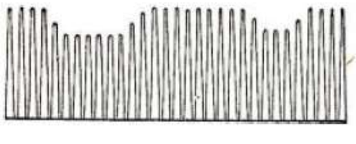

FIG. 11

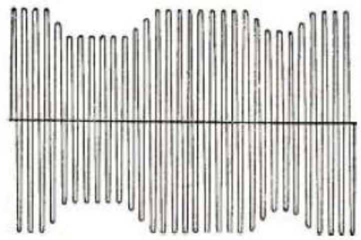

FIG. 10

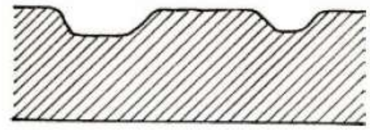

FIG. 12

Practical Lessons in
TELEVISION
(Lesson Two: Receiving a Picture—Scanning)

By F. L. Sprayberry

WE have now completed the study of the facsimile transmission apparatus and are ready to inspect the receiving equipment. All of the equipment described up to the amplifier input may be regarded as a sort of "microphone" which translates picture tone values into an electrical equivalent.

The picture signal that we have in Lesson 1 arrives on wire lines at the receiving equipment at the input of an audio amplifier to compensate for the loss it may have experienced during transit and the same type of band-pass filter is used (1200-2600 cycles) followed by a rectifier-detector system. Any type of detector might be used which would result in the true reproduction of the original picture component. With a diode detector, the original signal current wave would look graphically as in Figure 10 before detection, and as in Figure 11 after detection. This detected wave is, of course, filtered to eliminate the 2400 cycle pulses allowing the picture component as in Figure 12 to remain.

The apparatus shown in Figure 13 is used for the reception of the picture or rather the "synthetic" assembling or reconstruction of the picture from the received signal. This apparatus is strikingly like the transmitting apparatus. The rectified picture signal is fed to a single-reed, light-gate or valve and the intensity of current moves this reed in front of an aperture allowing more or less light to pass through it.

Start This Series Now!

IN Lesson One was described the method of transmitting a picture facsimile by the telephoto method. This lesson describes a telephoto method of receiving a picture and then goes on to the principles of consecutive scanning used in television. Radio experimenters, service men, and amateurs should follow this series of lessons carefully, as it will give them a clear understanding of the technique employed in television. This new art which is now starting to blossom out in America will have wide application as soon as the experimenter begins to awake more active interest and take part in the experiments.

The picture receiving cylinder or drum carries a regular photographic sensitive paper and in turning under the light beam is more or less exposed to the light. In the complete system from transmitter to receiver every grade or tone value of the original picture is translated into corresponding current intensity values, which are in turn translated into corresponding exposure values on the receiving sensitive paper so that an exact reproduction of the original picture is possible.

Obviously both the transmitting and receiving cylinders must be driven at precisely the same speed so that the reproduced picture will be an exact duplicate of the transmitted one. The speeds of the two cylinders are kept identical, independently, by means of precisely designed and adjusted apparatus for motor speed control.

The time required to transmit one picture with this equipment is determined by the length of the picture along the cylinder. It can scan the picture at the rate of 1 inch-per-minute along the cylinder axis—a 14 inch maximum size picture requiring 14 minutes for transmission.

In the preceding explanation we have given a complete system for translating any picture into an electrical signal and then reconstructing the picture again at a receiving point. This was explained in detail so that we will have a basis on which all of television is constructed—*a picture or scene being dissected into small areas for transmission.* Each of these areas has a tone or grade value between

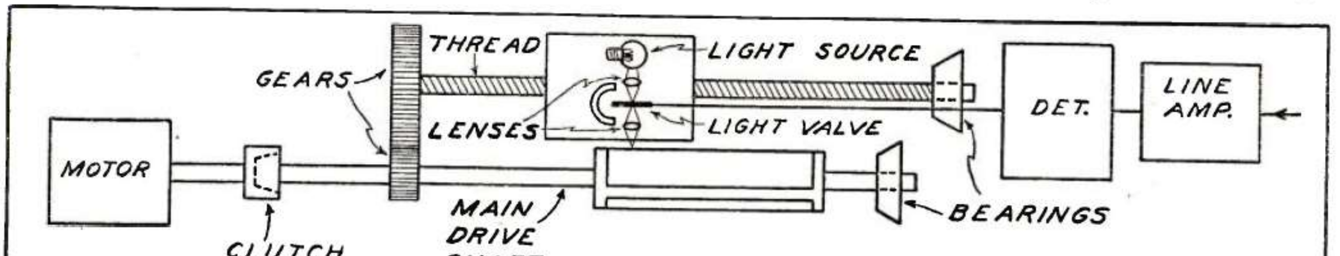

FIG. 13.

and including black and white and each individual area has an average tone value which must be uniform throughout. It should be obvious that the smaller this "elementary area" the greater will be the detail of the picture.

When printed in a half-tone a picture must consist of a group of elementary areas in a complete mosaic of the picture. There is no way to control the tone of ink as it is pressed on the paper. It will always print its complete density or full value, such as for black ink it will make the paper completely black where it touches. For this reason, to obtain variations in tone value for a picture, the size of each dot of ink must vary in accordance with the tone value of the picture. You can notice this in any newspaper or other half-tone.

Television consists in dissecting pictures very rapidly and in rapid succession, and reconstructing them in very much the same general manner as described. We can imagine the new problems which will be involved when we attempt to dissect a picture ordinarily requiring up to 14 minutes at the rate of 24 complete pictures per second!

The Flying Disc

It is quite natural that television should at first grow out of the Nipkow mechanical system. In television, we have no permanent copy of the pictures being transmitted and hence we must look at it as it is being transmitted and received. For this reason, the picture must be received or reconstructed on a flat or nearly-flat surface.

By means of appropriate apparatus we can project any subject, picture, or film on a flat surface and then rapidly dissect this surface by means of picking up grades or tones of illumination to be transmitted as equivalent electrical impulses. This may be done by a simple mechanical system as diagramed in Figure 14. An object "A" is placed in a flood lit area and a lens "B" is used to converge reflected rays from the object onto a circular disc called a Nipkow disc in honor of its inventor. This disc is usually made of aluminum and is about 2 ft. 6 inches in diameter. The disc is solid $\frac{1}{16}$ inch aluminum except for a series of "pin holes" approximately .04 inch in diameter in regular order about the edge of the disc. There are exactly 60 holes in this disc and they are usually spaced around the circumference of the disc —one every 6 degrees or 1½ inches. Rather than being on the same circle about the disc, each hole is displaced along the radius of the disc by almost its diameter. A path along the disc connecting the holes would therefore form a spiral—not a circle.

Disc Details

A detailed view of the entire disc is shown in Figure 15 and a magnified view of a section of it is shown in Figure 16. Here a section of the top portion of the disc is shown where the two ends of the spiral pattern formed by the holes come together. The approximate rectangle shown in dotted lines is the area covered by the holes in one revolution of the disc, one hole at a time.

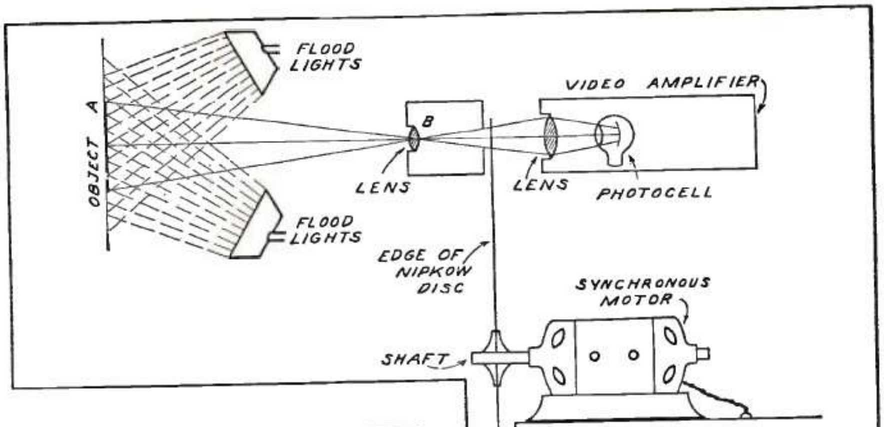

FIG. 14

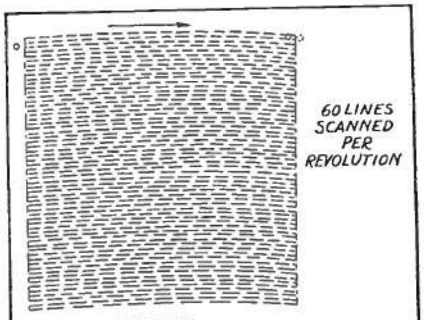

FIG. 17

How It Works

To magnify this situation still more as in Figure 17, we have the actual paths traced by each hole starting from the top of the area. The disc is moving to the right—clockwise—and we see the first hole just about to emerge from the right side while the next one to the left of the area is just about to enter the area. In moving just a small fraction until they are in the positions shown in the dotted circles, the first one has left the area and the second one has just entered. When this one has moved across the area describing an arc, as indicated by the dotted line, a third one enters the area. At no time is there more than one hole in the arc and in succession they cover the entire area in one revolution of the disc.

Now the paths of the holes are made to slightly overlap so that the area between two holes will be covered with adequate illumination. If we assumed each hole to stop at the exact top of the area these relative positions would look as in Figure 18. The holes being .025 inch in diameter with only .02 inch between their centers, they will overlap somewhat as shown. This greatly enlarged view shows just how the holes overlap each other.

So that the angle at which the light approaches the holes may not be critical they are "beveled" as shown by the greatly enlarged view of a section through the disc at Figure 19. The holes are so small that they prac-

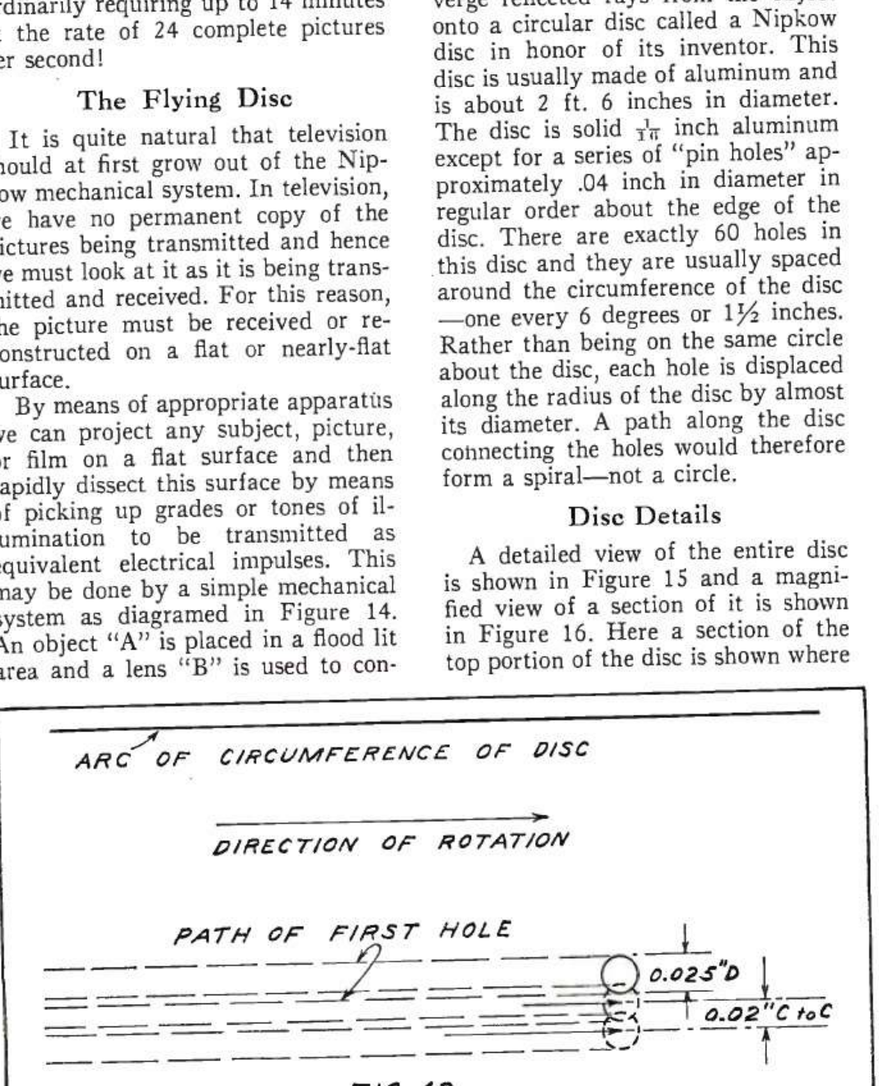

FIG. 18

(Turn to next page)

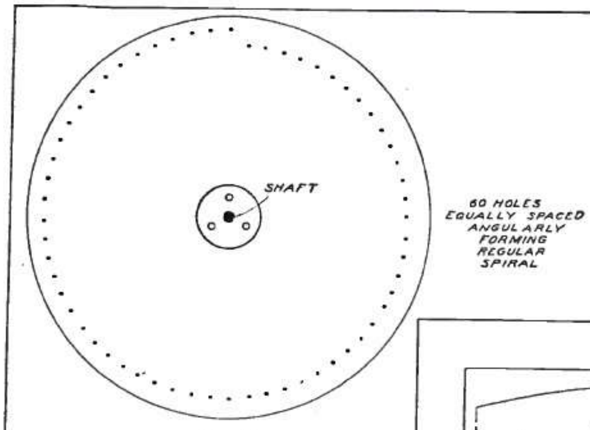

FIG. 15

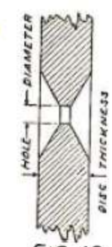

FIG. 19

tically form a tube in the disc of some length. Thus if the light approaches the disc at an angle only slightly off of the perpendicular, much of it will be cut off. In looking through a gun barrel or mailing tube we must allow the light to come straight to our eyes. However, light from a picture must come from various directions because of the size of its area and hence the holes in the disc must be beveled.

Lens Projects Image

Again referring to Figure 14, let us assume that the disc is driven at 15 revolutions per second by means of a "direct drive" synchronous motor.

The object is projected on the disc by means of the first lens to the left, and as the holes pass through the projected area, they allow light to pass through, corresponding exactly to the amount of light falling on the disc. Thus light values will be projected onto the photo-cell cathode and a current flow corresponding to this light intensity will flow.

For each picture in one revolution of the disc, the light from only one hole at a time is projected onto the disc and the changes of light value across the picture for each of the 60 lines or arcs down the picture will be simulated by changes in current flow in the photo-cell. Instead of the light traveling slowly across the picture, we have the aperture through which the light is reflected, passing very rapidly through the projected area allowing only one spot at a time to fall on the photo-cell.

Picture Elements

The width of the picture area is 1½ inches—corresponding to about 60 diameters of the holes considering the overlapping—giving the opportunity of changing the amount of light this many times for each scanned arc across the projected image. If the picture detail required more light changes in this space, the light value would be forced to vary

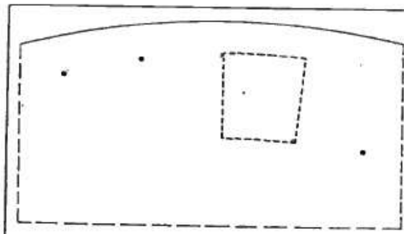

FIG. 16

before the hole moved its own diameter. This would destroy its original light value as the photo-cell may only respond to one light value at a time. This, therefore, limits the maximum detail obtainable across the picture. In a given space in a half-tone print we have an opportunity to place only one dot of the correct size and the diameter or area of this space limits the detail of the picture. As we go down the picture we have only 60 opportunities to perform this action, making a total of 60 across times 60 down or 3600 in all. The light may not change more than this number of times and still be effective on the photo-cell for one revolution of the disc on one picture. In rotating 15 times per second the whole process must be repeated this many times. This means that for one second, there can be a total number of effective light intensity variations amounting to 3600 x 15 or 54,000. Although the photo-cell can respond completely to many more changes in light value than this per second, let us investigate just why this would serve no purpose in this case.

Drawing your attention to Figure 20, where we have a greatly enlarged view of the flying disc apertures and picture segments for study, note that at A the picture line contains such detail that several dark and light spaces are projected on the aperture at one time. The photo-cell cannot respond to these individual light areas as it will pick up only the average light from the entire area of the aperture. Thus in passing over this section as a new dark area enters, another dark area leaves, and as a light area enters, another light area leaves, making the average light value practically constant. In fact, a graph of the percentage of available light from the entire aperture would be a slightly wavy line due to only a small increase or decrease in total light as the aperture travels across this picture section. This is shown A1.

Picture Detail

Now at B the picture gradation or detail is less, the dark and light spaces being more widely separated. As the aperture passes over this section, the dark space practically cuts off the light, while in a light space the light may come through practically 100%. Thus for less actual picture detail the system can respond much more fully. Note that at B1 where this light percentage is plotted, the variations are complete from zero to 100% of the available light.

Best Conditions

Any less detail than this, such as at C, will be picked up in the same way—that is, a maximum amount of light variation will be produced. This is why any amount of detail above 60 areas across the picture area will be increasingly less effective on the photo-cell. (*Turn to page* 497)

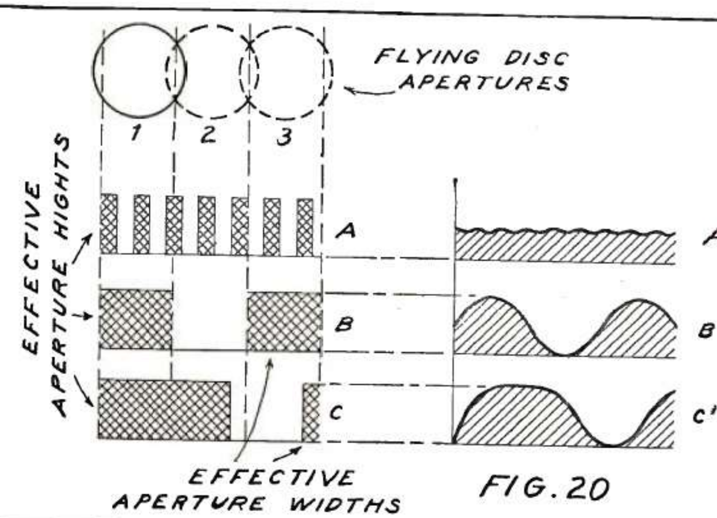

FIG. 20

D3—Technical Pamphlets on Intercommunication Systems. Wright-DeCoster, Inc.
D4—Transmitter Manual. Standard Transformer Corp.*
D5—"Skyrider" Receiver Booklet. Hallicrafters, Inc.
D6—The Muter Ballast Tube Catalog.*
D7—Centralab's Volume Control and Accessory Catalog.
Ja1—Modell's Radio Receiver Catalog.*
Ja2—Tube Chart. Raytheon Production Corp.
Ja3—1938 Receiver Line. Freed Mfg. Co.
Ja4—Catalog on I.F. Transformers. Aladdin Radio Industries, Inc.

Television Course

(Continued from page 476)

The picture picked up is thus a mosaic make up of 3600 elementary areas being uniform within themselves but from one to the other varying in shades of gray between and including black and white.

The variations of light at the rate of a possible 54,000 per second are translated into equivalent variations of anode current in the photo-cell—that is, the percentage of light striking the cathode of the photo-cell at any instant will cause a corresponding percentage of current to flow. And in one second these 54,000 impulses will be the dissected electrical equivalent of 15 slightly differing pictures in perfect sequence, a line at a time, one following the other. Just as soon as the last or innermost aperture of the disc leaves the picture area the top aperture outermost starts again to scan the area. Any change taking place in the projected picture in 1/15th of a second will be identified in scanning and the illusion of motion may be obtained by 15 slightly differing pictures per second.

With a conventional capacity coupled audio amplifier, these photo-cell current impulses are amplified so that they may be effectively transmitted. When a current is made equivalent to a voice or a sound wave it is called an audio frequency as it effects the auditory nerves on reception. A picture equivalent such as the 54,000 cycle impulse signal is called a "video" frequency as it effects the visual nerves on reception and reproduction.

What Is A Radio Tube?

Washington, D. C.—To prevent public deception in purchase of radio sets and tubes, the RMA is considering promulgation of an industry definition of what actually constitutes a radio "tube." An exact definition is being considered by the Association's engineering organization and Tube Division, for final consideration by the RMA Board of Directors.

Characterization of ballast resistors as "tubes" is a merchandising practice of which the RMA has taken cognizance and also the Federal Trade Commission in its proposed rules for the set industry which would prohibit advertising of so-called "ballast tubes" or dummy or fake tubes.

Serviceman's Diary

(Continued from page 452)

Jumped into the truck again—and found it started without a helping push from Cleopatra, standing by and ready to aid.

Next—an old house near the business section. A friend of the boss lives there and had brought in his Emerson midget with the complaint that it made a bad, buzzing sound when turned on during the day but was usually okay at night. We tried the set at the shop, telling him the trouble was probably at his location and not in the set and of course it played all right. While they are not close enough to car lines to pick much noise, there is a saw-mill nearby which might be guilty.

Went inside and switched the set on. As soon as the tubes heated, there was a buzz (and a mean one)! Too loud to be caused by trouble outside the house. I turned the set off and thought a moment. He claimed no trouble at night. As far as the house was concerned, the only difference between day and night operation was that at night lights were on. So I tried it with every light in the room switched on. No trouble. I called in the madam and located the switchboard with her help. One of the old-time cartridge-fused affairs which apparently hadn't been looked over for a long time. Located the proper circuit and had her try the set alone again. Sure enough, as soon as the set was switched on, an arc developed at one of the fuse block contacts. It lasted only a short period and occurred only from a no-load to load condition and not when the set was merely an added load on the circuit. I went over the entire board, tightening and cleaning all the fuse blocks and contacts. I don't think they'll have any more trouble.

U. S. Station List

(Continued from page 479)

WOR	Newark, N. J.	710	50.0
WORC	Worcester, Mass.	1280	0.5

(Continued on next page)