June 1, 1926.

1,586,966

A. A. CLOKEY

SYNCHRONIZING SYSTEM

Filed June 25, 1924

Fig. 1

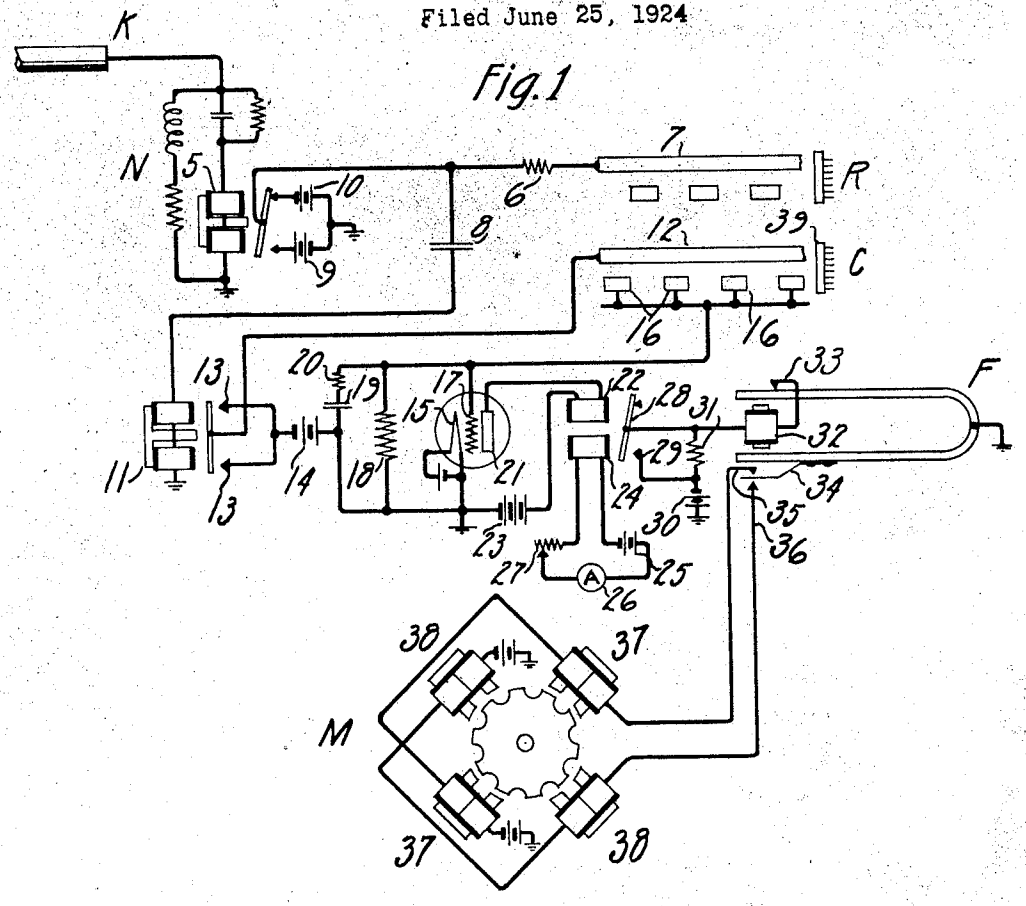
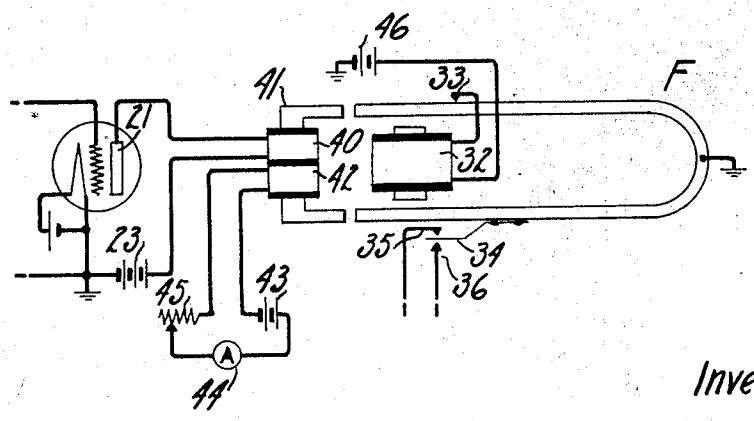


Fig. 2



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UNITED STATES PATENT OFFICE.

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SYNCHRONIZING SYSTEM.

Application filed June 25, 1924. Serial No. 722,198.

This invention relates to synchronizing systems, and has for its object a system for maintaining in very accurate synchronism motor driven mechanisms located at the distant ends of a signaling transmission line. The invention as illustrated herein, and it is particularly designed to be utilized, is embodied in a printing telegraph system of the usual multiplex type, in which distributors are located at distant stations at the ends of a single transmitting circuit, which distributors associate the circuit simultaneously with the corresponding transmitting and receiving elements at the distant stations.

In order that the receiving mechanism at one station may be associated with the signal circuit at that station during the same period of time that the transmitting mechanism at the other station is connected to the signaling circuit, some means must be provided for maintaining the respective distributors in synchronism.

Various synchronizing systems have been proposed which operate satisfactorily in multiplex telegraph systems employing not more than four transmission channels. However, there has recently been developed a continuously loaded submarine cable which is capable of operating at much higher speeds than have been possible heretofore, and, to attain the maximum efficiency with this cable, it is desirable to employ six or more transmission channels, in which case it is neccessary to provide more accurate means for correcting the speed of the distributors.

To obtain this desired accuracy of correction, and in accordance with a feature of the present invention, the line relay, when operated by signaling impulses transmitted over the line, serves in conjunction with the correcting segments of the distributor to control the input circuit of a vacuum tube, the output circuit of which is employed to regulate the frequency of the mechanism driving the distributors.

This and other features of the invention may be more clearly understood by reference to the accompanying drawing, in which Fig. 1 discloses the apparatus employed at the corrected station for maintaining accurate synchronism, only such apparatus being shown as is essential to a clear understanding of the present invention; and Fig. 2 shows a modification of the arrangement disclosed in Fig. 1.

Referring to the drawing, the cable K is connected to ground through a suitable shaping network N and the windings of relay 5. The armature of relay 5 is connected through a suitable resistance 6 to the common ring 7 of the receiving ring R of the distributor and also to one terminal of condenser 8. In its alternate positions, the armature of relay 5 is adapted to be connected respectively to the positive terminal of grounded battery 9 or the negative terminal of grounded battery 10. The condenser 8 is connected to ground through the windings of an impulse relay 11, the armature of which is normally maintained in a central position and is connected to the common ring 12 of correcting ring C of the distributor. The contacts 13, 13 of impulse relay 11 are connected to the negative terminal of battery 14, the positive terminal of which is connected to the filament 15 of a vacuum tube amplifier and to ground. The correcting segments 16, 16 of correcting ring C are connected together and to the grid 17 of the vacuum tube amplifier. Bridged across the input circuit of this amplifier is a high leak resistance 18 in parallel with a condenser 19 and resistance 20 connected in series. The plate 21 of the amplifier is connected in series with a winding 22 of the correcting relay and battery 23. The other winding 24 of the correcting relay is connected in series with the battery 25, indicator 26 and variable resistance 27. The armature 28 of the correcting relay is adapted in its operated position to engage contact 29, which is connected to ground through battery 30. Bridging the armature and contact 29 is the correcting resistance 31, which is thrown in and out of circuit by the operation of the relay. The armature 28 of the correcting relay is connected through the operating magnet 32, contact member 33 to one of the tines of the grounded tuning fork F. The other tine of fork F carries a contact spring 34, which alternately engages contacts 35 and 36 connected to alternate electromagnets 37, 37 and 38, 38, respectively, of the Lacour driving motor M.

In the modification shown in Fig. 2, the plate 21 of the vacuum tube amplifier and the battery 23 are connected to winding 40 of an electromagnet having a U-shaped core

member 41, the pole faces of which are in close proximity to the tine ends of vibrating fork F. A second winding 42 is provided on core 41 and is connected in series with a battery 43, indicating device 44 and variable resistance 45. One terminal of the operating magnet 32 of the fork F is connected through contact 33 to one of the tines which is grounded, while the other terminal of this electromagnet is connected through a battery 46 to ground.

In the operation of the device, the signaling impulses transmitted over cable K pass through the shaping network N and through the windings of line relay 5. Each time the line relay armature moves from one of its contacts to the other in response to a reversal of line current, the sudden rush of current in the circuit containing condenser 8 and the winding 11 of the impulse relay causes the armature of impulse relay 11 to momentarily make contact with one of the contact members 13, 13 and the negative terminal of battery 14 is thus connected to the common segment 12 of the correcting ring C of the distributor. The duration of this impulse may be varied somewhat by varying the capacity of condenser 8. If this impulse occurs at the instant when the brush 39 is passing over one of the segments 16, 16, a circuit is completed from the negative terminal of battery 14 through one of the contacts 13, common ring 12, brush 39 and segment 16 of correcting ring C, and then in parallel through the leak resistance 18 and the resistance 20 and condenser 19 in series to the positive terminal of battery 14, thus charging condenser 19 and causing negative potential to be applied to the grid 17 of the amplifier, thereby resulting in a reduction in the value of space current flowing in the output circuit of the amplifier. The current flowing in the winding 24 of the correcting relay is adjusted by means of the variable resistance 27 so that with a normal space current flowing in the winding 22, the armature 28 will be maintained in its operated position, thus shortcircuiting the correcting resistance 31 and causing the driving fork to run slowly. However, as the armature 28 falls back to its unoperated or fast position, as shown, due to the current in the amplifier output circuit being reduced by the application of a negative potential on the input circuit, resistance 31 is connected in series with the winding of the operating electromagnet 32, thus reducing the operating current and causing the fork to increase in frequency. The fork then continues to run fast until such time as the charge on condenser 19 shall have leaked off through resistance 18, when relay armature 28 will again return to its slow or operated position. It will, therefore, be apparent that so long as the correcting brush 39 lags behind the position for true synchronism, the condenser 19 will be repeatedly charged and result in holding armature 28 in a fast position, but just as soon as brush 39 returns to its true position, the charging impulses will cease to be impressed upon condenser 19 and armature 28 will return to its slow position.

The required degree of accuracy of correction may be obtained by properly adjusting condenser 19 and resistances 18 and 20 in the input circuit of the amplifier so that the time required for the discharge of condenser 19 is sufficient to permit the operation of electromagnet 22. It should be noted that this arrangement differs from other synchronizing systems in that the accuracy of correction is not dependent upon the time required for current to increase to a value that will operate an electromagnet, but is determined solely by the time required to build up a charge on condenser 19. Thus, if the brush 39 is on one of the slow segments 16 at the instant the armature of the impulse relay engages one of the contacts 13, the frequency of the fork is corrected in the right direction even though the brush at that instant was just on the point of leaving the segment 16.

In the modified arrangement of Fig. 2, the input circuit is varied in the same manner as in the arrangement just described. This variation produces a change in the current flowing through the winding 40 of the electromagnet, the core of which is provided with pole faces mounted in close proximity to the ends of the fork tines. There is thus produced a varying magnetic field which exerts a damping action on the fork tines in the manner disclosed and claimed in my co-pending application Serial No. 683,304, filed December 29, 1923. The effect of the second winding 42 of the electromagnet is to produce a constant magnetic flux in core 41 and by means of the adjustable resistance 45, the current through this winding is adjusted until the combined effect of the two windings with the normal space current flowing through winding 40 is such as to cause fork F to vibrate at a frequency slightly below that of the driving fork at the distant station.

What is claimed is:

1. In a synchronizing system, an amplifier, a distributor means responsive to signaling impulses transmitted over the line for charging a condenser, means controlled by the charging of said condenser and cooperating with said distributor for varying the potential across the input circuit of the amplifier, a driving mechanism, and means responsive to variations in the output circuit of the amplifier for varying the frequency of said driving mechanism.

2. In a synchronizing system, a vacuum

tube amplifier, a distributor, means responsive to reversals of line current for varying the potential impressed on the grid circuit of the amplifier, said grid circuit and distributor cooperating to control the time required to vary the current in the plate circuit of said vacuum tube amplifier, a driving mechanism, and electromagnetic means responsive to variations in the output circuit of the amplifier for varying the frequency of said driving mechanism.

3. In a synchronizing system, an amplifier, a line relay responsive to signal impulses transmitted over the line, a condenser charged by the operation of the line relay, an impulse relay in the charging circuit of said condenser, means under the control of said impulse relay for varying the potential across the input circuit of the amplifier, a driving mechanism, and means responsive to changes in the output circuit of the amplifier for varying the frequency of said driving mechanism.

4. In a synchronizing system, a rotary distributor to be driven in synchronism with a similar distributor at a distant station, a line relay, a condenser charged by the operation of said relay, an impulse relay in the charging circuit of said condenser, an amplifier, a condenser bridged across the input circuit of said amplifier, a correcting ring on the distributor cooperating with said impulse relay to impress a potential across said condenser, a mechanism for driving the distributor, and means in the output circuit of the amplifier for varying the frequency of said driving mechanism.

5. In a synchronizing system, an amplifier, means responsive to signaling impulses transmitted over the line and including a distributor for varying the potential across the input circuit of the amplifier, said potential being applied substantially independent of the time of contact of said distributor, a driving mechanism and an electromagnet in the output circuit of the amplifier for controlling the frequency of the driving mechanism.

6. In a synchronizing system, an amplifier, means responsive to signaling impulses transmitted over the line for varying the potential across the input circuit of the amplifier, a driving mechanism, and electromagnet having a pair of windings, one of said windings being connected in the output circuit of the amplifier, the other of said windings being adjustable to control the operation of said electromagnet with a normal space current flowing through the first of said windings.

7. In a synchronizing system, a driving mechanism, an amplifier, means under the control of the output circuit of the amplifier for varying the speed of the driving mechanism, and means responsive to signaling impulses transmitted over the line and independent of the time required for the operation of said speed varying means to control the input circuit of the amplifier.

8. In a synchronizing system, a line relay responsive to signaling impulses transmitted over the line, a plurality of correcting segments, and means under the control of said relay and cooperating with the correcting segments to store up momentary current impulses and subsequently slowly release the energy of said impulses to control the frequency of a driving mechanism.

In witness whereof, I hereunto subscribe my name this 24th day of June A. D., 1924.

ALLISON A. CLOKEY.