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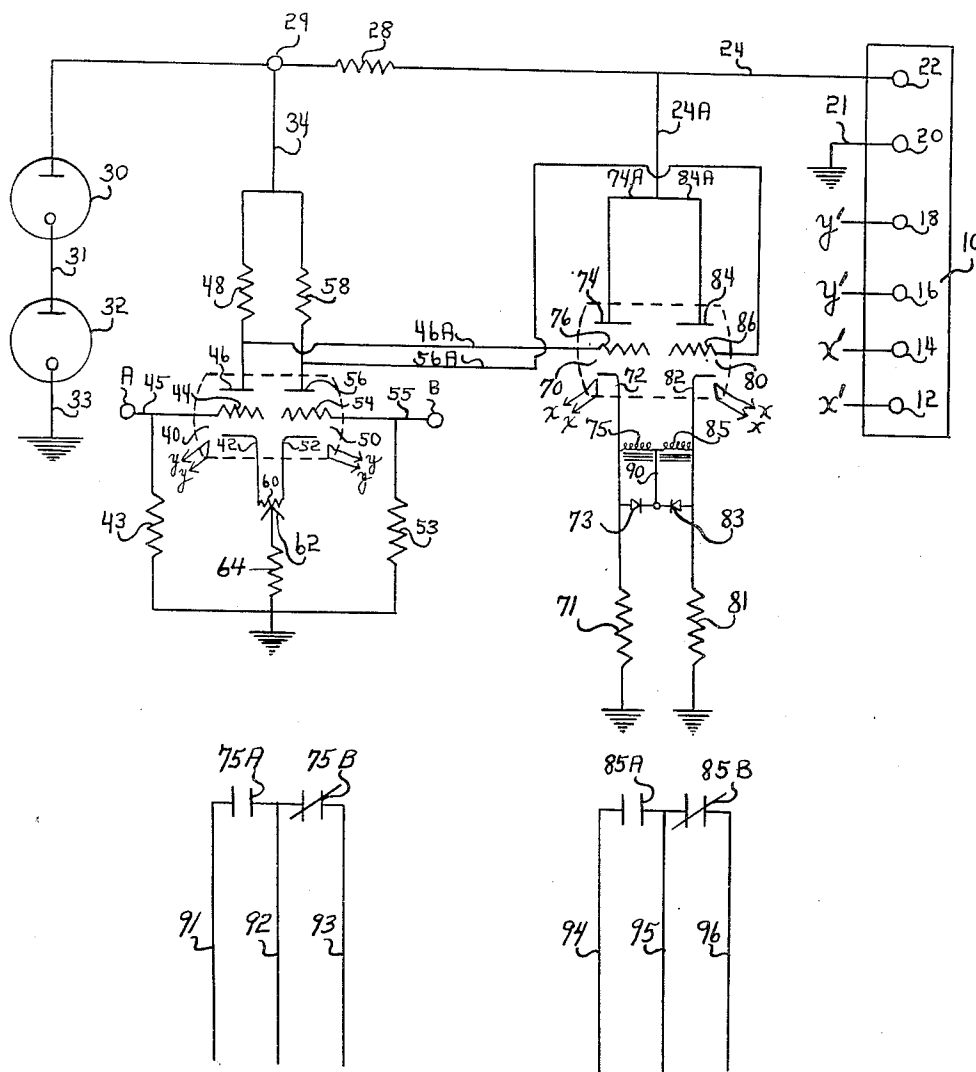
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AUTOMATIC ELECTRONIC ERROR CORRECTION CIRCUIT

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Fig. 1



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AUTOMATIC ELECTRONIC ERROR
CORRECTION CIRCUIT

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This invention relates to an improved error correction circuit operated in conjunction with motors, valves, or other mechanisms, to provide the desired correction. This circuit provides for detection of signal errors, amplification of these errors, and operation of relays, which in turn, control other devices which actually correct the error and bring it back to zero.

These objects are attained by means of an electronic circuit illustrated in the accompanying drawing, in which the figure shows one form of the electronic circuit for automatic error correction.

Referring to the circuit, numeral 10 indicates a source of electrical energy providing at terminals 12 and 14, or X^1-X^1 , a source of potential for the heaters X, X of cathode follower output tubes 70 and 80, and at 16 and 18 or Y^1-Y^1 , source of heater voltage for heaters Y, Y, of the bridge amplifier tubes 40 and 50, as well as a source of high voltage at terminals 20 and 22. The low voltage terminal 20 is grounded through line 21. The high voltage terminal 22 is connected by lines 24 and 24A to the plates 74 and 84 of the cathode follower tubes 70 and 80 respectively, and by line 24 and ballast resistor 28, to the regulated high voltage point 29, and thence through voltage regulator tubes 30 and 32 to ground as at 33.

Line 34 connects from the source of regulated high voltage 29 to the plate load resistors 48 and 58 of tubes 40 and 50 respectively. The bridge amplifier consisting of tubes 40 and 50 has equal grid resistors 43 and 53 connected from grids 44 and 54 respectively to ground. Cathodes 42 and 52 are connected by a potentiometer 60 whose slider 82 is connected through resistor 64 to ground. Plate 46 is connected by line 46A to the grid 76 of cathode follower tube 70. Plate 56 is connected by line 56A to grid 86 of cathode follower tube 80.

Tubes 40 and 50 may be combined in a single twin triode, such as a 6SL7, and cathode follower tubes 70 and 80 may be combined in a twin triode such as, a 12AU7; or pentodes may be substituted for triodes in the bridge amplifier and in the cathode follower stages.

Cathode 72 is connected by resistor 71 to ground and cathode 82 is connected by an equal cathode resistor 81 to ground. Rectifier 73 and rectifier 83 are connected back to back between cathodes 72 and 82. Relay coils 75 and 85 are connected in series between cathodes 72 and 82. Line 90 connects the junction points between the relay coils and rectifiers. Contacts 75A nor-

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mally open, and 75B normally closed, are operated by relay coil 75. Contacts 85A normally open, and 85B normally closed, are operated by relay coil 85. External connections are provided from these contacts by lines 91, 92, 93, 94, 95 and 96 to operate such external circuits as are desired, in accordance with the error signal impressed on inputs A and B.

Briefly, the operation of this circuit is as follows: The bridge amplifier consisting of tubes 40 and 50, is set up in a conventional manner except that very high values of plate load resistance 48 and 58 are used, being on the order of 2 or 3 megohms. Nationally, this means that a much higher gain will be achieved in the single stage of bridge amplification, but no power output can be obtained between the plates. Slider 62 is adjusted so that with no signal on inputs A and B the voltage between the plates 46 and 56 is zero or, if it is desired, the voltage between 46 and 56 can be made equal to zero with a small signal impressed on input A or B. The slider position of the resistor 60 may be shifted slightly to shift the balance in one direction or another.

When a signal is impressed on input A or B, the circuit is unbalanced and in accordance with bridge amplifier theory, the potential on one of the plates 46 or 56 is raised and the other is lowered by the amount depending upon the amplification of the circuit. This shift in voltage is applied to the grids of the cathode follower stages, and appears without amplification on the cathodes of these tubes, thereby, setting up nearly the same difference in potential between cathodes 72 and 82 as exist between plates 46 and 56.

Assuming that a positive voltage is impressed on input A as an error signal, the voltage on plate 46 will drop, and on plate 56 will rise. This will result in the voltage on cathode 72 dropping and the voltage on 82 rising, causing current to flow from cathode 82, through rectifier 83, through coil 75, and to cathode 72. Current does not flow through coil 85 because it is effectively short circuited by the germanium rectifier 83 which may be a type 1N48 or may be a vacuum tube rectifier, or a selenium rectifier, or any other low impedance type of rectifier.

If a negative signal is impressed on input A, the voltage on plate 46 will rise and that on plate 56 will drop, causing the voltage on grid 76 to rise, and on grid 82 to drop causing the voltage on cathode 72 to rise, and on cathode 82 to drop thus causing current to flow from cathode 72, through rectifier 73, and relay coil 85 to cathode 82. Thus, if the error is in one

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direction, current will flow through one relay coil, whereas, if the error is in the opposite direction the alternate relay coil is energized, therefore, there is provided a means of detecting errors of either polarity. By controlling the sensitivity of the relays, considering both pull on and drop out points, a very versatile arrangement is produced controlling the amount of errors which can occur before correction takes place and how closely the error will be brought to zero before correction stops. By using a very high gain bridge amplifier and very sensitive relays 75 and 85 with drop out and pull on points at very low current values, it is possible to produce an extremely sensitive and stable error correcting circuit. The impedance of the relay coils 75 and 85 can be made fairly low and the contacts accordingly quite rugged, because of the ability to match the impedance of a 1000 or 2500 ohm relay coil by proper choice of resistors 71 and 81.

This circuit enables the use of a simple high gain bridge balanced bridge amplifier having a possibility of using two separate inputs, while maintaining a low impedance output and eliminating the use of a differential or polarized relay; also, this circuit allows independent adjustment of the pull on and drop out voltage for error corrections and thus allows independent control of errors in each direction, a feature not available when a differential relay is used.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed otherwise than as set forth in the claims, but what I claim is:

1. In an electronic control circuit comprising a D. C. amplifier and a current operated control device driven by the output voltage of said D. C. amplifier, the said D. C. amplifier being in the form of a Wheatstone bridge circuit wherein the four resistance arms of the bridge comprise the internal D. C. plate to cathode resistances of a pair of similar amplifier tubes and two resistances connect the respective plates of the two amplifier tubes to a common point, the positive terminal of a D. C. power supply being connected to the common point, the negative terminal of the said power supply being connected to a point where the cathode currents of the two amplifier tubes are joined, the two said amplifier tubes having means of applying different signal voltages to the respective control grids thereof, said signal voltages being effective to control both the magnitude and the polarity of the amplifier output voltage which is taken from between the plates of the two said amplifier tubes; that improvement wherein the said current operated control device comprises two relays having their coils connected in series and each said coil being shunted by a unidirectional current device, the two said unidirectional current devices being connected in series and in opposition to each other, thereby causing the first of said relays to be energized and to perform one control function through means of the contacts thereof when the amplifier output voltage applied to the coils of said current operated control device is of one polarity, and causing the second of said two relays to be energized and to perform a separate and different control function through the means of its contacts when the amplifier output voltage applied to the coils of said current operated control device is of opposite polarity, and whenever the voltages at the two separate inputs

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of said D. C. amplifier are of equal magnitude and of the same polarity, the current in the coils of said current operated control device is zero and neither of said two relays is energized and neither of said control functions is performed.

2. The circuit of claim 1 including a cathode follower circuit connecting the amplifier output voltage to the relay coils of the current operated control device, said cathode follower circuit comprising a pair of similar cathode follower tubes and a pair of similar resistors connected to form a second Wheatstone bridge wherein the two resistors and the D. C. plate to cathode resistances of the two cathode follower tubes constitute the four resistance arms of the bridge, the second said Wheatstone bridge being energized by the said D. C. power supply, the plates of the cathode follower tubes being joined and connected to the positive terminal of the power supply and the cathode follower circuit resistors being joined and connected by the said point of juncture to the negative terminal of the D. C. supply, the said cathode follower circuit resistors being connected separately by the ends opposite the said point of juncture to the cathode of the said cathode follower tubes, the control grid of one of said cathode follower tubes being connected directly to the plate of one of the aforesaid amplifier tubes and the control grid of the second of the said cathode follower tubes being connected directly to the plate of the second of said amplifier tubes, the output voltage of the second said Wheatstone bridge being controlled by the output voltage of the said D. C. amplifier, the output of the cathode follower circuit being taken from between the cathodes of the said cathode follower tubes and applied directly to the said current operated control device, the said cathode follower circuit effecting an impedance match between the output impedance of the D. C. amplifier and the relay coil impedance of the said current operated control device.

3. The circuit of claim 2 wherein the output impedance of the D. C. amplifier is relatively high and the relay coil impedance of the current operated control device is relatively low.

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