

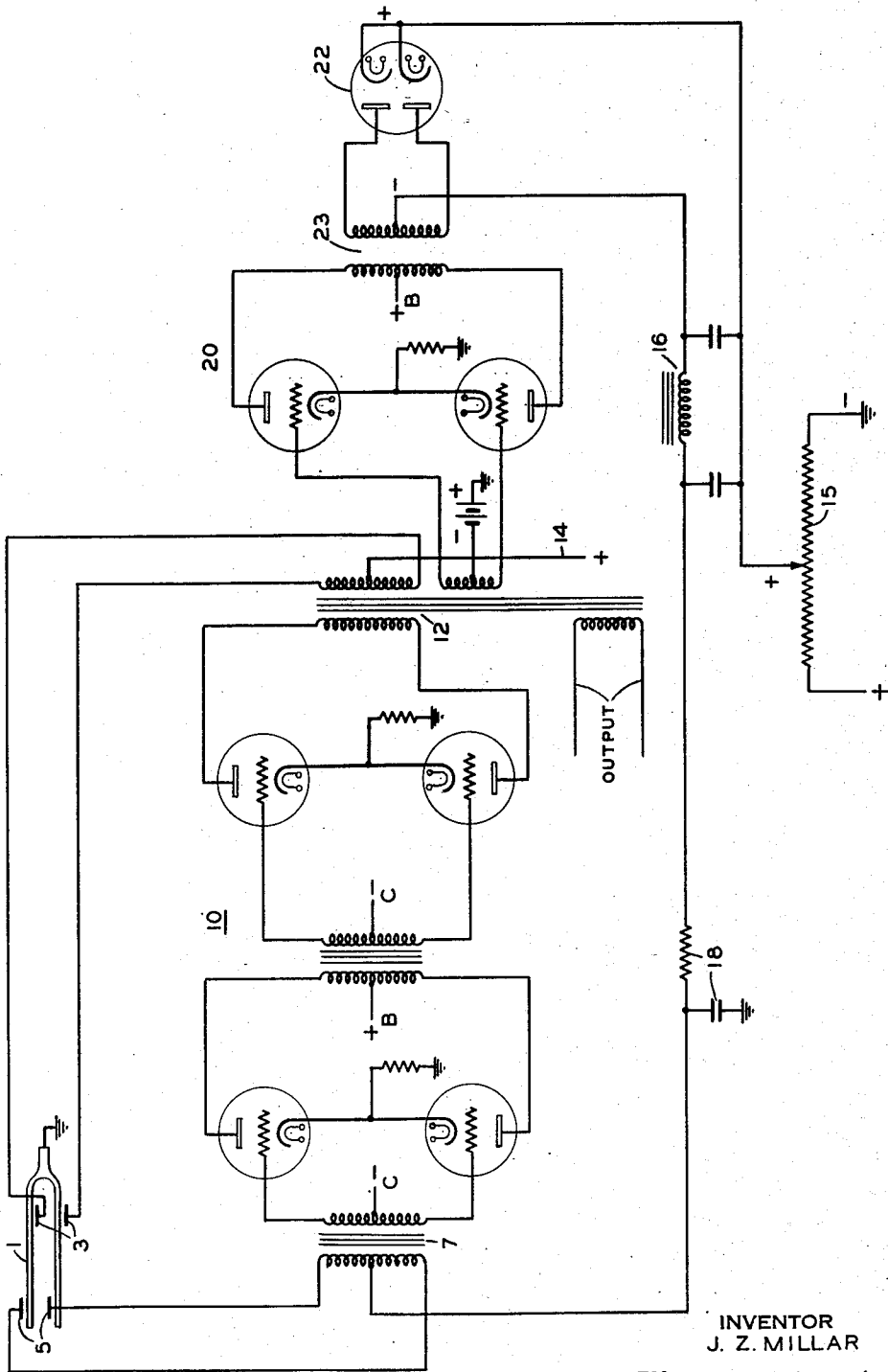
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CONTROL CIRCUIT FOR DRIVING FORK

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CONTROL CIRCUIT FOR DRIVING FORKS

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This invention relates generally to constant frequency sources of alternating current and more particularly to fork controlled sources of alternating current for use in connection with electric circuits involving synchronous control of electrically driven apparatus such as that used in facsimile transmission and reproduction.

In synchronous circuits which extend over great distances and are subject to interference from external sources of electrical potential, it is extremely important to control the frequency of alternating current driving potentials in such a manner that the frequency variation is limited to an extremely small amount. Previous sources of alternating current have been controlled by regulators of various types, but it has been found that none of them are suitable for long distance transmission lines of the type usually available for communication purposes.

Accordingly, it is the primary object of this invention to provide a source of alternating current of substantially constant frequency.

Another object of the invention is to provide a fork controlled source of alternating current, the regulation of which reduces the frequency variations to a minimum.

A further object of the invention is to provide a standard frequency tuning fork source of alternating current utilizing electrostatic principles for driving and regulating the same.

A further object of this invention is to provide a regulating system for a fork driving circuit which eliminates the effects of exterior interferences.

A further object is to provide a system which will regulate the output voltage without materially altering the wave form of the output voltage.

A still further object is to provide a system which attains a degree of regulation which is superior by virtue of the amplification between the voltage to be controlled and the effective polarizing voltage applied to the fork pickup plates.

A still further object is to provide a system wherein the regulation is independent of the gain of the amplifier being controlled.

A still further object is to provide a system wherein the amplifier may at all times be operated at optimum conditions.

A still further object is to provide a system wherein the circuit values which determine the operating points are few number and capable of readily being maintained in adjustment.

A still further object is to provide a fork controlled alternating current generating system

wherein circuit values which determine the operating amplitude may readily be adjusted to produce any particular amplitude and consequent frequency of output.

Further objects of this invention will be apparent to those skilled in the art from consideration of the following description taken in connection with the accompanying drawing, wherein the single figure is a circuit diagram of a fork driving and regulating circuit constructed in accordance with this invention.

Referring to the drawing, the source of alternating current frequency consists of a tuning fork 1 which is grounded and which includes drive plates 3 and pickup plates 5 which are positioned in such a manner with respect to the fork that an electrostatic field may exist between the fork and the plates. The pickup plates 5 are each connected to opposite ends of the primary winding of transformer 7, this transformer constituting a coupling to the amplifier 10. This amplifier is conventional in all respects and may include any desired number of stages of amplification in accordance with the requirements of the particular circuit to which power is to be supplied.

The output transformer 12 of amplifier 10 constitutes a coupling between the amplifier and the drive plates 3 of the tuning fork 1. The polarizing potential for drive plates 3 is supplied from a direct current source indicated at 14 and connected through the center tap of the secondary winding of transformer 12, the other polarity of the polarizing voltage being connected to ground whereby the difference of potential creates electrostatic field between fork 1 and plates 3.

An adjustable source of polarizing potential is connected through filter 16 and delay network 18 to the center tap of the primary winding of transformer 7 whereby pickup plates 5 are polarized with respect to fork 1. It should be noted that the pickup plates 5 are positioned on opposite sides of the fork with respect to the position of drive plates 3 whereby the electrostatic fields created by the polarizing potentials oppose one another. It should also be noted that the adjustment of source 15 provides means for adjusting the amplitude and frequency of vibration of fork 1 and consequently of the system output.

Regulation of the fork driving circuit is obtained through an additional amplifier 20 which is connected to a third winding of transformer 12 in such a manner that a certain portion of the output of amplifier 10 may be amplified by am-

plifier 20. Its output is coupled to a rectifier 22 through transformer 23, the output of rectifier 22 being connected across the filter 16 in such a manner that the voltages of the rectifier 22 and the source of potential 15 oppose one another.

The operation of the constant frequency source is started by vibrating the fork, at which time the pickup plates have an electrical potential generated across them because of the variations in the electrostatic field existing between the plates and the tines of the fork. This potential is fed into the amplifier 10 and amplified by any desired amount. The amplifier output is fed through coupling transformer 12 to the driving plates 3 on the fork 1. When no alternating current potential is being impressed upon the drive plates 3 there is a constant electrostatic attraction between the tines of the fork and the plates. When the voltage is applied from transformer 12 to the plates 3, the instantaneous positive and negative peaks will increase the electrostatic attraction on one tine and equally decrease the electrostatic attraction on the other tine. During the next half cycle the respective alternating current polarities will be reversed and the tines will move in opposite directions, thereby maintaining the fork in constant vibration. If the fork happens to increase the amplitude of its vibration, the pickup voltage across the plates 5 will increase and be amplified by the driving amplifier 10. This, however, will not cause increased amplitude of alternating current voltage on plates 3 for the reason that the amplifier 20 amplifies a portion of the output voltage of transformer 12 and feeds the same through transformer 23 to rectifier 22. The output of rectifier 22 opposes the direct current voltage derived from source 15 and circuit 16 to decrease this voltage by an amount equivalent to the change of voltage on plates 5. Since the decrease in this polarizing voltage reduces the generated voltage of plates 5, the net result is to reduce the driving power of the fork and thereby hold it at a constant amplitude. Any desired amplitude and frequency of output is obtained by adjustment of source 15.

The operation of the circuit as so far described is only partially effective to produce a constant voltage in the output of amplifier 10 as changes in amplitude of the pickup voltage might possibly produce hunting whereby variations in pickup voltage would produce variations in driving voltage. Therefore, delay network 18 is provided for the purpose of delaying the changes in polarizing voltage on the pickup plates 5, thereby eliminating the hunting effect.

From the above description it is evident that this invention provides a source of electrical potential of substantially constant frequency which is particularly adaptable for use in connection with synchronous control circuits and the like. While only one modification of this invention and its advantages have been disclosed in this application, other modifications and advantages within the scope of this invention will occur to those skilled in the art, and therefore it is desired that this invention be limited only to the extent required by the prior art and the appended claims.

What is claimed is:

1. A source of constant frequency electrical energy comprising a tuning fork, a pair of drive plates in push-pull relation to the tines of said fork, a source of potential for polarizing said plates to create an electrostatic field between the plates and the fork, a driving amplifier coupled

to said plates for feeding alternating current energy to said plates to drive the fork, a pair of pickup plates opposed to the drive plates for converting the mechanical energy of the fork to alternating current energy and coupled to the input of said amplifier for feeding alternating current potential of the desired frequency to said amplifier, a polarizing source of potential in circuit with the pickup plates and the fork for creating an electrostatic field between the plates and fork, a regulating amplifier coupled to the driving amplifier output for amplifying a portion of the output of said driving amplifier, a rectifier coupled to the regulating amplifier for rectifying its output and connections between the rectifier and the second polarizing source of potential to feed a regulating potential in opposition to the polarizing potential whereby variations in the output of the driving amplifier are fed back to the pickup plates in opposition to their polarizing potential to maintain the drive potential and the amplitude of vibration of the fork at a constant value.

2. A source of constant frequency electrical energy comprising a tuning fork, a pair of drive plates in spaced relation to the tines of said fork, a source of potential connected for polarizing said plates, an amplifier coupled to said plates for feeding alternating current energy thereto operatively to drive the fork, a pair of pickup plates positioned in capacitive relation with said fork and coupled to the input of said amplifier for feeding alternating current potential of the desired frequency to said amplifier, a polarizing source of potential connected to the pickup plates, an amplifier coupled to the output of said first amplifier for amplifying a portion of the output of said driving amplifier, a rectifier coupled to the output of the second amplifier and connections between the rectifier and the second polarizing source of potential to feed a regulating potential in opposition to the polarizing potential whereby variations in potential of the input of the first amplifier are fed back in opposition thereto to maintain the amplitude of vibration of the fork at a constant value.

3. A source of constant frequency electrical energy comprising a tuning fork, driving plates in push-pull relation to the tines of said fork, a source of potential connected for polarizing said plates, an amplifier coupled to said plates for feeding energy thereto, pickup plates positioned in capacitive relation to the driving plates and coupled to the input of said amplifier for feeding potential of the desired frequency to said amplifier, a polarizing source of potential connected to the pickup plates, an amplifier coupled to the output of said first amplifier for amplifying a portion of the output of said driving amplifier, a rectifier coupled to the output of the second amplifier and a circuit including the rectifier for feeding a regulating potential to the pickup plates to maintain the amplitude of vibration of the fork at a constant value.

4. A source of constant frequency electrical energy comprising a tuning fork, a pair of driving plates in spaced relation to the tines of said fork, an amplifier coupled to said plates for feeding alternating current energy to said plates to drive the fork, a pair of pickup plates positioned in capacitive relation with said fork and coupled to the input of said amplifier for feeding alternating current potential of the desired frequency

to said amplifier, a rectifier coupled to the output of the driving amplifier and a circuit including the rectifier for feeding regulating potential to the pickup plates to maintain the amplitude of vibration of the fork at a constant value.

5. A source of constant frequency electrical energy comprising a tuning fork and means for electrostatically driving the same, a rectifier coupled to said driving means for rectifying changes in the output of said means and means for applying energy to said fork in accordance with said changes to maintain its amplitude and frequency of vibration at a constant value.

6. A source of constant frequency electrical

energy comprising a tuning fork, driving plates in operative relation to the tines of said fork, a source of potential connected for polarizing said plates with respect to the fork, an amplifier coupled with said plates, pickup plates positioned in capacitive relation with said fork and coupled to the input of said amplifier for feeding potential to said amplifier, a source of potential in circuit with the pickup plates and the fork for polarizing the plates with respect to the fork and means for adjusting the polarizing potential to determine the amplitude and frequency of the amplifier input.

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