

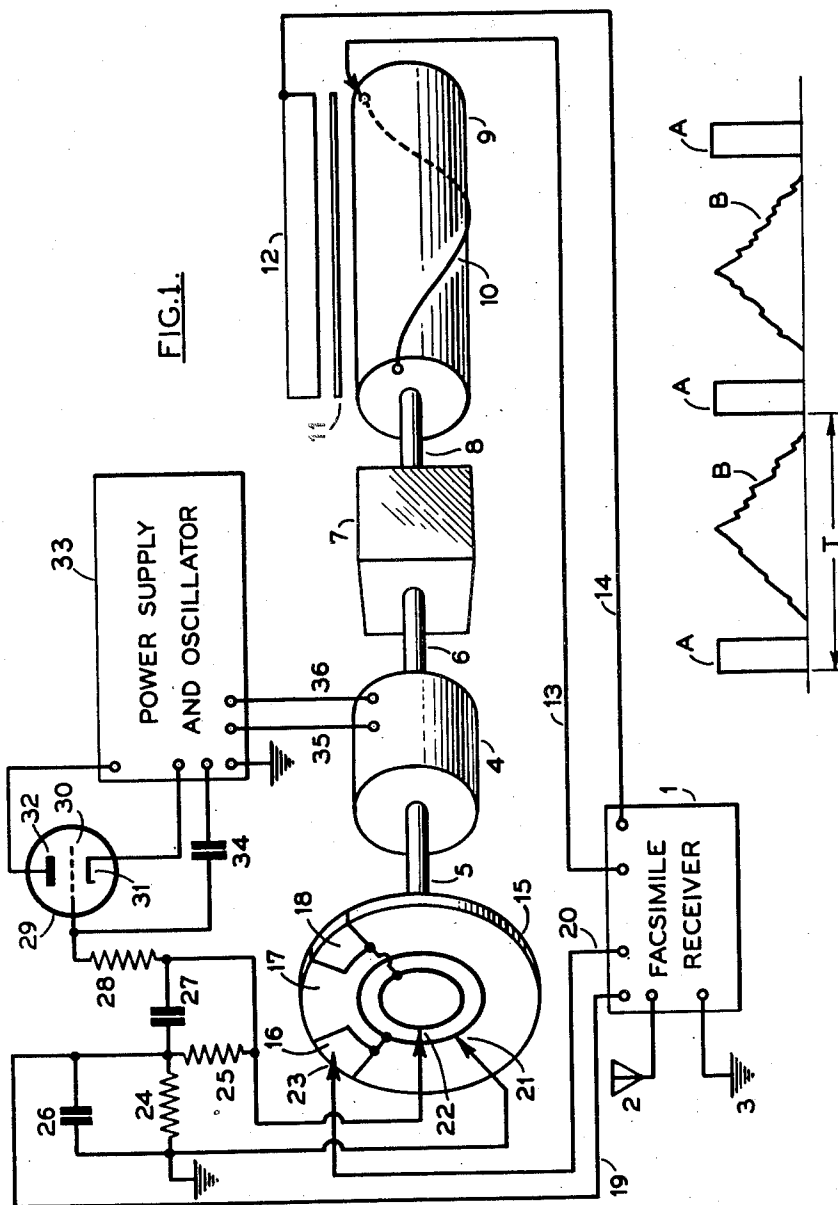
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FACSIMILE SYNCHRONIZING DEVICE

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FACSIMILE SYNCHRONIZING DEVICE

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The present invention concerns electrical control systems and, in particular, methods and devices for synchronizing facsimile recorders and the like.

In the art of facsimile, copy which is to be reproduced at a distant point is scanned point by point and line by line and reproduced in a similar manner. In order that the reproduced copy may be an exact facsimile of the original it is of utmost importance that the recorder move in exact synchronism with the transmitting scanner. This and other similar applications require methods and devices for operating remote devices in synchronism with a master control mechanism. It is common practice in facsimile technique to leave a space between lines in which is inserted an impulse which is transmitted with the signals representing the copy and to utilize this impulse at the receiving end to maintain the recorder in synchronism with the scanner at the transmitter. The present invention concerns methods of and means for utilizing this impulse to control the operation of the recorder in circuits which are simple and yet highly effective.

According to the present invention an electron tube oscillator generates an alternating current which is utilized to run the motor which turns the recorder drum. Oscillators which are suitable for this application are those whose frequency can be controlled by a control voltage. An oscillator which is particularly suited to this application has been shown and described in co-pending application entitled "Variable frequency oscillator," filed August 10, 1946, and bearing Serial Number 689,792. This oscillator has the characteristic that an increasingly negative voltage will cause its frequency to increase while an increasingly positive voltage will cause its frequency to decrease. Thus, if a motor is controlled or driven from this oscillator its speed will increase with an increasingly negative control voltage and will slow down when an increasingly positive control voltage is applied. According to the present invention the point in time at which the incoming synchronizing impulse occurs is compared to the relative phase or period of the recorder motor and if the motor is lagging, this impulse is utilized to generate a negative control voltage which tends to increase the motor speed and if the motor is leading or is fast, there is generated a positive control voltage which tends to slow the motor down. According to the present invention the circuits and apparatus provided to carry out this operation are simple and effective.

One object of the present invention is to pro-

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vide a new and improved method of and means for synchronizing the operation of an electrical motor by means of a regularly spaced synchronizing impulse.

Another object of the present invention is to provide a new and simplified circuit and method for accurately synchronizing a facsimile recorder motor by means of a regularly spaced synchronizing impulse.

Still another object of the present invention is to provide more accurate and effective synchronization of a facsimile recorder with a transmitter which sends out regularly spaced synchronizing impulses.

These and other objects of the present invention will be apparent from the detailed description of the invention given in connection with the various figures of the drawing.

In the drawing:

Fig. 1 shows one form of the present invention. Fig. 2 illustrates a facsimile signal and synchronizing impulse suitable for operation of the present invention.

Fig. 1 shows a facsimile receiver 1, of conventional design, many suitable circuits for which are well known in the art. Facsimile receiver 1 may receive its signals in any convenient manner as, for instance, from antenna 2, and ground 3. The facsimile recording mechanism may consist of any suitable periodically operating mechanism such as that shown comprising motor 4 having shaft 6 which drives gears in gear box 7 to reduce the speed sufficiently to turn recording drum 9 at a suitable speed through shaft 8. Recording drum 9 carries helical recording electrode 10 which cooperates with linear electrode 12 for marking a record sheet 11. Marking signals from facsimile receiver 1 are applied across helical electrode 10 and linear electrode 12 by means of wires 13 and 14 respectively. Motor 4 is synchronized or driven at a synchronous speed from a power supply and oscillator 33 by means of power supplied over leads 35 and 36. The driving oscillator contained in unit 33 is designed to operate at a nominal frequency which is close to the desired synchronous frequency required by the recorder and is capable of being shifted in frequency under influence of control tube 29, as set forth in detail in the above mentioned patent application. Although it is evident that control tube 29 may be connected to oscillator 33 by utilizing any suitable well known phase inverting circuit in such a way that an increasingly negative bias will decrease the frequency of the oscillator, for the purpose of the present description it is assumed

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that tube 29 is connected in such a way that an increasingly negative bias will increase the frequency of oscillator 33 and hence increase the speed of motor 4. Control tube 29 may be any suitable tube such as the triode shown having cathode 31 heated by conventional means not shown, control grid 30, and plate 32. For details of a connection of control tube 29 with oscillator 33 reference is again made to the above cited application.

Fig. 2 shows two lines of a typical facsimile signal suitable to the operation of the present invention. Each line repeated periodically includes a synchronizing impulse A and a signal B representing the facsimile copy to be reproduced. Each of the synchronizing impulses A is separated by a substantially constant time interval T. The present invention utilizes these impulses A to accurately, simply and effectively control the operation of the recording mechanism. In a system as shown in Fig. 1 this means controlling the speed of motor 4 through the medium of frequency controlled oscillator 33.

Facsimile receiver 1 of Fig. 1 in addition to supplying recording signals to the recording electrodes feeds synchronizing pulses over wires 19 and 20 in such a manner that wire 19 is pulsed in a positive polarity with respect to wire 20. According to the present invention if motor 4 is slow or lags behind the required synchronous speed these synchronizing impulses are utilized to generate a negative control voltage which is applied to grid 30 of tube 29 which has the effect of increasing the frequency of oscillator 33 and in turn increasing the speed of motor 4 to bring the system into exact synchronism. One manner in which this may be accomplished is shown in Fig. 1 where commutator 15 is mounted on shaft 5 of motor 4. Commutator 15 includes active segments 16 and 18 and inactive segment 17. Control grid 30 of tube 29 is connected through grid resistor 28 to two pulse storage circuits, one consisting of condenser 27 shunted by resistor 25, and the other condenser 26 shunted by resistor 24 both of which are connected in series between grid 30 and ground. In this way voltages established across either condenser 26 or condenser 27 are effective in biasing grid 30 and hence in affecting the oscillator frequency. With motor 4 rotating in a direction which causes commutator 15 to rotate in a counter clockwise direction as viewed in the drawing, commutator segment 18 arrives at a certain point after a given instant if motor 4 operates below a given speed and segment 16 arrives at the same point in advance of the given instant if motor 4 operates above a given speed. Commutator segment 18 is connected through slip ring contact 22 to the grid end of condenser 27 and commutator segment 16 is connected through slip ring contact 21 to the ground end of condenser 26. Positive lead 19 is connected to the junction point between condenser 26 and 27 and negative lead 20 is connected to stationary commutator contact point 23. Commutator segment 17 is blank and when the system operates accurately in synchronism with the transmitter synchronizing impulses A occur when contact 23 is in contact with blank segment 17 and no frequency correction takes place. Thus, if motor 4 tends to operate at a slightly lower speed than required to keep in step with the synchronizing impulses, commutator segment 16 will make contact with contact 23 during the time at which a synchronizing impulse A arrives

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in the system. When this happens, the synchronizing impulse will be impressed across condenser 26 in a polarity which will make grid 30 increasingly negative with respect to ground. As has been stated above, this will cause control tube 29 to increase the frequency of oscillation of oscillator 33 and hence speed up the operation of motor 4. On the other hand, if motor 4 is operating above synchronous speed, contact 23 will contact commutator segment 18 at the time at which synchronizing impulse A arrives and condenser 27 will receive a charging impulse in a polarity which tends to increase the bias on grid 30 in a positive direction with respect to ground and hence decrease the frequency of oscillator 33 and slow down the operation of motor 4. The amount of frequency correction will depend upon the amount by which the speed of motor 4 differs from the synchronous speed as determined by the timing of the synchronizing impulses due to the fact that the amount of corrective charge which is placed on either condenser 26 or 27 depends upon the degree of overlap of the synchronizing signal and the contact time of contact 23 with either segment 16 or 18. When exact synchronism is reached there will be, in general, a small more or less constant overlap in one direction or the other applying a steady correction and control to hold the oscillator frequency steady and in fixed phase relation with the synchronizing impulses. The frequency or speed correcting effects of the bias developed across either condenser 26 or 27 may be spread over as many or as few cycles as may be desired by varying the time constants of storage circuits 24—26 and 25—27. Also the time constants of circuits 24—26 and 25—27 may be made different so that the speeding up or slowing of the motor 4 may be relatively different. In general, it will be desirable to make the time constants of circuits 24—26 and 25—27 different so that the recorder is started during the transmission of a message or a series of messages the bias applied to the grid 30 of tube 29 will vary due to the difference in charge accumulated due to this difference of time constant and the motor speed will change until segment contact is made during the synchronizing pulse interval and synchronism is established. The time constants of circuits 24—26 and 25—27 may be made different, also, so that if the recorder is started and runs in synchronism but out of phase the facsimile signals will charge one condenser more than the other causing the frequency of oscillator 33 and hence the speed of motor 4 to shift until the synchronizing signals take hold as described above.

Among the alternate systems that might be used is a method wherein the motor will operate, in absence of control voltage, at either a lower or higher frequency than the required frequency, but not at both, and will be corrected to the required operating frequency by a pulse of one polarity designed to control the normal motor oscillator frequency up to the required frequency or down to the required frequency, the polarity of the pulses depending upon whether the circuit is designed to have the motor operate above the required frequency or below the required frequency.

While only these embodiments of the present invention have been shown and described many variations will be apparent to those skilled in the

art within the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. In a system for operating periodically operable devices in synchronism with a series of equally spaced impulses, the combination of, means for comparing the period of operation of said devices with the period of said impulses, means for generating a control voltage of one polarity in response to the period differences in one direction and of the opposite polarity in response to the period differences in the other direction, and means for correcting the period of operation of said device in response to said control voltages.

2. In a synchronizing device, the combination of, a source of synchronizing signals comprising regularly spaced pulses, a motor the speed of which is to be controlled by said pulses, a frequency controllable oscillator for at least partially determining the speed of said motor, means for generating a control voltage for said oscillator, means for increasing said control voltage to correct slow speed of said motor and for decreasing said control voltage to correct high speed of said motor under control of said pulses to maintain the speed of said motor under control of said pulses.

3. In a synchronizing device, the combination of, a source of synchronizing impulses, a motor the speed of which is to be controlled, a frequency controllable oscillator for at least partially determining the speed of said motor, means for generating a voltage for controlling the frequency of said oscillator, means for increasing said voltage in one direction with respect to a reference point in response to the slow operation of said motor and for increasing said voltage in the opposite direction in response to the fast operation of said motor for operating said motor in synchronism with said impulses.

4. In a synchronizing system, the combination of, a source of synchronizing impulses, a synchronous motor the speed of which is to be controlled, a frequency controllable oscillator for driving said motor, means for generating a voltage to control the frequency of said oscillator including two switches operated by said motor and applying said impulses in opposed polarity across two series connected capacitors to generate control voltages to correct the frequency of said oscillator in accordance with said impulses.

5. In a synchronizing system, the combination of, a source of synchronizing impulses, a synchronous motor the speed of which is to be controlled, a frequency controllable oscillator for driving said motor, means for generating a voltage to control the frequency of said oscillator including two switches operated by said motor and applying said impulses in opposed polarity across two series connected capacitors to generate control voltages to correct the frequency of said oscillator in accordance with said impulses wherein one of said switch applies said impulses to one of said capacitors to generate a control voltage in one direction and the other of said

switches applies said impulses to the other of said capacitors to generate a control voltage in the opposite direction with respect to a reference point.

6. In a synchronizing device, the combination of, a source of synchronizing impulses, a motor the speed of which is to be controlled, a frequency controllable oscillator for at least partially determining the speed of said motor, means for generating a control voltage of one polarity to at least partially determine the frequency of oscillation of said oscillator in response to operation of said motor below a predetermined speed, means for generating a second control voltage of opposite polarity to the first said control voltage for said oscillator in response to operation of said motor above said predetermined speed, and means for applying said control voltages to said oscillator to at least partially return said motor speed to said predetermined speed.

7. In a synchronizing device, the combination of, a source of synchronizing impulses, a motor the speed of which is to be controlled, a frequency controllable oscillator for at least partially determining the speed of said motor, means for charging a first capacitor in one polarity with respect to a reference point from said source of impulses in response to operation of said motor below a predetermined speed, means for charging the second capacitor in reversed polarity with respect to said first capacitor from said source of impulses in response to operation of said motor above said predetermined speed, and means for combining the resulting voltages across said capacitors and applying the resultant voltage to at least partially control the frequency of said oscillator in a direction to at least partially return the speed of said motor to said predetermined speed.

8. In a synchronizing device, the combination of, a source of synchronizing signals, a motor the speed of which is to be controlled in accordance with said signals, a frequency controllable source of alternating current for synchronously operating said motor, means for generating one control voltage in one polarity to increase the frequency of said source in response to the operation of said motor below a predetermined speed, means for generating a second control voltage in a polarity opposite to the first said polarity to decrease the frequency of said source in response to the operation of said motor above said predetermined speed, and means for applying said control voltages to control the frequency of said alternating current.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,350,008	Artzt	May 30, 1944
2,399,421	Artzt	Apr. 30, 1946