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2,785,223

FACSIMILE TRANSMITTERS

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FIG. 1

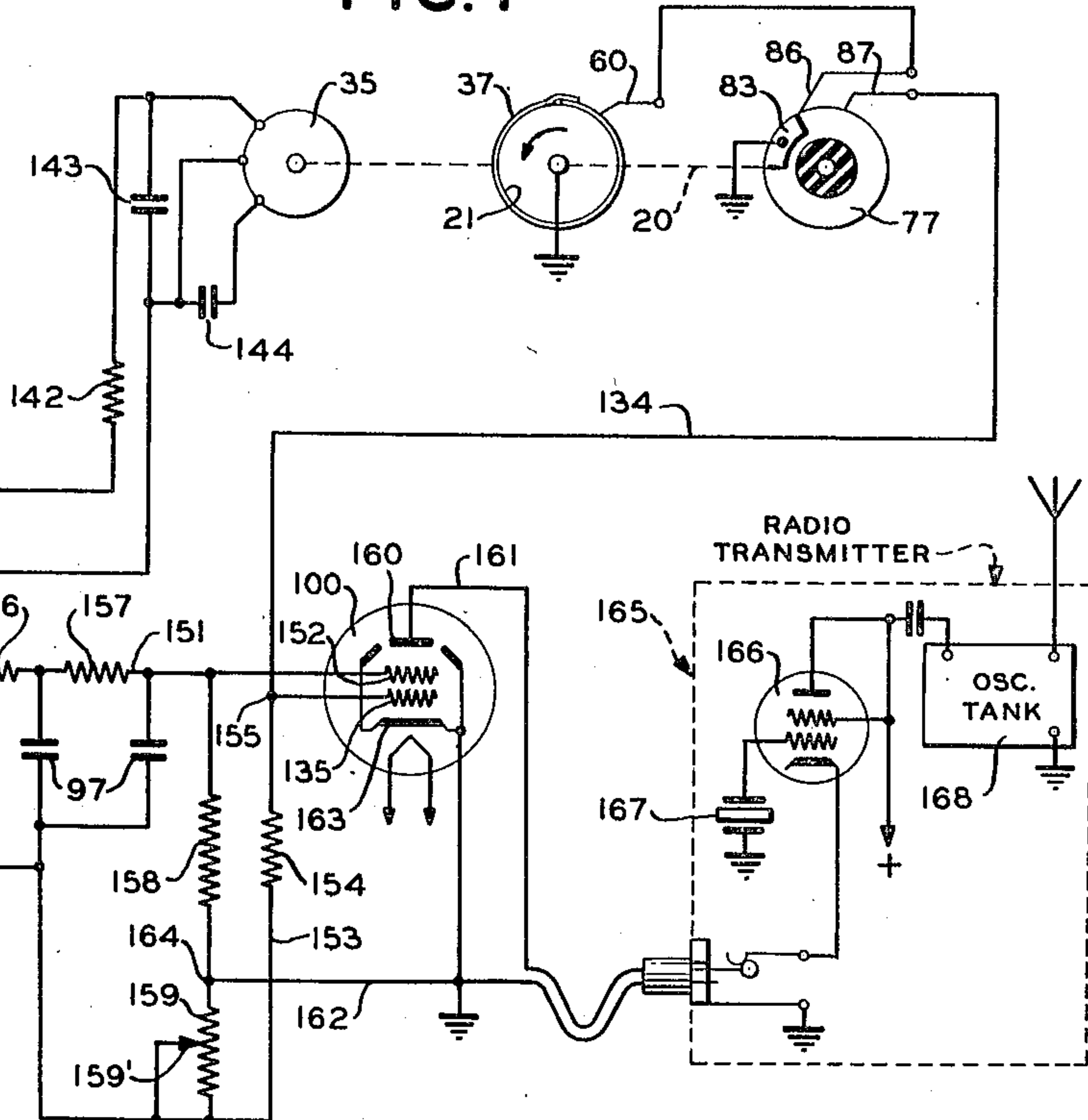


FIG. 2

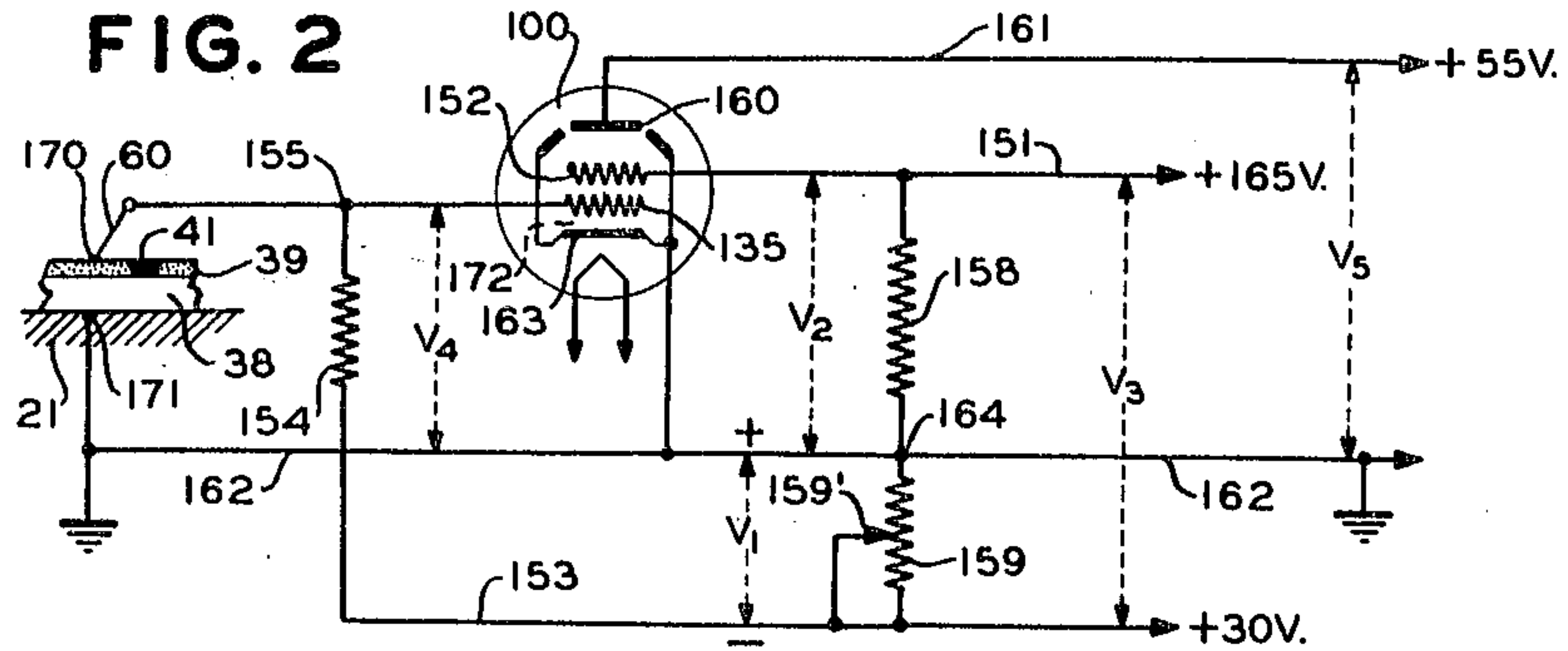
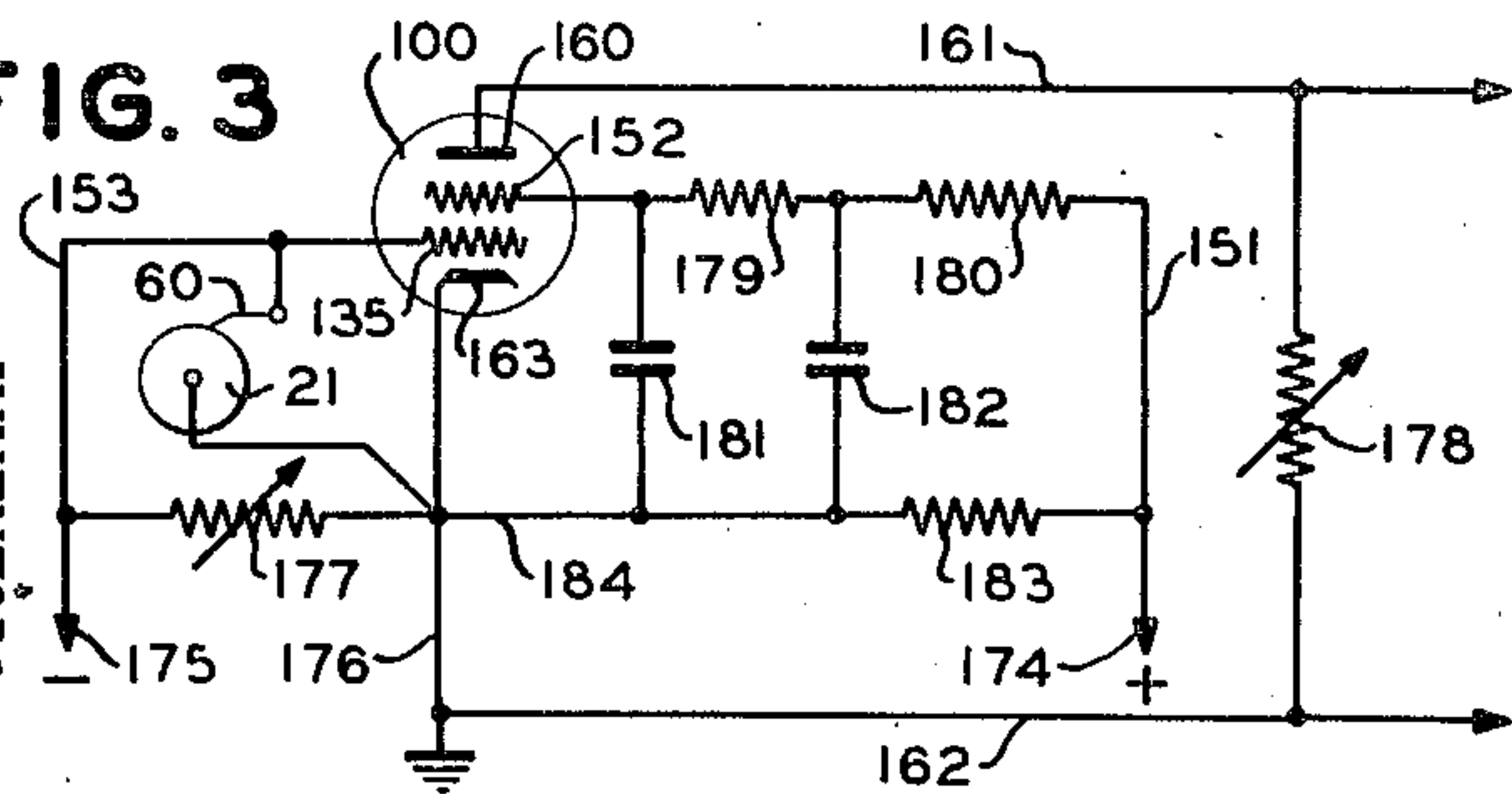


FIG. 3



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FACSIMILE TRANSMITTERS

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Original application November 16, 1948, Serial No. 60,334, now Patent No. 2,647,945, dated August 4, 1953. Divided and this application January 8, 1953, Serial No. 330,343

5 Claims. (Cl. 178—7.1)

This invention relates to facsimile transmission and more particularly to novel transmitting circuits employed with an electric stylus for direct scanning of the subject copy.

The present application is a division of applicants' copending application Serial No. 60,334, filed November 16, 1948 now Patent No. 2,647,945. The latter application discloses a facsimile system including a portable transmitter communicating with a distant receiver. The instant invention is concerned with the novel transmitting circuits, and only so much of the system disclosed in the parent application as is necessary for the understanding of the present invention is herein disclosed.

The facsimile transmitter has been designed to operate with a conducting paper on which the subject matter to be transmitted is marked with a pencil of soft graphite. After the information has been written on a sheet of this paper, the operator mounts the sheet on a rotary drum where it is scanned by an electric stylus. Reference is made to applicants' said copending application for a description of the rotary drum and its associated mechanical features. The pencil markings are conducting as compared to the high impedance of the unmarked paper and cause the stylus to produce voltage variations in the grid circuit of a vacuum tube. These voltage variations represent the scanned copy and are fed into the cathode circuit of a radio transmitter which sends the signals to a distant receiver.

It is therefore an object of this invention to provide transmitting circuits controlled by an electric stylus as it scans a message sheet for producing signal pulses in accordance with the scanned message.

A further object of this invention is to provide facsimile transmitting circuits for controlling a radio transmitter.

These and other objectives of the invention will be more fully understood from the following description taken in conjunction with the drawings in which:

Fig. 1 is a diagram of the transmitter circuits;

Fig. 2 is a simplified detail of the transmitter circuits; and

Fig. 3 is a modification of Fig. 2.

In the interest of consistency and convenience of examination, the various elements of the drawings are given the same reference numerals as in applicants' copending application Serial No. 60,334, filed November 16, 1948.

Referring to Figs. 1 and 2, a rotary drum 21 is adapted to support a sheet of paper 37 on which the subject matter to be transmitted has been recorded in conducting marks or characters. The blank 37 is an especially prepared sheet of paper comprising a base stock 38 of conducting material (for example, carbon) and a top layer 39 of porous insulating material. This top layer may be a coating of suitable powder adapted to be scraped away or penetrated by the point of a writing instrument, such as a pencil of soft graphite. Numeral 41 indicates a conducting mark made in this manner on the conducting layer 39. These marks, if properly made, penetrate to the

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conducting base 38 and make contact therewith. It may be explained that the minute particles of soft graphite scraped off the pencil by virtue of the pressure exerted in the process of writing fill the microscopic pores of the insulating layer 39 with conducting material which constitutes the record to be transmitted. We have, then, a sheet of paper with a conducting base stock and an insulating top surface on which the subject copy is written in conducting marks or characters.

All electric power for the transmitter comes from a small storage battery, which is indicated in Fig. 1 at 136. The battery leads go to the vibrator 96 and a suitable power switch 137 is included in one of the leads. The vibrator 96 is a standard commercial unit well known to electrical engineers and requires no description.

A transformer 138 comprises a primary coil 139 and two secondary coils 140 and 141. The primary 139 receives the output of vibrator 96 which converts the battery current (usually six volts) into a 110-volt, 60-cycle alternating current. The secondary 140 drives the synchronous motor 35, which is shown here as being of the drum type. A resistor 142 and condenser 143 serve to improve the wave shape of the alternating current supplied to the motor. A phase shifting condenser 144 is employed in the starting winding of the motor, which runs at constant speed to drive the drum 21 and the phasing commutator 77.

The secondary coil 141 supplies alternating current to the full-wave rectifier tube 99. This tube contains the usual elements consisting of two plates or anodes 145 and 146, a cathode 147 and a heater 148. The latter receives current from the battery conductors 149. A condenser 150 connected across the secondary 141 serves to reduce excessive voltage peaks and sparking at the vibrator contacts.

The cathode 147 of rectifier tube 99 is connected by a wire 151 to the screen grid 152 of a beam-power keying tube 100. The middle point of the secondary 141 is connected by a wire 153 to the control grid 135 of tube 100 through a resistor 154. For purposes of description, the wires 134 and 153 may be considered as being joined at point 155 from which a connection goes to the grid.

A pair of resistors 156 and 157 in combination with the condenser unit 97 (in reality two condensers within a cylindrical casing) constitute a resistance-capacity filter associated with rectifier 99 to provide D. C. grid and screen potentials for tube 100. These potentials are determined by resistors 158 and 159, which are connected in series across the lines 151 and 153. The resistors 158 and 159 constitute a voltage divider and the resistor 159 is adjustable by a tap 159' to regulate the voltage as required. The resistor 158 determines the potential for the screen grid 152 and resistor 159 provides the grid bias. The heater current for tube 100 comes from the battery leads 149.

The plate 160 of tube 100 is connected to an output lead 161 and the other output lead 162 is grounded. The cathode 163 is connected to lead 162 which goes to point 164 between the resistors 158 and 159. The conductors 161 and 162 constitute the output cable of the keying tube 100 and this cable is connected to the cathode circuit of the R. F. oscillator tube in the portable radio transmitter 165.

It is not necessary to show or describe the details of this transmitter because such devices are well known and understood. So we need only mention that the transmitter 165 contains an oscillator tube 166, a crystal 167 connected to the control grid of the tube, and an oscillator tank 168 connected to the plate of the tube. The plate circuit of keying tube 100 is completed through the output cable 161—162 and the cathode circuit, returning by way of the grounded and shielded side of the cable. The signals passing through the plate circuit of tube 100 are

sent out by the radio transmitter on its assigned carrier, as will be understood without further explanation.

Let us now see how the scanning of the message on sheet 37 by the stylus 60 controls the keying tube 100. For this description we shall refer to the simplified diagram of Fig. 2 which is really a part of Fig. 1 in rearranged form for easy understanding. The numerical voltages indicated in Fig. 2 are merely by way of example to show the positive and negative relationships between the conductors. Thus, the grounded conductor 162 is negative with respect to the plate conductor 161 but is positive with respect to conductor 153 which is at negative voltage. Although the given voltage numbers were actually used in one embodiment of our system, those numbers are not to be taken in a restrictive sense but solely for purposes of description.

The five voltages indicated in Fig. 2 by the symbols V1 to V5 represent the following conditions:

The voltage V1 between the points 164 and 159' is determined by the setting of the potentiometer tap 159' and is the negative bias voltage applied to the control grid 135. Once this voltage has been adjusted it remains constant.

The voltage V2 between lines 151 and 162 across the resistor 158 represents a suitable potential maintained between the screen grid 152 and the cathode 163 of tube 100. This screen grid voltage primarily determines the amount of current that will flow in the plate circuit of the tube.

The voltage V3 between the screen conductor 151 and the negative conductor 153 across the entire resistor 158 and a portion of potentiometer 159 is obtained from the rectifier 99 of the facsimile transmitter, as explained before. This voltage supply between the screen grid 152 and cathode 163 is relatively constant.

The voltage V4 between the control grid 135 and cathode 163 is a variable negative quantity depending upon whether the stylus 60 is on a mark or on clean paper, as we shall presently explain.

The voltage V5 between the conductors 161 and 162 is obtained from the radio transmitter 165 and will vary in proportion to variations in voltage V4.

Referring to Fig. 2, the effective resistance as measured across the thickness of the scanned sheet between the stylus point 170 and the grounded point 171 (which actually is the metal drum 21) will be called the paper resistance. Obviously this resistance is highest when the stylus is on clean paper—that is, when touching an unmarked spot on the insulating top layer 39, and is lowest when the stylus is on a conducting pencil mark 41.

It should be noted that the paper resistance is in shunt to the grid-cathode path 172. When the stylus 60 scans an unmarked spot, there is only a minimum flow of plate current in tube 100 because the paper resistance is very high and the control grid 135 is at a very negative potential. This minimum or no-signal current is just sufficient to keep the crystal 167 in the radio transmitter 165 vibrating at all times so as to maintain the oscillator tank 168 in an oscillating condition, but this minimum current is not high enough to operate the radio transmitter for facsimile transmission. This minimum or no-signal current may be called the "keep alive" current for the radio oscillator.

When the stylus 60 rides over a conducting mark 41, the paper resistance is so low that the control grid 135 is grounded and is therefore at zero potential. This allows a maximum current flow across the plate-cathode path in tube 100 and facsimile signals are sent out by the radio transmitter 165 corresponding to the marks on the scanned sheet.

We prefer to use an amplifier tube of the beam-power type because these tubes in general have a low screen-grid current, high efficiency and a high power output. By using a screen voltage of high value (V2 is indicated

as 165 volts in Fig. 2) we can make the plate current relatively high, which is desirable in our system because the plate voltage is limited to a low value (for example, 55 volts) by the characteristics of the small portable radio transmitter 165.

The best operation of the radio transmitter 165 requires a large plate current swing in tube 100 and that requires a maximum change in the grid voltage. For this purpose the bias voltage V1 is so adjusted by potentiometer 159 that the tube 100 is almost cut off when unmarked areas or background specks on the sheet are being scanned, and a low current is flowing. When a conducting mark is being scanned, the paper resistance is so low as compared with the resistor 154 that the grid 135 is grounded and this decrease in negative voltage V4 allows the tube to pass a high current which causes the radio transmitter 165 to send out corresponding facsimile signals. In effect then, the tube 100 is turned on when the stylus is on a mark and is turned off when the stylus is on clean paper.

A modified form of keying network involving our invention is shown in Fig. 3. Here, as in Fig. 2, the screen grid 152 is connected to the plus terminal 174 and the control grid 135 is connected to the negative terminal 175 of the power supply from rectifier 99. This voltage, as heretofore stated, is fairly constant. The cathode 163 goes to the grounded wire 176. An adjustable resistor 177 of high value is connected between wires 153 and 176 in shunt to the stylus 60. The resistance of element 177 is very high relatively of the resistance of a pencil mark in the stylus circuit.

The value of resistor 177 is so adjusted that, when the unmarked background of the paper is under scanning, the voltage between lines 153 and 176 will either hold the current in tube 100 to a minimum value or cut the tube off completely. A rheostat 178 connected across the output leads 161 and 162 may be used to maintain the low current of tube 100 during background scanning to a minimum "keep alive" value for the purposes previously explained.

When pencil marks are being scanned, the resistance between the stylus 60 and the grounded drum 21 is so low that the high resistor 177 is effectively short-circuited and the control grid 135 is grounded. The voltage between lines 153 and 176 is thus reduced to a very low value, while the voltage between lines 151 and 176 increases nearly to the full potential of the power supply. As a result of this great increase of the voltage of screen grid 152 and the removal of negative grid bias, the tube becomes highly sensitive and the plate current is made very large. This signal output is sent to the radio transmitter 165.

We would call particular attention to a low-pass filter associated with the screen grid 152 in Fig. 3, this filter comprising resistors 179 and 180 in line 151 and condensers 181 and 182 connected between the screen grid and the cathode 163. This filter slows down the build-up of the screen-grid voltage and thereby prevents or reduces the transmission of background of the high-frequency impulse type, such as spots on the paper, for instance. It goes without saying that this filter should be so designed that the finest lines scanned by the stylus will be transmitted without deterioration. A fixed resistor 183 of chosen value is inserted in line 184 to act in combination with the adjustable resistor 177 as a voltage divider to furnish the proper grid bias and screen-grid voltage so as to give the tube the desired sensitivity.

It is seen from the above that applicants have produced a circuit for conveniently controlling a radio transmitter in accordance with the electric stylus scanning of conductive marks on a message sheet.

Various modifications of the disclosed embodiment of the invention could be made within the scope of the appended claims.

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What is claimed is:

1. In a facsimile transmitter, electric scanning mechanism in which a stylus operates on electrically conductive paper having marked and unmarked areas which offer, respectively, low and high resistances from stylus to ground, an amplifying network including a keying tube, means for connecting the stylus to the control grid of said tube during a scanning operation, a source of voltage supply for said tube, the plate circuit of said tube constituting the amplified signal output of the network, means for impressing a negative bias on the control grid of such value that the tube will not pass a signal current when the stylus is on an unmarked area of high resistance, said grid biasing means including a resistor which causes the control grid to be practically grounded when the stylus scans a mark, the grounding of the control grid allowing a high current flow through the tube, and means for utilizing this high current to send out a signal corresponding to the scanned mark.

2. In a facsimile system, a transmitter provided with electric scanning mechanism in which a stylus operates on electrically conductive paper having marked and unmarked areas which offer, respectively, low and high resistances from stylus to ground, an amplifying network including a keying tube, means for connecting the stylus to the control grid of said tube during a scanning operation, said network including a source of voltage supply for said keying tube, the plate circuit of said tube constituting the amplified signal output of the network, a resistor in shunt to the stylus-to-ground connection across the paper, said resistor having a considerably higher resistance value than the resistance of the marked area of the paper, so that said resistor is effectively short-circuited when the stylus is on a mark, and connections responsive to the short-circuiting of said resistor for causing a high current flow through said tube, which thereby passes signals corresponding to the scanned marks.

3. In a radio facsimile system, a transmitting station provided with electric scanning mechanism in which a stylus operates on electrically conductive paper having marked and unmarked areas of different resistances, an amplifying network including a keying tube, a radio transmitter having an oscillator tube whose cathode circuit is connected to the output circuit of said keying tube, said oscillator tube being designed to operate only on a high current flow in said output circuit, connections responsive to the scanning of a mark on the paper for causing said keying tube to pass a high current and send out facsimile signals which operate said radio transmitter, and resistor means adjusted to such value as to cause a minimum current flow through said oscillator tube to maintain the radio transmitter in oscillating condition when the stylus scans an unmarked area on the paper.

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4. In a radio facsimile system, a transmitting station having electric scanning mechanism in which a stylus operates on electrically conductive paper with marked and unmarked areas which offer, respectively, low and high resistances from stylus to ground, an amplifying network including a keying tube, means for connecting the stylus to the control grid of said tube during a scanning operation, a radio transmitter having an oscillator tube and a crystal operated thereby, the cathode of said oscillator tube being connected in the output circuit of said keying tube, said oscillator tube being designed to require a high current flow in said keying tube for the transmission of scanning signals, connections controlled by the low resistance between stylus and ground for causing a high current flow in both of said tubes when the stylus scans a mark on the paper, whereby a signal corresponding to said mark is sent out by the radio transmitter, and means including an adjustable resistor to cause a predetermined minimum current flow through said oscillator tube when the stylus scans an unmarked area on the paper, said minimum current being insufficient to operate the radio transmitter but sufficient to keep said oscillator and crystal in oscillating condition.

5. In a facsimile system of the type in which a transmitting stylus operates on electrically conductive copy paper having marked and unmarked areas which offer, respectively, low and high resistances from stylus to ground, an amplifying network including a screen grid keying tube, means for connecting the stylus to the control grid of said tube during a scanning operation, said network including a source of voltage supply for the plate and screen grid of the tube, the plate circuit of the tube constituting the amplified signal output of the network, a resistor in shunt to the stylus-to-ground connection across the paper, said resistor having a considerably high resistance value than the resistance of the marked area of the paper, so that said resistor is effectively short-circuited when the stylus is on a mark, connections responsive to the short-circuiting of said resistor for causing a high current flow through said tube, and a low pass filter in said network adapted to slow down the response of said tube to sudden changes in the resistance of marked and unmarked areas on the paper, whereby the amount of background transmitted will be reduced while even fine marks will be transmitted at substantially full strength.

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