June 30, 1931. A. M. CURTIS 1,812,625

SIGNAL MONITORING DEVICE

Filed June 13, 1930 2 Sheets-Sheet 1

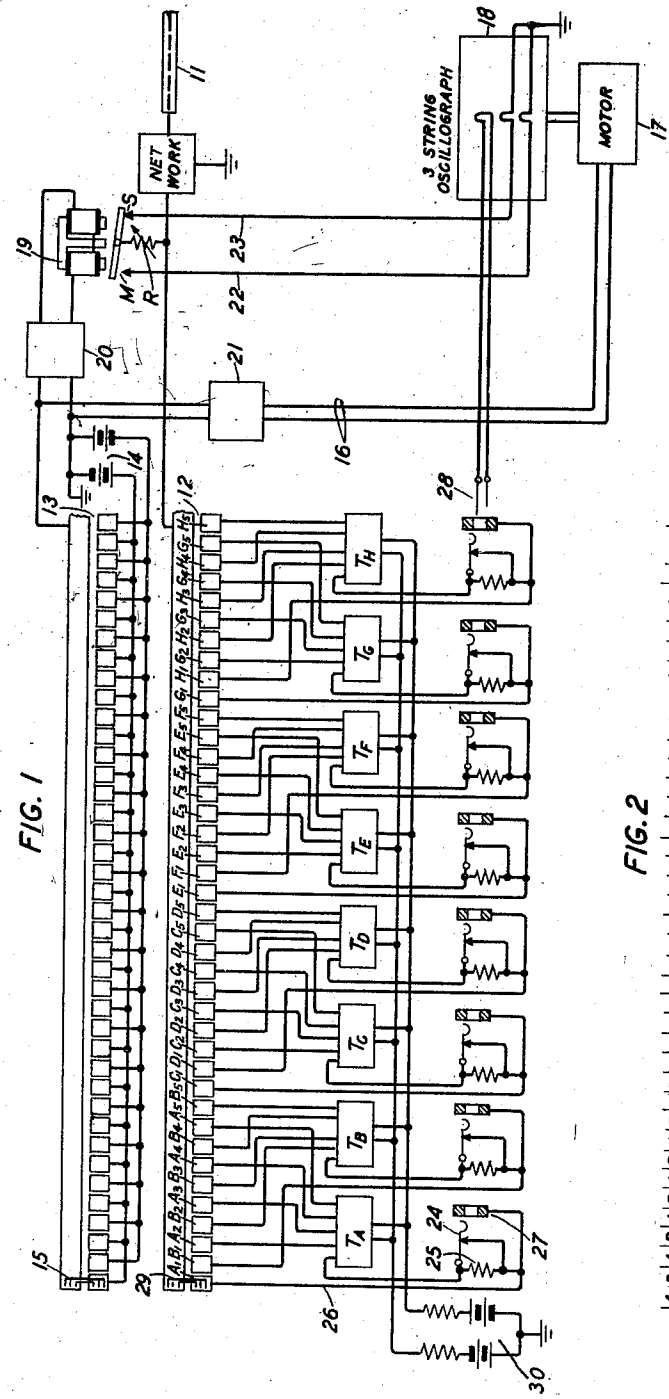

FIG. 1

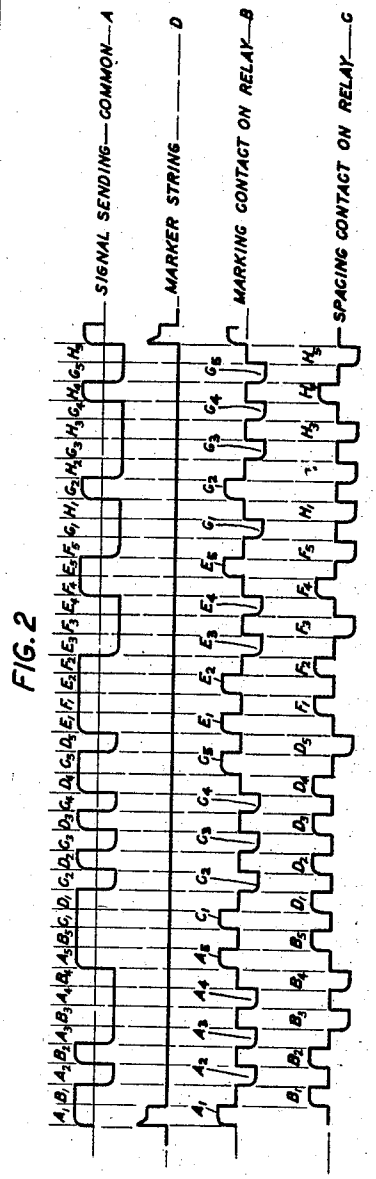

FIG. 2

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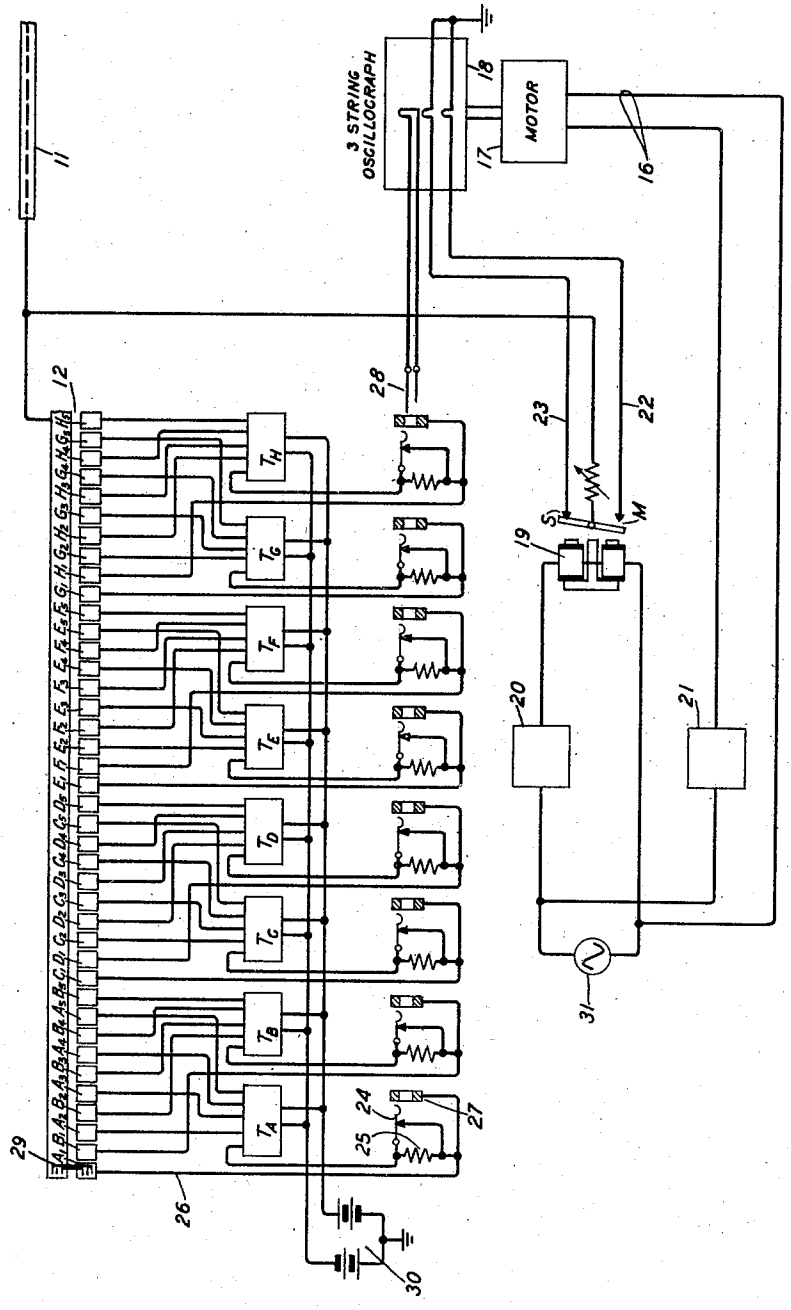

FIG. 3

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UNITED STATES PATENT OFFICE

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SIGNAL MONITORING DEVICE

Application filed June 13, 1930. Serial No. 460,846.

This invention relates to signaling systems and more particularly to submarine cable telegraph systems arranged for multiplex operation.

An important object of the invention is to secure, in systems wherein a single monitoring device is employed for a plurality of channels, an indication of the beginning of any one channel or group of channels.

Heretofore in systems wherein a single monitoring device such as a string oscillograph, has been employed for a plurality of channels, it has been very difficult to interpret the results of oscillograms taken of the signals in multiplex telegraph apparatus, as it is not possible, in the absence of any definite starting and stopping indications, to read the signal and to decide which pulses are associated with a certain channel.

The present invention obviates the greater part of this difficulty by providing a three string oscillograph whereof the third string may be adapted to be arbitrarily connected to any one of the circuits interconnecting the first contacts of the transmitters and the sending segments of a multiplex rotary distributor. Each of these circuits is equipped with a spring jack which normally maintains the circuits closed to permit the transmitter impulses to be impressed directly on the sending segments. By connecting the third string of the oscillograph to a two-wire plug suitable for insertion in any one of the jacks, a record may be had of the first impulse transmitted over any one channel thereby furnishing on the oscillograph paper an indication of the beginning of any channel.

In high speed submarine cable telegraph systems employing multiplex rotary distributors, means are provided for maintaining terminal apparatus at opposite ends of the system in synchronism. Ordinarily the terminal apparatus includes monitoring devices, such as string oscillographs at the sending end for the purpose of recording the nature of the signal impulses transmitted over the cable. However, as stated above, the present invention provides a single oscillograph of the three-string type for use on one or more channels of a system where the correction for synchronism is effected by electrical means such as disclosed in a copending application of W. A. Knoop, Serial No. 354,954, filed April 13, 1929, whereby the distributor and driving fork therein run in synchronism and an alternating current may be taken from some part of the driving fork circuit and impressed on a suitable relay which operates to permit the alternating current to be translated into pulses of the variety used in driving a phonic wheel timing motor for the string oscillograph. It may be necessary to employ a phase shifting circuit or a mechanical adjustment of some suitable type between the oscillograph motor and the source of alternating current for the purpose of enabling the timer lines, to coincide with the arrival of the brush of the distributor circuit concerned, on the front edge of the segments. Where the correction for synchronism is effected by mechanical means, such as disclosed in U. S. Patent 1,670,461, granted to G. A. Locke, May 22, 1928, an additional segmented ring set is provided on the sending distributor for the purpose of generating an alternating current of a frequency appropriate to drive the timing motor of the oscillograph at such a speed that the occulting vanes will mark the segment lengths on the oscillograph paper. Both of these arrangements wherein different correcting means are employed, will permit an oscillogram of a multiplex signal to be made in which the segment positions are plainly marked. However, the signal will still be illegible as no starting or stopping points for channels will be indicated, but this difficulty is obviated by the present invention as stated above.

In cases where the channels are divided into groups and the line impulses of the channels of each group are interleaved for transmission over the cable, the first line impulse of one channel is immediately followed by the first line impulse of another channel which in turn is followed by the second line impulse of the first channel, and so on. This makes the reading of the oscillogram much more difficult. This difficulty is also overcome by the present invention by employing

a high speed alternating current electromagnetic relay arranged to be driven by the current which drives the timing motor of the oscillogram in synchronism with the fundamental frequency of the line signals. The timer strings used to record the line signals on the oscillograph paper will be connected through the armature and contacts of the relay to the sending distributor rings, the timer strings being respectively connected to the relay contacts. The timer strings are each disconnected alternately from the sending distributor rings during one-half of a signal frequency, thus allowing each string to respond to the line impulses of only one of the channels in each group.

This invention will be better understood from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

Fig. 1 illustrates schematically a preferred embodiment of the invention applied to a system wherein the transmission channels are divided into groups and the line signals of one channel are interleaved with those of another channel in the same group for transmission over a submarine cable;

Fig. 2 is a series of curves representing the operation of the arrangement shown in Fig. 1;

Fig. 3 is a modification of Fig. 1.

Like parts are designated by like numbers.

Referring to Fig. 1, the arrangement shown is a schematic layout of the sending equipment of a multiplex submarine cable printing telegraph system adapted for eight channel transmission wherein the transmitters are divided into four groups of two each. The arrangement provides for producing on an oscillograph an indicating record of the first line impulse impressed on the cable by each transmitter. The eight transmitters T_A to T_H inclusive are arranged so that T_A and T_B form the first group, T_C and T_D form the second, T_E and T_F form the third, and T_G and T_H form the fourth. The transmitters are connected to cable 11 through sending distributor ring set 12 which for the purpose of illustration is shown developed. The sending ring set comprises a solid or a continuous ring and a segmented ring consisting of forty segments, ten for each group of two channels or five for each channel to correspond to the five pulse code usually employed in multiplex systems. The five contacts of transmitter T_A are respectively connected to the first, third, fifth, seventh and ninth segments, or those designated A_1 to A_5, and the five contacts of transmitter T_B are respectively connected to the second, fourth, sixth, eighth and tenth segments, or those designated B_1 to B_5. In like manner the five contacts of each transmitter of the remaining groups are respectively connected to the remaining alternate segments or those designated 1 to 5 of their corresponding letters. Thus, the line impulses originating in transmitter T_A, when impressed on the cable 11, are interleaved with those of transmitter T_B and the line impulses originating in transmitter T_C are interleaved with those of transmitter T_D, and so on, for the remaining groups of transmitters.

Assuming that correction for synchronism is effected by mechanical means such as disclosed in Locke U. S. Patent 1,670,461 supra, an additional ring set 13 having a continuous and a segmented ring is provided on the sending distributor. The segments of ring set 13 are equal in number and angular length to the segments of ring set 12. Ring set 13 is orientable with respect to ring set 12 for the purpose of permitting adjustment of the incidence of timer lines as stated previously. The alternate segments of ring set 13 are interconnected to form two groups which are respectively connected to opposite poles of battery 14 having a mid-tap to ground. Therefore, brush 15 which continuously rotates over ring set 13 causes to be generated in circuit 16 an alternating current of a frequency appropriate to drive the phonic wheel timing motor 17 of the three-string oscillograph 18, at such a speed that the occulting vanes of such motor will mark segments lengths on the oscillograph paper. The alternating current generated by the rotation of brush 15 is also impressed on the operating circuit for a polarized relay 19, the armature of which vibrates, in response to the generated alternating current, between its associated contacts M and S. Any discrepancy in proper phase relation between the generated alternating current and the timing motor 17 may be corrected by orienting ring set 13. An analogous phase discrepancy between the position of the timing motor vanes and the operation of the relay armature may be independently adjusted by phase shifter 20. In case ring set 13 is fixed, that is, not orientable, it may be necessary to insert an additional phase shifting device 21 in the operating circuit for motor 17 as shown.

The armature of relay 19 is connected to a conductor interconnecting the continuous ring of the sending set 12 and cable 11 and the relay contacts M and S are respectively connected by conductors 22 and 23 to the two monitoring strings of the oscillograph, thus allowing each monitoring string to respond to impulses impressed on the cable by the alternate transmitters. In this way, records of the two groups of alternate transmitters are made on separate curves, each divided into intervals of segment length by the lines produced by the light occulting vanes of the timing motor. Zero intervals on one curve occur during the recording of the transmitted impulses of the other curve.

The third or marker string which is shown

uppermost in the drawing, is provided in the oscillograph in order to indicate the first impulse impressed on the cable by each transmitter thereby providing a means for indicating on the tape the starting of any one channel. The circuit of the first transmitted impulse of the first channel may be traced from the first contact of transmitter T_A, normally closed contact 24 and resistance 25 in parallel, conductor 26, segment A_1 of ring set 12 to cable 11. This circuit is closed only when the rotating brush 29 engages segment A_1. Each of the circuits of the remaining contacts of transmitter T_A, as well as all the contacts of each of the remaining transmitters are subsequently closed in turn as brush 29 subsequently engages the remaining segments in succession. It is well understood in the art that the closure of each of these circuits impresses either a spacing or marking impulse on the cable 11, depending on the position of the corresponding transmitter contact at the time.

The means provided for cooperating with the third string of the oscillograph comprises a spring jack 27 for each of the circuits for transmitting the first impulse from each transmitter, the jacks being connected intermediate the transmitters and the sending distributor segments, and a two-wire (tip and sleeve) plug 28, common to all spring jacks 27, which is connected to the third string. Contacts 24 are adapted to be opened by the insertion of plug 28 into jack 27, and when the plug is inserted, resistance 25 regulates the amount of current flowing through the third string at the time brush 29 passes over the segment connected to conductor 26.

Should it be desired to determine the beginning of any channel in the record produced on the oscillograph, the plug 28 is inserted into jack 27 of the desired channel, in order that a portion of the current of the first transmitted impulse on the particular channel may flow through the third string to produce on the oscillograph paper an indication in alignment across the tape of the corresponding impulse sent out over cable 11. In this way the first transmitted impulse of any channel may be determined at a glance.

Operation of Fig. 1

A better understanding of Fig. 1 may be had by referring to Fig. 2 wherein curve A represents the signal wave sent by transmitters T_A to T_H when brush 29 rotates over the segments of ring set 12, it being noted that the signal impulses of one transmitter in each group are respectively interleaved with those of another in the same group. The curve B shows the voltage wave of the signal impulses successively transmitted by transmitters T_A, T_C, T_E and T_G as recorded by the circuit consisting of resistance R, the left-hand contact of relay 19, conductor 22, and the lowermost string of the oscillograph, it being noted that the duration of each impulse corresponds to the length of the segments of ring set 12, and that each impulse is followed by a zero interval of the same duration. Curve C shows the nature of the signal impulses successively transmitted by transmitters T_B, T_D, T_F and T_H, and recorded by the circuit consisting of resistance R, the right-hand contact of relay 19, conductor 23 and the middle string, it being noted that the impulses occur during the zero intervals in the wave shown in curve B. Thus, separate records are obtained of the signal impulses impressed on the cable 11 by the two groups of alternate transmitters. However, with no further indication there is no means of determining on these records the starting point of any particular channel. But with a third record in perfect alignment with the signal records, indicating the point at which the first transmitted impulse of a certain channel occurs, the starting point of any channel may be readily discernible. Assuming that it is desired to read the signal impulses transmitted by transmitter T_A, plug 28 is inserted into jack 27 connected to transmitter T_A and the first impulse transmitted by transmitter T_A appears in the uppermost record as depicted in curve D of the Fig. 2, this impulse appearing every time brush 29 passes over segment A_1. In like manner the first impulse of any of the other transmitters may be produced in the third record by inserting plug 28 into jack 27 connected to the particular transmitter.

Fig. 3 which shows a modification of Fig. 1, provides an arrangement suitably adapted in systems wherein electrical means for correcting for synchronism are employed and the distributor and the driving fork are run in synchronism. In this arrangement the alternating current for driving the phonic wheel timing motor 17 for oscillograph 18 at such a speed that the occulting vanes will mark segment lengths on the oscillograph paper, is taken from some point 31 of the driving-fork circuit. In this case the additional ring such as ring set 13 of Fig. 1 is not required. A suitable relay 19 operates in response to the alternating current in the same manner as described above. Likewise, phase shifting devices 20 and 21 may be necessary to permit proper adjustment of the incidence of the timer lines on the oscillogram with the passage of the brush onto the leading edge of the segments and the operation of the relay contacts.

Ordinarily the oscillographs used in high speed printing telegraph systems are provided with recording cameras, but they may also be furnished with visual observation devices (not shown) which could be used, at times, in place of the cameras, it being arranged to drive the motor for the mirror in each of

said devices at a certain fixed relation to the frequency of the current driving the timing motor 17 and the distributor 12. When no messages are being transmitted, certain repeated signals such as "spacing" letters R and Y alternately, or similar combinations, are being sent at the time, visual observations extending over several minutes might be made for the purpose of detecting failures which occur only at long intervals.

What is claimed is:

1. In a multi-channel impulse transmission system, a monitoring device common to all channels thereof, characterized in this, that means are provided for indicating a definite point in any channel in the monitor record of a plurality of channels.

2. In a multi-channel signaling system, a monitoring device, a rotary distributor and means respectively connected to one segment only of channels on said distributor, said means being capable of producing pulses to indicate on the monitor record the location of a particular channel.

3. In a multi-channel signaling system, a monitoring device, a rotary distributor, means included in the circuits respectively connected to the first segments only of channels on said distributor, to cause a pulse to be produced for any one channel so connected, to indicate on the monitor record the beginning of the channel.

4. In a multi-channel signaling system in accordance with claim 3, wherein each of said means comprising a spring, jack arranged to be operated by a single plug.

5. In a multi-channel impulse transmission system, a multiplex rotary distributor and a single monitoring device comprising a plurality of vibrating elements, some of said elements being arranged to make separate records of the impulses transmitted over each channel, and another of said elements being arranged to make a record of the first impulse transmitted over any one channel to identify the beginning of the channel on said records.

6. In a multi-channel impulse transmission system in accordance with claim 5, wherein the monitoring device is a multi-string oscillograph including an interval marking device driven in synchronism with said distributor.

7. In a multi-channel impulse transmission system wherein the impulses of one channel are interleaved with those of another channel for transmission over a high speed cable, a multiplex rotary distributor, a monitoring device comprising a plurality of vibrating recording elements, and means connected intermediate said distributor and said cable for transmitting impulses of one of said interleaved channels to one of said vibrating recording elements and for transmitting the impulses of another of said interleaved channels to another of said vibrating recording elements, a third vibrating recording element in said device being arranged to record one impulse only of one of said channels to indicate the position of the particular channel on the monitor record.

8. In a multi-channel impulse transmission system, a synchronously driven rotary distributor for interleaving the impulses of one channel with the impulses of another channel, a single operating device for separating said interleaved transmitted impulses into groups corresponding to their respective channels, arranged to be driven in synchonism with said distributor, a monitoring device for recording the transmitted impulses of each group separately, separate driving means for said distributor and said monitoring device, means for generating an alternating current of the same frequency as that of said distributor motor to operate said monitoring device motor, and means in said monitoring device for indicating the position of any one channel on the record.

9. In a multi-channel impulse transmission system in accordance with claim 8 wherein the separating device consists of a mechanical relay.

In witness whereof, I hereunto subscribe my name this 27th day of May, 1930.

AUSTEN M. CURTIS.