Aug. 30, 1932. H. H. HAGLUND 1,874,187

AUTOMATIC MEANS FOR CHANGING TIMING INTERVALS

Filed Dec. 4, 1930 3 Sheets-Sheet 1

FIG. 1

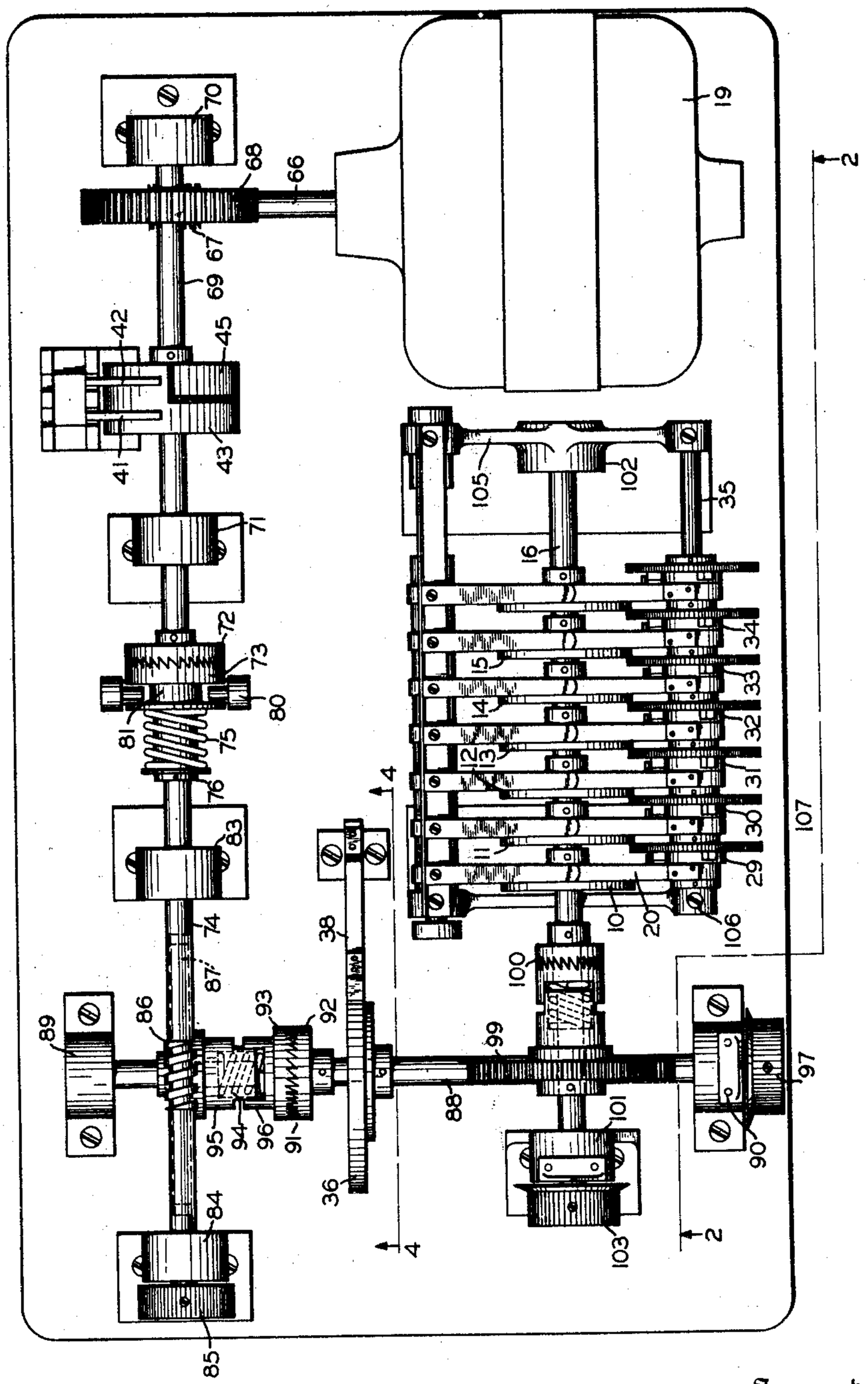

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FIG. 2

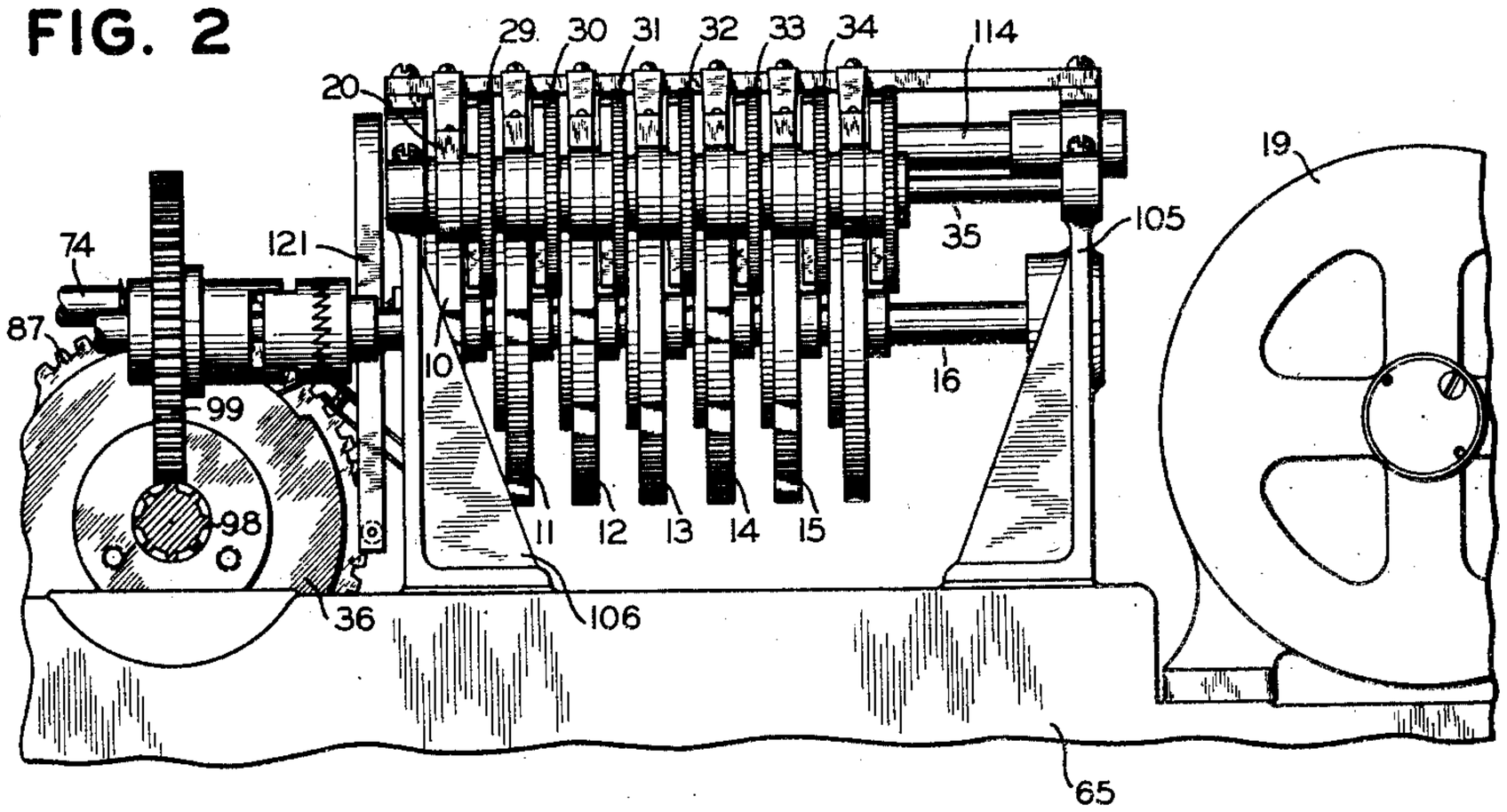

FIG. 3

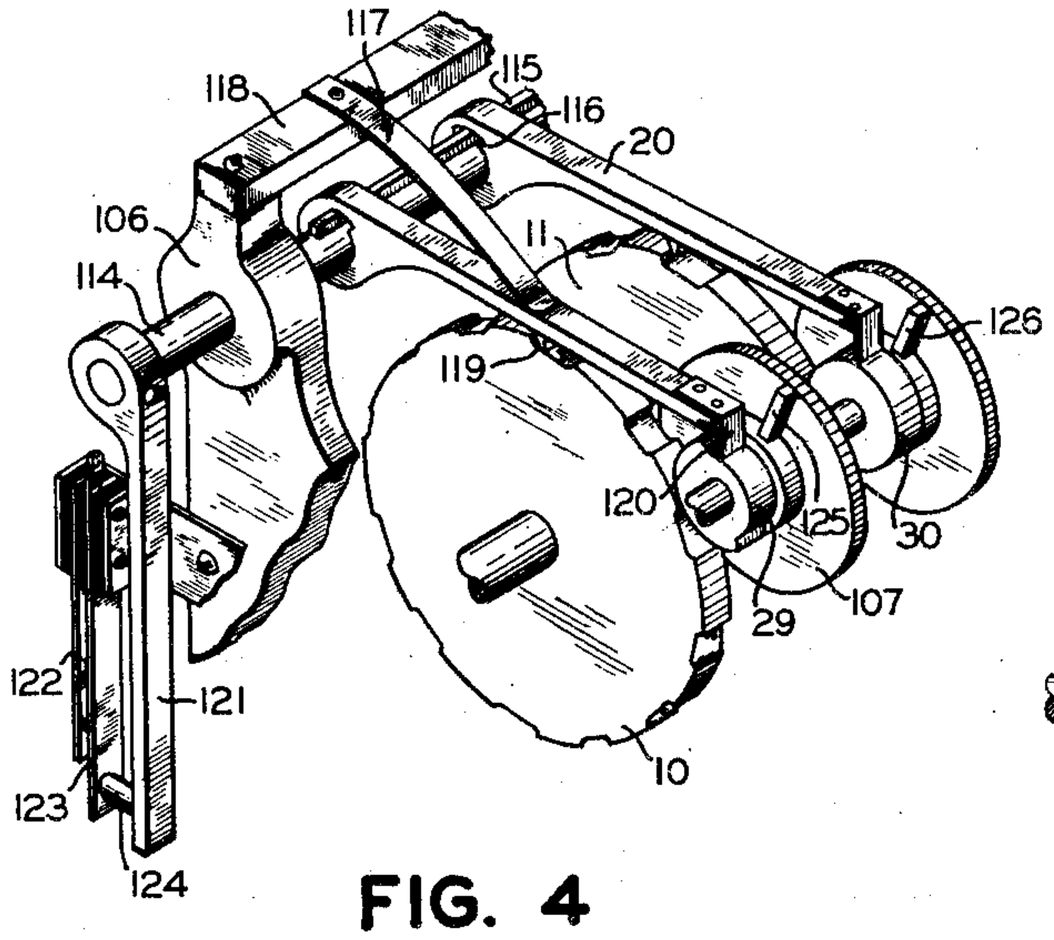

FIG. 4

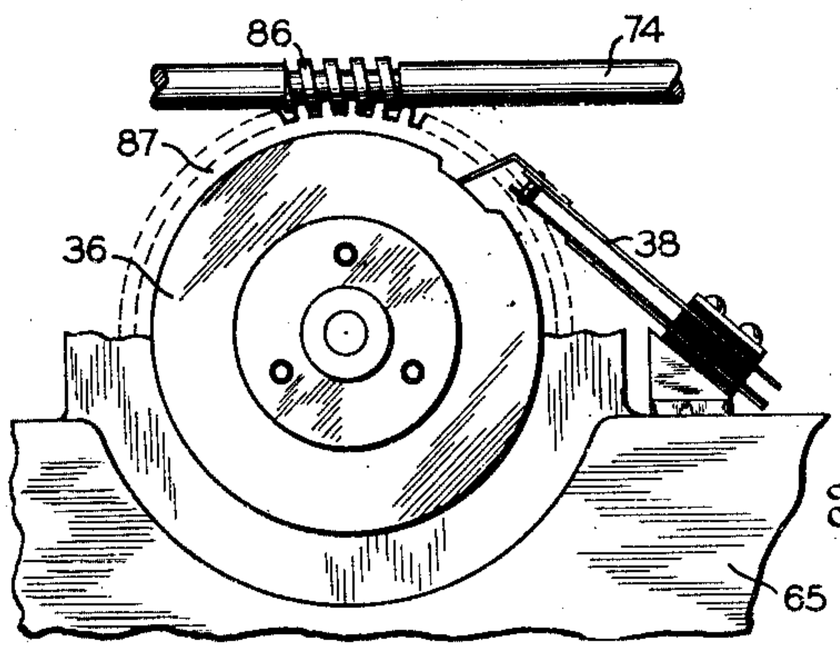

FIG. 5

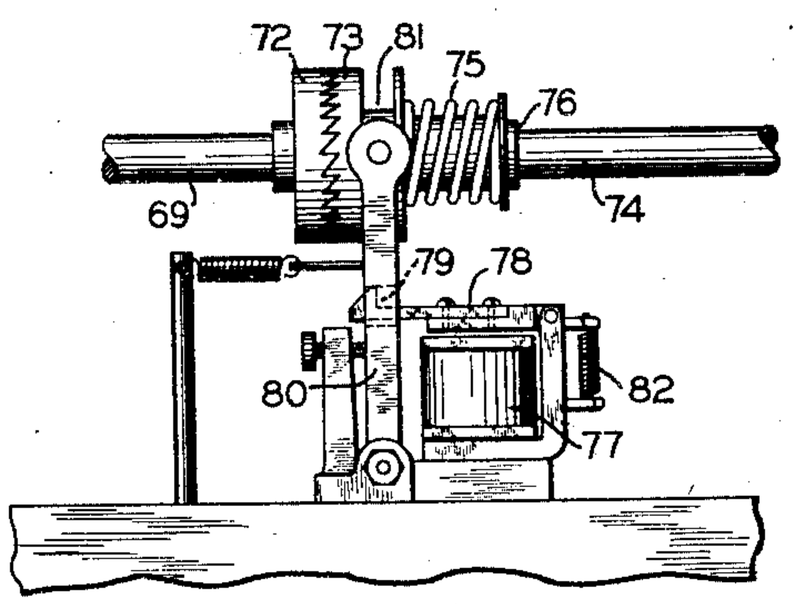

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FIG. 8

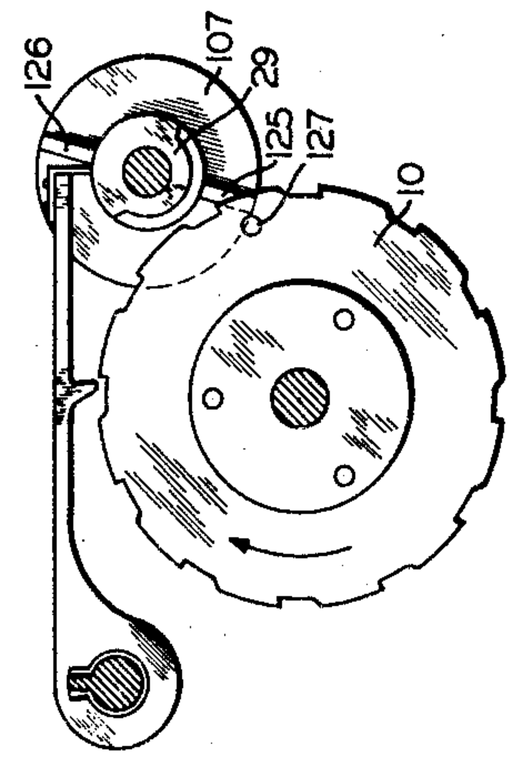


FIG. 7

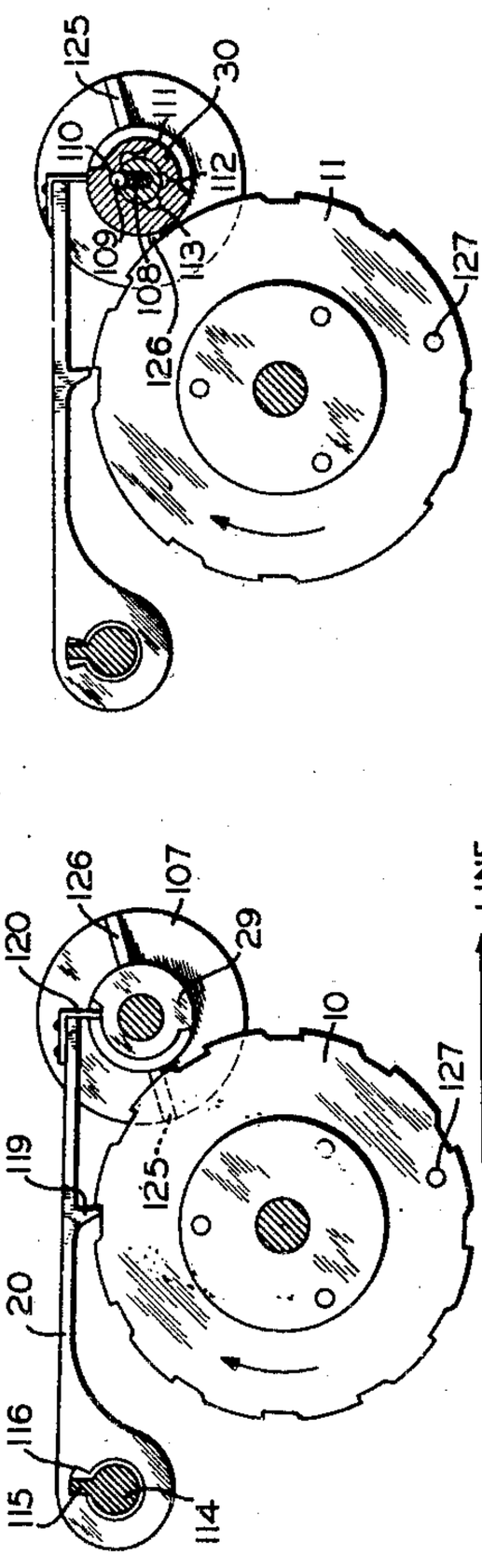
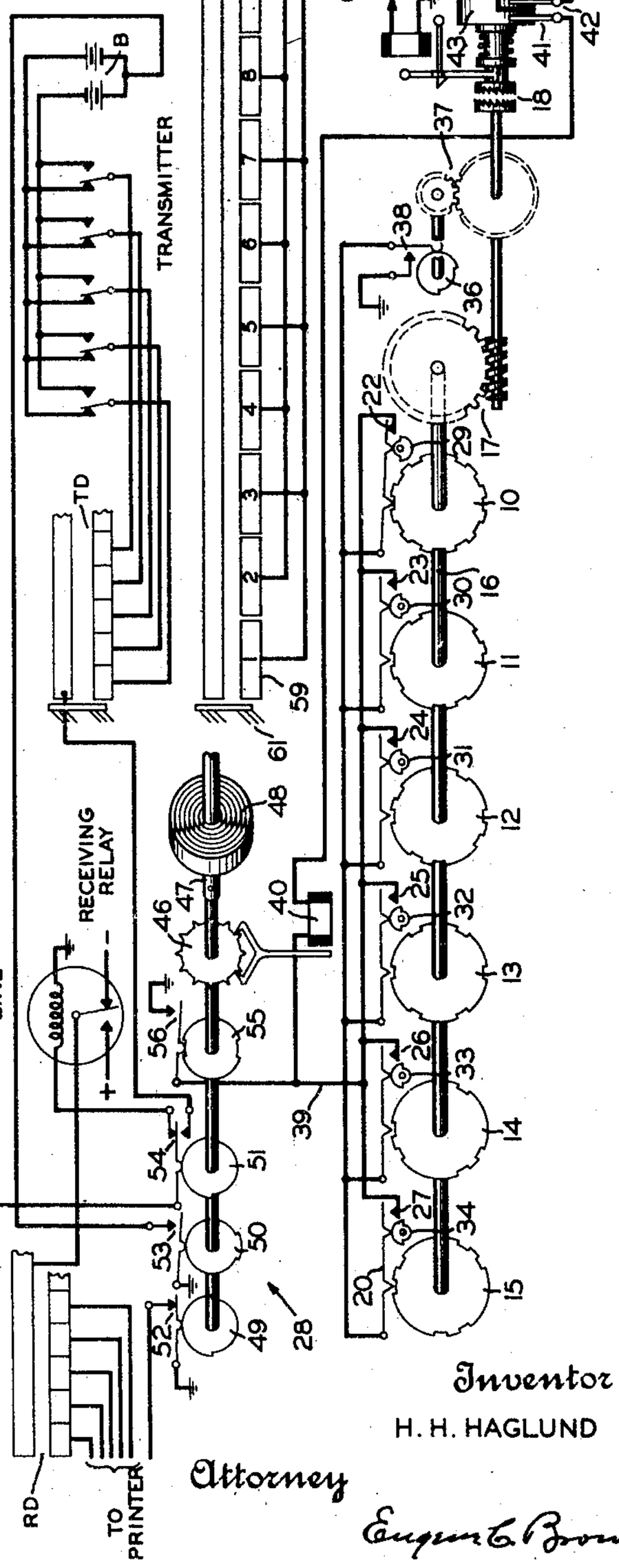


FIG. 6



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UNITED STATES PATENT OFFICE

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AUTOMATIC MEANS FOR CHANGING TIMING INTERVALS

Application filed December 4, 1930. Serial No. 500,106.

This invention relates to automatic telegraphic transmission over transmission lines and more particularly to mechanism for determining the periods of reversal of the direction of signaling over submarine cables.

The present day developments, in the field of loaded submarine cables, have made it possible to employ cables having electrical characteristics which permit of a speed of operation far in excess of any speed used heretofore over unloaded cables. At such high operating speeds difficulty is experienced however in constructing and adjusting an artificial line which will simulate the real cable with sufficient accuracy to permit duplex operation at the possible speeds of transmission over the cable and in some installations it has been the practice to operate the cable in one direction only at a time and to provide some means for automatically reversing the direction of transmission at frequent intervals.

In Patent #1,681,489 granted August 21, 1928, to Locke and Haglund, such a system for automatically reversing the direction of transmission over the cable at periodic intervals, by means of timing devices located at each station, is disclosed. In this patent, the reversing mechanism consists briefly of a series of switch actuating cams, driven by a friction clutch from an electric motor through an escapement mechanism. The timing device comprises a second series of switch operating cams, driven at different speeds through reduction gearing from the rotary distributor, the timing device serving first to complete a circuit, to start the driving motor of the reversing mechanism just prior to the time of reversing the direction of transmission, then to complete a pulsing circuit for the escapement magnet of the reversing mechanism at the exact predetermined switching time and finally to interrupt the motor circuit after the transmitting circuit connections have been reversed.

The timing cams are arranged so that they complete a cycle, that is, make a complete revolution in about twelve minutes. The traffic conditions do not remain constant throughout the day but are continuously changing so that at certain periods there may be a much greater demand for traffic in one direction than in the other and at other periods the bulk of the traffic may be in the opposite direction. To meet the requirements of such changing traffic conditions, a number of timing cams may be provided, coded to different periods of transmission in each direction. For instance, one cam may provide for transmission one minute east and one minute west; another may provide for transmission two minutes east and one minute west, another, one minute east and three minutes west, etc. The cams are arranged so that any cam may be manually selected to control the periods of transmission in each direction. A precision timing cam determines the exact time of reversing the circuit connections.

With the system set forth in the Locke-Haglund patent, when the cable dispatcher desires to change the period of transmission or timing interval, a message is sent out from one station instructing the operator or attendant at each of the terminal and repeater stations to manually change from one timing cam to another designated one. The change must be made within the same minute at every cable station concerned, the instructions usually specifying the change to be made at the next "zero", that is, at the end of the twelve minute cycle.

Since the message ordering the change may be received several minutes before the "zero" position is reached, the attendant in charge of the equipment at one or the other of the stations may become occupied with other work and consequently forget to make the change at the proper moment. This causes the stations to lose synchronism and delays starting up the circuit again.

It is one of the objects of the present invention to overcome this difficulty and to provide a timing mechanism which is semi-automatic in character, that is, in which means may be set manually during any portion of the cycle for automatically changing the control from cam to another at the end of the cycle.

Another object is to maintain the timing

mechanism at all stations accurately in synchronism.

Another object is to provide a simple and convenient means of adjusting the coded and precision cams relative to each other and to the driving means.

Other objects and advantages of the invention will appear hereinafter.

In accordance with the present invention an auxiliary cam is provided for each timing cam and the individual cam follower, associated with each timing cam, is so constructed that its motion may be controlled both by the timing cam and the auxiliary cam. Whenever a change is to be effected in the timing interval, the auxiliary cams serve to actually raise one of the cam followers from its timing cam and to lower another of the cam followers on to its timing cam at the end of the cycle. The auxiliary cams may be set manually at any time during the period of revolution of the timing cams, that is, immediately upon receipt of the dispatcher's message, but will not be effective to make the transfer until during the last minute of the cycle.

The timing cams are preferably rotated through reduction gearing by an electric motor, the speed of which is accurately maintained in direct relation to the speed of the transmitting distributor, by electrical impulses produced by a local ring of the distributor.

The invention will be more fully understood by reference to the accompanying drawings in which:

Figure 1 is a plan view of a timing mechanism embodying the present invention;

Figure 2 is a front elevation thereof;

Figure 3 is a perspective view showing two of the timing cams and their auxiliary cams and cam followers;

Figure 4 is a sectional view on the line 4—4 of Figure 1, showing another of the timing cams;

Figure 5 is a side elevation of the main operating clutch for starting the operation of the cams in unison at each station;

Figure 6 is an elevation view of one of the timing cams, showing the auxiliary cam positioned so as to raise the cam follower at the end of the cycle;

Figure 7 is an elevation view, showing the auxiliary cam arranged to lower the cam follower on to the timing cam at the end of the cycle;

Figure 8 is an elevation view, showing the relative position of the timing and auxiliary cams of Figure 6, at the end of the cycle; and

Figure 9 is a diagrammatic view of the timing mechanism and circuit reversing mechanism.

Referring first to Figure 9, I have shown the timing mechanism diagrammatically, as consisting of a series of six cams, 10, 11, 12, 13, 14 and 15, rigidly mounted upon a common shaft 16, driven preferably at a speed of one-twelfth R. P. M. through reducing gearing 17, and a ratchet clutch 18, from a combined D. C. and A. C. motor 19. Each cam is provided with a cam follower 20 adapted, when the follower engages a depressed portion of its cam, to close its associated contact. The cams are each provided with a different arrangement of raised and depressed portions whereby as the cam shaft revolves at a uniform rate each of the switches 22 to 27 may be closed at different intervals. Cam 10, for instance, is coded so as to close the switch 22 once each minute, to control the reversing mechanism, indicated generally at 28, to effect transmission one minute east and one minute west. Cam 11 effects transmission one minute east and two minutes west, cam 12 is coded for transmission two minutes east and one minute west, cam 13 two minutes east, two minutes west, cam 14 one minute east and three minutes west and cam 15 three minutes east and one minute west. Obviously, other arrangements may be provided, the above being shown by way of example only. It is obvious, of course, that the period of revolution of the cam shaft is not restricted to twelve minutes, this period being chosen merely for convenience in subdividing the different periods of transmission in each direction.

Each of the cam followers is extended to also engage auxiliary cams 29 to 34, individual to each timing cam, each of the auxiliary cams having one-half of its periphery raised and the other half depressed. The cams 29 to 34 are mounted on a common shaft 35 (Figure 1) and may be manually rotated thereon so as to position either the raised or recessed portion thereof beneath the end of its associated cam follower. With the auxiliary cams in the position shown in the diagrammatic view, the cam follower for timing cam 10 is free to follow the contour of the cam, so as to close the switch 22 twelve times during each revolution. The cam followers associated with the remaining timing cams are held free of the timing cams so that the switches 23 to 27 remain open as the cams revolve.

The seventh timing cam 36, which may be termed a precision cam, is also driven from the motor 19 through reduction gearing 37 and is geared so as to close its associated switch 38 at frequent intervals, as for instance every fifteen seconds.

The angular position of the cam 36 on its shaft, relative to the cams 10 to 15, is such that during each period of closure of one of the switches 22 to 27, switch 38 will also close. The switches 22 to 27 are all connected in parallel with each other and in series with the switch 38 so that upon the co-incident closure of the switch 38 and one of the switches 22 to 27, a circuit will be completed from the

ground, at switch 38, through one of the switches 22 to 27 and by conductor 39 to an escapement magnet 40 and thence by brushes 41 and 42 and commutator drum 43, to a source of potential 44.

The commutator drum 43 has a 180° sector 45 insulated from the remainder of the drum whereby, as the drum revolves, the brushes 41 and 42 will be bridged during each half revolution only, thereby supplying impulses to the escapement magnet 40.

The escapement magnet controls an escapement wheel 46 carried on a shaft 47 driven by a spring motor 48 and having a series of cams 49, 50, and 51, the function of which is to reverse the circuit connections of the cable transmitting and receiving apparatus through the switches 52, 53 and 54, so as to periodically reverse the direction of transmission, as is fully set forth in the aforesaid Locke-Haglund patent.

One of the cams 55, on shaft 47 serves to complete a locking circuit for the escapement magnet 40, as soon as the shaft 47 advances one step. The cam 55 has two short depressions, at diametrically opposite points on its periphery and the switch 56 associated therewith, has a cam follower pressing on the cam, whereby the switch is maintained closed by the raised portion of the periphery except when the cam follower is at one of the two depressed points.

Upon the first movement of the shaft 47, after completion of the pulsing circuit through the timing cams, the cam follower engages the cam 55 and is raised from the depression in the cam, thereby closing the switch 56 and establishing the locking circuit for the escapement magnet, whereby the magnet continues to step irrespective of the position of the timing cams, by the impulses supplied by the commutator 43, until the shaft 47 has moved through 180° from its starting point, at which time the escapement magnet and the shaft stop, due to the opening of the switch 56, as the opposite cam depression comes into position beneath the cam follower. The angular position of the timing cams is such that the pulsing circuit through these cams opened while the shaft 47 was rotating through the 180°.

The alternating current side 57, of the motor 19 is supplied with alternating impulses from the secondary winding of a transformer 58, the primary winding of which has one terminal connected to the odd numbered segments of a pulsing ring 59, on the face plate of the transmitting distributor TD and the opposite terminal connected to the even numbered segments of ring 59. The solid ring 60 is connected to battery of one polarity and the mid-portion of the primary winding is connected to battery of the opposite polarity, whereby as the brush 61 sweeps over the rings 59 and 60, current alternations of a frequency having a definite relation to the speed of the rotary transmitter, will be induced in the secondary winding, for accurately controlling the speed of the motor 19. The direct current side 62 of the motor is driven from a battery 63 through resistance 64, the field winding 65 of the motor being connected in shunt to the battery.

In the position shown, of the reversing mechanism 28, the line L is connected through the upper contact of switch 54 directly to the receiving relay, the tongue of which repeats the receiving signals through the receiving rings RD to the printer (not shown), the printer circuit being completed to ground through the switch 52. When a reversal of the mechanism 28 occurs, the receiving relay is disconnected from the line at the switch 54 and a circuit for the transmitting apparatus completed from ground through switch 53, to positive or negative battery B, transmitter contacts and transmitting rings TD, thence by the lower contact of switch 54 to the line L. The printer is disconnected at this time at contact 52.

The operation of the timing mechanism having been described with reference to the diagrammatic view, the specific construction of the timing mechanism will now be described in connection with Figures 1 to 8.

Mounted upon a suitable base is the motor 19, having a shaft 66 which, through a worm 67 and gear 68, drives a shaft 69 journalled in bearings 70 and 71 and having a ratchet clutch member 72 rigidly secured to its extreme left end (Figure 1). The commutator drum 43 is carried by the shaft 69.

Clutch member 72 engages with a driven clutch member 73, which is keyed to a shaft 74 and is slidable axially thereof. The clutch members 72 and 73 are normally held in engagement by a spring 75 disposed between the clutch member 73 and a fixed abutment 76, on the shaft 74. A magnet 77 (Figure 5) is mounted beneath the clutch member and the hooked end of its armature 78 extends through an opening 79 in a pivoted lever 80, having a yoke extending into an annular recess 81 formed in the clutch member 73. The outer hooked end of the armature 78 is urged upwardly by a spring 82 and when the clutch is manually disengaged, serves to latch the same in such disengaged position thereby disconnecting the motor 19 from the cam shafts, to be subsequently described. The function of the clutch 72, 73 is to permit the timing cams to be set manually in the same position at all stations and to be started into operation simultaneously at each station, by operating the magnet 77, in response to a transmitted signal.

The shaft 74 is journalled in bearings 83 and 84 and is provided with a knurled knob 85, whereby the shaft may be manually rotated independently of the motor 19. A worm

86, on the shaft 74, meshes with a gear 87, loosely mounted upon a shaft 88, journalled in bearings 89 and 90. The gear 87 drives the shaft 88 through a ratchet clutch 91, the driven member 92 of which is pinned to the shaft 88, the driving member 93 being loosely mounted thereon for both rotative and sliding movement. The clutch members 92, 93 are normally held in engagement with each other by a spring 94 coiled about the shaft 88 and disposed within a hollow recess in the key member 95 secured to the gear and engaging with the slotted extension 96 of the clutch member 93. The clutch 91 permits the shaft 88 to be rotated independently of the shaft 74, by means of a hand knob 97.

In the specific embodiment shown the shaft 88 is geared to operate at a speed of four R. P. M. and the timing cam 36, which for convenience may be termed the fifteen second cam, is secured to the shaft 88 and serves to close the switch 38 once each revolution thereof.

The cam shaft 16 is driven from the shaft 88 at a reduced speed through the worm 98 and a gear 99 (Figure 2) and through a clutch 100 of the same construction as the clutch 91. Shaft 16 is journalled in bearings 101 and 102 and is provided with a hand knob 103 for adjusting the angular position of the cam shaft relative to shaft 88, whereby the coded timing cams 10 to 16, mounted thereon, may be correctly positioned with respect to the precision timing cam 36. The cams 10 to 15 are secured to the shaft 16 to rotate therewith, preferably at a speed of one-twelfth R. P. M. at the normal signalling speed. Brackets 105 and 106 are disposed at the opposite ends of the group of cams 10 to 15 and carried between these brackets and arranged parallel to the shaft 16 is the shaft 35, upon which the auxiliary cams 29 to 34 are mounted for independent rotation. Each of the auxiliary cams has an operating disk 107 integral therewith by which the cam may be manually rotated into the desired position. The shaft 35 is drilled radially at 108 (Figure 7) beneath each of the auxiliary cams and is provided with spring pressed ball detents 109 arranged to engage in any of the four depressions 110 to 113, in the bore of each of the auxiliary cams, to hold them in any one of four predetermined positions.

Also extending between the brackets 105 and 106 and journaled therein is a shaft 114, having a longitudinally extending key 115. The individual cam followers 20 are mounted on the shaft 114 and have recesses 116 in their hubs somewhat larger than the key 115 so that they have limited rocking movement on the shaft.

Each cam follower is pressed into engagement with its timing cam or auxiliary cam by a spring 117 carried by a bar 118, extending between the bracket members 105 and 106. The cam followers are provided with insulated projections 119 and 120, the former being arranged to engage with the timing cam and the latter to engage with the auxiliary cam.

The shaft 114, outside the bracket 106 has a switch arm 121 adapted to operate a pair of switch contacts 122 and 123 through a pin 124. Contact spring 123 is biased to open position, towards the arm 121.

With the auxiliary cam 29 set as shown in Figure 3 and with the remaining auxiliary cams set in the position of auxiliary cam 30, the timing cam 10 alone will be effective for controlling the periods of reversal of transmission. As the cam 10 rotates the raised portions of its periphery rock the cam follower upward permitting the shaft 114 to rotate counterclockwise under the pressure of the contact spring 123 to open the contacts. When a depression in the cam 10 comes opposite the projection 119 of the cam follower, the shaft 114 is rocked in a clockwise direction under the pressure of spring 117, to close the switch contacts against the pressure of spring 123.

The key and slot construction permits the switch contacts to be operated by any one of the cam followers whenever the remaining cam followers are held free of their timing cams, whereby the single switch takes the place of the group of parallel switches 22 to 27, shown in the diagrammatic view of Figure 9. The contacts 122 and 123 are connected in series with the contacts of switch 38 associated with the precision cam 36 and with the escapement magnet 40 and commutator brushes 41 and 42, to supply the first stepping impulses to the escapement magnet.

With the construction so far described, in order to change the periods of reversal of transmission, it is necessary to set the auxiliary cams by hand, just at the end of a designated cycle. In order that each of the auxiliary cams may be manually set at any time during the cycle and automatically brought into operation to change the timing intervals at the end of the cycle, each auxiliary cam operating disk 107 is provided with two diametrically opposite bars 125 and 126, and each of the timing cams is provided with a pin 127, (Figures 6, 7 and 8) adapted under certain circumstances to engage the bar 125 or 126, to rotate its auxiliary cam into the proper position for controlling the operation of its cam follower.

Assume by way of example that the timing cam 10 is controlling the periods of reversal and it is desired, at the end of the cycle, to change over to timing cam 11. Immediately upon reception of instructions to this effect the auxiliary cam 29 may be rotated by hand to the position shown in Figure 6, that is, with the bars 125 and 126 extending nearly hori-

zontal and with the bar 125 projecting into the path of travel of the pin 127 of cam 10, in which position the depressed portion of the cam 29 will still be in position beneath the cam follower so that cam 10 will continue to control the periods of reversal until the end of the cycle. Auxiliary cam 30 is also manually set in the diametrically opposite position, as shown in Figure 7, with the bar 126 extending into the path of the pin 127 of cam 11. The detent 109 holds the cams in their set position. As the timing cam continues to rotate and during the last few degrees of its rotation, that is just at the end of the cycle, the pins 127 on the cams 10 and 11, engage the bars 125 and 126 of the auxiliary cams 29 and 30, respectively, and rotate the auxiliary cams such a distance that the cam 29 assumes the position shown in Figure 8, with the raised portion thereof beneath the cam follower and cam 30 assumes the diametrically opposite position, with the depressed portion of the cam beneath the cam follower. The follower of timing cam 10 is thus rendered ineffective to further control the switch contacts 122, 123 and the follower of timing cam 11 is lowered into contact with its timing cam whereby it will be operated by subsequent rotation of the cam 11, to control the periods of reversal of transmission.

In the same manner any of the auxiliary cams may be set at any period during the cycle, as immediately upon the receipt of the despatch's orders and the actual transfer will take place simultaneously and automatically at each cable station at the end of the cycle.

Obviously various modifications may be made in the construction and operation of the timing mechanism and the automatic control thereof and I do not desire to be limited to the specific arrangement shown and described.

What I claim is:

1. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising a plurality of cams, switch means controlled by a selected one of said cams, each of said cams being coded so as to operate said switch means at differently timed intervals and means for automatically changing the control from one cam to another.

2. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising switch means, a plurality of switch operating means having a predetermined cycle of operation and individually coded to actuate said switch means at differently timed intervals and means adapted to be positioned at any time during a cycle for automatically changing the control from one switch operating means to another, at a predetermined later period in the cycle.

3. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising a plurality of cams having a predetermined cycle of operation, switch means controlled by said individual cams, each of said cams being coded to operate said switch means at differently timed intervals and means adapted to be positioned at any time during a cycle for automatically changing the control from one cam to another at a predetermined later period in the cycle.

4. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising a plurality of cams, cam followers individual to each cam, switch means controlled by said individual cam followers, each of said cams being coded to operate said switch means at differently timed intervals and means adapted to be positioned at any time during a cycle for automatically engaging said cam followers at a subsequent period in said cycle, for changing the control from one cam to another.

5. A timing mechanism for controlling the reversal of direction of transmission over a transmission line periodically, comprising a plurality of timing cams coded for different periods of reversal, a cam follower for each cam, means controlled by the individual cam followers for effecting reversal of direction of transmission, an auxiliary cam associated with each cam follower and means for individually positioning said auxiliary cams, so that, at a definite point in the rotation of said timing cams the auxiliary cams will be actuated to hold certain of said cam followers free from contact with said timing cams and to permit another of said cam followers to move into contact with one of said timing cams.

6. A timing mechanism for controlling the reversal of direction of transmission over a transmission line periodically comprising a plurality of timing cams coded for different periods of reversal, a cam follower for each cam, means controlled by the individual followers for effecting reversal of direction of transmission, an auxiliary cam associated with each cam follower, each of said auxiliary cams having a position in which it holds its associated cam follower out of engagement with its timing cam and means operating at a predetermined point in the cycle of operation of the timing cams for moving said auxiliary cam from such position into a position to permit the cam follower to follow the contour of its timing cam.

7. A timing mechanism for controlling the reversal of direction of transmission over a transmission line periodically comprising a plurality of timing cams coded for different periods of reversal, a cam follower for each cam, means controlled by individual followers for effecting reversal of direction of transmission, an auxiliary cam associated with

each cam follower, each of said auxiliary cams having at least two positions in which it holds its associated cam follower out of engagement with its timing cam and means operating at a predetermined point in the cycle of operation of said timing cams for moving said auxiliary cam, when it is in one of said positions, into a position to permit the cam follower to follow the contour of said timing cam.

8. A timing mechanism for controlling the reversal of direction of transmission over a transmission line periodically comprising a plurality of timing cams coded for different periods of reversal, a cam follower for each cam, means controlled by individual followers for effecting reversal of direction of transmission, an auxiliary cam associated with each cam follower, each of said auxiliary cams having at least two positions in which it holds its associated cam follower out of engagement with its timing cam and at least two positions in which it permits the cam follower to follow the timing cam and means operating at a predetermined point in the cycle of said timing cam for moving said auxiliary cam, when it is in one of said first two positions, into a position to follow the cam and, when it is in one of said second two positions, to hold the cam follower out of contact with its timing cam.

9. In a telegraph system employing rotary transmitting and receiving apparatus, circuit reversing mechanism, timing mechanism for controlling the operation of said reversing mechanism, a driving motor for said timing mechanism and means including a segmented ring of said rotary apparatus, for maintaining a definite speed relation between the timing mechanism and said rotary apparatus.

10. In a telegraph system employing rotary transmitting and receiving apparatus, circuit reversing mechanism, timing mechanism for controlling the operation of said reversing mechanism, said timing mechanism comprising a plurality of cams differently coded and switch means actuated thereby, means for rotating said cams in definite speed relation with respect to said rotary apparatus and means for selecting, at one period in the revolution of said cams, the particular cam which will be effective to control said reversing mechanism at a later period in the revolution of said cams.

11. In a telegraph system employing a rotary transmitting and receiving apparatus, circuit reversing mechanism, timing mechanism for controlling the operation of said reversing mechanism, said timing mechanism comprising a plurality of cams differently coded, a driving motor for said cams and switch means actuated by individual cams, means controlled by said rotary apparatus for supplying pulsating current to said motor to maintain a definite speed relation between said cams and rotary apparatus and means for automatically changing the control from one cam to another.

12. In a telegraph system employing rotary transmitting and receiving apparatus, circuit reversing mechanism, timing mechanism for controlling the operation of said reversing mechanism, a driving motor for said timing mechanism and means controlled by said rotary apparatus for supplying pulsating current to said motor to maintain a definite speed relation between said cams and said rotary apparatus.

13. The combination with a transmission line, of signal transmitting and receiving apparatus at each terminal, means for connecting said transmitting and receiving apparatus to said line alternatively comprising switch mechanism, an escapement for controlling the operation of said switch mechanism, a timing mechanism maintained in synchronism with the message signaling impulses and a pulsator driven by said timing mechanism for periodically operating said escapement mechanism to reverse the line connections.

14. The combination with a transmission line, of signal transmitting and receiving apparatus at each terminal, means for connecting said transmitting and receiving apparatus to said line alternatively comprising switch mechanism, a stepping device for controlling the operation of said switch mechanism, a timing mechanism maintained in synchronism with the message signaling impulses, a commutator driven by said timing mechanism and switch means actuated by said timing mechanism for supplying electrical impulses to the stepping mechanism from said commutator, to reverse the line connections.

15. The combination with a transmission line, of a rotary signal transmitting and receiving apparatus at each terminal, means for connecting said transmitting and receiving apparatus to said line alternatively comprising switch mechanism, a stepping device for actuating said switch mechanism, a timing mechanism, a driving motor for said timing mechanism, means controlled by said rotary apparatus for supplying pulsating current to said motor to maintain a definite speed relation between the timing mechanism and said rotary apparatus, a commutator driven by said timing mechanism and switch means actuated by the timing mechanism for supplying electrical impulses to said stepping mechanism from said commutator, to reverse the line connections.

16. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising a driving shaft, a precision timing cam and a plurality of differently coded timing cams,

means including said precision cam and one of said coded cams for reversing the direction of transmission periodically, means for automatically changing the control from one of said coded cams to another at a predetermined period and means for varying the relative position of said driving shaft precision cam and coded cams.

17. A timing mechanism for controlling the period of transmission in each direction over a transmission line comprising a driving shaft, a precision timing cam and a plurality of differently coded timing cams, means including said precision cam and one of said coded cams for reversing the direction of transmission periodically, means for automatically changing the control from one of said coded cams to another at a predetermined period and manual means for independently varying the relative position of said precision cam and coded cams relative to each other and to said driving shaft.

18. A timing mechanism for controlling the periods of transmission in each direction over a transmission line comprising a driving shaft, a precision timing cam, a shaft therefor, a plurality of differently coded timing cams, a shaft for said coded cams, means including said precision cam and one of said coded cams for reversing the line connections, means for changing the control from one of said coded cams to another and an individual ratchet clutch for each of said cam shafts for driving the same, said clutches enabling said cams to be manually adjusted relative to each other and to said driving shaft.

In testimony whereof I affix my signature.

HAKON H. HAGLUND.