

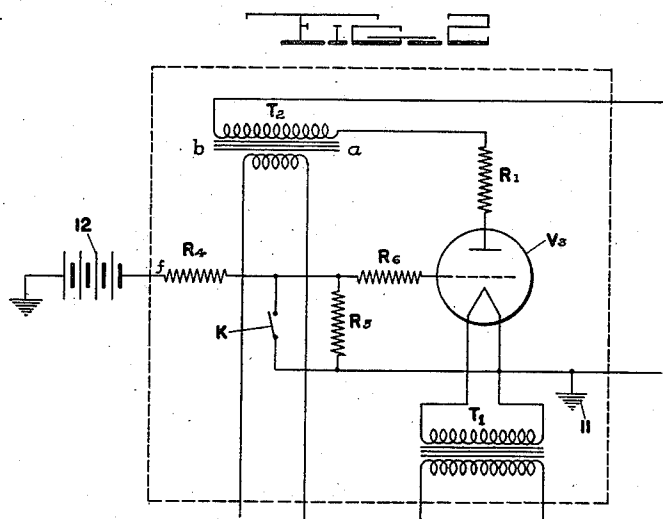
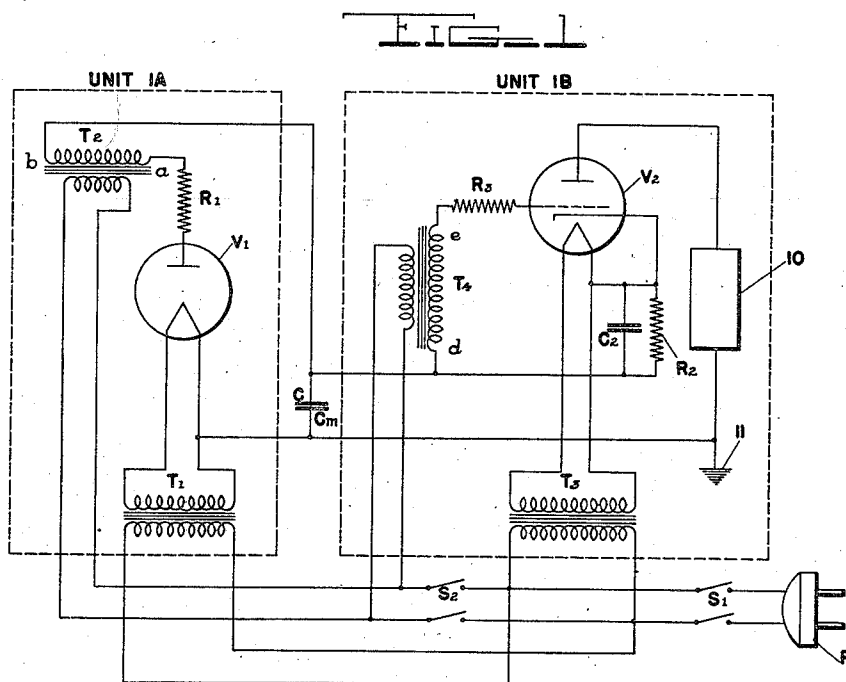
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DRIVER FOR ELECTRO-ACOUSTIC TRANSDUCERS

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DRIVER FOR ELECTROACOUSTIC
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1

This invention relates to a means for driving an electro-acoustic transducer by the application of a series of short spaced pulses of power. The driver of the invention is of the impulse type capable of delivering a large amount of power to the transducer during a short interval of time and then automatically becoming electrically isolated therefrom during a longer interval of time, during which the transducer is free to oscillate at its own natural mechanical frequency.

The driver of the invention possesses many advantages over the types of drivers now in use, the realization of which may be considered as being among the objects of the invention. One of these advantages is the fact that the driver does not affect the frequency of oscillation of the transducer except during the brief interval of time during which it is supplying power. A further advantage is the fact that the power is supplied in a single uni-directional pulse thereby reducing the tendency for the transducer to feed energy back to the driver, and thereby reducing losses in the driver itself. Still another advantage of this invention arises from the supplying of pulses at periodic intervals which results in the modulation of the output of the transducer at a predetermined frequency.

Other objects will appear from a consideration of the following description and the accompanying drawing, in which Fig. 1 is a circuit diagram of one form of the invention and Fig. 2 is a circuit diagram of a modified form of the invention.

Referring now to Fig. 1 of the drawing:

Unit 1A is one form of charging circuit for condenser C_m while unit 1B is one form of discharging circuit for condenser C_m . The condenser C_m thus stores energy momentarily between that part of the cycle during which it is charged and that part of the cycle during which it is discharged. Condenser C_m is a part mutually of both the charging circuit and the discharging circuit. One side of C_m is grounded.

In unit 1A, V_1 is a mercury vapor rectifier tube, T_1 is a filament transformer for said tube, T_2 is a plate supply transformer for said tube and R_1 is a resistor. The tube V_1 , the secondary of transformer T_2 and the resistor R_1 are connected in series with each other and with the condenser C_m , and these parts together comprise the circuit through which the charging of C_m takes place.

In unit 1B, V_2 is a mercury vapor rectifier tube provided with a control grid, T_3 is a filament transformer for said tube, T_4 is a grid biasing transformer, C_2 is a condenser, and R_2 and R_3

2

are resistors. The anode to cathode circuit of tube V_2 , the transducer 10 to which power is to be supplied, and the condenser C_2 , are connected in series with each other and with the condenser C_m , and these parts together comprise the circuit through which the discharging of C_m takes place. Resistor R_2 is shunted across C_2 . The grid of tube V_2 is connected through resistor R_3 and the secondary of transformer T_4 in series with said resistor, to the opposite side of condenser C_2 from that which connects to the cathode of tube V_2 .

Transformers T_2 and T_4 in units 1A and 1B respectively are so connected relative to each other that when power is applied, the A.-C. potential of end b of transformer T_2 relative to end a of said transformer is approximately in phase with the A.-C. potential of end e of transformer T_4 relative to end d of transformer T_4 .

P is a power plug for connection to an A.-C. power supply of suitable frequency, potential difference and current capacity. S_1 and S_2 are power supply switches, the former being connected between the power plug P and the primaries of all the power transformers of the driving circuit (said primaries being connected in parallel with each other), and the latter switch S_2 being connected between switch S_1 and transformers T_2 and T_4 in such a manner as to permit disconnecting the power supply from the primary windings of transformers T_2 and T_4 without disconnecting said power supply from the primary windings of the other transformers T_1 and T_3 .

The operation of the circuit as a whole is as follows:

When plug P is connected to a suitable A.-C. power supply and switch S_1 (but not S_2) is closed, the filaments and cathodes of tubes V_1 and V_2 become heated and the circuit is ready for operation. Keying is then effected by closing switch S_2 . When S_2 is closed, end a of the secondary of transformer T_2 becomes alternately positive and negative relative to end b . When end a is sufficiently positive relative to end b so that the anode of tube 1 is substantially more positive than its cathode, tube V_1 permits electrons to flow from its cathode to its anode and thence through resistor R_1 , secondary of transformer T_2 and to the plate c of condenser C_m which is thus charged with plate c negative relative to ground. During the portion of the cycle when C_m is being charged, the grid of tube V_2 in unit 2 is sufficiently negative to prevent tube V_2 from conducting current so that unit 1B has no appreci-

able effect on the charge on condenser C_m during said portion of the cycle.

When the grid end of the secondary of transformer T_4 is sufficiently positive relative to the other end of said secondary, tube V_2 conducts electrons from cathode to anode thereby permitting C_m to discharge rapidly through the discharge circuit so that most of the energy which C_m stores is transferred to the transducer. During the discharge of C_m , condenser C_2 is charged, the side of C_2 electrically connected to the cathode attaining a positive potential relative to the other side of C_2 . This charge on condenser C_2 is substantially greater than the peak potential difference across the secondary of transformer T_4 and is sufficient to provide a negative grid bias for V_2 even while the grid end of the secondary of transformer T_4 is becoming more positive relative to end d , thereby enabling the grid of tube V_2 to regain control of tube V_2 as soon as the discharge of C_m is completed.

Condenser C_2 discharges through resistor R_2 at such a rate that the grid bias of tube V_2 will not become positive or insufficiently negative to prevent conduction through said tube until nearly a full period of the impressed power supply after the discharge through tube V_2 takes place. Thus the discharge through tube V_2 is limited to one unidirectional pulse during each period of the power supply. The necessity for such a limitation arises from the fact that the transducer driven by this driving means oscillates mechanically for an interval after each driving pulse and by inverse action of said transducer an alternating voltage is caused to appear at the plate of V_2 during such mechanical oscillation. It is essential that repeated discharges of the tube V_2 at one or more instances of positive excursion of its plate potential during any interval between driving pulses be prevented. This applicants accomplish by the utilization of the combination R_2C_2 to apply a negative potential to the grid of V_2 immediately after the completion of each of said driving pulses.

During the time when tube V_2 is conducting, the anode of tube V_1 is maintained negative relative to its cathode so that the charging circuit has no appreciable effect on the charge on condenser C_m during the discharge period. However, when the anode of tube V_1 again becomes positive relative to its cathode, the cycle of operation, comprising the charging and subsequent discharging of condenser C_m , is again started, and this cycle is carried out periodically at the frequency of the impressed power supply.

The basic concept of this invention lies in the charging of a condenser from a power supply and a rectifier in combination, and the discharging of said condenser through a transducer by means of a valve which controls the time of said discharging and limits it to periodic unidirectional pulses.

A modification of the fundamental circuit of unit 1A of Fig. 1, which in no way conflicts with the objects or the embodiment of the invention as already set forth, is shown in Fig. 2. In this figure the tube V_3 is a mercury vapor rectifier tube having a control grid, K is a key and the parts of the circuit labelled R_1 , T_1 , and T_2 are identical in function to the parts of the same designation in Fig. 1. R_4 , R_5 and R_6 are resistors.

Resistors R_4 and R_5 of Fig. 2 are connected in series and a direct potential difference is applied across them by means of source 12 such that the end of R_4 marked f is negative relative

to ground. The point at which R_4 and R_5 are connected together is at a negative potential between that of the point f and ground 11 when key K is open but is at ground potential when key K is closed. Since the grid of tube V_3 is connected through the resistor R_6 to the junction of resistors R_4 and R_5 , a negative potential is applied to said grid so long as key K is open, and said grid is grounded through resistor R_6 when said key is closed. The tube V_3 has such characteristics that a sufficient negative bias, such as that applied to it with the key K open, prevents it from conducting electrons from its cathode to its anode, and such that zero grid potential permits said tube to operate as a rectifier. Thus K serves to key the circuit. When the circuit of Fig. 2 is employed in place of unit 1A of Fig. 1, switch S_2 of Fig. 1, may be omitted or may be kept closed.

Various modifications in the circuit may be made without in any way conflicting with the basic concepts of this invention. For instance, the electrical ground 11 may be moved to any desired point in the circuit, and the sequence of the various elements in tracing around either the charging or the discharging circuit may be altered in various ways. Transformers T_1 and T_3 may be supplied from a separate power supply of different frequency from that which supplies transformers T_2 and T_4 , or transformers T_1 and T_3 may be omitted and batteries used in their places to supply filament or heater current.

According to the provisions of the patent statutes, we have set forth the principal mode of operation of our invention and have illustrated and described what we now consider to represent its best embodiments. However, we desire to have it understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically illustrated and described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

We claim:

1. Means for driving an electro-acoustic transducer, comprising a charging circuit, a discharging circuit, said charging and discharging circuits including a first capacitor as a common part of both circuits, said charging circuit including a first rectifier, means for impressing an alternating potential difference on said rectifier whereby said capacitor will be charged once during each cycle of said alternating potential difference, said discharge circuit including said transducer, a second rectifier, and a second capacitor in circuit therewith and providing for the discharge of said first capacitor in less than a half-cycle of said alternating potential difference, a grid for said second rectifier, a control circuit for said grid, said control circuit including means for impressing an alternating bias potential on said grid in phase opposition to the first named alternating potential, and means for impressing a further bias potential of periodic exponential form on said grid, said means for impressing said further bias potential on said grid comprising said second capacitor, means actuated by the discharge of said first capacitor to charge said second capacitor, whereby upon the cessation of said discharge said second capacitor will impress a negative potential on said grid in excess of said alternating bias potential difference

5

and thus render said second rectifier non-conducting, and means providing for the dissipation of said charge on said second capacitor at a predetermined rate, whereby when said alternating bias has progressed through its negative half and again becomes positive, said exponential bias potential will have become insufficient to hold said grid negative throughout the positive half cycle of said alternating bias potential.

2. Means for driving an electro-acoustic transducer, comprising a charging circuit, a discharging circuit, said charging and discharging circuits including a first capacitor as a common part of both circuits, said charging circuit including a first rectifier, means for impressing an alternating potential difference on said rectifier whereby said capacitor may be charged once during each cycle of said alternating potential difference, a grid for said first rectifier, means for impressing a negative potential on said grid relative to the cathode of said first rectifier to prevent operation of said first rectifier, means for removing said negative potential from said grid of said first rectifier to permit operation of said first rectifier, said discharge circuit including said transducer, a second rectifier, and a second capacitor in circuit therewith and providing for the discharge of said first capacitor in less than a half-cycle of said alternating potential, a grid for said second rectifier, a control circuit for said grid, said control circuit including means for impressing an alternating bias potential on said grid and means for impressing a further bias potential of periodic exponential form on said grid, said means for impressing said further bias potential on said grid comprising said second capacitor, means actuated by the discharge of said first capacitor to charge said second capacitor, whereby upon the cessation of said discharge said second capacitor will impress a negative potential on said grid in excess of said alternating bias potential difference, and means providing for the dissipation of said charge on said second capacitor at a predetermined rate, whereby when said alternating bias has progressed through its negative half and again becomes positive, said exponential bias potential will have become insufficient to hold said grid negative throughout the positive half cycle of said alternating bias potential.

3. Means for discharging a capacitor periodically through an electro-acoustic transducer, in one uni-directional pulse each period, such means comprising a discharge circuit in series with said capacitor, said discharge circuit comprising said transducer, a rectifier, a second capacitor in circuit therewith, a grid for said rectifier, a control circuit for said grid, said control circuit including means for impressing an alternating bias potential on said grid, and means for impressing a further bias potential of periodic exponential form on said grid, said means for impressing said further bias potential on said grid comprising said second capacitor, means actuated by the discharge of said first capacitor to charge said second capacitor, whereby upon the cessation of said discharge said second capacitor will impress a negative potential on said grid in excess of said alternating bias potential difference, and means providing for the dissipation of said charge on said second capacitor at a predetermined rate, whereby when said alternating bias has progressed through its negative half and again becomes positive, said exponential bias potential will have become insufficient to hold said grid

6

negative throughout the positive half cycle of said alternating bias potential.

4. Means for driving an electro-acoustic transducer, comprising a charging circuit, a discharging circuit, said charging and discharging circuits including a first capacitor as a common part of both circuits, said charging circuit including a first rectifier, means for impressing an alternating potential difference on said rectifier whereby said capacitor will be charged once during each cycle of said alternating potential difference, said discharge circuit including said transducer, a second rectifier, and a second capacitor in circuit therewith and providing for the discharge of said first capacitor in less than a half-cycle of said alternating potential difference, a grid for said second rectifier, a control circuit for said grid, said control circuit including means for impressing an alternating bias potential on said grid, said bias potential being in such phase as to bias said grid negative during the charging portion of the cycle of said alternating potential difference, and means for impressing a further bias potential of periodic exponential form on said grid, said means for impressing said further bias potential on said grid comprising said second capacitor, means actuated by the discharge of said first capacitor to charge said second capacitor, whereby upon the cessation of said discharge said second capacitor will impress a negative potential on said grid in excess of said alternating bias potential difference, and means providing for the dissipation of said charge on said second capacitor at a predetermined rate, whereby when said alternating bias has progressed through its negative half and again becomes positive, said exponential bias potential will have become insufficient to hold said grid negative throughout the positive half cycle of said alternating bias potential.

5. Means for driving an electro-acoustic transducer, comprising a capacitor, a first rectifier in circuit therewith, means impressing an alternating current voltage on said rectifier whereby said capacitor will be charged once during each cycle of said alternating current, a discharge circuit for said capacitor including said transducer, a second rectifier in said discharge circuit, a control grid in said second rectifier, means impressing said alternating current voltage on said grid, whereby said rectifier will be rendered conducting once during each cycle of said alternating current and said capacitor will thereupon discharge therethrough, and means impressing a negative potential on said grid thereby rendering said second rectifier non-conducting upon the completion of said discharge and maintaining it in that state until said capacitor has again been charged.

6. Means for driving an electro-acoustic transducer, comprising a capacitor, a first rectifier in circuit therewith, means impressing an alternating current voltage on said rectifier whereby said capacitor will be charged once during each cycle of said alternating current, a discharge circuit for said capacitor including said transducer, a second rectifier in said discharge circuit, a control grid in said second rectifier, means impressing said alternating current voltage on said grid, whereby said rectifier will be rendered conducting once during each cycle of said alternating current, and said capacitor will thereupon discharge therethrough and means operated by said discharge to impress a negative potential on said grid upon the cessation of said discharge thereby

7

rendering said second rectifier non-conducting, and maintaining said negative potential on said grid for a predetermined time.

7. Driving means for utilizing an alternating current voltage to impress upon an electro-acoustic transducer a series of driving pulses shorter than a half-cycle of said voltage and for maintaining said transducer electrically isolated from said driving means during the intervals between said impulses, said means comprising a capacitor, means for charging said capacitor throughout alternate half-cycles of said voltage, means for discharging said capacitor through said transducer during the remaining half-cycles of said voltage, said discharging means including a rectifier, a control circuit for said rectifier, and means actuated by the discharge of said capacitor to apply a blocking voltage to said rectifier and to maintain said discharge means blocked for the duration of one of said intervals.

8. Driving means utilizing an alternating current voltage to impress upon an electro-acoustic

8

transducer a series of driving impulses shorter than a half-cycle of said voltage and for maintaining said transducer electrically isolated from said driving means during the intervals between said impulses, said means comprising a capacitor, means for charging said capacitor throughout alternate half-cycles of said voltage, a discharge circuit for said capacitor, said discharge circuit including a rectifier and said transducer, said discharge circuit providing for the discharge of said capacitor in less than a half-cycle of said alternating current voltage, a control grid for said rectifier, means actuated by the discharge of said capacitor to apply a blocking voltage to said grid during the intervening half-cycles of said alternating current voltage thereby rendering said rectifier non-receptive to energy fed back from said transducer following the completion of said discharge, for a period of time equal to the duration of one of said intervals.

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