March 4, 1952 P. W. CRAPUCHETTES 2,588,209

ELECTRONIC VOLTMETER WITH A PLURALITY OF INPUTS

Filed Dec. 8, 1947

Fig. 1.

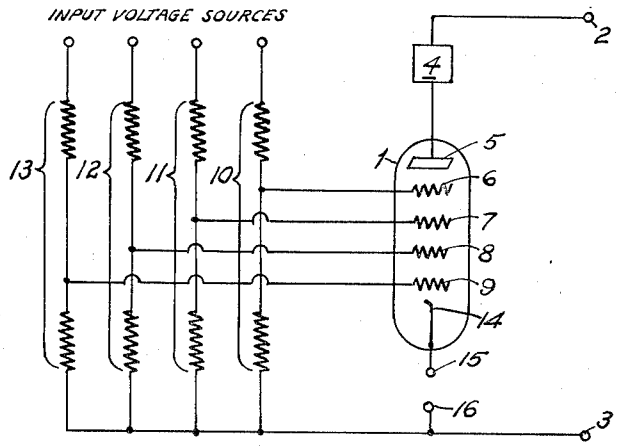


Fig. 2.

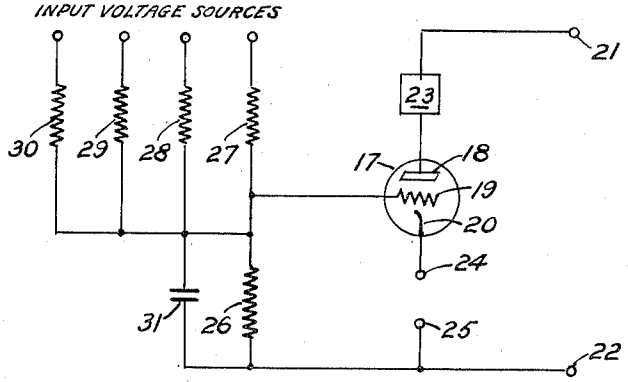
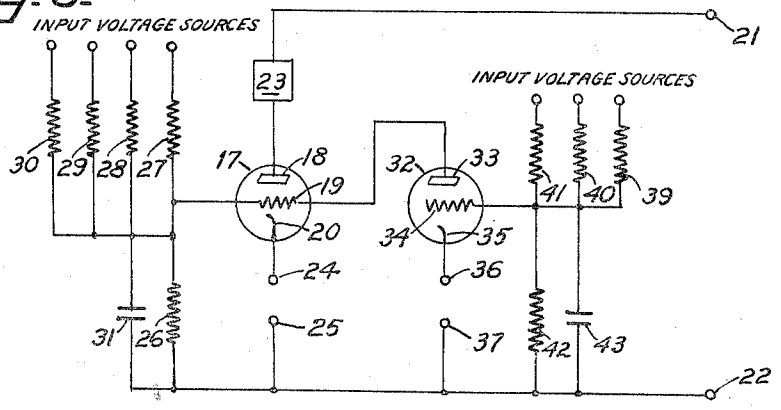


Fig. 3.



INVENTOR
PAUL W. CRAPUCHETTES

BY Bruce & Broaler

HIS ATTORNEYS

Patented Mar. 4, 1952 2,588,209

UNITED STATES PATENT OFFICE

2,588,209

ELECTRONIC VOLTMETER WITH A PLURALITY OF INPUTS

Paul W. Crapuchettes, Palo Alto, Calif., assignor to Michael R. Klein, San Francisco, Calif.

Application December 8, 1947, Serial No. 790,281

2 Claims. (Cl. 171—95)

1

This invention relates to electronic methods of and means for mixing or combining two or more input voltages so as to provide an electric current the magnitude of which is a function of some or all of the input voltages. Such electronic mixers are useful for a variety of purposes, such as the interpretation of data from electronic counting rings.

It is an object of the present invention to provide an electronic device for combining or mixing a number of independent voltages to give an output current, the magnitude of which depends upon the phase, sense, and magnitude of some or all of the input voltages.

A further object of the invention is to provide such a combining device free from inertia or other time lags, and capable of extreme speed of response.

Another object of the invention is the accomplishment of the aforementioned results with a minimum of interference or interaction between the various voltages fed to the device, and with relatively little power being drawn therefrom.

Other objects and advantages of the device herein described and claimed will appear from the specification and claims appended thereto taken in conjunction with the accompanying drawing wherein:

Figures 1, 2 and 3 are circuit diagrams depicting different embodiments of my invention.

In the most general method of carrying out the invention, there is provided an electron discharge device with associated power supply, the space current of which is controlled by relatively independent means responsive to a number of independent voltages, the magnitude of the space current providing the desired indication of the combined value.

One method of accomplishing this end is to apply, through appropriate potential dividers, each input voltage to separate control grid in a multigrid electronic discharge device. If all grids are so positioned as to have suitable transconductance characteristics with respect to the common space current, this method is capable of fulfilling the objects of the invention as set forth above.

Such a circuit arrangement is shown diagrammatically in Figure 1, wherein a hexode electron discharge device 1 is provided with space current from a direct current power source (not shown) through terminals 2 and 3, the space current being indicated by a device 4 such as a meter or signal device connected between positive terminal 2 and the anode 5 of the electron discharge device.

2

Control grids 6, 7, 8, 9 are fed from potential dividers 10, 11, 12, 13, respectively. The upper terminal of each of said dividers is connected to its respective input voltage source, while the lower terminals are connected in common to the negative terminal 3 of the space current source, as well as to the cathode 14 of the discharge device through a grid bias voltage supply source connectable across terminals 15, 16.

Another embodiment of the present invention is shown in Figure 2. Here again there is provided an electron discharge device 17, this one requiring a minimum of only three electrodes including an anode 18, a control grid 19, and a cathode 20. Like in the preceding embodiment, I also include space current power supply terminals 21, 22, an indicator 23, and grid bias voltage supply terminals 24, 25.

A resistor 26 is connected across the input to the device 17 and is itself common to all voltage dividers applying input voltage to grid 19. The separate sections of these voltage dividers are numbered 27, 28, 29, 30.

If the resistance of sections 27–30 inclusive of the dividers be large in comparison with the resistance of common section 26, there will be little interaction between the various input voltages. What little interaction there is, may be reduced still further if necessary by connecting a capacitor 31 across resistor 26. This has the effect of reducing the slope of any steep wavefronts of pulses of voltage from any of the input sources, so whatever interaction there may be between such sources will be less likely to cause erroneous indications in the anode circuit of the electron discharge device.

A third variant of the basic conception is indicated schematically in Figure 3. Here the operation is identical with the circuit arrangement of Figure 2, and corresponding circuit elements bear corresponding reference numerals in each figure.

The arrangement of Figure 3 differs from that of Figure 2 in that the input voltage on control grid 19 of the electron discharge device 17 is influenced by an additional increment derived from the space current of a second electron discharge device 32, the anode 33 of which is directly connected to grid 19 of the device 17, while the cathode 35 is connected through an appropriate bias source as represented by terminals 36, 37 to the other side of the input circuit feeding the device 17.

The control grid 34 of the device 32 is excited by some of the same input voltages by way of

voltage dividers involving separate resistors 39, 40, etc. and a common resistor 42 across the input electrodes of the discharge device, as are applied to control grid 19 of the device 17, with the result that phase reversal of input voltage in the device 32 tend to reduce the response of the device 17 to those components of overall input voltage applied to each grid simultaneously.

Like with the resistor 26, a capacitor 43 should preferably be connected across the corresponding resistor 42.

By appropriate adjustment of the ratio of the potential dividers concerned, and by proper selection of the bias voltages applied to the cathode circuits of each device, it is possible exactly to cancel any desired input voltage component, or alternatively to reverse the sense of predetermined components if desired.

The above described circuits have many useful applications in the art. One in particular, for which it is well adapted, is in the conversion of the relatively unintelligible indications of an electronic decade counter such as disclosed in the application of Michael R. Klein, Serial No. 634,031, filed December 10, 1945, now Patent No. 2,557,384, issued June 19, 1951, and which is based on a trigger circuit illustrated and described on pages 353–356 of Theory and Application of Electronic Tubes, second edition by Herbert J. Reich. In such application, each of the various dividers of the mixing circuit of the present invention will derive its voltage pulses from one of the output circuits of such electronic counter, and in response to the mixing of such pulses as previously pointed out, the indicator in the output of the mixing circuit, may be made to register a legible equivalent of the value which the electronic counter may be registering at any instant.

While I have disclosed certain specific embodiments of my invention in detail, the same is subject to alteration and modification without departing from the underlying principles involved, and I accordingly, do not desire to be limited in my protection to the specific details illustrated and described except as may be necessitated by the appended claims.

I claim:

1. An electronic mixer adapted for providing an indicating current responsive to a plurality of input voltages, comprising a first and second electron discharge device each including an anode, cathode, and control grid, direct voltage power supply providing space current for said first electron discharge device, current indicating means responsive to space current of said first device, a direct voltage grid bias source in the cathode circuit of said first device, and a plurality of potential dividers including a common resistive element shunted by a capacitor and the space current path of said second device, said potential dividers being connected between said grid bias source and control grid of said first device, and having purely resistive portions thereof terminating one in each source of said first-mentioned input voltages, said second device having control grid potential derived similarly from at least one potential divider connected to at least one of said sources of first-mentioned voltages.

2. An electronic mixer adapted for providing an indicating current responsive to a plurality of input voltages, comprising at least a first and second electron discharge device each including an anode, cathode, and control grid, direct voltage power supply providing space current for said first device, current indicating means responsive to space current of said first device, a direct voltage grid bias source in the cathode circuit of said first device, and a plurality of potential dividers including a common resistive element shunted by a capacitor and by the space current path of said second device, said potential dividers being connected between said grid bias source and control grid of said first device and having purely resistive portions thereof terminating one in each source of said first mentioned input voltages, said second device having control grid potential derived similarly from at least one potential divider connected to at least one of said sources of first-mentioned voltages, a separate grid bias source for said second device in the cathode circuit thereof, adjusted in magnitude to neutralize certain undesired components of space current in said first device when such undesired components are impressed simultaneously through separate potential dividers upon control grids of both said devices.

PAUL W. CRAPUCHETTES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,401,779	Swartzel	June 11, 1946

FOREIGN PATENTS

Number	Country	Date
52,666	Denmark	Feb. 8, 1937