April 3, 1928.

1,664,652

E. F. WATSON ET AL

PICTURE TRANSMITTING SYSTEM

Filed March 26, 1924 2 Sheets-Sheet 1

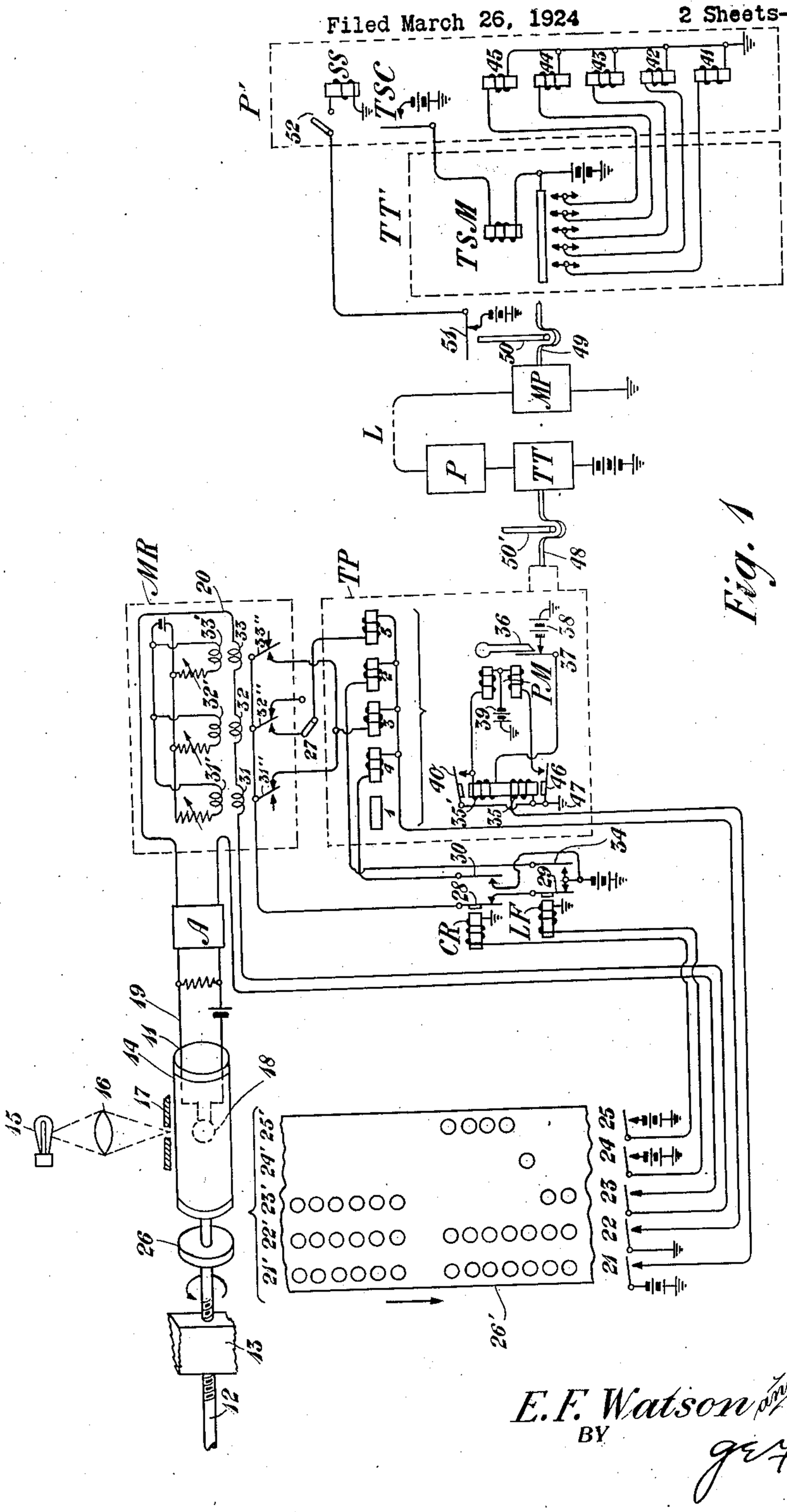

Fig. 1

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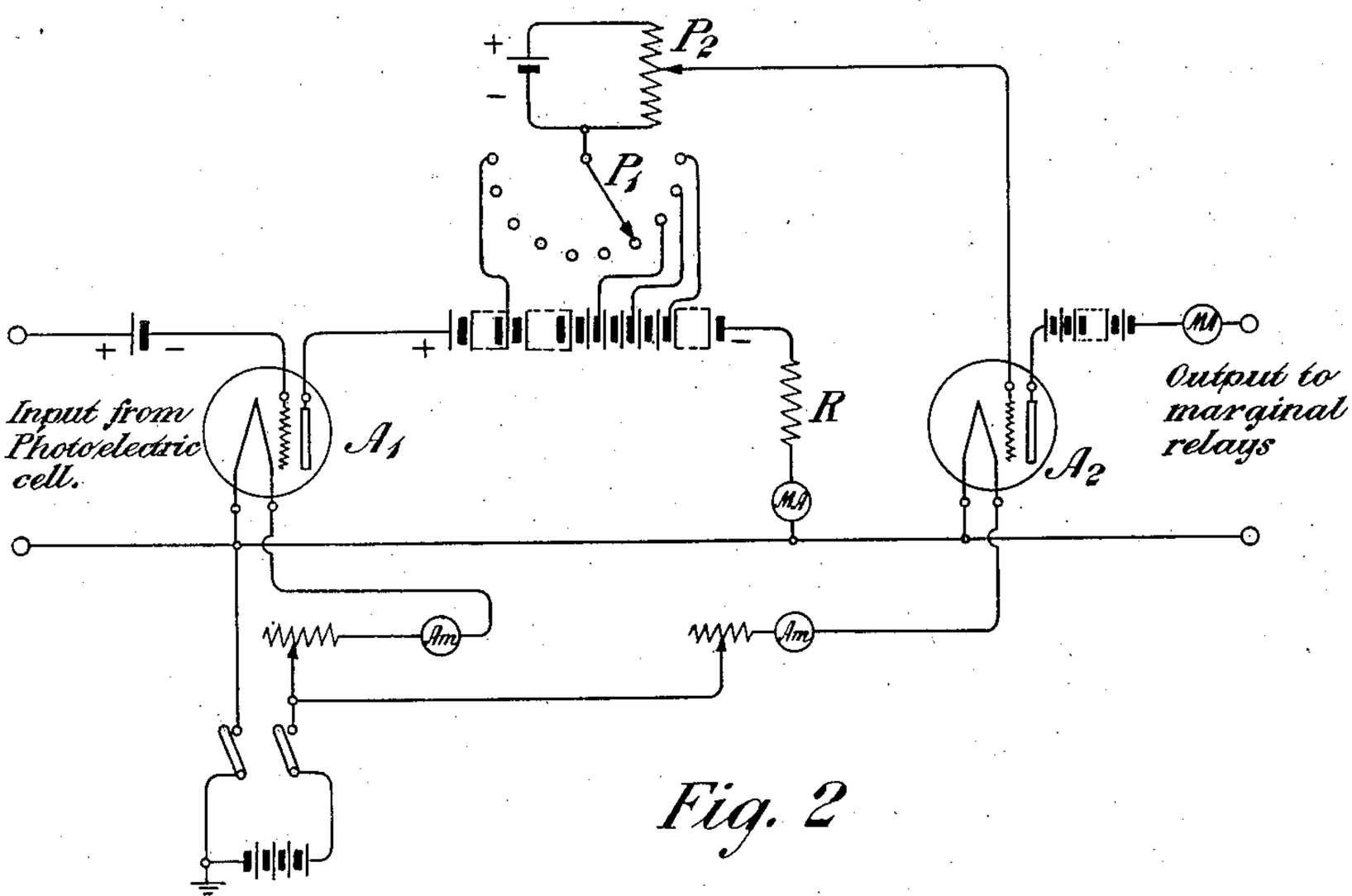

Fig. 2

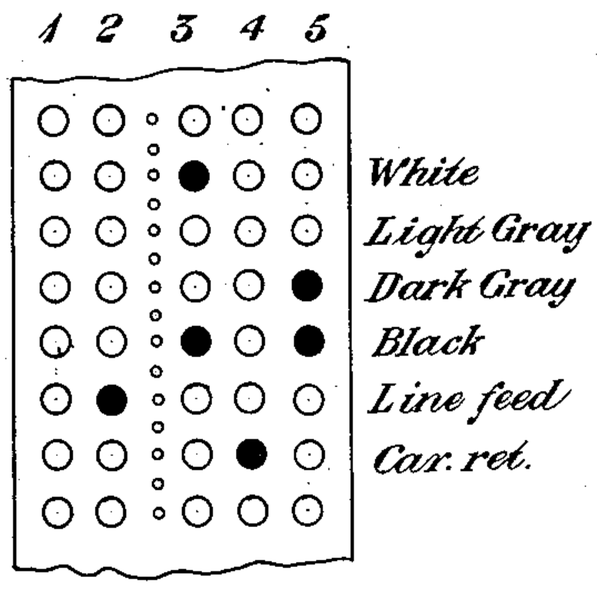

Fig. 3

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Patented Apr. 3, 1928. 1,664,652

UNITED STATES PATENT OFFICE.

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PICTURE-TRANSMITTING SYSTEM.

Application filed March 26, 1924. Serial No. 702,108.

The principal object of our invention is to provide a new and improved method and apparatus for the electrical transmission of pictures from one place to another at a distance. Another object of our invention is to provide for analyzing a picture into elements and sending code combinations over a line corresponding to the shade of each element, and at the receiving end printing a corresponding picture according to the "half-tone" principle. These and various other objects of our invention will become apparent in connection with the disclosure of a single embodiment of the invention which is made in the following specification taken with the accompanying drawings. It will be understood that this disclosure relates to the particular example of the invention which is chosen to illustrate it and that the invention is defined in the appended claims.

Referring to the drawings, Figure 1 is a general diagram of the system; Fig. 2 is a diagram of the amplifier indicated by the letter A in Fig. 1; and Fig. 3 is a diagram showing the code combination employed as punched in a tape.

The transparent glass drum 11 is mounted to rotate on its axis on the shaft 12 which is traversed lengthwise by screw-threaded engagement with the stationary block 13. A picture representation in the form of a semi-transparent film 14 is wrapped about the drum 11 and accordingly, as the drum 11 rotates and advances, the successive elemental areas of the film 14 pass in helical order under the opening in the screen 17. Light from the lamp 15 is focused by the lens 16 on this opening in the screen 17 and shines through the film 14 to the photoelectric cell 18 which is in the input circuit of the amplifier A. This amplifier is shown in Fig. 2. It consists of two three-electrode vacuum tubes A_1 and A_2 and the circuits and other elements comprised therewith as shown in this figure. The input from the photoelectric cell goes to the grid circuit of the three-electrode vacuum tube A_1 whose output is absorbed in the resistance R. By adjustment of the potentiometers P_1 and P_2, a suitable voltage is applied to the grid of the three-electrode vacuum tube amplifier A_2, and its output goes to the circuit 20 in Fig. 1, comprising the main windings 31, 32 and 33 of respective marginal relays. The devices represented by the symbol A*m* in Fig. 2 are ammeters and those represented by the symbol MA are milliammeters.

The three marginal relays having windings in series in the circuit 20 of Fig. 1 are adjusted by the respective branch circuits which comprise respective rheostats and biasing windings 31′, 32′ and 33′. The marginal relay assembly is designated MR. The marginal relay armatures 31″, 32″ and 33″ control energizing circuits for two of the five selector magnets shown, these two being magnet 3 and magnet 5.

With the switch 27 in the position shown, the system is adapted for sending when the film 14 is a negative. For white in the picture, no marginal relay will pick up and selector magnet 3 will be energized; for light gray in the picture, marginal relay 31 will pick up and no selector magnet will be energized; for dark gray in the picture, marginal relays 31 and 32 will pick up and selector magnet 5 will be energized; and for black in the picture, all three marginal relays will pick up and both selector magnets 3 and 5 will be energized. These relations are shown in Fig. 3.

If the switch 27 is thrown from the position indicated in Fig. 1, and if the film 14 is a positive, the foregoing relations between picture shades and the energization of the selector magnets 3 and 5 will be equally true.

The shaft 12 which carries the drum 11 also carries a drum 26 with five circumferential rows of contact closing studs. A portion of this drum 26, enlarged and developed, is shown at 26′, the respective rows of studs being designated 21′, 22′, 23′, 24′ and 25′, and the five contacts to be closed by the studs of the five circumferential rows are shown at 21, 22, 23, 24 and 25. It will be seen that there is a longitudinal row (more or less complete) of studs, that is, a row parallel to the axis of the shaft 12, for each successive picture element in one turn around the film 14. The contacts are placed so that for each picture element, they close in quick succession as follows: 23, 22 and 21. The closure at 23 causes actuation of the marginal relays, which set up a combination in the selector magnets, which then becomes effective by closure of the selector magnet cir-

cuits at 22, and this is followed by the actuation of the punch magnet PM by closure of the circuit of the punch magnet relay winding 35 at the contact 21. When the winding 35 is energized, the contacts 40 and 46 close, thus closing a circuit for the punch magnet PM from battery 39 to ground 47. Also, at the same time, there is closed a holding circuit for the relay from battery 38 through winding 35′ and armature 40 to ground 47. When the punch magnet PM operates, it attracts the armature 36 which breaks this holding circuit at 37. Thus, for each element of film 14, the code for its shade is punched in the tape in accordance with Fig. 3, where a solid black circle means a hole punched in the tape, but an unfilled circle merely indicates a position where a hole might have been punched.

The drum 26 rotates in the direction of the arrow, and when the edge of the film 14 reaches the opening in screen 17, the last stud of the circumferential row 23′ arrives at contact 23, and several positions in succession thereafter in row 23′ are blanks. At the next stage in the rotation of drum 26, a single stud in row 24′ engages corresponding contact 24, and closes the circuit of the line feed relay LF. This opens at 29 the circuit for selector magnets 3 and 5, thus guaranteeing against their possible false operation. Energization of the line feed relay LF also closes at 34 the circuit of selector magnet 2, so that the closure of contacts 22 and 21 causes the line feed code combination as shown in Fig. 3 to be punched in the tape.

At the next position, as the drum 26 rotates, the stud in the circumferential row 25′ closes the contact 25, thus energizing the carriage return relay CR. This opens at 28 the circuit for the selector magnets 3 and 5, guarding against possible false operation. Also, the energization of carriage return relay CR closes at 30 the circuit for selector magnet 4 and when the contacts are made at 22 and 21, the corresponding code combination is punched in the tape as shown in Fig. 3.

The carriage return studs in the circumferential row 25′ are repeated a number of times to insure that the carriage has ample time to return before printing starts again. Then as the drum 26 advances further, the normal set of studs in the three rows 21′, 22′ and 23′ are encountered and the code combinations are punched as already described by means of selector magnets 3 and 5 corresponding to picture shades as indicated in Fig. 3. The punched tape 48 issues from the tape punching assembly TP and passes under the lever 50′ to the tape transmitter TT. This is of the same kind as those used for transmitting text messages in printing telegraphy, so that it need not be described here. In well-known manner it sends successive current impulses over the line L corresponding to the code combinations in the tape 48. A printer P is operated by these code combinations at the sending station so that it shall have a picture reproduced in the same style as at the receiving station. The printer P is a page printer of the usual type capable of translating the telegraph line signals into characters printed on a page. For printing pictures it will usually be modified to give reduced character and line spacing as outlined below for printer P′.

At the receiving end of the line L, the current impulses actuate a machine perforator MP which produces the perforated tape 49, a copy of the sending tape 48. This machine perforator MP is of the kind used in receiving text messages for printing telegraphy, so that it will not be necessary to describe it here. The perforated tape 49 issuing from the machine perforator MP goes under the lever 50 and into the tape transmitter TT′. At P′ is an associated printer of the kind used in page printing telegraphy. This printer is of the motor driven type in which a clutch controls the starting and stopping of an operating shaft which makes one revolution in each character printed. The starting solenoid SS for the printer P′ is actuated by closing the switch 52 whose circuit comprises the contact 51. This causes the clutch to engage, starting the revolution of the operating shaft which will continue to revolve printing one character per revolution until the solenoid SS is deenergized. Contact TSC is operated from a cam on the printer operating shaft, closing once for each revolution. Whenever the tape transmitter TT′ takes in enough of the tape 49 to use up most of the slack between the machine perforator MP and the tape transmitter TT′, the tape 49 lifts the lever 50 and opens the contact 51, thus opening the circuit for the starting solenoid SS and stopping the printer P′. The tape stepping magnet TSM in the tape transmitter TT′ is actuated by successive closures of the tape stepping contact TSC in the printer P′. Hence when the printer is stopped by opening the circuit at 51, the tape transmitter TT′ is stopped by the cessation of the impulses determined at TSC.

The selecting magnets on the printer, 41, 42, 43, 44 and 45, select the proper characters to be printed as in ordinary text page printing telegraphy except that the code combination for white in the picture prints a blank, the code combination for light gray in the picture prints a small dot, the code combination for dark gray in the picture prints a medium dot, and the code combination for black in the picture prints a heavy dot. The printers P and P′ are modified to reduce the spacing from 10 per inch to

20 per inch and to reduce the line feed from 6 per inch to 20 per inch. The code combinations for carriage return and line feed effect these functions the same as in ordinary page printing telegraphy, and thus the sheet produced by the printer P′ as well as P, is a half-tone reproduction of the picture of the film 14.

We claim:

1. In combination, a photoelectric cell, a glass drum to carry a picture film, means to rotate the drum and traverse it along its axis, means to direct a beam of light through a spot of the film on the drum to said cell, so that as the drum rotates and advances, such spot will describe a helical course relatively thereto, selector magnets, means to control them by the effect of the said cell according to the light incident thereon, means to punch in a tape the code combinations determined by said selector magnets, and means to punch carriage return and line feed code combinations in the same tape when the edge of the film intersects the beam of light incident on the said cell.

2. In combination, a picture representation bent to cylindrical form, means to rotate it about its axis and traverse it meanwhile along its axis, means to direct a beam of light through a spot of said representation on a photoelectric cell, marginal relays, a circuit therefor in which the current is determined by said cell, means to punch code combinations in a tape as determined by said marginal relays, a drum rotating with said representation and determining the operation of said punching means for each successive elemental area of the representation, and means also operated by the rotation of the drum to punch carriage return and line feed code combinations in the tape.

3. In combination, a photoelectric cell, means to direct a beam of light upon said cell, means for varying said beam in accordance with the elemental tone values of a picture to be transmitted, means for preparing a tape with code combinations under the control of said photoelectric cell, a transmission line, a printer at the distant end of said line, means for sending code combinations of impulses over said line in accordance with the codes of the prepared tape, means responsive to said impulses for operating said printer to print a likeness of the picture, and means responsive to the impulses transmitted over said line for controlling the line feed and carriage return functions of said printer.

4. In an electro-optical image producing system, a light sensitive cell, means for subjecting said cell to the action of light in accordance with the tone values of successive elemental areas of a picture or object, an image of which is to be produced, thereby producing corresponding current variations in said cell, a plurality of relays the energization of which is controlled in accordance with said current variations, and means for periodically reducing said energization of the relays to restore them to the unactuated condition.

5. In an electro-optical image producing system, means for scanning a picture or object, an image of which is to be produced, a marginally operated device, means for energizing said marginally operated device in accordance with the tone values of successively scanned elemental areas of said picture or object, and means for reducing said energization of the marginally operated device between the scanning periods of successively scanned elemental areas of said picture or object.

6. In an electro-optical image producing system, means for scanning a picture or object, an image of which is to be produced, a plurality of relays, means for energizing said relays in accordance with the tone values of successively scanned elemental areas of said picture or object, and means for restoring said relays to the unactuated condition between the scanning periods of successively scanned elemental areas.

7. In an electro-optical image producing system, a light sensitive cell, means for actuating said cell in accordance with the tone values of successive elemental areas of a picture or object, an image of which is to be produced, thereby producing corresponding current variations in said cell, a plurality of relays, the energization of which is controlled in accordance with said current variations, a tape perforator comprising selector magnets, the actuation of which is controlled in accordance with the operation of said relays, an energizing circuit for said selector magnets, and means for periodically interrupting said energizing circuit.

8. The method of producing an image of a picture or object electro-optically, which comprises scanning elemental areas of said picture or object in succession, producing a current which varies in accordance with the changes in tone value of successively scanned elemental areas of the picture or object, utilizing said varying current to control the setting up of code signals for controlling the production of said image, and causing said varying current to be reduced in amplitude for a brief period between the scanning of successive elemental areas of said picture or object.

In testimony whereof, we have signed our names to this specification this 24th day of March, 1924.

EDWARD F. WATSON.
ALLAN WEAVER.