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A Television Projector

Lens Disc Affords 10 x 12" Screen Picture

By Ivan Bloch, E.E.

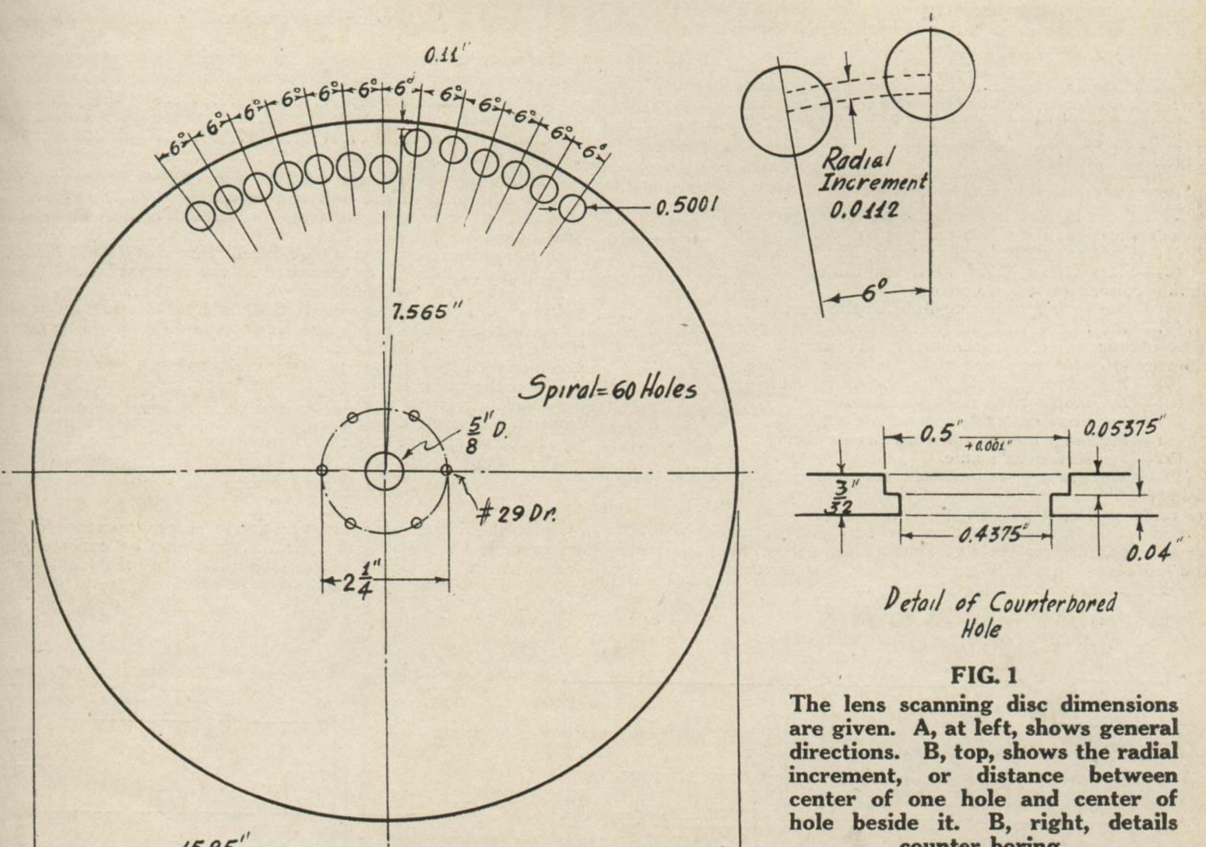

FIG. 1

The lens scanning disc dimensions are given. A, at left, shows general directions. B, top, shows the radial increment, or distance between center of one hole and center of hole beside it. B, right, details counter boring.

[The projector and accessories for a fine 10 x 12 inch television image on a screen for home use, as described in the following article, have been carefully tested in practice by the author and designer, Iva nBloch. He is a radio engineer specializing in television optics and has given demonstrations of images up to 3 x 3.5 feet with his tested apparatus, of the same nature as that described herewith. With lamps now available the 10 x 12 inch picture is preferable for home use. The reader is reminded that 10 x 12 inches constitutes a picture larger than the page on which these lines are printed which page is 9 x 12 inches.—EDITOR.]

CONTRARY to opinion, the construction of a television receiver producing a clear image 10 x 12 inches or larger is not beyond the skill of the experimenter, nor is it beyond his means.

The following details are not merely on paper, but have been incorporated in a machine which has been successfully demonstrated with a screen 3.5 x 3 feet, the image being brilliant and the detail excellent, when viewed at the correct distance.

It must be remembered by the televisionist that the heart of his

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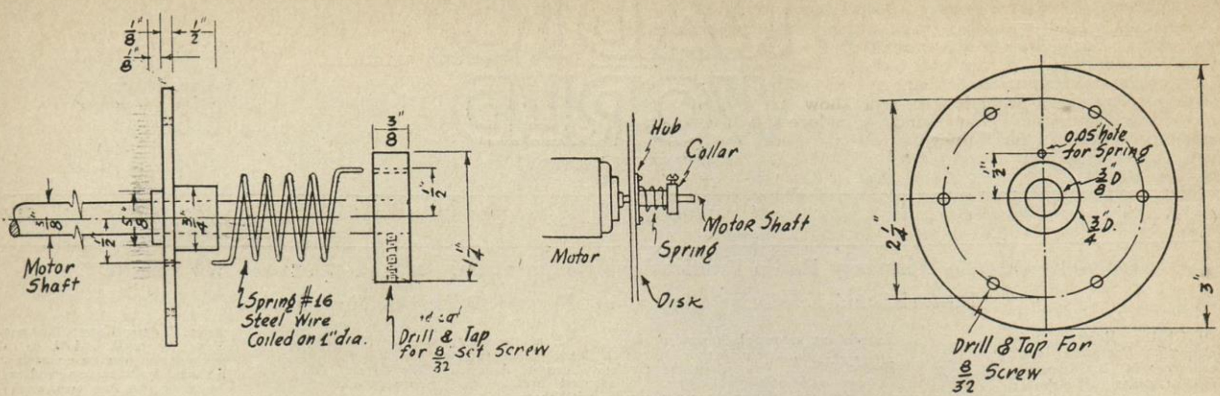

FIG. 2
Synchronizing spring hub.

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apparatus in reality is his receiver of television signals and that if he is the possessor of a good set, in conjunction with the projector which will be described, he will receive excellent pictures, well worth looking at, and clearly visible by a roomful of persons, without eye strain.

Before proceeding, it is well to set down those factors which will influence the design and construction. The first two are obvious: least expense and smallest space. The whole projector, screen and receiver should be housed in a moderately sized cabinet, with the screen adjustable if desired. Hence, an image 10 x 12 inches will be the limit under these restrictions. For large images it is necessary to have a portable screen. The third factor is the neon crater lamp. Recent lamps have shown exceptionally good light intensities with a "0.020" anode screen aperture; thus, such a lamp will be used. Fourth factor: the driving motor should be self synchronizing. Either it should be synchronous for those locations where the receiver is located on the same power network as the transmitter, or it should be of variable speed with a synchronizing attachment such as a phonic wheel.

Parts Required

With these factors in mind, the following parts will be needed, the specifications for which will come under subsequent headings.

(1)—One lens scanning disc with sixty holes for lenses.

(2)—Sixty lenses, 1.75" focal length, ½" in diameter, either double convex or plano convex.

(3)—One spring mounting-hub for the disc.

(4)—One motor with supporting bracket (if synchronous), or with phonic wheel attachment if of variable speed. Also a vibration-absorbing rubber mat. Suitable starting condenser.

(5)—One framing device for horizontal framing.

(6)—One motor rotary snap switch.

(7)—One neon crater lamp and socket.

(8)—One lamp holder and focusing device.

(9)—One screen in frame.

(10)—One cabinet with screen support, with space for television receiver and, if desired, broadcast receiver, short-wave converter and loudspeaker.

It is strongly advisable that the lens disc be made with extreme care. Unless the experimenter is an excellent mechanic and has access to a good machine shop, it is worth while to have the disc made or purchase it ready made.

Those who have already perused articles about certain models of projector type receivers may wonder why the disc as shown in the illustrations herewith is larger than may seem to have been the practice. Without going into elaborate details as to the reasons for the perhaps peculiar dimensions, let it be said that the commercial designers have been guided more by the ease with which the discs could be manufactured than by sound optical facts. The question of correct screen-element overlap has been evaded, its relationship to spiral pitch obscured. The disc dimensioned below and in the illustration takes these and other effects into consideration.

Specifications for Disc

The material for the disc is duraluminum, 3/32 inch thick and the blank should be flat. The main dimensions are as follows:

Overall diameter	15.85 inch.
Radius at furthest hole	7.565 inch.
Radial increments	0.0112 inch.
Hub hole	⅝ inch.

Mounting screw-holes on 2¼" diameter circle, spaced 60°.

It is best to drill the hub and mounting holes first so as to have all other dimensions from the actual center of rotation. The holes for the lenses are first drilled with a 0.4375" drill, then counterbored with a square-faced reamer of 0.5001" diameter to a depth of 0.05375" as indicated in the illustrations.

After the disc is completely drilled and the surfaces gently polished with fine emery cloth, it should be thoroughly cleaned of grease and oil. Then both sides of the disk should be coated with a dull optical black paint to prevent reflection. This may be accomplished by dipping, painting or spraying.

When the paint is completely dry, each hole must be cleaned very carefully with a sharply pointed tool which can be made from an old screw driver filed down. Extreme care is necessary so as not to remove any metal from the shoulder and the sides of the holes.

The Lenses

From the image size and the anode screen aperture of the crater lamp the lenses are specified. As may be expected, the design of the scanning disc was also affected by the focal length

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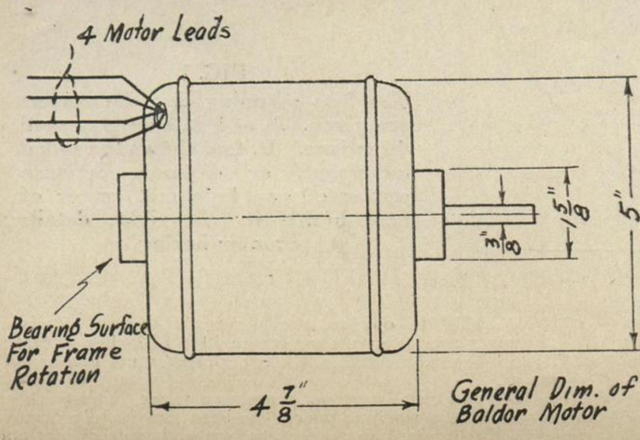

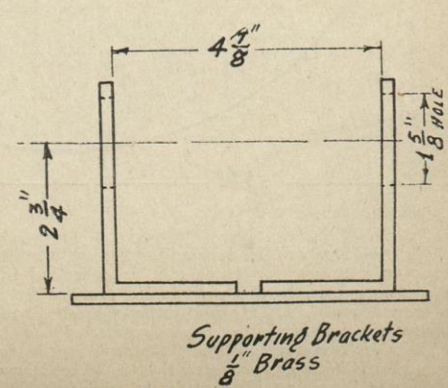

FIG. 3 **FIG. 4**

General dimensions of the Baldor synchronous motor, at left, and of the motor mounting brackets, at right.

(*Continued from preceding page*)

of the lenses. This is another point which others have passed over lightly. Such distortion is occasioned by angular lens distortion. Aberration is detrimental both to sharpness and detail of the image and lessens its brilliancy at the edges. The lenses selected, of 1.75 inch focal length, will allow the image to be projected in a minimum distance and yet reduce the above-mentioned distortion to such values as will not affect the results. The diameter of ½ inch allows plenty of light to go through the lens and allows for proper machining. These lenses can be obtained for about fifteen cents a piece and although this may seem a high price, if obtained from a reliable optical concern will reduce such possibilities as poor alignment between optical and geometrical centers, aberration, etc.

Several methods are available to the experimenter for the fastening of the lenses to the disc. The easiest, cheapest and most satisfactory method is cementing. However, it is best to use a cement such as the Capitol, which dries to brittle hardness. Some cements do not dry completely.

To cement the lenses, each hole is cleaned once more with wood alcohol. Proceeding one hole at a time, carefully coat the shoulder and hole with a bit of cement, then firmly press lens into place. Quite a bit of the cement will be squeezed over the lens surface, but this is not detrimental to the purpose, as the excess will be cleaned off. Each hole is thus treated until the whole disc is filled.

Removal of Excess Cement

Using the same tool with which the paint was removed from the holes, the excess cement is very carefully scraped off when thoroughly dry. If a small amount still overlaps by about 1/50 of an inch, the lens can be sure to remain in place. One must remember that for a disc of 15 inches in diameter revolving at 1,200 revolutions per minute, the peripheral speed is more than 50 miles per hour, at which rate a flying lens can be quite damaging to life and property.

With a smooth and clean cloth, the disc and lenses can be thoroughly wiped, thus completing the construction of the scanning element.

The mounting hub obviously serves to fasten or hold the scanning disc to the motor shaft. However, it is necessary to add to its function. The disc is fairly heavy and to bring it to synchronous speed by means of the motor used would involve a large time element.

A simple expedient is resorted to, in which the potential energy of the disc is stored into a coiled helical spring and then released suddenly into kinetic energy.

Picture the disc attached to the hub, the hub capable of freely moving about the motor shaft. We then fasten one end of a helical spring to the hub and the other to the motor shaft by means of a collar. When the motor shaft begins to rotate, the spring will wind by virtue of the inertia of the disc. This then constitutes a direct connection between disc and motor shaft, and as soon as part of the disc's inertia is overcome, the spring will then release its stored energy, giving the disc a considerable spin, thus aiding it to reach synchronous speed. It is naturally necessary to have a spring so wound that upon starting the motor, it will wind. For this projector, a spring wound clockwise, looking from the front end, will accomplish its purpose. This is shown in an illustration. With the Baldor motor, the hub, spring and associated collars are furnished. Otherwise, it will be necessary to construct this hub, not a difficult job on a lathe. Dimensions are given, but they need not be adhered to rigorously.

The Motor

The choice of two motor systems confronts the constructor. If he is located on the same alternating current power system as the transmitter, his problem is simplified a great deal. However, if he is not on the same synchronized network, it will be necessary to make certain provisions for self-synchronization.

If located on the synchronized network, a synchronous motor

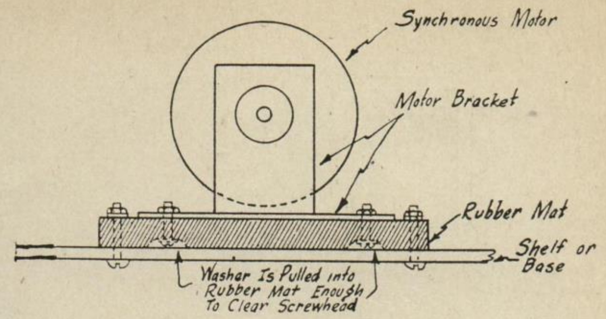

FIG. 5
Vibration-absorbing method of mounting motor and supporting bracket.

to run at 1,200 RPM and of 1/20 HP is needed. The Baldor synchronous motor type C, frame M3CN, is recommended. This motor requires an auxiliary condenser of 3 mfd. capacity, 400 d-c volt rating, to be used as specified by the manufacturers. As previously mentioned, this motor is equipped with a suitable spring hub and, furthermore, is equipped with bearing surfaces for frame rotation. This latter point needs some elaboration.

Two situations may exist at a television receiver. The disc may be running synchronously, but its relative position may not be the same as at the transmitter. The image may therefore be out of frame horizontally as well as vertically. The vertical framing is accomplished by starting and stopping the motor rotation by means of the starting snap switch. The horizontal framing requires that the whole image be shifted horizontally until it is in frame.

Frame Rotated About Own Axis

If it were possible to change the stator-rotor flux relationship in the ordinary motor, this would be simple. However, the same effect is accomplished by rotating the motor frame about its own axis. Thus, in order to do so, the frame must be supported at two points along its own axis and be allowed enough freedom of rotation so that a gearing or lever arrangement can be used to move the frame a small angular distance. This distance obviously need not be more than six degrees, as the picture frame limits are indicated by two radial lines separated by six degrees.

The Baldor motor when supported by a suitable bracket can be easily rotated. These supporting brackets can be made from brass and will have the general dimensions indicated in an illustration. In case some other motor is used, the frame legs must be removed and a supporting rig built. This naturally complicates matters, but the ingenuity of the constructor need not be taxed.

The other case under this heading, bearing on locations not on synchronized networks, obliges the use of a variable speed motor. The Baldor motor, type B, frame M2c, is recommended, although any good motor with a speed range of 1,750 RPM and 1/15 HP will do. The Baldor motor requires a 2 mfd. condenser at 400 volts d-c rating and also a starting rheostat as specified by the manufacturers. In order to synchronize, a phonic wheel attachment is used. The construction of such a phonic wheel is tedious, hence it is better to purchase it ready made. Kresge stores carry the phonic wheel and magnet assembly, also the necessary amplifier.

The purpose of the wheel is to make use of the 1,200 cycles picture frequency pulse, amplified to sufficiency and applied so that it will regulate the speed of the motor. The procedure is to run the motor to what seems to be its synchronous speed, which can be noticed by means of the image position, then close the synchronizer circuit, which will keep the image in frame.

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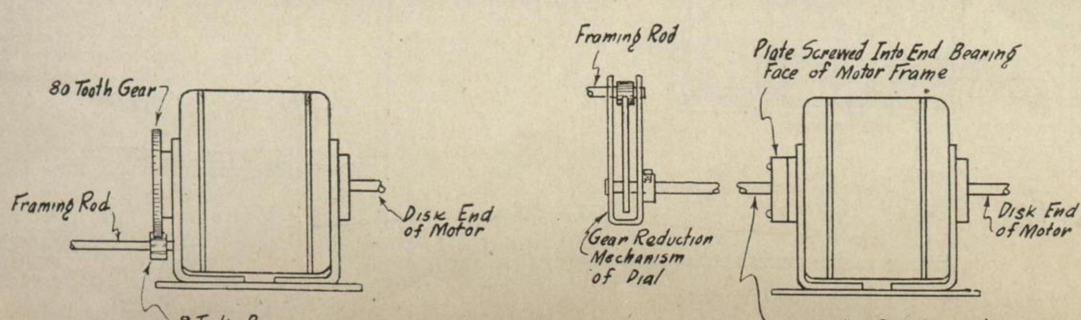

FIG. 6
(A), left, (B), two at right, show horizontal framing methods.

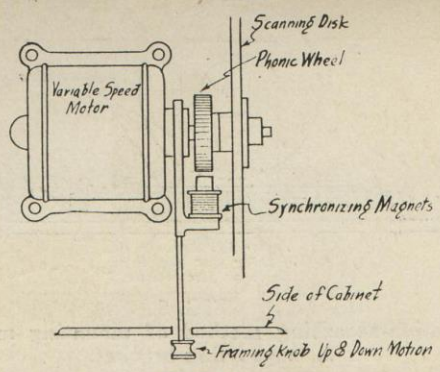

FIG. 7
General assembly of variable speed motor, synchronizing magnets and phonic wheel.

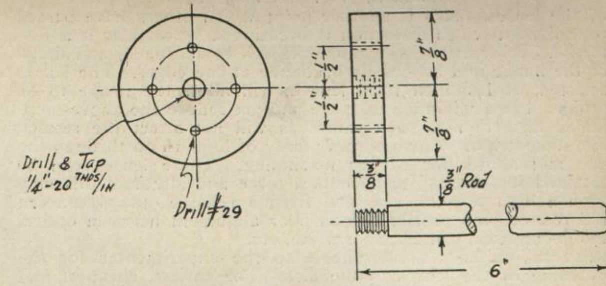

FIG. 8
The lamp support.

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An illustration indicates the position of the magnets, mounting, wheel, etc. The magnet mounting is so made that it is free to rotate about the motor frame collar. A small booklet entitled "The Romance of Television" and obtainable at the Kresge stores gives complete details of this synchronizing method.

Mounted on Rubber Sheeting

So as to minimize vibrational hum and noises, the motor and its supporting bracket should be mounted on a sheet of rubber ½ inch thick. Such sheets may be made from "kneeling pads" obtainable in chain stores. The method of fastening is shown.

In horizontal framing two cases are to be considered.

Where the motor frame is rotated, the problem resolves itself down to a simple gearing arrangement such as shown, or, if preferable, using a geared reduction dial mechanism. One must remember that since the picture frame swing is six degrees, only slight motions of the motor frame are necessary.

Hence, whatever motion is applied by turning the knob on the framing rod must be reduced before it reaches the motor frame. Generally, the total motor frame motion is not restricted to six degrees. However, as the leads from the motor would interfere with completely free motion, it is well to make some provisions to keep the rotation down to ninety or so degrees.

This may be done by screwing small stops on the motor frame. Another factor to take care of is that when the motor first starts there is a tendency for the frame to rotate, and if the brackets supporting it are very loose the rotation may be severe unless stops are placed. Hence it is advisable to put these stops in the correct position to prevent, first, the motor leads from being caught in the bracket, secondly, the frame from rotating when the motor is started.

Case of Variable Speed Motor

In the case of the variable speed motor, the synchronizing magnet assembly is rotated about the motor frame collar. This will exert a pull on the phonic wheel, the scanning disc and the motor shaft and twist them into frame position. By screwing a small rod into this magnet assembly, and allowing this rod to protrude through the side of the cabinet, the framing is accomplished with ease. This method can only be used with a variable speed motor.

To start and stop the motor in either case, a small rotary snap switch is used. With the variable speed motor, a starting rheostat is usually necessary and can be mounted on the front panel of the cabinet.

At the present time, neon crater lamps are not made in mass quantities and thus the distance from the socket base and the crater center will vary from lamp to lamp. It is necessary to provide adjustable means in every direction for proper focusing and crater alignment. The simplest and cheapest method makes use of the so-called physics clamp such as used in chemistry and physics laboratories. To support this clamp a small rod is used. Naturally, variations of this method can be suggested. As long as the lamp can be adjusted in any direction, any method is good. The one pictured is the simplest.

The Screen

The material for the screen should be chosen for the following characteristics: it should be translucent enough to let enough light through it, its surface should transmit this light in such a way that the observed image may be seen with equal intensity at angles up to thirty degrees from the normal. Ground glass

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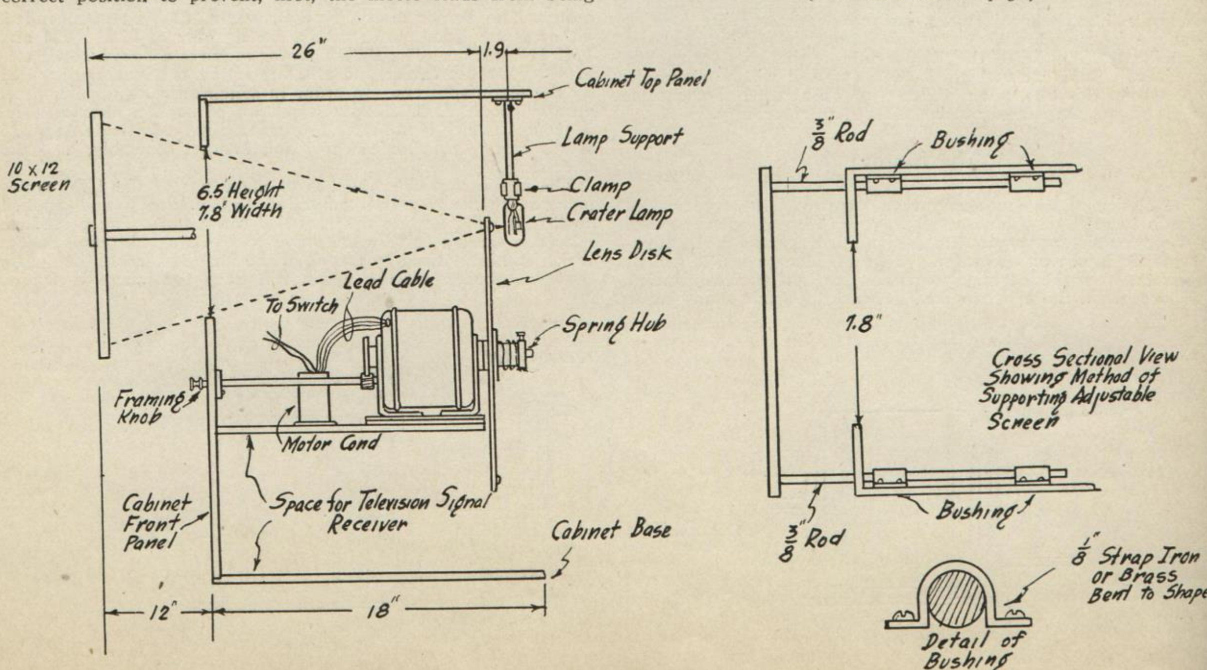

FIG. 9
General dimensions for cabinet.

PROJECTED VISION DEMONSTRATED IN POLYTECHNIC INSTITUTE

Brooklyn Times Photo

The 3x3.5 foot screen used by Ivan Bloch is at left, while at right are the receiving, scanning and projection apparatus. At left is E. J. Squire, of Polytechnic Institute, Brooklyn, N. Y., to whom Mr. Bloch is showing the apparatus. A lens disc like the one Mr. Bloch describes in the accompanying article was used.

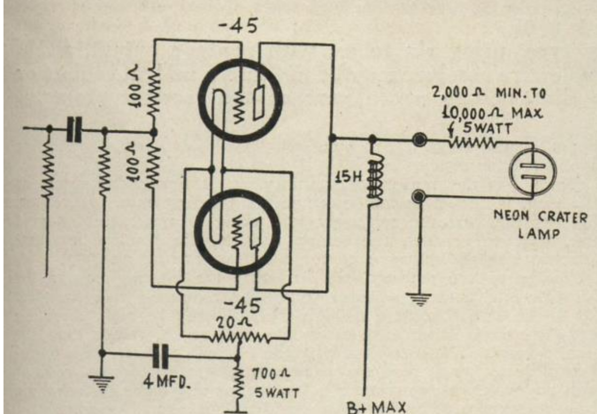

FIG. 10
One method of connecting a neon lamp to receiver output.

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has been used by nearly all experimenters and for its low cost, is recommended. However, for best results, the Translux screen material especially designed for television has not been excelled and if its cost is high, the features for which it is recommended overbalance this disadvantage. It is translucent, its angle of light distribution is correct, it cannot break, being of cloth-like material, and will not crack. It is much to be preferred over ground glass, or translucent sheet rubber which dries and cracks rapidly. Furthermore the material has been designed by projection engineers especially for television use, so that one may expect maximum efficiency from it.

A small frame is needed for the screen but its construction should require no description. For flexible material one must provide for stretching.

The Cabinet

A few suggestions can be made about the cabinet, the design for which will vary with the individual. The projector may be mounted above the television signal receiver as shown. It also may be mounted quite separately or with a broadcast receiver, short-wave converter and loudspeaker. The later combination is especially attractive, but also is most elaborate. In the figure shown, the projector is mounted on a shelf placed above the television signal receiver. The whole cabinet is not much larger than an ordinary radio cabinet and with an adjustable screen can be made inconspicuous. The constructor's taste and ingenuity will govern his design. The illustration offers a few suggestions. The motor may be seen mounted on brackets and rubber mat. The framing rod extends to the front panel. The motor condenser is screwed into the shelf in back of the motor. The lamp socket is screwed into the cabinet top. The method of mounting the screen is a simple one. This allows one to push or pull the screen to desired image size; naturally the lamp is to be adjusted for each screen position.

This design allows considerable variation in the constructor's methods. This will allow him to participate in the work, not only in the constructional sense, but in the design of his machine. There are certain parts, such as the disc, somewhat involved and therefore cannot well be made at home. But such parts as the lamp support or framing devices can be made in numerous ways.

The operation of the projector is extremely simple. The lamp is first focused and aligned to the screen—this is a simple matter. The television signal is tuned in by sound. The motor switch is then turned on as well as the neon crater lamp switch. The image will then appear on the screen, usually out of frame. The first step is to frame vertically by means of the stop and start switch. This only requires opening the motor circuit a few times, rapidly until the image is in frame vertically. The horizontal framing is accomplished by slowly turning the framing knob. The image will then be in frame and may need retuning.

It might be well to mention a few words about the output circuit of the television signal receiver. The impedance of the neon crater tubes is very low and its value may range from —200 ohms to + 200 ohms. In order to allow some sort of an impedance match, it is necessary to place a resistance in series with the lamp, so that no matter what its resistance may be, the combination of its resistance and the series resistance will always be large enough to constitute a load on the output stage. The series resistance also serves to reduce the current flow through the lamp. Certain lamps will take 25 milliamperes as operating value, while others will take more. It is to be recommended that the output stage be as shown for best results.

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