Aug. 12, 1969 A. NATHAN 3,461,315

ELECTRONIC SIGNAL SELECTOR

Filed May 9, 1966

FIG. 1

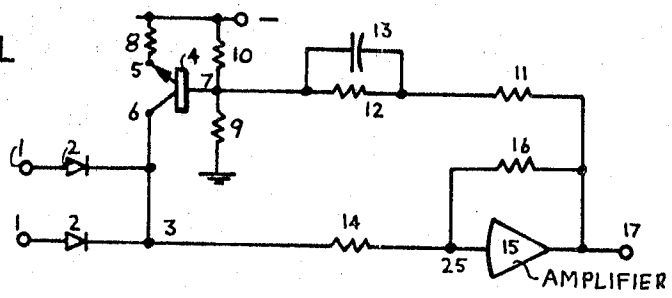


FIG. 2

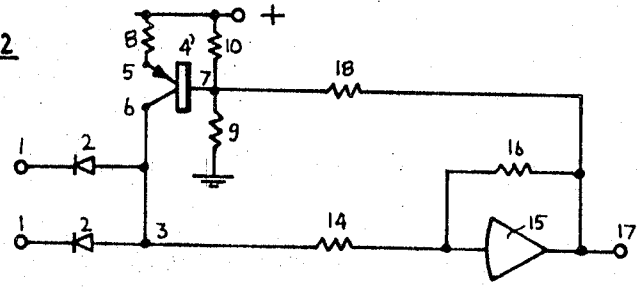
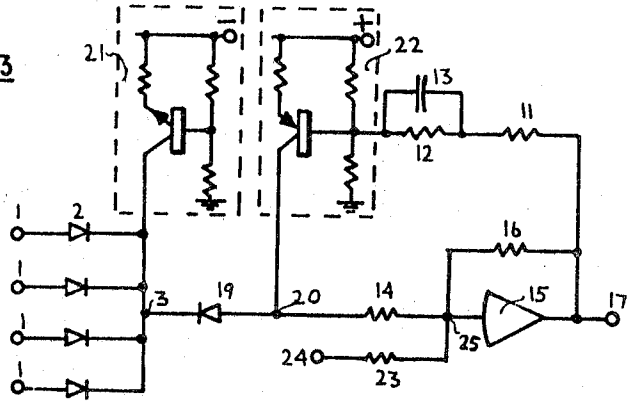


FIG. 3



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United States Patent Office 3,461,315 Patented Aug. 12, 1969

3,461,315

ELECTRONIC SIGNAL SELECTOR

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Filed May 9, 1966, Ser. No. 548,620
Claims priority, application Great Britain, May 18, 1965, 21,078/65
Int. Cl. H03k 5/20
U.S. Cl. 307—235 9 Claims

This invention relates to electronic circuits for the selection of the greatest or smallest of two or more electrical signals.

Diode selection circuits, comprising a plurality of diodes having a point of common output connection are well known in the art. In a maximum selection circuit, for example, the anode of each diode accepts a corresponding input voltage and all cathodes are connected to said point of common connection, from which a current is withdrawn. The voltage at said point is then substantially equal to the greatest of the input voltages. A similar circuit, having reversed diodes, is a minimum selector.

For accurate operation of such diode selection circuits it is desirable that the total current flowing through said point of common connection into the diodes be physically uninfluenced by the input voltages. For this purpose a constant current generator may be connected to said point and such a generator supplies a constant current thereto. If, however, a load is connected to the point, said total current depends upon the input voltages, because some of the current supplied by the generator is diverted into the load, and the magnitude of this diverted current is influenced by the magnitude of the output voltage, and this depends upon the input voltages.

If a sign changer is connected to the point of common connection and a load is connected thereto, the voltage selection can be improved as compared with the direct connection of the load to said point, but the input impedance of the sign changer now loads the point of common connection. This effect is particularly pronounced if the sign changer uses some types of transistorized operational amplifiers.

This invention provides means to compensate for this effect.

It is, therefore, an object of the invention to provide improved diode-type voltage selectors.

Another object of the invention is the provision of improved voltage selectors for use in input converters and in cascade squarers and cascade multipliers.

Input converters and cascade squarers and multipliers are described in the following:

U.S. Patent No. 3,084,862; Nathan (Input Converter) Electronic Engineering, vol. 36, No. 432, February 1964, pp. 106–7; Nathan (Product Convertors)
British Patent No. 939,486; Nathan (Input Converter)
British Patent No. 1,003,329; Nathan (Cascade Squarers and Multipliers)
Nathan: "The Cascade Squarer," Proceedings I.E.E., vol. 112, No. 4, April 1965, pp. 694–697
Nathan: "The Cascade Multiplier," I.E.E.E. Transactions on Electronic Computers, EC–14, No. 2, April 1965, pp. 243–247

More specifically, the invention provides means for the compensation of undesirable loading effects in selection circuits, such that the total current flowing into the selection means is substantially physically uninfluenced by the values of the input signals.

Further objects and advantages of the invention will become apparent from the following description, which

is given by way of example, with reference to the accompanying drawings, in which

FIGURE 1 is a circuit diagram of one embodiment of a maximum voltage selector according to the invention;

FIGURE 2 is a circuit digram of one embodiment of a minimum selection circuit according to the invention;

FIGURE 3 is a circuit diagram of one embodiment of the invention applicable to cascade multipliers.

In the circuit of FIGURE 1, **1** are two input terminals each receiving an input voltage. Diodes **2** are connected thereto and have a point of common output connection **3**. **4** through **10** is a conventional current generator supplying current to point **3**. It comprises NPN transistor **4** having emitter **5**, collector **6**, and base **7** connections. Emitter connection **5** is connected through resistor **8** to a point of constant negative potential at —. Base connection **7** is connected to resistors **9** and **10**, whose other terminals are respectively grounded and connected to said point of constant potential. The current supplied from collector terminal **6** to point **3** is essentially determined by the potential at base connection **7**. Its value is approximately equal to the negative of the potential difference of the potentials at — and at base connection **7** divided by the resistance of resistor **8**.

Assuming for the moment that components **11** through **17** are absent, the circuit is a conventional voltage selector, producing at point **3** a voltage representing the highest of the input voltages. Physical diodes are not ideal, and their current/voltage characteristics are curved. For accuracy of operation of the selector it is therefore desirable that the current flowing into the diodes from point **3** be physically uninfluenced by the values of the input voltages. This is the reason for using the circuit made of components **4–10**, which is a constant current generator. The base potential at **7** is determined by resistors **9** and **10**; as explained above, it determines the current supplied by the generator to point **3**.

If a load is now connected to point **3**, some of the current supplied by said generator is diverted into it. Moreover, the diverted current depends upon the voltage at this point. The current flowing into the diodes thus ceases to be constant and accuracy of selection is impaired.

In FIGURE 1, **14–17** is a sign changing amplifier, comprising the high-gain operational amplifier **15**, input resistor **14**, feedback resistor **16** and output terminal **17**. It produces at terminal **17** a voltage whose sign is opposite and whose magnitude is proportional to that at point **3**. Any load would now be connected to terminal **17** and would thus not affect the current through the diodes. Point **3** is now loaded by resistor **14** whose other terminal is at ground potential, due to the "virtual ground" induced by the operational amplifier. Moreover, in many instances the resistance of resistor **14** cannot be very high. For example, in some transistor amplifiers a large input resistance would cause undesirable offset voltages, because of the input current of the amplifier. Thus resistor **14** can divert an appreciable current.

The invention provides a resistive connection through resistors **11** and **12**, in this example, between terminal **17** and base connection **7**, for the compensation for this undesirable effect. Capacitor **13** connected in parallel with resistor **12** improves the frequency response of the device.

Compensation is achieved as follows: If an input voltage causes a rise in the potential at point **3**, the current flowing from point **3** into resistor **14** increases and the potential at terminal **17** decreases, causing a decrease in the potential at base connection **7**, and thereby an increase in the current supplied from collector terminal

6 to point 3. (In this example the supplied current is negative, so its magnitude actually decreases.)

Full compensation is achieved when the increase in the current supplied by the current generator is equal to the increase in current flowing from point 3 into resistor 14.

In one example of the circuit according to FIGURE 1, the diode current was 1 ma., approximately. 8: 1.5 kilohm. 9: adjustable between 220 and 320 kilohm. 10: 5.6 kilohm. 11: adjustable, 10 kilohm max. 14 and 16: 12.5 kilohm each. Voltage at —: —15 volts 12: 33 kilohm.

FIGURE 2 is a circuit diagram of a similarly compensated minimum selector according to the invention. Compensation is achieved through resistor 18 connected between output terminal 17 and base connection 7. The voltage at point 3 represents in this example the smaller of the input voltages. Transistor 4' in current generator 4'–10 is, in this example, a PNP transistor, and a positive current is supplied by it to point 3. The operation of this selector is similar to that of FIGURE 1. A rise in the potential at 3 again causes a decrease in the potentials at terminal 17 and at base connection 7, thereby causing an increased current from collector terminal 6 into point 3.

FIGURE 3 is a circuit diagram of one embodiment of a maximum selection and signal shift circuit as used in a cascade multiplier and described in the relevant corresponding references. In operation, the signal at the point of common output connection 3 represents the largest of the four input signals at the corresponding input terminals 1.

As explained in the references, diode 19, connecting point 3 and terminal 20, is used for voltage compensation. Current generators 21 and 22 supply negative and positive currents to point 3 and terminal 20, respectively, so that diode 19 is always conducting. The total current flowing into the diodes connected to the input terminals from point 3 is equal to the sum of the (negative) current supplied by generator 21 and the (positive) current supplied by generator 22 minus the current flowing from terminal 20 into resistor 14. The sign changer is converted into a sign changing adder through the use of a second input resistor 23, connecting input terminal 24 with the input terminal 25 of the operational amplifier 15. The voltage at output terminal 17 is therefore a linear combination of the voltages at terminals 20 and 24. Compensation for the current flowing into resistor 14 is provided as before, through resistors 11 and 12, connecting output terminal 17 with current generator 22. In this example, the operational amplifier is used in the circuit primarily for effecting a signal shift for the selected voltage, effected by the voltage at terminal 24. Thus the only additions to the circuit required in order to effect compensation according to the invention are the components connecting terminal 17 with current generator 22, i.e., in this example, resistors 11 and 12 and capacitor 13.

Although this invention has been rescribed and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the scope of this invention being limited only by the terms of the appended claims.

What I claim is:

1. An electronic signal selector for the selection from a plurality of input signals of an output signal having a fixed magnitude relation with respect to said input signals, comprising a plurality of input means for accepting a plurality of input signals; a point of common output connection; a plurality of unidirectionally conductive means, each of said unidirectionally conductive means connected at one end to a corresponding one of said input means and all said unidirectionally conductive means connected at their other ends to said point of common output connection; current means connected to said point of common output connection for supplying current thereto; sign changing means having an input terminal and an output terminal, said input terminal connected to receive an electrical signal from said point of common output connection, said sign changing means producing at said output terminal a second signal that is a substantially linear function of said electrical signal such that said second signal decreases when said electrical signal increases; circuit means connecting said output terminal with said current means for causing said current supplied by said current means to be physically influenced by the value of said electrical signal such that the total current flowing into said plurality of unidirectionally conductive means is substantially physically uninfluenced by the values of said input signals.

2. The device as recited in claim 1, wherein said sign changing means has an input resistance such that the magnitude of the current flowing into it is at least one tenth of the magnitude of said current supplied by said current means, for predetermined values of said input signals.

3. The device as recited in claim 1, wherein said current means includes transistor means having emitter, collector and base connections; said collector connection is connected with said point of common connection and said base connection is connected with said circuit means.

4. The device as recited in claim 3, including first and second resistance means each connected at one end to a point of constant potential and both connected at their other ends to said base connection.

5. The device as recited in claim 1, wherein said circuit means includes resistive means connecting said output terminal with said current means.

6. The device as recited in claim 1, wherein said signals are represented in the form of electrical potentials.

7. The device as recited in claim 6 wherein said unidirectionally conductive means are composed of diode means.

8. The device as recited in claim 1, wherein said sign changing means includes means for producnig a predetermined shift in the value of said electrical signal.

9. The device as recited in claim 8, including further input means for accepting a constant input signal, wherein the magnitude of said predetermined signal shift is substantially proportional to the value of said constant input signal.

References Cited

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U.S. Cl. X.R.

324—140; 328—115, 175