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ELECTRICAL PHASE REVERSAL DEVICE

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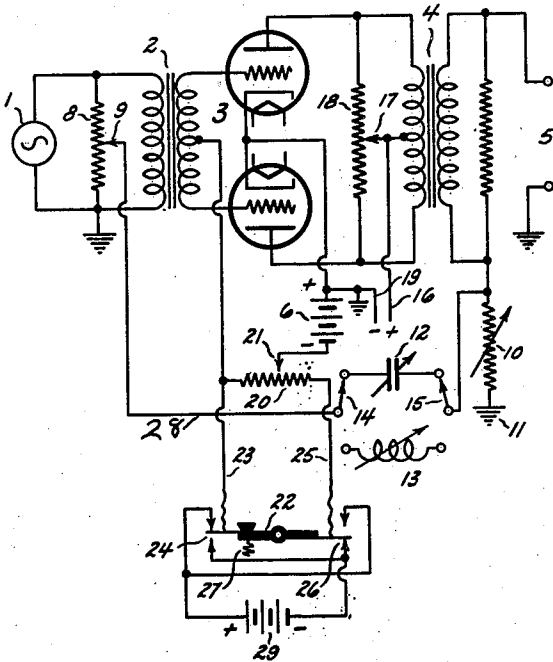


Fig. 1

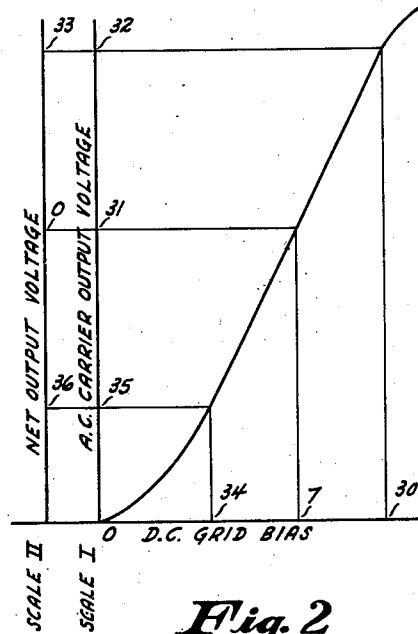


Fig. 2

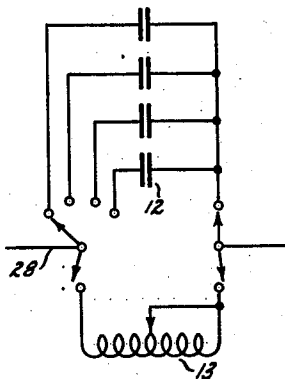


Fig. 3

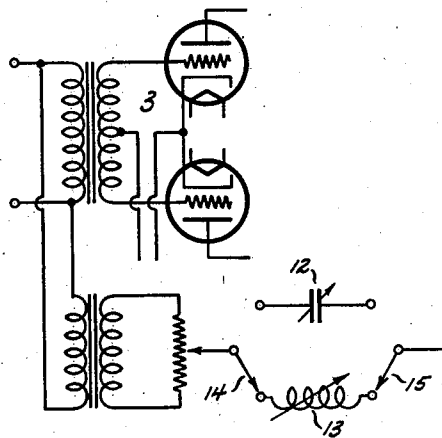


Fig. 4

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ELECTRICAL PHASE REVERSAL DEVICE

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12 Claims. (Cl. 178-66)

This invention relates to phase reversal devices.

An object of the invention is to provide arrangements for reversing the phase of an alternating current or potential.

5 Another object is to provide arrangements for reversing the phase of an alternating current or potential with no time lag except that due to the infinitesimally small time of electron current passage through an electron tube.

10 A further object is to produce a reversal of an alternating current or potential by reversal or other variation of a D. C. bias of an electron tube.

15 Other objects will appear in the following description, reference being had to the drawing, in which:

Fig. 1 is a circuit diagram showing one embodiment of my invention.

20 Fig. 2 illustrates the D. C. bias-output voltage characteristic of the push pull circuit of Fig. 1 and also the counter voltage of the by-pass circuit as well as the net voltage of the output.

Fig. 3 illustrates a particular phase adjusting device.

25 Fig. 4 illustrates a modification.

30 There are various uses for phase reversal circuits or devices, one such use being in telegraphy where the code characters in the communication of intelligence are produced by reversing the phase of an alternating current or potential, but my invention is useful in connection with any system where phase reversal is described.

35 In Fig. 1, I illustrates a generator of alternating current of any frequency. The generator is connected by transformer 2 to the input of a push pull vacuum tube stage 3. The output of this push pull stage is fed through transformer 4 to an output circuit 5, one terminal of which is grounded as is also one terminal of the alternating current source 1, though obviously neither
40 of these is essential. The battery 6 alone is capable of biasing the grids to the point 7 in Fig. 2.

45 A resistance 8 is connected across the terminals of the alternating source 1. An adjustable tap 9 is connected to this resistance and to a terminal of transformer 4 and also to an adjustable resistance 10 grounded at 11. In this connection either a condenser 12 or an inductance 13 may be inserted by the switch arrangement 14, 15, to
50 control the phase of the current.

55 The positive terminal 16 of the plate supply of the push pull stage is connected to the center of the primary of transformer 4 and also to a tap 17 adjustably connected to resistance 13

though the resistance and tap may be omitted when desired. The negative terminal 19 of the plate supply is connected to ground, as shown.

The common return of the grids of the vacuum tubes include a variable part of resistance 20 as
5 a variable control bias. The value of the control bias is adjusted by means of the tap 21 connected to the biasing battery 6.

While a variable control bias of proper value and of any frequency of variation, may be made
10 to produce the reversal of phase of the alternating current, I have shown for illustrative purposes only, a telegraph key 22 for producing a reversal of direct current bias on the grid. One end of the resistance 20 is connected through
15 conductor 23 with contact 24 of the telegraph key and the other conductor 25 is connected to the contact 26 of the telegraph key. With this arrangement the spring 27 holds the key in position to apply by means of battery 29 a positive
20 bias in series with the negative bias 6. There is then minimum negative, or most positive bias on the grids of the tubes. When the key is depressed a negative D. C. potential is applied in series with the negative bias 6. In this position
25 the two bias voltages add and produce maximum negative D. C. bias on the grids.

As will be noted from the circuit arrangement of Fig. 1, part of the output of the generator 1 proceeds directly through the push pull stage to
30 the output 5 and another part passes through the tap 9, conductor 28, condenser 12 or inductance 13, as the case may be, to resistance 10 and back to the alternating source through ground. A voltage drop is thus produced in resistance 10.
35 This drop is in series with the voltage produced in the secondary of the transformer 4. By proper adjustment of the condenser 12, or of inductance 13, as the case may be, the voltage drop in the resistance 10 may be readily made to be 180°
40 out of phase with the voltage produced in the secondary of transformer 4, and by adjustment of either the tap 9 or the resistance 10, or both of them, the value of the drop in resistance 10 may be readily made equal to the voltage at the
45 terminals of the secondary of the transformer 4.

With the resistances 9 and 20 all out of the by-pass and grid circuits, respectively, and negative bias value 7 the amplified A. C. voltage has the value 31 of scale I of Fig. 2. If now the
50 proper adjustments are made for value and phase, the by-passed voltage appearing in resistance 10 is equal to and opposite to the amplified voltage. The output voltage is then zero.

With the tap 21 suitably adjusted on the re- 55

istance 20 and with the key in the upper position, a positive bias from battery 29 is applied to the grids of the push pull tubes in opposition to the normal negative bias of battery 6. This decreases the negative bias or renders it positive, depending upon the tube characteristics and carries it to point 30 in Fig. 2. The value of the amplified voltage is given by 32 on scale I, while the by-passed voltage still has the value 31. Scale II gives at 33 the resultant or output voltage with the zero value of the scale on the line through point 31. This voltage of course has the phase of the amplified voltage.

With the telegraph key 22 depressed the potential of the battery 29 is applied in the reverse direction. As before, the by-passed voltage appearing in resistance 10, will be unchanged in both value and phase but the amplified voltage will now be less because the amplification is decreased with increase of negative bias to point 34. With this bias it has the value given by 35. The net voltage has the value given by 36 of scale II. Since the unchanged by-passed voltage predominates, the output voltage is 180° out of phase with the voltage given by 33, but equal thereto in value. The variation of the D. C. bias thus reverses the phase of the alternations but does not change the value, though obviously the value could be changed if this were desired.

The operation of the telegraph key 22 instantly reverses the phase of the alternating potential and the reversal of phase has no appreciable lag, being as fast as the flow of electrons. Of course there is a lag in the mechanical operation of the key 22 for reversing the D. C. potential but this telegraph key is merely an example selected for explaining the operation. It will be apparent that if the bias were varied at radio frequency there still would be no appreciable lag in the reversal of the phase of the alternating voltage.

My invention can be used regardless of the frequency of the alternating source, the phase of which is to be reversed. This generator may operate at very low frequency or at extreme ultra high frequency with no difference in operation.

On low frequency or even at moderately high frequency laminated iron cores may be used in the transformers and inductances as shown in Fig. 4. At high or very high frequencies the condenser 12 may have rotor plates interleaving with stator plates for producing the necessary adjustment of capacity. At lower frequencies a condenser of proper value would be selected and placed in circuit or there may be a bank of condensers, as shown in Fig. 3. The inductance in any case would be more suitably adjusted by short-circuiting some of the turns, as indicated in this Fig. 3, although variometers are obviously suitable, particularly at high frequencies.

The bias does not have to be of any definite value. After having balanced the by-passed voltage with the amplified voltage in phase and value the normal bias could be set at the point 30. The phase of the alternations could then be reversed by applying a D. C. negative voltage that would carry the bias down to point 34.

Obviously the normal bias source 6 could be omitted and the phase reversal secured by balancing the voltages at the point on the curve where there is zero bias and varying or reversing the bias from the source 29 about this point.

This invention obviously is not limited to a push pull arrangement of the tubes as a single tube can be used with like results.

It will be apparent that the counter E. M. F.

could be impressed on the output of the amplifier in a variety of ways; an additional way being indicated in Fig. 4 where parts similar to those of Fig. 1 have been given similar reference characters.

Various other modifications in this and other features may be made without departing from the spirit of the invention.

Having described my invention, what I claim is:

1. In an electrical phase reverser, an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input circuit, means for producing in said output circuit a voltage equal and opposite to the voltage produced therein by said amplifier tube, and means for increasing and reducing the last mentioned voltage equal amounts above and below the next to last mentioned voltage for reversing the phase of the resultant alternating voltage in said output circuit.

2. In an electrical phase reverser, an amplifying tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input circuit, means including a by-pass for producing in said output circuit a by-passed voltage equal and opposite to the voltage produced therein by said amplifier tube, and means for applying a variable bias between the cathode and control electrode to alternately increase and decrease the amplified voltage above and below the by-passed voltage for reversing the phase of the resultant alternating voltage in said output circuit.

3. In an electrical phase reverser an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input, a by-pass connection between said source and said output, means for adjusting the value of the voltage impressed on said output through said by-pass to equal that of the output of said amplifier tube, and means to adjust the phase of the by-passed voltage 180° from the voltage in said output impressed through said tube, means for applying a variable bias between the cathode and control electrode to alternately increase and decrease the amplified voltage above and below the by-passed voltage for reversing the phase of the resultant alternating voltage in said output circuit.

4. In an electrical phase reverser, an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input circuit, a by-pass connection between said source and said output circuit, means for adjusting the value of the voltage impressed on said output circuit through said by-pass and means to adjust the phase of said voltage 180° from the voltage in said output circuit impressed through said tube, means for biasing the control electrode in respect to the cathode, and means for varying said bias for reversing the phase of the resultant voltage in said output circuit.

5. In an electrical phase reverser, an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input circuit, a by-pass connection between said source and said output circuit, means for adjusting the value of the voltage impressed on said output circuit through said by-pass and means to adjust the phase of said voltage 180°

from the voltage in said output circuit impressed through said tube, a source of unidirectional voltage for biasing the control electrode in respect to the cathode and means for applying a variable bias between the cathode and control electrode to alternately increase and decrease the amplified voltage above and below the by-passed voltage for reversing the phase of the resultant alternating voltage in said output circuit.

6. In an electrical phase reverser, an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating potential connected to said input circuit, a by-pass connection between said source and said output circuit, means for adjusting said connection to impress on said output circuit through said by-pass a voltage equal in value to and opposite in phase from the voltage in said output circuit impressed through said tube, a source of unidirectional voltage for biasing the control electrode in respect to the cathode and means for varying said additional source to alternately increase and decrease the amplified voltage above and below the by-passed voltage for reversing the phase of the resultant alternating voltage in said output circuit.

7. In an electrical phase shifter two amplifier tubes connected in push pull relation, said tubes having control electrodes, anodes and cathodes, a source of alternating potential connected between the control electrodes of said tubes, a negative bias connected between the control electrodes and the cathodes, an output circuit connected to said anodes, a by-pass between the source of alternating potential and the output circuit of said tubes for producing an alternating voltage in said output circuit equal and opposite to the voltage impressed on said output circuit through said tubes, and means for applying a variable bias between the cathode and control electrode to reverse the phase of the net voltage in said output circuit.

8. In an electrical phase shifter, two amplifier tubes connected in push pull relation, said tubes having control electrodes, anodes and cathodes, an input circuit connected to said control electrodes, a source of alternating potentials connected to said input circuit, a negative bias connected between the control electrodes and the cathodes, an output circuit connected to said anodes, a by-pass from said source around the amplifier tubes for producing an alternating voltage in said output circuit, equal and opposite to the voltage impressed on said output circuit through said tubes, means for biasing the control electrodes in respect to the cathodes and means for varying said bias to cause each of said voltages to predominate alternately over the other for reversing the phase of the resultant alternating voltage in said output circuit.

9. In an electrical phase reverser, an amplifier tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating E. M. F. connected to

said input circuit for producing an alternating E. M. F. in the output circuit, means for producing in said output circuit an alternating E. M. F. of opposite phase to that produced therein by said amplifier tube, and means for increasing one of the output E. M. F.'s above the other for producing a resultant alternating E. M. F. of one phase and for reducing it below the other for producing an alternating E. M. F. of opposite phase.

10. In an electrical phase reverser, an amplifying tube having a control electrode, a cathode and an anode, input and output circuits for said tube, a source of alternating E. M. F. connected to said input circuit for producing an alternating E. M. F. in said output circuit, means for producing in said output circuit an alternating E. M. F. of opposite phase to that produced therein by said amplifier tube, and means for applying a variable bias between the cathode and control electrode for increasing the amplified E. M. F. above the by-passed E. M. F. for producing in the output circuit a resultant E. M. F. of one phase and for decreasing it therebelow for producing an alternating E. M. F. of opposite phase.

11. In an electrical phase shifter two amplifier tubes connected in push-pull relation, said tubes having control electrodes, anodes and cathodes, a source of alternating E. M. F. connected to the input circuit of said tubes and producing an alternating E. M. F. in the output circuit, a negative bias connected between the control electrodes and the cathodes, a by-pass between the source of alternating E. M. F. and the output circuit of said tubes having means for producing an alternating E. M. F. in said output circuit opposite in phase to the E. M. F. impressed on said output circuit through said tubes, and means for varying said bias for increasing the amplified E. M. F. above the by-passed E. M. F. for producing in the output circuit a resultant alternating E. M. F. of one phase and for decreasing it therebelow for producing a resultant alternating E. M. F. of opposite phase.

12. In an electrical phase shifter, two amplifier tubes connected in push-pull relation, said tubes having control electrodes, anodes and cathodes, a source of alternating E. M. F. connected to the input circuit and producing an alternating E. M. F. in the output circuit thereof, a negative bias of a predetermined value connected between the control electrodes and the cathodes, a by-pass from said source around the amplifier tubes having means for producing an alternating E. M. F. in said output circuit, opposite to the E. M. F. impressed on said output circuit through said tubes with a bias of said value, means for increasing the value of said bias to produce in the output circuit an alternating E. M. F. of one phase and for decreasing the said value to produce therein an alternating E. M. F. of opposite phase.

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