾	11½	13¾	16	18¾
	1½	2½	3	4	4¾	5½	6¼	7¾	9½	11	12½	14	15½	18	22	25
7	1	1½	2	2½	3	3½	4	4¾	5¾	7	8	9	9¾	11¾	13¾	16
	1¼	2	2¾	3¼	4	4½	5½	6¾	8	9½	11	12	13½	16	19	22
8	¾	1¼	1¾	2¼	2½	3	3½	4¼	5	5½	7	7¾	8½	10	12	14
	1¼	1¾	2½	3	3½	4	4¾	5¾	7	8¼	9½	10½	11¾	14	16½	19¼
10	½	1	1½	1¾	2	2½	3	3½	4	5¼	6¼	6½	6¾	8¼	9½	12½
	¾	1½	1¾	2¼	2¾	3¼	3¾	4¾	5¾	6½	7½	8	9½	11¼	13¾	15

Machine Heads.

It was the original intention of the writer to give detailed instructions for the adjustment of each make of machine. In looking over the field, however, this is deemed to be impractical. Not only are there many makes of machines, but nearly every one has two or more models, and to cover them all would take up an immense amount of space. Instead, therefore, I have concluded to give general instructions which will cover the essential adjustments of all but two machines, touching somewhat, however, on each one individually, in so far as the model most in use is concerned. One exception is the Motiograph. This machine is of such radically different construction from anything else on the market that I feel it necessary to include detailed instruction concerning it. One thing in particular which equally applies to all machines is, **keep them clean.** This is not much of a task if the head be wiped off each day, and there is nothing looks more slouchy than a machine head covered with gum, oil and dirt. "Cleanliness is next to godliness," and it applies here as elsewhere. As to oil: Any good grade of medium oil that will not gum is suitable for a machine, but cheap oils should by all means be avoided, since they are diluted with kerosene. There is no motion picture machine bearing which is not adequately lubricated with **one drop of oil.** More than this is too much and will just run, or be thrown off, making a dirty mess and perhaps injuring the film. A drop of oil doesn't look like much, true, but it will cover more surface than you may imagine, and once a bearing is covered with oil an additional gallon would not make it run one whit better. Some operators wash out the bearings once in a while with gasoline. This does no harm and may do some good, although the writer thinks the benefit derived is largely imaginary, unless a gummy oil is being used. To do this, just run the machine slowly while you flood the bearings with gasoline from an ordinary oil can, continuing until the bearings are thoroughly washed out. A piece of old Turkish towel is ideal to clean a machine head with, as it can be drawn into the crevices and gathers all the oil and dirt.

Of intermittent mechanisms there are two types, viz.: the cam and star and the cam and pawl, the latter being commonly known as the "finger feed." It is not the purpose of this work to discuss the relative merits of the two methods of moving the film, but merely to give necessary instructions for their adjustment. The adjustment of the Power's, Edison and American intermittent movements are practically the same, so that one instruction will do for all. It is of the utmost importance that there be absolutely no lost motion between the star and cam, while at the same time there must be absolutely no binding. The adjustment to eliminate lost motion between the star and cam is a very simple operation, but few there are who make it right. The cam shaft of the machines named all run in bronze metal bushings, which may be removed and renewed, and they should be just as soon as they become worn. The operation is too simple to require much explanation. To renew the old one, loosen the set-screw which holds the bushing and slip it (the bushing) out and the new one in. With the Edison machine it is best to first remove the gears, so that you may readily get at it. The one on the left-hand end is more difficult, especially in the Power's, since the shaft must be taken out, but even this is readily done. Just examine the mechanism closely before you begin and you will be able to see how it is done. Right here let me caution you. **Don't** imagine you are working on a freight-car or a locomotive. **Don't** go at it with a four-pound hammer, a Stillson wrench and a cold chisel. If something sticks a little, have a little patience and remember that your getting mad at it won't help to any appreciable extent. You may feel like going after it with an axe, but while that might cool your temper down it won't improve matters a particle and will probably make them considerably worse.

You are working on a delicate piece of machinery and you must proceed gently, else, instead of repairing, you will do precisely the opposite. Motion picture machine parts are accurately made, and if something doesn't come out readily you can pretty near be sure it is for the reason that you are not going about it right. Of course, it may be necessary to use a punch and tap a boxing or shaft lightly, but in such cases one should use a **soft steel or brass punch** or a piece of hardwood. Be very chary about using a tempered punch except for very light tapping. The star shaft runs in bronze metal bushings also, but the holes in these bushings are not central. They are what are called "eccentric bushings," and turning them slightly has the effect of raising or lowering the star shaft in relation to the cam shaft, thus tightening or loosening the star in relation to the cam. Now in making this adjustment it is **absolutely essential that the star shaft be kept exactly parallel with the cam shaft**, and right here is where all but the very best operators fall down. If one bushing be turned more than the other a condition, or its exact reverse, such as is shown in Fig. 37, is produced, though in the picture it is exaggerated.

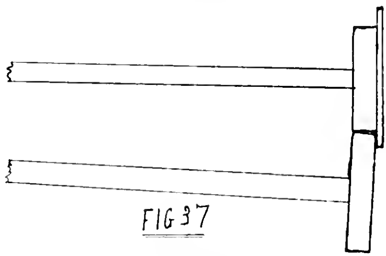


FIG 37

To take up lost motion between the star and cam, loosen the set-screws which hold the bushings. These screws will be found in the face of the casting opposite the bushings. Now, with a screwdriver, turn the bushings until there is no lost motion in the star when the cam pin is clear of the star slot. **But be very sure to turn both bushings exactly**

FIG 38

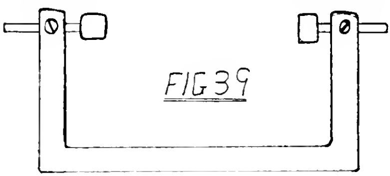


FIG 39

the same amount. There are several ways of knowing when you have turned the bushings the same, but the three I shall name are simple enough for anyone to carry out successfully. One is to lay a straight-edge across the end of each bushing and with the point of a knife blade make a scratch-mark at one edge of each bushing, extending it on to the frame, as per Fig. 38. When the bushing is turned the marks will, of course, separate, and with a machinist's steel rule, using a condenser lens for magnifying, you may easily measure just how much you have turned each bushing, or you can, after making the scratch-mark, set an ordinary carpenter's compass open about half an inch and setting one point on the scratch-mark at edge of bushing, make a mark on the casting wherever the other compass point comes. Now by using this latter mark you can tell with the compass when you have turned each bushing the same. Another and better method is to have a pair of small, inside calipers, calipering the distance between the two shafts as near their ends, inside the bearings, as you can get. It will require some little ingenuity to do this, as the shafts are not the same size throughout their length; by calipering the shafts before moving the bushings, marking the measure of each caliper and then measuring for the same increase of measure at each end, you will get it right, assuming that the shafts were parallel to start with.

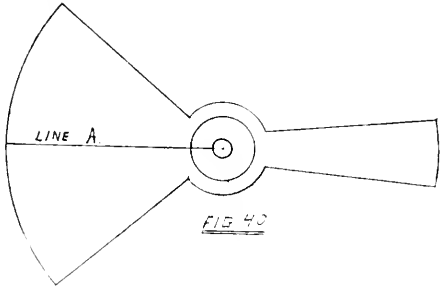
The best way of all I can recommend is to make a tool like Fig. 39. It is a half-inch square piece of iron with two screwdriver points held in place by set-screws. With this tool you will move both bushings precisely the same if you are at all careful. If you produce a condition such as is shown in Fig. 37 you will wear both the cam and star face on a bevel as well as cutting the side of the cam, star, star slot and cam pin. You may say, "Oh, it won't be enough to amount to much," but I say to you, there is where you are much mistaken. So rapid and accurate must be the work of the star and cam that they must be absolutely mechanically correct, and this is impossible under the condition shown in Fig. 37. The time is at hand when the best possible results are going to be demanded of the operator. The "picture as steady as a rock house" will be an actuality in the near future, and the operator is going to be expected to produce it. This he cannot do unless his intermittent movement, at least, is in perfect adjustment and condition. The haphazard, "guess-at-it" adjustment of machine mechanism must be abandoned and accuracy substituted instead.

The American machine bushings are a little different from the Power's and Edison in that they are longer and are turned by inserting a pin in holes in their sides. Also they are clamped by short bars instead of by set-screws. Their action is precisely the same, however. The Motiograph star movement will be dealt with further on.

The star, the pin of the cam and the intermittent sprocket, especially the first and last named, should be watched and promptly renewed when there are signs of serious wear. In the nature of things, the thicker the star is, other things being equal, the longer it will wear, but as soon as the points wear sharp or the slots are loose on a new cam-pin the star should be renewed. The spurs on the intermittent sprocket wear faster than is imagined, and worn sprockets are responsible for much mischief. Examine these spurs occasionally, looking at them carefully, and if one side--the side bearing on the film—is worn concave the sprocket should be promptly renewed. With the finger feed machine the film gradually cuts a slight groove on the under side of the pawls, or fingers. This is hard to detect by looking at the pawls while attached to the machine, and it causes a slight but constant vibration on the curtain. If there is such a vibration, remove the pawls and examine them, replacing with new ones if a groove is discovered. It doesn't have to be a deep groove to make mischief. Remember that every 1-1000 of an inch becomes noticeable when magnified on the curtain. The aperture plate is another thing to be closely watched. You must remember that a very slight variation of the film from the projection lens seriously affects the focus. With some machines using short, pliable tension springs the pressure of the short spring on the film wears a short depression in the aperture plate tracks. When the film passes through this depression, which is usually deepest in its center, there is a decided tendency to "cup," and in any event the entire picture is not exactly the same distance from the projection lens. This is bound, to some extent, to affect the focus. Worse than this, however, sometimes the springs wear one side of the track more than the other or wear depressions at either end of the springs with a hump in the middle. This will cup the film every time, and, if it is bad, affect the focus very much. Plates worn thus should be replaced immediately. In threading, the operator should make it an invariable practice to run his finger around the edge of aperture. Dirt and dust will collect, and a grain of dust the size of the head of a pin will look like a cobblestone on the curtain. A picture fringed with ragged edges caused by dirt in the aperture is a standing advertisement of the carelessness or incompetency, or both, of the operator in charge.

SETTING THE SHUTTER.

Setting the shutter is a simple operation, but comparatively few men in charge of operating rooms know how to do it correctly. Here is a method which is correct and will work equally well on any machine: Loosen the shutter on its shaft and take it off. On the wide blade lay out the center line A, Fig. 40. Now replace it loosely on its spindle. Next cut a short piece of film (say a foot long) exactly on the dividing line between two pictures. Thread this into the machine and by looking through the projection lens, frame it up carefully. Be very sure to get it exactly in frame. Now carefully, with the flywheel, turn the machine in the direction it runs until the end of the film is **exactly half way across the picture opening.** Turn the shutter, in the direction it runs, on its spindle until mark A, Fig. 40, is exactly half way across the aperture opening. Tighten your



shutter on its spindle and the job is done. It is best to set your framer in central position while doing this job. With the Motiograph machine set the crease in the center of the inner shutter blade opposite end of film and set outer shutter in exactly the same position. That is to say: set inner blade as directed and tighten it on shaft. Then, without moving machine a particle, set the outer blade central back of inner blade. A moment's thought will convince you that a shutter set thus must be right if the shutter itself is properly proportioned. The office of the wide blade of the shutter is to cover the aperture entirely during the time the film is in motion and not an instant longer. With some machines the film begins to move just a trifle before the opening is entirely covered. This is for the reason that unless it be too much the effect is not noticeable on the curtain and every bit taken from shutter width increases the amount of light which reaches the screen.

The narrow blade of the shutter is of no particular interest to the operator except that he wishes to study the peculiarities of optics. It is added to the shutter simply for the reason that the flicker caused by one blade alone comes far enough apart that the eye catches them more noticeably than the more rapid flicker of two blades. Perhaps that particular explanation is somewhat crudely put, but in the main it is correct. Take all the spokes but one out of a wagon wheel and revolve it rapidly. You see that one spoke plainly all the time. Put in all the spokes and revolve the wheel at the same speed and you see no spokes at all—just a sort of blur. Project light through the revolving wheel with one spoke and you will see the spoke's shadow plainly. Project light through the revolving wheel with all its spokes and you will see no spoke shadow at all, but the amount of light going through will be reduced. Right here let me say that those purchasing machines should closely examine into the matter of its shutter width. If the intermittent movement be comparatively slow the shutter must perforce be wider than in a machine with faster movement, and this naturally reduces the light you will get to the curtain from a given arc intensity. In other words, you must have a more powerful light to get the same result on the curtain if your machine has slow intermittent movement with consequent wider shutter. Look into this carefully. That is the secret of the one pin movement being better than the two pin. Its star movement is necessarily very much faster, which allows of material reduction in shutter width.

On machines where the side of shutter hub and spindle can be plainly seen it is a good plan to mark the shutter while it is set right. Do this by making a small prick-punch mark on the spindle close to the hub. On the hub, exactly opposite the punch mark make a scratch mark. You may now set the shutter correctly any time it slips by simply bringing the two marks together. To set a shutter quickly and with approximate accuracy turn the machine by its flywheel in the direction it runs until the star has completed its movement and the cam pin is just half-way out of star-slot. Now revolve shutter on its spindle in the direction it runs until aperture just begins to open, and tighten shutter on its spindle. With some machines it is necessary to have aperture quite a little open when pin is half-way out of star-slot. By "half-way out" I mean half its diameter out of the slot. This will, or should, be very nearly right. It applies equally to the finger feed machines, but cannot be used with double shutter machines. With them the leaves of the shutter should be set so as to just barely close the opening (in its exact center) should, be very nearly right. It applies equally to the finger feed machines, but cannot be used with double shutter machines. With them the leaves of the shutter should be set so as to just barely close the opening (in its exact center) as the star begins to move. Ordinarily, however, double shutters require very fine adjustment. I would recommend to purchasers of machines that they insist on being provided with an exact pattern cut from paper, of the shutter of each machine under consideration. By placing these patterns one on top of the other you can see at a glance which one cuts the most light. In this test both the small and large blades should be taken into consideration. On double shutter machines the width of both blades must be counted; that is to say, you must add together the width of both wide and both narrow blades. Another accurate method of setting a shutter is as follows: Set frame in a central position. Turn flywheel in direction it runs until cam-pin has entered half its diameter into star slot; make scratch mark on rim of flywheel and exactly opposite it, on some fixed part of machine, make a light prick-punch mark. Now turn flywheel until cam-pin has emerged one-half its diameter from star and exactly opposite the prick-punch mark make another scratch mark on rim of flywheel. Now measure around flywheel between the two scratch marks and exactly half way between them make a third mark. Now set this last mark exactly opposite the prick-punch mark and set line A, Fig. 40, exactly half way across the aperture and your shutter will be right.

Sprocket idlers should never run clear down on the film. There are setscrews for the purpose of holding the idler away from the sprocket and they should be set so that the idler is off the sprocket by about the thickness of a film or a trifle more. Idlers running clear down have a tendency to make the film climb the sprocket teeth. The tension springs which hold film against aperture plate should be set so as to provide just enough pressure to prevent vibration in the film and **no more.** Some operators who are too lazy or ignorant to keep their intermittent movement in adjustment seek to take up the lost motion by added pressure of tension springs. The result is accomplished all right, unless the case be too bad, but at expense of heavy wear on driving gear, star, cam-pin, aperture plate and film. The office of the tension springs is to stop the small section of film between the upper loop and the intermittent sprocket and hold each picture absolutely stationary before the aperture during the time of its exposure. More tension than is required to accomplish this is very bad practice. Keep your intermittent movement in accurate adjustment and a very slight tension will do the required work. Automatic fire shutters all depend on the same principle, viz.: centrifugal force. They are too simple to require remark other than that they are rather delicate in their action and should be kept scrupulously clean and in the best of order.

Machines.

THE EDENGRAPH.

The Edengraph machine is new to the projection fraternity, therefore it is in order to give detailed instruction. The gears are incased in a dustproof casing, the back side of which is a plate of metal sliding in grooves which lifts out, disclosing the entire gearing of the machine. To set the shutter remove the gear cover plate and you will see, just over the fly-wheel, a thumbscrew on the end of a universal joint shaft. Loosen this thumbscrew and you may turn the shutter at will. Now turn the fly-wheel in the direction it normally runs until the intermittent sprocket is just ready to move. Hold fly-wheel stationary and revolve shutter until it covers all but about one-quarter of an inch of the lower part of the aperture opening. Now **hold the shutter (not the fly-wheel) stationery** with one hand while you tighten the thumbscrew on end of universal joint shaft with the other, and the job is done.

You will notice the frame-up carriage is counterbalanced by a spring held by a rod which terminates in a large, dark-colored, smooth screw on top of machine, near right front corner. Look at this arrangement carefully and you will see how it works. But the mere adjustment of this counterbalance is not always sufficient. Should the frame-up carriage be too loose and work up or down as the machine runs, you may tighten it by first loosening the three large screws in upright bar which forms one angle of front, right corner of machine. Next tighten (or if frame-up works too hard, loosen) the four small screws which are seen up and down near edge of machine at front, right-hand corner. Adjust these screws so that carriage works just right and then re-tighten the three screws you loosened first. The sprocket idlers must be so adjusted (you can easily see how it is done) that they will set away from the sprockets by about twice the thickness of an ordinary film. The automatic (fire shutter) governor is inside the fly-wheel. To get at it remove the screw in center of fly-wheel, as well as the washer under it. Tap the washer lightly and it will fall out. Next set the intermittent sprocket just so it is beginning to move. Grasp the sprocket tightly and hold it stationary while you twist the fly-wheel in the direction it normally runs, pulling outward on it at the same time, thus working it off the shaft.

The automatic governor may be easily removed by first taking fly-wheel off and then opening the gate, after which remove the screw, the head of which is right beside edge of large gear, and which holds Y-shaped lever carrying cone-ring. When you have this screw removed just pull the whole thing straight out, being careful you see how it all comes apart, so that you can get it together again. To remove the intermittent movement from machine proceed as follows: Remove fly-wheel and governor as before described. Next remove the lens holder on operating side of machine. You will now see the heads of three large, flat screws on operating side of machine. Remove the lower one and pull out the shaft and gear it holds. Take off the lower (take-up) sprocket and pull out the spindle. Remove the collar on crankshaft and pull shaft and gear out. Now look inside the machine and just to one side of intermittent oil casing you will see a large, flat-headed screw, with another immediately below the casing. Remove them and you can pull out the whole casing, tapping lightly on center of end of intermittent sprocket if necessary to start it. Be very careful that you don't injure the intermittent sprocket teeth on bottom of aperture plate tracks as you pull casing out. To take up lost motion between star and cam remove cover of oil casing, and in top edge of casing, just over shaft, will be seen a small set screw. This screw holds the star shaft bushing, which extends through casing and clear out to the sprocket and is eccentric. By loosening the screw you may turn the bushing and tighten or loosen (according to the way you turn it) the star in relation to the cam-wheel. To remove star just drive out small (taper) pin in hub of star and pull shaft out. To remove cam, drive out pin (taper) in its hub and pull shaft out. To remove the revolving shutter take off thumb-screw at end of universal joint shaft and pull gear off. In the back of the square casting, held by cast elbow arm, you will see two screws.

Remove these two screws and the whole shutter, bevel gears, shafts and all, comes away. Once in six months remove cover of intermittent oil casing and clean oil-well out good, filling with fresh sperm oil. Fill the well up to half the diameter of the cam-wheel. The foregoing, I believe, covers all essential operations at all apt to be necessary with the Edengraph. Some of the operations described may seem complicated, to read the instructions, but really they are simple enough, the main thing being that you study each move carefully so as to be sure to get things together again right. Engine valve-oil will be excellent for the gears of the Edengraph, though ordinary oil will do nicely; wash gears out once in a while with gasoline or benzine. The take-up tension is made tight or loose by loosening split collar on lower magazine shaft and turning it one way or the other. This tightens or loosens the belt, according to which way it is moved.

EDISON UNDERWRITERS' MODEL.

Edison Underwriters' Model, Type "B."—The Edison "B" Model is a somewhat new type of projector, though following in general along the familiar lines of the Edison construction. This machine has the advantage, over previous Edison types, of a rigid iron frame which makes for elimination of vibration.

The upper and lower steel sprockets are flanged, the idea being to prevent badly worn film jumping off. The idlers are held against the sprocket by springs, and are kept the proper distance away by means of flanges on the sides, so that adjustment by the operator is not necessary. These flanges revolve independently of each other. The intermittent idler is held in place, though it bears directly on the film and is self-aligning. These idlers can be easily removed for repairs or renewal, merely by driving out the spindle upon which they revolve; first, however, loosening the tiny screws in the center of the face of each idler.

The framing lever can be made to work hard or easy by loosening or tightening the screws in either bearing holding the rack and pinion shaft.

The aperture, or picture gauge, is held upon the face of a casting, which in turn rests upon the back side of the frame, and held in place by two screws. If, for any reason, this plate is disarranged, it can be adjusted by loosening the screws, aligning properly and tightening again. Care should be taken to have these screws tight at all times.

The shutter of this machine is set as follows: Set the framing lever in the center of its travel. Now, remove the lens, and looking in through the lens hole, turn the balance wheel of the machine in the direction it runs until the cam pin has entered half of its diameter in the star slot, first, of course, having loosened the shutter on its spindle. Having the cam pin entered half of its diameter in the star slot, grasp the balance wheel firmly to hold it stationary, and revolve the shutter in the direction it normally runs until the solid wing of the shutter covers three-quarters of the aperture. This is, or should be, about right. Tighten the shutter on the spindle slightly, put in a film, and try it. If there is travel-ghost, slip the shutter slightly one way or the other until it is just right and then tighten it securely on its spindle.

To eliminate lost motion, between the star wheel and cam, proceed as follows. The star shaft runs in eccentric bushings, one at either end. These bushings are held in place by small set screws in the face of the casting. Loosen these set screws and turn the bushing at either end slightly —just enough to take up the lost motion. This operation is more fully described on another page. The end of the right hand bushing may be got at by sticking the screw-driver through one of the holes in the main crank driving gear and balance wheel. The intermittent sprocket and shaft may be removed by slipping out the left hand bushing, removing the aperture plate and the lower film guard which comes up between the rims of the sprockets. The star, shaft and sprocket may then be removed. The cam shaft may be removed as follows: Take out the screw at the end of the crank shaft and pull off the gear. Now remove the large intermediate gear next below the top sprocket gear. This exposes two screws, one in the upper, and one in the lower end of the casting which holds end of balance wheel, or cam shaft. Remove these screws and carefully pry off this frame side cap. Next loosen the set screw in face of casting which holds bushing at opposite end of cam shaft, and slip the bushing out. You may now, having first removed the aperture plate, pull the whole shaft, balance wheel and cam away.

The take-up is so arranged that it can be placed in front of mechanism or beneath the baseboard, to suit conditions. The take-up is of the frictional type and may be adjusted by compressing the tension spring on the take-up reel shaft to increase the friction, or loosening to decrease it. When magazine is in lower position (or beneath baseboard), the driving belt is arranged with idler pulley and a weight to keep a constant tension on the belt, obviating the necessity of cutting the belt for readjustment.

THE LUBIN CINEOGRAPH

The new model of the Lubin Cineograph presents certain peculiarities worthy of notice. It is of the familiar star-and-cam type of construction, but the movement is unique in that the ends of the intermittent shaft are counterbored to receive the cone-shaped tips of the intermittent eccentric bushings, instead of the shaft entering into and extending through the bushings as is usual. Lost motion between the star and cam wheels is eliminated in the same manner as is described on page 108. Great care must be exercised that the bushings set up snug against the ends of the intermittent shaft on either side, and that the intermittent sprocket spurs be kept exactly in line with the center of the tracks of the aperture plate. The intermittent bushings are released in their setting by loosening the screw in the face of the casting opposite each intermittent bushing. In the ends of each bushing is a screwdriver slot by which it may be turned. The intermittent sprocket star and shaft may be removed from the machine by taking off the apron which comes up between the flanges of the sprocket, loosening the left-hand bushing, slipping it back, and lifting out the whole intermittent shaft and star.

The framer may be made to work easy or hard by tightening or loosening the two screws in the center of the face of the machine casting almost opposite the intermittent idler roller. The balance wheel shaft and cam may be removed from the machine by moving the lower apron and the two boxings which hold it in place. The idler brackets of this machine are supposed to be held the proper distance from the sprockets by the springs, and the only adjustment possible is by bending the end of the springs slightly where it fits in the flat space on the bracket spindle.

End motion in the shutter shaft should not be tolerated. It may be eliminated by moving the brass collar which sets against the boxing inside the machine up tight against the boxing, at the same time holding the shutter spindle as far forward as possible. The whole shutter gear and spindle may be removed from the machine by taking off the front plate and removing the two screws holding the boxing and the bracket of the carriage frame. The shutter of the new Lubin machine is of the three-wing variety, and sets out in front of the mechanism in front of the lens. To set this shutter, loosen it on its shaft, and turn the machine by its fly-wheel in the direction it normally runs until the intermittent has moved and the cam pin has emerged exactly half of its diameter from the star slot. Now revolve the shutter on its spindle in the direction it normally runs until the wide blade covers a trifle more than half of the lens, setting the shutter as closely to the lens as you can get it, tighten one of the screws slightly on the shaft, put a film in the machine and try it. If there is no travel-ghost, you have it right; if travel-ghost develops, slip the shutter a trifle on its spindle until you get it just right, tighten up both screws and the job is done. Use a good grade of medium heavy oil on this machine.

The automatic fire shutter is too simple to require any detailed instructions, as, I believe, are all other points of this machine.

THE MOTIOGRAPH.

The Motiograph so far as its principal elements are concerned, differs but little from other well-known motion picture machines, with the exception of the fireproof shutter, which is operated by a ball governor that is similar in principle to that used for governing a steam engine. It also has a geared connection from the main crank shaft through the upper reel arm so as to make it possible to rewind the films from the main crank, an operation not provided for in other machines. Another feature that differs from most other machines is that the gearing is encased within the frame instead of being exposed. Its mechanism is simple and by a little careful attention it will be easily understood. It is a well-built mechanism and, like other well-finished pieces of machinery, it needs intelligent care and attention.

The manufacturers of the Motiograph have issued a very complete instruction book and I shall make an effort to cover only a few additional points that are liable to require attention in actual service, and more especially with the 1909 No. 1 Model. In the 1910 Model, several of the features referred to herein have been arranged in a manner that the instructions given herewith would not apply to them. In fact, instructions for the 1910 Model, in addition to those found in the manufacturers' instruction book, are, I believe, unnecessary.

The iron pedestal on which the machine rests should be fastened very firmly to the floor, otherwise it is liable to rock slightly when the films are rewound rapidly.

The automatic shutter governor may be removed by loosening the two bushings in which the ends of its shaft run and slipping them out. They are held in place by set screws. In replacing same set the inner bushing just so that the shutter is completely closed when the shaft is against the bushing. Tighten bushing in place and set the outer bushing in against the hub of the governor and withdraw just the barest trifle, barely enough so that there will be neither lost motion endwise or binding. If set so it binds the result would be excessive wear besides making the machine run hard.

The star and cam are inclosed in a cast metal casing which may be removed in its entirety as follows: Open the film-gate. Remove the front plate which holds the lens. Inside the machine, to the left as you look in, you will see a flat bar extending up and down, which connects the frame-up lever with the intermittent casing before mentioned and which we are to remove. In the side of this bar is a thumb screw which goes through the bar and bears on the casting to hold the bar over in place, since it, the bar, is only attached to the intermittent casing by slipping on a pin. Loosen this thumb screw and press the bar to the left to detach from the pin. You will see, also to the left, a round, upright rod terminating in a thumb screw on top of the machine. This rod passes through two split lugs on the intermittent casing, and it is by tightening or loosening the screws in these lugs that the frame-up lever is made to work easy or hard. Loosen these screws and by the thumb screw on top of machine remove the rod entirely, which will leave the intermittent casing loose and ready to pull out, except for its connection with the tumbling rod, called the ball arbor. This tumbling rod connection is a loose connection and the whole intermittent casing may now be pulled out by a little manipulating, first setting the slot in tumbling rod so that it points directly toward you. To replace, set slot in tumbling rod hub so that it points toward you and enter tumbling rod hub so that it points toward you and enter tumbling rod in its place. Now enter the fork in casing casting on the upright rod directly behind tumbling rod hub, swinging casing into place, replacing upright rod at left, attaching the frameup bar, not forgetting to tighten thumb screw and leaving all as it was when you began.

To install a new star or cam remove intermittent casing as above directed. Next remove the guard plate on casing (catalogued as "Stripper Plate") by removing the three screws which hold it in place. Next loosen the set screw in hub of tumbling rod connection hub. Inside the tumbling rod connection hub you will see the end of the cam shaft, which is held by the set screw just named, and it may now be driven out by tapping with a soft steel, or brass punch, or a piece of hardwood. Don't use a hard steel punch under any conditions Having removed the cam and shaft the star is released by removing the two screws in hub of sprocket wheel. Just loosen them and pull out the star. The bushings in which the star shaft runs are removed by loosening the set screws holding them which are directly above them on top of casing casting.

To adjust the star and cam to eliminate lost motion, loosen the set screw in top of casing directly above cam wheel. In front, by the side of the tumbling rod connection will be seen the flange of the bronze bushing with a hole in it and a set screw bearing on each of its beveled sides. Loosen the bottom screw and tighten the top one until lost motion is eliminated, but don't get it tight enough to bind. Tighten all set screws tight when through. There is no need to pay any attention to the alignment of shafts, since manipulating the set screws takes care of everything. One point should be looked carefully to, and that is in replacing the cam shaft (if you have had it out) to get the set screw hole directly over the hole in the shaft. This is important, since the shaft is slightly tapered and a part of the office of the set screw is to draw it home.

To remove balance wheel, take off the bridge and remove the set screws in hub of wheel. I say "remove" them for the reason that they go deeply into the shaft. The flywheel may then be pulled off. The flywheel shaft and inner bushing may be removed as follows: Remove the film gate and under where its back edge was, directly in line, up and down, with the flywheel shaft will be seen a set screw. Remove this and the shaft and bushing can be pulled out, first, however, removing first gear wheel above shaft, back of where flywheel was.

Some of the operations described, such as removing the main shaft, may never become necessary, but then again it might be one of the first things an operator would have to do, and unless he knew exactly how to go about it he might experience some trouble.

To remove the main shaft, take off the gear cover and you will see a sort of gridiron, called the "bridge." Remove this, carefully replacing the screws in their holes so they will not get lost. Incidentally you will notice in the bridge two bronze boxings in which the shafts of the flywheel and automatic governor run. These boxings may be readily renewed by loosening the set screws boxings may be readily renewed by loosening the set screws which hold them, slipping them out and the new ones in. Having removed the bridge, slip off the large gear wheel on end of crank-shaft. Now look at crank-shaft hub on other side of the machine and half way down on either side see a small hole in the casting. Remove the crank and looking into the hole where its shank was you will see a pin extending through the shaft and projecting on either side. This pin engages in the slot in end of crank-shank and drives the machine. You must now set this pin exactly opposite the small holes in the hub and with a small punch carefully drive it out. It is not a taper pin, but perfectly straight and drives either way. When you get the pin placed just right have someone grasp the opposite end of the shaft and hold it in place. Insert the shank of the crank a quarter of an inch or so, so as to divide the shock of the blows between the shaft and the cast hub. Tap the punch sharply (but not too hard) with a light hammer. A sharp, light blow is the thing for such a job. The pin removed, you may pull the shaft out at the gear end. To replace, just reverse the process. You will have to reset the shutter, however, since removing the bridge throws it out.

The operator taking charge of a Motiograph for the first time should examine the machine very closely and be very certain he finds all the oil holes. As has been stated, the machine is well built and if you overlook bearings when oiling the bearings may bind.

The shutter of this machine is set the same as before described, except that the crease in the wide blade is used as line A, Fig. 40, and the second shutter is set central with the first, being sure that the machine does not move at all until the second blade has been tightened in place. I believe the foregoing takes care of all the special features the operator is likely to contend with in operating the Motiograph. And now I think this is all I shall say concerning machine heads. It is a hard subject to handle, under the circumstances, at best.

THE PATHE PROFESSIONAL PROJECTOR.

The Pathe Professional Projector is perhaps the simplest moving picture mechanism on the American market, and by reason of this simplicity the necessary directions to the operator will occupy considerably less space than those of other machines.

The machine is threaded by bringing the film out of the upper magazine, over the top of and down between the top sprocket and its idler. From the upper loop the film goes down through the gate, the lower loop being formed in a protected recess between the intermittent sprocket and the lower take-up or feed sprocket. Care must be had not to have loops too long, or film will rub against the iron of the machine and become scratched. Use a little judgment and common-sense in forming the loops with this machine.

The tension is taken care of by two long tension shoes set in the gate and held in place by two flat springs on the front of the gate. Should the aperture plate film tracks become worn, they may be removed by loosening the three small screws seen in their face. Should top gate idler spring become too slack and not hold the idler in its place, remove front fire guard and the spring which holds the idler bracket and carefully bend it (the spring) slightly. The shoe which holds the film against the intermittent sprocket should be renewed whenever it shows any considerable sign of wear. It is removed by merely loosening two springs and slipping it out of place.

To remove the intermittent sprocket for renewal, first take off the large crank gear and its shaft. Next remove the pin from the hub of the lower chain sprocket wheel and drive out shaft, thus removing the center gear on the operating side. We next remove the remaining large gear which meshes into the small flywheel pinion, by taking out the screw in the center of its hub.

Now, looking in the front (lens side) of the machine, we see two large screws which hold the framework of the shutter gear and spindle; remove these two screws. Immediately above these two will be seen, on either side, two more large-head screws which hold the lower end of intermittent casing frame, with two more above holding the upper end. Remove all of these screws and the whole framework, intermittent and flywheel will lift out. Now having the intermittent casement thus removed from the machine, the substituting of a new intermittent sprocket will be a very simple operation. The putting of the intermittent back into the machine is merely the reversal of the process of taking it out, being sure, however, that there is no dirt on the bearings of the intermittent framework when you put it back, and that all screws are set up good and tight.

The chain which drives the upper feed sprocket should be well oiled with a mixture of vaseline and graphite or other similar compound. The chain should not be very tight, neither should it be loose.

On the gate of the machine is the automatic fire shutter, and right beside the flywheel the lever which operates it. Immediately under the gate latch is the screw which holds this lever in place. Should the shutter not work freely it will probably be by reason of the fact that this screw is a trifle too tight, the remedy being to loosen it. This lever is worked by an eccentric on the inner hub of the flywheel. Looking at the inner side of the flywheel you will see a wide slot or groove in its surface. It is in this groove that the automatic fire shutter governor works, and it should be kept sparingly lubricated with vaseline.

The star wheel runs in an oil well which should be kept filled with a heavy lubricating oil.

The Pathe Company recommends that the star wheel be not adjusted or in any way interfered with by the operator. They claim that the star wheel and cam, if kept properly lubricated, will outwear the balance of the mechanism.

The holes for oiling are as follows: Two on the shutter shaft (one in the front and one in the back); two on the intermittent sprocket, on either side; two on the star-wheel shaft; one next to the flywheel (which lubricates the automatic shutter mechanism); one on the outside of the flywheel; two on upper sprocket shaft; two on the lower sprocket and one in the hub of the large gear on operating side of the machine.

On the inside of the fire shutter are the two steel rollers which hold the film in place on the lower or take-up feed sprocket. It is not only necessary but essential that these rollers shall revolve freely at all times.

The take-up tension on the lower magazine is controlled by a fibre washer working between two steel surfaces compressed together by a spring, the amount of tension being governed by the milled thumbscrew on the end of shaft. We would advise that you take this apart and examine it so that you will be familiar with its working, being careful, of course, to put it together properly. The chain plate which drives the take-up should not be too tight, and the tension should only be such as will barely take up the film clear through to the end of the run.

The setting of the revolving shutter to eliminate travel-ghost is accomplished by slipping it in or out on the spindle. The screw in the head setting, of course, in the spindle slot.

The intermittent movement may be examined at any time by removing the screws in the side of the casing, but, as I before stated, the company recommends that the operator let the intermittent severely alone.

THE POWER'S MACHINE.

The Powers machine is a finely built piece of mechanism and like all other finely made machines requires intelligent attention and care. It is, however, perhaps one of the easiest machines there is to adjust, since its mechanism is all "in sight." The Power's No. 6 is such an entirely different form of construction from any other machine that detailed instruction on the mechanism is imperative. Trusting that the various manufacturers will understand my position and that I have no desire other than to treat everyone fairly and impartially, doing even and exact justice to all, and that the fact that I say more about one machine than another indicates nothing except that the writer feels one to require more detailed instruction than another, I will proceed.

The New Power's No. 6 Model Cameragraph is such an absolutely unique departure in projection apparatus that it also must be dealt with in detail. This machine was designed primarily to compete in the European markets where projection machinery is heavily constructed. It is, therefore, a more massive, heavily built machine than any other American built projection mechanism. In this machine the star and cam, in their old, familiar form, are dispensed with, the intermittent movement being accomplished by means of a heavy, hardened steel star, somewhat in the form of a pointed Maltese cross (Fig. 42), and a circular, flat steel cam-ring (Fig. 42) 5-16ths of an inch thick, with an outside diameter

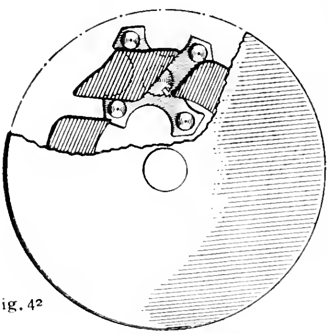


Fig. 42

of 2½ inches and an inside diameter of 1½ inches, these measures being approximate. This form of intermittent is absolutely non-adjustable. Do not attempt to adjust this movement, for there is no adjustment you can make. The casing covering the intermittent is oil-tight and the small oil cup should receive from 15 to 20 drops of oil per day according to length of day's run. Use a medium machine oil if it is obtainable. Three In One oil is too light unless mixed with heavier oil.

Lost motion occurring in the intermittent movement of this machine does not affect the film since the star (cross) and cam revolve in the same direction, instead of in opposite directions, as is the case with the old style star and cam. The whole intermittent movement may be removed from the machine as follows: Loosen the set screw in take-up feed sprocket and slip sprocket spindle, gear and belt-wheel out to left. Loosen brass collar on inner end of shaft which carries the large gear which drives the take-up gear-wheel and slip gear and shaft out to the left. This will allow you to remove the cover to the intermittent oil casing, which is done next. Having removed cover, take out the large screw in center of fly-wheel and take fly-wheel off. With a block of hardwood and hammer tap end of shaft lightly, if necessary, to start fly-wheel off. You may now pull the cam and shaft out to the left. If you wish to also remove the cross and its shaft, just take off aperture plate and remove pins which secure intermittent sprocket to shaft. You can then pull cross and shaft out. With the latest machines it is not necessary to loosen the sprocket on its shaft to remove the cross and shaft. Just loosen the screw holding left hand bushing in place, and the whole thing, cross, shaft, bushing and sprocket will slip out. To replace just reverse the operation described. Should the intermittent sprocket shaft at any time have end play, loosen the set screw on the front of the right-hand boxing and shove the brushing out to the right up snug against the washer on the end of the shaft and tighten up the set screw.

With this machine it is essential that all sprocket idlers be kept away from the sprockets by about twice the thickness of an ordinary film. This is essential with any machine, but especially so with the Power's No. 6. Set screws and locknuts are provided for the purpose. The frame-up carriage is made to work easy or hard by tightening or loosening the wing-nut on side of frame-up lever bearing. **It is absolutely necessary that the shutter be placed as close to the lens as possible.** Setting it any distance from the lens will have a tendency to cause a travel-ghost. To set the shutter, loosen the two screws in outside shutter-hub (the hub is in two pieces) just enough so that you can slip the shutter around by using some slight pressure. Turn the machine by its fly-wheel until the intermittent sprocket has completed its movement and just barely come to rest. Now hold the fly-wheel perfectly stationary while you slip the shutter **in the direction it normally runs** until the wide blade (the one with stamp on it) covers just a trifle more than half the lens. Now put in a film and set the framer just so that the bottom dividing line of the pictures shows. If it looks black, without any flashes of light across it, move framer until top dividing line is in view (running the film meanwhile, of course), and if that also shows clear black without light flashes across it the shutter is right. If there are flashes of light on either dividing line slip the shutter a little until both dividing lines, above and below, show the same. Then tighten the screws in hub and you are done. Be very sure that the shutter shaft is always clear up as far as it will go. Should the screws loosen and let it drop a trifle it would have the effect of throwing the shutter out of time. This shaft is held by two screws, one over and one under the shaft. Set them both up tight. Keep the collars which hold the shutter shaft end-wise set up pretty close to the boxing, as the shaft should have as little end play as possible without binding. By means of the loose ring, held in place by three large thumb-screws the projection lens may be turned until its handle comes into convenient position for manipulation. To thread the No. 6 bring the film down from magazine, under roller, up over sprocket and under idler, thence down through gate, intermittent, and take up sprockets and into lower magazine in the usual manner, leaving a rather long lower loop between intermittent and take-up sprockets. The upper loop bulges straight out in front. Other points concerning this mech-anism seem too simple to require special mention.

THE STANDARD MOVING PICTURE MACHINE.

The Standard Moving Picture Machine presents several features peculiarly its own. It, therefore, also must be treated in detail. Should lost motion develop between the star and cam it may be easily eliminated by loosening the four screws holding the steel bar which compresses the bronze bushings carrying the intermittent shaft at either end. In the left hand end of each one of these bushings will be seen a small hole; insert the end of a small nail in these holes and turn the bushing slightly upward until all the lost motion, or practically all of it, has been eliminated and the intermittent sprocket feels tight. Be careful and turn each one of these bushings the same amount, else you will get the intermittent out of alignment with the cam shaft, producing a condition described and illustrated on page 108. This condition must be carefully avoided since, not only will it injure the star and cam, wearing their surface on a bevel, but it will also cause the film to bear only on one side of the intermittent sprocket, thus producing injury to the film and causing a bad performance.

In adjusting your intermittent sprocket be very careful that the spurs of your sprocket are in line with the film tracks of the aperture when you get through. This is very essential as you will see by careful examination. The film runs down between two solid guides on either side and if the spurs of the sprocket set a little over to one side bad injury to the film will inevitably result. Be very careful on this particular point.

To remove the intermittent sprocket shaft and star for repairs or renewal, proceed as follows: Take the machine head off its base, first, of course, removing the magazines and lenses. Lay the head down on a bench with the film gate up. The gate will be in the way, we will therefore remove it. As will be seen, it is held in place by a shaft at the bottom. This shaft in turn is held in place by a set screw in the bottom of the casting. Loosen this screw, which is not countersunk in the shaft, and drive the shaft out to the right. In driving out a shaft always use a brass punch or piece of hard wood, never use a hard steel punch. Next, turn the machine over with the lens side up and remove the front plate. Again reverse the position of the machine with the gate side up and remove the lower sprocket and shaft by driving out the taper pins in the sprocket and in the hub of the small gear wheel. The shaft will then slip out to the left, releasing the gear and sprocket, together with the brass chute through which the film passes to the lower magazine. Next remove the film slide. The film slide is the plate covering the gate side of the machine and extending down between the flanges of the intermittent sprocket into and through the lower film loop recess. This plate is removed by taking out one screw at its lower end immediately behind where the lower sprocket was; one flat head screw on either side just above the steel bars holding the intermittent bearings, and the two gate latch screws. Next unscrew the two steel caps which hold the bronze boxes of the intermittent shaft and the star wheel and its shaft may be lifted out.

When replacing the intermittent sprocket, star and shaft be sure that both bronze bushings or bearings are in line, that is to say, be sure that both these bushings set precisely the same so that the shaft is held exactly parallel with the cam shaft. This, as has been before explained, and is further explained and illustrated on page 108, is of the utmost importance. Other than this the replacing of the star shaft is merely a reversal of the process of its removal, except that when screwing on the cap nearest the star wheel be sure to tighten the upper screw as tight as possible first; then the other three screws may be tightened a little at a time. Also be careful, as has been before noted, that the intermittent sprocket is in exact line with the aperture plate film track.

To install a new revolving shutter you must take your machine apart just as has been already described for the removal of the star shaft. You must also remove the middle shaft, that is to say, the large shaft immediately behind the intermittent shaft. This is done by removing the taper pins in the hubs of the three gears it carries and driving the shaft out. The first thing is, set the framing device exactly half way of its travel, or so that the handle is parallel with the base of the machine. Next see that your aperture plate is screwed on in its place. Then the center of the cam pin which drives the star wheel must be set in the center of the intermittent sprocket bearing. Then set your shutter so that the center of the shutter is in line with the center of your aperture plate. When a new shutter is sent out it is set and pinned on the shaft so that it will be in correct position when installed in the machine, but you must experiment by moving it forward or back, changing the relation of the teeth of the large and small gears which drive the shutter, until it is in position as above set forth. The tension is supplied by a double shoe having a track on either side, held in place in the aperture opening of the gate by two flat springs. Should the tension become weak you may reach in at the top of the aperture and slip this shoe out, that is to say, just pull the shoe out over the springs. Bend the springs inward and replace the shoe, or, should the tension be too tight, it may be weakened by bending the two springs backward.

Bearing on either side of the intermittent sprocket is a split steel shoe which should be set about twice the thickness of a film away from the sprocket by means of the two set screws provided for the purpose, located immediately under the shoe. Having set this just right, set up the lock nut on the set screws very tight with a pair of pliers. To remove this steel shoe or intermittent tension guide remove the screws holding the flat tension springs on the face of the gate. Also the central flat spring near the two small set screws at the bottom of the shoe. Having done this the shoe will readily slip out.

The take-up on the lower magazine is adjusted by a milled thumb screw on the end of its spindle, which acts on a spiral spring. This thumb screw is locked in place by a flat head screw in its face; loosen this screw and the thumb screw may readily be turned. Tightening the spiral spring with the thumb screw of course increases the tension, while loosening it lessens the same. The chain belts should not be kept tight, neither should they be very loose, but they should be lubricated, preferably with a compound of vaseline and graphite, though any good lubricating oil will do. In the hub carrying the upper sprocket wheel of the magazine will be seen a milled thumb screw on the end of a shaft working in an upright slot. This arrangement is for the purpose of tightening the magazine chain belt. To tighten the other chain belt, that is to say, the one connecting the magazine with the machine, loosen the screw at the bottom of the upright casting carrying the two magazine chain sprockets and swing the whole arm ahead or back according to whether you wish to loosen or tighten the chain.

The machine should be oiled with a good grade of oil, not too heavy, but of good body. The oil hole for the shutter gears will be found right beside the lower left hand corner of the aperture opening, with the word "OIL" over it.

To thread the machine, bring the film down out of the upper magazine through the fire trap, under the top sprocket, and close its idler, the handle of which is on the left side of the machine. Now bring the end of your film down and slip it through the brass chute and into the lower magazine, attaching it to the reel. Now bring the film down over the aperture and engage the perforations with the teeth of the intermittent sprocket, leaving sufficient slack for the upper loop. The top loop should not be long enough so that it will strike the top of the machine, else the film will be liable to injury through scratching. Form the lower loop in the recess of the machine as large as possible, engage the perforations with the lower sprocket and close the gate, all the time, of course, holding the film up tight over the aperture while you form the lower loop with your left hand. Now revolve the lower reel until all slack is taken up and the operation is complete.

The motor of this machine is a self oiler. Do not imagine from this, however, that it will run for six months without oil. At least twice a week take off the oil cups, empty them, and fill with fresh oil, and occasionally put in a new feeding wick.

In the foregoing descriptions of the various machines, it would require a vast amount of extra space to illustrate all the parts of the different mechanisms in full. The manufacturers of any of these machines will be pleased to amplify the descriptions given herein by sending, upon request, their own illustrated catalogues and charts showing all the parts, both separate and assembled. For addresses of the several makers, see advertising pages at the end of this book.

Miscellaneous.

THE STEREOPTICON.

Song slides should be thoroughly cleaned before they are used. The mark of a dirty finger is not at all decorative. The audience is not at all interested in the "whorls" of your fingers. In using a single lamp it is essential that you handle the carrier gently when taking out and putting in slides. Shomehow a brick house don't look exactly natural dancing up and down, or at least I never thought it did. The least movement of the carrier is magnified many times on the curtain. The stereo picture should be brilliant and should be clear all over. Many operators persistently allow their stereo pictures to have yellow corners. With a very long focus lens, or one of too small diameter, this is not always to be avoided. But aside from these circumstances there is no excuse for such a condition. An excellent colored flood to be used with the stereo may be made as follows: Take an old reel and remove the hub. Next drill three small holes equidistant from each other around the circumference of the two reel sides, making the holes match so that the two sides may be bolted together. Next cover all the holes but one in one of the sides with colored gelatin paper. Lay the other side on and clamp the two together with small stove-bolts. Now affix the hub to one side and attach the whole to a suitable standard so that it will revolve freely before, and close to, the stereo projection lens. One hole must be left open so that when it is before the lens the picture can be projected through or white light may be thrown. Another wheel like the one just described may be added, thus giving a considerable range of colors. Every operator should provide himself with plenty of spot slides made from ordinary tin or stovepipe metal. The easiest way to cut them out is to cut the spot pattern from paper and paste it on the metal. You can then cut out the pattern with a file accurately. Glass slides are not good for spots, since remaining so long in the heat quickly breaks them.

The operator who has a dissolver may work out some very pretty spotlight effects by having a supply of various shapes and dissolving one into the other. He may also select certain blocked out flower song slides and by removing the emulsion for a spot produce nice effects, particularly on a singer. The man who has both a dissolver and spotlight may make some splendid effects by use of the colored flood before described in conjunction with the spot; also he may, in conjunction with the spot, produce some new and beautiful effects on certain vaudeville turns by using the spot small and with the dissolver at the same time throwing on slides of ground, moss and other glasses. By slow dissolving with some carefully selected glasses, using the small spot at the same time, some very beautiful effects are produced.

SLIDE CARRIERS.

There are several forms of slide carriers on the market, the one most in use being the old-style wooden carrier with two sides, or slide compartments. This form of carrier is now made in metal, but it is objectionable from the fact that it gets very hot and is then difficult to handle. Little need be said concerning this carrier except that a small handle should be screwed on the end next the operator so that it can be pulled towards one, instead of having to reach over and shove it from the further end. No matter what kind of carrier you are using, there should be a permanent metal mat attached to the stationary part, the mat being made of size to just fit the stage. You can then throw a flood light

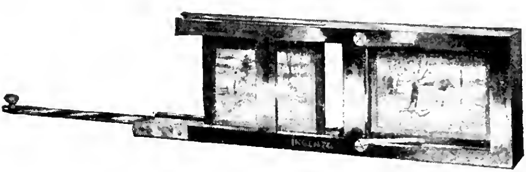


Fig. 34.

without plastering the whole front wall with light, and when, as sometimes happens with certain skirt-dance slides, there is no mat on a slide, it fits the stage or curtain, anyhow. For running song slides with a single lamp the "Ingento" dissolving carrier (Fig. 34), made by Messrs. Burke & James, Chicago, is the best article the writer has seen to date. It does not dissolve, for that is an impossibility with a single lamp, but the effect, when the carrier is properly handled, is the best the writer has seen. It is not the purpose of these articles to advertise anyone's goods, but in some cases the purpose of the series cannot be served without naming specific articles. A very good effect is had, also, by taking a piece of light green Venetian glass, cut in convenient form, and passing it slowly in front of the projection lens, meanwhile moving the carrier. Properly done, the effect is really very nice.

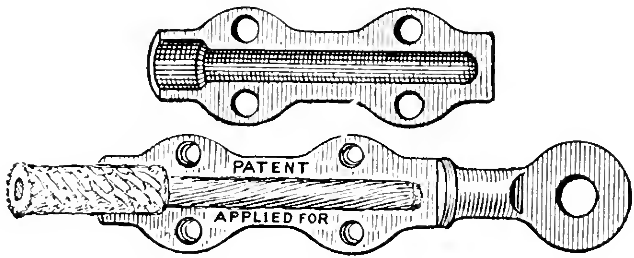


Fig. 35.

Further back I named the Bell wire terminal as excellent for cable ends. Since then samples have been sent me of a terminal (Fig. 35) made by the Robert Webb Electric Co., Pittsburg, Pa., which is perhaps the most substantial of anything on the market. They are made for different sized wires and appear to be an excellent article.

Where the machine has not an automatic shutter there should be a foot shutter. In fact, there should be one anyhow, since the automatic may go back on you, and if there is a foot shutter ready to connect up instantly, you will experience slight inconvenience and delay.

Fig. 36 shows plainly how to make a quick-acting, serviceable foot shutter. The plan, so often followed, of attaching a tiny little foot pedal to the floor, is very bad, since it compels the operator to sit in a cramped position. The writer uses a long bar made from one-inch wood, set on edge about eight inches from the floor. This allows of placing the foot in several positions, which is a decided relief, especially on an all-day's grind. This pedal should be placed about directly under the edge of the machine table and its height from the floor should be according to the height the machine sets. With the machine 3 feet 6 inches from table to floor, the top of the pedal should be 8 inches from the floor when the shutter is down. If a film tank is used in place of a take-up, it will be necessary to attach a flat strip to top of pedal or else set the pedal itself flatwise. The back end is attached by a screw or bolt to something substantial and the front end should slide up and down in a block like A (Fig. 36), attached to the front wall. The

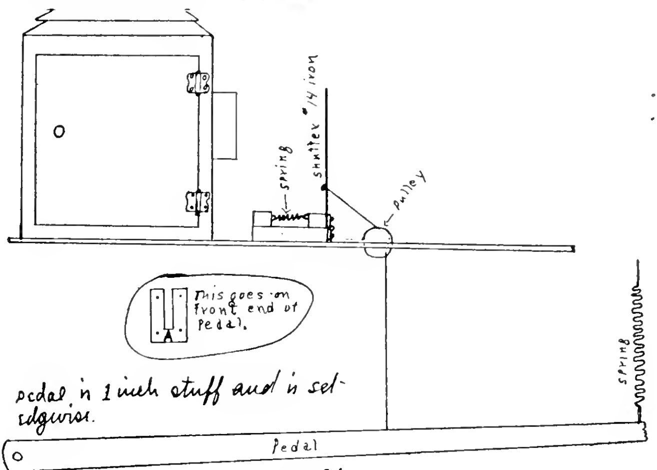


FIG 36.

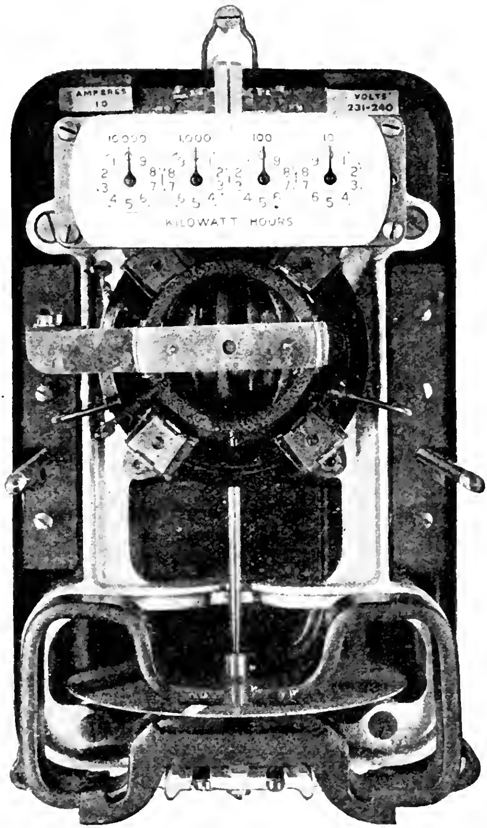
bottom of the slot in the block should be so that the pedal will just strike it when the shutter is wide open, thus relieving the strain on the shutter and chain. The shutter should be attached to the pedal by a brass chain such as is used on the flush tanks of toilet rooms. A shutter made as directed will work, and work **right**, but it will have to be modified when there is a film tank in place of a take-up. It will snap shut the instant the foot is removed. Right here is an excellent illustration of the slovenly methods employed in very many operating rooms. The average foot shutter you will find attached to the shutter by a scrap of wire—often two or three pieces of wire patched together. The pedal will be a little piece of board about 4 by 8 inches, attached to the floor by a strap hinge, which, in nine cases out of ten, is partly or wholly loose. Do things **right**, or get out and give someone the job who will! One of the first things my father taught me was "if a thing is worth doing at all, it is worth doing well."

The longer I live, the more firmly I am convinced that the old gentleman was absolutely right. The "Oh, that's good enough!" workman is a miserable failure at anything he undertakes. The "Oh-that's-good-enough-I'll-do-just-as-little-as-I-can-and-keep-on-the-payroll" man is **not** an operator, or much of anything else, for that matter, no matter how much he may know. In fact, it is not what you know that counts, but what application you make of your knowledge. To be a **real operator** you must not only **know**, but you must also **do**. Wages are too low, I am well aware, but when the writer gets to the point where he doesn't feel ambitious enough to do his work right, owing to low wages or anything else, he will quit, and he will do it very suddenly, too. There is absolutely no excuse under the heavens for doing things any other way than right.

THE ELECTRIC METER.

The meter is a very simple affair, consisting of a small motor which actuates the pointers to the dail by means of a train of gears. This motor is placed in the series with the lamps or motors using the current passing through it. The motor is so constructed that if it were operating under a pressure of one volt, with one ampere of current flowing, it would require, under those conditions, precisely one hour to record one Watt, which would, therefore, be one Watt hour. It, therefore, follows, that if it were working under a pressure of 110 volts with one ampere of current flowing, the Watts being the product of the volts times the amperes, the instrument would record 110 Watts in one hour; or if the pressure be one volt with 110 amperes flowing, the record for one hour would be 110 Watts. If, on the other hand, 30 amperes were flowing under a pressure of 110 volts, then in one hour's time the meter would register 30 times 110, or 3,300 Watts. That, in brief, is the way the meter works and records Watt, or killowatt, hours.

The reading of meters is equally as simple as their op-



Mechanism of Recording Watt Meter.

eration, and any customer can read his own meter if he so desires, by following a few simple directions which we give for the benefit of interested persons. Electricity is measured by the kilowatt hour or by the watt hour, one kilowatt being equivalent to 1,000 watts.

When attempting to read a meter, first note carefully the unit in which the dials read. On all meters used by the Edison Company, the figures above or below the dial indicate the value of one complete revolution of the pointer, therefore one division indicates one-tenth of the amount marked above or below.

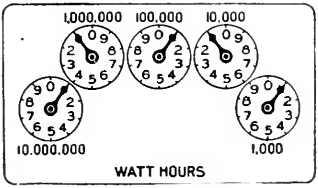
Note the direction of rotation of the dial pointers. Counting from the right on a watt meter, the pointers of the first, third and fifth dials rotate in the direction of the hands of a watch, whereas the pointers of the second and fourth dials move in the opposite direction. Similarly, on a kilowatt hour meter the pointers of the first and third dials move in the direction of the hands of a watch, and the pointers of the second and fourth dials move in an opposite direction. The dials must always be read from right to left, and the figures should be set down as read. Always read the figures on each dial which the pointer has last passed or has just covered.

Each dial reading depends on the reading of the one next to it on the right. Unless the one before it has completed a revolution or passed the o, the pointer which is being read has not completed the division on which it may appear to rest, and still indicates the last figure passed over.

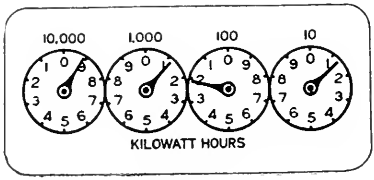
Always ascertain if the register is direct reading, that is, has no multiplying constants. Some registers are not direct reading but require that the dial reading be multiplied by a constant in order to obtain the true reading. This is for the purpose of keeping meters of various capacities uniform in size. If the constant were not used, meters of larger capacity would be much larger and heavier than those of small capacity. If the register face bears the words "multiply by ½," or "multiply by 2," etc., the actual reading should be multiplied by ½ in the first case, or doubled in the second, and similarly for other constants.

Next multiply the difference between the present reading and that of the last month by the rate per kilowatt hour you are paying, and you have the amount of your bill in dollars and cents.

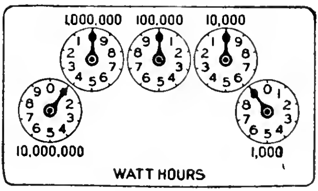
The accompanying fac similies of meter dials give examples of meter readings which may actually occur in practice. For example, in No. 2, the dial at the extreme right reads 900. The second apparently indicates 0; but since the first has not completed its revolution, but indicates only 9, the second cannot have completed its division, hence the second dial indicates 9 also. The same is true of the hand of the third dial; the second being 9, has not quite completed its revolution, so that the third has not completed its division, therefore we again have 9. The same holds true of the hand



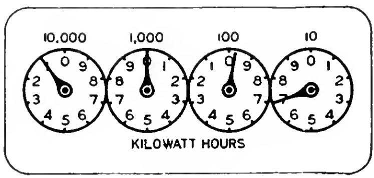
No. 1.



No. 3.



No. 2.



No. 4.

Facsimiles of Meter Dials.

of the fourth dial. The last hand (the extreme left) appears to rest on 1; but since the fourth is only 9, the last has not completed its division, and therefore indicates 0.

Putting the figures down from right to left, the total reading is 999,900. By similar reasoning the value of other indications may be obtained.

General House Equipment.

THE CURTAIN.

The writer has viewed many different kinds of curtain and curtains covered with several kinds of patent coatings, but to date has seen nothing he thought was better, all things considered, than plain, white plaster. Such a curtain may be readily cleaned by sandpapering lightly with No. 0 or ½ sandpaper. Sheet metal may be used by nailing the joints down level and tight and covering them with a thin putty made from Spanish whiting and white lead in about equal proportions, thinned with boiled linseed oil to proper consistency. This putty should be smeared on with the fingers and carefully wiped until the nilheads and joint is covered and leveled up as much as possible. Coat the whole curtain with white lead mixed with about one-third boiled linseed oil and two-thirds turpentine, adding a little ultramarine blue (ground in oil) to the paint to whiten it. White calcimine may also be used with good effect, but it is likely to peel on metal. A little blue should be added to it as well as to paint. If the latter is used on metal be sure there is no grease or oil on the metal. If there is, remove it with soap and water. Use two or three coats of thin calcimine or paint rather than one heavy one.

Ordinary bleached bed sheeting of good quality makes the best cloth curtain and it may be readily laundried. It may be had, if I rightly remember, eight feet wide.

If cloth is used stretch it perfectly tight so that there will be no wrinkles. The curtain should set as nearly as possible square with the machine—or, rather, the machine should set square with the curtain. It will be found that much brilliancy will be added to the picture by painting all the curtain except the space actually occupied by the picture a dead black made by mixing dry lampblack with boiled linseed oil and turpentine, in proportions of one-third and two-thirds. The objection to this is that the stereo picture is not the same size or shape as the moving picture, so that where both are used it is impossible thus to outline. A neat, heavy moulding around the curtain adds very much to the effect, but better yet is a "flare" from eighteen inches to two feet in depth such as one sees in the proscenium arch of a theater. The curtain should be of size to accommodate a picture in which the figures will be at least life size. Nine by twelve will do nicely for a small house, but for a house of ample dimensions the picture should be at least fifteen feet in width. It must be remembered, however, that every foot added to the picture size adds enormously to the necessary light intensity to produce equal brilliancy. A certain amount of light is projected to the curtain and is diffused over a given area, depending on the size of the picture. The 9 x 12 picture covers 108 square feet, while the 15 x 18 occupies 270 feet of curtain space—considerably more than twice as much. The writer has often been amused to hear operators discussing the matter of current and asserting that they never use more than twenty-five amperes, or thirty-five amperes, or whatever the individual's preference happened to be. Let me say right now that such talk is foolish. The light intensity, within certain limits, is governed (not altogether, but largely) by the amperage and the light intensity necessary to produce a given result will depend almost altogether on the **size of the picture projected.** In planning your house this matter should be given due consideration. Better have a good small picture than a large one bad. The writer is using forty-five amperes of direct current at the present time, but he throws a fifteen-foot picture in a house where there is lots of light, part of it being daylight which strikes the curtain badly in the forenoon. Under different conditions he could get better results with one-third less current.

EFFECT OF DAYLIGHT AND HOUSE LIGHTS ON THE PICTURE.

Every particle of light, especially daylight, which strikes the curtain directly dims the brilliancy of the picture, but if the light rays be shaded from the curtain so that they do not strike it directly it is astonishing how light the room may be without causing material damage. This matter of lighting the auditorium while the picture is on involves several problems. The direct white rays must not strike the curtain, neither must they strike the eyes of the audience from the front. The best plan the writer has seen, taking everything into consideration, where the ceiling is of moderate height is to use ceiling lights for this purpose, shading the rays downward by means of a metal cone shade. Light green globes make a very pretty effect and do not seem to seriously affect the picture unless placed too close to it. They give off considerable illumination. Care should be taken that the piano lamp rays do not strike the curtain, either directly or by rays reflected from the music. It is, of course, desirable to have the auditorium as light as possible without damaging the picture. Any method which will not allow the direct light rays to strike the curtain or the eyes of the audience will serve. By "striking the eyes of the audience," I of course mean in such manner as to blind them with the glare as they look forward toward the picture. Guard these two points carefully and you will be the gainer.

ILLUMINATING THE AUDITORIUM.

The placing of lights, aside from those to be burned during the time the picture is on, is a matter which must be governed entirely by the size, shape and height of the room and the color of the walls and decorations. As a guide in this matter it may be said that dark walls will reflect only about 20 per cent. of the light, whereas a clean, white surface reflects fully 80 per cent., with varying percentages for shades between. Added height of ceiling also operates to reduce a given light intensity. The following table give the approximate general effect produced by different numbers of sixteen candle-power lamps placed in a room of medium height with walls of medium shade:

No. lamps per 100 sq.ft. of floor surface.	Approximate effect.
1.0	Dull
1.5	Medium
2.0	Good
3.0	Bright
4.0	Brilliant

In general it does not pay to be stingy with light in a theater. Between shows the auditorium should be well lighted, otherwise it is, if not depressing, at least not calculated to produce the best impression on the audience. Moreover, lack of plenty of light looks cheap and is an error from any and every point of view. In general it may be said that the bulk of the light should be on the ceiling. Placing a lot of lights around the curtain edge, unless they be ground glass globes, is a mistake. Their glare is thrown directly in the eyes of the audience, which, to say the least, is not pleasant. Taking the ordinary storeroom theater as an example, seating capacity 300, four ceiling clusters of eight 16 c. p. lamps each, with a good reflector above each cluster, will produce an excellent effect, these to be supplemented by six or eight 8 c. p. globes on either wall, designed to burn during the performance. These latter to be either colored light green or else their rays shaded downward by a proper reflector which will neither allow the direct light rays to reach the curtain or the eyes of the audience. On the floor, under the end chair of each fifth row of seats, may be placed a small globe enclosed in a small metal box one side of which is covered by wire screen. The wire screen is placed next the aisle and the aisle floor is thus lighted. The wires to these lights are carried under the floor, coming through a small hole to each lamp, the circuit being handled from the main switchboard and lighted only when the house is dark. A light enclosed in a metal box with glass front in which the word "EXIT" is blocked out, with letters in red, should be over each exit, this circuit, as has already been explained, being handled only by a switch located in the box office. One, two or all of the ceiling clusters should be arranged to be handled by a switch located in the operating room, as well as from the main switchboard. By this plan when the show is ready to start the other lights are pulled when the operator is given his cue. The operator then starts his machine and pulls the ceiling lights, thus the picture is on and the house dark at one and the same instant, producing a very nice effect. When the picture is done the operator snaps on the lights as the machine stops. Also if anything goes wrong the operator can instantly light, or at least partially light, the house.

It is best to have your lights so arranged that a part of them may be burned at a time without materially affecting light distribution as a whole, merely making the illumination less brilliant. This saves current when the janitor is cleaning up, also there may be other times when you will not need the full number of lights. The distribution of light and the location of the lamps will depend on the size and shape of the room and the decoration. Aside from what has already been said there is little to say of value. Each one must size up his house and plan his light scheme along lines which seem best for that particular case. But **don't** imagine because Mr. Jones has his theater lighting distributed in a certain way you have to make an exact copy. The light scheme which looks well and produces a splendid effect in Mr. Jones' house may look very bad in yours. Where there is a stage used for players it should by all means be **brilliantly lighted.** The writer does not know that there is any established rule setting forth a certain number of candle power per square foot of stage. He believes there is not. The following will, he thinks, serve fairly well on any stage, however: **Foots**—One 16 c. p. lamp to every 6 or 7 inches the full width of the proscenium opening. **Borders**—One 16 c. p. lamp to each 7 inches, full width of stage, with one row of borders to every 4 feet of stage depth, counting from the front curtain line. The front row of borders should be hung as close to the front curtain as is practical. The number of border lights per row may be somewhat reduced where the height from floor to borders is shallow, say under 10 feet. The above stage lighting may seem excessive to some managers of small theaters, but take my word that it **pays** in the long run to have plenty of light on the stage. Your stage circuits should be so arranged that each alternate light of both foots and borders can be extinguished in scenes where not much light is desired. An effective, cheap border trough is made by placing the lamp sockets on the flat side of a 2x4 and then nailing a strip of heavy tin or sheet metal on its edge so that it will project about 7 inches, the strip of metal to run the full length of the border, of course. This trough should be hung at such angle that the lights cannot be seen from the front row of seats. Paint the inside of the trough white.

This trough is cheaper and almost as good as those used in large theaters. Anyone can make them.

As to scenery, there is little use in offering advice, but whatever set or sets you may decide upon they should be made and painted by people who make such work a business. It will be far cheaper in the long run, since such scenery not only will look far better but will last much longer. Advertisements on the front curtain, or anywhere in the house, for that matter, are in bad taste. They cheapen the whole house, just as advertising slides thrown on the curtain do. *Better keep away from that game.* It does not pay.

The stage floor should be solidly constructed in order to avoid excessive vibration from dancing. It should have a top finish of carefully selected narrow hard maple flooring. The stage floor should be kept scrupulously clean, but very little water should be used. Wipe it up with a wet cloth, wiping dry immediately with dry cloths. The footlight gutter should by all means be deep enough so that the tops of the globes cannot be seen by the audience from any part of the house. If this is impractical then flare the front edge inward a trifle over the globes. Proper dressing rooms should in all cases be provided in houses in which there will be actors. Any room where proper and ample dressing rooms cannot be had is unfit for any but a straight picture show, if it is for that. Theater managers will do well to remember that even the "twenty per" actor (?) is human and entitled to some consideration—at least to dressing room conditions which make for common decency. Theater managers provide such conditions, but the rapid growth of the cheap theater has unfortunately produced a too numerous breed of would-be managers, just as it has produced thousands of would-be operators. These men know little or nothing about the amusement business, though as a rule by the time they have been managing a small five-cent house from two to six months they feel ready and willing to offer expert advice to Klaw & Erlanger. They simply succeed in earning the contempt of wise theatrical men. Many such men seem to think a 3 x 4 toilet room for a man or woman actor is a sinful waste of space. Put yourself in the actor's place, friend, and think how you would like to suffer the dressing room conditions provided in too many nickel theaters.

VENTILATION.

The matter of ventilation is one of much importance, both Summer and Winter. There are too many owners and managers who seem to imagine that stirring up the air with wall or ceiling fans is "ventilation." **It is nothing of the sort.** Ceiling and wall fans perform an important office in cooling the theater, since rapidly moving air, for reasons not necessary to go into, produces a sensation of coolness to the human body. Ventilation, however, does not necessarily have much to do with coolness. The office of ventilation is to purify the air in a room by removing it, substituting out of doors air instead. Here we have two separate and distinct propositions as applied to Summer and one as applied to Winter, viz.: In Summer a movement of the air by wall or ceiling fans, or both, to produce coolness, and a pumping out of the air by an exhaust fan or vent flues to purify. In Winter we have only the changing of the air, but that is even more important in Winter than in Summer, since the house is then tightly closed. As to ceiling or wall fans for cooling, their size and number will depend, of course, entirely on the size of the house, but comparatively large fans are always best for several reasons. **It does not pay to buy cheap fans!** They are an abomination and source of noise, continual trouble and expense. By all means **get good fans.** It will pay you well to do so. But having procured them do not imagine you can put them up, make the connection and let them run for six months without attention. Most fans are self-oiling, but that does not mean they will run for six months with one filling of the cups without serious damage to the journals. Nor does it pay to try to make them do it! Oil is cheap—considerably cheaper than worn and cut journals and ruined armatures. Where wall fans are only run three or four hours a day they may be allowed, unless something goes wrong with them, to run for two weeks without attention, but it is an excellent rule to set certain days, in such cases the first and fifteenth of the month, for overhauling the fans, and make it an invariable rule to attend to this duty on these days. The "overhauling" should consist of emptying the oilcups and refilling with fresh oil, examining the whole fan and cleaning it thoroughly, closely examining the commutator and brushes, replacing brushes that are getting too short and seeing that the brushes make good contact with the commutator bars. If there is sparking at the brushes the trouble should be remedied or it may in time cause serious damage. It may be caused by an almost invisible bit of copper pulled across the insulation between two commutator bars. This may be removed with No. 00 sandpaper or by very careful scraping with a knife blade. The oil in the cups may look all right, but it gets dirty and needs renewing. All this involves some work, but there is no excellence without labor—and it pays, in the long run, in dollars and cents, in temper saving and in satisfaction both to yourself and your patrons. You may say, "O, my fans run all right without all that monkey business!" Granted, but your fans will be in the junk pile when those of the man who follows my directions will be practically as good as new and you will have spent dollars in repairs where he has spent dimes. Your service will have been more or less unsatisfactory, at least at times, while his will have been practically perfect at all times. Wall fans should be placed at convenient height and set to blow backward diagonally towards the audience's faces, but the height of center of draught should be such that excessive air current will not be felt in the seats. A little experimenting will determine the proper angle to set the fans, but it pays to observe these details closely.

For ventilation there are two methods, viz.: The exhaust fan and the vent flue. With the latter I do not purpose to deal, since that is a problem for the sanitary engineer. Where practical it is best to locate the exhaust fan at the rear (stage end) of the house, since then the air will be drawn the full length of the room when the front doors are opened. The fans should be of ample size, since it is much cheaper to operate a large, slow-speed fan than a small, high-speed one; moreover, the low-speed fan is more nearly noiseless—an important consideration in a theater, especially if there be acting. The larger, lower speed fan is much the best in every way. It is stated that in a crowded theater the air should be changed once in five or six minutes, but the writer is unable to discover what this assertion is based on.

Other authorities say there should be 1,500 cubic feet of air per person per hour. Again I have been unable to discover what this is based on. The average person, so say the medical fraternity, breathes about 25 inches of air per breath and breathes an average of 18 times per minute. This would indicate an hourly consumption of about 15 cubic feet of air per person. But the human body gives off gases aside from this which help render the air impure. Still the writer believes, and is willing to assert, that an entire change of the air once every ten minutes is amply sufficient when the house is full to capacity. In fact he very much questions if even this time is not much shorter than there is any real need of. He is a believer in thorough ventilation and plenty of fresh air, but there is no earthly sense in throwing away money pumping more air than is necessary. In Summer the air becomes impure much faster by reason of the perspiration thrown off which carries with it impurities. The writer lays no claim to being anything even approaching an expert in ventilation, but plain reason seems to tell him that 1,500 cubic feet of air per person per hour is excessive as is the changing of air every five or six minutes. You will have to "show me" the necessity for any such air movement as that. Having decided how often you want the air changed any fan manufacturer will be able to provide a suitable sized fan to do the required work.

The fan speed should be regulated by a controller, however, since it will not be necessary to run it to speed when the house is but partially filled; also it may be necessary to slow it down when singing or vaudeville is on. And now a further word concerning fans. Some makers set their fan blades at a wide angle and run them slow speed, while others prefer the high speed and slight blade angle. Common sense will tell you that the fan with heavy blade angle will move more air than will one with slight blade angle, speed being equal. It therefore follows that you can run the wide angle bladed fan at lower speed and secure the same results. Such a fan is considerably less noisy in operation, besides requiring less power per cubic foot of air moved. The most effective speeds for properly designed exhaust fans will be found to be about as follows: 24-inch fan, 700; 30-inch, 550, and 36-inch, 450 revolutions per minute The speed controller should be located either at the main switchboard, at the stage switchboard or in the operating room, as seems best in the individual case. In purchasing an exhaust fan, as in other things, don't look at the price so much as at the quality. That is to say, don't buy a poor fan because it is cheap. It will be very costly by and by if you run it long.

SEATING.

So far as price goes a theater may be seated with opera chairs costing from as low as $1.25 each to as high as one wishes to go, a very comfortable, substantial seat being available at about $1.40 each. Upholstered seats are not desirable in moving picture theaters from any point of view. They would be a distinct disadvantage any way one might look at it. The audience remains seated such a comparatively short time that the non-upholstered seat, provided it be properly made, is perfectly comfortable and in Summer it is much cooler also. Second-hand chairs are often available at very low figure, but you should either see them or have a guarantee in writing as to their size, condition, etc., with privilege of examination before paying if shipped from a distance. Theater seats should always have a wire hat holder beneath the seat and on the back of each seat should be affixed a very small ring or staple through which the ladies may thrust a hatpin to hold their headgear instead of being obliged to hold them in their laps. Two small staples, one one-half inch above the other, are best. You will probably have to throw a slide on the screen calling attention to the arrangement until the ladies become accustomed to it. You will find it will be highly appreciated by ladies who remove their hats. Advertisements in The Moving Picture World will put you in touch with manufacturers of theater seats who will send prices, descriptions and illustrations of the various styles of seats.

One very essential and important feature in seating is to utilize all available space, but at the same time not get the rows so close together that the user will experience discomfort. The requirements of Chicago will serve as a safe guide in this respect. It is as follows: 32 inches from chair back to chair back. Chicago law is good to follow in the matter of aisles also. It calls for aisles 3 feet wide if more than one and 4 feet if but one. Taking the above as a basis to measure seating capacity of a room, proceed as follows: Measure from the stage to the point you wish to locate your front row of seats. From this point measure to the point where the rear of your last row of seats will be. Multiply this measurement by 12, to reduce to inches, and divide by 32. The last result will be the number of rows. Next measure the width of the room and subtract width of the aisle, or combined width of all aisles if more than one. Multiply remainder by 12, to reduce to inches, and divide the result by width of chair you intend using, which may be 18, 20 or 22 inches. Next multiply the number of rows by the number of seats per row and the result is the seating capacity of your room. Of course if length of all rows is not the same you will have to subtract the deficiency of short rows or else measure all rows separately, adding all together and dividing by chair width. Theaters having curved rows usually have an architect's floor plan to figure from.

All theaters should have a properly sloped floor. The day of the flat floor is past. Such a house is hopelessly out of date and behind the times. What this slope will be will necessarily depend somewhat on how much you are able to get if the installation be in a building already erected. All the slope you can get up to the point where the rows of chairs must be on steps is an advantage. The best floor slope result the writer has seen is a newly constructed Chicago moving picture theater. The floor is of cement and the slope is about 5 feet in 50. There are two ways of getting a slope in an old flat floor room, viz.: Build an incline on top of the old floor or drop the front end of the old floor down into the basement. The latter is much the best where it can be done. The first named plan has the disadvantage of requiring a slope from the entrance up to the new floor level. Never use steps for this, since in case of panic people would certainly pile up on them and many be injured or killed. They are not likely, however, to fall on an incline, even though it be quite steep, especially if it be carpeted with heavy coarse matting, securely nailed down.

As regards seating plans, I think it would be somewhat a waste of space to elaborate upon them. The main thing is to have no long rows of seats unbroken by an aisle, and so arrange your exit, which in all cases should be entirely separate from the entrance, so that there will be the least possible congestion when the crowds are passing out. It is by far the best, where it can be so arranged, to have the exit at the opposite end of the house from the entrance. This is in some cases possible where there is an ample passage between the theater building and the next adjoining, provided it be not a public alley. This plan relieves all congestion caused by interference between people coming in and those passing out. In ordinary storeroom theaters the central aisle plan is almost invariably the best. Where it is practicable to have a center aisle and one at either side, it is a most excellent plan to use the center aisle exclusively for persons passing out, the incoming ones being steered into the side aisles, none being allowed to enter the center aisle. As the people usually do not come in in big crowds, the side aisles, where this plan is adopted, may be comparatively narrow. Where there are long rows of seats unbroken by an aisle, it is dangerous in case of panic; also it is annoying to patrons, in that late comers have to crowd past many seats to reach center seats in the row. In picture theaters, the further the front row of seats is from the curtain, the better, since when one is very close to the curtain, all sense of perspective is lost: moreover, the picture is little more than a blur.

It is better to locate the piano in a pit in the center under the curtain or stage front, since the piano player then has a constant view of the picture without effort. This is essential, if he or she is to produce the best results in following the film action with music. Carpet all aisles with heavy matting or linoleum. The sound of people walking on the bare floor is very annoying to an audience. The curtain should be at such height, if possible, that the head of a man standing at the front row of seats will not interfere in the picture. As regards picture size, there is no rule. It depends on the house entirely. But it may be said that the picture should, if possible, be at least ten feet wide. A picture twelve feet wide is called life size from the fact that in this size there are a greater percentage of life-size figures than in any other.

From twelve to fourteen feet width usually makes the best appearing picture. Unless it is absolutely necessary, do not throw the top of the picture clear up to the ceiling. It does not look so well as when there is a margin of from six inches to two feet. After all other cleaning is done for the day, every seat should be carefully dusted. There is nothing more annoying to a lady in a light-colored dress than to find her costume soiled by a dusty theater seat. It amounts to an outrage.

MUSIC.

Music is a matter of greater importance than many moving picture theater managers seem to imagine. Get a good piano player, **who can read any music at sight** and **make him or her attend strictly to business.** Pay a salary which will justify you in demanding the best work and then see to it that your player makes good. A piano player who cannot read music at sight has no rightful place in a moving picture theater, especially if illustrated songs are run. But the song is a comparatively small matter. Always and invariably the piano player can help out a film wonderfully if he or she wants to and knows how. Often and often have I entered a theater while the film was running and seen the piano player industriously engaged in talking to a friend, dividing her attention impartially between the friend and a wad of gum. He or she would have got busy or been fired in just one minute had I been managing that house. The piano player should have a wide range of "know it by heart" music; should watch the picture closely and play suitable music, with due attention to producing as many of the noises as are practical with that instrument. There is no reason, where a drummer cannot be employed, why an auto horn, a chime bell and a whistle cannot be manipulated by the piano player. They can easily be attached to the instrument within easy reach, and such things help. A piano player can do much if he or she wants to and mighty little if he or she doesn't want to and doesn't have to. Of course you will have to spend more for good service, but it pays to do it.

Where the house has seating capacity to justify there should always be a drummer. But **get a good one.** A good drummer can perform wonders in adding to the effectiveness of a film, but a poor one is worse than none. The up-to-date moving picture theater drummer has contrivances for imitating almost any sound and he knows how to use them, too. It may be safely said that any 300 capacity house which has available capacity business should have a drummer and piano player. More need not be added except in large houses. I feel that I cannot impress too strongly on managers the advisability of getting all you can out of the available music.

BELL WIRING.

Where there is simply the installation of one bell to consider it is a very simple matter. Test your bell or buzzer (a "buzzer" is just a bell without the bell part) by holding the binding posts of a battery against the binding posts of the bell. If it does not ring either the battery or bell is not right. If it is a new battery it is pretty sure to be the bell which is at fault. After testing fasten your bell and push button in place where you want them to be. Run a wire from one battery binding post to one side of the push button. Run a wire from the remaining side of the battery to one side of the bell and run a wire from the remaining side of the bell to the remaining side of the push button and the job is done. Where two batteries are used connect the zinc of one with the carbon of the other with a short piece of wire, using the remaining posts for your connections as above set forth. Where more than two batteries are to be used for any purpose connect the first two as above and connect the next and remaining ones the same way. This is series connection and will raise the voltage.

Run-down dry batteries may be renewed as follows: Remove them from the cardboard casing and punch them full of holes an inch from the top, being careful not to punch into the carbon and break it; also not to disturb sealing wax around top. Immerse batteries in solution made of 1 pound sal ammoniac to 1 gallon of water. Leave in solution half an hour, then remove and stand upside down for an hour, being careful the solution does not, as it leaks out, connect the zinc and carbon, for it will then act as a "short" and run the batteries down again. Wipe dry and replace in cardboard case and they are ready for use.

Few there seem to be who understand the three wire system of wiring bells. This system is the most economical of any in amount of wire used and it contemplates the ringing of any number of bells from one battery, each bell being rung by its own push button and no other. Nor will any push button ring any other bell than its own. The system is quite simple and easily understood. Common No. 18 cotton covered bell wire is large enough and good enough unless the distance from button or battery to bell be excessive, which is not likely in a theater. If the wires are to be run

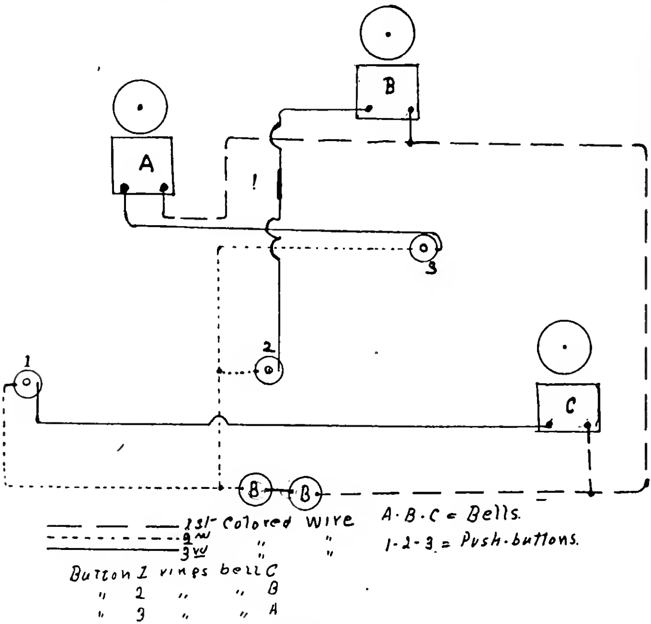


FIG 41

through very wet or very damp places they should be rubber covered wires through that space or else be insulated on small porcelain insulators the same as are electric light wires. To install such a system get your bells and batteries and test them all to be sure they are in good working order. Put up the bells (or buzzers) and push buttons wherever you wish them to be If two batteries are used connect the carbon of one to the zinc of the other by a short piece of wire. Now get three colors of bell wire. The reason for three colors is to avoid mistakes and confusion and to be able to find any particular wire anywhere afterwards, without tracing it clear from the battery or bell. The use of three colors of wire simplifies matters exceedingly. Suppose you get red, blue and white. You take one color, say the blue, and run it from one (either) binding post of the battery to one (either) binding post of each bell. You may run separate wires from the battery binding post to each bell or run one wire reaching all bells or you may branch off to a bell at any point. Next take another color (red, for instance) and run from the other battery binding post to one (either) side of each push button. You now have one side of the battery connected to one side of each bell and the other side of the battery connected to one side of each push button. You next, with the remaining color (white) wire, connect the remaining side of each push button with the remaining side of **the bell it is to ring**, and the job is done. The blue wire (blue in this case) is called the common bell wire, the red wire is called the push button wire and the whites are called the individual wires. It is these latter wires which determine which bell a button will ring and you may cause a button to ring a different bell by simply changing the individual wire to that bell. Fig. 41 shows a plan of this system. In running your wires they may be, except as before noted, simply stapled to the woodwork with small staples, but you should never run two wires under one staple, since if you drive the staple a trifle tight you may form a short circuit through the iron of the staple.

Then, too, if a wire is in a place where it will swing a little the insulation is likely to wear through, thus forming a short circuit even though not clamped tightly by the staple. A short circuit may cause your bell to ring all the time or not ring at all, according to its location. If on the two wires leading to the push button the bell will ring continuously until the battery is worn out. If on the wire running from bell to battery and the wire running from button to bell the bell won't ring at all. Several wires may be run together in a bunch by using wood cleats. An additional bell or buzzer may be installed at any time as follows: Test the bell and install it and its push button wherever you want them to be. Now with a piece of first color wire connect one binding post of the bell with the first color wire already in use wherever you can find it. With a piece of second color wire connect one side of the push button with a second color wire wherever you can find one. Understand you can just tap on to these wires at any point you can locate one of proper color. Now connect the remaining side of the button with the remaining side of the bell with third color wire and the job is done. The rules governing this system of wiring are as follows: One side of the battery must be connected with one side of each bell by first colored wire. The other side of the battery must be connected to one side of each push button with second color wire and the remaining side of each button must be connected with the remaining side of the bell it is to ring with third color wire.

Location and Management.

SELECTING A THEATER LOCATION.

To one embarking in the moving picture theater business the first and most important consideration is location. This, as applied to the city and to the small town, presents two entirely separate and distinct propositions, involving quite different problems. The moving picture field has been so well covered that it is now well-nigh impossible to find a desirable location where there is no immediate competition. So true is this that the prospective owner may make up his mind at the outset that it is necessary to "butt into" a field already more or less covered, unless he buys out some established house. and even then he cannot be assured of no competition, since another house may be put in at any time. But the man who fears competition, provided there be business available for two or more houses, or for one and partly enough for another, is **not** the right man to enter the nickel theater field.

The first thing to do in selecting a location is to **thoroughly inform yourself concerning local laws** governing theaters, particularly the class of house you propose installing. You will then be in position to look at store rooms, or plans for the house you will erect, intelligently, and determine whether or not any given room can be made to comply with the law as applying to the class of theater you propose to install, or whether any given plan is available. The main points to look after in this connection are exits, stage requirements, aisles, and fireproofing, the latter being of importance in some of the larger cities. To cite cost of failure, considering the last named item to be in Chicago: suppose you selected a store that suited you and leased it, but later discovered it to have non-fireproof walls (only stone or brick is accepted as fireproof), and there were one or more stories above the theater room. You would, under the Chicago law, have to cover the entire surface of both walls and the ceiling with sheet asbestos, covered with sheet metal, before you would be allowed to open. Look after such things closely or you may be the loser.

Now having thoroughly investigated and posted yourself as to the law, the next step is to seek an available location. In considering the matter of location, the first thing is, of course, a suitable room or a site for building. If a store room, the first consideration is height of ceiling. If under thirteen feet, the room should be rejected. Even thirteen feet is too low, but it may be made to do after a fashion, particularly if the front end of the floor can be dropped down into a basement, making a slope. Next comes the matter of seating capacity, which may easily be figured as before set forth. If the room is available in these two respects (the writer would consider no room with a capacity of less than two hundred) and it is found that it can be made to comply in all respects with local laws, the next thing is the investigation of available business. If the neighborhood be a very wealthy one, a nickel house will likely draw no considerable patronage except children, servants and transient. The ideal location is a densely populated workingmen's residence section, with frontage on a much-traveled business street. There are many problems to consider when seeking a city location. The matter of race (nationality) must be looked after carefully, since some sections may be peopled almost exclusively by any one of half a dozen foreign-speaking nationalities. This, under some conditions, might prove disastrous. Take the lower class Italians. If any considerable number of them patronized your house you would have to look to them entirely for your revenue, since a house patronized by any number of them will have to depend on them alone for support. Any considerable number of negroes will queer a house with all other races; and there are other races to which you must cater exclusively or not at all, so that the matter deserves close investigation when seeking a city nickel theater site.

Straight-laced church neighborhoods have, as a rule, been found to give scant patronage, no matter how clean and high-class the program be kept. It does not necessarily follow that success may not be had in such communities, but the chances are that the patronage will at least be smaller than it would be in another equally populous neighborhood.

Here, too, is another thing to remember: In a city where there are many forms of amusement, people will not go far to visit a nickel theater. Your house must therefore be located close to its "base of supplies." Where transient trade is expected to form any considerable portion of the receipts, a careful computation should be made of the number passing per hour and the number of hours they will be passing while your house is open; also, whether or not the location is such that the passers-by will be inclined to stop to view a show. To illustrate the last point: Some time since a man opened a five-cent theater in the first block north of the Clark Street Bridge, Chicago. I told him at the time the house would be a failure, basing my prophecy on the following: When Clark street leaves the bridge (viaduct) on the north, it slopes down for one block to Kinzie street, the street being lined with a few cheap stores and dealers in steam-heating supplies. There are practically no nearby residences (flats), and the hotels, of which several are close by, and rooming houses are practically entirely occupied by the cheaper class theatrical people. The trade must therefore be all transient. People who start up that incline do so with intent to cross the river to the loop district, and, having a definite object in view, they will not stop by the way to see a nickel show. Coming north, the same, reversed, is true. The house was a flat failure. I cite this instance to show you that such things must be considered in seeking city locations, unless one wishes to deliberately invite failure.

Competition in a city; it is hard to say just when a given location, if it be densely populated, is fully covered. In one place on North Clark street, Chicago, there are six houses, all doing a land office business, within three blocks. People often start in at one end and go to all of them. It forms quite a nickel theater center and, as a matter of fact, the congestion of theaters at this point actually draws people, to some extent, from quite a distance. They will come and spend an entire evening in these houses. I do not feel that any advice of value can be given in this respect. If there are people enough and you put in as good or a better house than the other ones and give as good or a better show, there is no reason why you will not get your share of the business, and if your show is the best you will get the most of it, too.

SELECTING A SMALL TOWN LOCATION.

The selection of a small town location is quite a different proposition from the foregoing and presents a different set of problems. Of course, what has been said concerning the selection of a store room for remodeling into a theater applies equally in a city or small town. It is the matter of possible patronage which presents the difference. No rule can possibly be laid down as to the size of town capable of supplying the necessary patronage to make the venture a paying one. Theaters have been installed in villages of less than one thousand and have been successful in a small way. In such cases, however, it is usually a strictly family affair, no help at all being hired. The only expense of amount is film service, rent and light. These articles are not designed to deal with conditions of this sort, however. In figuring the matter of expense for a small town theater the items may be estimated about as follows: Operator, $15.00 per week; ticket seller and ticket taker, $5.00 to $6.00 each; piano-player—singer, $15.00; service, with express charges, $30.00 to $40.00; light, $6.00; rent, $10.00; or a total of about $100.00 per week. This will be about minimum if you propose to give a really acceptable show. Of course, I well know that many small town theaters get an operator for as little as $10.00, a piano-player—singer for $12.00, and service for $15.00 (even less, in some cases), but take my word, they don't and can't put on a show worth seeing. Ninety dollars per week may be taken as a minimum for putting on a creditable show in a small town where rents are comparatively low. This means 1,800 paid admissions to meet the expense account alone. It is therefore up to you, Mr. Prospective Investor, to carefully and intelligently "size up" conditions and decide that you can see the ninety coming back to you each week, bringing with it something over and above for your own pocket.

To accomplish this "sizing up," several things must be carefully considered. First and foremost, what are the present amusements of the people? Have they been accustomed to purchasing their amusement, or will you have to educate them to do it? Is the community a straight-laced one, where there will be a howl from the pulpit and from the little 2 by 4 weekly paper every time the exchange sends you an even mildly sensational film? You must remember that in small communities the preachers and editors are men of small caliber, usually, but possessed with an exaggerated idea of their importance as guardians of the public morals. They may even welcome the chance, even though a slim one, of getting into the local limelight by jumping on you. This will not ruin you, but "every little bit helps," and it is well to look closely at even such matters. Consider carefully what the source of public income is. If a large percentage of the workmen are factory employees with semi-monthly or monthly paydays, you are likely to do a rushing business around payday and nothing between times. Investigate as to whether or no the people, as a rule, retire early. If so, it will operate to congest the business into a short space of time, thus requiring a larger seating capacity than if it spread out an hour or two longer. Is the town compact or widely scattered? In bad weather people will not go far to a nickel show, therefore this is a point of considerable importance under some circumstances. Of course, in sizing up a location you must use your own good sense and judgment. Neither I nor anyone else can give directions which will take the place of your own intelligence. All I can do is point out a few of the more important items bearing on the subject, or which may under some conditions bear on it. But each individual case will be different from every other one, and a man must use his brains in such matters. Study all conditions closely. Decide what is the very least clear profit you would be satisfied with and then estimate as closely as possible whether or not your prospective patronage will be sufficient to produce it after meeting the expense bill. Don't let your wishes warp your intelligence.

EMPLOYEES.

A cheap or poor operator is dear at any money. Get a good operator and see to it that he produces the results. Remember, however, that the people of old could not make brick without straw. Neither can an operator produce results unless he has the equipment to produce them with. No matter how small the house, there should be at least one usher, and he should be well and neatly dressed at all times. The ticket taker should also be neatly dressed, in a uniform, if possible. The writer has in hundreds of instances seen a ticket taker in his shirt-sleeves, unkempt, and even with a cigar or cigarette in his mouth. Such a spectacle would convey the impression to my mind that the show was likely to be as slouchy as the man in the door. Others, I think, would have the same idea and pass the house by. The ticket seller should preferably be a young lady of good appearance, minus the usual wad of gum. She must know how to make change accurately and quickly, of course.

ADVERTISING.

It pays to advertise. But the best methods of advertising a moving picture show is a subject on which there is wide diversity of opinion. The neat colored posters which may now be had with nearly all films at low cost are excellent for the arcade. Neat showcards announcing the program are also excellent arcade advertisements. In small towns it is more than likely that the papers can be induced to give space to some film synopsis matter, especially if an advertisement be carried by the house. A common arrangement is to contract for a given space by the month or week, the publisher agreeing to give an equal amount of space to notes of the show in his reading matter. Giving of souvenirs is not, as a rule, good practice. It savors too much of hiring people to come to your show, paying them with some comparatively worthless trinket that is more than likely thrown away. Spend the souvenir money in improving your program, is my advice. If you have a competitor and you start giving "souvenirs," he will follow suit immediately, and neither of you are the gainer, but both lose just that much.

One good, and perhaps the best, advertising scheme is to have a genuine feature film occasionally and advertise it to the limit. The people your advertising draws to see that film will have their attention effectively drawn to the house, and if they see a good show they will return to see other films. Another excellent scheme is to secure some good patriotic film and have a children's day on Saturday. Secure the school principal to lecture on the subject, if possible, and admit the youngsters at two or three cents on that occasion. Have a good comedy film, being careful that it is strictly "clean." The children will tell their parents all about it and the talk will advertise your house, of course. To do this properly, however, the school teachers should be interested. In fact, there are many forms of advertising possible to the man who uses his brains and **thinks.** You must be a schemer to make the best success in the show business. The man who goes into the moving picture business thinking it is play, that the money will just roll in without effort on his part, had better try something else. The show business, moving picture or otherwise, requires **hard work,** and lots of it. Of course, in its infancy, while moving pictures were a curiosity, almost anyone could make big money with almost any old show at all, and without much effort. But, take my word, those days are past and gone —and they aren't coming back, either. There is still money in the business, and good money, too, for the man of ability, energy and eternal push.

FILM SERVICE.

In the matter of service you must remember that a flowery advertisement, full of promises, does not necessarily imply the best service. It rather indicates that the advertiser has in his employ an excellent ad.-writer. There is just one really business-like, intelligent way of buying film service. By subscribing to the Moving Picture World and **keeping its copies all on file** you will be enabled to not only see at a glance just what each new film is—a synopsis of its action —but also see its exact date of release. Now decide just what limit you wish to place on the age of films sent you and then write to several exchanges, asking for quotations on that service. To illustrate: Suppose you decide you want no films older than fifteen days. You write, asking for quotations on the number of reels you want per week, changed so often, no subject to be more than fifteen days old. You are now in position to check up and get exactly what you pay for. If you think some subject is older than your contract calls for, all you have to do is glance at its date of release in the files of the paper. If you use two reels you can contract for one reel with ten or fifteen-day limit, and one twenty, thirty, forty or sixty-day limit. The point, is, you place yourself in position to absolutely demand and get what you pay for. You should demand a clause in the agreement that any subject over age shall be paid for at half price or be not paid for at all. This is the sensible, business-like way of purchasing film service. It absolutely eliminates all disputes. The terms "first run," "second run" and "third run," as now used, depend largely on the elasticity of the exchange manager's conscience. "Commercial run" means nothing at all—or, rather, it means anything the exchange thinks it can work off on you. Of course, exchanges will ridicule this, but it is cold, hard facts, nevertheless, as they well know. Keep all film release dates carefully on file, buy your service with age limit, and you can't be buncoed. In the matter of carbons, nearly one-half may be saved by purchasing in 1,000 lots.

CHANGES.

It is the fashion to change films every day, but to the writer's mind this is not always good practice. Of course, whether it is or not will depend to a considerable extent on circumstances. As a rule, however, taking cost into consideration, I do not believe it pays, especially if film must be shipped a considerable distance. It is seldom that any considerable portion of the community will see the picture in one day. If it be a good picture and it is retained two or three days it will advertise itself and thus bring added patronage. I am firmly convinced that, as a general proposition, it does not pay to change films more than three times a week. Some managers are so extreme in the matter of changes that they demand a daily change of as much as three reels. In the writer's humble opinion this is sheer nonsense. It works a hardship on the exchange and whether it gains the house any additional business is very questionable—very questionable, indeed. "But," replies the change-mad manager, "I have steady patrons who come every day and must have different pictures or I lose them." Granted! But have you enough of them to make up for the added cost of such service? I very much doubt it. I am firmly convinced that the manager who gives three changes a week will have more clear profit on the week's business than the one who pays for daily change. Also many managers demand a daily change of song slides. They also demand all new stuff. Of course, they don't get it, since there is not enough produced to meet such a demand. In the writer's judgment the people better enjoy a song they know, provided it be not something that has been "sung to death" quite recently. Many of the new songs are very poor—some of them very poor indeed. The audience naturally does not care for them and would, I am sure, enjoy an older, better song far more. A good song, with good slides, may be run two or three days with better results than daily change and take what you get.

TICKETS.

Tickets may be had very cheap of any supply house or film exchange. The little cardboard is in the hands of the patron but a moment and the cheap ticket is as good as the more costly ones. All tickets should be numbered and you should have a supply of several colors, changing color every day. Children, particularly boys, will slip past the door-keeper occasionally and come back next evening with the ticket they thus saved. Only tickets of the day's color should be honored. Many houses have the name of the theater printed on the ticket. Unless you order in large enough quantities to have this done without extra expense, little is gained by it. All tickets should be numbered consecutively so that by taking the number of the first and the last ticket sold the day's receipts are quickly computed. Tickets with stay-over coupons may be had. They are a double ticket and the patron coming in late retains the coupon, which entitles him to remain for the next show. The ushers take up these coupons during intermission. They come in rolls the same as ordinary tickets, but the roll is double the thickness. These tickets, provided your exchange does not handle them, may be had of the Selig Polyscope Company, Chicago. They are numbered consecutively. The ticket taker takes up the whole ticket, coupon and all, until the show starts, after which patron retains the coupon. Occasionally count the day's tickets and see if they tally with sales. Dishonest ticket takers may hold out tickets and sell them. Never allow your ticket taker the privilege of passing people in at his discretion. If you want anyone to have free admittance, give him a written pass. If allowed this privilege, ticket takers will very frequently abuse it. Always provide a ticket box, of which no one but the manager should have the key. Oblige ticket taker to deposit all tickets therein as soon as received. The manager himself should personally burn all tickets in the box after the show each day. Never delegate this job to anyone else. Maybe they will burn them all and maybe their friends will be generously supplied with tickets. You can't always sometimes tell.

VAUDEVILLE.

Never tolerate any "monkey business" by actors while on the stage. Make them attend strictly to business. Allow no smiling at or talking to someone in the wings under any circumstances. Never allow an actor to "roast" the audience. Also do not allow an audience, or the hoodlum element therein, to roast an actor or guy him or her. Provide actors with reasonable dressing-room conveniences and treat them right. On the other hand, impress on their minds the fact that they are there to work and that nothing less than the best they have will go. Vaudeville acts may be had from $25.00 per week for a single or $50.00 for a double, to as high as you want to go. Every large city has booking agencies from which you may be supplied. Consult the columns of the various theatrical papers for their advertisements, or write your exchange. Acts vary in length from, usually, ten to twenty minutes. As a rule, the house is obliged to stand traveling expenses one way. By traveling expenses I mean railway fare only. All actors should be required to be at the theater one-half hour before their turn is due to go on. If you have vaudeville you absolutely must have a piano player who can read at sight, not only printed music but hand-written stuff as well. For vaudeville you must have a spotlight and should have color effects.

TRAVELOGUES AND OTHER ILLUSTRATED LECTURES.

The illustrated lecture, or travelogue, is a nice thing provided it be properly put on. The slides must be clean and well handled. Not to exceed 18 amperes of current should be used on lecture slides, since they are likely to remain in the light several minutes. To cut down the current an extra rheostat may be temporarily connected in series. A dissolver is almost indispensable to the illustrated lecture, though the carrier described at Fig. 34 may be used with fairly good results. The lecturer **absolutely must speak slowly and distinctly.** Reading the lecture impairs the effect very much. Naturally four-fifths of the effect as a whole depends on the lecturer himself, or herself. The sing-song talker, or the talker who speaks so fast or so low that the words cannot be followed except by an effort, spoils it all. Properly done, the illustrated lecture is excellent. Wrongly done, it is worse than nothing at all.

HINTS TO OPERATORS.

Keep your eyes on the screen.

Never imagine that you know it all.

Do not read while turning the crank.

Keep your oily rags in a spring top can.

Do not experiment after the show has started.

Keep your film in a metal box when not in use.

Allow no one in the booth during a performance.

Clean house in the "coop" once a week at least.

There is no use for a match in any operating room.

You are not a clean workman if you have a dirty machine.

Every moving picture booth is a little problem in acoustics.

Whatever the operator says can be heard all over the house.

Some of his words were better left unsaid, and songs unsung.

The real operator knows a week ahead when the breakdown is coming.

He examines his machine every morning to see where it is wearing.

When the crank stops the lamp house starts (to get out of the way).

Managers' and Operators' Trouble Department.

Every week the Moving Picture World devotes three or more pages to the solution of problems that confront the operator and theater manager. The following are selected at random to give an idea of the usefulness and popularity of this department in which every reader of the World is invited to participate.

Setting Carbons, Sprocket Holes Show.—Charlestown, W. Va., writes saying that the sprocket holes show on right-hand side of picture at times. Says machine is a new one and service is 20 to 30-day stuff. Asks why blue spot shows in center of picture and if setting carbons different would reduce the noise. Is working on A. C. 110-volt 60-cycle current, using a transformer.

With a narrow, steel straightedge see if your top and intermittent sprockets and gate idlers are all in line with the aperture. That is to say, see that none of them set to one side in relation to the aperture. Also see if the tension springs bear squarely on the tracks. Possibly one spring sets to one side and occasionally pushes the film over a trifle. Sometimes the showing of sprocket holes is the fault of the camera that took the original picture or the printing machine that made the positive. But this only occurs semi-occasionally, whereas I understand your trouble happens quite frequently. To test the alignment make a steel straightedge half an inch or so wide. An old corset steel will do if it is perfectly straight on one edge. Test it on a square or machinist's rule. If your sprockets or idlers are out of line, line them up. If your tension springs don't bear squarely on the tracks make them do so. As regards the spot in your curtain, it may be due to any one of several things. First try moving your lamphouse backwards and forwards as far as it will go. If that don't take it out see to it that the tip of your lower carbon isn't burning up in front of the crater on the upper carbon; if it is then the spot is doubtless merely the shadow caused by the tip of the lower carbon which is set too far ahead. Move it back just a trifle. If this is not the cause then try two 7½-inch condensing lenses. In your sketch the carbons are set all right but the lamp sets straight up and down. If you are actually using it that way and get good light from it you can do more than I could.

Angle your lamp exactly the same as for D. C. Possibly you might reduce the noise by a different carbon set, but it would be at the expense of light. I would recommend you to get a copy of The Moving Picture World of August 7, 1909, in which is contained (page 187) illustrations of different carbon sets, both A. C. and D. C., price 10 cents.

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Size of Picture.—Billings, Mont., writes asking what size of picture would be advisable in a small house, with 50-foot throw; also whether large or small picture has any effect on the flickering.

Regarding the size of picture, I would have to know just what you mean by a small house. I may say, however, that a 10 by 12 picture is usually accepted as life size, from the fact that more figures appear life size than in any other size picture projected. It is very suitable for a small house. The size of the picture makes no difference as regards the amount of flickering. This is about the only advice I can give you without knowing the exact size of house, height of ceiling, etc.

* * *

Size of Picture, etc.—California (name suppressed) writes: "What size picture should I throw at 84 feet and what focal length condenser and projection lens should I have? How much current should I use (A. C.) to get good results at this distance? How may I determine the exact current flow?

I cannot answer your query except in this way: The size picture you should project does not depend at all on the length of throw. It depends on the size of your house, etc. Decide what size picture you want and then I'll tell you the size lenses necessary to give it, but remember that, while the throw has practically nothing at all to do with the picture's brilliancy, its size has and the larger you make your picture the more current you must use to secure a given curtain brilliancy. You have a certain amount of light, you understand, and when you increase the size of your picture you spread that light around over more surface. Do you see the point? A picture 12 x 14 has more than twice the number of square feet surface to illustrate than has one 8 x 10. You must therefore have twice the light to secure the same brilliancy to each square foot—**do you see the point?** You cannot determine the exact number of amperes used without a reliable ammeter. You know approximately the number your rheostat or transformer is supposed to give, however. The manufacturer carefully computes the amount of resistance necessary to pass a given current on a given voltage and builts his rheostat or transformer accordingly. You may compute the horse-power of your arc by multiplying the voltage by the number of amperes flowing, which gives watts. Seven hundred and forty-six watts equals one horse-power.

Shaft Level—Lenses.—New York City, N. Y., asks: "(1) I get a 12 x 14-foot picture at 55 feet. What size lens have I and what focal length condensing lenses should I have? (2) How can I measure to see if intermittent shaft of Powers No. 5 is level? (3) Can a flag be projected on the screen as if it were waving by means of some mechanical device or must one have a film?"

(1) Multiply throw in feet by exact width of aperture and divide the result by width of picture in feet. Result will be equivalent focus of lens. In your case it is about a four-inch lens and you should have two 7½-inch condensing lenses. (2) The cam shaft of Powers No. 5 is always level, provided the bushings are not worn unevenly. Measure from center of cam shaft at one end to center of star (intermittent) shaft. Then measure the same at other end and if the shafts are the same distance apart at both ends the intermittent (star) shaft is level. (4) No. A film is necessary.

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Ghost Trouble.—Kansas (name suppressed by request), asks the cause of the dark spot in the center of his curtain. Says he has tried moving lamp backward and forward as well as the whole lamphouse

I think, neighbor, you probably have your lower carbon just a little too far in advance of the upper one. This causes the lower tip to burn so that it interferes with the light, causing a shadow on the curtain.

* * *

Curtain Coating.—Minneapolis, Minn., asks what I consider the best water-color coating for a plaster curtain.

The best thing I know of is English whiting mixed with water and fish glue, to which has been added a little ultramarine blue, enough so that it looks a trifle blue in the pail, but be careful not to get too much. There should be enough glue to prevent the coating from rubbing off easily. English whiting may be had of any wholesale drug store at about 10 cents per pound, and five pounds is more than ample for any curtain.

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Inside Decoration.—Mt. Clemens, Mich., asks for decorative scheme for his theater. Sends sketch and says it seats 430 people. Has 18 inch stucco moulding at top and walls are flat.

I think, Mt. Clemens, unless you were to employ a high class decorator, you would be able to procure a much more satisfactory effect by the use of papers than by use of paints. It is quite possible to work out some really beautiful effects in paper, and effects which by no manner of means look cheap. Whether you use paint or paper, however, use burlap for the dado, either of shade to correspond to walls or plain burlap to be painted after it is put on. No matter whether paint or paper is used, block out both ceiling and walls in panels. If paint is used you may secure, from any decorator, stencils suitable to properly decorate the borders of the panels. If paper is used there are many panel decorations possible. As to the color scheme, there are many, but a combination of dark red dado, russet or dove colored walls, with panels of a lighter shade and ceiling some light, complimentary color will look well as also will dark green dado, lighter green walls with very light yellow panels (greenish yellow) and ceiling same as panels will look well. The stucco moulding may be the same as the walls or panels and picked out in bronze paint.

* * *

Measuring Lenses.—Franklin, La., asks which end of a projection lens should be next the light and which next the wall when measuring focal length? Also asks if measurement should be from point midway of the lens to the wall.

In measuring projection lenses, stereo or moving picture, I usually hold the lens as it would be in the machine, were the wall the lamphouse and the window the curtain. In other words, with the front end of lens next the window or source of light, and with back end towards the wall. Projection lenses are made up of two sets of lenses mounted in a tube at a distance from each other varying with the focal length of the lens. The longer the focal length the greater will be the distance between the two lenses. The first thing I do when I measure a lens for equivalent focus is to mark on the outer surface of the lens tube, or jacket, the point exactly half way between the two lenses. When I have focused the image of the window, or lamp filament (if I use a lamp as source of light), I measure from this mark for "equivalent focus" or from the back side of lens nearest wall to the wall for "back" focus. Dealers and exchanges usually use the "back" focus, while lens manufacturers generally use the "equivalent" focus. In ordering lenses of a given focal length always state whether you refer to "back" or "equivalent" focus. The difference between the back and equivalent focus of any lens will be the back focus plus half the distance between the front and back lenses.

* * *

Current Strength.—Nashville, Tenn, asks: "(1) What is best capacity for arc on direct current for long throw on moving picture work? (2) Assuming that from a light standpoint 60 amperes at 50 volts is satisfactory, would there be danger of the film catching fire due to the intense heat of such an arc, remembering that D. C. would develop greater heat than A. C.? (3) Is it possible to say how many seconds it would require to set film on fire from heat of a 60-ampere, 50-volt arc?"

(1) It takes no more current to project a given size picture

100 feet than it does fifty. As I have previously explained, it is the **size of the picture** that determines the necessary light strength to produce a given brilliancy and **not** the distance the picture is projected. (2) There is no use "assuming" that a 60-ampere D. C. arc would be satisfactory, for it would not. I have known of sixty amperes being used, but I have seen no appreciable advantage in increased current strength after passing the fifty ampere mark. You cannot handle the arc to advantage with current exceeding fifty amperes—or at least that has been my experience. There would be no danger so long as the film is kept moving. I would not care to risk less than forty feet per minute on that kind of light, however. (3) One-half second would probably be sufficient. It would depend to some extent on how small a spot you had. The smaller the greater amount of heat, of course.

* * *

Carbons Needle.—Sapulpa, Okla., writes setting forth his troubles as follows: "My carbons burn back from the point, sometimes as much as an inch or two. There are two other houses here and we all use current from the same generator. One of these houses and myself are using compensarcs and the other fellow has a rheostat for resistance. They both seem to be using more current than I do yet their carbons burn fine. The same trouble has existed in this house for a long time—long before I became its operator. Can you suggest a remedy or tell me what is wrong?"

I have not quoted all this letter, but sufficient to show what Sapulpa is up against. By "burning his carbons back," Sapulpa undoubtedly means what is called "needling." That is to say, his carbons burn to a long, slim point. This is caused by undue heating in the carbon, the effect of which is to burn out the binder and allow the carbon to drop away (disintegrate) without being consumed (volatilized) in the arc. Sapulpa will find a heap of fine, black carbon in the bottom of his lamphouse just under the carbons. Needling may indicate several things, or any one of several, rather. You may be using carbons which are too soft. You may be using carbons of poor quality. It may be that your transformer (Compensarc) is giving an excess of current, some error having been made in its construction (windings). I would suggest that you have the electric light company test your current flow with an ammeter, if possible. But first proceed as follows: With a file clean out the inside of your carbon arms thoroughly so that the carbon will make good electrical contact with the arms. Get a few of the other fellow's carbons and put them in your lamp for a trial. Let the other fellow try some of your carbons. Thus you will determine whether or no the fault is in the carbons themselves. If not, then it is pretty near a cinch that you are getting too much current. I assume that you are using 5/8 cored carbons, of course. Because the other fellow seems to be drawing more current than you it does not follow that it is the fact. Remember this: needling is caused by poor binder in the carbon or else by excessive heat in the carbons. The first is an easily discoverable fault, since one has but to try other carbons. The latter can be found by searching for the cause of the heating.

* * *

Film Buckles or Bad Lens.—Troy, Ohio, says: "We notice, especially when any printing appears, that the outside of picture appears plain, whereas its center is out of focus. In printed matter the central letters appear confused."

Taking into consideration the machine you have, I would almost swear your trouble lies in the projection lens. In other words, you have a poor lens. If there is another house in your town try to borrow their lens long enough to test it on your machine and if the trouble disappears with its use the case is proven. Otherwise have your film exchange send you a lens to try out. It is also possible the trouble lies in your aperture plate or tension springs. If tracks are worn on aperture plate or if one or both tension springs set too far in or out (do not bear squarely on tracks) it will probably cause the film to cup out or in a trifle as it passes the aperture and this would produce exactly the condition you describe. Remedy is a new aperture plate or set springs right, as the case may be. I, for certain reasons, believe, however, the fault lies in your lens. Cheap projection lenses do not have a flat field.

* * *

Dirty Sprockets.—St. Louis, Mo., writes: "Does or does not the dirt which gradually collects on the face, or rim, of the sprockets do any harm. Can you tell me some quick, easy method of removing same. I clean off the face of all my sprockets every day before the first show. The operator of a nearby house ridicules me for it and calls me a 'grandmother.' What do you think about it?"

I think the operator of the nearby house simply makes a display of his ignorance. Certainly the dirt does harm. It most decidedly makes the film jump if it is on the intermittent sprocket and helps along any inclination the film may have to climb the teeth of the other sprockets if it is on them. The best, easiest and quickest method of cleaning the sprockets is by brushing them with a stiff bristled toothbrush. Every operating room should have a toothbrush for this purpose. In this connection let me again say that the whole machine should be kept scrupulously clean. A dirty, oil-covered machine infers a sloppy workman. A sloppy workman in turn infers almost anything else than a first class show.

Setting Shutters.—New York City, N. Y., writes asking that I give illustrated instructions for setting the shutter of Power's No. 5, Power's No. 6, Edison one and Edison two-pin machines and the Motiograph.

I hardly think this is feasible or even desirable. There are so many different models of the various machines, mostly with a somewhat different shutter for each model, that that one thing would render such instructions of slight value. I would much rather try to get the operators to understand the underlying principle of the shutter and they would then be able to set any shutter with very little trouble. It must be understood that the office of the shutter is to cut off the light while the intermittent sprocket is in motion. That is what the shutter is for and it is for nothing else under the sun. The wide blade is always the one that does the business, the narrow blade (or blades, where shutter is in two pieces, as in the Motiograph) being merely to help to eliminate the flicker. The narrow blade is disregarded utterly in setting any shutter. Now, in order that the shutter cut as small a percentage of the light as is practical without developing a "travel ghost" (white streaks shooting up or down from white objects in the picture or from letters in a title), the shutter is made narrow enough so that it does not quite cover the aperture during all the time the film is in motion. It has been found that although the film may start to move while the aperture is still open about one-fourth (I speak of all shutters except the double wing variety like the Motiograph now) there is no evil effect. This is called making the shutter "late." But, on the other hand, however, it is usually necessary that the shutter cover the entire aperture until the film has stopped moving. In other words, while it is possible to allow some leeway at the beginning of the movement, none is permissible at the last end. One thing I must mention, viz.: where the shutter does not travel with the frameup carriage the frameup should always be set midway of its travel before setting the shutter. With the Motiograph, if you have the two wings just barely come together in exactly the center of the aperture just as the intermittent sprocket starts to move you will be all right. As to the outside shutters (shutters in front of the lens, such as the Power's No. 6), they are easier than easy. Just loosen the screws which hold it until it will slip under slight pressure. Now put in a film and run a couple of feet, stop and slip the shutter a trifle, run some more, slip the shutter a little more and so on until you get it exactly right. You can tell when it is just right by framing up a little past the lower dividing line and a little down past the upper dividing line. If the dark dividing lines between the pictures look all right and not streaked and your picture looks O. K., too, you have it just right.

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