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STABILIZED CRYSTAL TRIODE SYSTEM

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FIG. 1.

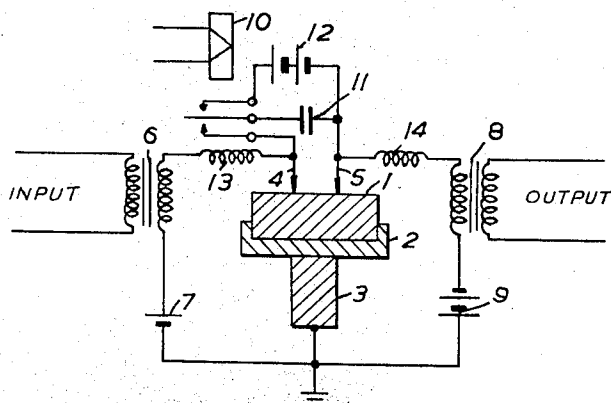
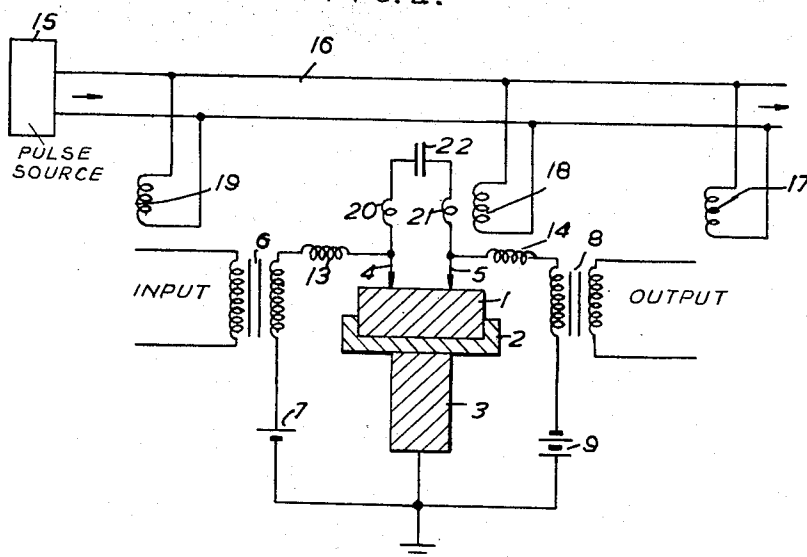


FIG. 2.



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STABILIZED CRYSTAL TRIODE SYSTEM

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4 Claims. (Cl. 179-171).

1.

The present invention relates to electric amplifying devices employing semi-conductors which have been called "crystal triodes."

It is known to mount a crystal of germanium or other suitable semi-conductor in a metal base or holder with which it makes contact over a relatively large area, and to provide it with two electrodes arranged close together in contact with the surface of the crystal. Then, provided that the surface of the crystal is suitably treated, and that a suitable electroforming process is applied to the electrodes, the device (which has been called a "crystal triode") can be operated as an amplifier in which one of the electrodes (called the "emitter electrode") is an input electrode, and the other (called the "collector electrode") is an output electrode.

A preferred electroforming process is described in the specification accompanying U. S. application No. 150,412 filed March 18, 1950 of K. A. Matthews-C. de B. White for "Electric Semi-Conductors."

Experience has shown that some crystal triodes in time tend to vary their performance, or to become unstable, they may become noisy, and their characteristics may be affected by changes in humidity or temperature, or by picking up of electrical disturbances produced by sparking apparatus in the vicinity.

It is the principal object of this invention to overcome these troubles, and this object is achieved according to the invention by providing arrangements for applying sharp pulses periodically between the emitter and collector electrodes.

These pulses can be applied in such manner as not to interfere with the normal operation of the crystal triode, and it has been found that the changes which tend to take place in the characteristics and performance of the crystal triode are inhibited by the periodical application of the pulses.

Simple means are also envisaged for simultaneously pulsing a large number of crystal triodes without causing any mutual interference between them, so that the additional cost of the pulsing arrangements spread over a large number of crystal triodes becomes unimportant.

The invention will be explained with reference to the accompanying drawing. In Fig. 1 a simple circuit is shown for applying pulses to stabilise a crystal triode when in normal operation as an amplifier, for example. Fig. 2 shows how a common pulsing source may be applied to stabilise simultaneously a large number of crystal triodes in normal operation.

2.

In Fig. 1 the crystal triode is shown as comprising a germanium crystal 1 (assumed to be of the N-type), fixed in a metal base or holder 2 with a terminal shank 3. The emitter and collector electrodes are designated 4 and 5, and may take the form of sharply pointed wires or catwhiskers, or these electrodes may consist of metal films or coatings suitably deposited on small areas of the crystal surface, as described in the specification of U. S. application No. 228,486 filed May 26, 1951 of A. T. Starr et al. for "Crystal Diodes and Triodes." Signals to be amplified are applied through a transformer 6 having its secondary winding connected between the emitter electrode 4 and the base electrode 3, in series with the usual positive polarising source 7 for the emitter electrode. Amplified signals may be taken from a transformer 8 having its primary winding connected between the collector electrode 5 and the base electrode 3, in series with the usual negative polarising source 9 for the collector electrode. This is the simplest possible amplifying circuit and can be taken to represent any desired type of circuit.

According to one embodiment of the invention, a relay 10 (or other suitable switch or trembler) is provided periodically to charge a capacitor 11 from a source 12 and to discharge it between the emitter and collector electrodes 4 and 5. If N-type germanium is used, the source 12 should preferably have its negative terminal connected to the collector electrode 5. The switch or relay 10 may be driven from a suitable source (not shown) of periodic current to operate at the rate of perhaps once per second, or it may be connected in a self interrupting circuit or arranged to give a short train of rapidly repeated pulses at periodic intervals, for example, a train of 20 pulses once per minute, or caused to operate periodically in any known way. The capacity of the capacitor might be of the order of 100 micro-microfarads, and the potential of the source 12 might be of the order of a hundred volts. By avoiding the introduction of resistance in the discharge circuit of the capacitor 12, additional to that contributed by the crystal triode itself, the duration of the pulses applied to the electrodes 4 and 5 can be reduced to the order of $\frac{1}{40}$ microsecond or less. It is found that in these circumstances the noise introduced by the operation of the relay 10 is negligible, or becomes so after continuous application of the pulses for some time.

Small high frequency choke coils 13 and 14 may be inserted if necessary in the signal circuits,

as shown, to prevent the short pulses from loss by being shunted through these circuits and producing noise therein.

It can be arranged so that by use of the values such as those already suggested, the capacitor 11 will have a negligible effect on the operation of the crystal triode.

In Fig. 2 an arrangement for simultaneously pulsing a plurality of amplifier circuits is shown.

The elements of the amplifier circuit are the same as in Fig. 1 and have been given the same designation numbers. The pulsing arrangement includes a source of pulses 15 generating very short pulses (perhaps with a duration of $\frac{1}{100}$ microsecond) repeated at the rates already suggested. The pulses are supplied to a busbar circuit 16 to which are connected the primary windings of any number of pulse transformers 17, 18, 19 etc., one for each crystal triode to be stabilised. The transformer 18 is shown to have a secondary winding comprising two sections 20, 21 of perhaps one turn each connected in series respectively with the emitter and collector electrodes 4, 5 of the crystal triode. The loop circuit is completed by a small capacitor 22, and the two sections 20, 21 are connected series aiding round this loop. The transformer 16 should preferably be poled so that when N-type germanium is used, the initial and largest peak of the transient pulse current circulates round the loop so as to make the collector electrode 5 negative to the emitter electrode 4. The amplitude of the pulse should be just sufficient to maintain the stability of the crystal triode.

It will be understood that the transformers 17 and 19 (and any others, not shown, connected to the busbar circuit 16) will be arranged in corresponding crystal triode circuits in the same way as the transformer 18. Thus all the crystal triodes will be stabilised simultaneously from the single source 15.

It is not essential to have both the secondary sections 20 and 21. One of them could be omitted.

Crystal triodes are rather susceptible to dampness, and are generally found not to be very reliable or constant in operation unless they are enclosed in a hermetically sealed container. This greatly increases the cost, but it is found that an ordinary unenclosed crystal triode when pulsed in the manner described operates more reliably and with much less serious variation. The noise level is also reduced. It has also been found that the noise produced by a sealed crystal triode is reduced by periodic pulsing in the manner described.

If P-type germanium is used in the crystal triode, the bias sources 7 and 9 and the source 12 in Fig. 1 will all need to be reversed, and also the poling of the transformers 17, 18, 19 etc., in Fig. 2.

It will be understood that although the circuits shown in Figs. 1 and 2 to illustrate the invention are amplifier circuits, the stabilising pulses could be supplied to a crystal triode employed as a modulator or demodulator, or as a rectifier, or in fact in any circuit in which signals are operated upon or otherwise translated. The crystal triode might also be employed as an oscillation generator, and the application of pulses in the manner described would suppress unwanted noises arising from the crystal triode.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

1. An electric circuit for translating signals, comprising a crystal triode having a base electrode and emitter electrode and a collector electrode, separate biasing means between each of the emitter and collector electrodes and said base electrode, input means for applying the signals to be amplified to said emitter electrode, output means for deriving amplified signals from said collector electrode, a source of short stabilizing pulses, stabilizing means for applying said short stabilizing pulses between said collector and emitter electrodes, and means for suppressing said stabilizing pulses and blocking the application thereof to said base electrode, said last mentioned means comprising a first choke coil connected between said emitter electrode and the input means, and a second choke coil connected between the said collector electrode and the output means.

2. A circuit according to claim 1 in which the said stabilising pulse source comprises means for periodically charging a capacitor and then discharging it between the said emitter and collector electrodes.

3. A circuit according to claim 1 in which the said stabilising means comprises a transformer having a primary winding connected to the said pulse source, and a secondary winding connected between the said emitter and collector electrodes.

4. A circuit according to claim 3 in which the said secondary winding is divided into two parts separated by a capacitor.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,486,776	Barney	Nov. 1, 1949
2,524,035	Bardeen et al.	Oct. 3, 1950
2,569,347	Shockley	Sept. 25, 1951