

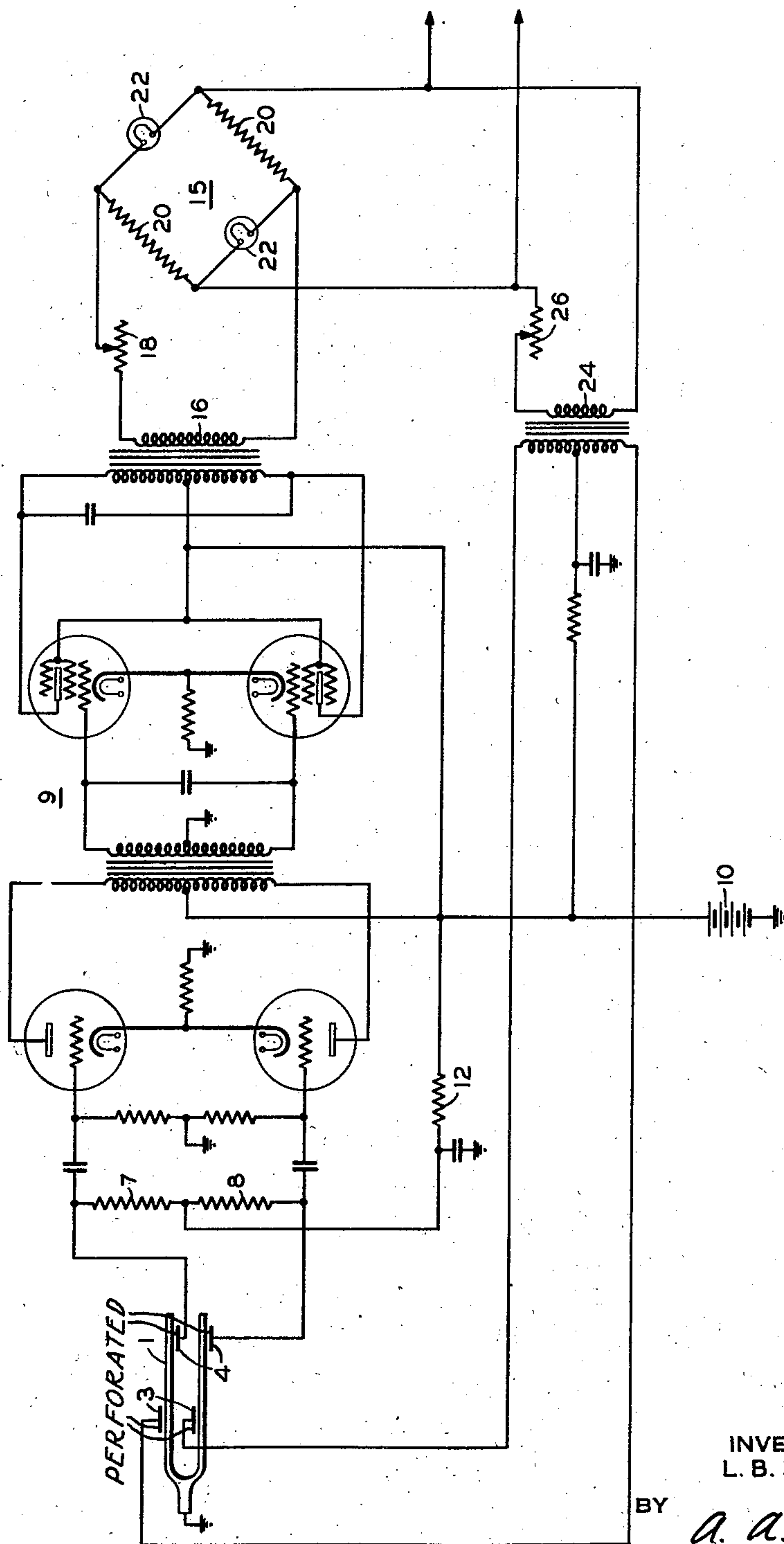
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L. B. ROOT

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CONTROL CIRCUIT FOR DRIVING FORKS

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BY

INVENTOR
L. B. ROOT

A. A. Smith
ATTORNEY

UNITED STATES PATENT OFFICE

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CONTROL CIRCUIT FOR DRIVING FORKS

Leland B. Root, Water Mill, N. Y., assignor to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

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This invention relates generally to a method and apparatus for generating a constant frequency alternating current and more particularly to a fork controlled source of alternating current and a circuit for controlling the fork to obtain a constant frequency output.

It is necessary to utilize a highly accurate source of driving power for alternating current drive mechanisms, particularly those used in facsimile picture transmission systems. It is known that various types of mechanical apparatus for generating alternating currents have been used for driving and controlling electrical apparatus, and it is also known that vacuum tube circuits have been used for driving tuning forks through electromagnetic couplings, but these particular fork driving circuits have been found to be inaccurate in that the frequency of the alternating current output varies through a range sufficient to render the apparatus unsuitable for use in facsimile systems. The reason for this is that eddy currents within the fork resulting from the effects of the magnetic field have been found to set up electromagnetic forces which load the fork and change its amplitude frequency of vibration. Furthermore, electromagnets are found to age, thereby changing their driving force and the frequency of vibration of the fork. Furthermore, magnetic apparatus is subject to the effects of stray magnetic fields which alter the driving force of the magnets. These variations in amplitude and frequency, induced by the use of magnetic apparatus, are amplified in the driving amplifier and fed back to the fork in such a manner that the variations are built up and result in extreme variations of the frequency of the alternating current output.

Accordingly, the primary object of this invention is to provide a new and improved method and apparatus for driving a standard frequency fork generator.

Another object of this invention is to provide an electrostatic drive for tuning forks when they are used as alternating current generators.

Another object of this invention is to provide a method and apparatus for regulating the output of the driving amplifier so as to hold the fork amplitude constant and obtain a constant frequency output.

A further object of the invention is to provide a current generator which will regulate its output voltage without materially altering the wave form thereof.

A still further object of the invention is to provide an alternating current generating sys-

tem wherein an amplifier driven fork is regulated independently of the gain of the amplifier.

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 point are few in number and capable of readily being maintained in adjustment.

The objects and advantages of this invention will be better understood from consideration of the specification, taken in connection with the accompanying drawing wherein the single figure of the drawing is a circuit diagram illustrating the preferred modification of this invention which comprises a standard frequency fork and a circuit for driving and controlling the same.

Referring to the drawing, a tuning fork 1 is provided for the purpose of generating a constant frequency alternating current. The fork is driven by a pair of perforated electrostatic plates 3 which are connected to the output of the amplifier 9. As illustrated, the amplifier comprises two stages, but this showing is by way of example only and any desired number of stages may be used. Fork 1 is also provided with perforated pickup plates 4 which are connected to a resistance coupling comprising a pair of resistors 7 and 8. Polarizing potential is applied to the resistors 7 and 8 from a source 10 through a delay network 12, resistors being used as a coupling for the reason that they are not subject to stray magnetic fields or other interference. Plates 3 and 4 are perforated in such a manner that air cushioning or loading between the plates and the tines of the fork is prevented.

The output of the amplifier 9 is coupled to a Wheatstone bridge 15 by the output transformer 16 and through an adjustable resistor 18. The Wheatstone bridge 15 is made up of a pair of resistance arms 20 which may be of any form of zero temperature coefficient wire. The other two arms of the bridge comprise a pair of incandescent lamps 22 shown by way of example, the impedances of which are non-linear with respect to changes in impressed voltage. Other forms of non-linear impedance may be used. Thus, although the input voltage is varied over a considerable range, the resulting current changes in the respective arms vary the resistance and consequent voltage drop in such a manner that the net output of the bridge remains constant.

The output of bridge 15 is connected to transformer 24 and thereby coupled with the driving

plates 3 of the fork 1. Transformer 24 is also utilized for supplying a polarizing voltage to plates 3 by connecting the source of potential 10 to the midpoint of the secondary winding.

When the fork 1 is in a static condition and no alternating current potential is impressed thereon, the direct current biasing voltage creates a constant electrostatic field between the tines and the drive plates or pickup plates 3 and 4, respectively. When the fork is started or vibrated the pickup plates 4 have an alternating current potential generated therein as a result of the variations in the electrostatic field caused by the fork vibrations. This potential is impressed across the input of the amplifier and amplified by the desired amount, for instance from $\frac{1}{4}$ of a volt to 110 volts, which appears across the output transformer 16. This output is adjusted by means of rheostat 18 to insure operation within the regulating range of bridge 15 and is fed through the Wheatstone bridge 15 and transformer 24 to the driving plates 3 wherein instantaneous positive and negative potential 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 their respective opposite directions whereby the fork is maintained in constant vibration.

If for any reason the output of the amplifier to transformer 16 varies, this new value of voltage is applied to the Wheatstone bridge 15 but the resulting current changes in the respective arms varies the resistance across the incandescent lamps in such a manner that the output of the bridge remains constant. Therefore, the driving voltage across transformer 24 is also constant whereby the driving voltage across the plates 3 does not change and the fork 1 is driven at a constant amplitude.

If it is desired to make a small change of frequency of the fork, this may be done by changing the amplitude by means of rheostat 26 which is connected in series with transformer 24. The fork then becomes stable at a new amplitude, but at a slightly different frequency.

From the above description it is evident that the regulation of the fork driving power is independent of the gain of the amplifier or any of the other constants in the amplifier circuit. Therefore, the amplifier may at all times be operated at optimum conditions. Furthermore, it is evident that the circuit is simple and inexpensive to construct as well as to operate, the circuit values which determine the operating characteristics being few in number and capable of readily being maintained in adjustment.

Although one modification only of this invention has been illustrated herein, it will be evident to those skilled in the art that various other modifications are possible and therefore it is desired that this invention shall be limited only by the prior art and the appended claims.

I claim:

1. A source of alternating current comprising a tuning fork, a pair of electrostatic pickup plates in push-pull relation with the tines of said fork, means for creating an electrostatic field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived from the plates, a pair of driving plates positioned in capacitive relation with the fork in opposed relation to the pickup plates, a source of potential for polarizing

the drive plates with respect to said fork to create an electrostatic field between the fork and the plates and a coupling from the output of said amplifier to said drive plates for supplying a drive potential to maintain the vibrations of the fork.

2. A source of alternating current comprising a tuning fork, a pair of electrostatic plates positioned in capacitive relation with the tines of said fork, means for creating an electrostatic field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork, a source of potential for polarizing the drive plates with respect to said fork to create an electrostatic field between the fork and the plates and a coupling from the output of said amplifier to said drive plates for supplying a drive potential to maintain the vibrations of the fork.

3. A source of alternating current comprising a tuning fork, a pair of plates positioned in capacitive relation with the tines of said fork, means for creating an electric field between the fork and said plates, means for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork, a source of potential connected between the fork and the driving plates for creating an electrical field therebetween and a coupling from the output of said amplifier to said plates for supplying a drive potential to maintain the vibrations of the fork.

4. A source of alternating current comprising a tuning fork, a pair of pickup plates positioned in capacitive relation with the tines of said fork, means for creating an electrical field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived from the plates, a pair of driving plates connected to and energized by the amplifier and positioned in capacitive relation with the fork for driving the same and a source of potential connected between the fork and the driving plates for creating an electrical field between the fork and the driving plates.

5. A source of alternating current comprising a tuning fork, a pair of pickup plates on said fork, a pair of drive plates on said fork, means for polarizing said plates with respect to the fork to create an electrical field between the plates and the fork and an amplifier coupling the driving plates to the pickup plates.

6. A source of alternating current comprising a tuning fork, a pair of electrostatic pickup plates in push-pull relation with the tines of said fork, means for creating an electrostatic field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork in opposed relation to the pickup plates, a source of potential connected between the fork and the driving plates for polarizing the drive plates with respect to the fork to create an electrostatic field between the fork and the plates, a bridge circuit coupled to the output of said amplifier and comprising a pair of opposed resistance arms and a pair of opposed arms including incandescent lamps the resistance of which varies non-linearly with relation to the input potential whereby the output of said bridge is constant and a coupling circuit between the bridge and the drive plates

of the fork for supplying a constant drive potential thereto.

7. A source of alternating current comprising a tuning fork, a pair of electrostatic pickup plates positioned in capacitive relation with the tines of said fork, means for creating an electrostatic field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork, a source of potential connected between the fork and the drive plates for polarizing the drive plates with respect to the fork to create an electrostatic field between the fork and the plates, a bridge circuit coupled to the output of said amplifier and comprising a pair of resistance arms and a pair of arms including incandescent lamps the resistance of which varies non-linearly with respect to the input potential whereby the output of said bridge is constant and a coupling circuit between the bridge and the drive plates of the fork for supplying a constant drive potential thereto.

8. A source of alternating current comprising a tuning fork, a pair of pickup plates positioned in capacitive relation with the tines of said fork, means for creating an electric field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork, a source of potential connected between the fork and the driving plates for creating an electrical field between the fork and the plates, a bridge circuit coupled to the output of said amplifier for feeding a drive potential to the driving plates and comprising a pair of resistance arms and a

pair of arms including incandescent lamps the resistance of which varies non-linearly with respect to potential whereby the output of said bridge is constant.

9. A source of alternating current comprising a tuning fork, a pair of pickup plates positioned in capacitive relation with the tines of said fork, means for creating an electrical field between the fork and said plates, an amplifier coupled to said plates for amplifying the electrical potential derived therefrom, a pair of driving plates positioned in capacitive relation with the fork, a source of potential connected between the fork and the plates for polarizing the drive plates with respect to the fork to create an electrical field between the fork and the plates and means coupled to the output of said amplifier for supplying constant drive potential to the drive plates.

10. A source of alternating current comprising a tuning fork, a pair of pickup plates on said fork, a pair of drive plates on said fork, means for polarizing said plates with respect to the fork to create an electrical field between the plates and the fork, an amplifier coupling the driving plates to the pickup plates and means in the amplifier output for maintaining the same at a constant value.

11. A source of alternating current comprising a tuning fork, at least one perforated pickup plate on said fork, at least one perforated drive plate on said fork, means for polarizing said plates with respect to the fork to create an electrical field between the plates and the fork and an amplifier coupling the driving plate to the pickup plate.

LELAND B. ROOT.