Oct. 10, 1933. M. B. LONG 1,930,246

SYNCHRONIZING SYSTEM

Original Filed Dec. 18, 1923 2 Sheets-Sheet 1

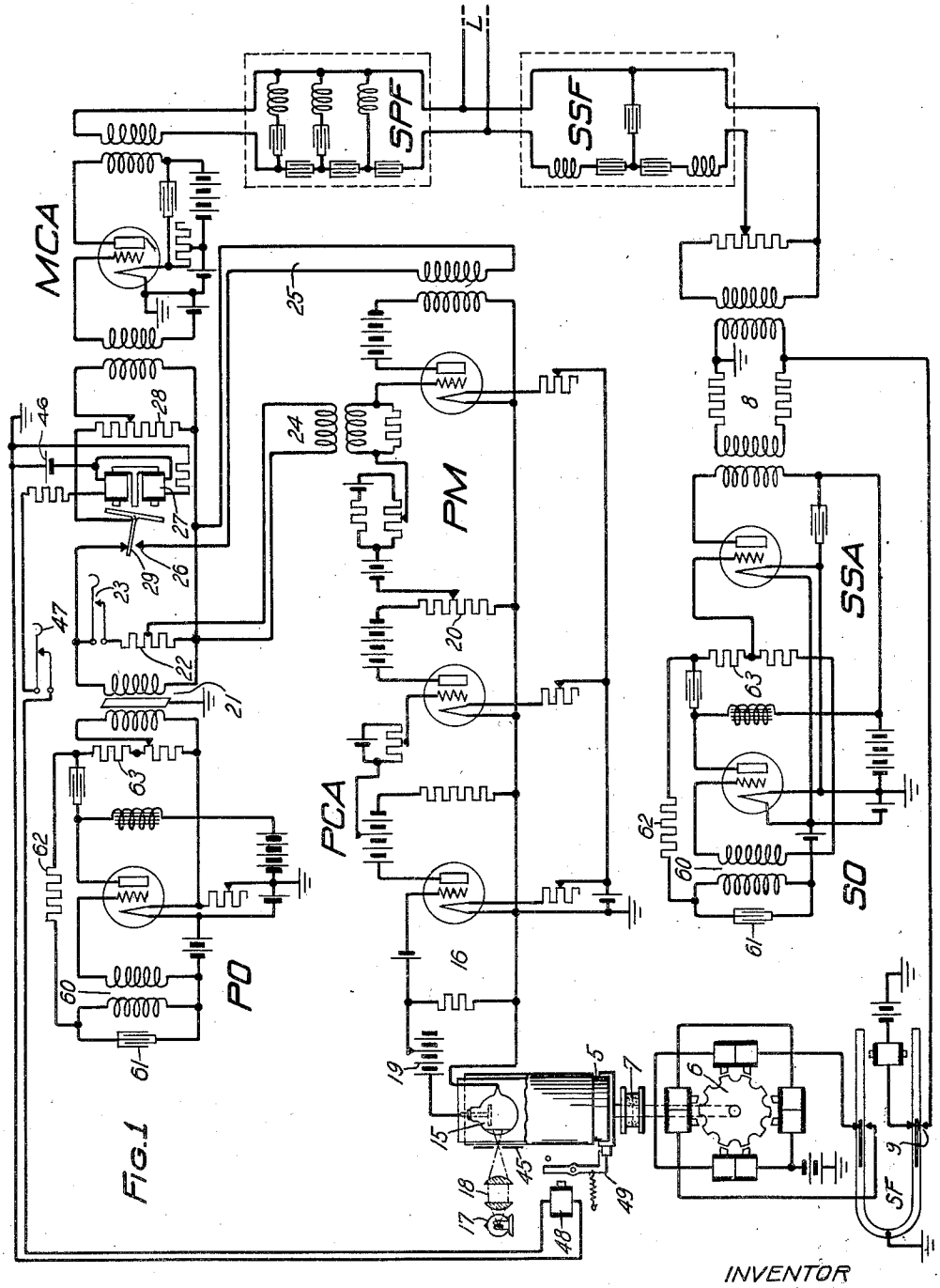


FIG. 1

INVENTOR
M. B. LONG
BY
Chas. Sprague.
ATTORNEY

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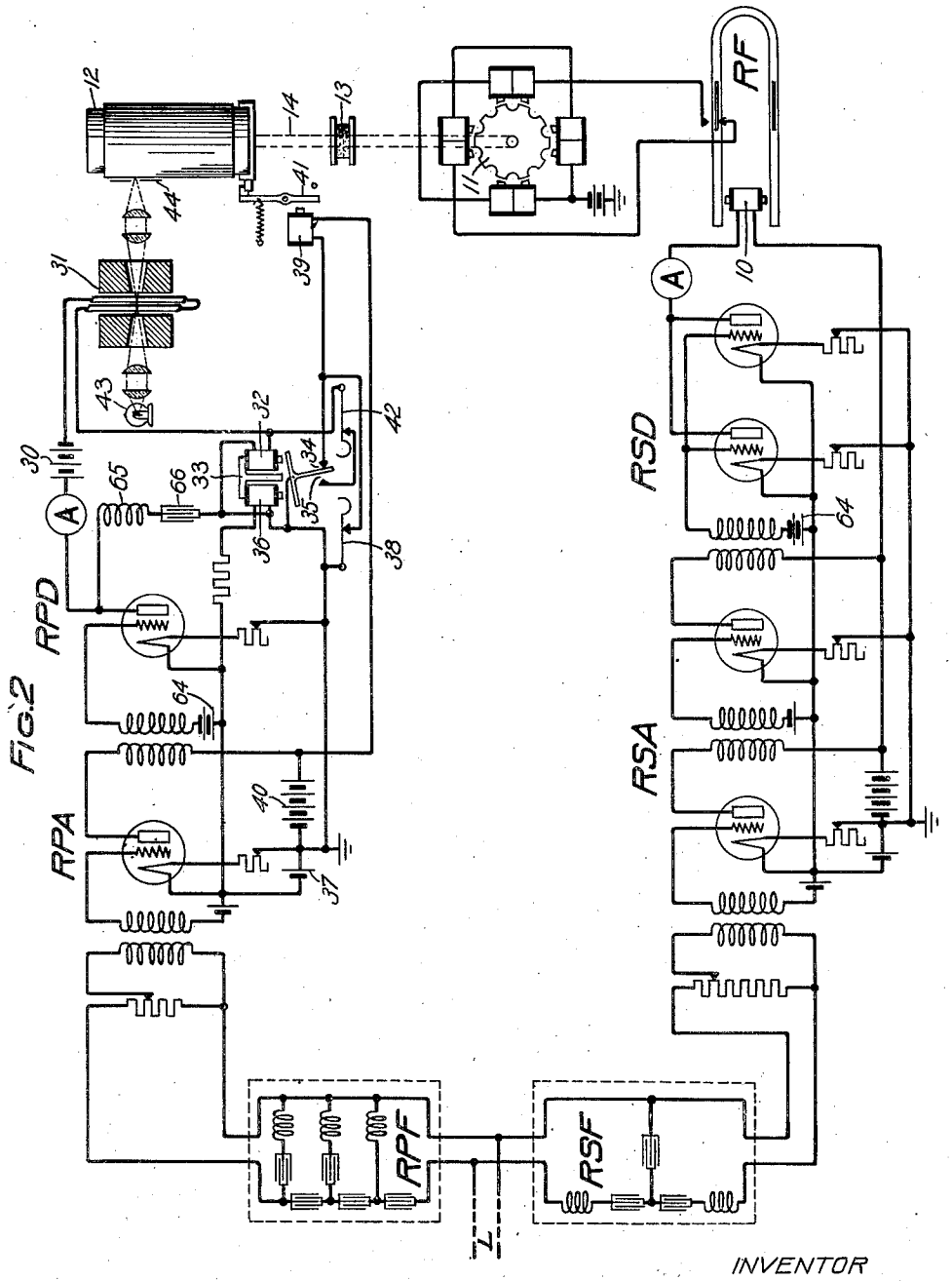


Fig. 2

INVENTOR
M. B. LONG
BY
C. L. Sprague.
ATTORNEY

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1,930,246

SYNCHRONIZING SYSTEM

Maurice B. Long, Glen Ridge, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Original application December 18, 1923, Serial No. 681,347. Divided and this application February 18, 1929, Serial No. 340,903, and in Germany August 23, 1924

10 Claims. (Cl. 172—293)

This invention relates to synchronizing and more particularly to the synchronization of the movable elements employed at different stations respectively of a carrier picture transmission system.

This invention is a division of a copending application, Serial No. 681,347, filed December 18, 1923, which matured into Patent 1,706,032, March 19, 1929.

In accordance with this invention synchronization of movable elements is accomplished in a novel, simple and effective manner.

In a preferred embodiment of the invention, the elements to be moved in synchronism are under the control of a carrier current of a frequency different from another carrier current transmitted over the same line between the primary mechanisms at the two stations, such as signaling apparatus. The elements to be synchronously operated are driven by two separate sources of current and the synchronizing carrier current, which is suitable for transmission over the line or other transmission medium connecting the stations at which these elements are located, is modified in accordance with the variations in the current from one of the first mentioned two sources of current to cause similar variations in the current from the other of these two sources.

In a specific embodiment of the invention herein shown and described for the purpose of illustration, two carrier waves of different frequencies are transmitted over an ordinary telephone circuit. One of these waves is modulated by varying current from a photo-electric cell for transmitting the picture characteristics, while the other is used for producing synchronized movement of the scanning and reproducing elements. The first mentioned waves are also used to effect the release of the scanning and reproducing elements simultaneously to commence the transmission process. These elements are driven by phonic wheels, each of which is controlled by a tuning fork. At the sending station, the fork causes the transmission of impulses of synchronizing waves, while at the reproducing station the fork is actually driven by detected current so that it vibrates in synchronism with the fork at the sending station.

Fig. 1 shows schematically the apparatus at the sending station and its connection to the transmission circuit.

Fig. 2 shows schematically the apparatus located at the reproducing station and likewise its connection to the transmission circuit.

The complete system is shown by placing Figs. 1 and 2 side by side, with Fig. 2 on the right hand side.

Referring now to the drawings, a sending drum 5 is driven by a phonic wheel 6 by means of a shaft shown diagrammatically by dotted lines. The coupling between the drum 5 and the phonic wheel 6 is through a friction clutch 7. The phonic wheel 6 is itself driven by tuning fork SF in well known manner. An electron discharge oscillator SO supplies carrier waves which are amplified by electron discharge amplifier SSA and transmitted through circuit 8 and low pass filter SSF to the line L for transmission to the reproducing station of Fig. 2. An extra contact 9 on tuning fork SF short circuits circuit 8 periodically at the frequency of vibration of the tuning fork SF. At the reproducing station of Fig. 2, these synchronizing waves are transmitted through low pass filter RSF, amplified in the two-stage electron discharge amplifier RSA, and detected by the electron discharge detector RSD to drive the reproducing tuning fork RF by means of impulses of current in driving magnet 10. The detector RSD consists of two electron discharge devices connected in parallel. An ammeter A is inserted in the output circuit of detector RSD for maintenance purposes. The receiving fork RF drives phonic wheel 11 in well known manner, which in turn drives reproducing drum 12 through friction clutch 13 and shaft 14. The shaft 14 is shown diagrammatically by dotted lines.

A photoelectric cell 15 located inside of sending drum 5 is connected to the input circuit 16 of a two-stage electron discharge amplifier PCA. Light from a lamp 17 is focused by means of lens 18 upon the surface of sending drum 5, which is transparent. The light ray also passes through an aperture in an opaque shield 45. On the surface of the drum 5, a transparency of the picture to be transmitted is secured and the light passing through this transparency of the picture causes a varying current from the battery 19 to flow through the photoelectric cell 15 and to be impressed upon the input circuit 16 of amplifier PCA. The output circuit of picture amplifier PCA is connected to an electron discharge modulator PM by means of potentiometer 20. Another electron discharge oscillator PO supplies carrier waves which are amplified in an amplifier MCA and transmitted through high pass filter SPF to the line L.

Waves from the oscillator PO may be impressed upon the amplifier MCA by either one of two paths. One path extends from the output circuit of the oscillator circuit PO through shielded transformer 21, potentiometer 22, when switch 23 is closed, circuit 24, modulator PM, output circuit 25 which includes the contact 26 of relay 27, and potentiometer 28 to the input circuit of amplifier MCA. The other path extends from transformer 21, contact 29 of relay 27 and potentiometer 28 to amplifier MCA.

The energizing circuit for the upper winding of relay 27 includes battery 46, switch 47 and relay 48. If this energizing circuit is opened at

switch 47, the lower winding of relay 27 is effective to close contact 26. When the switch 47 is closed, the upper winding of relay 27 is effective to close contact 29. Under this same condition, armature 49 of relay 48 is attracted and locks sending drum 5 against rotation.

At the reproducing station, picture carrier waves from the oscillator PO are transmitted by high pass filter RPF, amplified by amplifier RPA, and impressed upon reproducing demodulator RPD. Connected in the output circuit of demodulator RPD is a battery 30, the movable wires of light valve 31, and winding 32 of relay 33.

The opening between the movable wires of light valve 31 controls the amount of light from lamp 43 which affects a sensitive film secured to reproducing drum 12. The light from lamp 43 is focused first upon the movable wires of light valve 31 and then upon the surface of the drum by lenses as shown. The light is further concentrated by passing through an aperture in the opaque shield 44.

The armature of relay 33 is held in the position shown with contact 34 closed by the current flowing in winding 32 when carrier waves are impressed upon the input circuit of demodulator RPD. When such waves are not being received, the armature of relay 33 is moved into a position closing contact 35 by current in winding 36 from battery 37.

The closure of switch 38 completes a circuit for relay 39 through battery 40. Current in relay 39 attracts its armature 41 to lock drum 12 and prevent its rotation. Another circuit for relay 39 through battery 40 is closed when contact 34 of relay 33 is closed, even though the switch 38 is opened. It is to be noted that the closure of switch 38 forms a short circuit about the contact 34. The circuit completed by the closure of switch 42 and contact 35 forms a short circuit about the winding 32 of relay 33.

The oscillators SO and PO are of well known type and are identical except for the different constants of the circuit required to produce carrier waves of different frequencies. Each one has a three-electrode electron discharge device having an input circuit coupled to the output circuit by transformer 60. The frequency is determined by the tuned circuit consisting of the left hand winding of transformer 60 and condenser 61. Connected in series with the feed back portion of the output circuit is a high resistance 62. The output waves for transmission purposes are transmitted through potentiometer 63. In the case of oscillator PO, it is preferable to have the potentiometer variable in such a manner that the working circuit cannot be connected across the entire resistance of the potentiometer.

The amplifiers SSA, PCA, MCA, RSA, and RPA each include three-electrode electron discharge devices and are so designed as to properly transmit and amplify the waves impressed thereon.

Similarly, the detector RSD and demodulator RPD employ three-electrode electron discharge devices. A relatively large grid polarizing battery 64 is used in each case to accomplish detection and demodulation. In the demodulator RPD, a tuned circuit, consisting of an inductance coil 65 and a condenser 66 is provided to prevent current of carrier frequency from being impressed upon the light valve 31. Circuit 65, 66 is tuned to the frequency of carrier waves produced by oscillator PO.

The filters are designed according to the principles set forth in Campbell Patent No. 1,227,113, May 22, 1917.

Method of operation

The method of operation will now be described.

The drums 5 and 12 are set at the starting position in any suitable manner. The transparency of the picture is placed on drum 5 and a sensitive recording blank is placed on drum 12. Switch 47 is closed, which locks drum 5 through the energization of relay 48 and closes contact 29 of relay 27. Switch 38 is closed, which locks drum 12 by the energization of relay 39. Switch 42 is kept open.

The circuits of the electron discharge devices are then energized. Synchronizing carrier waves from the oscillator SO are transmitted through amplifier SSA, circuit 8, low pass filter SSF, line L, low pass filter RSF, amplifier RSA, to detector RSD. Picture carrier waves are supplied by oscillator PO and transmitted through transformer 21, contact 29 of relay 27, amplifier MCA, high pass filter SPF, line L, high pass filter RPF, amplifier RPA, to demodulator RPD. Demodulated current flows in light valve 31 and winding 32 of relay 33 to close contact 34.

Tuning fork SF is then set in vibration and phonic wheel 6 is started. This tends to rotate sending drum 5 through friction clutch 7, but drum 5 is locked by the armature 49 of relay 48. At contact 9 of fork SF, the train of carrier waves from oscillator SO is periodically interrupted at circuit 8, so that trains of waves are transmitted to the line L. These waves in detector RSD cause impulses of current in driving magnet 10 to drive tuning fork RF in synchronism with tuning fork SF. Phonic wheel 11 is started and tends to drive drum 12 through friction clutch 13, but is prevented from doing so by the armature 41 of relay 39.

Switch 23 is now closed, switch 42 is closed and switch 38 is opened. Picture carrier waves from oscillator PO are impressed upon the input circuit of modulator PM, the output circuit of which is still open, however, at contact 26. Drum 12 is still held in locked position by the energization of relay 39 through a circuit including contact 34 of relay 33.

Everything is in readiness now to start the transmission of the picture. Phonic wheels 6 and 11 are rotating synchronously. Drums 5 and 12 are locked against rotation. Light valve 31 is energized by demodulated picture carrier waves.

To start the actual transmission, switch 47 is opened and kept open during the transmission process. The opening of switch 47 deenergizes relay 48, which unlocks sending drum 5. The upper winding of relay 27 is deenergized so that contact 26 is closed and the output circuit 25 of picture modulator PM is connected to the input circuit of amplifier MCA. During the time that the armature of relay 27 is moving from contact 29 to contact 26, the picture carrier waves are interrupted. Such interruption allows the armature of relay 33 to move from contact 34 to contact 35 because of the deenergization of winding 32. This unlocks reproducing drum 12 by the deenergization of relay 39. The closure of contact 35 places a short circuit around winding 32 so that the subsequent receipt of carrier current by demodulator RPD upon the closure of contact 26 cannot again energize winding 32 to lock drum 12.

The varying tone values of the transparency of the picture cause varying currents through the photoelectric cell 15. Carrier waves from oscil-

lator PO are modulated by these varying currents after amplification in amplifier PCA, and transmitted to the demodulator RPD. Corresponding varying currents in the output circuit of demodulator RPD cause movement of the wires of light valve 31 so that the light impressed upon the reproducing blank is varied in accordance with the light transmitted through the transparency of the picture at the sending drum 5.

At the conclusion of the process, switch 47 is closed to lock transmitting drum 5. The attendant at the reproducing station observing that the movement of the light valve has ceased, can either open switch 42 or close switch 38 or both to lock the reproducing drum 12.

The drums can then be returned to their starting position in preparation for the transmission of another picture.

Various modifications of the specific embodiment of the invention, which has been described, can be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. Means to synchronize two rotating devices comprising two tuning forks, one each for causing the rotation of said devices, a source of waves the frequency of which is independent of the frequency of vibration of said forks, a circuit extending between said rotating devices over which waves from said source are transmitted, means to vary said waves in accordance with the vibration of one of said forks, and means to cause the vibration of the second fork in synchronism with the first fork operated by current derived from said varying transmitted waves.

2. In a synchronizing system, two phonic wheels, two tuning forks for driving said wheels at a speed proportional to the rates of vibration of said forks, a source of carrier waves, a circuit over which said carrier waves are transmitted, means to interrupt said carrier waves at a rate proportional to the vibration of one of said forks, and means under the control of said interrupted waves for driving said second fork in synchronism with said first fork.

3. In a synchronizing system, two phonic wheels, two tuning forks for driving said wheels at a speed proportional to the rates of vibration of said forks, an electron discharge oscillator supplying carrier waves, a circuit suitable for transmitting said waves, means to short-circuit said circuit periodically at a rate proportional to the vibration of one of said forks, an electron discharge detector connected to said circuit for providing impulses of current in accordance with said interrupted train of carrier waves, and means to drive the other of said two forks by said impulses of current, whereby synchronism of vibration is maintained between said two forks.

4. In a synchronizing system, two mechanically independent elements to be moved in synchronism, means for starting the movement of said elements simultaneously, means for operating each of said elements, and means comprising an alternating current varied at selected intervals according to the movement of one of said elements when operated to hold the other element in synchronism.

5. In a synchronizing system two mechanically independent elements to be moved in synchronism, means for restraining the movement of said elements to hold them in a predetermined position, means for releasing said restraining means to initiate the movement of said elements simultaneously, means for operating each of said elements, and means comprising an alternating current varied at selected intervals according to the movement of one of said elements when operated to hold the other element in synchronism.

6. In a synchronizing system two movable elements located at different stations respectively, separate sources of current for driving said elements, a transmission channel connecting said stations, two sources of carrier current at one of said stations, means for starting the movement of the element at one of said stations and for simultaneously modulating the carrier current from one of said sources to control the starting of the movable element at the other station, and means for modulating the carrier current from the other of said sources for maintaining said movable elements in synchronism.

7. A transmission system comprising transmitting apparatus at one station, receiving apparatus at another station under control of said transmitting apparatus, means for generating and transmitting alternating carrier current for effecting said control, moving elements at said stations forming parts of said transmitting and receiving apparatus respectively, and means for generating and transmitting for short intervals at a time over the same medium as said first carrier current a separate carrier current of different frequency for maintaining said moving elements in synchronism.

8. A control circuit interconnecting two stations, a motor driving mechanism at each station, vibrating driving forks for each of said motors, means associated with said control circuit at each of said stations and controlled by the frequency of vibration of the fork at one station for controlling the frequency of vibration of the fork at the other station, starting mechanism for each of said motor driving mechanisms, and means associated with said control circuit at one of said stations for simultaneously operating said starting mechanisms.

9. A control circuit interconnecting two stations, a motor driving mechanism at each station, vibrating driving forks for each of said motors, means associated with said control circuit at each of said stations and controlled by the frequency of vibration of the fork at one station for controlling the frequency of vibration of the fork at the other station, clutch mechanisms for each of said motor driving mechanisms, relay means associated with said control circuit at one of said stations tuned to respond to oscillations of a desired frequency, an operating circuit for the clutch mechanism at said station controlled by said relay means, and means at the other of said stations for applying to said control circuit oscillations of a desired frequency to operate said relay means and for operating the clutch mechanism at said last mentioned station.

10. The method of synchronizing two movable devices at widely separated places which comprises operating the two devices, generating an alternating current at one of said places independent of the movement of the devices, varying said alternating current according to the frequency of operation of the device at said first place, transmitting the varying alternating current to the other of said places and utilizing the received current to control the frequency of operation of the second device.

MAURICE B. LONG.