Jan. 3, 1939. A. WEAVER 2,142,339

PICTURE BROADCASTING SYSTEM

Filed July 7, 1934 6 Sheets-Sheet 1

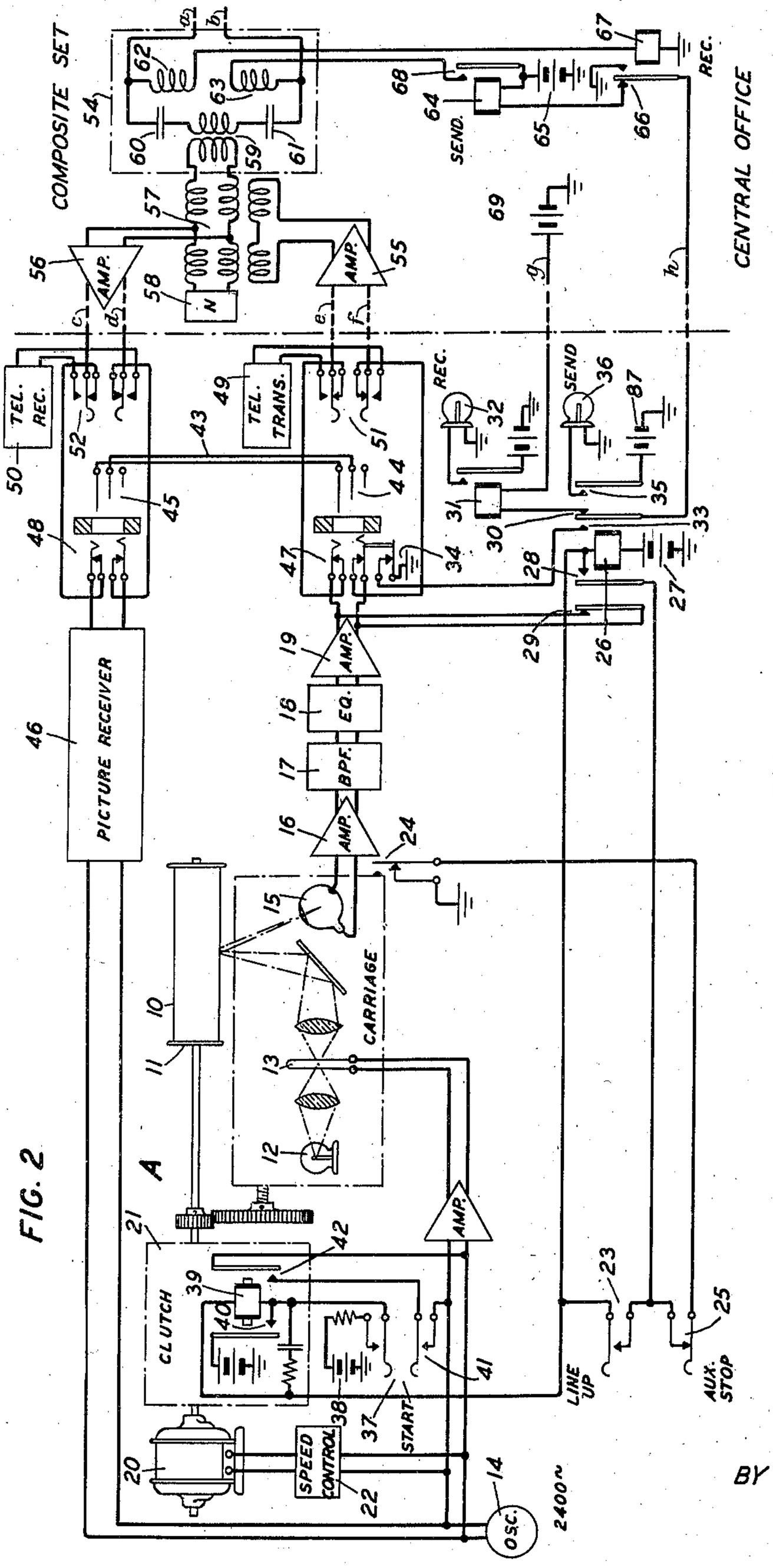

FIG. 2

FIG. 1

FIG.2	FIG.3	FIG.4	FIG.5	FIG.6	FIG.7

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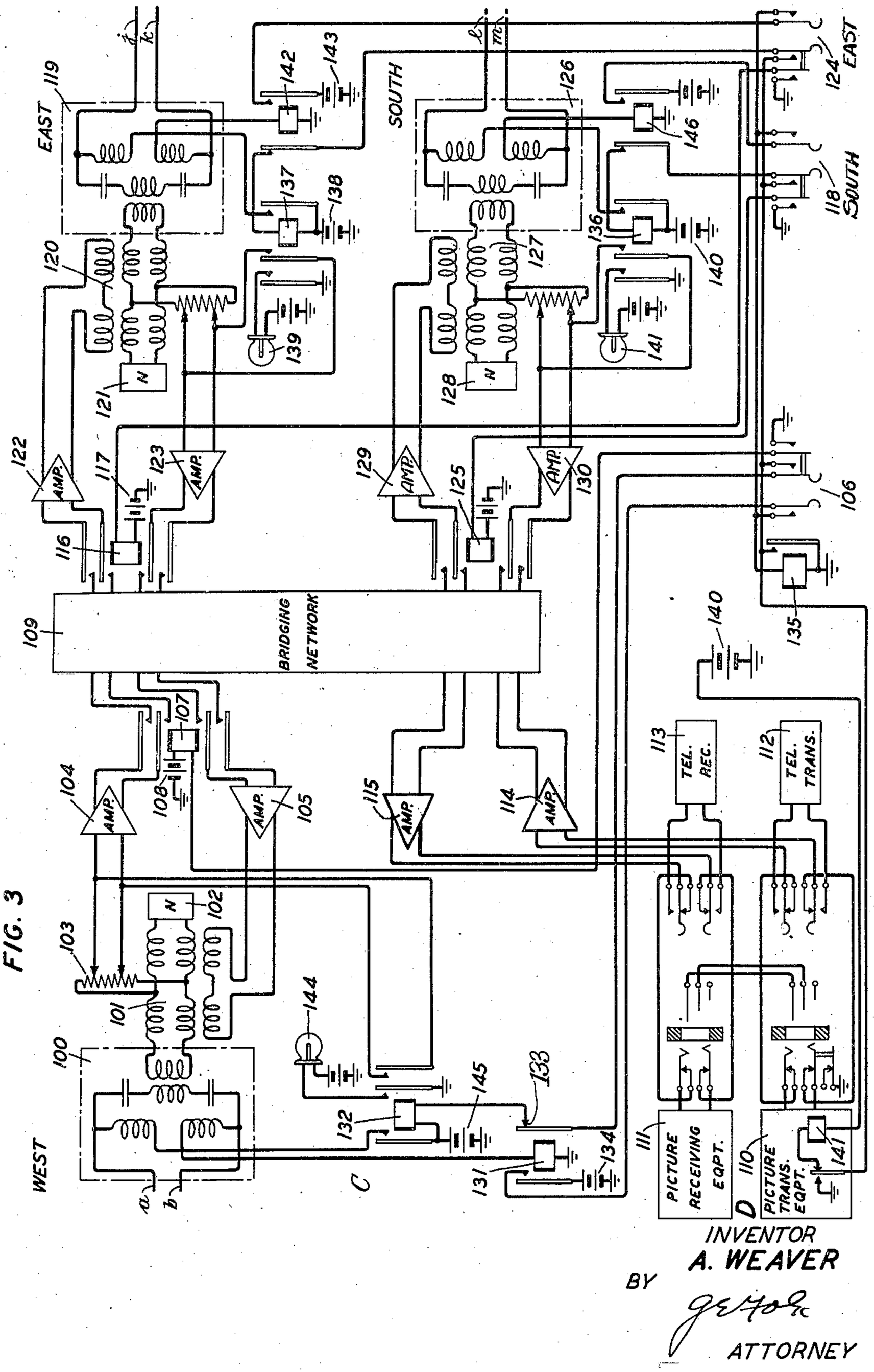

FIG. 3

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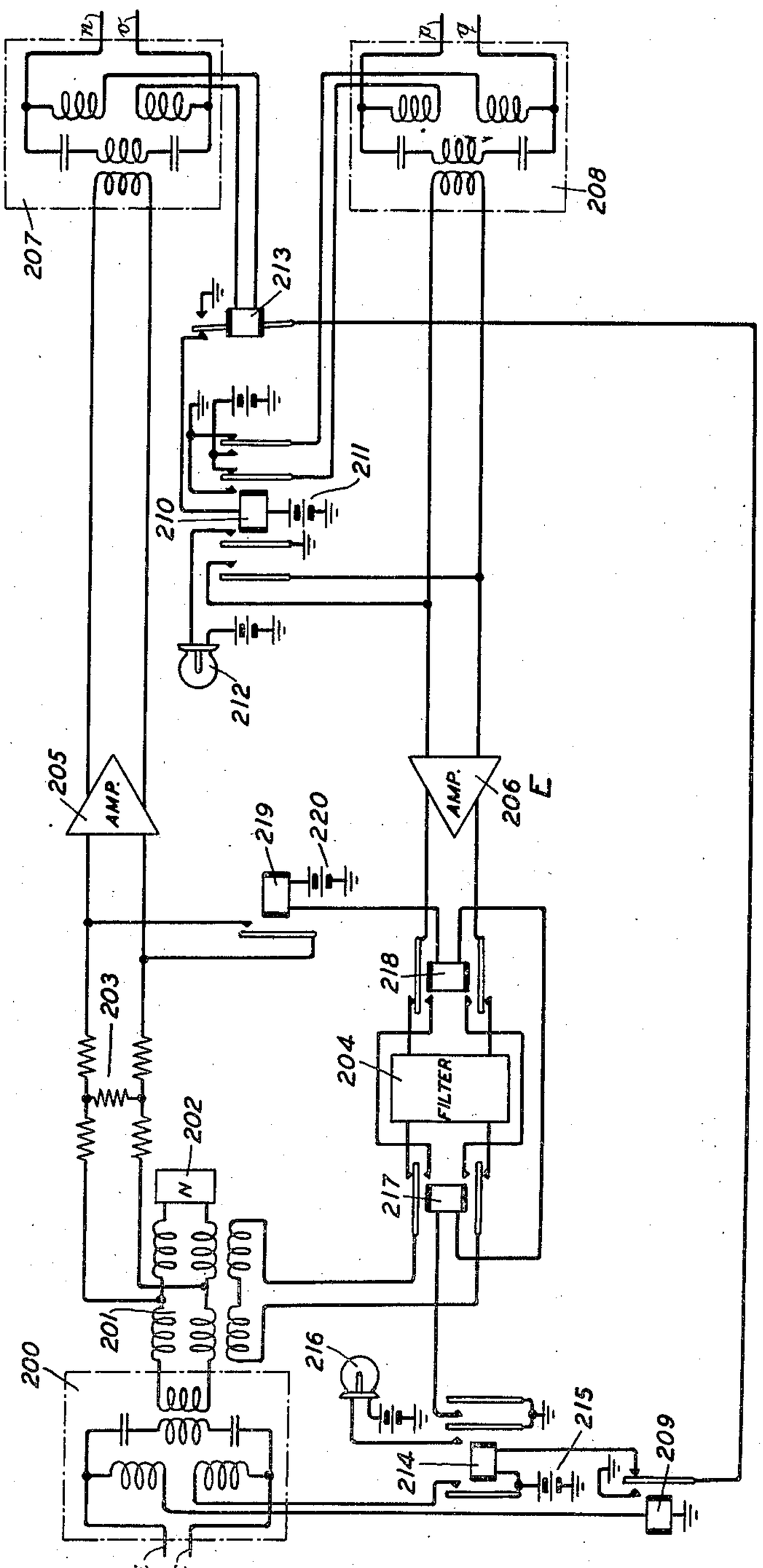

FIG. 4

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PICTURE BROADCASTING SYSTEM

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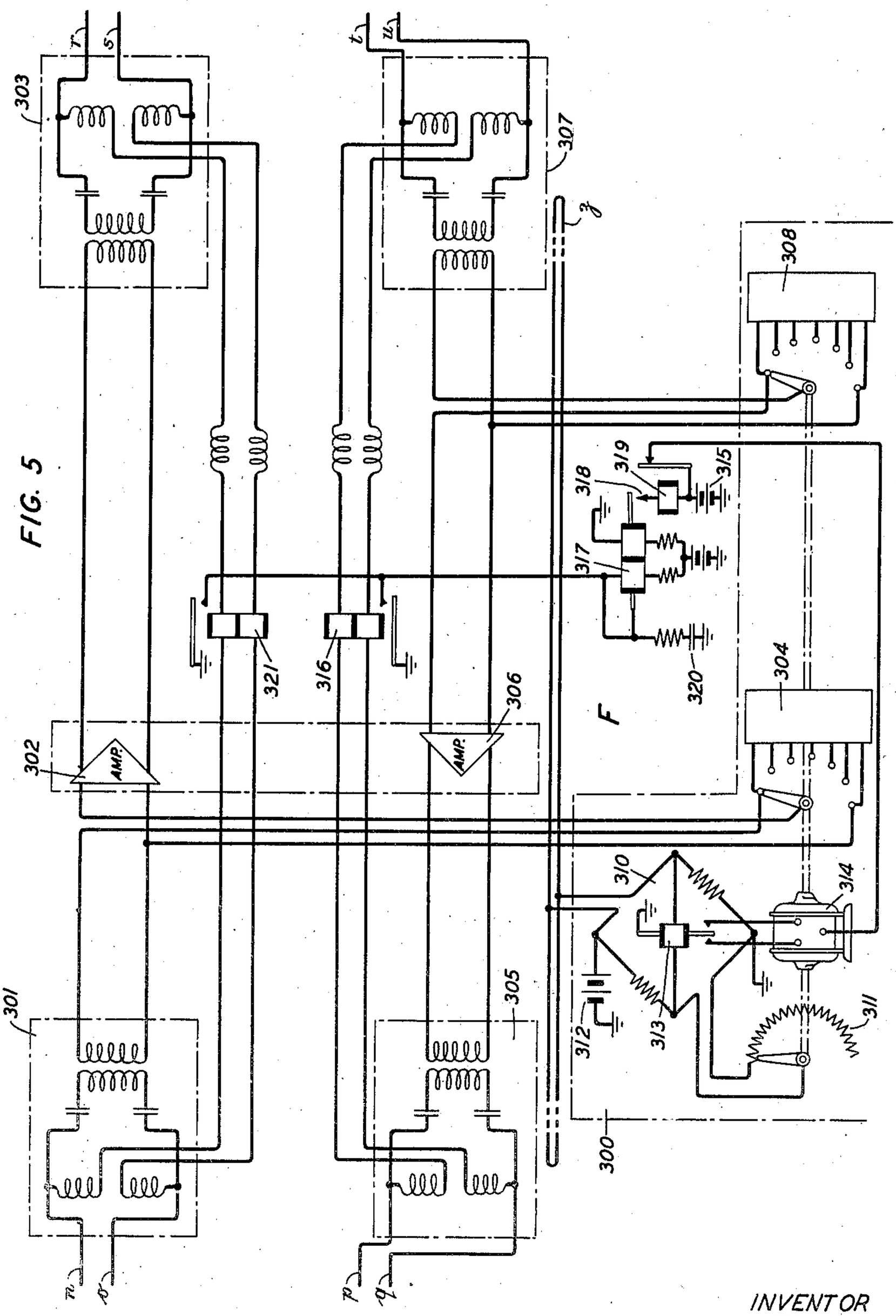
FIG. 5



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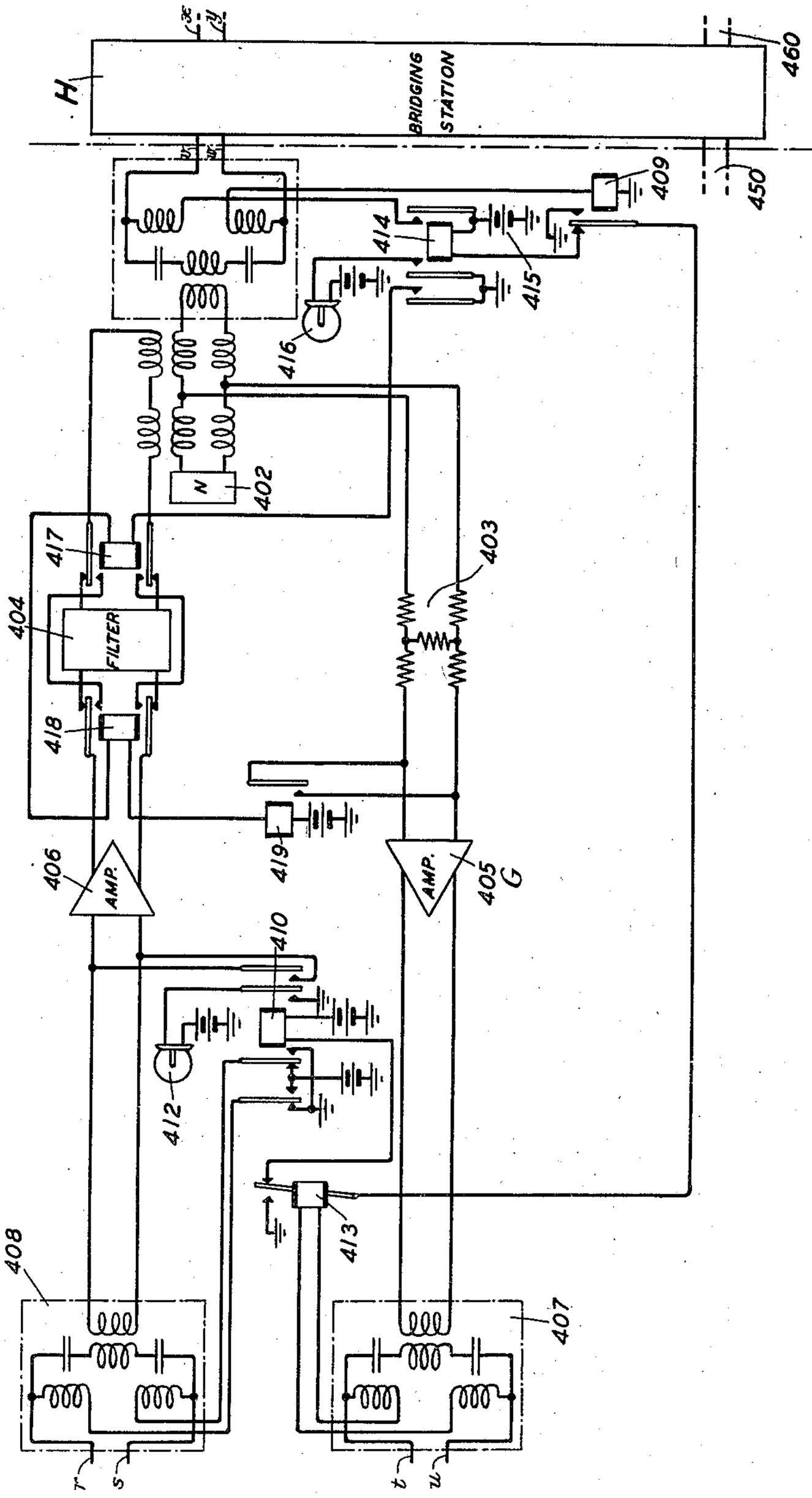

FIG. 6

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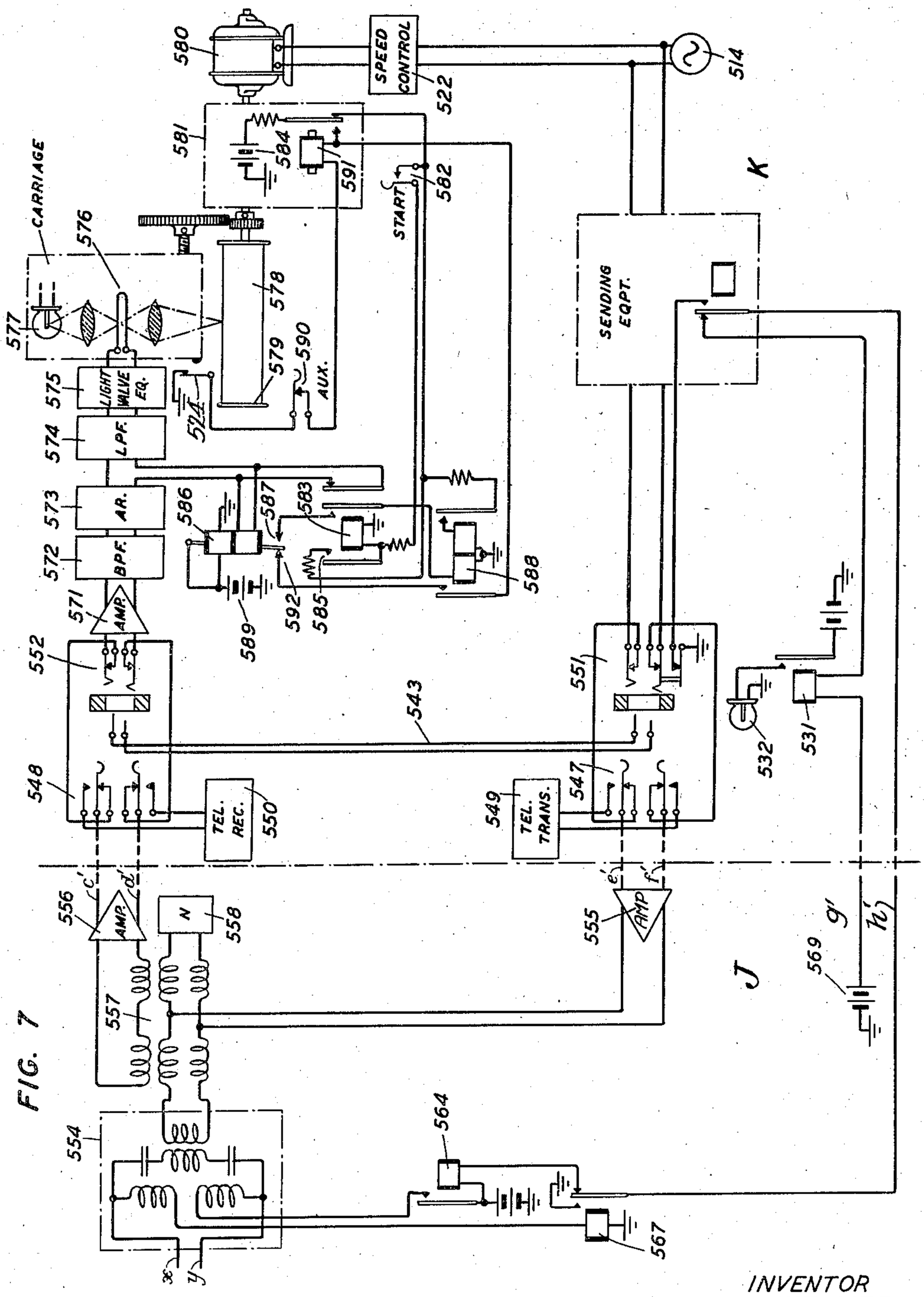

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Patented Jan. 3, 1939 2,142,339

UNITED STATES PATENT OFFICE

2,142,339

PICTURE BROADCASTING SYSTEM

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Application July 7, 1934, Serial No. 734,152

7 Claims. (Cl. 178—6)

This invention relates to signalling systems and methods and particularly to a system for broadcasting pictures.

An object of the invention is to provide a system for broadcasting pictures, particularly over telephone lines, which is simple to operate and capable of reproducing pictures of high quality.

In the picture broadcasting system shown and described herein for the purpose of illustration, a picture may be transmitted from any station to each of the other stations of the system or, if desired, to a number of other stations less than the total number. Each station is provided with picture transmitting and receiving apparatus and telephone transmitting and receiving apparatus. The telephone receiver may be of the loud-speaking type. At each station there is provided a key of the non-locking type which, when operated, causes the transmission of a direct control current which is utilized to control apparatus along the transmission path to the other stations so that telephone or picture signalling current can be transmitted in one direction only from the first station to the distant station. Indicating lamps are provided at the terminal stations and also at repeater stations remote from the terminal stations for indicating the direction of transmission for which the system has been conditioned under control of the direct current control signal. A switch associated with the rotatable picture scanning and picture reproducing cylinders at each station is provided for automatically stopping the rotation of the picture cylinders and simultaneously removing the direct current control from the system.

The transmission network which is used for picture transmission between stations is also utilized for transmission by telephone of necessary instructions in connection with the operation of the picture transmitting and receiving equipment, thus eliminating the expense of a separate communication channel for this purpose. The direct current control circuits are composited on the same wires that are used for picture and telephone transmission. In certain respects the transmission requirements are more severe for picture transmission than for telephone transmission. For example, relatively small abrupt changes in attenuation or transmission level of the transmission system which would have no noticeable effect on speech transmission, would be so noticeable in a picture reproduction as to render it unsatisfactory. In the present system, therefore, the direct current control is utilized to prevent the operation of automatic gain control apparatus while a picture is being transmitted. Poor quality of a picture reproduction is also caused by echo effects on a line due, for example, to a slight unbalancing of a two-wire line at the two-way repeaters. For this reason the direct current control is also employed for controlling the repeater to prevent transmission through it in the direction opposite to the direction in which the picture is being transmitted. At bridging points where a plurality of transmission lines may be connected through a bridging network, short circuits are applied by means of the direct current control to all input circuits to the bridge except on the line transmitting the picture current into the bridge for the purpose of reducing the noise currents applied to the circuits and to increase the loss in the cross-talk paths. When a four-wire circuit is connected to a two-wire circuit, the connecting terminating equipment includes a filter for preventing singing when the circuit is used for two-way telephone transmission. This filter introduces sufficient delay distortion as to seriously impair the quality of a picture reproduction. Rather than employing an expensive delay equalizer for correcting for this delay distortion, this filter is cut out of the circuit under control of the direct control current when the circuit is used for picture transmission.

A picture broadcasting system embodying the invention will now be described in detail, reference being made to the accompanying drawings in which:

Fig. 1 shows the method of arranging the succeeding figures of the drawings; and

Figs. 2 to 7, inclusive, when arranged as shown in Fig. 1, illustrate diagrammatically a complete picture broadcasting system.

Each of the terminal stations is provided with picture transmitting apparatus for producing an alternating current modulated in accordance with the tone values of successively scanned elemental areas of a picture, and picture receiving apparatus for utilizing the picture currents received from a distant station to control the exposure of the elemental areas in succession of a light sensitive picture reproducing surface in synchonism with the scanning at the transmitting point. Any number of terminal stations may be provided and a picture may be transmitted from any station to all or any desired number of other stations. In order to avoid unnecessary repetition in the drawings, only three terminal stations are shown and the transmitting equipment is shown in detail only at station A of Fig. 2 and the

receiving equipment is shown in detail only at station K of Fig. 7.

At the station A a picture 10 to be transmitted is mounted on the rotatable picture cylinder 11. Light from source 12, after being interrupted by a light valve 13, energized by current from the alternating current source 14 of 2400 cycles, for example, is directed upon a small spot on the picture 10 and the light reflected from this illuminated spot is received by the photoelectric cell 15. The scanning apparatus including the light source 12 and the photoelectric cell 15 is moved in the direction of the axis of the picture cylinder 11 as the cylinder rotates so that the elemental areas of the picture lying along a helical path are scanned in succession. The current set up in the circuit of the photoelectric cell is amplified in the amplifier 16 transmitted through the band-pass filter 17 and equalizer 18 and further amplified by the amplifier 19. This portion of the apparatus is disclosed in greater detail in U. S. Patent No. 2,041,822, granted to A. D. Dowd, May 26, 1936. The picture cylinder and scanning apparatus may be connected under control of an operator to a driving motor 20 by means of an electromagnetically operated clutch 21. This clutch mechanism is described in detail in U. S. Patent No. 2,105,879, granted to C. C. Towne, Jan. 18, 1928. The motor 20, when started, operates continuously at a speed which is maintained accurately at a constant value under control of current from the source 14 of constant frequency alternating current and the speed control apparatus 22. This speed control apparatus is fully described in U. S. Patent No. 2,050,624, granted to E. R. Morton, Aug. 11, 1936. The apparatus at station A for operating the clutch magnet to start the picture cylinder 11 and the scanning apparatus, and for simultaneously sending out a signal for controlling the starting mechanism at the distant station is similar to that described in U. S. Patent No. 2,059,564, granted to A. D. Dowd, Nov. 3, 1936.

In order to transmit a picture from station A, the operator at this station closes the non-locking line-up key 23. This operation momentarily closes a circuit from ground through the adjustable stop switch 24, auxiliary stop key 25, through line-up key 23 through the winding of relay 26 to grounded battery 27, thus causing the operation of the relay. The relay locks up through its contact 28. The operation of this relay opens at its contact 29 the short circuit across the output of the picture terminal amplifier 19, thus permitting the picture carrier to be transmitted over the transmitting loop *ef* which connects the local station with a central office B. The operation of the relay opens at contact 30 the energizing circuit for a receiving control relay 31, thus preventing the energization of the receiving lamp 32, and closes at contact 33 a circuit from ground at 34 to the line *h* for the purpose of sending out a direct control current from the central office to control apparatus along the transmission path to the distant stations and at the distant stations, thereby conditioning the system for picture transmission from station A only to the distant stations. The operation of relay 26 also completes a circuit at contact 35 for energizing a sending lamp 36 by current from battery 87, thereby indicating to the operator at station A that the system has been conditioned for picture transmission from station A. The operation of relay 26 also places a short circuit across the line-up switch 23 so that the transmission of a picture may be started when the non-locking start key 37 is operated. The operation of key 37 completes a circuit from grounded battery 38 through the winding of clutch magnet 39 through contact 28 of relay 26 through auxiliary stop key 25 and the adjustable stop switch 24 to ground, thus operating the clutch magnet to start the movement of the picture cylinder 11 and its associated scanning apparatus. The magnet 39 locks up through its contact 40. When the start key 37 is operated and the clutch magnet 39 energized, the circuit which supplies current from the alternating current source 14 to the light interrupting valve 13 is short-circuited through contact 41 of key 37 and contact 42 of clutch magnet 39, thus interrupting the transmission of carrier current over the line *ef*. This interruption in the transmission of carrier current exists only for a brief period while the key 37 is closed since the short circuit is removed due to opening of contact 41 when the key 37 is released. This brief interruption of the carrier current causes the starting of the picture receiving apparatus at the distant station and the picture which is scanned at station A is thus reproduced at the distant station. The auxiliary stop key 25 is provided to permit the operator to stop the picture transmitting machine and to remove the direct current control from the system at any time. When the picture 10 has been transmitted, the switch 24 mounted on the base of the picture transmitting machine is automatically opened thus stopping the machine by opening the energizing circuit for clutch magnet 39 and removing the direct current control from the system by opening the energizing circuit for relay 26.

When it is desired to reproduce a picture locally at the terminal station A the connector 43 terminated in plugs 44 and 45 is used to connect the local picture transmitting apparatus with the local picture receiving apparatus 46, this apparatus being terminated for this purpose in the jacks 47 and 48 respectively. The insertion of the plugs 44 and 45 in the jacks 47 and 48 disconnects the picture transmitting and receiving apparatus from the lines *ef* and *cd*, respectively, to the central office and also opens the circuit to ground 34 so that ground will not be connected to line *h* when the relay 26 operates. For transmitting a picture locally, it is necessary to operate first the line-up key 23 so that the short circuit at the output of amplifier 19 will be opened at contact 29 and subsequently the start key 37 for starting the picture cylinder and scanning apparatus and interrupting the carrier current for starting the picture cylinder and scanning apparatus of the picture receiving equipment.

Each terminal station is also provided with telephone transmitting apparatus 49 and telephone receiving apparatus 50. The keys 51 and 52 may be operated to connect the telephone transmitter and receiver to the lines *ef* and *cd* respectively and to disconnect the picture transmitting and receiving apparatus from the line. The telephone receiver may be of the loud-speaking type which is connected to the line by the operator as soon as a picture has been transmitted so that each station may be called in by an operator at any other station. The operator may then operate key 51 to connect in his telephone transmitter so as to carry on two-way telephone communication with any other station.

At the central office B the transmitting loop *ef* and the receiving loop *cd* terminate in the repeater equipment comprising amplifiers 55 and

56, hybrid coil 57 and balancing network 58. The repeater equipment is connected to a composite set 54 comprising repeating coil 59, condensers 60 and 61 and inductance coils 62 and 63. The line *ab* connects the composite set at central office B with the bridging repeater station C.

When the operator at station A operates the line-up key 23 to connect ground to the line *h* the sending relay 64 at the central office is energized by current from grounded battery 65 through a circuit including contact 66 of receiving relay 67. The operation of relay 64 closes a circuit at contact 68 to connect grounded battery 65 to line *b*. If the line-up key 23 at station A has not been operated and the system has been conditioned at some distant station for transmission from that station to other stations, including station A, a direct current transmitted over line *a* energizes the receiving relay 67 to open contact 66, thus disconnecting line *h* from the sending relay 64 to prevent the transmission of a control current from station A, and to connect ground to the line *h*, thus causing the energization of relay 31 by current from grounded battery 69 at the central station. The operation of relay 31 closes a circuit to cause the lamp 32 to be energized by current from battery.

Station C of Fig. 3 is a bridging or switching station equipped with apparatus to permit an operator to connect together any number of two-wire lines terminating at this station. There is also associated with station C a terminal station D equipped like station A for transmitting and receiving pictures and for transmitting and receiving speech. The line *ab* from central office B is connected to a composite set 100 like the set 54 at central office B. The composite set is connected to a repeater comprising hybrid coil 101, balancing network 102, potentiometer 103 and emplifiers 104 and 105. When the locking key 106 is operated, a circuit is completed for energizing relay 107 by current from grounded battery 108, thus connecting amplifiers 104 and 105 with a bridging network 109. The bridging network comprises resistance elements connected in such a manner that the attenuation from any input terminal to all output terminals of the bridge, except on the same branch circuit, is approximately 30 decibels, whereas the attenuation from any input terminal to the output terminal of the same branch is very much greater than 30 decibels. The impedance at each input and output terminal is about 700 ohms. Such a bridging network is described in detail in U. S. Patent No. 2,019,603, granted to C. W. Green, Nov. 5, 1935. A terminal station D similar to terminal station A comprising picture transmitter 110, picture receiver 111, telephone transmitter 112, and telephone receiver 113 is also connected to the bridging network through the one-way amplifiers 114 and 115. When the relay 116 is energized by current from battery 117 due to the operation of locking key 124 the two-wire line *jk* is connected to the bridging network 109 through the composite set 119, and a two-way repeater comprising the hybrid coil 120, balancing network 121 and amplifiers 122 and 123. When key 118 is operated to cause the energization of relay 125, two-wire line *lm* is similarly connected to the bridging circuit 109 through composite set 126 and a two-way repeater comprising hybrid coil 127, balancing network 128 and amplifiers 129 and 130.

Assuming for the present that keys 106, 118 and 124 are operated to connect lines *ab*, *jk* and *lm* all to the bridging network 109, then the closing of the line-up key 23 at station A will cause the sending relay 64 at central station B to operate, thus connecting battery 65 to line *b*. Current from source 65 will thus operate sending relay 131 at station C to open the energizing circuit for receiving relay 132 at contact 133 and to connect grounded battery 134 to the winding of relay 135, causing it to operate. With relay 135 operated, ground is connected through switch 124, when operated, to the winding of sending relay 137, thus causing it to be energized by current from grounded battery 138. The operation of relay 137 completes an energizing circuit for sending lamp 139 and connects grounded battery 138 to line *j*. The operation of relay 137 also applies a short circuit to the input of amplifier 123. Similarly, due to the operation of relay 135 ground is connected through switch 118, when operated, to the winding of sending relay 136 thus causing it to be energized by current from grounded battery 140. The operation of relay 136 completes an energizing circuit for sending lamp 141 and connects grounded battery 140 to line *l*. The operation of relay 136 also applies a short circuit to the input circuit of amplifier 130. Thus the operator at station A may condition the system for transmitting pictures from station A to station D and to the stations connected to bridging station C by lines *jk* and *lm*. If the switch 118 at bridging station C is not operated there will be no transmission to the station connected to line *lm* and if the switch 124 is not operated there will be no transmission to the station connected to line *jk*. By opening switch 106 and closing switches 118 and 124 station A will be disconnected from the system and the stations associated with line *jk* will be connected with the station associated with line *lm* and also with station D. Of course, a larger number of lines, such as *ab*, *jk* and *lm* may be connected to the bridging network 109 if desired and an operator at station C may connect any desired combination of lines into the system.

If an operator at some distant station connected to line *jk* wishes to transmit a picture, grounded battery is applied to line *k* to cause the operation of relay 142. The operation of relay 142 applies grounded battery 143 to relay 135 to cause it to operate, switch 124 being closed. The operation of relay 142 opens the energizing circuit for relay 137 so that battery cannot be applied to line *j*. If switch 118 is closed ground is applied to the winding of relay 136 to cause its energization by grounded battery 140 and the operation of relay 136 causes the lamp 141 to be energized and grounded battery 140 to be applied to line *l*. If switch 106 is closed, the operation of relay 135 will also cause ground to be applied to the winding of relay 132 to cause it to operate, thus energizing lamp 144 and applying grounded battery 145 to line *a*. Grounded battery applied to line *a* will operate relay 67 to apply ground to relay 31 to cause it to operate to energize receiving lamp 32 at station A. In the same way a station connected to line *lm* may control other stations in the system by causing the energization of relay 146 by grounded battery applied to line *m*.

The apparatus connected to line *lm* is not shown, but may be similar to that connected to line *jk* which will now be described. The system may employ both two-conductor, open-wire transmission lines such as *ab*, *jk*, and *lm* and also four-wire cable circuits such as *nopq*. Fig. 4 shows a

repeater station E equipped with apparatus for connecting two-wire line *jk* to four-wire cable circuits *nopq*. Line *jk* is connected to the composite set **200** like the composite set **54**. The composite set **200** is connected to a two-way repeater comprising hybrid coil **201**, balancing network **202**, attenuation network **203**, filter **204** and amplifiers **205** and **206**. Amplifier **205** is connected through composite set **207** to the outgoing conductor *no* and amplifier **206** is connected through composite set **208** to the incoming conductor *pq*. If the operator at station A, for example, operates the line-up key **23**, grounded battery is supplied to line *j*, as previously described, and relay **209** is operated. The operation of relay **209** supplies ground to relay **210** to cause it to be energized by current from grounded battery **211**. The operation of relay **210** causes the energization of sending lamp **212**, causes the input of amplifier **206** to be short-circuited and connects positive battery to line *q* and ground to line *p*. When positive battery is connected to line *n* and ground to line *o* by means of a relay similar to relay **210** at the distant end of line *nopq*, relay **213** operates to open the energizing circuit of relay **210** and to connect ground to relay **214**, causing its operation by current from battery **215**. Battery **215** is thus supplied to line *k* to control apparatus at bridging station C as previously described. The operation of relay **214** also causes the energization of lamp **216** and causes ground to be applied to relays **217**, **218** and **219** which are thus operated by curent from battery **220**. The operation of relays **217** and **218** connect amplifier **206** directly with the hybrid coil **201**, disconnecting filter **204** from the circuit. The operation of relay **219** places a short circuit on the input of amplifier **205**.

Fig. 5 shows a repeater station F on the cable circuit *nopq* equipped with automatic gain control apparatus or pilot wire regulator **300**. A simple type of pilot wire regulator is shown for illustration, but other types of pilot wire regulators may obviously be employed. For example, a regulator of the type shown in U. S. Patent No. 2,017,654, granted to J. A. Coy and H. I. Romnes, Oct. 15, 1935, may be used. For convenience in describing the circuit, the four-wire cable is labeled *nopq* where it enters the repeater station and *rstu* where it leaves the repeater station. The pilot wire *z* consists of two conductors parallelling the four-wire cable and short-circuited at its ends. In practice a plurality of repeater stations employing pilot wire regulators are used on a long cable. The cable conductors *no* are connected through composite set **301**, variable attenuating network **304** of the pilot wire regulator **300**, amplifier **302**, and composite set **303** to the conductors *rs* of the cable. Similarly, the cable conductors *pq* are connected through composite set **305**, the variable attenuating network **308** of the pilot wire regulator **300**, one-way amplifier **306**, and composite set **307** to the conductors *tu* of the cable.

The pilot wire *z* which may extend from station E to the repeater station G of Fig. 6, for example, forms a loop which is connected into one arm of the Wheatstone bridge **310**. The opposite arm of the bridge consists of a variable resistor **311**. Battery **312** is connected across two opposite vertices of the bridge and a polarized relay **313** is connected across the other vertices of the bridge. A motor **314** which drives the arm of the variable resistor **311** and the arms of variable attenuators **308** and **304** is energized in one direction or the other by current from source **315** depending on the direction of the current in the bridge circuit through the winding of polar relay **313**. When there is a change in attenuation of the pairs of the cable *no* and *pq*, due to temperature changes, for example, there is a corresponding change in resistance of the pilot wire *z* of the cable. As a result the bridge **310** will be unbalanced to cause the operation of relay **313** and motor **314** in one direction or the other depending upon whether the resistance of the pilot wire has increased or decreased. The motor will operate to change the setting of variable resistor **311** until the bridge balance is restored and the settings of variable attenuators **308** and **304** will be changed to add or take out attenuation to restore the overall attenuation of the cable circuit to the normal value. However, a sudden change in the attenuation such as is produced by changing the setting of variable attenuators **308** and **304** is not desired when a picture is being transmitted since such a change in attenuation would result in one part of the picture reproduction being noticeably of darker tone value than another portion although no such change in tone value is present in the original picture. For this reason the energizing circuit for motor **314** is opened under control of the direct control current when a picture is about to be transmitted. When relay **210** at station E operates to connect positive battery to line *q* and ground to line *p*, polar relay **316** is operated to apply ground to one terminal of a winding of polar relay **317** and the relay **317** will operate to close contact **318** which completes the energizing circuit for relay **319** and thus causes the relay **319** to operate to open the energizing circuit for motor **314**. If relay **316** should be accidentally released for a period less than two seconds, as would occur, for example, due to the grounding of line *g* connecting station A with central office B for a short period, the condenser **320** would merely partly charge during this interval and the relay **317** would not release. In the same way when positive battery is applied to conductor *r* and ground to conductor *s*, as would be the case when a picture is being transmitted in the opposite direction from that assumed above, relay **321** will operate to connect ground to a terminal of winding of relay **317** to operate it and thus cause the operation of relay **319** which opens the energizing circuit for motor **314**.

Fig. 6 shows a repeater station G like the repeater station E of Fig. 4 for connecting the four-wire cable *rstu* to the two-conductor open-wire line *vw*. The apparatus at station G has been numbered to correspond with the numbering of the corresponding parts at station E with the exception of the first digit. At station G the numerals applied to the apparatus extend from **400** to **420** while at station E the corresponding apparatus is numbered from **200** to **220**. This apparatus requires no further detailed description.

There is also shown in Fig. 6 a bridging station H like the bridging station C of Fig. 3. The two-wire line *vw* going to station G, *xy* going to central office J of Fig. 7 and lines **450** and **460**, which go to other stations not shown, are connected into the bridging station H.

The central office J of Fig. 7, like central office B of Fig. 2, is connected to the two-wire line *xy*. Line *xy* is connected through the composite set **554**, like composite set **54** at station A, and a two-way repeater comprising hybrid coil **557**, balancing network **558** and one-way amplifiers **555** and **556**. The picture sending apparatus

570 at the terminal station K is connected through jack 551 and key 547 to the loop *e'f'* which is connected to the amplifier 555 at the central office J. The loop *c'd'* which connects the amplifier 556 with the local station K is connected through key 548 and jack 552 to amplifier 571, band-pass filter 572, amplifier-rectifier 573, low-pass filter 574 and light valve equalizer 575 to the light valve 576. Light from source 577 is directed through the light valve to a small spot on the light sensitive picture film 578 mounted on the picture cylinder 579. The motor 580, when the electromagnetically controlled clutch 581 is operated, drives the picture cylinder 579 to rotate it about its axis and the optical apparatus comprising light source 577 and light valve 576 to move it in the direction of the axis of the cylinder so that the tone values of elemental areas of the picture are reproduced in succession along a helical path in synchronism with the scanning of the elemental areas of a picture at a transmitting point, station A for example. This portion of the picture reproducing apparatus is disclosed in greater detail in Patent No. 2,041,822 supra. The clutch mechanism is described in detail in Patent No. 2,105,897 supra. The motor 580, when started, operates continuously at a speed which is maintained accurately at a constant value under control of current from source 514 of constant frequency alternating current, having the same frequencies as the source 14 at station A, and the speed control apparatus 522. This speed control apparatus is fully described in the patent of E. R. Morton, supra.

The arrangement for operating the clutch 581 so as to start the picture receiving apparatus substantially simultaneously with the picture transmitting apparatus under control of a transmitting operator at station A, for example, is described in detail in Patent No. 2,059,564, referred to above. When the non-locking start key 582 is momentarily operated by the attendant at station K, the winding of relay 583 is energized by current from grounded battery 584. The operation of relay 583, which locks up through contact 585, removes a short circuit across the lower winding of polarized relay 586 causing it to operate to close contact 587. Relay 588 is thus operated by current from battery 589 and this relay is locked up by current from battery 584. The operation of relay 588 completes the circuit from ground through adjustable stop 524, auxiliary stop key 590, winding of clutch magnet 591, to contact 592 of relay 586. When a distant transmitting operator now operates the start key of a picture sending machine, as at station A, for example, the carrier current supplied to the lower winding of relay 586 is momentarily interrupted. This causes the relay 586 to operate to close contact 592 thus completing the circuit to grounded battery 589 and energizing the clutch magnet 591 to start the receiving machine.

When the operator at station A, for example, operates the line-up key 23 battery is connected to line *x* to cause the operation of relay 567 at the central office J. Ground is thus connected to one terminal of the winding of relay 531 to cause it to be energized by current from battery 569. The lamp 532 is thus caused to be energized by current from battery. In addition to causing the energization of lamp 532, the relay 531 may obviously perform some other function which may be desired to condition the receiving station for receiving a picture. The connector 543 may be used to connect the picture transmitting and receiving apparatus at station K for reproducing a picture locally, as at station A. Station K, like station A, is also provided with telephone transmitting apparatus 549 and telephone receiving apparatus 550.

To review the operation of the complete system, assume now that the operator at station A wishes to transmit a picture to a number of other stations including station K. He will first operate switches 51 and 52 and announce into the telephone transmitter 49 that the operators at the other station should prepare the apparatus at their station to receive a picture. If desired the operator at station A may also operate the line-up key 23 at this time so that a visible signal is produced at the station K for calling the operator. In this case the auxiliary stop key 25 must be subsequently operated if it is desired to restore the system for two-way telephone communication. If the operator at station K is not ready to receive a picture, or if, for any other reason, he wishes to communicate with station A, he will operate his talking key 547 so that he may carry on two-way telephone communication with the operator at station A. When operator A has given the necessary instructions as to the size of the picture to be transmitted, for example, the operators will restore keys 51, 52, 547 and 548 to connect the picture transmitting and receiving apparatus to the central stations. Operator K will adjust the adjustable stop contact 589 on the base of the receiving machine, operator A having previously set the adjustable stop contact 24. Operator A will now momentarily close the line-up key 23. Sending relay 26 will thus be locked up to remove the short circuit from the output of picture terminal amplifier 19, to energize sending lamp 36, to open the energizing circuit to receiving relay 31 and to complete the energizing circuit for sending relay 64 at the central office B. The operation of relay 64 will connect grounded battery to line *b* going to the bridging repeater station C where the direct current transmitted over line *b* will operate sending relay 131. The switches 106 and 124 at station C having been operated, the operation of relay 131 will cause the energization of relay 135 to place ground on one terminal of winding of relay 137, causing it to operate. The operation of relay 137 will cause the lamp 139 to be energized to indicate that the circuit at station C is set up to transmit pictures through to line *jk*. The operation of relay 137 will short-circuit the input to amplifier 123 to prevent transmission through the amplifier 123. A short circuit is thus applied to all the lines transmitting into the bridge circuit, except the line for transmitting picture current into the bridge circuit, for the purpose of reducing noise currents applied to the circuit and to increase the loss of the cross-talk paths. The operation of relay 137 will also cause battery to be applied to line *j*.

At repeater station E the direct current transmitted over line *j* will operate receiving relay 209 to open the energizing circuit of sending relay 214 and to apply ground to winding of relay 210 causing it to be energized. The operation of relay 210 will cause the lamp 212 to be energized to indicate that the circuit is conditioned for transmitting from line *jk* to four-wire cable circuit *nopq*. Relay 210 when operated will also place a short circuit on the input of amplifier 206 to prevent echo effects. The operation of

relay 210 will also place positive battery on line *q* and ground on line *p* to cause the operation of relay 316 at repeater station F.

The operation of relay 316 will cause the energizing circuit for motor 314 to be opened by contact of relay 319 to prevent the operation of the automatic gain control apparatus including variable attenuators 308 and 304. The current which operates relay 316 flows through lines *t* and *u* to cause the operation of relay 413 at repeater station G. The operation of relay 413 will open the energizing circuit for relay 410 and connect ground to winding of relay 414 to cause its operation. The lamp 416 is thus energized to indicate that transmission is from the four-wire cable circuit *rstu* to two-wire line *vw*. The operation of relay 414 will also cause ground to be connected to the circuit including relays 417, 418 and 419 causing these relays to be energized. The relay 419 when operated short-circuits the input to amplifier 405 to reduce noise currents on the line and to prevent singing and the operation of relays 417 and 418 will disconnect filter 404 from the transmission path. This filter is required in the circuit for two-way speech transmission to prevent singing but is not required when a picture is being transmitted in one direction on the circuit. The filters if allowed to remain in circuit when pictures are being transmitted would introduce sufficient delay distortion to lower the quality of a picture reproduction considerably. The operation of relay 414 will also connect grounded battery 415 to line *v*. At bridging station H, relays corresponding to relays 131, 135 and 137 of bridging station D will operate and grounded battery will be connected to outgoing line *x* thus causing the operation of relay 567 at central office J. The operation of relay 567 connects ground to the winding of relay 531 at terminal station K to cause lamp 532 to be energized, thus indicating to the operator at station K that the system has been conditioned for picture transmission to his station.

The operator at station K then operates the non-locking start key 582 to condition the starting circuit as previously described. The operator at station A then operates the start key 37. This causes the energization of clutch magnet 39 at station A to start the operation of the picture transmitting machine and momentarily interrupts the carrier current transmitted to station K. At station K the interruption of the received carrier current causes the operation of clutch magnet 591 to start the picture receiving machine. When the operator at station A releases the non-locking start key 37, the carrier current is again transmitted and, due to the operation of the picture transmitting machine, this carrier current is modulated in accordance with the tone values of successively scanned elemental areas of the picture. At station K the received picture current, after being amplified and rectified, actuates the light valve 576 to control, in succession, the exposure of the elemental areas of the light sensitive surface 578 to reproduce the picture thereon.

When the picture has been transmitted the automatic stop 24 mounted on the base of the picture sending machine at station A automatically opens the energizing circuit for the clutch magnet 39 to stop the picture sending machine and opens the energizing circuit for relay 26 to remove the direct current control from the system, thus restoring the system for two-way telephone communication. The automatic stop 524 at station K will also operate to stop the picture receiving machine. An operator at any other station may now condition the system for broadcasting pictures from that station.

In the picture broadcasting system as described, the direct control current performs certain specific operations for conditioning the system for one-way picture broadcasting. Obviously, however, the direct control current may be utilized to perform functions, other than those specifically described, which may be found necessary in any system which may be set up.

What is claimed is:

1. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance network, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive current from any of said lines and distribute it simultaneously to the others of said lines, means at each of said stations for controlling the transmission of control impulses other than the signaling impulses simultaneously to each of the other stations, and means at each of said stations to condition apparatus thereat under control of said impulses transmitted under control of any other of said stations.

2. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance network, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive current from any of said lines and distribute it simultaneously to the others of said lines, circuit control means at each of said stations in addition to said signal transmitting and receiving apparatus for controlling the transmission of control impulses simultaneously to each of the other stations, and means at each of said stations to condition apparatus thereat under control of said impulses transmitted under control of another of said stations.

3. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance network, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive signaling current from any of said lines and simultaneously distribute it to the others of said lines, two-way repeaters in said lines respectively, and means at each of said stations for controlling the transmission of control impulses other than the signaling current to simultaneously condition all of said two-way repeaters.

4. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance network, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive current from any of said lines and simultaneously distribute it to the others of said lines, a two-way repeater in at least one of said lines, circuit control means at each of said terminal stations for controlling the transmission of direct current impulses simultaneously to each of the other stations, and means at each of said stations to condition apparatus thereat under control of said direct current impulses transmitted under control of another of said stations.

5. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance net-

work, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive current from any of said lines and simultaneously distribute it to the others of said lines, a two-way repeater in at least one of said lines, means at each of said stations in addition to said signal transmitting and receiving apparatus for controlling the transmission of direct current control impulses simultaneously to each of the other stations, direct current repeating apparatus associated with each of said two-way repeaters for repeating said direct current impulses, and means at each of said stations to condition apparatus thereat under the control of said direct current impulses transmitted under control of another of said stations.

6. A signaling system comprising three or more stations, signal transmitting and receiving apparatus at each of said stations, an impedance network, connecting lines associating said impedance network with said stations respectively, said network being adapted to receive current from any of said lines and simultaneously distribute it to the others of said lines, two-way repeaters in each of said lines adjacent said network, circuit control means at each of said stations for controlling the transmission of control impulses other than the signaling current simultaneously to each of the other stations, means at each of said two-way repeaters under control of said control impulses for conditioning said repeaters for one-way operation, and means at each of said stations for conditioning apparatus thereat under control of said impulses transmitted under control of another of said stations.

7. An image broadcasting system comprising three or more stations, signaling means at each of said stations for transmitting image current to each of the others of said stations simultaneously, image receiving means at each of said stations, means at each of said stations for controlling the transmission of control impulses other than the signaling current to each of the other stations simultaneously, and means at each of said stations for conditioning the apparatus thereat under control of said impulses transmitted under control of another of said stations.

ALLAN WEAVER.