New Television Apparatus

Latest Developments by Messrs. Belin and Holweck

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(Paris Correspondent, RADIO NEWS)

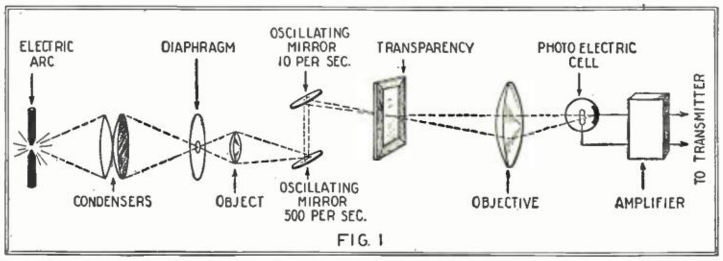

Fig. 1. After the light from the arc has been concentrated by the condenser lenses it is caused to pass in a wavy line over the transparency (See Fig. 2) and the variations of the transmitted light are registered on the cell.

THIS new apparatus is based on the modulation of a light beam exploring a photographic plate. Let us recall to those of our readers, who have forgotten that the microphone is an apparatus for modulating an electric current, that it transforms the continuous current into a very irregular one. It faithfully obeys the word, that is to say, the fundamental sound, its timbre and its harmonics. Obviously, the microphone is too crude to transform vibrations in a light beam into electric current vibrations. For this work, selenium cells or photo-electric cells are used. These cells take the same place in the transmission of pictures that the microphone takes in the transmission of sounds.

Selenium in this regard was a fine discovery, and the discovery of the photo-electric cell has re-awakened old-time hopes, although perhaps it is incapable of performing the high-frequency modulations of current required in television. We shall see later why this is the case.

TRANSMISSION

The system of transmission is represented essentially by two little oscillating mirrors (see Fig. 1), one placed above the other. The lower mirror, of very narrow width, oscillates vertically at a frequency of 500 cycles per second; the upper mirror, somewhat larger, oscillates horizontally at about 10 oscillations per second. The lower mirror, receiving the luminous beam, impresses on it as reflected 500 oscillations per second. As this beam is also received by the upper mirror, which oscillates in a line perpendicular to that of the lower mirror, the projected beam will be resolved into two sets of different oscillations, each with its own frequency and its own direction.

Suppose now that this beam is received on a screen placed in front of it. Let us follow its course.

The oscillations of the 500-cycle mirror makes it traverse the screen uninterruptedly from right to left and left to right, but the beam at the same time answers to the oscillations of the 10-cycle mirror, which moves in a direction perpendicular to that of the first. It, therefore, is acted upon by two forces. The resultant is traced upon the screen as a luminous line of the form shown in Fig. 2; that is to say, the screen is swept over by the ray alternately from right to left and vice versa and then from above downwards and back again.

However, if we watch the screen, our eyes will see no sign of the oscillations, because the ray takes only one-tenth of a second to cover the entire surface. The persistence of vision does not permit us to see movements of such rapidity.

We have alluded to a screen to explain how the ray would traverse such a surface. In the actual apparatus this screen is replaced by a photographic plate, which the light traverses. This plate is composed of transparent and opaque sections and also has a whole scale of tints varying from intense black to absolute transparency. The pencil of light is then greatly affected in its intensity, according to whether it traverses one or another of these tints; it will therefore experience, as it leaves the plate, a modulation such that its intensity will change in value at every instant. As this light, varying as above, is projected on a photo-electric cell, the cell will pass a very feeble current, the intensity of which will depend on that of the light which reaches the cell. But so far, the actual experiments have not been made with the photographic plate. A plate was used without any half-tones, carrying only black and white portions.

The reader's attention is called to the fact that the photo-electric cell contains two electrodes, the cathode being composed of an interior layer of metallic potassium and the anode of a very light ring of nickel or platinum. The anode and cathode are connected in a circuit with a battery. When a ray of light reaches the cell, the circuit is instantly closed and the current passes. Naturally, the stronger the light, the more current passes. It is thus, by the action of this apparatus, that it is hoped to transfer light modulations into modulations of an electric current, which is connected finally to a vacuum tube amplifier before being sent to the receiving station. In practice, this amplified current will be sent into the radio transmitting station and transmitted by radio to the receiver.

After what we have said, it is easy to understand that if a reproduction on a reduced scale is desired, such as an image of the moving picture film, about 1 x ¾ inches the points will be much closer together and more numerous per unit of surface than on a screen of 6 x 9 feet area. Now, coming back to the film, a point less than .001 of an inch will be enough to reproduce an image under good conditions. The analysis of the image to be transmitted, will come down, therefore, to the production of 10,800 points. As all the surface of this image is

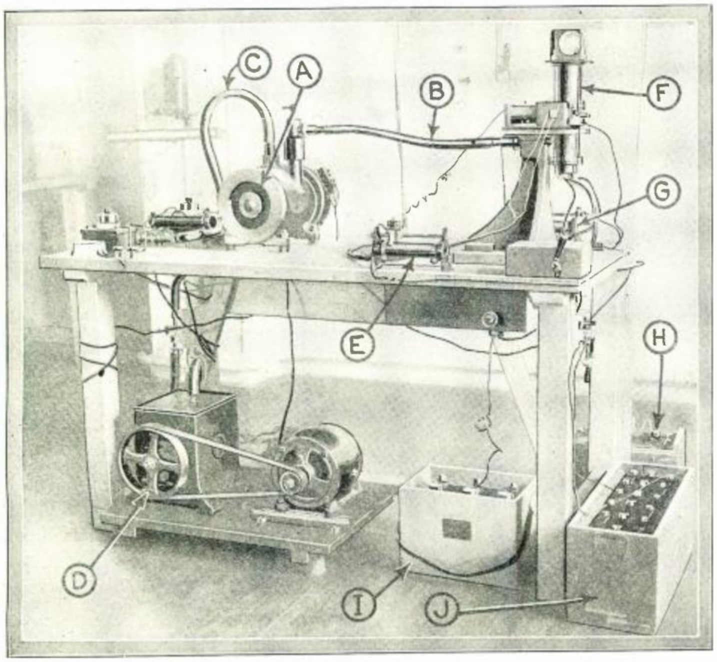

Fig. 5. The receiving apparatus: A is the Holweck molecular pump; B, tube connecting with oscillograph; C, tube connecting pumps; D, preparatory or "fore" pump; E and G, rheostats; F, oscillograph; H, I and J, batteries for concentrating coil, filament and low-frequency coil.

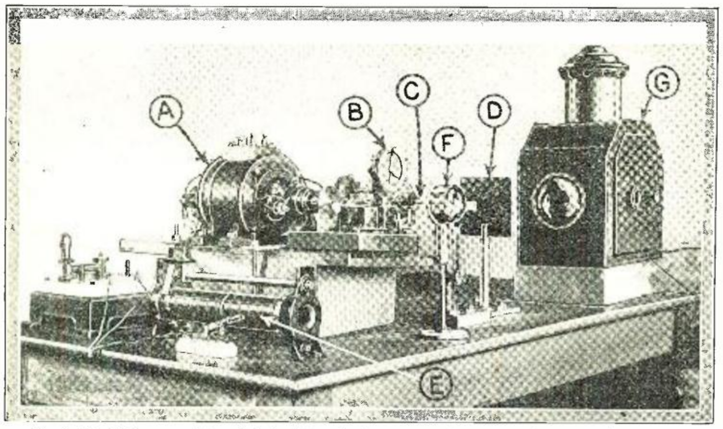

Fig. 3. The Belin transmitter: A is the 500-cycle alternator used as a motor for the moving mirrors; B, microphone of low-frequency mirror; C, "transparency" (photo film) support; D, diaphragm; E, alternator rheostat; F, objective lens; G, arc lamp.

swept over in 1/10 of a second, each point of the plate has only 1/108,000 seconds to act.

The transparent parts of the photographic negative will pass enough light to enable the cell to carry out its functions, but the semi-opaque parts will require probably a light beam of the luminous intensity of an arc-light to properly affect the cell. However, if the photographic plate is larger, the dimensions of the pencil of light should be increased. Under these conditions, we may ask if the photo-electric cell, with increased light pencil, will respond sufficiently to the changes in light?

THE SYNCHRONIZING DEVICE

The movement of the oscillating mirrors gives us a curious mechanical problem to solve, for we must not forget that the transmission apparatus must be synchronized with the receiving apparatus. The oscillating mirrors are acted on by a little alternator, which sends current of a frequency of 500 cycles per second either over a wire or by radio-transmission to the receiving stations and which acts like a motor for keeping the mirrors in motion. It is necessary to send not only the current of 500 cycles, but also another one of 10 cycles that drives the upper mirror. In the experimental arrangement the upper mirror was connected to an ordinary microphone by a light metallic bar, whose end rested upon the microphonic membrane (see Fig. 3). At the end of each oscillation of the 10-cycle mirror, the rod, by its pressure on the membrane sent a current each .1 of a second, which was received by the receiving station; and in conjunction with the 500-cycle current, acted to synchronize the sending and receiving apparatus.

It is hoped to dispense ultimately with the microphone. It is not necessary to transmit two different currents at different frequencies; it is enough to transmit a current of 500 cycles to insure the synchronism of the two stations. This is because the movements of the two mirrors are mechanically conjugate, being actuated by the same motor. At the receiver a frequency-changing apparatus may be used for lowering the frequency from 500 cycles to 10 cycles, a part of the original current at 500 cycles, being utilized directly.

HOLWECK CATHODE OSCILLOGRAPH

Here comes in the art of Mr. Holweck, expressed in his cathode oscillograph. This is simply a modification of the three-electrode tube used in radio-telephony. Above the filament, Fig. 4, is placed the grid, a circular plate with a hole in its center, above which a disc of similar form acts as the plate, which is also pierced by a central hole with a little copper tube above it. The filament requires a potential of about two volts. The varying potential in the modulated circuit is applied between grid and filament. Finally, the plate is kept at a constant potential of 1,500 volts by a special battery.

The apparatus thus formed being in action, there is produced between filament and plate, a stream of electrons which is "canalized" in the vertical tube surrounded by a little coil. The action of this is to concentrate in a very fine ray the invisible shaft of electrons. Their bombardment is made visible by their reception on a fluorescent screen placed in the upper part of the oscillograph. We must add that the oscillograph tube is evacuated, by a Holweck molecular pump. (Fig. 5.)

The current, modulated at the transmitter, and picked up by the receiver reaches the filament and the grid of the oscillograph tube. This current will introduce a disturbance in the normal emission of electrons, a disturbance which corresponds exactly with the variations of the modulated current at the transmitter. The luminous point produced on the fluorescent screen of the oscillograph tube varies in intensity in accordance with the passage of the luminous pencil at the transmitting station, as it traverses light and dark portions of the photographic plate. This phenomenon is very apparent when the point is kept fixed upon the fluorescent screen. It gives a little blue speck of light, comparable to a star on a beautiful winter night.

But this only gives us a fixed point on the screen. This is far from the reproduction of the image! What are we going to do? Our readers know that an emission of electrons is very sensitive to the presence of a magnetic field. The presence of a small coil surrounding the tube of the oscillograph, which "canalizes" the electrons, shows its sensitiveness very clearly. When it is not excited the stream of electrons fills the little tube. When a current passes, the stream is contracted and the trace, which it produces on the screen, shrinks up until it is only a brilliant point.

Putting aside the question of television, we are here face to face with some very curious electrical phenomena. The stream of electrons, in fact, is displaced in any direction whatever, merely by bringing a bar magnet near the oscillograph; the luminous trace will be seen to describe a circle on the screen. Remove the magnet and the point returns to the center. This extreme sensitiveness has been utilized for making this point of light repeat the movements that the mirrors give to the pencil of light, at the transmitting station.

Two ordinary coils are placed near the oscillograph at an angle of 90°. Through one is passed the 500-cycle current and through the other the 10-cycle current. After

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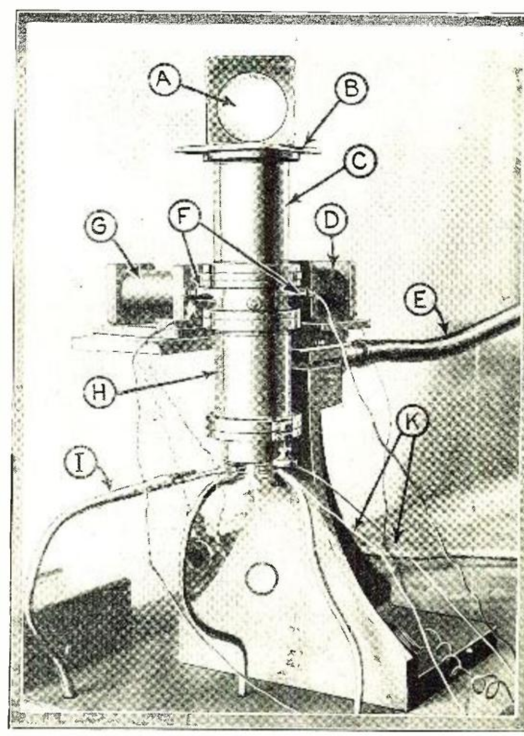

Fig. 6. The Holweck oscillograph: A is a prism on which visible images form; B, fluorescent screen of calcium tungstate; C and H, oscillograph tube; D, low-speed electric motor; E, tube from molecular vacuum pump; F, terminals of the concentrating coil; G, high speed motor; I, plate connection. (1500 volts); J, filament connection; K, grid filament lead.

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what we have said it will be seen that each of the magnetic fields which they produce will have the effect of displacing the stream of electrons in exactly the same way that the luminous ray is displaced by the oscillating mirrors at the transmitter. As these movements of the receiving spot of light are performed under the direct control of transmitting apparatus (alternator and microphone) synchronism is secured in a rigorous degree and the reproduction of the picture at the transmitting station can be obtained on the screen of the oscillograph. The illustration, Fig. 6, shows that this screen, which is placed horizontally upon the oscillograph, has been adjusted there so that a prism reflecting the beam gives a slightly inclined image which is easier to observe.

Up to the present time, Messrs. Belin and Holweck have only tried their apparatus on pictures without half-tones; that is to say having only black and white areas. It is the first step towards the transmission of an image printed in half-tones, such as is used

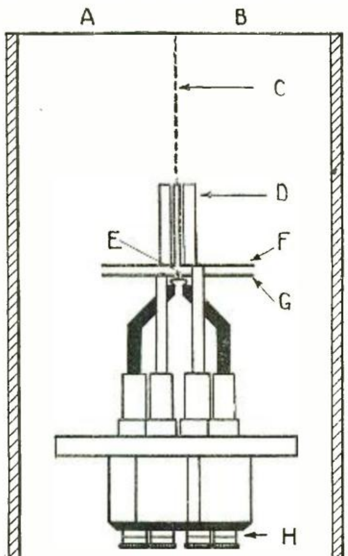

FIG. 4

The Holweck apparatus: A-B is the fluorescent screen on which the electron stream, C, traces a line of light; D is the concentrating coil; E, the filament; F, the plate; G, the grid; H, terminals for the supply circuit.

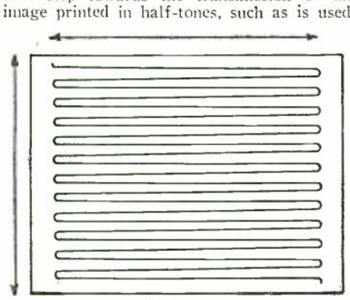

FIG. 2

Fig. 2. Due to the oscillations of the two mirrors, the beam of light follows a zig-zag path across the screen as indicated above. It oscillates horizontally 500 times per second, and vertically 10 times per second.

in ordinary projection. When this purpose is attained, it will be possible to transmit a moving picture film and to receive it by radio on another film, which can be projected under ordinary conditions.

This will be the first heat in the television race.

The Improved "Bass Note" Circuit

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OPERATING THE SET

To tune the set, turn the potentiometer and rheostat knobs about half way around. Then set both tuning dials at approximately the same reading, finally moving them to the right or left until a station is heard. After a station has been received, adjust the potentiometer until a slight squeal is heard, then turn the potentiometer to the left a trifle and retune each tuning dial until maximum signal strength is received. A slight further adjustment of the potentiometer will give maximum clarity and volume to the speech or music. Several refinements in tuning can now be made.

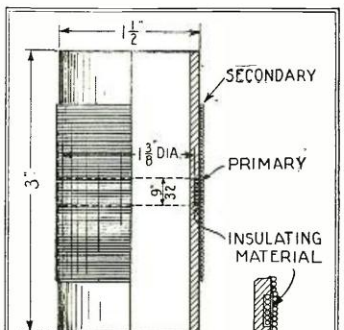
The rheostat at the extreme right may be used as a volume control and as a selectivity adjustment. The receiver will be most selective when the rheostat is turned to about one-quarter, or one-half, way around from the left. Turning this knob still further to the left will reduce the volume as much as is desired.

The potentiometer acts not only as an oscillation control, but also as a vernier volume adjustment.

The purpose of the left-hand, or tandem-compensating, condenser, is to tune exactly the two main-section variable condensers. For local reception this adjustment is very seldom required. When tuning in distant stations, however, it will be necessary to set the rotor, so that the capacities between it and the two sections of the stator are equally distributed.

In other words, the rotor should be in neutral position. After the distant station has been located on the dial, the knob controlling this condenser should be turned to either the right or left, as will be quickly indicated when this adjustment is made. A careful adjustment of this condenser will bring in distant stations with maximum volume.

The small balancing condenser within the set can be adjusted once and when this



The three inductances in the R.F. circuit are constructed on forms the size of which is given above. For the No. 1 coil, the primary consists of 15 turns, tapped at the 10th; the secondary having 105 turns and is wound over the primary as shown. The No. 2 coil has 18 turns in the primary; and the No. 3 coil has 15. The secondaries of all these three coils have the same number of turns, 105. The primaries are wound with No. 30 D.S.C. wire and the secondaries with No. 26 D.S.C. wire. The tap in the No. 1 primary is for a long antenna; the entire coil being used for a short one.