The Sun

Television Data Sheets

Compiled by RALPH R. BATCHER.

OPERATING CHARACTERISTICS OF CATHODE RAY TUBES

At the present time the most expensive single item in a television receiver is the cathode ray tube. While the types and sizes generally available at this time have been primarily designed for oscillographic work, many of them can be arranged to function also in such receivers. The main considerations are as follows:

1. Ability of the tube to focus the spot to a size of the order of a sixty-fourth of an inch or less, when it is moving across the screen.

2. Ability to retain such a focus at any portion of the screen (except at the extreme edge, where the spot falls on the point of curvature of the glass).

3. Ability to modulate the intensity of the electron stream, more or less linearly with applied bias. The intensity brilliance of the spot should be controllable thereby from maximum brilliance to complete extinction.

4. Ability to secure this modulation or control of brilliance without affecting either the velocity of the ray, or upsetting the focusing adjustment.

5. Have a deflection system that will deflect the ray practically proportionally to the applied voltages on the deflection plates. Moreover the deflection, when an applied voltage of a certain polarity is connected across the deflection plates, should be equal and opposite to the deflection produced when the same voltage is reversed to the plates. This can be accomplished in general only when the connection leads to all of the deflection plates are brought out to separate terminals on the base or side wall of the tube.

Tubes for oscillographic purposes will generally perform fairly well even if one or all of the above five special features are absent. These problems are up to the tube designer, since little can be done to improve conditions by circuit changes if the tubes have any of these inherent difficulties. If, however, the basic design is good; if care has been exercised in the assembly of the elements in the tube to obtain symmetry, and if the exhaustion is carried out to proper degree, then any deficiencies are probably due to circuit troubles.

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CATHODE RAY TUBE CLASSIFICATION

Cathode ray tubes are classified in several ways, such as size, type of screen, deflection characteristics and focusing method.

By SIZE: This is the most obvious and general of all classifications. The most important dimension, of course, is the screen diameter. The amount of light available to illuminate the screen is dependent upon the anode voltage, and since large tubes have a greater screen area to cover, it follows that the larger the tube the greater the anode potential that must be used.

By SCREEN FLUORESCENT CHARACTERISTICS: The main requirement for television is to have a screen with a pleasing color (either sepia colored or a white spot is advised) and sufficient sensitivity.

By DEFLECTION ARRANGEMENT: Most tubes are equipped with electrostatic deflection plates, but a few types are arranged for external deflection coils only. It may be that the possible reduction in cost due to this elimination will more than offset the more difficult scanning oscillator setup, so that such tubes may become more popular for television.

By FOCUSING METHODS: There are three main divisions here, referring to important features in the design of the electron gun. In GAS-FOCUSED tubes the filament temperature must be carefully adjusted, to control the electron density in the ray. A small but definite amount of gas (helium, &c.) is passed into the tube after exhaustion. This gas functions to counteract the mutual repelling of the electrons and thus prevents dispersion. The bias voltage to a shield surrounding the cathode affects both the brilliance of the spot and the focus, so that this type of tube is not suitable for television, where the spot must remain focused at all brilliance levels.

In the ELECTRON-LENS focused tubes special focusing electrodes are interposed between the cathode and anode, upon each of which a critical potential is placed. Symmetrical radial electrostatic fields are thus produced, which redeflect any diverging electrons into the jet thus bringing about focusing.

In MAGNETICALLY-FOCUSED tubes (also a type of electron lens focused tubes) a reconcentration of the diverging electrons is produced by magnetic focusing coils placed around the tubes at definite points. This arrangement readily permits accurate focusing, but is not as convenient as the preceding type. Either of the last few types may be used in television.

two

Sheet 210.4.

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CATHODE RAY TUBE CLASSIFICATION

Progress in independent research and experimentation by private individuals has been hampered, for one thing, by the lack of cathode ray tubes that were particularly adapted for television needs, that is, having the characteristics listed in sheet 210.3. However, tubes have now been made available for this field by RCA-Radiotron in both 9″ and 5″ models. These types, known as the 1800 and 1801 types, respectively, are listed in the following table, with a few typical British tubes for comparison.

	BRITISH			U. S. A.	
Make.	Cossor	Baird	Ediswan	RCA-Rad.	RCA-Rad.
Type.	3272	15mw2	12 H	1800	1801
1. Screen diameter......	12-in.	15-in.	12-in.	9-inch	5-inch
2. Screen color..........	white	white	white	yellow (sepia)	yellow (sepia)
3. Total length..........	26-in.	33.5	26-in.	21-inch	15,75
4. Anode No 2 voltage (maximum)	5000	7000	6000	7000	3000
5. Anode No. 1 voltage (maximum).........	1250	none	1200	2000	1000
6. Focus grid voltage (max)	625	none	400 approx.	[illegible]	none
7. Grid volts to modulate —black to white....	106	20	15	25	15
8. Max. screen input power (milliwatts sq.cm.)	3.5	3.5	——	10	10
9. Heater volts..........	1.8	2.2	2.0	2.5	2.5
10. Heater current........	2.4	2.5	1.5	2.1	2.1

It will be noted that item No. 7 gives an idea as to the maximum video signal strength necessary to modulate the cathode ray from black to white. This factor will be referred to in later data sheets. It is also to be noted that the RCA tubes are not equipped with deflection plates, so that a magnetic deflection coil system must be used. The Baird tube listed above is also deflected magnetically, and in addition has magnetic focusing.

Sheet 210.5.

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Television Data Sheets

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DEFLECTION SENSITIVITY WITH MAGNETIC FIELDS

The magnetic deflection sensitivity of a cathode ray tube is rather difficult to determine, since the usual magnetic field is rarely confined within measurable boundaries. It is only possible to state the probable deflection that would be obtained when coils of a definite size are used. Even then several other factors affect the sensitivity, such as: the anode voltage, the position of the coils on the neck of the tube, the length of the cathode ray tube, the efficiency of the magnetic return circuit (if used) and, of course, the current strength in the coils.

For a given set of coils the deflection is proportional to the ampere-turns. To keep the inductance for the 13,230 cycle sweep small it is therefore necessary to use large variations in the current strength. The amplifier that is used to couple the deflection coils to the scanning oscillator, must have some such tube as the 2A3 or the 6L6 types which are capable of producing large current swings. A 6L6 tube has a plate current variation of the order of 0.125 amperes under certain working conditions, which would give one ampere-turn for every eight turns on the coils. Taking a typical pair of deflection coils used with an RCA type 1,800 tube with 5,000 volts on the anode, we find by experiment that about 5.2 ampere-turns per inch deflection are required, or around four ampere-turns with 3,000 volts on the anode. This would indicate that a total of 250 turns on both coils (comprising one pair) would give a deflection of about six inches, that is 250x⅛ amp. divided by 5.2 equals 6 inches.

The effective impedance of this deflection coil system is rather low, so that the amplifier plate circuit is properly loaded by an impedance matching transformer interposed between the plate circuit and the deflection coils. This transformer also isolates the deflection coils from the d. c. component of the plate current, which would deflect the spot continually toward one edge of the screen. These transformers will be described in later Data Sheets.

For lower frequency operation, such as for the framing oscillator frequency, more turns in the coils can be used, so that a lower current swing is needed.

One of the reasons that tubes arranged for magnetic deflection only, have been considered so frequently for television use, while the usual oscillograph tube uses electrostatic deflection methods, is that in the former case, two definitely fixed deflection frequencies are used, so that the circuit constants can be arranged to be most effective at those frequencies. In oscillographic use a wide band of frequencies must be planned, for this presents considerable difficulty in the design of suitable deflection coils.

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MAGNETIC FOCUSING OF CATHODE RAY

In some tubes that have been developed for television reception, magnetic coils are used to concentrate or focus the electron ray (sheet 010.2). One or more coils of wire, not greatly different from the field coil of a loud speaker, are mounted on the neck of the tube, near the anode and clamped so that the magnetic axis coincides with the axis of the tube. A d c is applied to this field and the current is adjusted so that the current is correctly focused on the screen. To accomplish this concentration the radial field at the ends of the coil are used (actually only the radial component of the field that exists at the end of the focus coil closest to the fluorescent screen is utilized). It is of course necessary that the polarity be right to accomplish focusing.

Under ordinary conditions electrostatic focusing fields (formed by the application of selected potentials to a series of electrodes) has the advantage of greater convenience, and less auxiliary equipment. Since good results can be obtained with the electrostatic lenses when properly designed the question might be asked: Why bother with focusing coils?

The answer is that some reduction in the cost of the tube can be obtained since several internal elements that are rather critical to assemble are eliminated. Then under certain conditions superior focusing can be obtained.

In a magnetically focused tube the total voltage is applied to an electrode relatively close to the cathode. This condition results in the formation of a jet with the smallest possible diameter with a given cathode emission area. The process is that a single lens element is formed by the electrodes which restricts the electron jet into a small jet having a high velocity. The magnetic field corrects for the normal dispersion along the tube. This can be adjusted for the exact distance to the screen by adjusting the current in the coil or its position on the tube.

There is one condition that must be observed, viz., the deflection field (generally magnetic deflection is used with these tubes) must not interlink the focusing field or else a curve or twist is given each scanning line. A magnetic shield is sometimes used to keep these fields separated. In order to operate satisfactory the field should not extend axially to interlink the anode electrode, as this distorts the jet entering the magnetic field. Internal electrodes in the tube should be of non-magnetic materials.

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SIZE OF SCREEN

The enjoyment of a television program depends upon a number of factors: the contrast, size, brightness, color, detail, and absence of interference and flicker. The contrast is dependent upon the amplitude of the signal potential applied to modulate the light intensity. Brightness deals with the steady light value per unit area, and its value may depend upon local viewing conditions—the color of the spot, the location of receiver (whether in a light or dark room), &c. Both the contrast and the brightness factors are adjusted manually in each receiver. Strange as it may seem the size of the picture for the home reception can be too large as well as too small.

Omit

The optimum size depends upon the size of the average picture element, or for approximate computations—the width of a scanning line. Assuming average visual acuity and an average viewing distance of ten feet, the optimum size of picture would be fifteen inches high. This height would result in the most pleasing line structure. Individuals with visual sensitivity greater than this average, might even prefer a smaller picture and would move farther away. Exceedingly large pictures with the same number of lines would appear coarse and grained.

OMIT

The term "visual acuity" refers to the ability of the eye to distinguish small details. An object one foot long at a distance of one foot would present an angle of 60 degrees, since the ends of this object and the eye form an equilateral triangle. An object 0.2 inches long would form an angle of one degree. An object one-sixtieth of this length would form an angle of one minute (one-sixtieth of a degree) with respect to the eye.

Therefore a visual acuity of one minute of an arc indicates that the eyes can distinguish an object 1/100th inch long at a distance of three feet. This represents the sensitivity of the average eye.

A add p 40A

By the same computations a picture say 7 by 9 inches would appear best at a distance of around five feet. This is about the largest picture that can be obtained with a 12-inch diameter cathode ray tube. This indicates that reception on the small cathode ray tube is limited to the entertainment of small groups only.

For this reason a diligent search is being made by many research organizations to find a method suitable for large group entertainment. There are three distinct methods of attack on this problem. The first is to develop larger cathode ray tubes; the second is to reflect the picture or project it onto a larger screen; and the third, to use a completely mechanical system wherein a beam of visible light is deflected and modulated in accordance with television scanning principles.

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Television Data Sheets

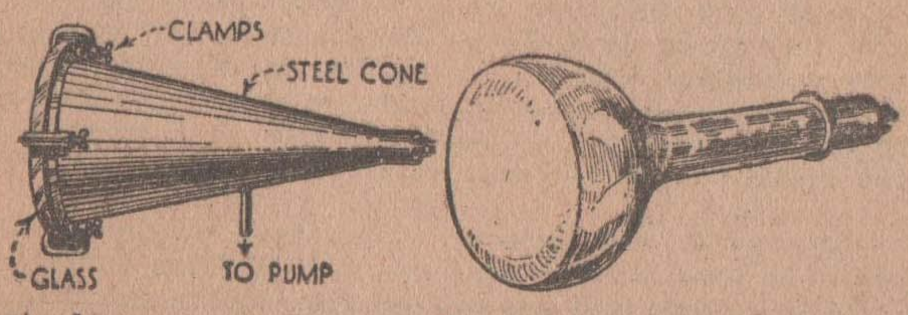
Compiled by RALPH R. BATCHER.

LARGE DIAMETER CATHODE RAY TUBES

The ever present problem of air pressure on the cathode ray tube screen, amounting to fifteen pounds per inch, has been the main obstacle in producing large cathode ray tubes. A few have been reported, notably the tube developed by the RCA, with a 30-inch diameter screen. This tube was made with a plate glass disk 2 inches thick, sealed onto a flange on the rim of a cone, 4½ feet long, made of boiler plate (see figure ~~below~~). A pressure of over five tons, distributed over the surface of this screen, accounts for the unusual thickness of the glass. Such a tube would give a picture about 1½x2 feet, but even this is insufficient for theater or assembly use.

Tubes with 15-inch to 18-inch screens are not uncommon in Europe and it is possible that improved manufacturing methods will reduce the cost of such tubes to a value low enough for home use.

In order to withstand the pressure, these tubes are designed so that the large end is more nearly spherical. This screen curvature (see figure) introduces a little more distortion, but when viewed in a mirror the difference is not great, provided that the spot remains focused at all points on the screen.



The actual screen opening in a television receiver has its corners rounded, which permits the enlargement of the center parts of the picture, which comprise the most interest.

The glass has to be well annealed and free from strains due to unequal tempering. If a tube gives way the inrushing air forces the neck of the tube downward and considerable damage to other circuit elements is possible.

An analysis shows that an increased screen diameter means increased tube length (since the ray cannot be deflected through too great an angle without distortion), increased cathode emission and a greater electron velocity as well. The electron beam energy required increases in proportion to the area of the screen.

All in all, it seems that the use of larger cathode ray tubes is not a solution for auditorium installations for televised programs.

Sheet 210.9.

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Television Data Sheets

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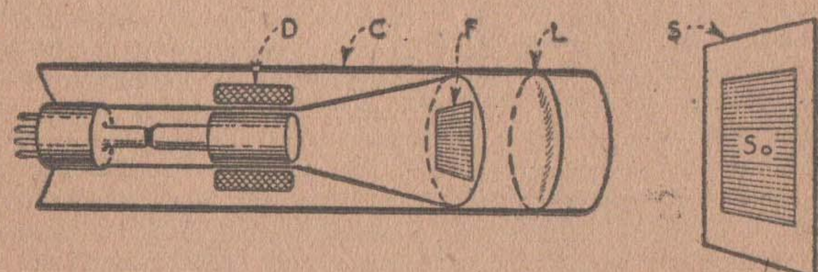
PROJECTION TUBES

Many designs have been disclosed during recent years for cathode ray tubes capable of throwing a picture on a large wall-screen, such as is used for motion pictures. The differences between such tubes and ordinary cathode ray tubes are matters of detail rather than principle.

Consider the projection arrangement shown. Here a cathode ray tube is placed behind a lens (L) so that the fluorescent light from the screen (F) is projected on an opaque screen at SO. The tube, lens, deflection coils (D) and sometimes a video amplifier besides are mounted in a shield (C).

In order that the projected picture be larger than the original it is necessary that the distance FL be less than LS. The original brilliance of the picture must be quite intense in order to make up for the losses in the glass of the lens, and to give adequate illumination on the large screen S. All lenses lose a certain per cent of the light passing through them varying from 20 per cent to 25 per cent. This loss is unavoidable.

The second factor requires careful consideration. There is no advantage in using a projection tube unless large sized images are produced. That is, a double sized enlargement may hardly be worth the additional expense involved, whereas a tenfold enlargement is decidedly important, and a sixteen by twenty foot enlargement from an eight by ten inch original would be an answer to the theater problem.



Problems that are inherent with the design of a projection tube are the same as those found with the ordinary tube, but the difficulties of their solution are much greater, viz., deterioration of the cathode emitter surface, burning of the fluorescent screen with high intensity electron bombardment, and the lowering of the vacuum by the degassing of metal parts by high speed bombardment.

It can be said, however, that these problems are gradually being solved and it seems that the projction tube method eventually will be an important part of the television system.

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PROJECTED TELEVISION PICTURES

Obtaining large pictures is one of the most sought after features for television reception at the present time. Nearly all large television research organizations have some form of this equipment under investigation. There are two distinct fields to take care of: a projection system giving pictures up to 3x4 feet for home use, and one giving an enlarged picture of sufficient size to cover a theater screen.

The problem is commonly concerned with the use of a high intensity cathode ray tube (sheet 210.10), although some systems of mechanical scanning offer an attractive substitute.

In the cathode ray system, obstacles have arisen in the handling of high voltages, (10 to 100 kilovolts) in the design of emission sources, i. e. heavy duty cathodes capable of holding up under such voltages and in a fluorescent screen capable of withstanding heavy bombardment. High speed electrons are capable of causing destructive action on all ordinary materials. In fact it was shown many years ago that a diamond placed in the path of a cathode ray would burn up.

Other factors which are receiving attention are the development of better projection lenses and the improvement of projection screens, on which the picture is to be thrown.

In the matter of higher voltages, projection tubes have been constructed with insulation values sufficient to permit operation in excess of 50 kilovolts. Such a tube would give from 40 to 60 times the illumination that a tube with 7 kilovolts would produce. Since the latter tube would cover an area of about 2.0 square feet, so that an anode voltage of 50 k. v. would prove satisfactory on a screen having about 60 square feet, or about 6¾x9 feet (allowing for a 50 per cent loss of light in a projection lens) or possibly 9x12 feet if the room is kept quite dark.

The output brilliance of the fluorescent screen increases according to a rate which is approximately dependent on the square of the anode voltage, at least for the lower range of voltages, although at potentials of 20 k. v. or over, the output may exhibit saturation and less output would be obtained than this square law would indicate. Hence, it has been necessary to improve the fluorescent materials when operating at the higher bombardment values.

(To be continued)

SHEET 210.11.

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PROJECTION SYSTEMS—FLUORESCENT SCREENS

Latest reports from the laboratories have indicated that high intensity fluorescent materials has been greatly advanced by improvements along several lines:

1. Control of the purity of the ingredients both as to the elimination of unwanted substances and the correct "alloying" with intensifying ingredients; i. e., chemical materials added to improve the light generating efficiency, and to bring about the desired fluorescent color.
2. Proper processing of the screen, as to size of particles, layer thickness and method of applying the material to the glass.
3. Control of bombarding current. The electrons in the stream striking the screen must be carried away from that screen, and back into the normal acceleration voltage circuit.

The last item refers to the charge that appears on the screen after receiving a stream of negative electrons. If electrons hitting the screen cannot escape, the charge would build up to a voltage high enough to repel the ray. However, it happens that the surface leakage and secondary emission from the screen are great enough to prevent the accumulation of a high charge and in most of the present day direct viewing tubes with glass envelops the screen is rarely over 15 to 20 volts negative with respect to the final anode potential.

This charge on the screen accounts for the movement of part of the picture on a screen when the outer surface of the glass is touched with the finger which is frequently commented upon by television observers using sets not provided with plate glass windows. The field through the glass alters the electron-charge density on that part of the screen which acts to repel part of the electron ray as it enters the influence of that field.

Projection tubes of the type illustrated on Data Sheet 210.12, having screens with a metal backing are not greatly influenced by the stray charges on the screen, since the metal backing tends to dissipate them. The bond between the fluorescent material and the backing plate can be made much stronger in this type, since the former can be fused directly onto the surface of the metal. Such a screen seems to have a much higher saturation level and so is better adapted to the high potential service needed for projection tube use.

An example of projected television has been afforded by the Baird system. which is being tested in the New York area. This system uses a tube with a screen having a 24 square-inch area, and having an electron velocity produced by a 50 k. v. anode potential.

This system is capable of producing a picture approximately 9x12 feet in size, with enough brilliance for theater use.

(To be continued)

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PROJECTION SYSTEMS—LENSES

The use of large screen projection tubes for home television receivers should not greatly increase the tube cost, since the smaller size will offset the increased cost due to the higher insulation values needed, assuming that the design principles have been completed. The cost of a higher voltage power supply and filtering unit will be greater, however, and in addition there is the cost of the lens. The latter items, however, do not require periodic replacement as does a tube, whatever its type.

For theater use the lens cost is quite important. In the Baird system, mentioned in sheet 210.13, two lenses are available, one having an F/1.8 opening and a 14" focal length, the other an F/1.6 opening and a 10" focal length, to take care of theaters of different lengths (projection booth to screen).

As camera enthusiasts know, lenses differ in many respects. Close up work with a short focus lens brings in greatly distorted perspection, with nearby objects greatly exaggerated in size. The same lens used further away gives correct size and shape ratios, but the resulting view is very small. The better method is to use a lens with a longer focal length and to work at a distance. This lens will magnify the field of vision so that a larger view is obtained.

However, the brightness of the picture varies inversely as the square of the focal length, so that in doubling the latter four times the exposure time is required. Lens sizes are rated in the F scale, or the ratio of the diameter to focal length.

Thus the F/1.8 lens mentioned above would have a diameter of (14/1.8) or over 7½ inches, and the F/1.6 lens a diameter of (10/1.6) or 6.25 inches. Either lens would be considered enormous compared with the sizes usually used in moving picture projectors.

The lenses have to be designed to produce but little distortion (or aberration), which requires accurately computed curvatures. Aberration increases quite rapidly with increased diameters and accurately corrected lenses are costly.

For home use the picture size need not be much larger than two feet across and small-sized fluorescent screens are preferable. This permits smaller diameter and relatively inexpensive lenses.

SHEET 210.14.

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PICTURE MAGNIFICATION.

The use of magnifying lenses to enlarge television pictures is not new. In fact, it was the only method possible during the time that scanning disks were employed in the receiving system. In the latest adaptation it is used to enlarge the image from one of the smaller cathode ray tubes—5 inches in diameter or less. Good results are possible if the lens is properly selected and mounted. Several principles will be considered here.

In the first place, the lens must have a diameter as great as the desired enlargement. This means that in order to get a picture 9 inches in diameter, the lens itself must be at least 9 inches in diameter.

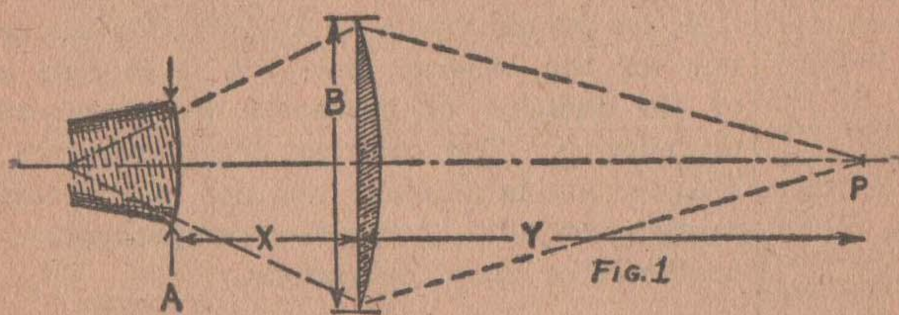

FIG. 1

It will be observed that the brilliance will be reduced, actually for two reasons—the first being that a certain amount of light is lost when passing through any kind of a lens, the optical efficiency being from 50 per cent to 80 per cent, depending on the character of the lens and its surface cleanliness. The second reason is that with the larger view, a given amount of light is spread over a larger area, resulting in a less brilliant picture. In using ordinary uncorrected lenses (of the reading glass type for instance) the picture may appear distorted, wherein straight lines in the picture show up as curves in the enlargement.

The optimum viewing position for good visibility and minimum distortion is generally greatly circumscribed. Except for a favored position directly in front, the view will be eclipsed by the rim of the lens. For this reason the seating arrangement in the room must be considered.

X The relations between the various factors that affect the result are shown in Fig. 1. Here a cathode ray tube screen having a diameter (A) is located (X) inches behind a lens, the latter having a diameter (B). This lens has a focal length of (L) inches. The problems to be investigated are the correct position for setting (X) and the optimum value of (L) so as to provide a convenient observing distance (a), say four to six feet away.

(To be continued.)

SHEET 210.15.

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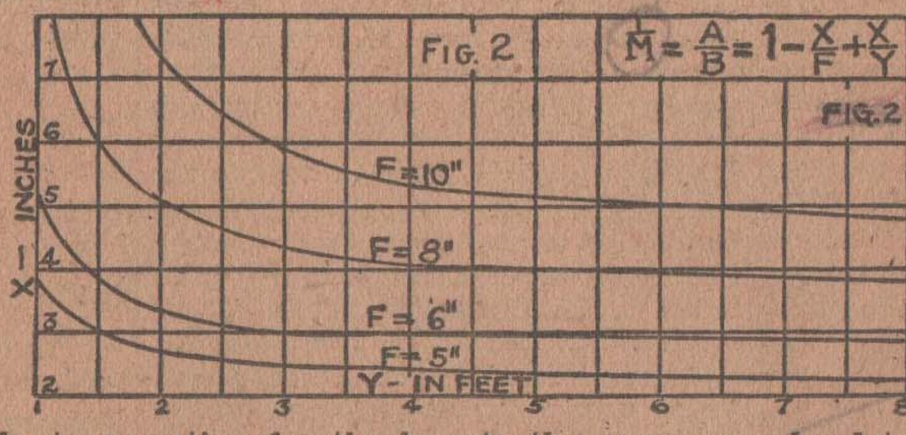
PICTURE MAGNIFICATION

(Continued from Sheet 210.15.)

The effectiveness of a lens in front of a television tube to bring about a magnification can be determined by a rather simple relation. The definition of the magnification is the ratio of the apparent size of the picture to its actual size on the screen, or in most cases, the ratio of the diameter of the lens to the diameter of the cathode ray tube screen. The latter relation is true if the observer stands back far enough so that the image on the screen fills up the whole surface of the lens. At such a position the greatest magnification exists that is possible with that diameter lens.

There are two other factors which must be determined before the problem is solved: the distance between lens and screen and the best focal length of the lens. It will be noted that the maximum magnification is limited by the lens diameter only, and not by the focal length of the lens itself. The focal length of a lens can be measured by focusing the sun or a distant light on a card and measuring the separation between the card and lens when a sharp focus is obtained. x



The best separation for the lens to the screen can be determined by application of the relation shown at the ~~lower~~ corner of Fig. 2. This relation is based on the distances illustrated in Fig. 1 on the preceding sheet. Let us assume a lens with a focal length of 10 inches and a diameter B equals 8.25 inches, and a cathode ray tube screen diameter A equals 4.75 inches. This would permit a magnification of 1.75. For convenience the above relation has been plotted on a curve, Fig. 2, which shows how the lens to screen distance (Y) must be adjusted to give a convenient observing distance considering the room and the audience to be accommodated.

It will be observed that while a lens having a short focal length, five or six inches, must be accurately adjusted as to its distance from the screen. A direct viewing lens which would improve position is less critical. A lens having a diameter of 8¼ inches and a focal length of 5 inches would be relatively thick at the center and therefore would be quite heavy.

(To be continued.)

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PICTURE MAGNIFICATION

(Continued from Sheet 210.16.)

It is seen from the foregoing analysis that the size and weight of a lens for magnifying the picture from a television screen is a disadvantage in many cases. The advantage of lens magnification is found only when small cathode ray tubes are used, because then the lens is quite reasonable in size. For example to double the size of a 3-inch screen would require a 6-inch lens. It could conveniently be a lens with an 8-inch focal length mounted 6.7-inches from the screen. A directly viewing lens which would improve the view of a 9-inch tube would be economically impractical and in this case it is better to go to the projection type of tube and lens, as described on Sheet 210.10, and following sheets.

On the other hand it is possible with a given lens diameter, to magnify a three-inch picture to the same size obtained with a five-inch tube. However, the picture clarity and brilliance would suffer unless exceptionally fine focusing was to be had, and a higher anode voltage is used than would otherwise be necessary.

The relations shown on Data Sheet 210.16 are the result of theoretical considerations. It was shown there that the picture magnification possible depended mainly on the outside diameter of the lens used. Practically, however, it may be necessary to be content with somewhat less magnification, since the edges of the picture may become unbearably warped by lens distortion, or the brilliance may become too low for good visibility. Finally it is not possible for more than one or two people to place themselves at the position where best focusing occurs—the location referred to in Fig. 2, Sheet 210.16. It will be seen from these curves that the lens-to-screen distance will be approximately one-half of the focal length of the lens.

The best seating arrangements for a lens-magnified television program is to have all seats directly in front of the lens, but this is not possible when more than two or three observers are present. In any case the positions should be arranged within as narrow an angle as possible.

In any arrangement the lens must be mounted on an "outrigger" support of some sort or else the tube must be set back in the camera so that the lens is mounted on or back of the panel (for minimum distortion the lens should be set so that the face that is flat or that has the least curvature, is toward the tube). The latter arrangement gives the best results since the cathode ray tube is located in a darkened place, which has the effect of improving the contrast in the picture and of reducing the highlights and reflections of room lights. It also gives the best simulation of a receiver with a "large" cathode ray tube. A deeper cabinet must be provided but possibly no deeper than one which would take care of a larger cathode ray tube giving the same size picture.

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THE SKIATRON

The main requirement for television excellence up to the present has been the capability of receivers to show details of the scene clearly and sharply. This is still the most important consideration although of late more and more effort is being put on other factors such as the size and brilliance of the picture. The latter factors are related, since if plenty of light is available the size can be readily magnified. Many research groups believe that the usefulness of a cathode ray tube of the usual type is limited, since there seems to be an upper limit to the useful light output.

The problems of size and brilliance are important enough to have instigated a great deal of research work along other lines. Many ingenious schemes have been proposed to overcome the difficulties of mechanical scanning such as high speed scanning motors that run evenly and precisely, and means for controlling light intensity at the high rate of change determined by the picture frequency.

One system which offers great promise, according to reports from Great Britain, is a system disclosed by Scophony, Ltd., which uses the noiseless, precise scanning of the cathode ray tube, together with the simplicity of its light modulating capabilities, and still is capable of producing large projected pictures having a high order of brilliance and quality, without the use of high operating voltages.

The system uses a special cathode ray tube, called a Skiatron, having a screen which is normally translucent, but which becomes discolored and more or less opaque wherever the cathode rays strike. For once nature seems to favor the process, for the several characteristics possessed by these screens all work to make the system effective: the screens are not difficult to produce, the degree of opacity varies more or less proportionally with the applied beam modulating voltage and what is most gratifying: the picture fades out in a short time—say one-twentieth of a second!

The latter characteristic permits setting up a whole frame at a time. A strong light focused through this screen is thus projected on an external wall screen in the manner of a magic lantern or a movie projector. Since the picture fades after a fraction of a second, a continuous succession of new frames must be set up by the scanning process so that moving scenes can be handled, the same as in ordinary television reception.

The data disclosed by the Scophony organization have not indicated progress beyond the experimental stage. The basic principles involved are not new, because it has been known for many years that many chemical compounds (even ordinary table salt) become temporarily discolored when exposed to cathode rays.

One of the difficulties experienced at present is that the light does not become completely cut off by the screen, at spots where a deep shadow is to be reproduced. This can probably be improved in time, by using stronger cathode ray beams for scanning.

(To be continued.)

The Sun
Television Data Sheets

Compiled by RALPH R. BATCHER.

THE SKIATRON.

(Continued.)

There are many ways by which a variable or pulsating light wave can be converted into a variable current of electricity. However, to accomplish the reverse effect, the conversion of a variable electric current into corresponding changes in the intensity of a light ray is not so easy, particularly under conditions where large amounts of light are to be controlled and when the modulating frequency is high.

In the Scophony arrangement mentioned in the previous sheet, 210.18, the usual screen of a cathode ray tube is replaced by a plate coated with special material (non-fluorescing), actually particular salts of an alkali metal. The plate may be a thin sheet of mica (M) in Fig. 1, so placed that a beam of light from a brilliant source (A) can shine through it and into a projection lens (L). The various transparent and opaque areas produced on this plate (M) are therefore projected upon a wall screen (S), where it may be viewed by a large group of observers.

Since the plate must be scanned by an electron ray, the electron gun (G) must be located at an angle, outside of this optical path, thus the Skiatron might have a general appearance somewhat like an Iconoscope pickup tube.

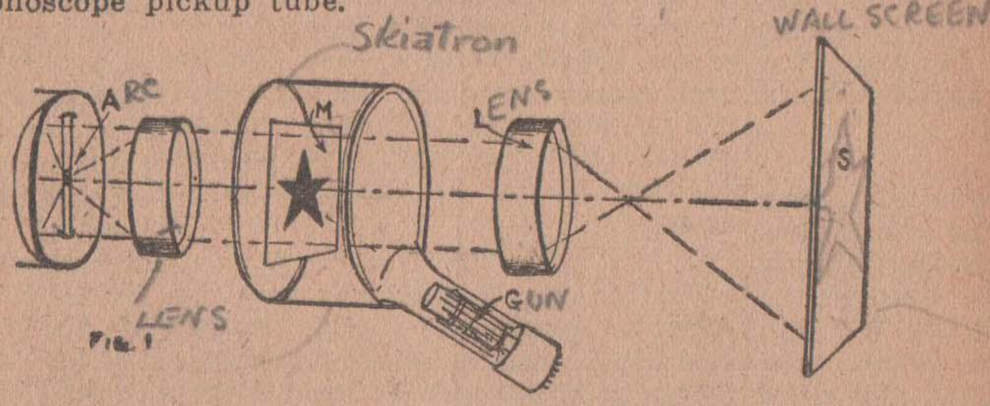

Fig. 1

The coating on the plate may be a thin film of a single chemical salt or combination of salts such as certain alkaline iodides, bromides or chlorides, that have been found to discolor under electronic bombardment. The illumination may be from any source that has enough power to give the required brilliance.

It may be noted that numerous other investigators have applied the light control principles to projection cathode ray tubes. For instance, Von Ardenne has used a tube containing a screen coated with the mineral Sphalerite, which is a substance that rotates the polarization plane of light when activated. When polarized light from an external source is projected through such a screen the opacity of each portion depends upon the degree of polarization produced by the scanning ray.

SHEET 210.19.

(To be continued.)

The data sheet published on May 11 should be filed as No. 210.18.

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