

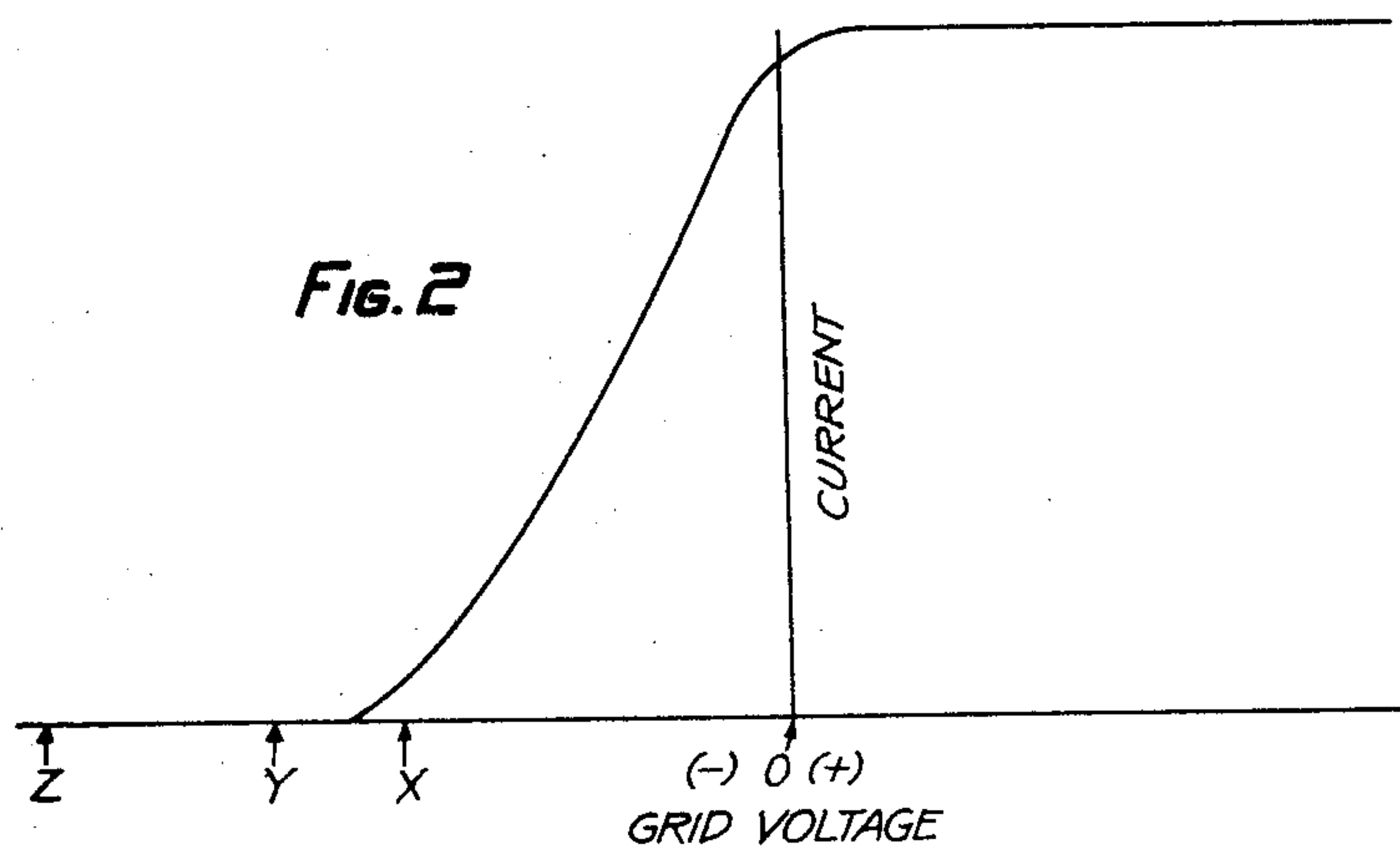
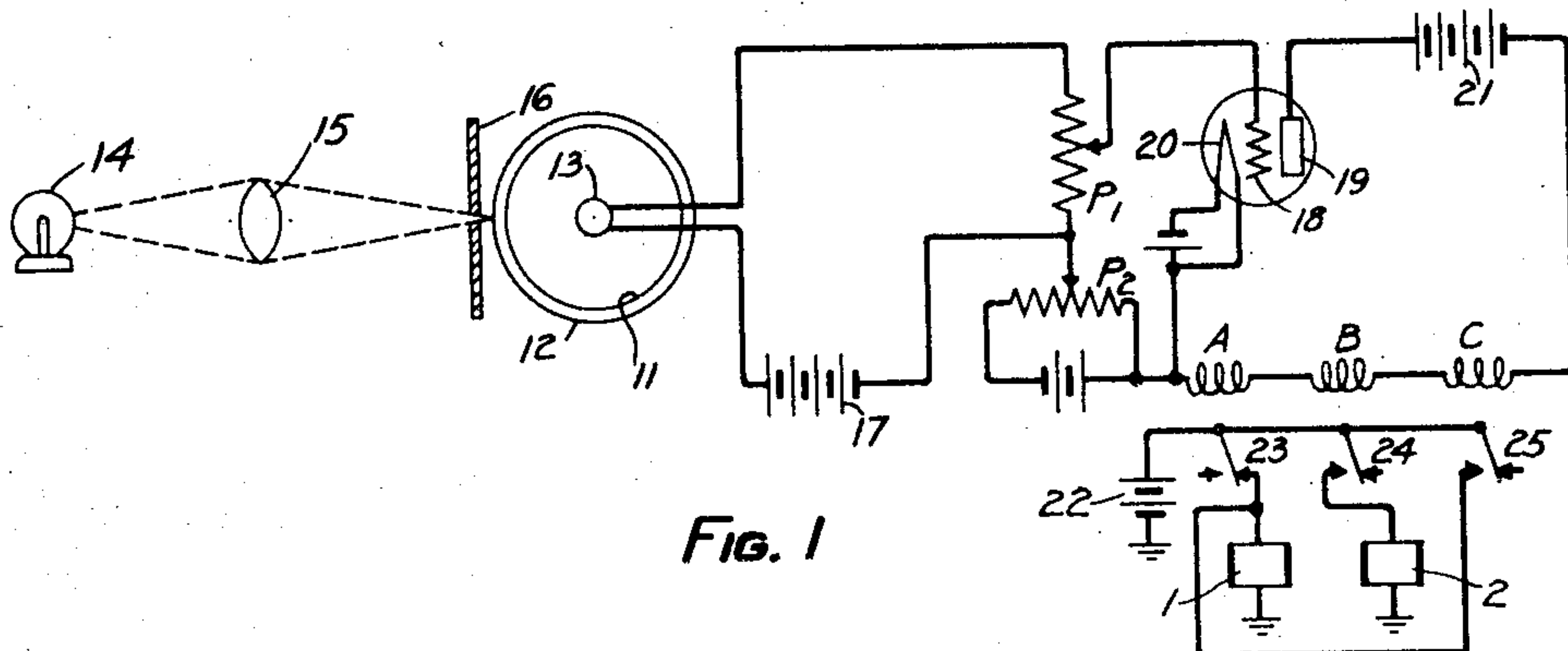
Jan. 31, 1933.

A. WEAVER

1,895,531

ELECTROOPTICAL SYSTEM

Original Filed March 26, 1924 3 Sheets-Sheet 1



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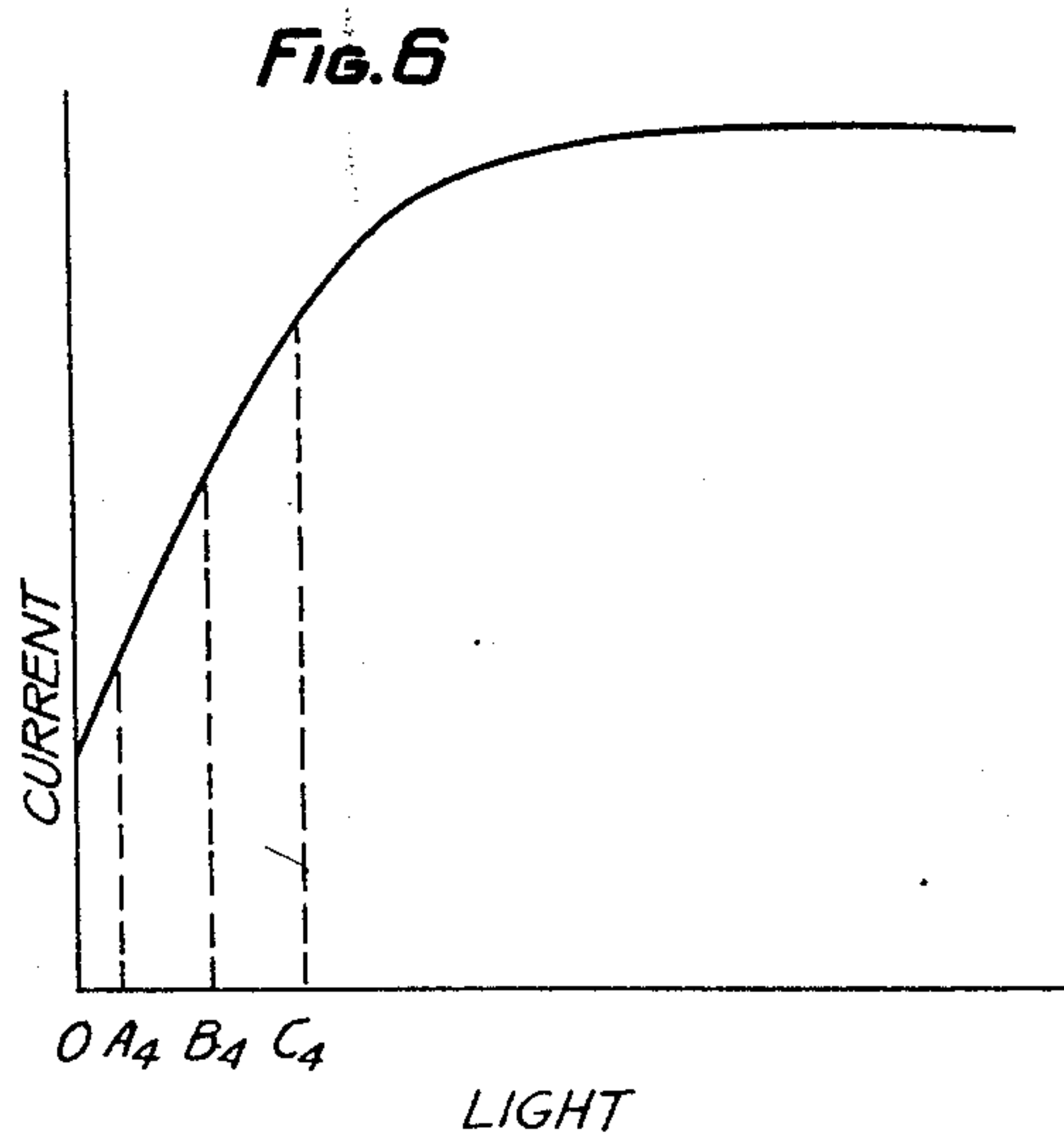
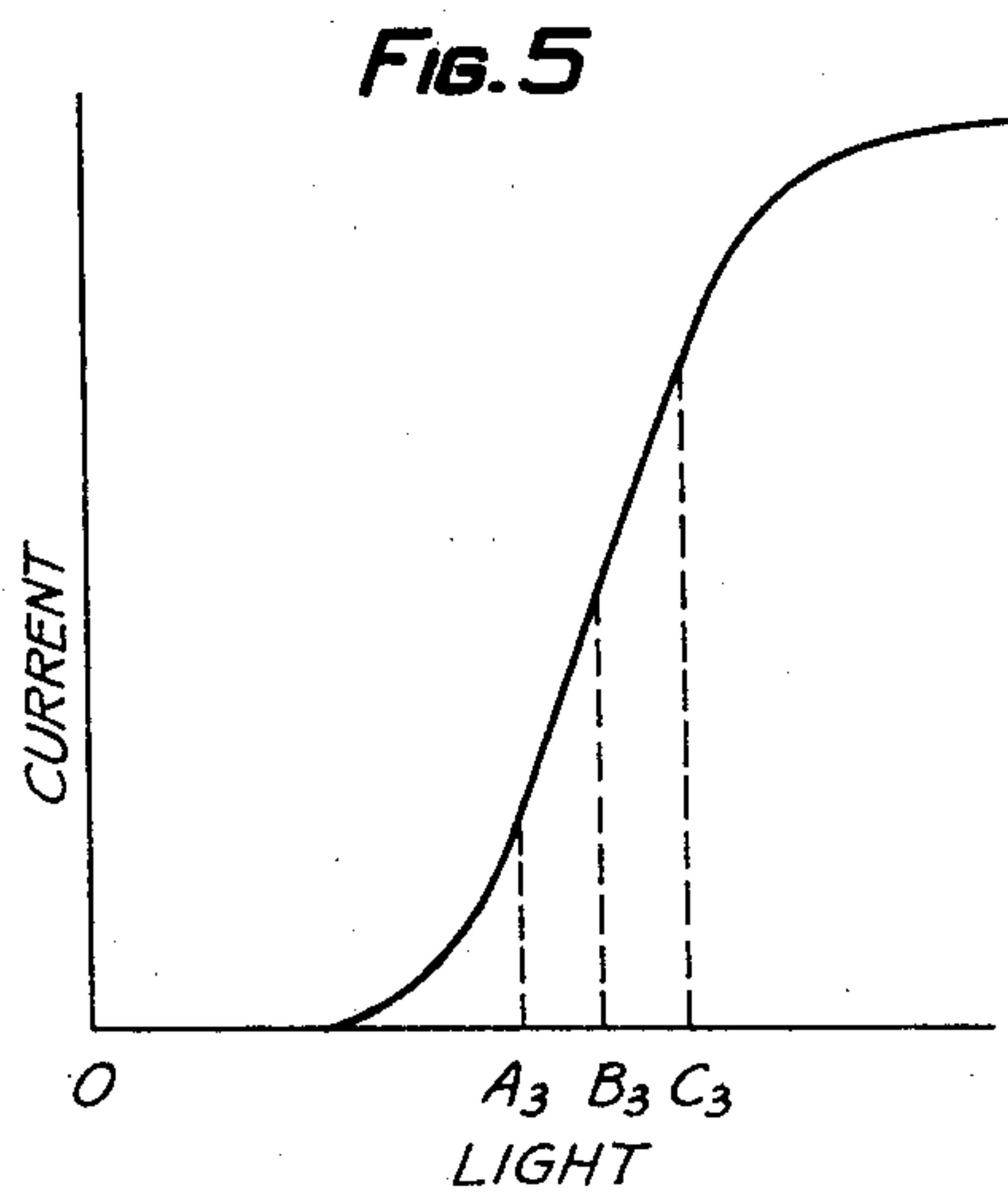
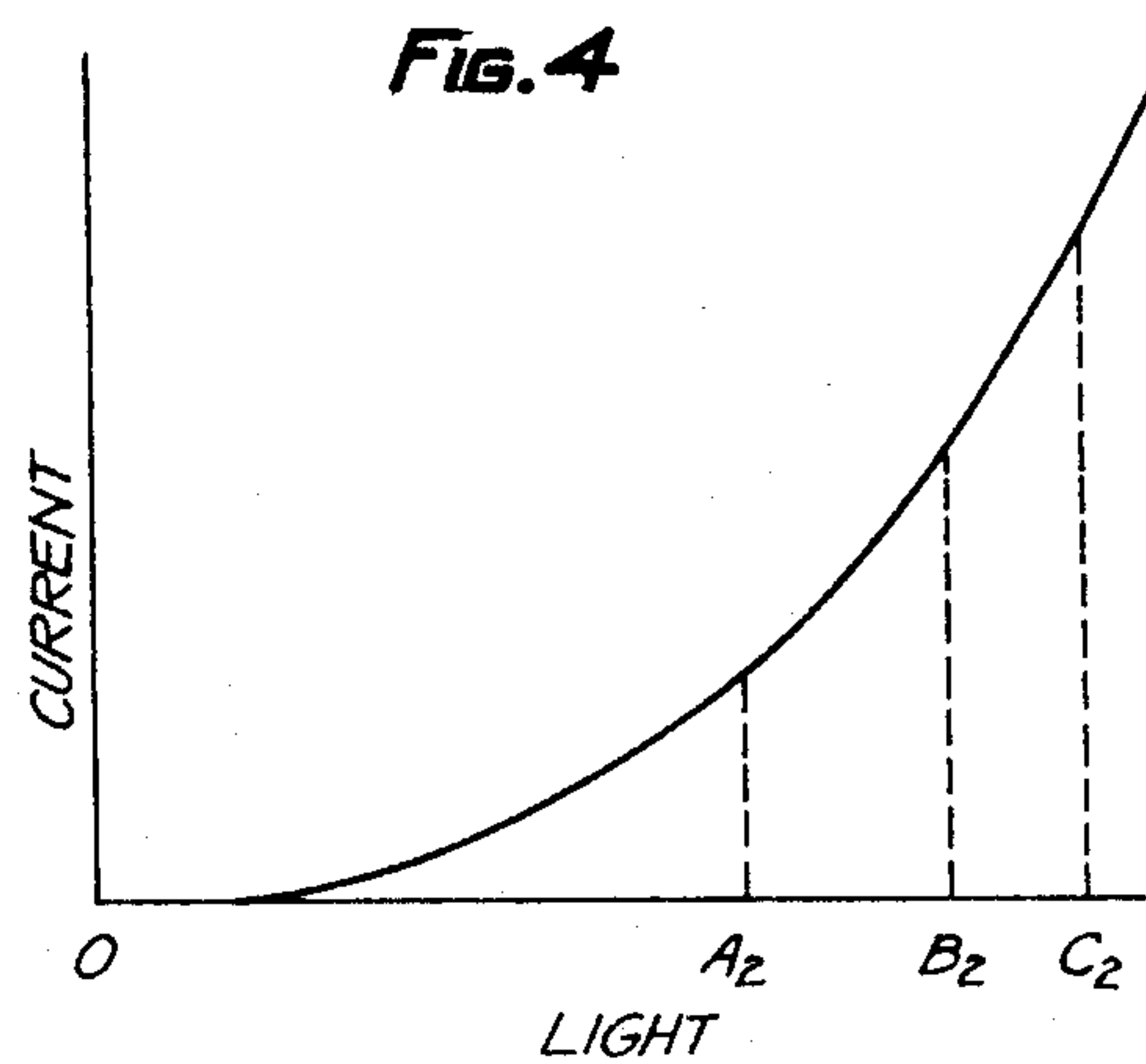
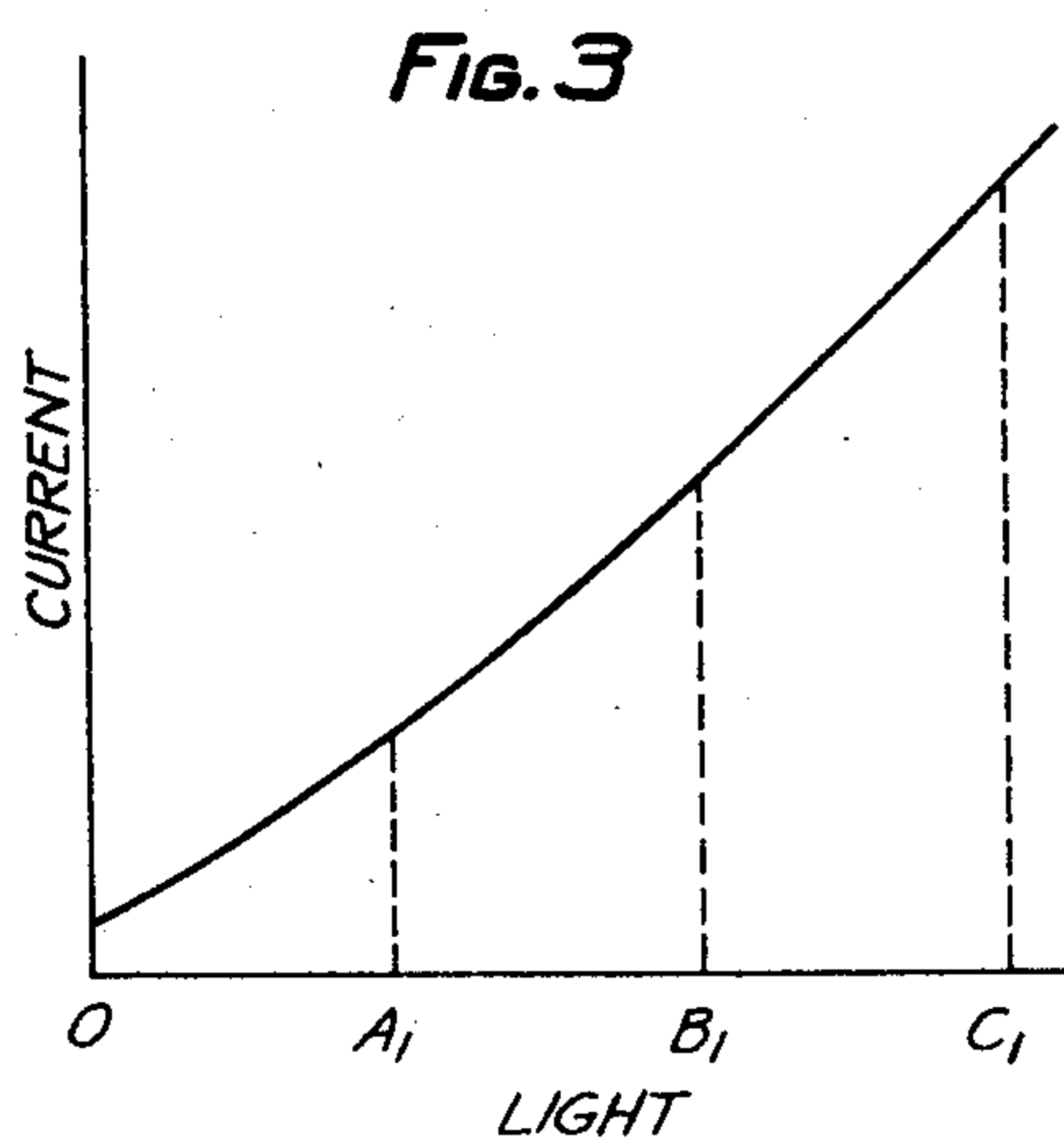
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ELECTROOPTICAL SYSTEM

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ELECTROOPTICAL SYSTEM

Original Filed March 26, 1924 3 Sheets-Sheet 3

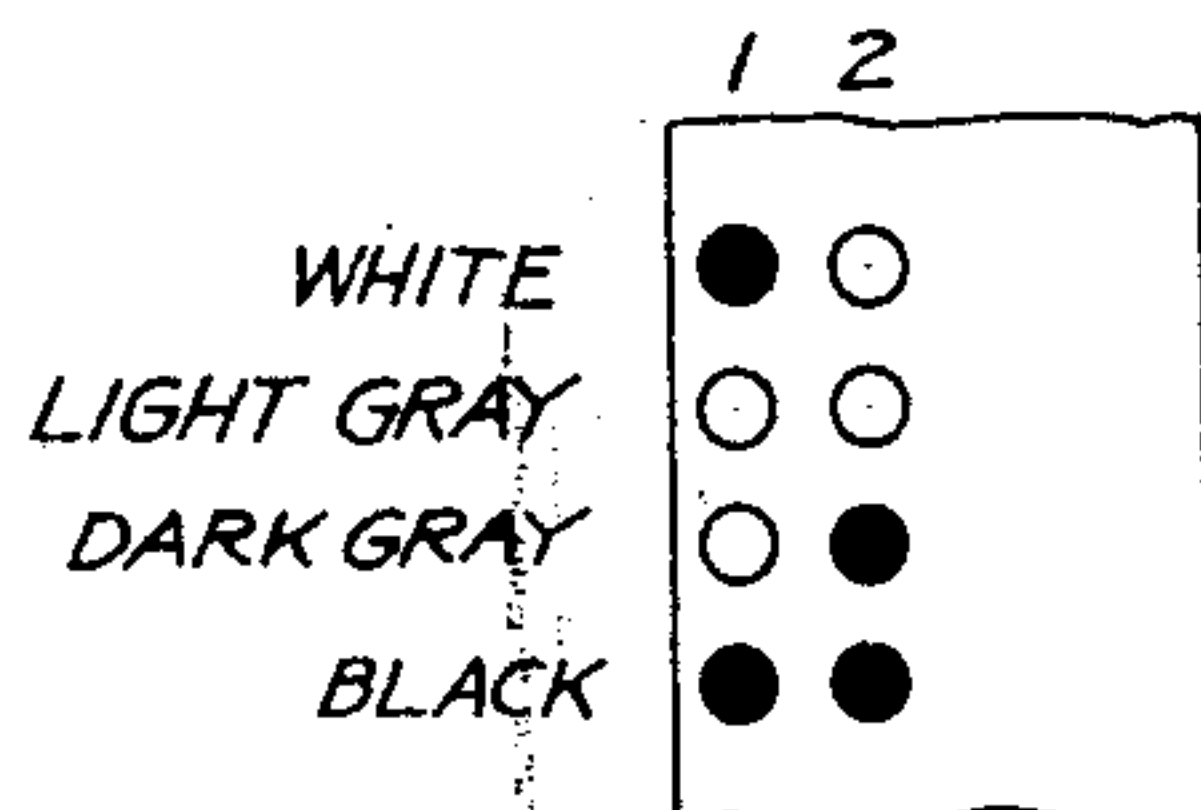


FIG. 7

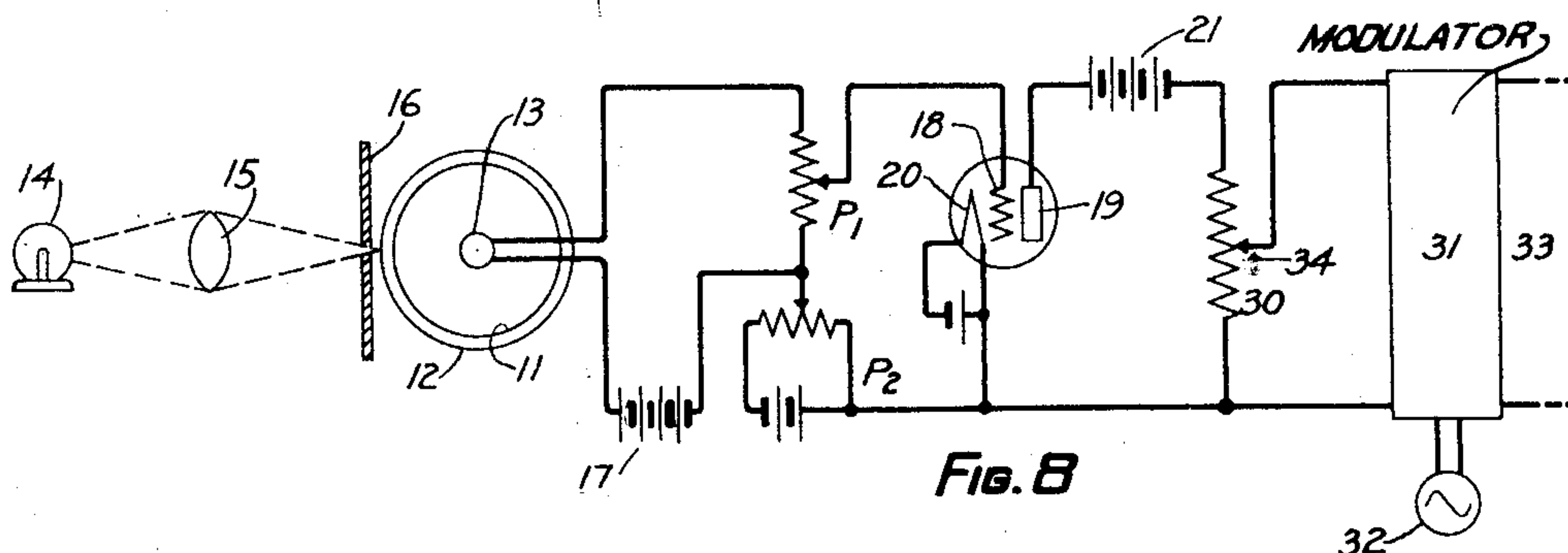


FIG. 8

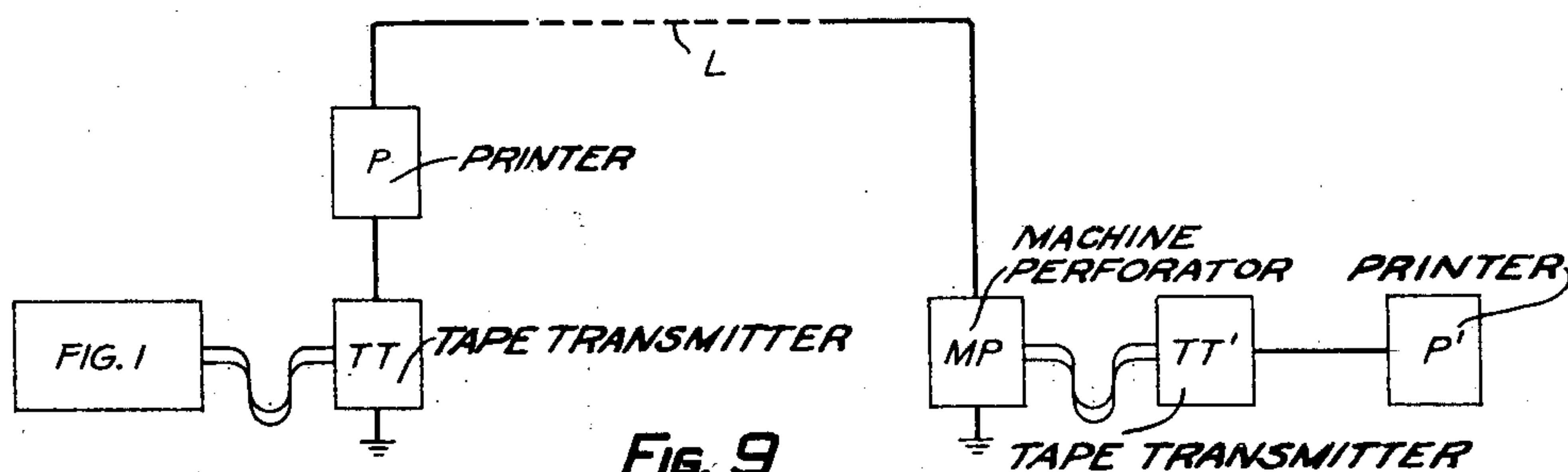


FIG. 9

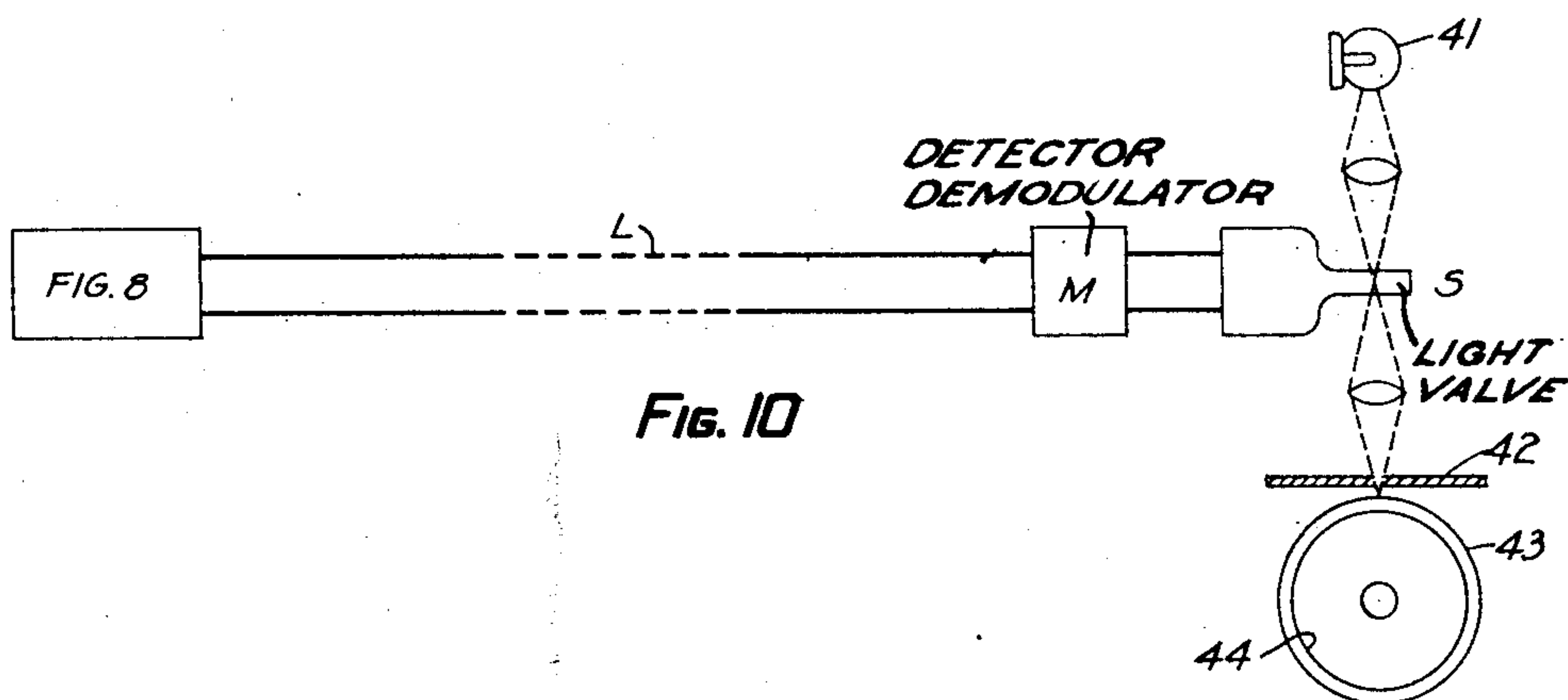


FIG. 10

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ELECTROOPTICAL SYSTEM

Original application filed March 26, 1924, Serial No. 702,109. Divided and this application filed June 18, 1930. Serial No. 462,025.

This invention relates to electro-optical systems and more particularly to reproducing amplifiers used in such systems.

This application is a division of my co-pending application Serial No. 702,109, filed March 26, 1924, now Patent No. 1,783,321, granted December 2, 1930, for electrical transmission of pictures.

An object of this invention is to provide an improved combination of reproducing amplifier, light reactive device and adjustable means therebetween for obtaining more effective operation in an electro-optical system.

An illustrative embodiment of the invention is a picture transmitting system employing potentiometer adjustments between the light sensitive cell and the reproducing amplifier for variably controlling the static grid potential whereby uniform reproduction with light reactive cells of varying characteristics can be effected. Specifically a "C" battery and a variable potentiometer are connected in the filament grid circuit between the grid and the light sensitive cell so as to predetermine the relationship between the output current of the amplifier and the light controlled current from the photoelectric cell.

In one of the arrangements selected for illustrating the invention a picture representation in the form of an under-exposed film is wrapped around a slowly rotating glass cylinder and scanned with an intense spot of light. The transmitted light varying in intensity with the density of the film is received by a suitably positioned light sensitive cell and converted into varying electrical currents which are transmitted to a three electrode reproducing amplifier. Upon proper adjustment of a potentiometer in the grid filament circuit no current will flow in the plate circuit of the amplifier until the transmitted light reaches a comparatively large value. This adjustment serves to compensate for an under exposure of the film being scanned. The output of the reproducing amplifier is used to operate three marginal relays which in turn control the circuits of the two selector magnets. These magnets cause holes to be punched in a tape in accordance with the impulses transmitted from each

successive element in the picture. With a suitable device commonly used in well known printing telegraphy a tape at the receiving end is perforated corresponding to that of the sending end. For films of very little contrast potentiometer adjustments are made so that a small change of current in the light sensitive cell produces a large change of voltage on the grid and a large change of current in the plate circuit of the reproducing amplifier.

A modification of the arrangement described above is the same from the source of scanning light to the vacuum tube amplifier, but instead of marginal relays being used in the plate circuit of the amplifier, a variable resistance is used to couple the output circuit of the amplifier to the input circuit of a carrier current modulator. Thus instead of a tape being perforated, a modulated carrier wave is sent out over a line to a receiving station.

Various other objects of this invention will become apparent upon consideration of the following detailed description and appended claims.

Referring to the drawings, Fig. 1 is a diagram illustrating a picture transmitting system embodying my invention; Fig. 2 is a characteristic curve for the plate current as a function of the grid voltage in a three-electrode vacuum tube amplifier; Figs. 3, 4, 5 and 6 are curves showing the amplifier output current as a function of the transmitted light with various adjustments in my system; Fig. 7 shows a punched tape embodying the code for my system; Fig. 8 is a diagram of apparatus alternative to that shown in Fig. 1; and Figs. 9 and 10 are general symbolic diagrams of the entire systems of which the apparatus of Figs. 1 and 8 respectively are parts.

The glass drum 11 is rotated slowly on its axis and traversed lengthwise in the meantime, so that the spot underlying the opening in the screen 16 describes a helical course relatively to the drum 11. Wrapped about the drum 11 is a picture representation in the form of a semi-transparent film 12. The lamp 14 has its light focused by the lens 15

at the opening in the screen 16 and this light shines through the film 12 and the drum 11 on the photoelectric cell 13.

This cell 13 is in circuit with the battery 17 and according to well known principles, the current in this circuit will vary in dependence on the light that passes through the underlying spot of the film 12 to the cell 13.

The grid 18 of a three-electrode vacuum tube or audion has its circuit completed to the filament 20 through an adjustable portion of the resistance of the potentiometer P_1 , the entire resistance being comprised in the circuit of the photoelectric cell 13. The electromotive force normally applied to the grid 18 is determined by the potentiometer P_2 . As the current through the cell 13 increases, the potential drop in the portion of the potentiometer resistance P_1 comprised in the grid circuit increases, and vice versa; thus the current in the cell 13 determines a corresponding voltage on the grid 18.

The plate circuit of the audion comprises the battery 21, the plate 19 and the filament 20 and the windings of three marginal relays A, B and C. These are adjusted so that for a certain small amount of light in the cell 13, none of them picks up; for a limited increase of the light, A only picks up; then with more light A and B pick up; and with still more light, A, B and C pick up.

The armatures of the relays A, B and C control the circuits of the two selector magnets 1 and 2.

Referring to Fig. 7, this shows a tape with a transverse row of positions for holes to be punched for each successive picture element in the film 12. In Fig. 7, a solid black circle means a hole punched in the tape and an open circle merely indicates a position at which a hole might have been punched. At any position of the tape a hole in the column marked 1 will be punched when the magnet 1 is energized, and similarly, for the column marked 2 and the magnet 2. In accordance with what has been said, the code indicated in Fig. 7 can readily be verified.

Fig. 2 shows a curve giving the relation of the output current to the grid voltage in a three-electrode vacuum tube amplifier such as that shown in Fig. 1. Fig. 2 presupposes a certain constant voltage in the plate circuit as given by the battery 21.

For a good ordinary film, in order to actuate the marginal relays A, B and C with definiteness, a desirable relation between the light falling on the photoelectric cell 13 and the current in the output circuit of the amplifier will be as given by Fig. 3. The quantity of light to produce enough current to cause the relay A to pick up is given by the abscissa OA_1 . An increase in the quantity of light to OB_1 gives enough current to cause the relay B also to pick up, and an increase in the quantity of light to OC_1 causes the re-

lay C in addition to pick up. Such a characteristic as that shown in Fig. 3 can readily be obtained by adjustment of the potentiometers P_1 and P_2 in Fig. 1. The potentiometer P_2 is adjusted to give the negative voltage OX (in Fig. 2) on the grid, when the light on cell 13 is zero.

Assume that the film 12 is lighter than the usual film,—that is, that it may have been under-exposed but still possesses sufficient contrast. In this case a suitable relation between light and current will be that given by Fig. 4. It will be seen that here no current will flow in the plate circuit until the light reaches a comparatively large value, and not until the light reaches the amount given by the abscissa OA_2 will the current rise to a sufficient value to pick up the first marginal relay A. Further increments in the light will then cause the additional relays B and C to pick up in succession. This kind of a characteristic will be obtained with the apparatus in Fig. 1 by making P_1 a proper value and by adjusting the potentiometer P_2 until the normal grid potential corresponding to zero light on the cell 13 is at the negative value indicated by the abscissa OY in Fig. 2.

Again, suppose the film 12 has very little contrast, such as might be obtained when the original view has insufficient contrast. A suitable current light characteristic will then be as shown in Fig. 5. This will be obtained by adjusting the potentiometer P_2 to give a strong normal negative voltage on the grid 18 as indicated by the abscissa OZ in Fig. 2 and by adjusting the potentiometer P_1 so as to include a large part of its resistance in the grid circuit. This latter adjustment makes a small change of current in the circuit of the cell 13 produce a large change of voltage on the grid 18 and a large change of current in the circuit of the plate 19, all as shown in Fig. 5. With the explanation that has gone before it will be readily apparent how adjustments may be made for an over-exposed film, corresponding to Fig. 6.

Fig. 8 shows a modification which is the same as in Fig. 1 from the source of light 14 to the vacuum tube amplifier 18—19—20. Instead of having marginal relays in the plate circuit as for Fig. 1, the plate circuit in Fig. 8 comprises the battery 21 and a resistance 30. The adjustable tap 34 enables one to apply as input to the modulator 31 any desired fraction of the voltage drop through the resistance 30. At 32 is a source of alternating current which is put into the modulator 31 and modulated from the input circuit last mentioned and the modulated current is put on the line 33.

In this modification the amplitude of the modulated carrier for any amount of light falling upon the light sensitive element is represented by the corresponding ordinates

of the curves of Figs. 3, 4, 5 or 6. When the system is operated according to the condition represented by Fig. 3 the relation between light transmitted through the picture representation and the amplitude of the modulated carrier current is seen to be approximately linear. The picture formed at the receiving station will then be an approximate reproduction of the picture representation at the sending station.

When the system is operating according to the condition of Fig. 5 for instance, the relation between light and modulated carrier current is non-linear. The curve is now such that the high lights will be made lighter and the shades darker. The received picture will therefore possess more contrast than the picture representation at the sending station.

The perforated tape produced by the apparatus of Fig. 1 is fed to a tape transmitter TT as shown in Fig. 9. This tape transmitter and the remaining elements of Fig. 9 here to be mentioned are devices commonly used and well known in text message printing telegraphy, hence they are shown only symbolically in the figure and are described only briefly here. The tape transmitter TT determines the sending of code current impulses on the line L, which are received in the machine perforator MP, which perforates a tape at the receiving end corresponding to that at the sending end. The tape from the machine perforator MP goes to a tape transmitter TT', which controls the operation of the printer P'. This printer P' prints a blank for the shade white in the picture, a small dot for light gray, a medium dot for dark gray and a large dot for black. Thus it will be seen that the sheet produced by the printer P' is a half-tone reproduction of the picture corresponding to the picture representation 12 of Fig. 1.

Each time the edge of the film 12 passes the opening in the screen 16, a special code combination is punched in the tape. The corresponding currents sent over the line L and recorded in the tape at the receiving end determine the carriage return and line feed functions in the printer P'.

The currents from the tape transmitter TT also determine the operation of a printer P at the sending station, so that the sending station will have a copy of the picture in the same style that it is reproduced by the printer P' at the receiving station.

When the transmitting apparatus of Fig. 8 is employed, the entire system will be as shown in Fig. 10. The modulated carrier currents put on the line L at the sending station go to detecting and demodulating apparatus M at the receiving station. The output current from the apparatus M controls a light valve S which determines the quantity of light from a source 41 to the spot of the sensitive surface 43 that underlies the

opening in the screen 42. The surface 43 is on a drum 44 which is rotated and traversed in synchronism with the drum 11 at the sending station. Accordingly the exposure of the surface 43 to the light from the source 41 corresponds to the shade of the film 12 and when the surface 43 is developed, it will give a representation of the picture.

What is claimed is:

1. A reproducing amplifier comprising a bulb containing a filament and a grid, a circuit connecting the filament and grid and containing a source of potential and a light reactive cell, and a potentiometer connected across the filament and grid for controlling the grid potential whereby uniform reproduction with light reactive cells of varying characteristics can be effected.

2. A reproducing amplifier comprising a bulb containing a filament and a grid, a circuit connecting the filament and grid and containing a source of potential and a light reactive cell, a potentiometer and a resistance connected across the filament and grid for controlling the grid potential whereby uniform reproduction with light reactive cells of varying characteristics can be effected.

3. In combination an electric discharge device having a filament, an anode, and a control electrode, an anode-filament circuit therefor including means responsive to variations in the amplitude of the space current, a control electrode-filament circuit therefor including variable means for normally negatively biasing the control electrode with respect to the filament and an impedance element connected in series therewith, a light sensitive device and a source of current connected in series with said light sensitive device whereby the normal biasing potential impressed upon the control electrode is opposed by the potential drop across said impedance element produced by the current flowing through said light sensitive device.

In testimony whereof, I have signed my name to this specification this 16th day of June 1930.

ALLAN WEAVER.