

Aug. 27, 1940.

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2,212,968

FACSIMILE SYNCHRONIZING SYSTEM

Filed April 21, 1938

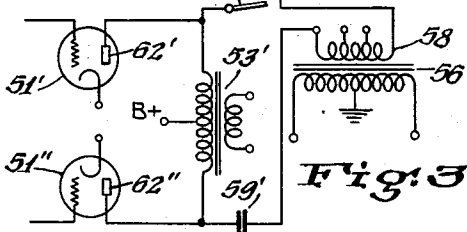
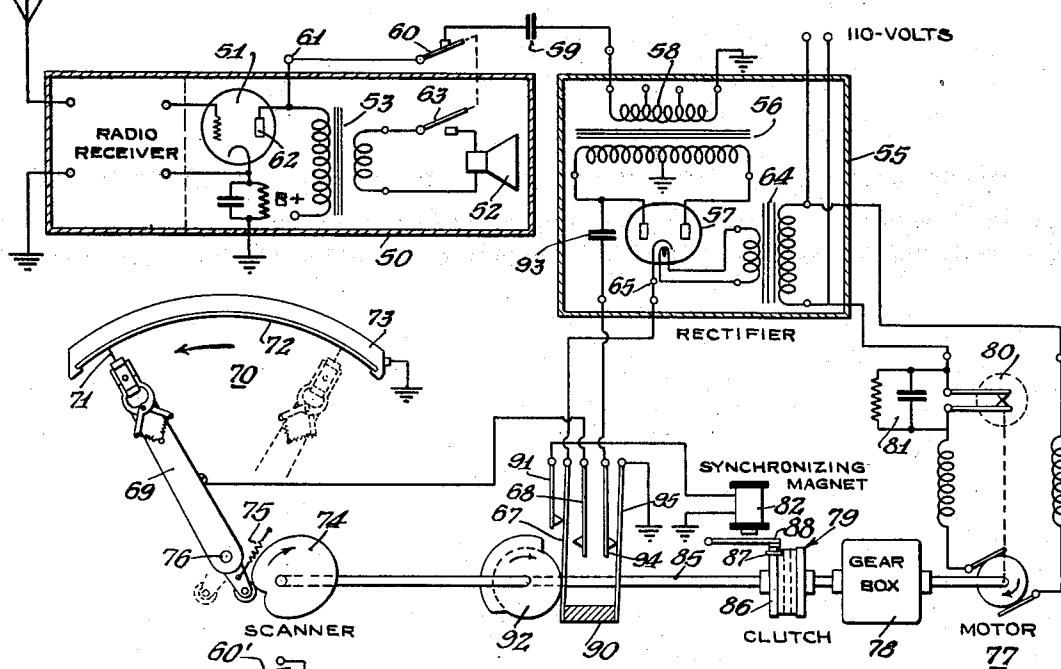
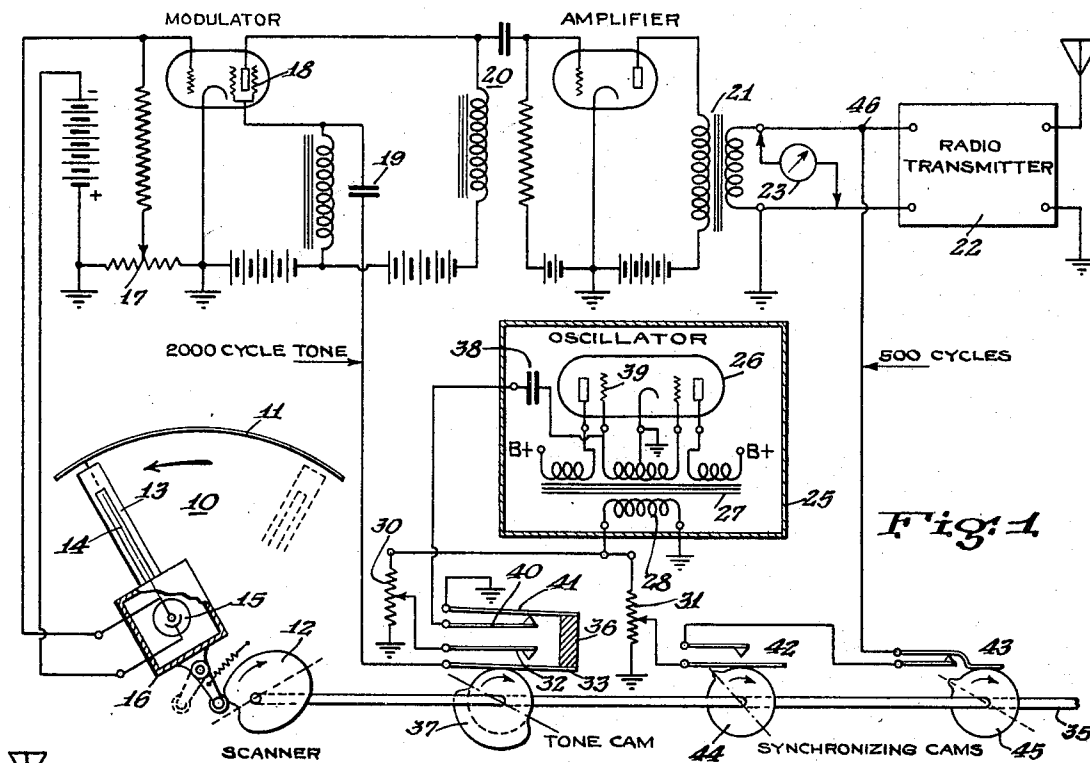


Fig. 2

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2,212,968

FACSIMILE SYNCHRONIZING SYSTEM

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Application April 21, 1938, Serial No. 203,222

3 Claims. (Cl. 178—69.5)

This invention relates to facsimile systems, and more particularly relates to novel methods of and means for maintaining a transmitter and receiver in synchronous relation.

5 In accordance with my present invention, I contemplate novel means for accurately predetermining the duration of transmission of a synchronizing signal within very close limits. In the prior art, a single cam was generally used to
10 both open and close the same switch member to control the beginning and ending points of the transmitted synchronizing current. I have found that for the synchronizing signal to be most effective in facsimile work, it should be of very
15 short duration, lasting on the order of one-fiftieth of the scanning cycle, namely about seven mechanical degrees.

Prior art unitary cam switch control has not been reliable and cannot effect such small accurately determined synchronizing signals due to mechanical lagging and other similar difficulties.
20 In accordance with my present invention, I employ two switches in circuit with the alternating current synchronizing signal. The switches are successively actuated to predetermine the instant of starting and stopping of the transmission
25 of the synchronizing current. At the receiver novel means are provided for selectively segregating the synchronizing current from the picture signals for actuating the start-stop synchronizing mechanism and maintain the receiver scanner in synchronous movement with the transmitter scanner.
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Further, in accordance with my present invention, novel circuitual arrangements are provided
35 for coupling an individual facsimile unit with an ordinary radio receiver. This coupling is effected in a simple manner. The coupling unit comprises circuits for rectifying the picture signals and means for selectively changing the characteristics
40 of the rectifier unit to provide the predetermined frequency synchronizing impulse for maintaining the recorder in synchronous condition.

It is accordingly an object of my present invention to provide novel methods of and means
45 for transmitting a synchronizing signal.

Another object of my present invention is to provide novel apparatus for accurately predetermining the duration of a transmitted synchronizing signal.
50

Still another object of my present invention is to provide a novel arrangement for accurately predetermining the cyclic starting and stopping positions for the transmission of a synchronizing current.
55

A further object of my present invention is to provide novel methods of and means for selectively receiving a synchronizing signal for maintaining a recorder in synchronous operation.

Still a further object of my present invention is to provide a novel coupling unit between an individual facsimile recorder and a standard broadcast radio receiver.

These and further objects of my present invention will become apparent in the following description taken in connection with the drawing, in which:

Figure 1 is a schematic diagram of a preferred facsimile transmitter incorporating the principles of my present invention.

Figure 2 is a schematic diagram of a preferred facsimile recorder operated in accordance with the principles of my present invention.

Figure 3 is a modified arrangement for connecting a facsimile recorder to a radio receiver.

Referring now to Figure 1, a facsimile scanner unit 10 is oscillated across an arcuately held record sheet 11 by a modified heart-shaped cam 12. The transmitter scanner schematically here represented may well be the unit such as disclosed in my copending application S. N. 123,770 filed February 3, 1937, entitled "Continuous sheet facsimile system," although other well-known scanning units may be used. The transmitter scanner unit consists essentially of a source of light, generating a beam focused upon sheet 11 through element 13.
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The beam or pencil of light is reflected from the record sheet and focused through tubular lens element 14 upon a photoelectric cell 15 contained within the scanner housing 16. As is well known in the facsimile art, variations in the shading of the recording sheet 11 along the scanning region correspondingly variably affect the intensity of light impinged upon photoelectric cell 15. The photoelectric cell is connected in circuit with the modulator stage for producing electrical signals varying in accordance with the elemental shading of the scanned record sheet.
40

The modulator stage is preferably a screen-grid vacuum tube, the control grid of which is connected to the anode of the photoelectric cell 15. A biasing control potentiometer 17 is employed to control the intensity level of the photoelectric cell variations upon the output of the modulator. A carrier frequency current is connected to the screen-grid electrode 18 of the modulator stage through a coupling condenser unit 19. The combination of electrical actions in the modulator stage generate a picture modulated carrier frequency.
55

quency current which is coupled to the amplifier stage through coupling impedance elements 20.

The output of the amplifier stage is coupled to a suitable transformer 21 to a schematically indicated transmitter 22 for radio transmission to a remote receiver stage. It is to be understood that different communication channels than radio may be employed. The output impedance of transformer 21 may, for example, be 500 ohms to match the standard coupling impedance of speech input circuits employed in radio broadcast stages. A high impedance level indicator 23 such as a D. B. meter, is connected across the output of transformer 21 for assisting in the initial adjustments of the transmitter unit.

An electronic oscillator 25 is employed to generate and supply the 2000 cycle carrier frequency or tone to the modulator stage. Oscillator 25 essentially comprises a double triode electronic tube 26 coupled through transformer element 27 to generate the sustained current oscillations at the required frequency. The output winding 28 of the oscillator has one terminal connected to ground potential and the other terminal connected to two potentiometer element units 30 and 31. Potentiometer 30 is connected to the coupling condenser 19 for the modulator stage through cam-switch members 32—33. When switch 32—33 is closed the output of oscillator 25 is directly applied to the screen grid 18. This connection occurs preferably during one hundred and eighty mechanical degrees of each rotation cycle of control shaft 35. Actuation of cam switch 36 is through cam 37 secured on control shaft 35.

Scanner 10 generates picture signals in its excursion from left to right corresponding to a 180° rotation of the control shaft 35. The scanner is returned to its left end position during the remaining 180° rotation of shaft 35 during which time no picture carrier signals are transmitted in the preferred arrangement. Carrier tone switch 32—33 is opened by suitable design of cam 37 at this point.

During the return stroke (to the left) of the scanner 10, the frequency of the generated current of oscillator 25 is changed to that of the synchronizing frequency. In a preferred example, a 500 cycle synchronizing current is used. The frequency of oscillator 25 may be changed by shunting a condenser element 38 between grid element 39 and ground. This switching is effected by elements 40—41 of cam-switch 36 and occurs alternately with the removal of carrier current from screen grid 18. By properly proportioning the value of the capacitance of condenser 38, an accurate value of the 500 cycle generation is effected. It is to be understood that other known expedients for changing an oscillator frequency may be employed for changing the normal picture carrier frequency of oscillator 25 during the return stroke of scanner 10 and that this frequency might be an increased value rather than a decreased one.

Potentiometer 31, being in circuit with the output of oscillator 25, is directly connected to the secondary side of the output transformer 21 at point 46 through a novel arrangement for accurately predetermining the duration of the connection of the synchronizing signal across this point. In accordance with my invention, I provide a novel arrangement using two switches 42 and 43 connected in series, respectively actuated by cams 44 and 45. Switch 43 is in normally closed circuit relation; switch 44, in normally open circuit relation. No synchronizing current

accordingly flows from potentiometer 31 to point 46 during the return stroke period of scanner 10 until switch 44 is closed.

Cams 44 and 45 are designed with short projecting nibs for actuating the associated switches 42 and 43. Cam 44 is arranged on shaft 35 to close switch 42 at the predetermined instant the synchronizing signal is to be started for transmission during each cycle. A cam can be depended upon to accurately perform this closing function. The closure of switch 42 completes the circuit between potentiometer 31 and point 46. Closure of switch 43 is made to preferably occur when scanner 10 has practically completed its return stroke.

It will be recalled that during this interval, switch 40—41 is closed and the output of oscillator 25 is at the synchronizing signal frequency, namely 500 cycles in the present example. The end point of the synchronizing signal transmission is accurately determined by cam 45 which is adjusted to actuate normally-closed switch 43 to open the switch at the proper instant. It will now be evident that an accurate control of the starting and stopping point of the synchronizing signal in each cycle can be accurately prearranged by my novel means.

The advantages of this arrangement by switches 42 and 43 are apparent when synchronizing signals of very small duration are required. I have found through extensive experimentation that synchronizing signals of short duration more accurately effect synchronizing of the receiver scanner. Thus, when the cycle of the scanner is one second long, giving sixty lines of scanning per minute, I have found that a synchronizing signal duration of one-fiftieth of this cycle, namely two-hundredths of a second, is most satisfactory. My experiments have further shown that the angular position and duration of the synchronizing signal of this short duration and of even shorter duration can be readily accomplished by the herein disclosed multiple switching means.

The synchronizing signal is ended just before the scanner 10 approaches its extreme left position in readiness for its picture scanning excursion. At this time, cam 37 alters the position of cam switch 36, opening blades 40—41 to cause a picture tone of 2000 cycles to be generated, and closing plates 32—33 to connect the 2000 cycle tone to the screen grid 18 of the modulator stage. Control shaft 35 is rotated at a predetermined speed such as by a synchronous motor through reduction gearing. In the given example, shaft 35 rotates at 60 revolutions per minute, effecting sixty scanning operations and corresponding synchronizing signal transmissions per minute. The picture modulated carrier and synchronizing signals are accordingly alternately transmitted across radio transmitter channel 22 to the remote receiving stage.

Figure 2 is a diagrammatic representation of a preferred system for recording the transmitted facsimile signals. A standard broadcast radio receiver is indicated at 50. The output stage 51 represents the conventional audio-frequency output amplifier stage coupled to loud speaker 52 through step-down transformer 53.

In accordance with my present invention, I provide a novel coupling unit 55 for coupling the facsimile recorder 70 to the radio receiver. Coupling unit 55 essentially comprises a step-up transformer 56 and a thermionic rectifier unit 57. Primary 58 of transformer 56 has one termi-

nal connected to ground and the other terminal connected to the radio receiver through a coupling condenser 59. Switch 60 connects transformer 56 to terminal 61 of the radio receiver. A preferred coupling point to the radio receiver is to the anode 62 of the output stage 57 thereof. This connection insures the maximum voltage signal output from the radio receiver to the facsimile coupling unit 55.

Connecting-switch 60 may be manually operated when facsimile reception is to commence. However, it is at present usual to connect the facsimile receiver at the earliest morning hours since the broadcasting of facsimile programs occur at that time. Accordingly, switch 61 together with the associated switches for starting both the radio receiver 50 and the facsimile system in operation may be time-clock controlled in a manner well known in the art. A second switch 63 is shown mechanically ganged with switch 60 to open the circuit connection to the loud speaker 52 to prevent the facsimile signals from causing a sound disturbance. It is entirely feasible to maintain the loud speaker 52 in circuit to aurally determine the quality and nature of the signals.

Coupling unit 55 also contains a step-down power transformer 64 used to energize the heater element of rectifier 57. Rectifier 57 is preferably of the duo-diode type, with the anodes connected to the outer ends of the secondary of coupling transformer 56. The 2000 cycle modulated carrier picture signal currents received by unit 50 are further amplified in magnitude by transformer 56 and then rectified at 57. The signal energy output is represented between the cathode 65 and ground. Cathode 65 is connected to the scanner 70 through switch blades 67—68 through the oscillating scanner arm 69. Arm 69 is electrically connected to the pivotally mounted stylus point 71 which bears against record sheet 72. Sheet 72 is secured in position against a metallic platen 73. Platen 73 is electrically connected to ground to complete the picture signal circuit to rectifier 57.

The diagrammatically illustrated recorder is similar to that described in my co-pending application S. N. 156,625, filed July 31, 1937 entitled "Facsimile recorder." Record sheet 72 is maintained in position to establish contact with platen 73 and cooperate with the oscillating stylus 71. Record sheet 72 is a conducting paper which is electrically sensitized in accordance with the picture signals to build up a facsimile reproduction corresponding to that transmitted from scanner 10. Heart-shaped cam 74, in cooperation with spring 75, produces an oscillating movement of arm 69 about pivot 76.

A non-synchronous motor 77 is preferably employed to drive cam 74 through a reduction gear box 78 and a friction clutch 79. Motor 77 may be an A. C. induction motor, or a motor of the A. C.-D. C. type. An electrical governor 80 is mechanically connected to the rotor of motor 77, and employed to maintain motor 77 at a predetermined speed of rotation. Governor 80 electrically opens and closes the 110 volt power leads to the motor 77 to drive it at proper speed. A spark filter 81 is connected across governor 80 to minimize sparking.

Synchronous scanning movement of oscillating arm 69 is effected by means of the governor controlled motor 77 and the start-stop synchronous actuation of the clutch 79. Synchronizing magnet 82 is controlled by the short duration synchronizing signal in a manner to be described. I

have found that by operating the recorder control shaft 85 at a speed about five per cent greater than that of control shaft 35 of the transmitter, the scanner arm 69 will arrive at its initial left-end position in readiness for its recording stroke, in sufficient time before reception of the synchronizing impulse to start it off again for most operating conditions. Driven plate 86 of clutch 79 contains a projection 87 which abuts armature 88 to stop the rotation of shaft 85 until the synchronizing impulse is received to release armature 88.

Cam switch 90 is maintained in the position illustrated during the return stroke of oscillator 69. Signal plate 67 is connected to the synchronizing magnet 82 through contact 91. Normally no signal is impressed upon magnet 82 until a synchronizing impulse is received. I have found that the synchronizing impulse should be of very short duration to initiate the scanning excursion at recorder 70 at the predetermined starting position. I have further found that the time lag for the operation of the synchronizing magnet through its armature 88 to release the clutch 79 is, for recorders of the type described, of the order of about .02 second, and that the synchronizing pulse duration should be made with this figure as a minimum for best operation.

In other words, while a synchronizing impulse of the shortest duration is preferable, the minimum limit is that of the time lag for the synchronizing mechanism to function. At the instant the synchronizing magnet is energized, cam 92 operates cam switch 90 to the right to open the synchronizing magnet circuit and close signal blade 67 upon contact 68, thereby impressing the rectified picture signals upon the stylus for recording on sheet 72 in a manner already described. The recording stroke occurs during 180 mechanical degrees of rotation of control shaft 85 at which time the cam switch 90 is released to the illustrated position to repeat the cycle of operations described.

An important feature of my invention resides in the novel means for selectively controlling the impression of the synchronizing impulse upon magnet 82 to avoid conflict between the synchronizing signal and picture signal at the output of the rectifier, I provide a filtering means embodied by condenser 93 to by-pass essentially all the signal frequencies above the synchronizing frequency of 500 cycles. The 2000 cycle carrier together with its side bands of picture signal modulations are well above the 500 cycle value so that the by-pass condenser 93 connected to one side of the secondary of the coupling transformer 56 is usually sufficient for such cases. Condenser 93 by-passes the higher frequencies from transformer 56 to ground through switch elements 94—95. It is to be understood that my invention contemplates more involved filtering means actuated by the cam switch 90 if more selective signal separation is required.

The preferable signal level for operating the recorder 70 is in the order of 100 to 300 volts. The expedient of the filtering condenser 93 has been found to readily reduce the 2000 cycle signal level to a value of 15% of the original and thereby insure the prevention of interference with the 500 cycle tone passing through to the rectifier 57 substantially unattenuated. The 500 cycle synchronizing impulse is rectified at 57 and is applied to the synchronizing magnet through switch 67—91 as a unidirectional current impulse of short duration.

An alternate method of connecting the coupling transformer 56 of the signal coupling unit 55 to the output stage of a standard radio receiver is illustrated in Figure 3. A push-pull output amplifier stage containing the triodes 51' and 51'' is illustrated as connected to the push-pull transformer 53', normally coupling this stage to the loud speaker unit. 60' is the time clock operated switch corresponding to the switch 60 in Figure 2, and connects plate 62' of tube 51' to one side of the primary 58 of the coupling unit. A coupling condenser 59' is shown connected to the opposite plate 62'' to prevent the passage of direct current to transformer 56. The impedance of the primary winding 58 is preferably of the order of the impedance of the primary winding of transformer 53'.

It is to be understood that my present invention may be practised in various modified forms and arrangements without departing from the spirit and scope thereof and accordingly I do not intend to be limited except as set forth in the following claims.

I claim:

1. A facsimile transmitter comprising means for generating a carrier frequency current; means for modulating said carrier current in accordance with picture signals; means for substantially changing the frequency of said generated carrier current for transmitting a synchronizing frequency current while maintaining the amplitude constant between successive picture signal transmission intervals; and a facsimile receiver comprising a synchronizing means and means whereby said synchronizing means is selectively responsive to said synchronizing frequency current.

2. A facsimile transmitter comprising means for generating a carrier frequency current; means for modulating said carrier current in accordance with picture signals; means for changing the frequency of said generated carrier current to produce a synchronizing frequency current between successive picture signal transmission intervals; and means including circuit connections for transmitting said changed carrier current for a predetermined interval as a receiver synchronizing signal comprising a first and second switch, said second switch initiating said synchronizing signal and said first switch terminating said synchronizing signal.

3. A facsimile transmitter comprising an oscillator circuit for generating a carrier frequency current; means for modulating said carrier current in accordance with picture signals; means for reducing the frequency of said generated carrier current to produce a synchronizing frequency current between successive picture signal transmission intervals; and means including circuit connections from the output of said oscillator circuit for transmitting said reduced carrier current for a predetermined short interval as a receiver synchronizing signal comprising first and second successively actuated switches connected in series relation, said first switch being in normally closed circuit position, said second switch being in normally open circuit position, said second switch initiating said synchronizing signal and said first switch terminating said synchronizing signal.

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