

Oct. 10, 1933.

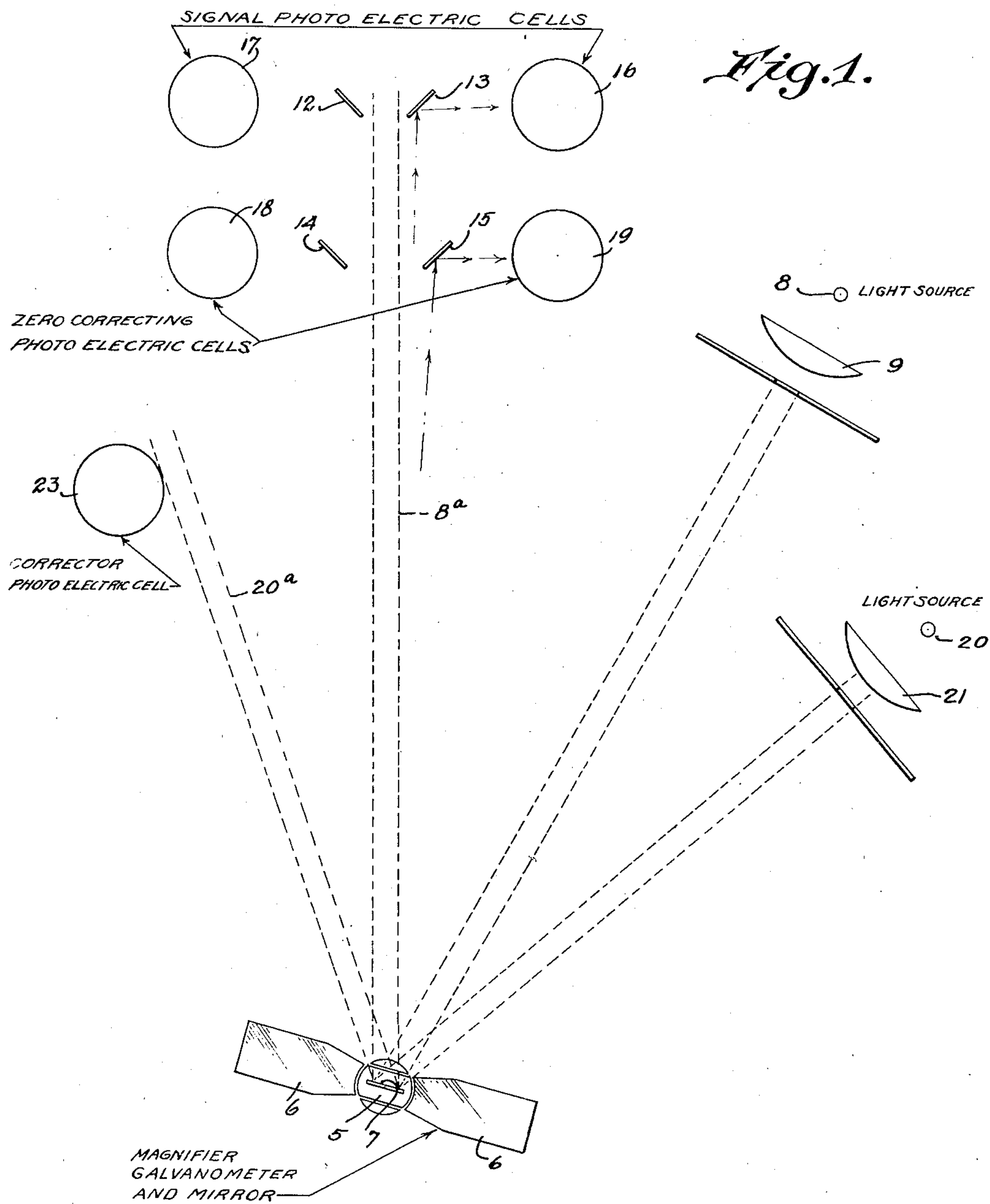
H. H. HAGLUND

1,929,947

CABLE SIGNAL REPEATER

Original Filed Jan. 29, 1929

4 Sheets-Sheet 1



Inventor

H. H. Haglund

Eugene C. Brown
Attorney

Oct. 10, 1933.

H. H. HAGLUND

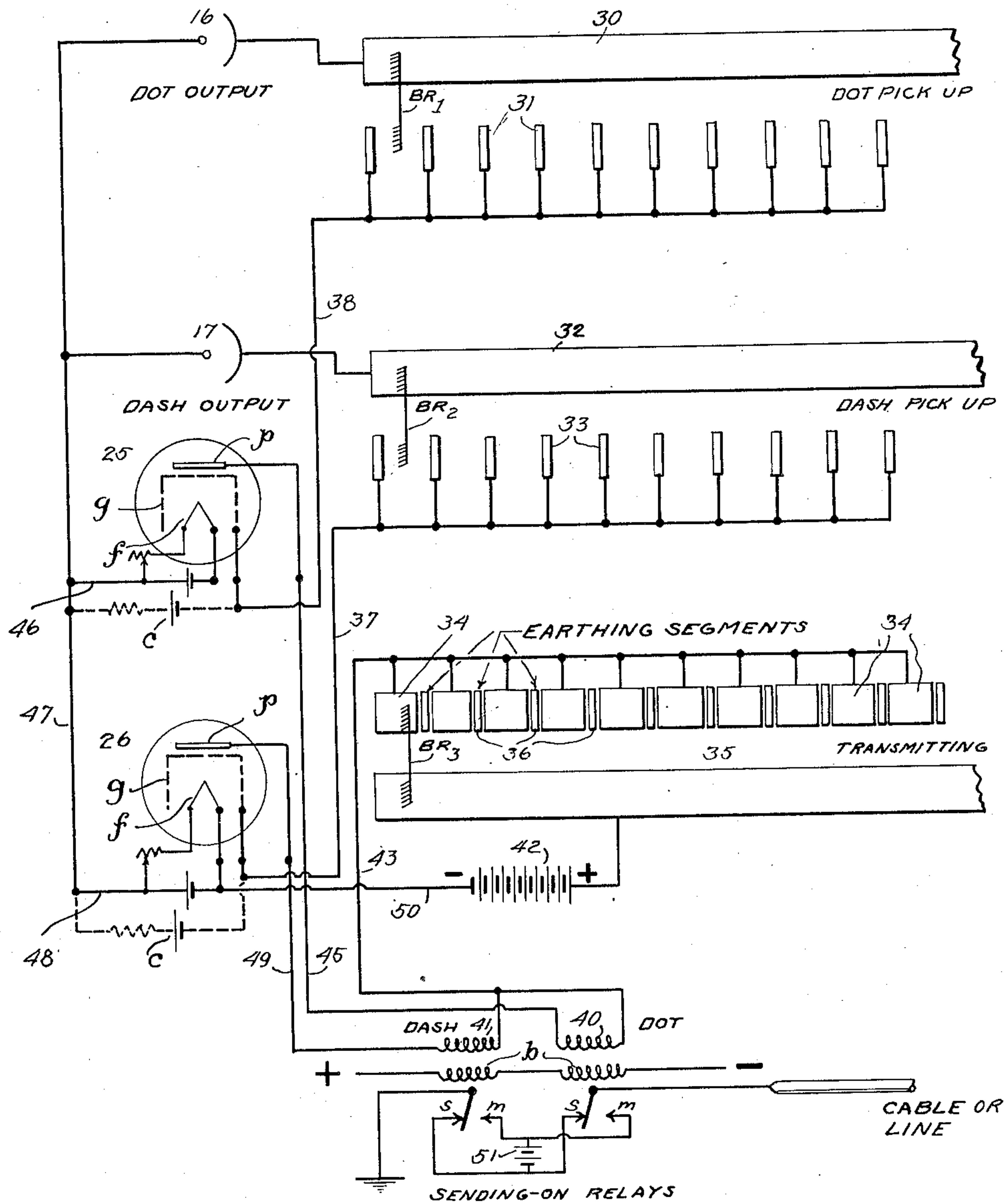
1,929,947

CABLE SIGNAL REPEATER

Original Filed Jan. 29, 1929

4 Sheets-Sheet 2

Fig. 2.



Inventor

H. H. Haglund

Eugene C. Brown
Attorney

Oct. 10, 1933.

H. H. HAGLUND

1,929,947

CABLE SIGNAL REPEATER

Original Filed Jan. 29, 1929 4 Sheets-Sheet 3

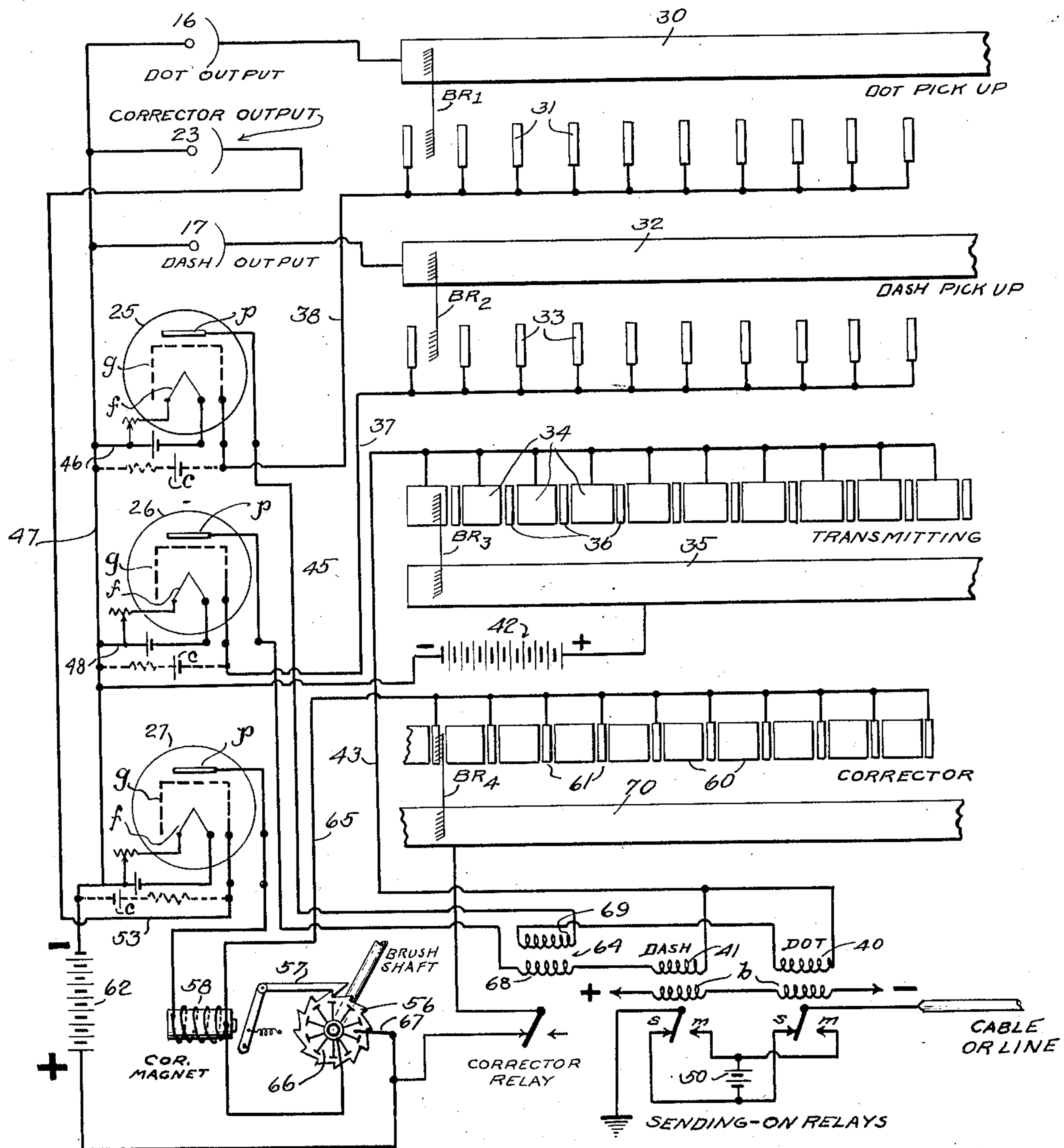


Fig. 3.

Inventor
H. H. Haglund

Engene C. Brown
Attorney

Oct. 10, 1933.

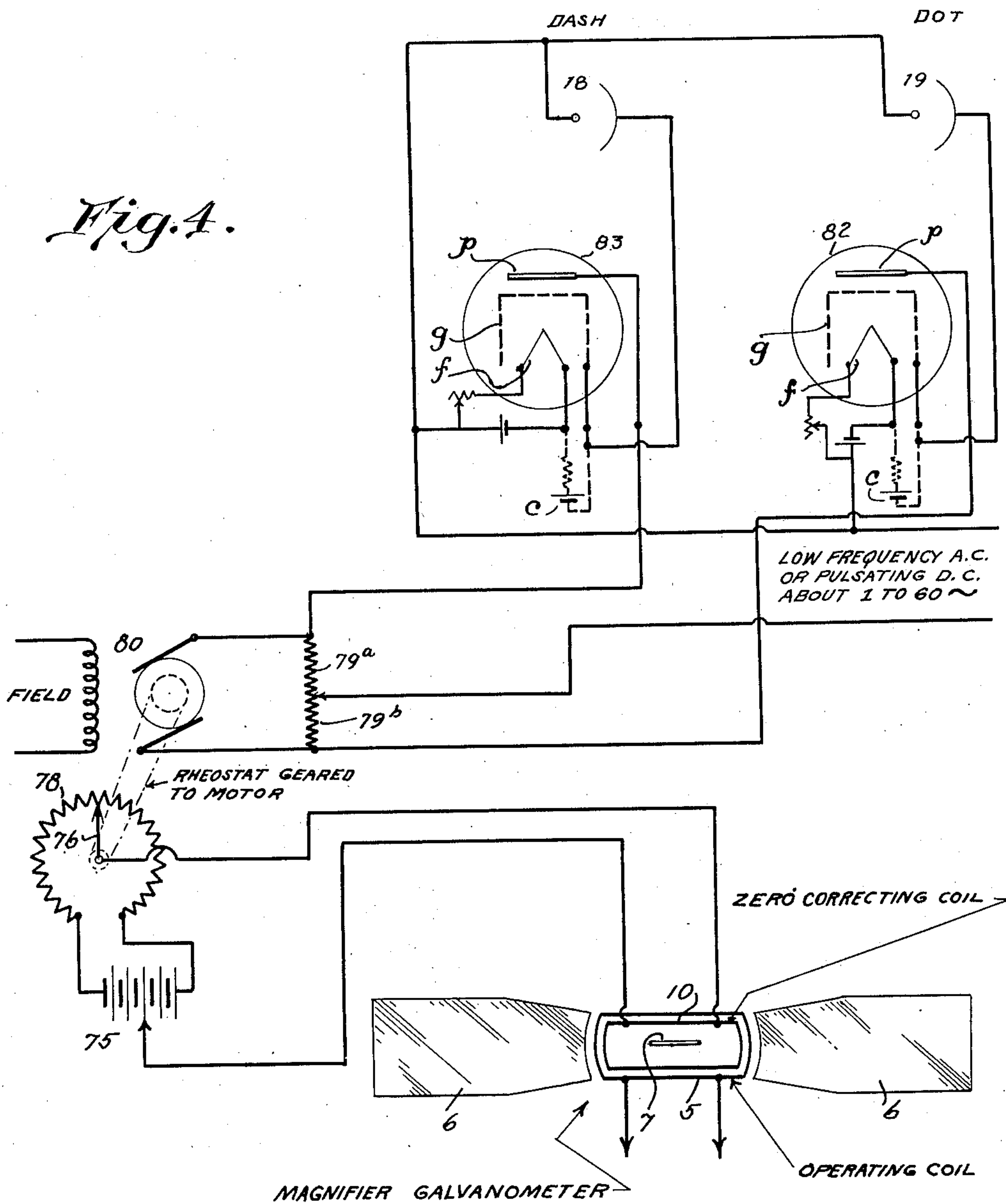
H. H. HAGLUND

1,929,947

CABLE SIGNAL REPEATER

Original Filed Jan. 29, 1929

4 Sheets-Sheet 4



Inventor

H. H. Haglund

Engene C. Brown
Attorney

UNITED STATES PATENT OFFICE

1,929,947

CABLE SIGNAL REPEATER

Hakon H. Haglund, Flushing, N. Y., assignor to
The Western Union Telegraph Company, New
York, N. Y., a corporation of New York

Application January 29, 1929, Serial No. 335,963
Renewed May 6, 1932

62 Claims. (Cl. 178—63)

This invention relates to means for impressing amplified current impulses upon a repeating transmitter, such as a rotary transmitter, by the direct action of a cable magnifier of the galvanometer type, thereby eliminating the use of drum relays and all local relays, except the transmitting relays of the repeater.

One object of my invention is to provide means whereby the beam of light reflected by the mirror of the well-known cable galvanometer magnifier will directly control the connection of the amplifying generator to the distributor rings of the rotary transmitter or repeater. The elimination of the relays which have heretofore been required to supply the local positive and negative impulses to the rotary distributor in accordance with the feeble cable impulses, greatly simplifies the apparatus, renders the reception more accurate, reduces the cost of maintenance and increases the speed or output.

My invention may be embodied in various arrangements of apparatus, those disclosed in the accompanying drawings being merely illustrative for the purpose of making a clear and complete disclosure of the invention.

Figure 1 is an illustrative diagram of an arrangement of photo-electric cells the output of which is directed into the rings of the distributor as the cells are subjected to a beam of light reflected from a light source by the mirror carried by the moving coil of the cable galvanometer.

Figure 2 is a diagram of a rotary distributor arranged in association with photo-electric cells and thermionic tubes, as a repeater to transmit into a line or cable regenerated impulses corresponding to the received cable signal impulses.

Figure 3 is a diagram of an arrangement similar to Fig. 2 with the addition of means for correcting the phase relation of the brushes with respect to the signal impulses.

Figure 4 is a diagram showing an arrangement for counteracting the "wandering zero" effect produced in the cable magnifier galvanometer by earth currents or other disturbances.

In this invention I employ gas-filled thermionic tubes of such construction that when the anode is connected to positive battery and a certain potential is applied to the grid, the tube will "start" and current will flow from the anode to the cathode. As soon as the plate current begins to flow the grid is instantly surrounded by a sheath of positive ions and has no further effect. This sheath, usually only a fraction of a millimeter thick, contains the whole voltage

drop between the grid and the space surrounding it. Changing the grid voltage merely changes the thickness of the sheath and has no effect on the potential of the rest of the space. Hence the grid is powerless to stop the plate current, once it is started. It can only be stopped by removing the plate voltage.

The function of the grid may therefore be likened to a trigger. The amount of power required to start the tube is exceedingly small. A thermionic tube having the characteristics described is disclosed in patent to Irving Langmuir No. 1,289,823. The name "thyatron" has been applied to tubes of this type in an article entitled "Gas-filled thermionic tubes" by A. W. Hull, published in the Journal of the American Institute of Electrical Engineers, November, 1928, page 802, in which other forms are described.

In Fig. 1 I have shown the usual cable magnifier galvanometer, in which the feeble signal impulses received over the cable cause the delicately suspended coil 5 to oscillate between the magnet poles 6. A beam of light from the source 8 is concentrated by the lens 9 upon the mirror and is reflected midway between pairs of mirrors 12, 13 and 14, 15 when the coil is in zero position. During normal conditions, when the coil 5 is rotated to the right by a signal impulse the reflected beam 8^a swings over until it strikes the mirror 13 and is reflected upon the selenium or photo-electric cell 16. When the coil is rotated to the left by a signal impulse of the opposite polarity the beam is reflected by the mirror 12 upon the photo-electric cell 17.

In case the normal zero position of the coil 5 is shifted from its true position by the presence of earth currents or other disturbances, thereby displacing the beam to one side or the other of the normal zero position, the amount of this angular displacement will be added to the swing of the beam in the same direction by the next corresponding signal impulse so that a portion of the beam will fall upon the mirror 14 or 15, and be reflected upon the zero correcting photo-electric cell 18 or 19.

Light rays from another source 20 are concentrated by the lens 21 upon the coil mirror and are reflected as the beam 20^a, which is intercepted by the corrector photo-electric cell 23, when the beam is swung to the left by the mirror 7 carried by the galvanometer coil. The manner in which the photo-electric cells and thermionic tubes are incorporated in the circuits of the repeater or transmitter is shown in Figs. 2, 3 and 4 and will now be described.

In Fig. 2, I have shown a very simple diagram of circuits to illustrate the manner of utilizing the signal photo-electric cells 16 and 17 of Fig. 1 in a rotary repeater or transmitter. A terminal of each cell is connected respectively with the solid ring of the dot pick-up and the dash pick-up, the other terminals being connected in parallel to the cathodes of the gas-filled hot cathode thermionic tubes 25 and 26. As these devices are well known by engineers I have not thought it necessary to illustrate the batteries for the photo-electric cells. For purposes of illustration I have shown the filaments heated by the usual "A" battery but I may employ the indirect method of heating the cathodes such as one of the types described in said article by Hull. I may also use a vaporizable cathode, such as mercury, to produce the ionization and form the ionized path across the arc. As previously explained, the grids *g* completely shield the cathodes from the anodes or plate elements *p*.

The operation is as follows:—

The brushes BR_1 , BR_2 and BR_3 of the rotary distributor or repeater are assumed to be rotated over the rings synchronously with the incoming signal impulses in the usual well understood manner. If at the instant the brush BR_1 contacts with one of the small segments 31 of the dot pick-up rings, the light beam 8^a is reflected by the amplifier mirror 7 upon the dot photo-electric cell 16, a voltage from the latter will be impressed upon the grid *g* of the thermionic tube 25 over the conductor 38. Since at the same moment the brush BR_1 made contact with said segment 31, brush BR_3 made contact with the corresponding live segment 34 of the transmitting rings, thereby causing current to flow through the coil 40 of the dot sending-on relay over a circuit from the plus pole of battery 42 through solid transmitting ring 35, brush BR_3 , segment 34, conductor 43, relay coil 40, conductor 45, plate *p* and cathode *f* of tube 25, and conductors 46, 47 and 48 to minus pole of the battery. This energizes the dot relay, causing its tongue or armature to move over against its marking contact *m* and thereby sending a dot signal impulse into the cable. As previously explained, the grid in the tube which I employ starts the current between the plate and cathode but has no further control of the current. The signal impulse will therefore be transmitted into the cable until the circuit through the relay is broken as the brush BR_3 passes off the live segment 34 onto the adjacent grounded or earthing segment 36. The tongue of the dot relay is then returned to its spacing contact *s* by the current constantly flowing through the biasing coils *b*.

In a similar manner, if the light beam 8^a is thrown by the mirror 7 of the cable magnifier galvanometer upon the mirror 13 and reflected upon photo-electric cell 17 at the instant the brush BR_2 contacts with a segment 33 of the dash pick-up rings, thereby impressing a voltage from said cell upon the grid *g* of tube 26 via conductor 37, a current will flow from battery 42 through brush BR_3 , segment 34, conductor 43, coil 41 of the dash relay, conductor 49, the anode and cathode of the tube 26, and conductor 50 to battery, thus causing the armature or tongue of the dash relay to swing over to its marking contact *m* and sending a dash impulse from cable battery 51 into the cable. As previously explained, the current will continue to flow from the battery 42 through the brush BR_3 , tube 26 and relay coil 41, after the brush BR_2 has moved off of the dash pick-up

segment 33, because in the type of tube used the grid has no control of the current after it has started to flow between the anode plate and the cathode. Hence the current will continue to flow through the coil 41 until the brush BR_3 passes off of the segment 34.

As is well known by all telegraph engineers, the distributor brushes BR_1 , BR_2 and BR_3 which are rotated over the rings of the repeater or distributor by the synchronous motor, must be adjusted from time to time to maintain them in exact synchronism with the signal impulses received over the cable. It is customary to rotate the brushes of the receiving distributor or repeater at a rate of speed very slightly greater than the rate of the received impulses and to provide correcting means for stepping the brushes backward whenever they advance too far.

In Fig. 3, I have illustrated a correcting means for maintaining the phase adjustment of the brushes in association with the apparatus for receiving and repeating the signal impulses shown in Fig. 2. The output of the corrector photo-electric cell 23, controlled by the beam 20^a from the mirror 7 of the cable magnifier, is connected by conductors 47 and 53 with the grid *g* of the thermionic tube 27. The shaft which carries the distributor brushes and is rotated by a synchronous motor, as usual, cooperates with a ratchet wheel 56 and pawl 57, in such a manner that the shaft will be moved backwardly the distance of one tooth of the ratchet each time the correcting magnet 58 is energized. This device is well known and hence need not be further described.

The operation of the correcting means is as follows:—If the rotary distributors at the transmitting and receiving stations are running in proper synchronism, the corrector brush BR_4 will be on one of the dead segments 60 of the corrector rings at the time the light beam 8^a is moved by the magnifier 7 from zero position to dash position so that the beam will be reflected from the mirror 12 upon the dash photo-electric cell 17. The light beam 20^a will simultaneously be directed upon the corrector photo-electric cell 23. Under these circumstances, no correction is needed and no correction will be brought about since at this moment the brush BR_4 is on a dead segment and hence there is no plate battery connected through the corrector magnet to the anode of the tube 27 and therefore the operation of the photo-electric cell at this instant can have no effect upon the tube. If, however, the rotary distributors are not in proper synchronism, the corrector brush BR_4 will make contact with a live correcting segment 61 at the instant the light beam 20^a is projected upon the corrector photo-electric cell. The operation of this cell 23 will, therefore, apply a voltage to the grid of the tube 27 which will start the tube so that a current will flow from the positive terminal of the correcting battery 62, through the spacing contact and tongue of corrector relay 64, through the solid ring, brush BR_4 and corresponding live segment 61 of the corrector rings, conductor 65, corrector magnet 58, anode and cathode of tube 27 to the negative terminal of battery 62. This will operate the corrector magnet and cause the pawl 57 to engage a tooth of the ratchet 56 which immediately engages the brush shaft by a clutch, not shown. As soon as the ratchet begins to move, contact is established through the commutator 66 and brush 67 so that current from the battery 62 continues to flow through the corrector magnet 58 and the tube 27 regardless of the position

of the brush BR₄, to ensure the completion of the stroke of the corrector after which the current will be automatically cut off at the commutator, thus deenergizing the magnet and permitting the pawl 57 to return to normal position. Immediately following this operation of the corrector device, the current flowing through the circuit of the dash relay 41 flows through the coil 68 of the corrector relay, thereby moving its tongue to the marking contact *m* and thereby breaking the connection between the battery 62 and the solid corrector ring 70, thus making it impossible for the corrector device to again operate until after a dot signal impulse has been received. A current through the circuit of the dot relay 40 also flows through the coil 69 of the corrector relay and thus returns the tongue of the corrector relay to its spacing contact *s*, and again connects the solid ring 70 with the positive pole of the correcting battery 62, so that the corrector is again in position to operate when the light beam 20^a again operates the corrector photo-electric cell 23.

All cable magnifiers are more or less affected by "wandering zero" produced by earth currents or other disturbances and hence some means must be provided for "zero correction." I have illustrated in Fig. 4 a circuit by which this correction may be accomplished in my present invention. In addition to the operating coil 5 of the cable magnifier, I provide the suspended oscillating member with a zero correcting coil 10, one terminal of which is connected to the midpoint or split of the battery 75, the other terminal being connected to the movable arm 76 of a potentiometer 78 which is connected across the positive and negative terminals of said battery. The movable arm 76 is operatively connected by suitable gearing to a reversible electric motor 80. The field winding of this motor is connected to a source of power, not shown. The armature is connected, as shown, to the anode plates of two thermionic tubes of the type previously described, the grids of which are connected directly to the output of the two photo-electric cells 18 and 19 which are positioned with respect to the other cells as shown in Fig. 1. The cathodes of the thermionic tubes and the midpoint of the potentiometer 79 across the brushes of the armature, are connected to a low frequency A. C. or pulsating D. C. source of power.

As indicated in Fig. 1, the arrangement of the zero-correcting photo-electric cells 18 and 19 is such that the light beam 8^a from the magnifier will not strike them when the zero position of the magnifier is normal and unaffected by earth currents, but when the zero position of the galvanometer coil is shifted by earth currents, the light beam 8^a will be caused to strike the mirror 14 or the mirror 15, depending upon the zero bias caused by the earth currents, when the coil is actuated by the signal impulses coming over the cable. If the zero position of the magnifier coil is displaced by earth currents, say upon the dot side, so that a dot signal impulse causes the light ray 8^a to be reflected by the mirror 15 upon the dot zero correcting photo-electric cell 19, thereby applying a voltage to the grid of the thermionic tube 82 which operates to start the tube 82, permitting a current to flow from the low frequency source through the tube and the lower portion 79^b of the potentiometer across the armature terminals, this establishes a drop of potential across said potentiometer and causes the

motor armature to rotate and move the arm 76 of the potentiometer in a direction which causes current from battery 75 to flow through the zero correcting coil 10 of the magnifier in such a direction as to counteract and equalize the deflection which was produced by the "wandering zero." When the zero deflection of the magnifier has been reduced so that the light beam no longer falls upon the zero correcting photo-electric cell, the current will cease to flow through the thermionic tube when the anode plate current next falls to zero.

In case the wandering zero effect then causes the magnifier coil to be distorted in the dash direction, the dash zero correcting photo-electric cell 18 will be operated, thus starting its corresponding thermionic tube 83 into operation, in the manner previously described which will start the motor 80. The latter will now run in the opposite direction so that the correction will again be applied in a direction which will counteract that produced by the wandering zero.

It will be understood that the corrector means for maintaining the proper phase of the distributor brushes shown in Fig. 3 and the zero correction of the cable receiving galvanometer shown in Fig. 4 are shown separately for the purpose of clearness. I have indicated in dotted lines the arrangement for applying a stabilizing battery voltage to the cathode when found desirable.

I wish it to be understood that the illustrative diagrams are merely for the purpose of clearly disclosing my invention and that various changes in the circuits will be obvious to engineers without departing in any manner from the invention. I have shown the transmitting rings of the distributor connected to the sending-on relays which transmit impulses into a cable but it is evident that the transmitter segments may be connected to the selecting magnets of a printer.

I claim:

1. In a signaling system, a signal responsive means comprising a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, a source of current, means for connecting said source in circuit with the anode and cathode for predetermined intervals in synchronism with the signals, and means for impressing a starting voltage upon the grid in synchronism with the signals.

2. In a signaling system, a signal responsive means comprising a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, a source of current, means for connecting said source in circuit with the anode and cathode for predetermined intervals in synchronism with the signals, a photo-electric cell having its output terminals connected respectively to the grid and cathode, and means for projecting a beam of light upon said cell in synchronism with the signals.

3. A signal repeating system, comprising a receiving device having a movable member actuated by received signal impulses, a repeating transmitter equipment including a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the

grid potential, a transmitting circuit including a source of current and means for connecting the terminals thereof respectively to the anode and cathode synchronously with the signal impulses, and a voltage generating device having its output terminals connected to the grid and cathode respectively, and means controlled by said receiving device for operating said voltage generating device.

4. A cable telegraph repeater system, comprising a receiving device having a movable member adapted to be oscillated by received signal impulses, a distributor equipment including transmitting rings and a brush movable thereover in synchronism with the received impulses, a transmitting circuit connected to the solid and segmented elements of said transmitting rings and including a source of current and a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, and means controlled by the movable member of said receiving device for impressing a voltage upon the grid to start the flow of current through the tube from said source synchronously with the signal impulses.

5. A cable telegraph repeater system, comprising a receiving device having a movable member actuated by received signal impulses, a distributor equipment including transmitting means and a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, so that a voltage impressed upon the grid operates to start the current from a source connected to the anode and cathode but has no further control upon flow of current, and means controlled by said movable member for impressing a starting voltage upon the grid.

6. A cable telegraph repeater system, comprising a receiving device having a movable member actuated by received signal impulses, a distributor equipment including transmitting means and a thermionic tube of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, so that a voltage impressed upon the grid operates to start the current from a source connected to the anode and cathode but has no further control upon flow of current, a photo-electric cell having its output terminals connected respectively to the grid and to the cathode, and means associated with said movable member for projecting a beam of light upon said cell in synchronism with the signal impulses.

7. A signal repeating system, comprising a receiving device having a movable member actuated by the received dot and dash signal impulses, photo-electric cells positioned to receive a beam of light projected thereon by said movable member, a plurality of thermionic tubes of the type described, wherein the grid, anode and cathode elements are so constructed and arranged that, when started, the current flowing between anode and cathode is unaffected by the grid potential, a source of current having one terminal connected to the cathodes of said tubes, distributor means comprising segmented contactor paths connected respectively in circuit with the output

of said cells and the grids of said tubes, and in circuit with said source and the anodes and cathodes of said tubes, the brushes of said distributor being moved over the segmented paths in synchronism with the received signals, and dot and dash sending-on relays in circuit with the respective tubes.

8. A signal repeating system as set forth in claim 7, and being provided with phase corrector means comprising a photo-electric cell, a thermionic tube and segmented contactor path coacting to operate the corrector magnet of the usual brush phase adjusting device.

9. In a signal repeating system as set forth in claim 7, the movable member of said receiving device being provided with a zero correcting coil, a source of current connected to the terminals of said coil and normally balanced to produce no current therethrough, thermionic tubes of the type described, having their anodes and cathodes connected to a source of low frequency or pulsating current, means operatively connected in circuit with said tubes adapted to unbalance said source and cause a current to flow through said zero correcting coil in one direction or the other corresponding to the operation of one or the other of said tubes, and photo-electric cells connected respectively to the grids and cathodes of said tubes to thereby impress a starting voltage thereon when the respective cells are operated by the beam of light projected thereon by the movable member, when the latter is affected by earth currents or other disturbances.

10. A signal repeating system, comprising a relay having a movable member adapted to be actuated by the received signal impulses, said member having a zero correcting coil, a pair of thermionic tubes of the type described, having their anodes and cathodes connected to a source of current, a pair of photo-electric cells having their output terminals connected respectively to the grid and cathode of said tubes, said cells being positioned to be operated by a beam of light controlled by the oscillations of said movable member, and means actuated by the flow of current in one or the other of said tubes for causing a current to flow in said zero correcting coil in one direction or the other depending upon the tube that is operated.

11. The method of repeating signal impulses, which consists in establishing recurrent potentials in synchronism with the received impulses, causing said potentials to establish a field in an arc path in a circuit connected to a source of power which first starts the flow of current from said source across the arc and then automatically nullifies the effect of said field upon the continued flow of current, interrupting the current flow after a predetermined interval and transmitting the recurrent periods of current flow from said source.

12. A communication system, comprising a signal responsive apparatus including a thermionic tube relay characterized by anode, cathode and starting electrode elements so constructed and arranged that current continues to flow in the anode-cathode circuit unaffected by the potential of the starting electrode after being started by a positive starting potential applied to the starting electrode.

13. In a communication system as set forth in claim 12, means for impressing the received intelligence signals upon the starting electrode, a transmitting circuit including a source of current, and means for connecting said transmitting

circuit to the anode and cathode synchronously with the received signals.

14. In a communication system, apparatus for repeating and regenerating the received intelligence signals, comprising a receiving three-element tube relay characterized by the anode, cathode and starting electrode elements so constructed and arranged that current continues to flow in the anode-cathode circuit irrespective of the starting electrode potential after being started by a predetermined potential applied to the starting electrode, means for impressing the received signal impulses upon the starting electrode, a source of current and a distributor operating to complete the connection of said source to the anode and cathode and to a transmitting circuit synchronously with the received intelligence signals for predetermined intervals.

15. In a signaling system, apparatus for increasing the effective length of received signal impulses, comprising a thermionic device to receive the signal impulses, said device being characterized by continued operation unaffected by the grid potential after being started by an impulse applied to the grid.

16. In a signaling system, receiving means responsive to impulses of short duration, tubes of the thyatron type responsive to said short impulses, operating irrespective of grid potential after being started by said impulses, and impulse transmitting means determining the duration of operation of said tubes.

17. In a signaling system, apparatus for receiving from a line of cable impulses of short duration recurring in rapid succession, electromagnetic translating devices, tubes of the thyatron type having an input circuit including a grid element connected to receive said impulses of short duration and an output circuit including anode and cathode elements connected to said translating devices, said grid, anode and cathode elements being so constructed and arranged that the output circuit is unaffected by the grid potential after being started, and means for determining the duration of the operation of the output circuit.

18. In a signaling system, a signal responsive means comprising a thermionic tube of the type described wherein the grid, anode and cathode elements are so constructed and arranged that when started the current flows between anode and cathode unaffected by the grid potential, a source of current, means for connecting said source in circuit with the anode and cathode for predetermined intervals in synchronism with the signals, and means for impressing a starting voltage upon the grid in synchronism with the signals.

19. In a signaling system, a signal responsive means comprising a thermionic tube of the type described wherein the grid, anode and cathode elements are so constructed and arranged that when started the current flows between anode and cathode unaffected by the grid potential, a source of current, means for connecting said source in circuit with the anode and cathode for predetermined intervals in synchronism with the signals, a photo-electric cell having its output terminals connected respectively to the grid and cathode, and means for projecting a beam of light upon said cell in synchronism with the signals.

20. A signal repeating system, comprising a receiving device having a movable member actuated by received signal impulses, a repeating

transmitter equipment including a thermionic tube of the type described wherein the grid, anode and cathode elements are so constructed and arranged that when started the current flows between anode and cathode unaffected by the grid potential, a transmitting circuit including a source of current and means for connecting the terminals thereof respectively to the anode and cathode synchronously with the signal impulses, and a voltage generating device having its output terminals connected to the grid and cathode respectively, and means controlled by said receiving device for operating said voltage generating device.

21. A cable telegraph repeater system, comprising a receiving device having a movable member adapted to be oscillated by received signal impulses, a distributor equipment including transmitting rings and a brush movable thereover in synchronism with the received impulses, a transmitting circuit connected to the solid and segmented elements of said transmitting rings and including a source of current and a thermionic tube of the type described, operable, when started, irrespective of the grid potential, and means controlled by the movable member of said receiving device for impressing a voltage upon the grid to start the flow of current through the tube from said source synchronously with the signal impulses.

22. A cable telegraph repeater system, comprising a receiving device having a movable member actuated by received signal impulses, a distributor equipment including transmitting means and a thermionic tube of the type described, operable, when started, irrespective of the grid potential so that a voltage impressed upon the grid operates to start the current from a source connected to the anode and cathode but has no further control upon flow of current, and means controlled by said movable member for impressing a starting voltage upon the grid.

23. A cable telegraph repeater system, comprising a receiving device having a movable member actuated by received signal impulses, a distributor equipment including transmitting means and a thermionic tube of the type described operable, when started, irrespective of the grid potential so that a voltage impressed upon the grid operates to start the current from a source connected to the anode and cathode but has no further control upon flow of current, a photo-electric cell having its output terminals connected respectively to the grid and to the cathode, and means associated with said movable member for projecting a beam of light upon said cell in synchronism with the signal impulses.

24. A signal repeating system, comprising a receiving device having a movable member actuated by the received dot and dash signal impulses, photo-electric cells positioned to receive a beam of light projected thereon by said movable member, a plurality of thermionic tubes of the type described, operable, when started, irrespective of the grid potential, a source of current having one terminal connected to the cathodes of said tubes, distributor means comprising segmented contactor paths connected respectively in circuit with the output of said cells and the grids of said tubes, and in circuit with said source and the anodes and cathodes of said tubes, the brushes of said distributor being moved over the segmented paths in synchronism with the received signals, and dot and dash sending-on relays in circuit with the respective tubes.

25. In a signalling system, a gaseous conduction

device capable of a sustained discharge, an input and an output circuit arranged to supply a starting condition to said device to create a sustained discharge therein and a means for applying light fluctuations to said element in accordance with telegraph code signals.

26. In a signalling system, a gaseous conduction device, an input and an output circuit therefor, a voltage generating element in said input circuit responsive to radiant energy and arranged to apply a starting condition to said device to create a sustained discharge therein and means for applying variations of radiant energy to said element in accordance with telegraph signals.

27. In a signalling system, a gaseous conduction device, an input and an output circuit therefor, a photo-electric cell in said input circuit arranged to supply a starting condition to said device to create a sustained discharge therein and signal responsive means for applying light fluctuations to said element.

28. In a signalling system, a light responsive device, means for applying light fluctuations thereto in accordance with telegraph signals to produce corresponding voltage fluctuations, and electro-statically controlled discharge device, means operating in synchronism with such signals for applying said voltage fluctuations to said electro-statically controlled device to produce a sustained discharge therein and means independent of said light responsive device for terminating said discharge.

29. In a signalling system, a light responsive device, means for applying light fluctuations thereto in accordance with a telegraph code, to produce corresponding voltage fluctuations, a distributor having input and output segments, said input segments being in circuit with said light responsive device, and means controlled by voltage fluctuations applied to said input segments, for causing a current flow through said output segments.

30. In a signalling system, a light responsive cell subject to light variations in accordance with a telegraph code, an electric discharge device, said cell being arranged to initiate discharges through said device and synchronously operating contact mechanism for determining the period of said discharges.

31. In a communication system, a source of electrical variations, means for translating said electrical variations into light variations, a light sensitive cell subject to said light variations and a gaseous discharge tube associated with said light sensitive cell and adapted to be controlled thereby.

32. In a communication system, a source of electrical variations, means for translating said electrical variations into light variations, a light sensitive cell subject to said light variations, an electric discharge tube associated with said light sensitive cell so that discharges will be started therein in accordance with said light variations and separate means for determining the duration of said discharges.

33. In a communication system, a source of electrical variations, means for translating said electrical variations into light variations, a light sensitive element subject to said light variations, a gaseous discharge path associated with said element and adapted to have a discharge started therein in accordance with said light variations and means independent of said element for maintaining said discharge.

34. In a communication system, a source of electrical variations, means for translating said

electrical variations into light variations, a light sensitive element subject to said light variations, a gaseous discharge device having an input and an output circuit, said element being included in said input circuit for starting discharges therein in accordance with said light variations and means for interrupting said output circuit periodically to discontinue said discharges.

35. In a signalling system, a light responsive cell subject to light fluctuations in accordance with a telegraphic code, a gaseous discharge tube having a starting element, means for momentarily applying the output of said cell to said starting element to initiate discharges in said tube and means for maintaining said discharges over sustained periods.

36. In a signalling system, a light responsive cell subject to light fluctuations in accordance with telegraph code signals, a gaseous discharge tube having a starting element, means for momentarily applying the output of said cell to said starting element synchronously with said signals to initiate discharges in said tube, said tube being constructed so as to maintain said discharges for sustained periods after being started, a synchronously controlled mechanism serving to determine the period of operation of said discharges and signal responsive means in circuit with said contact mechanism arranged to be controlled by said discharge current.

37. A signalling system comprising a source of signals, a signal responsive device, a gaseous discharge tube, and a synchronously operated contact mechanism, said tube being controlled jointly by said contact mechanism and said signal responsive device to produce accurately timed discharges therein.

38. In signalling system, a source of telegraph signals comprising two different line conditions occurring in irregular succession, an electric discharge device responsive solely to one line condition, a second electric discharge device responsive solely to the other line condition, an output circuit for each device and separate current responsive means in each output circuit.

39. In signalling system, a source of telegraph signals comprising two different line conditions, a gaseous discharge path, means responsive to one line condition for producing discharges in said path, a second gaseous discharge path, said means being responsive to the other line condition to produce discharges in said second path and mechanism operating synchronously with said signals for terminating said discharges.

40. In a signalling system, a source of impulses of irregularly mixed polarities, an electric discharge tube individual to each polarity and distributing mechanism for selectively applying starting conditions to said tubes in accordance with the polarity of the received impulses.

41. In a signalling system, a source of impulses of irregularly mixed impulses, an electric discharge tube corresponding to each polarity, a light sensitive cell associated with each tube and a distributing mechanism for selectively energizing said cells whereby to applying starting conditions to said tubes in accordance with the polarity of the received impulses.

42. In a signalling system, a source of signals of mixed line conditions, a gaseous conductive device corresponding to each line condition, means for selectively initiating discharges through the said devices in accordance with said line conditions and means for maintaining said discharges over sustained periods, an output circuit for said

tube and means for periodically interrupting said output circuit to terminate said discharges.

43. In a signalling system, a source of signals of mixed line conditions, a gaseous conductive device corresponding to each line condition, means for selectively initiating discharges through the said devices in accordance with said line conditions and means for maintaining said discharges over predetermined periods independently of line conditions.

44. A signalling system comprising a receiving device responsive to dot and dash signal impulses, photo-electric cells positioned to receive a beam of light projected thereon by said receiving device, a plurality of gaseous discharge tubes so constructed and arranged that, when started, current flows therein unaffected by the starting condition, distributor means operating synchronously with said signals for momentarily applying the output of said cells to said tubes to create discharges therein and serving also to determine the period of operation of said discharges and current responsive means in the output of said tubes.

45. In a signalling system, a source of signals, a plurality of electric discharge paths, means responsive to said signals for selecting a discharge path for operation and separate means for timing the starting of the discharge in said path.

46. In a signalling system, a source of signals of mixed marking and spacing conditions, a plurality of electric discharge tubes, means responsive to said signals for selecting a tube for operation and separate means operating synchronously with said signals for applying a starting condition to the selected tube.

47. In a signalling system, a source of signals, a plurality of electric discharge tubes, means responsive to said signals for selecting a predetermined tube for operation, separate means for starting a discharge through the selected tube and further means for determining the period of operation of said discharge.

48. In a signalling system, a source of signals, a plurality of electric discharge tubes, means responsive to said signals for selecting a tube for operation, synchronously operating contact means for applying a starting condition to the selected tube and a synchronous distributor in the output circuit of said tube.

49. In a synchronous system, a source of telegraph signals, a plurality of light sensitive cells, a source of light, means for scanning said cells with said light to produce current flow therein in accordance with said telegraph signals, and an individual discharge device controlled by each cell and current and arranged to have a discharge maintained therein, independently of said cell after being started, and means for terminating said discharge after a predetermined period.

50. In a telegraph system, a synchronously operating distributor, a phase correcting mechanism therefor, a discharge tube, means for applying a starting potential to said tube in response to a predetermined signal condition, means for operating said phase correcting mechanism when a discharge occurs in said tube and means for preventing a discharge therein when a correction is not required.

51. In a telegraph system, a synchronously operating distributor, a phase correcting mechanism therefor, a plurality of discharge tubes, means for applying a starting potential to both of said tubes in response to a predetermined signal condition, signal responsive means in the

output circuit of one of said tubes and said phase correcting mechanism in the output circuit of the other tube, and means for preventing a discharge in said latter tube when a correction is not required.

52. In a telegraph system, a source of signals, a synchronously operating distributor having signaling and correcting segments, said correcting segments being out of phase with said signals when the signaling segments are in phase therewith, a phase correcting mechanism for said distributor and a discharge tube controlled conjointly by said signals and said correcting segments and arranged to operate when said latter segments are in phase with the signals to actuate the phase correcting mechanism, whereby to restore the phase relation of the signaling segments relative to the signals.

53. In a telegraph system, a source of signals, a synchronously operating distributor, a phase correcting mechanism therefor, a gaseous conduction tube of the type in which a discharge once started therein continues independently of the starting condition and means controlled by predetermined of said signals for initiating a discharge through said tube when the distributor is out of phase whereby to operate the correcting mechanism to restore the phase relation, and means controlled by said correcting mechanism for terminating the continuance of said discharge.

54. In a telegraph system, a source of signals, a synchronously operating distributor, a phase correcting mechanism therefor, a discharge tube, and means including said distributor for initiating a discharge through said tube in response to predetermined signal conditions, when the distributor is out of phase, and means including said correcting mechanism for maintaining said discharge, said correcting mechanism being operated by said discharge to restore the phase relation of the distributor.

55. In a signalling system, a source of electric signals, a synchronously operating distributor, a plurality of light sources, a light sensitive cell corresponding to each light source, common means operated by said signals for applying light from each source to its corresponding cell, a discharge tube individual to each cell and controlled thereby, and signal responsive means in circuit with one of said tubes and phase correcting mechanism for the distributor in circuit with the other of said tubes.

56. In a signalling system, a source of signals, a distributing mechanism, a plurality of discharge tubes, means individual to each tube for applying starting conditions thereto, each of said individual means being controlled in part by a common signal condition and in part by said distributor mechanism, whereby either one or both of said tubes is operated depending on the phase condition of the distributing mechanism.

57. In a signalling system, a source of telegraph signals, a receiving apparatus comprising a plurality of discharge tubes, and means individual to each tube for applying starting conditions thereto, each of said means being operated by a common signal condition.

58. In a signalling system, a source of telegraph signals, a receiving apparatus comprising a plurality of discharge tubes, means individual to each tube for applying starting conditions thereto, each of said means being operated by a common signal condition, and means in the out-

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

put circuit of each tube for performing independent functions.

59. In a signalling system, a source of telegraph signals, a receiving apparatus comprising one or more discharge tubes responsive to said signals for performing signalling functions, and an auxiliary tube operable concurrently with one or more of said tubes for performing auxiliary or non-signalling functions.

60. In a signalling system, a source of telegraph signals, a plurality of discharge tubes having input and output circuits, means in the input circuit of each tube controlled by a common signal condition for applying starting conditions to each of said tubes and means in the output circuit of one tube for controlling the output circuit of the other tube.

61. A signal repeating system comprising a relay having a movable member adapted to be actuated by received signal impulses, said mem-

ber having a zero correcting coil, a pair of discharge tubes, a pair of photoelectric cells having their output terminals connected respectively to the input of said tubes, said cells being positioned so as to be operated by a beam of light controlled by the oscillations of said movable member, and means actuated by the flow of current in one or the other of said tubes for causing a current to flow in said zero correcting coil in one direction or the other depending upon the tube that is operated.

62. A signal repeating system comprising a signal responsive device having a zero correcting means, a pair of discharge tubes selectively operated by said signal responsive device and means actuated by the flow of current in one or the other of said tubes for actuating said zero correcting means in a direction depending upon the tube which is operated.

HAKON H. HAGLUND.

25

100

30

105

35

110

40

115

45

120

50

125

55

130

60

135

65

140

70

145

75

150