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E. B. NORRMAN

1,937,583

OSCILLATION GENERATOR

Filed April 23, 1932

Fig. 1.

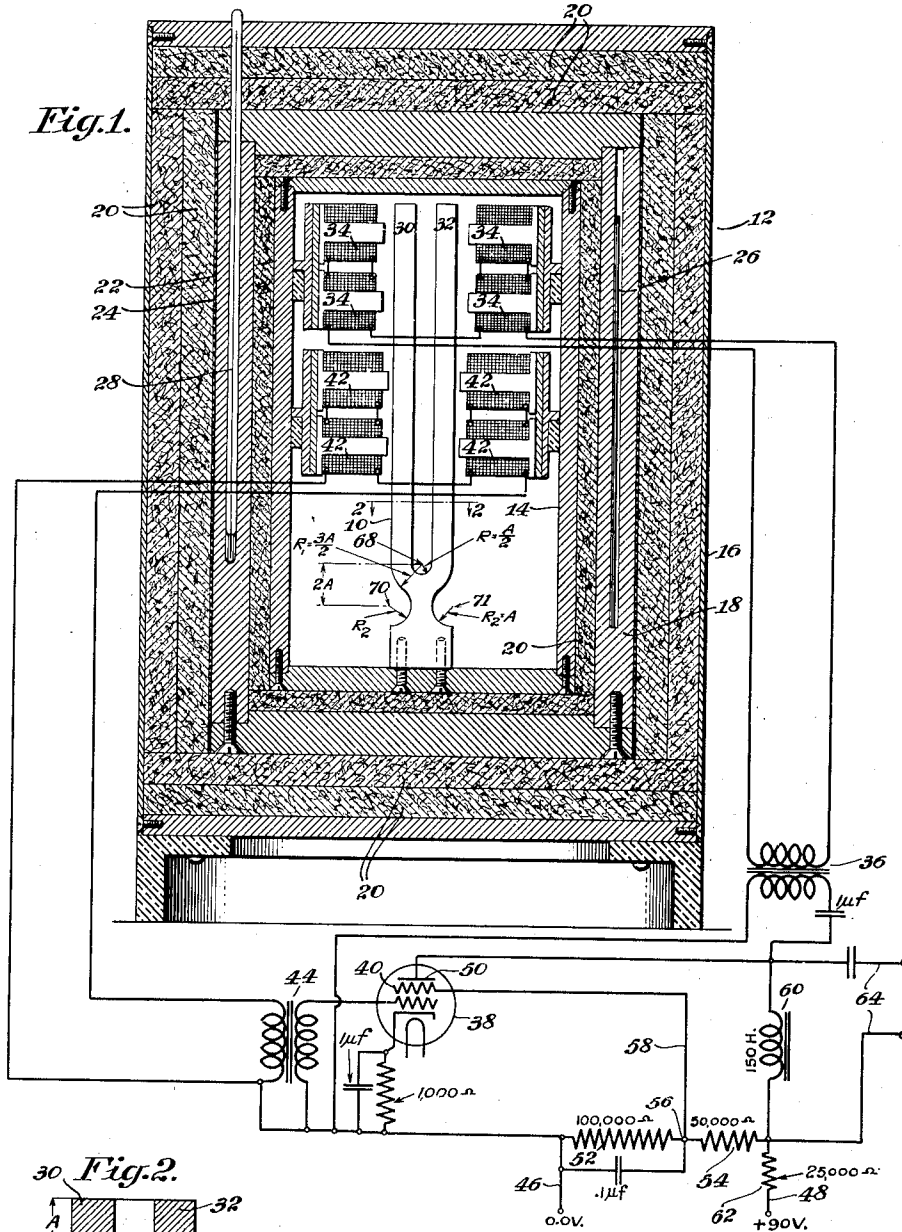


Fig. 2.

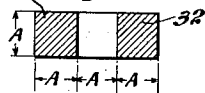


Fig. 3.

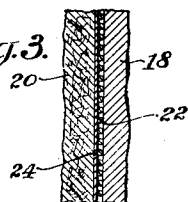
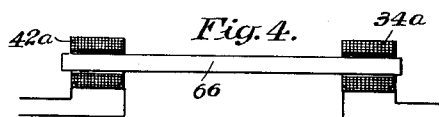


Fig. 4.



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OSCILLATION GENERATOR

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4 Claims. (Cl. 84-409)

My invention relates to improvements in oscillation generators and, more particularly, to generators of the type embodying a vibrating member such as a tuning fork.

5 One of the objects of my invention is to provide an improved system of the character referred to which has practically perfect stability.

Another object of my invention is to provide an improved tuning fork construction which is particularly useful in systems of the character referred to, and which has a damping factor many times less than the respective damping factors of the various tuning forks constructed heretofore.

15 Other objects and advantages will hereinafter appear.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

20 Figure 1 is a simplified, diagrammatic view of a system embodying my invention, some of the parts being shown on an enlarged scale and in section;

Fig. 2 is an enlarged sectional view, the section being taken on the line 2-2 in Fig. 1;

Fig. 3 is an enlarged fragmentary view taken from Fig. 1; and

Fig. 4 is a fragmentary sectional view, showing a proposed modification.

30 In Fig. 1, the vibratory member in the system is shown as being in the form of a tuning fork 10 mounted in suitable heat-regulated apparatus 12 for the purpose of maintaining the temperature of the fork practically constant at a predetermined point during operation.

40 The apparatus 12 is shown as comprising an inner metallic container 14, an outer metallic container 16, and an intermediate metallic container 18. It is proposed to make these three containers of aluminum. Suitable heat insulating material 20 is interposed between the containers, as shown.

Heat is supplied to the apparatus 12 by a suitable heating coil 22 wound non-inductively between a layer of suitable insulating paper 24 and the outer surface of the container 18, as shown in Fig. 3, the heating coil and the paper extending throughout substantially the entire length of the container.

50 Constant temperature regulation is obtained by a suitable thermostatic element 26 which may be disposed in a hole or cavity in the wall of the container 18. A similar hole or cavity is also formed in the wall of this container to receive a suitable indicating thermometer device 28. The

details of the heat control system and those of the regulating thermostat are well known and include the usual relay device, and form per se no part of my present invention. No disclosure of these details is, therefore, believed to be necessary, the only requirement being that this circuit and the various parts comprising the same be effective to maintain the temperature practically constant at the desired point.

60 For the purpose of driving or imparting vibratory movement to the tines 30 and 32 of the fork, series-connected electromagnetic coils 34 are supported in any suitable manner from the inner wall of the container 14, and are inductively connected by a transformer 36 to the plate circuit of a thermionic amplifier tube 38 having at least four electrodes, one of which is a screen grid 40. Electromagnetic pick-up coils 42 are also suitably supported from the inner wall of the container 14 in close proximity to the fork tines, these coils being inductively connected by a transformer 44 to the grid circuit of the tube 38.

A direct current supply source comprising voltage supply lines 46 and 48 supplies operating potentials to the screen grid 40 and the plate 50 of the tube 38. For this purpose, series-connected resistors 52 and 54 are connected as shown across the supply lines 46 and 48, the screen grid 40 being connected to an intermediate point 56 of the resistance 52-54 by a connection 58. The plate 50 is connected to the supply line 48 through a suitable inductance 60.

A resistance 62 is connected in the supply line 48 in series with both the plate and the screen-grid circuits of the tube 38.

90 In operation, as the tines of the fork vibrate, the tube 38 is caused to oscillate at the frequency of the fork by the joint action of the coils 34 and 42 and the associated circuits. A current wave at the fork frequency is thereby generated in the plate circuit of the tube, and is caused to flow through the driving coils 34. A similar current wave at the fork frequency is induced in the pick-up coils 42 by electro-magnetic induction, and this wave, applied to the grid circuit of the tube 38, maintains the same in oscillation at the fork frequency. As is well understood, the ratios of the transformers 36 and 44 and the relation between the polarities of their respective windings are such as to contribute towards this action. As the current wave in the plate circuit of the tube is constant at the fork frequency, an accompanying voltage wave, constant at the fork frequency, appears across the output lines 64.

An important feature of my improved system resides in the supply connection comprising the resistors 52 and 54. In this combination, the ratio between the resistance sections 52 and 54 on opposite sides of the intermediate connection point 56 is such that upon variation in the voltage across the lines 46 and 48 over the normal operating range, the potentials on the screen grid 40 and the plate 50 will vary in such an amount as to cause equal variations, but in opposite senses, of the amplification factor of the tube. In other words, an increase in the screen grid voltage decreases the amplification factor and vice versa, while increase in the plate voltage increases this factor and vice versa, the one variation compensating for the other so that the amplification factor of the tube remains constant independently of the occurring variations of the voltage across lines 46 and 48 over the normal operating range. The resistance 62 operates to make the operation still more stable than might otherwise be the case upon variation in the voltage across lines 46 and 48.

In a system constructed in accordance with my present disclosure using the values of resistance, capacity, inductance and voltage designated in the drawing, the variation in frequency of vibration of the tuning fork was found to be less than five parts in ten million for a variation in the supply voltage plus or minus eight per cent of the normal voltage.

Instead of using a tuning fork for the vibratory member, it is contemplated to employ the principle of magnet-striction, in which case a bar 66 of magnetic material is substituted for the fork 10. Electromagnetic coils 34a and 42a are disposed as shown at opposite ends of the bar 66, and correspond respectively to the coils 34 and 42 in Fig. 1. In this modification, the bar expands and contracts, or vibrates longitudinally at a frequency equal to that of the current wave through the driving coil 34a, and a current wave at the same frequency is induced in the pick-up coil 42a and supplied to the grid circuit of the tube 38. In other respects, the circuit and operating action is the same as in Fig. 1.

An important feature in my system, in cases where a tuning fork is used, resides in the specific construction of the fork. This construction, as more clearly shown in Fig. 2, is characterized by the fact that the width of, the thickness of and the distance between the tines are substantially equal to a given dimension designated by the reference character A. My improved constructions of tuning fork is further characterized by the fact that the base ends of the tines merge with each other in a perfect half circle as shown in Fig. 1, wherein the inner and outer radii, measured from a center 68 disposed on the longitudinal axis of the fork, are equal respectively to one-half A and three-halves A. Another characterization of my improved fork construction resides in the fact that the base ends of the tines merge with the base on circles each having a radius equal to A and taken on centers 70 and 71, each the same distance from the longitudinal axis of the fork, and each located a distance equal to twice A measured from the center 68 in a direction longitudinally of the fork axis.

A tuning fork constructed as described above, wherein A was $\frac{1}{4}$ inch, was found to have a very low damping factor, to be substantially free from affects of vibrations that might develop in the base block on which it is mounted, to be characterized by the fact that the fork vibrations

are not conducted to the base block. All of these characteristics contribute toward a very low damping factor, which, for this particular fork, was found to be from four to fifteen times less than the respective damping factors of the various other forks constructed heretofore. With regard to the latter, it is a fact that the damping factors of some cannot even be measured in their electrical driving circuit because they stop vibrating almost instantaneously when the driving power is shut off.

The great frequency stability of my improved system is attributed in large part to my improved construction of tuning fork.

The constant frequency voltage wave across the output lines 64 may be utilized, after suitable amplification if required, to maintain the operation of a great variety of devices in step with the fork vibrations at the constant frequency. For example, my improved system may be used to synchronize operating action of transmitting and receiving equipment in television and facsimile systems, or to control a synchronous driving motor in a clock or timing system. In this connection, it will be understood that the fork frequency and the values of resistance, capacity, inductance and voltage will be chosen to comply in the most advantageous way with particular operating requirements.

The various values of resistance, capacity, inductance and voltage given in the drawing are not critical in any strict sense of the word, and may be varied over a substantial range. Furthermore, various modifications or changes within the conception of those skilled in the art may be made without departing from the spirit of my invention or the scope of the claims.

I claim as my invention:

1. In a system of the character described, a vibratory member, an amplifier tube having at least four electrodes one of which is a screen grid and another of which is a plate, means for imparting vibratory movement to said member including a coil supplied from the plate circuit of said tube, means for causing said tube to oscillate at substantially the normal frequency of vibration of said member, said last-named means including a pick-up coil supported in proximity to said member and supplying the grid circuit of said tube, voltage supply lines one of which is connected to said plate, resistance means connected across said lines, and a connection between said screen grid and an intermediate point of said resistance means, the respective resistance sections on opposite sides of said intermediate point being such that the amplification factor of said tube remains substantially constant independently of occurring variation in the voltage across said lines over the normal operating range.

2. In a system of the character described, a direct current supply source, voltage output lines, and means supplied from said source and operating to generate a voltage wave at substantially constant frequency and apply the same across said lines; said means including a screen-grid amplifier tube, a vibratory member, means for imparting vibratory movement to said member and including a coil supplied from the plate circuit of said tube and supported in proximity to said member, and means for causing said tube to oscillate at substantially the normal frequency of vibration of same member and including a pick-up coil supported in proximity to said member and supplying the grid circuit of said tube.

3. In a system of the character described, a direct current supply source, voltage output lines, and means supplied from said source and operating to generate a voltage wave at substantially constant frequency and apply the same across said lines; said means including a screen-grid amplifier tube, a tuning fork, means for imparting vibratory movement to said fork and comprising electromagnetic coils supplied from the plate circuit of said tube and supported respectively in proximity to the tines of said fork, means for causing said tube to oscillate at substantially the normal frequency of vibration of said fork, said last-named means including electromagnetic pick-up coils supported respectively in proximity to the tines of said fork and supplying the grid circuit of said tube, the plate of said tube being connected to the high-voltage side of said direct current supply source, resistance means connected across said supply source, and a connection between the screen-grid of said tube and an intermediate point of said resistance means, the ratio of the respective resistance sections on opposite sides of said intermediate point being such that the amplification factor of said tube remains substantially constant independently of occurring variation in the voltage across said lines over the normal operating range.

4. In a system of the character described, a vibratory member, an amplifier tube having at least four electrodes one of which is a screen grid and another of which is a plate, means for imparting vibratory movement to said member including a coil supplied from the plate circuit of said tube, means for causing said tube to oscillate at substantially the normal frequency of vibration of said member, said last-named means including a pick-up coil supported in proximity to said member and supplying the grid circuit of said tube, voltage supply lines one of which is connected to said plate, resistance means connected across said lines, a connection between said screen grid and an intermediate point of said resistance means, the respective resistance sections on opposite sides of said intermediate point being such that the amplification factor of said tube remains substantially constant independently of occurring variation in the voltage across said lines over the normal operating range, and a resistance connected in said one of said voltage supply lines in series with both the plate and screen-grid circuits of said tube.

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