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W. G. H. FINCH ET AL

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CONTINUOUS FACSIMILE SYNCHRONIZING SYSTEM

Filed Feb. 11, 1941

2 Sheets-Sheet 1

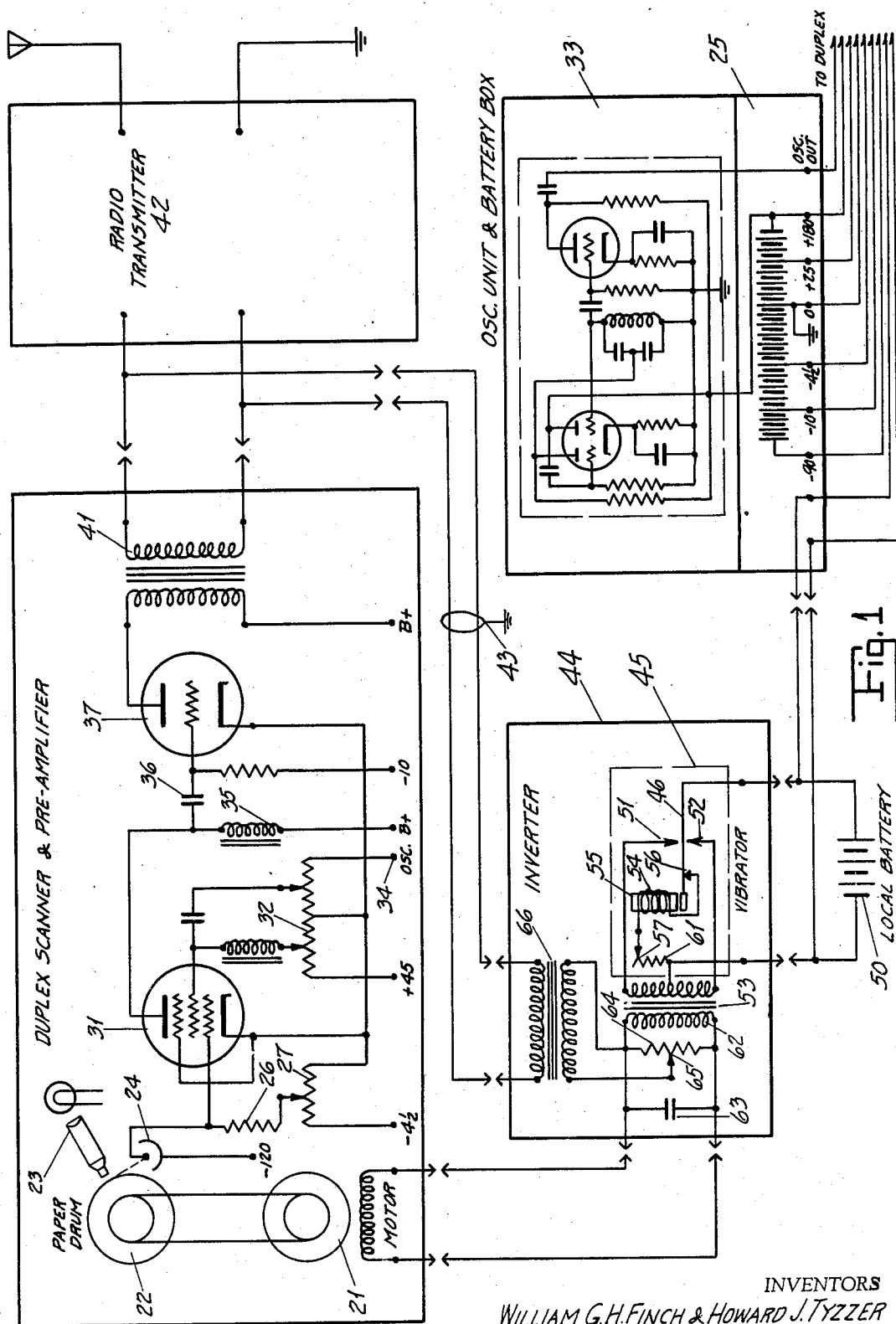


Fig. 1

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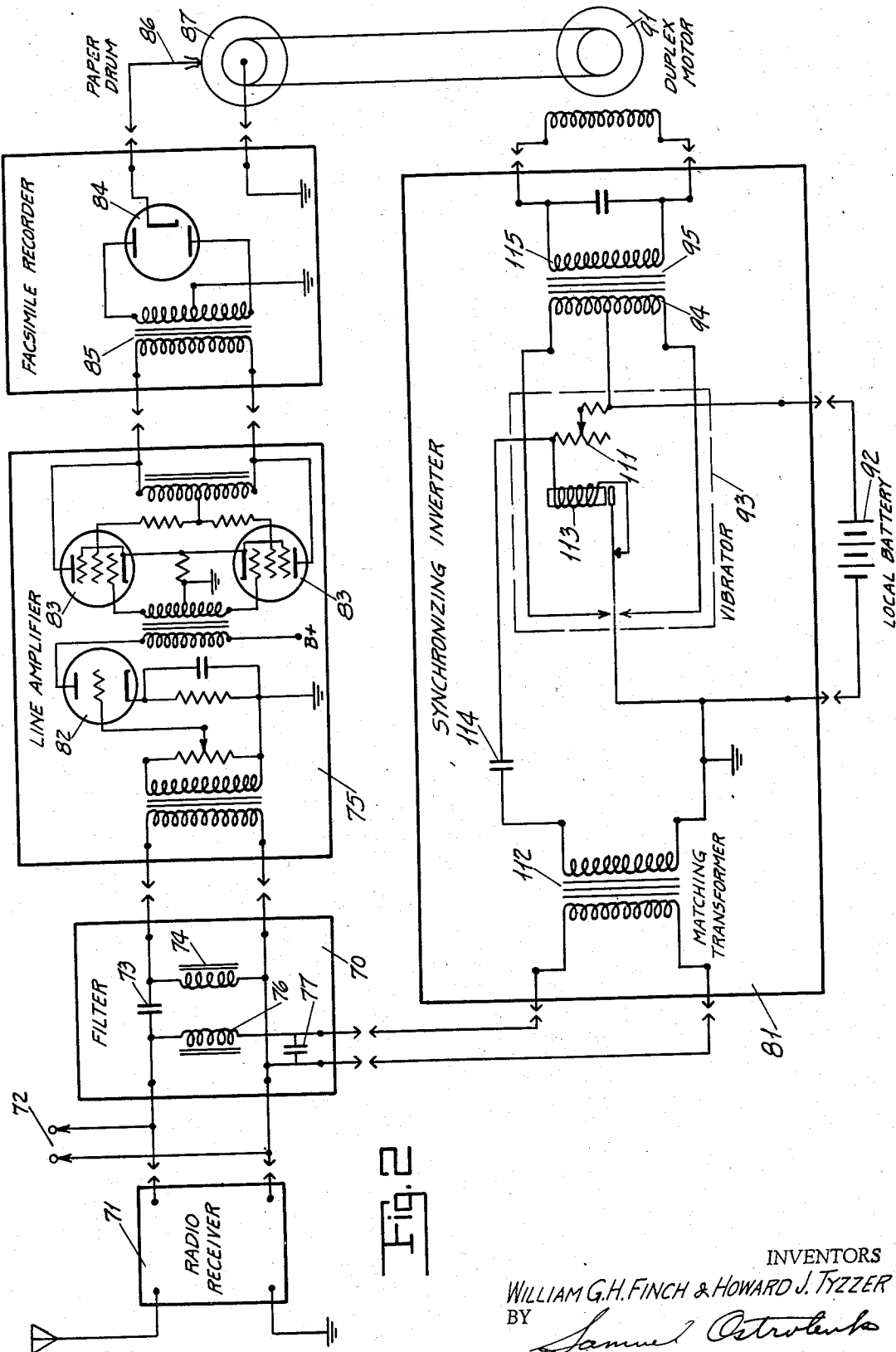


Fig. 2

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UNITED STATES PATENT OFFICE

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CONTINUOUS FACSIMILE SYNCHRONIZING
SYSTEM

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Application February 11, 1941, Serial No. 378,352

3 Claims. (Cl. 178—69.5)

Our invention relates in general to the field of facsimile transmission and reception, and more particularly concerns an improved method for maintaining the facsimile transmitter and recorder in synchronism.

In the art of picture transmission, it has long been recognized that synchronization of transmission and reception equipment presented problems which seriously limited the application of such apparatus in homes and mobile units. It has been common in facsimile to employ a start-stop synchronizing system which essentially utilized a recording drum rotating at a higher speed than the corresponding image drum at the transmitter. Periodically, at the termination of each scanning cycle, the receiving drum would be halted to await the reception of a synchronizing impulse generated at the transmitter. This synchronizing pulse when applied to an appropriate signal channel released the halting mechanism to permit unimpeded rotation of the drum for another recording cycle.

This system had the disadvantage of excessive wear arising from periodic starting and stopping of the movable members. Furthermore, during the transmission of the synchronizing signals the transmission of picture signals would cease, thus resulting in a loss of transmission time and efficiency in operation.

The application of synchronous motors to the recording and transmission drums could not be relied upon to effect absolute synchronous rotation thereof, since generally power systems from which the facsimile equipment at different stations was operated were not of identical frequency. Also, the start-stop facsimile transmission system was normally considered a necessary feature if the power supplies were to be of the direct current type, as would normally be encountered in portable equipment.

Our invention contemplates a facsimile transmission-reception system which may be operated from alternating or direct current supplies and which will maintain uninterrupted synchronism between the movable members. We may employ similar synchronous motors at both the transmission and recording apparatus and operate these from power supplies, the frequencies of which are automatically adjusted to correspond at both ends.

If the power supplies employed to drive the movable members at each end are alternating current power mains of differing frequency, then this novel synchronizing system will compensate for any difference of the order of several cycles

per second. Normally, however, so large a variation is not encountered in commercial power systems.

If direct current is utilized at either end, we employ an inverter circuit which translates this direct current into alternating current of the desired synchronous frequency. This is applied to the driving mechanism to cause the operation of facsimile scanning equipment. If our novel synchronizing system is employed in connection with the duplex portable facsimile unit illustrated and described in my copending application Serial No. 318,230, a single inverting circuit may be employed to operate the transmission and reception apparatus contained within the combined units.

Essentially, our invention comprises a scanning means for deriving a current which varies in accordance with the lights and shades of elemental areas of the picture to be transmitted. This current is then impressed upon conventional radio transmission apparatus or upon a telephone transmission line. The scanning apparatus is operated by a synchronous driving mechanism, the energy for which may be secured through any form of power supply.

If the transmitter power supply is of the alternating current type, then a signal which varies in frequency in accordance with this alternating current, or a higher harmonic thereof, is superimposed upon the picture currents and transmitted in a similar manner.

If the power supply is of the direct current type, then a vibrator or inverter circuit is utilized to translate this current into an alternating current of synchronous frequency for driving the scanning mechanism and for applying a synchronizing current to the transmission means.

At the receiving end of the facsimile system, the incoming signals are amplified and impressed upon a two channel filter circuit which functions to separate the picture and continuous synchronizing signals. The picture currents are impressed in a well known manner upon a conventional recording apparatus driven by a synchronous mechanism. The synchronous source of motive power is operated at a frequency which corresponds identically with that of the incoming synchronizing signal; and any form of power supply may be employed.

It is therefore an object of our invention to provide a novel and improved form of facsimile synchronizing mechanism.

Another object of our invention is to provide a facsimile transmission and reception system wherein the scanning mechanisms at both ends

are operated continuously while being maintained in absolute synchronism.

Still another object of our invention is to provide a novel method for maintaining synchronism between facsimile transmission and reception equipment operated from a direct current source of energy.

A further object of our invention is to provide a novel facsimile synchronizing system wherein a vibrator circuit is utilized to translate electrical energy at one frequency into energy at the synchronous frequency of the facsimile system.

These and other objects of our invention will now become apparent in the following specification taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic circuit diagram of the facsimile transmission apparatus employed in a duplex system, and

Figure 2 is a schematic circuit diagram of the facsimile reception and recording apparatus employed in the duplex system.

Referring now particularly to Figure 1, there is shown the conventional form of facsimile transmitting apparatus. Thus a schematically illustrated source of motive power 21 continuously drives an image drum 22 by a suitable positive coupling means. Associated with the image drum 22 is an optical system 23 which in the well known manner causes a light beam to be focused upon the surface of the drum and reflected upon the photoelectric cell 24.

The optical system is displaced axially relative to the image supporting drum 22 and thus the spot of light focussed upon the drum 22 follows a helical path thereabout.

The photoelectric cell and the associated vacuum tube apparatus is energized through suitable connections from a direct current source 25 which may comprise a battery or a rectified and filtered alternating current.

The currents generated within the photoelectric cell 24 fluctuate in amplitude substantially as the lights and shades of the image to be transmitted. These currents, when flowing through the resistors 26 and 27, correspondingly energize the control grid of a vacuum tube amplifier 31.

Variable resistors 27 and 32 in the vacuum tube circuit permit the variation of contrast of the generated picture signals. Vacuum tube 31 in addition to serving as an amplifier also serves as a modulator and the signals generated within the oscillating unit 33 are impressed upon the terminal 34. Therefore, the output across the load impedance 35 is a carrier frequency modulated in accordance with the lights and shades of the image on the picture drum. The frequency of the oscillator may be an audio frequency and may be adjustable to suit the particular application.

The output signal is coupled through condenser 36 to an additional amplifier 37 which energizes a conventional radio transmitter 42 through output transformer 41.

Depending upon the application, the radio transmitter may be eliminated, and the output signals may be impressed upon a telephone line for transmission to a remote point.

The driving energy for the motor 21 may be obtained from an alternating current supply as, for instance, the standard 60 cycle power line. Under these circumstances, a control frequency equal to the power frequency or a harmonic thereof is impressed upon the radio transmis-

sion apparatus 42 or the telephone line by means of transmission line 43 which, as may be seen from Figure 1, is in parallel with the output of the photoelectric cell amplifier circuits.

Some difficulty may be experienced if an attempt is made to transmit a sixty cycle alternating current signal over an ordinary telephone line inasmuch as such lines normally will cause comparatively high attenuation thereof.

Under these circumstances a higher harmonic of the sixty cycle signal may be transmitted, thus, for instance, the fifth harmonic, or three hundred cycles per second, may be separated from the sixty cycle signal and impressed upon the telephone line. Generally, there will be no interference between this harmonic and the lowest frequency of the modulated picture current impressed upon the line.

If the equipment is portable or if, for any other reason, a direct current power supply must be employed at the transmitter, we employ a novel inverter circuit 44 for translating the direct current available into an alternating current suitable for driving the synchronous motor 21. The inverter may comprise a vibrator 45 which functions to periodically interrupt the local direct current supply 50 to cause an alternating current of corresponding frequency to flow.

The vibrator employs a pivoted, conductive and magnetic arm 46 operable between two contacts 51 and 52 which are in turn joined to the primary terminals of a transformer 53. The arm 46 is normally biased toward a rest position midway between the contacts 51 and 52. Neither of these contacts is engaged when the arm is at rest. The vibrator coil 54 operates upon magnet core 55 to control the movement of the operating arm 46 and is energized through contacts 56 and 57.

The coil 54, as may be seen in Figure 1, is in circuit with a variable resistor 61 which is adjustable to control the vibrator frequency. In the rest position, the contact 56 bears against the conductive arm 46, and accordingly, when the local battery is switched into the vibrator circuit, the coil 54 will be energized. This will cause the magnetization of the core 55 and the movement of the arm 46, which in turn will cause the engagement of the arm 46 and contact 51. Thus, current will flow through the transformer primary from the local battery 50. Movement of the arm will interrupt the circuit through coil 54 at contact 56, and hence deenergize the coil 54. The arm 46 will then reverse its movement, and due to its initial momentum, swing through the mid-position and engage contact 52. This will cause a surge of current through the transformer primary in a direction opposite to that obtained for motion of the arm toward the pole 55. Also, since arm 46 reengages contact 56, the cycle of events described will be periodic.

Contact 56 is yieldingly supported in order that the arm 46 may swing through the midposition to engage contact 52. The interrupted and periodically reversed current flowing through the transformer primary will cause an alternating current of corresponding frequency to flow in the secondary 62 which is in parallel with a condenser 63. This condenser effectively reduces the harmonics developed by the transient switching of the vibrator. The alternating current is then impressed upon the synchronous motor 21 to cause rotation thereof.

In parallel with the energizing source for the synchronous motor is a variable resistor 64 which

is tapped at 65 and joined to a coupling transformer 66. This transformer provides a matched coupling between the synchronous motor supply circuit and the circuit 43 for impressing control frequency currents upon the transmitter. If required, the circuit 43 may be critically tuned to suppress harmonics of the power currents.

As previously mentioned, the circuits illustrated in Figures 1 and 2 may be the components employed at a single station; that is, they may, when taken in combination, comprise a duplex facsimile transmitter and receiver. Thus the power supply 25 which is indicated in Figure 1 normally is available to energize the circuits indicated in Figure 2.

However, if an individual receiver is employed and is independent of any transmitting apparatus, distinct power supplies may be utilized.

Referring now to Figure 2, conventional facsimile reception and recording means are illustrated. Thus signal generated at a transmitter such as that indicated in Figure 1 may be received by the schematically indicated radio apparatus 71.

If a telephone transmission line is employed, then the radio apparatus may be dispensed with and the line terminals 72 employed.

The incoming signals are demodulated and detected in the radio circuits and impressed upon the multi-channel filter 70. This filter comprises a parallel arrangement of high-pass and low-pass electrical wave filters which selectively energize the recording apparatus and the synchronizing mechanism.

Thus the schematically illustrated high-pass filter, namely series condenser 73 and shunt inductance 74, passes the picture signals to the amplifying apparatus 75.

The filter is normally designed to be highly selective and thus to discriminate against any of the synchronizing frequency signals inducing the fundamental and any higher harmonics thereof.

The synchronizing signals are selectively separated from the picture signals by the low pass filter, namely, series inductance 76 and shunt capacitance 77, and impressed upon the synchronizing and driving circuit 81.

The picture signal circuits are of conventional form and, as indicated, a vacuum tube amplifier 82 drives a push-pull power amplifier 83 which, in turn, energizes a full-wave rectifier 84 through output transformer 85. The output of the rectifying circuit 84 is impressed upon the recording stylus 86 which is operable upon a recording drum 87. The recording mechanism may comprise any of the well known light beam or dry conductive recording systems.

The drum 87, which is conductive if the dry recording paper system is employed, is driven by a synchronous motor 91 which in turn is energized from the local power supply. As is well known, if the local power supply is an alternating current of frequency identical with that employed at the transmission end, then the recording drum 87 will operate in exact synchronism with the transmitting drum.

If a local alternating current power supply is available, but if its frequency varies somewhat from the supply at the transmitting end, then it is necessary to shift the frequency thereof by the control means 81 indicated in Figure 2 so that the synchronous speeds for transmitting and recording are the same.

As illustrated in Figure 2, the power supply available for the synchronous motor 91 comprises

a direct current source 92 and accordingly, the direct current must be translated into an alternating current. Accordingly, the direct current is impressed upon a vibrator circuit 93 wherein the direct current is periodically interrupted by arm 110 to generate an alternating current in the primary 94 of the transformer 95.

This vibrator may operate in a manner similar to that described in connection with the vibrator at the transmitting circuit illustrated in Figure 1 and the frequency thereof may be adjusted somewhat by the variable resistance 111.

The synchronizing current received through the low-pass selective filter are coupled to the vibrator coil 113 through the transformer 112 which functions to match the impedance of the transmission line at the synchronizing frequency.

This transformer couples the signal to the coil 113 of the vibrator and the vibrating arm 110 is caused to vibrate in synchronism with the impressed currents.

Thus it may be noted that the energy required to drive the vibrating members is derived mainly from the local battery supply 92, while the incoming synchronizing signals determine the vibrator frequency.

A condenser 114 is inserted in the coupling circuit in order that the transformer 112 does not short circuit the direct current power supply 92. This condenser, however, permits the comparatively unimpeded passage of the synchronizing frequency.

The natural period of the vibrating members is initially adjusted to be of the order of the synchronous frequency employed at the transmitting circuit. However, as well known, temperature fluctuations and various other factors will influence the natural frequency of the vibrator and thus ordinarily tend to shift the frequency from that of the transmitter. However, the vibrator coil 113 which is controlled by a signal identical in frequency to that employed at the transmitter serves to maintain exact synchronism therebetween by causing the vibrating arm 110 at the receiver to fall into step with the synchronizing frequency. Thus the current in the tuned secondary 115 of the transformer 95 is an alternating current equal in frequency to that utilized to drive the transmitting motor 21. This current is then employed to energize the motor 91 of the recording scanning apparatus which, as is schematically illustrated in Figure 2, is coupled to the recording drum 87.

Similarly, if alternating current is employed instead of the local battery 92, the major portion of the energy required to drive the vibrator movable arm 110 is taken from the supply mains. As previously mentioned, commercial alternating current mains rarely differ in frequency by more than a fractional part of a cycle, and therefore relatively little synchronizing energy need be impressed upon the coil 113, in order that arm 110 fall into step therewith.

Accordingly, alternating current of one frequency is translated into current at a frequency which is equal to that employed for motivating the movable members at the transmitter. If for any reason, the frequency should vary at the transmitter, then a corresponding change will occur at the receiver, and result in effect, continuous synchronization.

Helical movement of the stylus with respect to the drum is attained in any well known manner and the motion of the recording drum 87 will be continuous during operation and exactly similar

to that of the transmitting drum 22. As a result, the starting motion experienced with the prior art facsimile machines has been entirely eliminated. This effectively speeds up facsimile transmission and reception and minimizes the receiver and transmitter wear.

Since many modifications of the specific disclosures hereinabove set forth will now be obvious to those skilled in the art, we therefore prefer to be bound only by the spirit and scope of the appended claims.

We claim:

1. In a picture transmission system, a receiver mechanism for providing visual indications in accordance with the received picture signals; a motor for driving said receiver mechanism; a source of direct current; a vibrator; an electromagnet connected to said source of power through said vibrator whereby said electromagnet is energized at a predetermined periodicity for maintaining said vibrator in vibration at said periodicity; a second circuit extending through said electromagnet; means for providing an alternating current corresponding to the rate of reception of said picture signals to said electromagnet, whereby said electromagnet is held energized at a periodicity fixed by said alternating current; and a source of direct current to said motor through said vibrator for applying alternating current to said motor at a periodicity determined by said source of alternating current.

2. In a picture transmission system, a receiver mechanism for providing visual indications in accordance with received picture signals; a source of alternating current having a frequency corresponding to the frequency of said received picture signals; an electromagnet connected across said alternating current; a source of direct cur-

rent; a vibrator operated by said electromagnet; circuit connections from said source of direct current through said vibrator to said electromagnet; a motor for driving said receiver mechanism; a transformer having a primary; a mid-tap connection from said transformer to one terminal of said source of direct current; and circuit connections from the opposite terminals of said primary to respective terminals on the opposite sides of said vibrator; said last mentioned terminals being adapted to be alternately engaged by said vibrator as the vibrator vibrates for extending the second terminal of said source of direct current sequentially to each of said opposite terminals of said secondary; said vibrator being tuned to vibrate at substantially the frequency of said source of alternating current.

3. In a picture transmission system, a receiver mechanism for providing visual indications in accordance with received picture signals; an electromagnet; a source of direct current; a vibrator; a vibrating circuit extending from said source of direct current through said vibrator to said electromagnet; a source of alternating current having a frequency in accordance with the rate of reception of said picture signals; means for energizing said electromagnet under the combined action of its local vibrator and said source of frequency; means controlled by said electromagnet for generating a frequency corresponding to said received frequency and receiving its energy from said source of direct current; a motor; and means for applying said last mentioned frequency to said motor.

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