Feb. 11, 1941. J. L. FINCH 2,231,442

MONITOR FOR MULTIPLEX TELEGRAPH SYSTEMS

Filed April 30, 1937 2 Sheets-Sheet 1

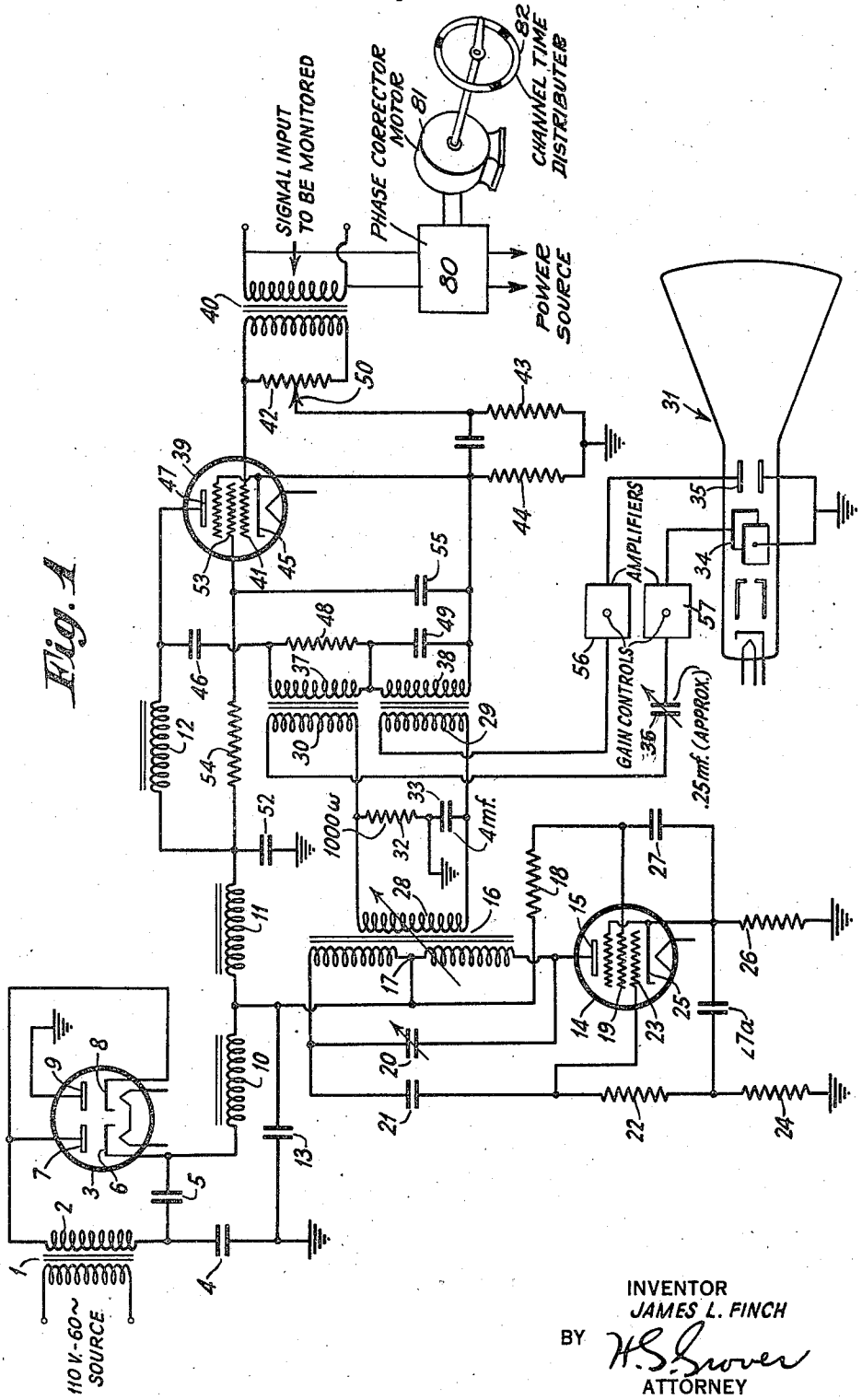


Fig. 1

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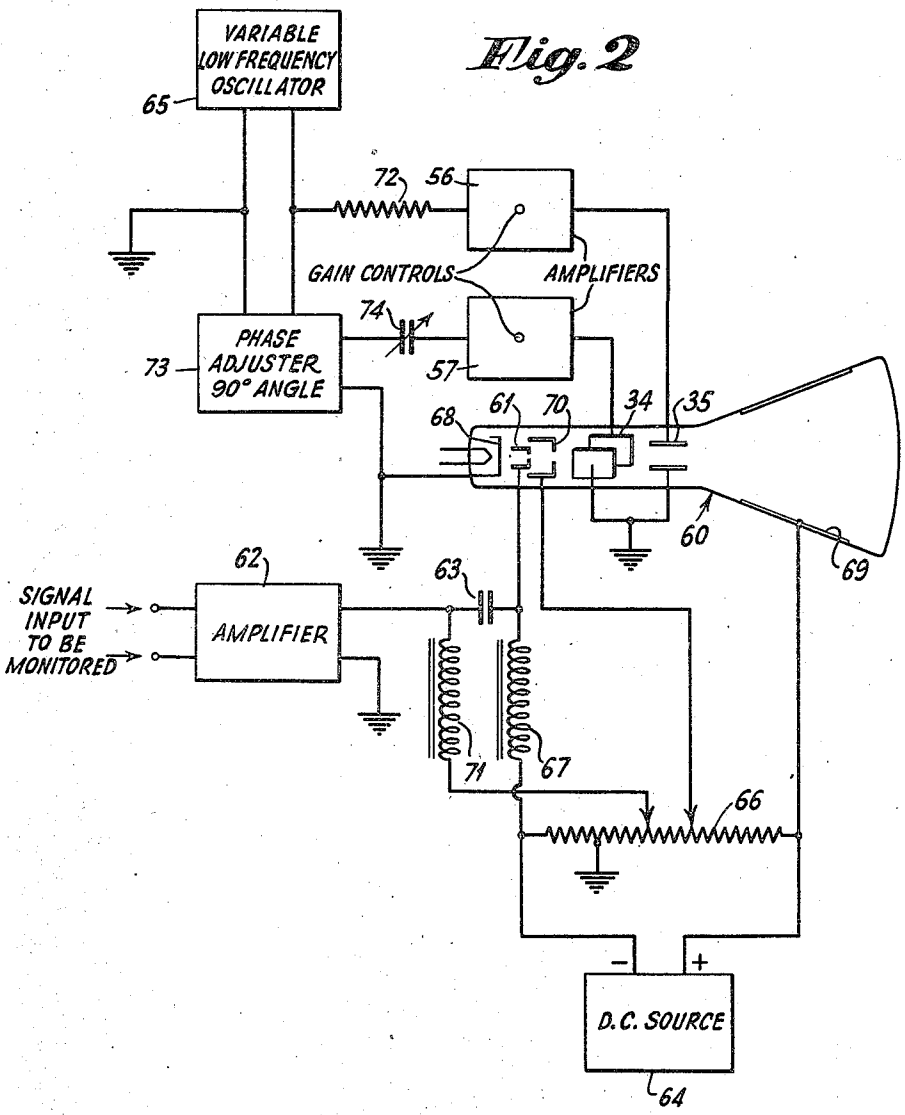
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Fig. 2



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MONITOR FOR MULTIPLEX TELEGRAPH SYSTEMS

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5 Claims. (Cl. 178—69)

This invention relates to a monitor for a time division multiplex telegraph system and more particularly it has to do with a device which has been found to be serviceable in the supervision of radio telegraph terminal equipment.

In multiplex radio telegraph systems it is important that the keying operations be carefully observed in order to determine as promptly as possible any departures of the keying signals from the channel time allotments of the multiplex system. Present day practice in the operation of multiplex telegraph systems makes it essential that a constant tone frequency and the frequency of signalling impulses be maintained in step. If the time is not equally divided between the different channels of the multiplex system, then failures are apt to occur in the assignment of each signal to its proper channel. Furthermore, the marking and spacing intervals of the code signals become clipped because they do not register with the commutation points.

Accordingly, it is among the objects of my invention to provide a monitoring indicator whereby the correct impress of keying signals upon the transmitter shall be clearly indicated as in phase or out of phase with the operation of the commutator which distributes the time allotments to each signaling channel.

In carrying out my invention I have found that the cathode ray tube oscilloscope lends itself readily to the indication of operating conditions. The keying of code signals on each of a plurality of multiplexed channels is clearly indicated by the image which may be projected on the fluorescent screen of an oscilloscope. The transient keying signals occur so rapidly as to give effect to persistence of vision phenomena so that definite areas of the fluorescent screen appear to be lighted up continuously. If these areas appear to move in one direction or another certain indications are thereby given which are helpful to the operator in controlling the operation of the terminal apparatus.

My invention will now be described in detail, reference being made to the accompanying drawings in which

Figure 1 represents diagrammatically a circuit arrangement of a preferred embodiment, and

Fig. 2 shows a modified circuit arrangement.

With reference to either of the embodiments illustratively used in the following description, it may be said that essentially there is required a suitable power supply unit, a very low frequency oscillator, a phase differentiating device for maintaining a 90° phase difference between voltages impressed upon the horizontal and vertical deflecting circuits respectively in a cathode ray tube oscilloscope, and finally an amplification stage on which input signals may be impressed and thence delivered to suitable control circuits of the oscilloscope, whereby indications may be made on the fluorescent screen.

Referring first to Fig. 1, there is shown a power supply unit which comprises a transformer 1 for obtaining a suitable voltage from any available commercial alternating current, say, of 60 cycle frequency. The secondary 2 of the transformer feeds energy to a duplex diode tube 3. This tube acts as a voltage doubler. One side of the secondary is electrostatically grounded through the condenser 4 and is provided with a return circuit through a capacitor 5 to the cathode 6 of the tube 3. The anode 7 and the cathode 8 are interconnected, while the anode 9 is grounded.

Rectified current is taken off from the cathode 6 and from the capacitor 5 and its ripple component is smoothed out by means of suitable chokes 10 and 11. A grounded by-pass condenser 13 is preferably connected to a point intermediate the chokes 10 and 11.

The low frequency oscillator unit comprises an electron discharge tube 14 preferably of the pentode type, having its anode 15 connected through a conventional Hartley oscillator circuit to the D. C. source described in the preceding paragraphs. This circuit includes a variably reactive transformer 16, the primary of which has an intermediate tap 17 in circuit with a connection between the filter chokes 10 and 11. A screen grid potential is also derived from the filter system and fed through the resistor 18 to the screen grid 19. The two transformer primary terminals are intercoupled through the tuning condenser 20 thereby forming a resonant circuit which is tunable to the low frequency required for suitable operation of the oscilloscope deflector circuits. In the exemplary embodiment under discussion frequencies from 14 to 23 cycles per second are contemplated although other frequencies may, of course, be obtained, if required.

Energy is fed back from a suitable point on the resonant circuit 17—20 through a capacitor 21 to the control grid 23. The control grid 23 has a relatively low impedance path to ground through the resistors 22 and 24. The cathode 25 is also grounded through a suitable resistor 26, the ohmic value of which is considerably higher than that of the combined resistors 22 and 24. The capacitor 27 serves as an ordinary alternating current path from the screen grid 19 to the cathode

25. Any variation in cathode voltage with respect to ground is also impressed on the grid leak 24 through condenser 27a, and thus prevents degenerative effects which might otherwise be present if the energy were inadequately by-passed through the resistor 26.

The secondary winding 28 of the transformer 16 delivers oscillations to the windings 29 and 30 of two transformers whose function will presently be explained. From these transformer windings circuits may be traced respectively through amplifiers 56 and 57 and thence to the horizontal and vertical deflecting plates of a cathode ray tube oscilloscope 31. The plates so connected are opposed to companion plates which are grounded.

The voltage generated in the winding 28 is impressed across a resistor 32 and a capacitor 33, the respective values of which are preferably of the order of 1000 ohms and 4 microfarads. Two voltages are thus obtained with a 90° phase difference therebetween. One of these voltages is fed toward the horizontal deflecting plates 34, while the other voltage is fed toward the vertical deflecting plates 35. A capacitor 36 having an approximate value of .25 microfarad serves to adjust this circuit so as to obtain exactly 90° of phase displacement with respect to the voltage in the vertical deflecting circuit. Each of the amplifiers 56 and 57 is provided with an adjustable gain-control device so that the amplitudes of horizontal and vertical deflection of the cathode ray may be equalized, thereby to produce normally an image of circular pattern.

Voltages from the keying circuits of the multiplex telegraph system to be monitored are superimposed upon the oscillator output voltages by means of the transformers whose windings 29 and 30 have already been mentioned. These transformers possess primary windings 37 and 38 respectively. These primaries, however, are excited by potentials which are substantially in 90° phase relation to one another, although both voltages are derived from the output circuit of an amplifier tube 39 which is preferably of the pentode type.

The signal input is preferably fed through a transformer 40 and thence it is impressed upon the control grid 41. This grid is suitably biased by means of resistors 42, 43 and 44 forming a circuit to the cathode 45. The output circuit of the tube 39 may be traced from the cathode 45 through the transformer primary coils 38 and 37 and thence through a by-pass condenser 46 to the anode 47. A positive D. C. potential is applied to the anode 47 from the power supply unit and through the reactor 12. A grounded capacitor 52 aids in dissipating any ripple component in the power supply. Positive potential for the screen grid 53 is obtained from the power supply unit through the resistor 54. The screen grid 53 may be electrostatically grounded through the capacitor 55 and resistor 44.

A phase displacement between the voltages across the windings 37 and 38 respectively is obtained by virtue of a resistor 48 across the terminals of the winding 37 and a capacitor 49 across the terminals of the winding 38. This phase displacement results in circular deflection of the oscilloscope spot responsive to the signal frequencies in a manner similar to that produced by the low frequency oscillator.

Part of the signal input energy may be used to control a phase corrector 60 whereby the driving motor 61 is held in synchronism with the incoming signals. The motor 61 drives a channel time distributor 62 in accordance with well known practice.

In the absence of signals the path traced by the electron beam causes a pattern of substantially circular shape to be imaged on the fluorescent screen of the oscilloscope 31. This is due to the rotary control of the deflecting circuits by the oscillator. When, however, impulses are derived from the signalling circuit these additional voltages are superimposed upon the oscillator voltages and cause greater deflections to be made during certain instants. The action may be described more in detail as follows:

In order to produce the desired indications the gain in the amplifier 39 is adjusted by means of the variable tap 50 on the potentiometer 42 so that if the voltages were to be derived from a continuous signal tone frequency alone the oscilloscope circle would be much smaller than when produced by the output of the oscillator alone.

Let it now be assumed that the signals to be monitored are derived from two multiplex channels and that the commutator frequency is substantially 22 cycles per second. The frequency of the oscillator will also be set to 22 cycles. Let it now be assumed that on both channels a tone keying with a series of dots is effective. At the instant when the oscilloscope spot is at the highest point of its circle channel A may have just been given control of the transmitter. Then channel A will maintain control while the spot travels from that point through an arc of 90° to the extreme right point on the circle. Channel B will then take control for the next 90° of travel. Channel A will have control for the third 90° and channel B for the last 90°. Since both channels are making dots, the first interval of time during which channel A has control will constitute a marking interval and the first period of time during which channel B has control will also be a marking interval, while during the other two periods the transmitter will be in the spacing condition. Thus, while the spot is traveling from the extreme upper position through 180° arc to the lower position, the tone signal should be on. For the remaining 180° it should be off. When the tone signal is on it causes a superimposed circular deflection of the spot and thus traces what appears to be a helical line centered about the circle which it traces when the signal is off.

When miscellaneous characters of the Morse code are being transmitted by one or both channels then the various quadrants of the circle will have marking characters for part of the time. However, these characters will always start and stop at the ends of the quadrants. If the signal is properly balanced, then these points where starts and stops are made will be truly 90° apart. If, however, the length of time assigned to the various channels is incorrect, then these starting and stopping points will not be truly 90° apart and that fact can be noted by means of the indications made on the oscilloscope screen.

In case there should develop any irregularity in the spacing of the channel assignment this also can be noted by an irregular or jumpy action of the pattern traced by the spot on the cathode ray tube screen. In case there is interference of any kind on the radio circuit this would be superimposed on the signal and can be noted by miscellaneous deviations of the trace from the picture which would normally be expected. Likewise any breaks in the characters can easily be seen.

I have assumed that the signal input is a

tone signal for purposes of description. It will also be possible to impress on this monitor picture, transient currents corresponding to the start and stop of marking characters on the transmitter. This could be obtained by feeding the output of a radio frequency monitor rectifier to the input terminals. Thus, while the transmitter was either on marking or spacing, a steady current would flow through the input transformer winding and no deflection would be caused from this source. At the start and stop of characters this current would change and cause a transient deflection of the spot. In some cases this type of input signal may be found preferable to that of a tone signal.

Referring now to Fig. 2, I show a modified form of the invention in which the oscilloscope comprises a cathode ray tube 60 having a control grid 61 in addition to the usual electrodes as shown in the tube 31 of Fig. 1. The signal input to be monitored is fed through the amplifier 62 and across the capacitor 63 to the control grid 61.

A direct current power supply unit 64 furnishes the necessary operating potentials to the cathode ray tube 60, and to the amplifier 62. This same unit 64 may also be used to supply power to the variable low frequency oscillator 65, and to the amplifiers 56 and 57, although the connections thereto are not shown, due to the fact that these portions of the system may be of conventional design and Fig. 2 is largely a block diagram.

A potentiometer 66 is grounded at one point so that the negative terminal may connect through a reactor 67 to the control grid 61, thereby to bias the same strongly negative with respect to the grounded cathode 68.

Anode potential is fed directly from the source 64 to the anode 69 nearest the fluorescent screen of the cathode ray tube. A lesser positive voltage is derived from a tap on the potentiometer 66 and fed to the focussing anode 70. Any suitable anode potential may be taken off the potentiometer 66 and fed through a reactor 71 to the anode or anodes of tubes (not shown) in the amplifier 62.

The oscillator 65 functions in the same manner as the oscillator of Fig. 1. The output energy is fed partly through a resistor 72 to the amplifier 56 and partly through a phase adjuster unit 73 and a variable capacitor 74 to the amplifier 57. The amplifiers 56 and 57 are each provided with gain controls so that their output voltages may be equalized at any operating frequency.

In the operation of the system shown in Fig. 2 a circular path is traced by the "spot" on the oscilloscope screen due to the 90° phase difference between the potentials applied to the horizontal deflecting plates 34 and the vertical deflecting plates 35, respectively, these potentials being derived, as has been explained, from the low frequency oscillator 65. Impulses from the keying source, however, are fed through the amplifier 62 to the control grid 61 of the cathode ray tube. This grid is negatively biased to such an extent that the electron beam is blocked, say for spacing signals, and reaches the fluorescent screen only during marking signals. Different arcs of the circular path on the screen are, therefore, illuminated. The allotment of time to the marking signals of different channels can thus be compared by noting whether the illuminated arcs are longer or shorter than they should be for equalization of the channel time.

While I have confined the foregoing description substantially to two specific embodiments of the invention, it will be understood by those skilled in the art that various modifications may readily be made without departing from the spirit and scope of the invention itself.

I claim:

1. A monitor device for synchronous telegraph keying systems, comprising an electron discharge tube oscillator, a source of keying signals, a channel time unit distributor with which said keying signals are intended to be maintained in synchronism, means for adjusting the frequency of said oscillator to a value having substantially a sub-harmonic relation to the channel time unit frequency, a cathode ray tube oscilloscope having horizontal and vertical beam deflecting means, means for deriving from said oscillator potentials which have a 90° phase difference therebetween, means under control of said keying signals for splitting the impulses thereof into two voltages having a 90° phase difference, and means for superimposing each of the last mentioned voltages respectively on different voltages derived from the oscillator and for impressing the same respectively on the horizontal and on the vertical beam deflecting means thereby to produce an oscilloscope image having traces of concentric arcs whose subtended angles are indicative of the conditions to be monitored.

2. A device in accordance with claim 1 and having means including capacitive and resistive elements for producing the phase differentiated voltages which are respectively applied to the horizontal and vertical deflecting means.

3. An indicator for use in multiplex code signal keying systems, comprising a cathode ray oscilloscope having horizontal and vertical beam deflectors, a variable low frequency oscillator, means including a phase-splitting device for feeding energy from said oscillator to each of said deflectors, the potentials of said energy as fed to the different deflectors having a quadrature phase relationship to each other, and means for similarly splitting the phases of potentials derived from a code signal source and superimposing the last said potentials respectively on the oscillator potentials, thereby to produce an image pattern on the oscilloscope screen which image pattern is of differentiated radii and is indicative of the timing of impulses from said code signal source with respect to the potentials of a given synchronizing tone frequency.

4. In the operation of a synchronous multiplex telegraph transmitter having a monitoring device which includes an oscilloscope, and a low frequency oscillator, the method of indicating agreement with or departure from a given synchronizing frequency in respect to the timing of multiplex code signals, which comprises adjusting said oscillator to a frequency having an aliquot relationship to said synchronizing frequency, combining signal energy with the output energy from said oscillator, splitting the combined energy into quadrature phase differentiated potentials and causing the cathode ray of said oscilloscope to be deflected in rotary paths under control of said phase differentiated potentials, said paths being substantially restricted to arcs of two distinct and predetermined radii.

5. A monitor system for indicating a synchronous relationship between the alternating current output from an oscillator and the rhythmic impress of signal code elements on a telegraph circuit, said system comprising a cathode ray tube oscilloscope having horizontal and vertical de-

flecting circuits, a potential phase-splitting device under control of output energy from said oscillator and operable upon said deflecting circuits to produce a rotary scanning action of the electron beam in said oscilloscope, a second phase-splitting device coupled to said telegraph circuit, means for feeding potentials of one phase from said second phase-splitting device to one of said deflecting circuits, and means for feeding potentials of a quadrature-related phase from said second phase-splitting device to the other of said deflecting circuits, the overall effect upon said deflecting circuits being to obtain distortion of the rotary image pattern produced by said oscilloscope in dependence upon said synchronous relationship.

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