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ELECTRONIC SWITCHING SYSTEM

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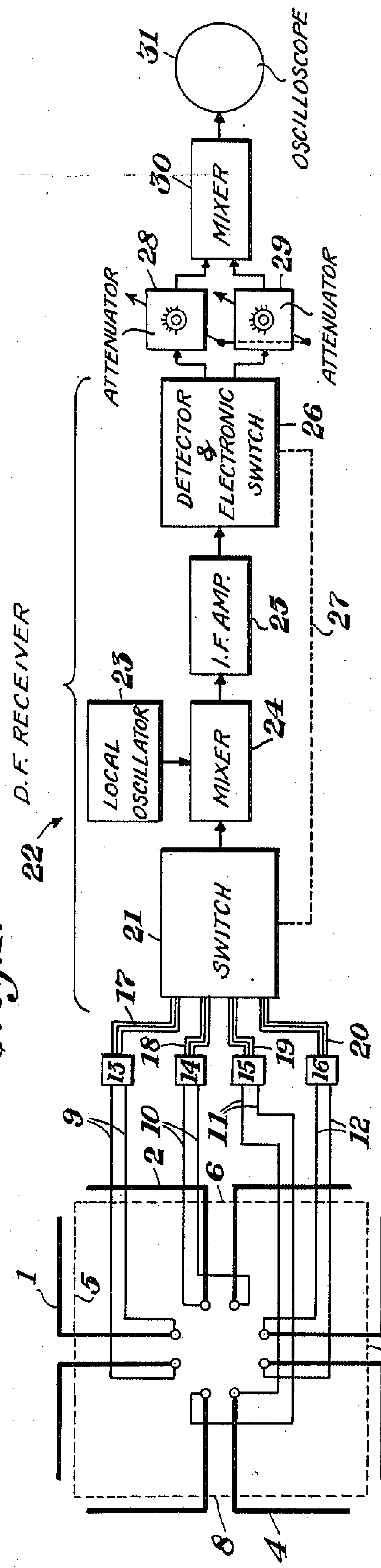

Fig.1.

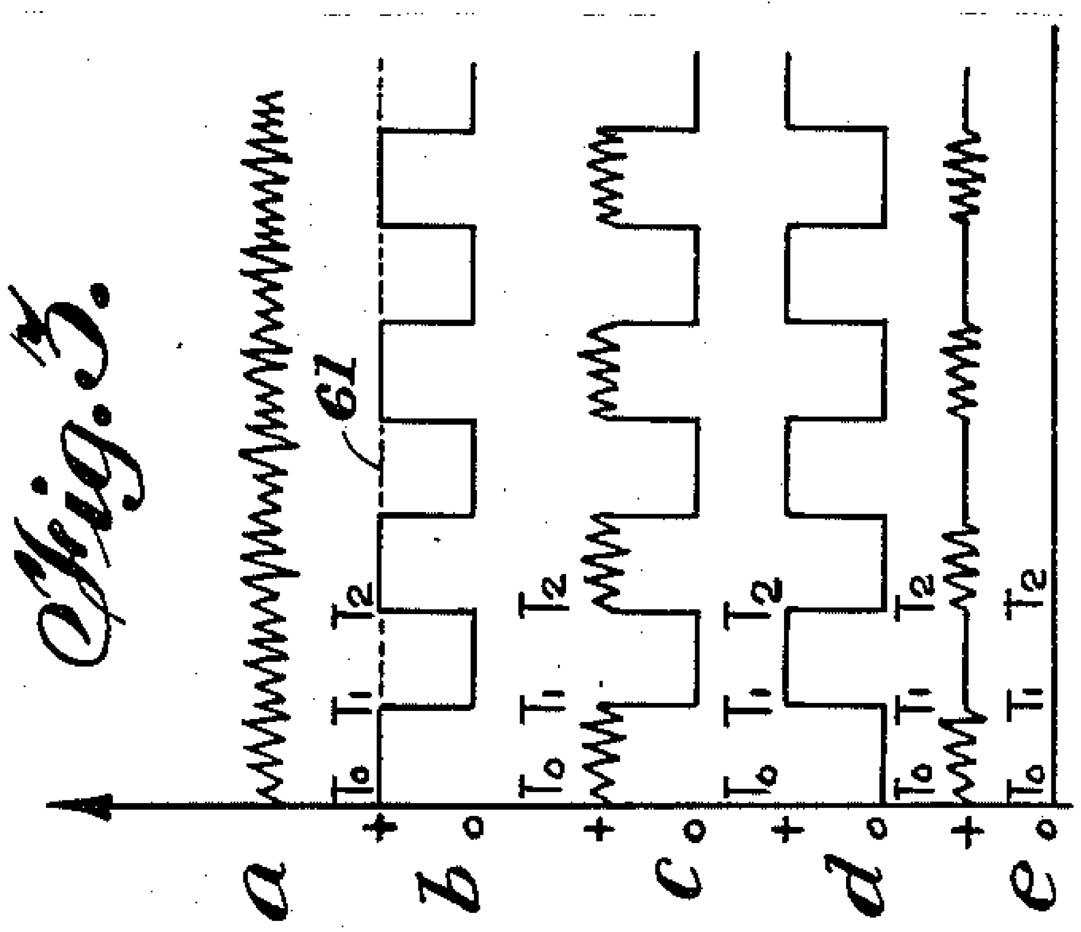

Fig.3.

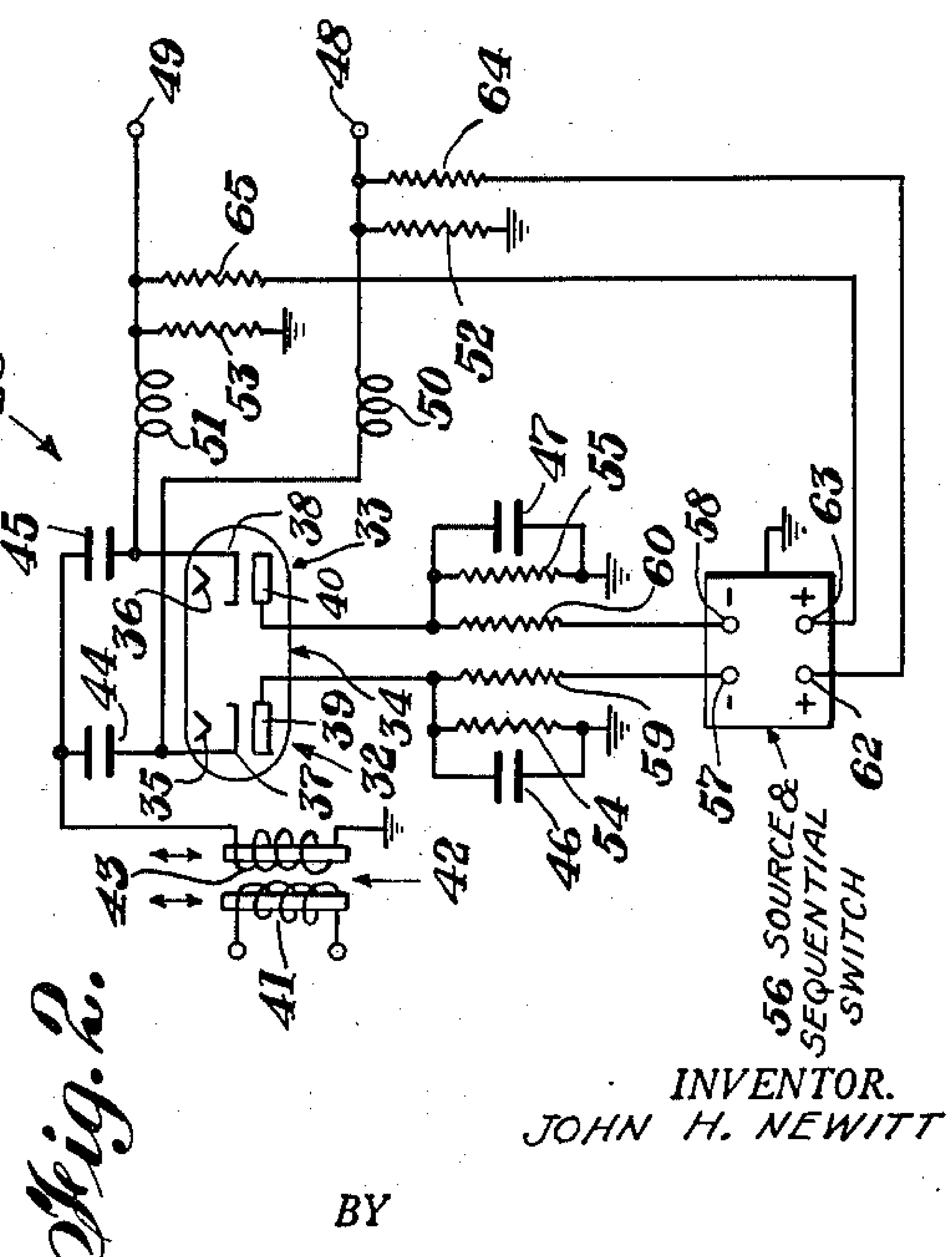

Fig.2.

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ELECTRONIC SWITCHING SYSTEM

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8 Claims. (Cl. 343—121)

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The present invention relates to electrical switching systems.

In certain types of switches, such as certain types of electronic switches, the effect of the switching voltages appears in the output of the switch and produces a change in the switched currents. In many systems this change is undesirable.

An example of the effect of the switching voltages on the switched current occurs when a diode is used as the switch and conduction of the diode is periodically blocked by switching voltages in the waveform of spaced rectangular pulses that periodically cause the switched current to be cut off. During periods when the diode is conducting, its output consists of the switched current superimposed on a direct current. This direct current is the initial electron velocity current (Edison effect).

When a switching voltage (the rectangular pulse) is applied to the diode in the proper direction and of sufficient value, the diode ceases to conduct. This cuts off the switched currents. It also shuts off the initial electron velocity current, thereby causing an abrupt drop in the direct current level in the output. At the instant when the diode again becomes conductive, the initial electron velocity current starts again, producing an abrupt rise of current in the output which, after reaching a certain level, flattens out and continues at substantially said level (except as modulated by the superimposed switched currents) until the diode is again made non-conductive when again this direct current level drops. Accordingly there appears in the output of said switch substantially rectangular pulses synchronous with the switching pulses and having an amplitude depending on the value of the initial electron velocity current. In many applications these output pulses are undesirable and produce disadvantageous results. For example if such switches are employed ahead of oscilloscopes, as in certain direction finders like those described in the copending application of Nathan Marchand for "Direction finders," Serial No. 565,142, filed November 25, 1944, Patent No. 2,448,041, issued August 31, 1948, and in my copending application John H. Newitt for "Electronic switching system," Serial No. 579,451, filed February 23, 1945, Patent No. 2,457,173 issued December 28, 1948, these output pulses will appear on the screen of the oscilloscope and interfere with the desired indications.

An object of the present invention is the provision of an improved switching system and method of switching.

Another object is the provision of an improved electronic switching system in which the switching control voltages do not change the switched currents.

A further object of the present invention is the provision with an electronic switch of means for compensating for the effects of the switching voltages.

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A still further object of the present invention is the provision of an improved electronic switch which also serves as a detector.

Still another object of the present invention is the provision in a shiftable radiant acting system, such as, for example, a direction finding receiver or beacon, of an improved electronic switching system in which adjustment is made for the effects of the switching voltages.

Still another object of the present invention is the provision in a shiftable radiant acting system of an arrangement which serves both as an electronic switch and as a detector and in which adjustment is made for the effect of the switching voltages.

Other and further objects of the present invention will become apparent and the foregoing will be best understood from the following description of an embodiment thereof, reference being had to the accompanying drawing, in which:

Fig. 1 is a diagram, partly schematic, and partly in block form, of a direction finding system embodying my invention;

Fig. 2 is a schematic diagram of the detector and electronic switch disclosed in block form in Fig. 1; and

Fig. 3 is a curve used in describing the operation of said detector and electronic switch.

As shown in Fig. 1, I provide four antenna units 1, 2, 3 and 4, each of which is rendered uni-directional by shield means 5, 6, 7 and 8 respectively. The antenna units illustrated are dipoles and are respectively connected by dual transmission lines 9—12 to known conversion boxes 13—16 respectively. These conversion boxes convert from said balanced dual transmission lines to coaxial lines 17—20 respectively.

Coaxial lines 17—20 are sequentially coupled by means of a switch 21 to a direction finding receiver 22. Said switch 21 may be of the type described in my aforesaid copending application, or of any other suitable type.

While it will be appreciated that the direction finding receiver may be of different types, the type illustrated is that of a superheterodyne receiver. The direction finding receiver 22 includes a local oscillator 23 which beats with the energy received from switch 21 in a mixer 24. The output of the mixer 24 is then passed through an intermediate frequency amplifier 25.

In accordance with my invention, the output of the intermediate frequency amplifier 25 is fed through an arrangement serving both as a detector and an electronic switch 26. The arrangement 26 may be synchronized with switch 21 as indicated by broken line 27 so that the output of said arrangement 26 is switched in accordance with the antenna unit connected to the direction finding receiver. The arrangement 26 embodying an important feature of my invention will be described in detail hereinafter in connection with Figs. 2 and 3. The output of arrangement 26 is fed to two attenuators 28 and 29. The outputs of attenuators 28 and 29 are fed through a known mixer 30 so that they can be impressed on an indicator, such as for example oscilloscope 31.

As described in the aforesaid application of N. Marchand, the attenuators 28 and 29 serve to control the relative amplitude of the energy derived from the different antenna units, as indicated in the indicator. The attenuators may be calibrated, the calibration thus giving an indication of the direction from which the energy is being received.

Referring now to Fig. 2, the exemplary detector and the electronic switch arrangement 26 there illustrated employs a pair of electron discharge devices in the form of diodes 32 and 33 for both detection and electronic switching purposes. The diodes 32 and 33 may be made in the form of a double diode 34 in which both diodes 32 and 33 are contained within a single envelope. Diodes 32 and 33, as illustrated, are of the indirectly heated type having heaters 35 and 36, cathodes 37 and 38, and anodes 39 and 40 respectively.

Detection is accomplished by the following arrangement. The signal output from the intermediate frequency amplifier 25 (see Fig. 1) is applied to the primary 41 of an intermediate frequency transformer 42 (see Fig. 2), the secondary 43 of said transformer having one end thereof connected to cathodes 37 and 38 through condensers 44 and 45 respectively. The other end of secondary 43 is connected through ground via condensers 46 and 47 respectively to anodes 39 and 40 respectively. It will therefore be seen that the signal energy appearing across the secondary 43 of transformer 42 is impressed across the diodes 32 and 33 and is therefore rectified.

The rectified energy is delivered to output terminals 48 and 49 by connecting cathodes 37 and 38 through intermediate frequency choke coils 50 and 51 to terminals 48 addd 49 respectively. Choke coils 50 and 51 serve to block the intermediate frequency current from the rectified or direct current circuit. The direct current circuit is completed by providing resistors 52 and 53 connecting terminals 48 and 49 respectively to ground and by resistors 54 and 55 connecting the anodes 39 and 40 respectively to ground.

Switching is accomplished by controlling the conduction of diodes 32 and 33, said diodes being alternately blocked by switching voltages derived from a source and sequential switch 56. Since the diodes are to be repeatedly switched abruptly on and off, the source 56 supplies trains of rectangular pulses. Any of various known devices such as a commutator connected to a D. C. source, may be employed as the source 56.

As illustrated in Fig. 2 said source 56 is connected to ground and supplies negative pulses with respect to ground at terminals 57 and 58, said pulses appearing first at one of said terminals and then at the other sequentially. Terminals 57 and 58 are connected through resistors 59 and 60 to the anodes 39 and 40. The switching voltages from source 56 are thus arranged to block diodes 32 and 33 in such manner that when diode 32 is conducting, diode 33 is blocked, and vice versa.

In the absence of compensating means such as will be described hereinafter in the course of my invention, the effects of the switching voltages would appear in the output, that is, at output terminals 48 and 49. This will be best understood from the following description, reference being had to Fig. 3. Curve *a* of said figure, represents the detected signal energy. Due to the initial electron velocity current which will flow through resistors 52 and 53, a direct current potential drop will exist across said resistors 52 and 53 which is represented in Fig. 3 curve *b*, by the dotted line 61. This normal potential drop will appear at output terminals 48 and 49 respectively. By the term "normal" I mean that the effects of the signal energy are disregarded. From the foregoing it will be seen that when diodes 32 and 33 are conductive, positive potentials will appear at output terminals 48 and 49 at the level 61 curve *b*, the level 61 being positive with relation to ground. The actual potentials appearing at terminals 48 and 49 will consist of a potential having a value as indicated by level 61 as modulated by the signal energy. This is depicted in curve *c*, Fig. 3, between time T_0 and T_1.

When, however, switching voltages are applied to the diodes to block conduction thereof, these switching voltages not only prevent the signal voltages from appearing at the output terminal 48 or 49 but also cut off the initial electron velocity current and eliminate the potential drop caused thereby. The result is that not only is the signal energy cut off but there is a drop in potential of the terminals 48 and 49 as illustrated during time T_1—T_2, curves *b* and *c*. This drop in potential appears on the oscilloscope and interferes with the indications thereof.

In accordance with my invention, I provide means for adjusting or compensating for this drop.

I accomplish this by applying positive pulses across resistors 52 and 53, as illustrated in curve *d*, Fig. 3, each time the tube associated with either of said resistors 52 or 53 is blocked by the switching voltages. For example, during the time T_1—T_2 when one of the diodes is blocked and therefore the voltage drop across one of the resistors 52 or 53, due to the initial electron velocity current, is eliminated, I apply a positive pulse which raises the potential across said resistor to substantially the same level as if the initial electron velocity current continued to flow.

These positive pulses which may be derived from terminals 62 and 63 of source 56, or any other suitable source, are synchronized with the switching voltages and are applied across resistors 52 and 53 through current limiting resistors 64 and 65 respectively. These positive pulses illustrated in curve *d*, are substantially of the same value as the voltages produced by the initial electron velocity current across resistors 52 and 53. Thus the D. C. level of the output is substantially constant. Consequently, despite the switching operation and the effects of the switching voltages, the outputs as seen at terminals 48 and 49 consist of the signal voltages superimposed on a constant D. C. level, as illustrated by curve *e* of Fig. 3. Thus the effects of the switching voltages do not appear in the output and do not interfere with the indication of the signal voltages on the oscilloscope.

While I have described the details of one embodiment of my invention, it will be apparent that numerous modifications may be made without departing from the teachings thereof. For example, while I have described two diodes used s electronic switches, it is apparent that one or many more diodes may be used for this purpose. Furthermore, while I have described my invention in connection with diodes, it will also be apparent that triodes and other multi-element tubes may likewise be employed. With triodes or tubes having a greater number of electrodes, there will be a D. C. voltage drop produced during conduction which will be eliminated when conduction of said tube or tubes is blocked. In accordance with my invention, compensation or adjustment for the effect of the switching voltages on said drop may be made in the manner hereinabove described. Furthermore, while I have described one system incorporating my invention, it will be apparent that it may be used in various other systems. Therefore it should be distinctly understood that this description is given merely by way of illustration and is not to be considered a limitation of my invention as hereinabove indicated and defined in the accompanying claims.

I claim:

1. In an electron discharge device system, wherein during conduction of said device a direct current voltage drop appears across the output thereof, the combination of means to apply a voltage for blocking conduction of said device, and means for directly and simultaneously applying the opposite polarity of said voltage to said output acting in coordination with said blocking means for compensating the direct current drop loss in the output during blocking.

2. A system according to claim 1 in which the blocking means comprises a source of switching voltages with means for impressing the same on said discharge device.

3. A system according to claim 1 in which the compensating means comprises means for applying to the output, voltages substantially equal to and in the same vectorial direction as said direct current voltage drop.

4. In an electronic switching system, a plurality of electron discharge devices connected with the output of said system so that during conduction of one of said devices a normal direct current voltage drop is maintained across said output, a source of switching voltages, means for impressing said switching voltages on said electron discharge devices to block conduction thereof in sequence, and means for applying voltages directly from said source to the output of said system synchronously with said switching voltages, said applied voltages being substantially equal in value to said voltage drop and in the same vectorial direction, to thereby maintain substantially said normal voltage drop across said output during blocking of said device.

5. An electronic switching system for switching signal voltages from a source to a load comprising an electron discharge device, an input circuit connecting said source of signal voltages to said electron discharge device, an output circuit connecting said electron discharge device to said load so that during conduction of said device a normal direct current voltage drop is maintained in said output circuit, a source of switching voltages, means for impressing said voltages on said electron discharge device to block conduction thereof, and means for applying voltages directly from said source to said output circuit synchronously with said switching voltages, said applied voltages being substantially equal in value to said normal voltage drop and in the same vectorial direction, to thereby maintain substantially said normal voltage drop in the output circuit of said system during blocking of said device.

6. An electronic switching and detector system for detecting radio frequency energy and switching said energy between a source and a load comprising an electron discharge device, means for connecting said source and said load with said electron discharge device so that the conduction of said device produces a normal direct current voltage drop across said load and the radio frequency energy from said source is detected, a source of switching voltages, means for impressing said switching voltages on said device to block conduction thereof and thereby eliminate said normal voltage drop, and means for applying voltages directly from said source to the load in synchronism with said switching voltages, said applied voltages being substantially equal in value to said normal voltage drop and in the same vectorial direction, to thereby maintain substantially said normal voltage drop across the said load.

7. A system according to claim 6, wherein the electron discharge device is a diode.

8. A direction finding system comprising a plurality of differently directed antennas, a direction finding receiver, and a switching system for switching current from said antennas to said receiver, said receiver including an electronic switching and radio frequency detecting arrangement comprising an electron discharge device, means for impressing radio frequency energy on said device, means for deriving from said device detected energy from said radio frequency energy so arranged that conduction of said device produces a normal direct current voltage drop in the deriving means, a source of switching voltages, means for impressing said switching voltages directly from said source on said device to block conduction thereof and thereby eliminate said normal direct current voltage drop, and means for applying voltages to the deriving means in synchronism with said switching voltages, said applied voltages being substantially equal in value to said normal voltage drop and in the same vectorial direction, to thereby maintain substantially said normal voltage drop in said deriving means.

JOHN H. NEWITT.

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