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SYNCHRONOUS DRIVING SYSTEM

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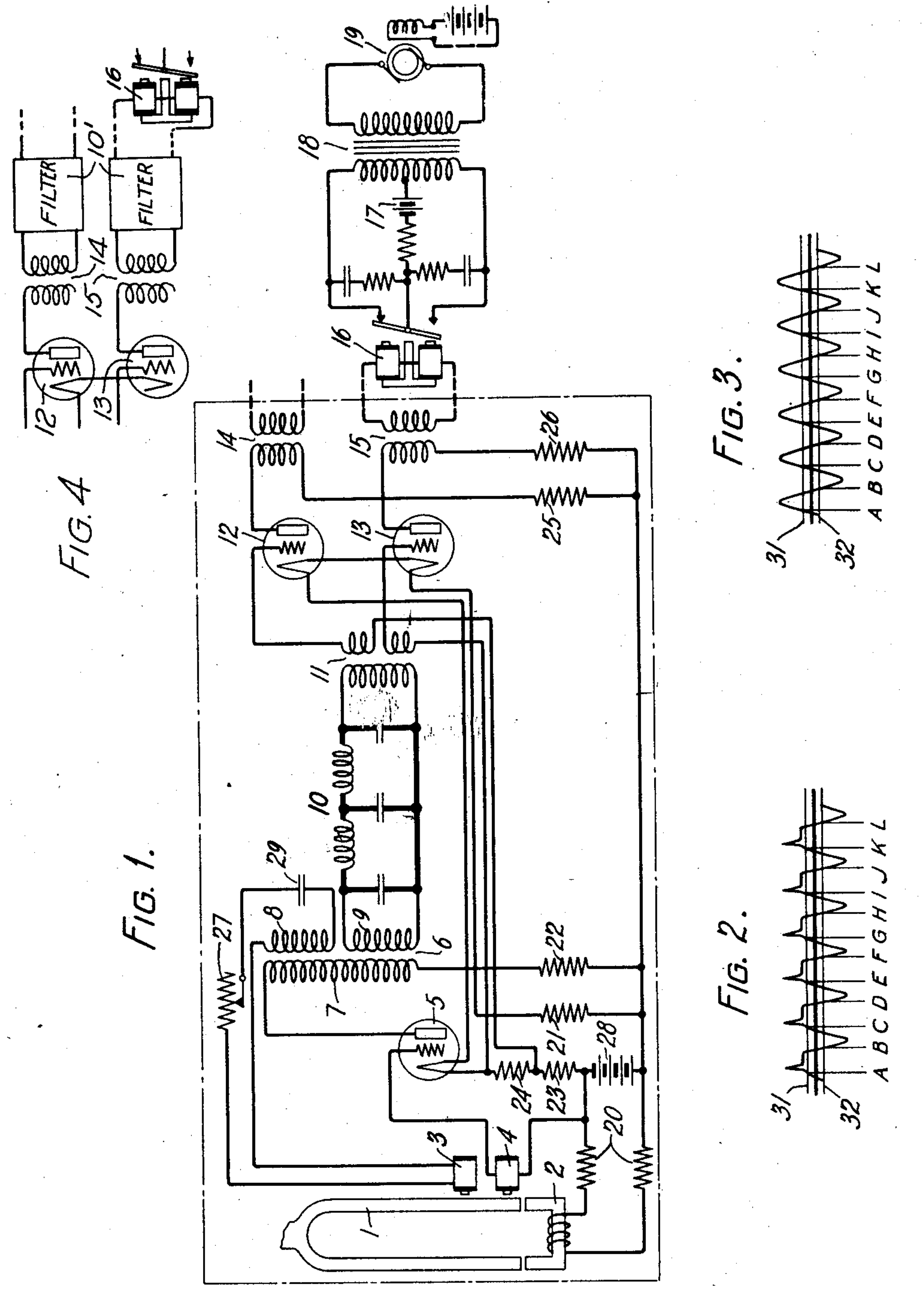

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SYNCHRONOUS DRIVING SYSTEM

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This invention relates to synchronous telegraphy and an object is to increase the reliability and efficiency and reduce the maintenance expense of constant speed synchronous driving systems that utilize a vacuum tube oscillator as the source of constant frequency current.

In high speed synchronous communication systems vacuum tube regenerative tuning forks are sometimes used as sources of constant frequency waves. These waves are applied to a polar relay which vibrates in synchonism therewith and supplies from its contacts positive and negative current alternately to the primary winding of a transformer, the secondary of which is connected to the armature of a synchronous motor. In normal operation vacuum tube oscillators of the type utilized produce a distorted wave due to the presence of even harmonics. The effect of such a distorted wave on the relay is to cause it to remain in one position longer than in the other and to feed an unbalanced current to the transformer. This unbalanced current may be resolved into a desired alternating component and an undesired direct current component which reduces the effective permeability of the transformer core material and causes the transformer to draw an excessive magnetizing current from the relay. This heavy current burns the relay contacts which as a result require frequent attention. Applicant has discovered that by placing a low pass filter in the output circuit of the vacuum tube to remove the even harmonics from the wave supplied and thus prevent biased operation of the relay, the transformer magnetizing current is materially reduced and as a result burning of the relay contacts is to a large extent avoided.

In the drawings, Fig. 1 discloses a fork controlled vacuum tube oscillator containing a filter in accordance with this invention; Figs. 2 and 3 are curves representing the output wave of such an oscillator without and with the filter respectively; and Fig. 4 shows a modification of Fig. 1 wherein filters are employed in each circuit connecting the frequency setting fork system with a device to be controlled.

Referring to Fig. 1, the apparatus within the rectangle represents a complete fork controlled vacuum tube oscillator adapted to supply alternating current of constant frequency to two independent circuits through the output transformers 14 and 15. A relay driving a synchronous motor through a transformer is shown connected to transformer 15 and a similar apparatus may be operated from transformer 14.

The oscillator circuit proper comprises the fork 1, pick-up coil 4 feeding into the vacuum tube 5, and driving coil 3, which is coupled to the output circuit of the vacuum tube 5 through transformer 6. Part of the energy from tube 5 is transmitted through a separate secondary winding 9 of transformer 6, and filter 10 to the amplifying tubes 12 and 13 and thence to the output transformers 14 and 15. The oscillator is adapted to draw energy for both the filament and plate circuits of the vacuum tubes from a single source 28. Resistances 23, 24 and 21 are connected in series with the filaments of the tubes to reduce the voltage to the proper value. The filaments of all the tubes are connected in series and the proper grid-biasing voltage for each tube is obtained by connecting its grid return lead to such a point in the filament circuit as to utilize the voltage drop in the resistances 23, and 24 and the filaments of some of the other tubes.

The resistances 22, 25 and 26 reduce the voltage of power source 28 to the proper values for application to the plates of the different tubes and also serve as protection devices to limit the current flow in case of a short circuit in the wiring.

Electromagnet 2 mounted at the end of fork 1 and energized through resistances 20 from source 28 is to compensate for the effect on the fork frequency of variations in the voltage of the power supply. Thus if the voltage of source 28 should increase, it would increase the space current of tube 5 and deliver more power to the polarized electromagnet 3, which would tend to increase the magnitude of vibration of the fork. The increase in voltage of source 28 would, however, also increase the magnetic attraction of electromagnet 2 on the fork tines. This has the effect of increasing the tension in the fork tines and also of increasing the work done by the tines in cutting through the magnetic field of the electromagnet. Both effects tend to reduce the amplitude of vibration and compensate for the stronger driving impulses from magnet 3.

It is to be understood that an increase in the amplitude of vibration reduces the frequency, and vice versa. For this reason variable resistance 27 is inserted in the drive magnet circuit to make fine adjustments in frequency by varying the amplitude.

In operation, the motion of the steel fork tines changes the flux in the polarized pick-up coil 4, which has a permanent magnet core, and develops an electromotive force corresponding in frequency to the frequency of vibration of the fork. This electromotive force is applied to the grid of oscillator tube 5 and the amplified energy from the output of the tube is fed back through the secondary winding 8 of transformer 6, condenser 29 and variable resistance 27 to drive magnet 3, which also is permanently polarized by suitable means. When the spaces between the pick-up and drive magnets, and the fork tines, are adjusted for stable operation, it is found that the amplitude of vibration is limited by the oscillator tube 5 which overloads and acts to limit the amount of power applied to transformer 6 and the drive magnet 3. The wave supplied by tube 5, when the tube is overloaded, is badly distorted, due to the presence chiefly of even harmonics, and may have a form like that of the curve in Fig. 2. If such a wave were applied to polar relay 16, it would cause the armature of the relay to lie against one contact longer than the other. That this is the case may readily be seen from a study of Fig. 2 in which lines 31 and 32 above and below the zero line respectively, indicate the potential required to operate relay 16. Thus at time A the relay would operate to close on one contact and remain in that position until time B when it would operate to close on the other contact. The average lengths of time during which current flows in each direction through the primary winding of transformer 18 are therefore proportional to the distances AB and BC. The net result of applying current to the transformer for longer periods in one direction than in the other is to produce an unbalanced direct current in one direction which tends to saturate the core material. As a direct result of this saturation, the permeability of the transformer core material is reduced; the inductance of the primary winding is reduced, and an increased magnetizing current is drawn from battery 17 over the contacts of relay 16. The increased current may cause the contacts to corrode much more rapidly than they would if the core were not saturated.

The distortion in the oscillator output wave may be reduced to a certain extent by increasing resistance 27 so that the amplitude of vibration of the fork is insufficient to overload tube 5, but under such conditions the fork is unstable and the output power is greatly reduced. Accordingly, it is found preferable to permit the oscillator tube to work overloaded and to insert a low pass filter 10 of conventional type in the output circuit. This filter is designed to cut off waves of frequencies slightly higher than any frequency at which the oscillator would normally operate, but to permit the fundamental wave to pass with little attenuation. The cut-off point of the filter will still be low enough, however, to greatly attenuate all harmonics so that the wave applied to the transformer 11 may be practically a pure sine wave as shown in Fig. 3. It may readily be seen that the relay 16 when operated by a pure wave such as that shown in Fig. 3 would always be held for the same length of time in each position, and that, accordingly, there would be no average unidirectional magnetizing current in transformer 18 to produce saturation and the resultant contact trouble as outlined above.

Although in Fig. 1 the filter 10 has been inserted between the oscillator tube 5 and the amplifier tubes 12 and 13, two filters 10′ may be used as shown in Fig. 4, one inserted in each of the output circuits of amplifier tubes 12 and 13. Where tubes 12 and 13 are overloaded so as to introduce considerable distortion themselves, it would be advantageous to insert the filter in the amplifier output circuits.

What is claimed is:

1. A synchronous driving means comprising a source of alternating current waves of unsymmetrical form, a relay operated by said waves to supply current pulses of alternately opposite polarity over its contacts, an inductive circuit which comprises a magnetic core of material the permeability of which decreases at high magnetizing forces, for producing in response to said pulses of alternately opposite polarity an alternating current wave of a uniform maximum amplitude, and a selective circuit inserted in said source of unsymmetrical waves to render said waves symmetrical in form.

2. A synchronous driving means comprising a source of alternating current waves of unsymmetrical form, a relay operated by said waves to supply current pulses of alternately opposite polarity over its contacts, an inductive circuit comprising a transformer having a core of material the permeability of which decreases at high magnetizing forces, for producing in response to said pulses of alternately opposite polarity an alternating current wave of a uniform maximum amplitude,

and a filter circuit inserted in said source of unsymmetrical waves to render said waves symmetrical in form.

3. A self-oscillatory circuit for driving a relay at a constant speed and in an unbiased manner comprising a vibratory mechanical element, a pick-up coil for deriving energy from said element, circuit arrangements for feeding back energy from said coil to said element to maintain it in vibration comprising a discharge device amplifier and a drive coil, and a circuit connecting said pick-up coil with said relay through said amplifier including a filter between the amplifier and the coil for suppressing harmonics of the frequency of said element.

4. A source of waves of unsymmetrical form, a relay operated by waves from said source and having contacts associated with a source of direct current, an inductive circuit comprising a magnetic core arranged to control the output current intensity to be supplied with current pulses of alternately opposite polarity from said source of current by said relay, and a selective circuit inserted between said source of waves and said relay whereby said waves are made symmetrical.

5. A source of waves of unsymmetrical form, a polar relay operated by waves from said source and having contacts associated with a source of direct current, an inductive circuit which comprises a magnetic core of material the permeability of which decreases at high magnetizing forces, supplied with current pulses of alternately opposite polarity from said source of direct current by said polar relay, and a low pass filter inserted between said source of waves and said relay whereby said waves are made symmetrical.

6. A source of waves of unsymmetrical form, a polar relay operated by waves from said source and having contacts associated with a source of direct current, a transformer circuit comprising a core of material the permeability of which decreases at high magnetizing forces, supplied with current pulses of alternately opposite polarity from said source of direct current by said polar relay, and a low pass filter inserted between said source of waves and said relay whereby said waves are made more symmetrical.

7. A source of waves of unsymmetrical form comprising a vacuum tube oscillator the fundamental frequency of which may be adjusted between set limits, a low pass filter connected to said source having a cut-off point higher than the upper frequency limit of said source but lower than twice the lower limiting frequency of said source, a vacuum tube amplifier for amplified waves received from said filter, a polar relay operated by the amplified waves having an armature movable between two fixed contacts, a transformer having a primary winding with a mid-tap, the ends of said primary winding being connected to said respective fixed contacts of said relay, a source of direct current connected between the mid-tap and said armature, a secondary winding on said transformer, and a synchronous motor connected thereto.

8. In combination, a source of electric oscillations comprising a thermionic vacuum tube having an input circuit and an output circuit, a vibratory element, magnetic driving means controlled from the output circuit of said tube for vibrating said element, means responsive to the motion of said element to produce an electromotive force connected to the input of said tube, a low pass filter connected to the output circuit of said tube, a polar relay operated by waves received from said tube through said filter and having a contact movable between two fixed contacts in response to said waves, and an inductive circuit supplied with current flowing in one direction therethrough from the movable contact when it is in one position and in the opposite direction when the movable contact is in its opposite position.

9. A source of constant frequency alternating current, a filter connected thereto for removing even harmonics from the wave produced by said source, a plurality of vacuum tube amplifiers, the input circuits of which are connected to the output circuit of said filter, a relay connected to the output circuit of each amplifier, an inductive device having a core subject to magnetic saturation, a source of direct current, contacts on said relay, and connecting means between said contacts, said source and said inductive means whereby said relay in vibration supplies current pulses of alternately opposite polarity from said source of current to said inductive means.

In witness whereof, I hereunto subscribe my name this 30th day of November, A. D. 1927.

AUSTEN M. CURTIS.