

Jan. 16, 1968

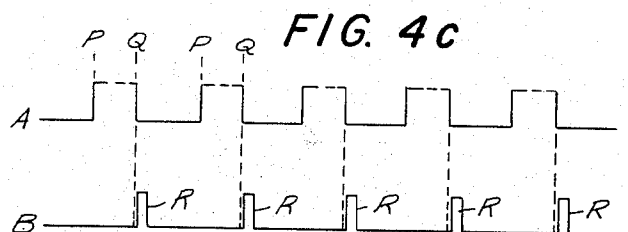
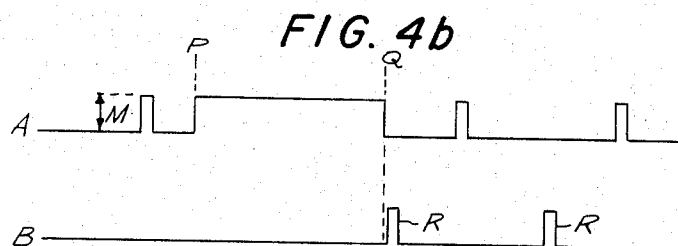
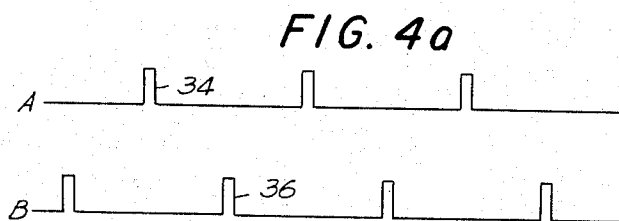
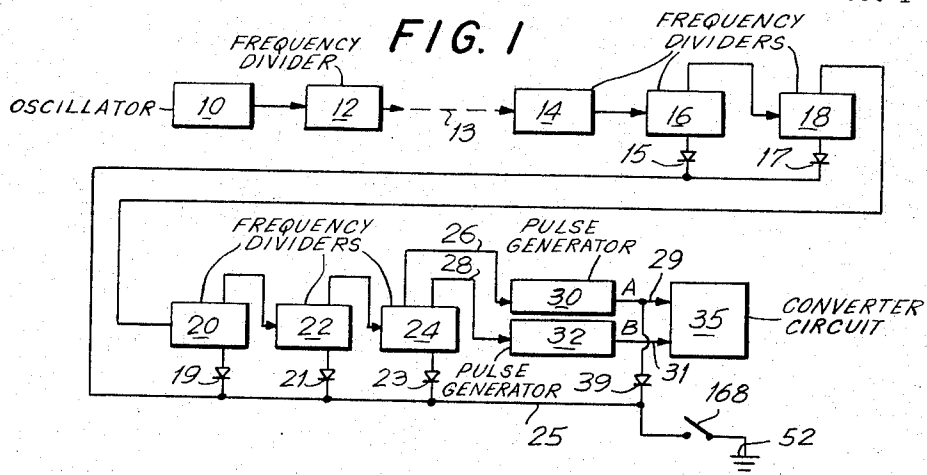
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3,363,410

APPARATUS FOR ADJUSTING ELECTRIC TIMEPIECES

Filed Jan. 25, 1966

4 Sheets-Sheet 1



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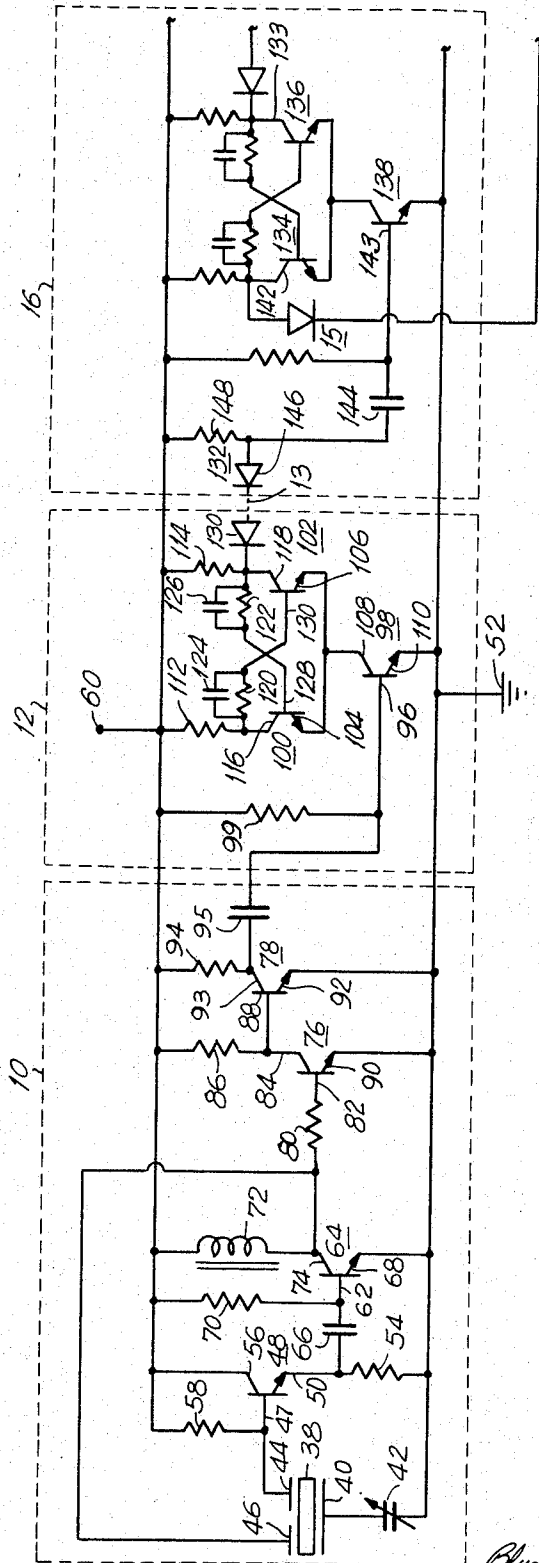


FIG. 2

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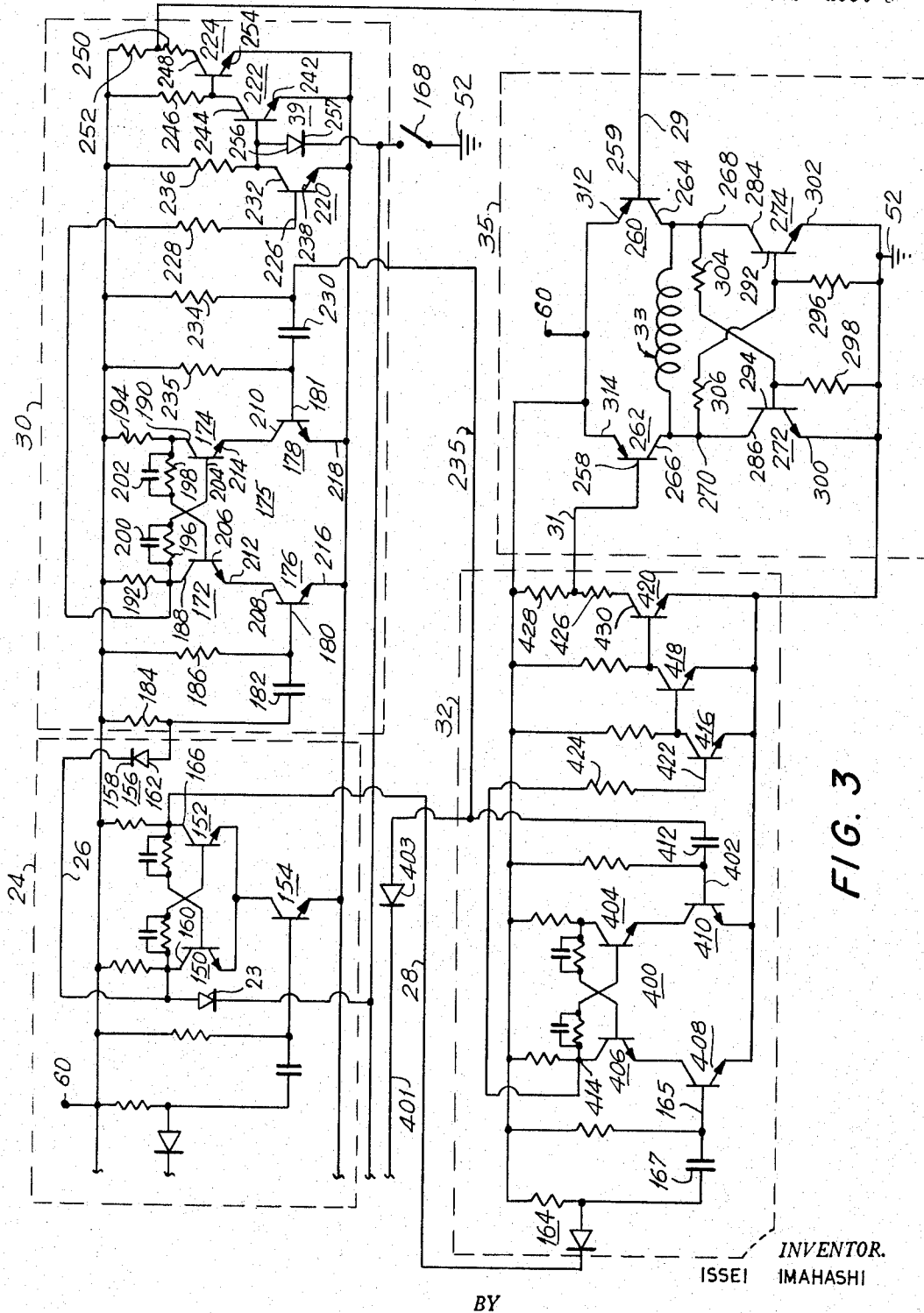
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FIG. 4d 

FIG. 4e 

FIG. 4f 

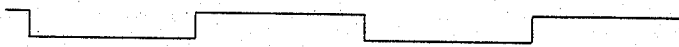
FIG. 4g 

FIG. 4h 

FIG. 4j 

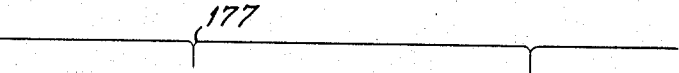
FIG. 4k 

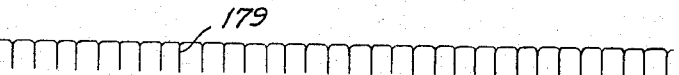
FIG. 4l 

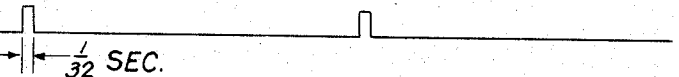
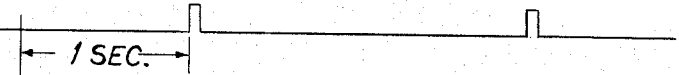
FIG. 4m 

FIG. 4n 

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APPARATUS FOR ADJUSTING ELECTRIC
TIMEPIECES

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7 Claims. (Cl. 58—34)

ABSTRACT OF THE DISCLOSURE

The apparatus described selectively manually controls the timing of the indicator arm of an electric timepiece. A stable clock oscillator drives two parallel chains of multivibrators to produce two pulse series of selectively variable repetition rate and selectively variable phase relationship which drive an electro-mechanical converter, with the converter advancing the indicator arm by single increments for each pulse applied thereto. The pulse width of the first pulse series is selectively varied, while the second pulse series is selectively inhibited to thereby interrupt the supply of driving pulses to the converter to maintain the indicator arm at rest for a period of time corresponding to the pulse width of the first series pulses.

This invention relates to an electric timepiece adjusting apparatus and more particularly to such an apparatus which may be manually controlled to start, stop or adjust any electric timepiece to preselected timing conditions.

In order to precisely measure the time duration of an event occurring over a period of time it is necessary to precisely synchronize the initiation and termination of the event with the starting and stopping of the timing apparatus. When using an electric timepiece to time the event, to accomplish this synchronization with a high degree of accuracy it is necessary to provide an electric initiation pulse to the timepiece at the instant that the event begins and to provide an interrupting pulse at the instant that the event terminates. Additionally, in order to reset the timepiece it is necessary to apply a selectively variable number of pulses to the timepiece to advance the indicator hand to a predetermined position.

An object of the present invention is to provide an apparatus for manually adjusting an electric timepiece.

A further object of the present invention is the provision of an electric timepiece adjustment apparatus operative to stop, start or advance the indicator hand of the electric timepiece to a predetermined position.

In accordance with the principles of the present invention there is provided a pulse source for producing a first and second series of pulses suitable for driving an electric timepiece electro-mechanical converter. The first and second series of pulses have a selectively variable pulse repetition rate with said second pulse series having a selectively variable phase relationship to the first pulse series. Control means are connected to the pulse source for selectively varying the pulse width of a preselected pulse of the first pulse series and inhibiting means are operatively connected with the pulse source and control means for selectively inhibiting the occurrence of pulses of the second series for a period of time corresponding to the pulse width of the preselected pulse of the first series. Accordingly, the supply of driving pulses for the electro-mechanical converter is thus interrupted and the timepiece indicator arm is maintained in a rest position for a period of time corresponding to the width of the preselected first series pulse.

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The novel features of the present invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a block diagram showing the general arrangement of the component parts of the present invention.

FIGS. 2 and 3 comprise schematic diagrams of various component parts shown as blocks in FIG. 1 as follows:

FIG. 2 comprises schematic diagrams of oscillator 10, flip flop 12 and flip flop 16.

FIG. 3 comprises schematic diagrams of flip flop 24, pulse generators 30 and 32 and converter circuit 35.

FIG. 4 comprises waveform diagrams showing the pulse trains produced in one embodiment of the present invention and their phase relationships, of which

FIG. 4a shows the pulse trains A and B produced by pulse generators 30 and 32 respectively;

FIG. 4b shows the pulse trains produced when the timepiece indicator arm is stopped for a preselected period of time;

FIG. 4c shows the pulse trains produced when it is desired to advance the timepiece indicator arm by a preselected number of increments.

FIGS. 4d-4n are waveform diagrams indicating the waveform of the potential at various points in the circuitry of FIGS. 2 and 3 as follows:

FIG. 4d indicates the potential waveform at the collector of the left hand side switching transistor of flip flop 14.

FIG. 4e indicates the potential waveform at the collector of the right hand side switching transistor of flip flop 14.

FIG. 4f indicates the potential waveform at collector 133 of flip flop 16 as shown in FIG. 2.

FIG. 4g indicates the potential waveform at collector 166 of flip flop 24 as shown in FIG. 3.

FIG. 4h indicates the potential waveform at collector 160 of flip flop 24 as shown in FIG. 3.

FIG. 4i indicates the potential waveform at base 165 of transistor 408 in pulse generator 32 as shown in FIG. 3.

FIG. 4k indicates the potential waveform at base 180 of transistor 176 in pulse generator 30 as shown in FIG. 3.

FIG. 4l indicates the potential waveform at lead 235 which interconnects base 402 of transistor 410 in pulse generator 32 and base 181 of transistor 178 in pulse generator 30 as shown in FIG. 3.

FIG. 4m indicates the potential waveform at collector 414 of transistor 406 in pulse generator 32 as shown in FIG. 3.

FIG. 4n indicates the potential waveform at collector 188 of transistor 172 in pulse generator 30 as shown in FIG. 3.

In FIG. 1 oscillator 10 serves as the time standard for the electric timepiece (not shown) which is to be adjusted and may suitably comprise a stable quartz crystal or tuning fork oscillator, to provide control pulses at a preselected frequency. The pulse output of oscillator 10 is fed to a series of frequency dividers of similar configurations 12, 14, 16, 18, 20, 22 and 24 in serial arrangement, the aforementioned frequency dividers typically comprising bistable multivibrators known as flip flops. Resetting diodes 15, 17, 19, 21 and 23 are connected together at their respective cathodes by leads 25 and function in a manner described below. The function of the serial arrangement of flip flops 12-24 is to derive from the output of oscillator 10 a series of pulses having a preselected pulse repetition rate, the desired frequency generally

being one pulse per second. The dual pulse outputs at leads 26 and 28 of flip flop 24, which is the last in the chain of flip flops 12-24, is applied to pulse generators 30 and 32 respectively. The pulse output of pulse generators 30 and 32 are shown in FIG. 4a as waveforms 34 and 36 which comprise a pair of synchronized pulse trains each having a period of 2 seconds, so that pulses from generators 30 and 32, alternately occur at time intervals of 1 second.

The pulse output of pulse generators 30 and 32 i.e. pulse trains A and B respectively are applied to the electro-mechanical converter circuits 35 of the electric timepiece (not shown) which is to be adjusted. The electro-mechanical converter itself comprises a coil as shown in FIG. 3 wound on an electro-magnet (not shown) and operative to drive an escape wheel which in turn advances the indicator arm of the timepiece.

FIG. 2 is a detailed schematic diagram of various components of the system block diagram of FIG. 1.

In FIG. 2, oscillator 10 is shown in schematic form as being a crystal controlled oscillator comprising a crystal 38 having a contact 40 on one side thereof connected to variable capacitor 42 and contacts 44 and 46 on the other side thereof. Contact 44 is directly connected to base 47 of transistor 48 and to collector 56 through input resistor 58 which are connected together at D.C. supply terminal 60. The output of transistor 48 is taken from emitter 50 which is connected to ground terminal 52 through resistor 54, and applied to base 62 of transistor 64 by means of coupling capacitor 66 which is connected at the other end thereof through resistor 54 together with emitter 68 to ground terminal 52. Resistor 70 and coil 72 are connected together at supply terminal 60, the other end of coil 72 being connected to collector 74. The output from transistor 64, taken at collector 74, is applied to a two stage amplifier generally shown at transistors 76 and 78 by resistor 80 which is connected to base 82. Collector 84 is connected to supply terminal 60 through load resistor 86 and directly to base 88 of transistor 78, while emitters 90 and 92 are connected together to ground terminal 52. The amplified pulse output from oscillator 10 is coupled from collector 93, which is connected to supply terminal 60 through load resistor 94, by capacitor 95 to flip flop 12 at base 96 of transistor 98, capacitor 95 being connected to supply terminal 60 through resistor 99. Flip flop 12 is an emitter coupled bistable multivibrator and comprises a pair of switching transistors 100 and 102 which are alternately rendered conductive to provide a switching function in a manner well known to those skilled in the art. Transistors 100 and 102 are connected together at their emitters 104 and 106 respectively, and at collector 108 of transistor 98, with emitter 110 being directly connected to ground terminal 52. Resistors 112 and 114 respectively interconnect collectors 116 and 118 to supply terminal 60 and resistors 120 and 122, having commutating capacitors 124 and 126 respectively connected thereacross, interconnect bases 128 and 130 to collectors 118 and 116 respectively.

The output of flip flop 12 is taken at collector 118 by diode 130 and is applied to the succeeding flip flop at the base terminal of the transistor in the common emitter circuit of the emitter coupled bistable multivibrator in the same manner as shown at base 96 of transistor 98. The succeeding flip flops are identical to flip flop 12 in circuit configuration and operation and hence have been indicated by the dotted line 13.

The output of flip flop 14, which is identical in configuration to flip flop 12 as described above, is taken from diode 132 which corresponds to diode 130 of flip flop 12 and is applied to flip flop 16 as hereinafter described. Flip flop 16 is an emitter coupled bistable multivibrator generally shown at switching transistors 134 and 136 and common emitter circuit transistor 138, and is identical in circuit configuration and operation to flip flop 12, as shown above, with the exception of resetting diode

15 connected at its anode to collector 142 of transistor 134. Accordingly, a detailed description of the schematic connections of flip flop 16 as shown in FIG. 2 and operation thereof is omitted here. The output of flip flop 14 is connected to base 143 of transistor 138 through coupling capacitor 144 which is connected at its other end to anode 146 of diode 132 and to supply terminal 60 through resistor 148. Flip flops 18, 20 and 22 are identical in circuit configuration to flip flop 16 and hence their operation may be clearly understood by reference to the system block diagram of FIG. 1.

Flip flop 24 is indicated in detailed schematic form in FIG. 3 as comprising switching transistors 150 and 152 in the configuration of an emitter coupled bistable multivibrator with transistor 154 in the common emitter circuit of transistors 150 and 152. Flip flop 24 is identical in configuration to flip flop 16 described above, with the exception of diode 156 which has its cathode 158 connected to collector 160 of transistor 150 and its anode 162 connected to the input of pulse generator 30. Diode 164 similarly interconnects collector 166 of transistor 152 to the input of pulse generator 32 at base 165 through coupling capacitor 167.

Pulse generators 30 and 32, which are operative to develop the driving pulses for application to electro-mechanical converter circuit 35, are identical in circuit configuration with the exception of resetting switch 168 and resetting diode 39 in pulse generator 30, and are similar in function and operation. Accordingly, only the circuit configuration of pulse generator 30 will be detailed herein, it being understood that pulse generator 32 operates in a similar manner except as otherwise indicated. Pulse generator 30 comprises a bistable circuit generally shown at switching transistors 172 and 174 and accompanying transistors 176 and 178 respectively connected in the emitter circuits thereof.

Flip flop 24 provides a dual pulse output, from the collectors 160 and 166 of switching transistors 150 and 152 by leads 26 and 28 respectively and hereinafter designated as outputs A and B respectively. The A output of flip flop 24 is applied to pulse generator 30 by diode 156 to base 180 of input transistor 176 through coupling capacitor 182. Anode 162 and base 180 are connected to supply terminal 60 through resistors 184 and 186 respectively, and switching transistors 172 and 174 are connected at their collectors 188 and 190 to supply terminal 60 through resistors 192 and 194. The output and input of switching transistors 172 and 174 are interconnected by resistors 196 and 198 together with commutating capacitors 200 and 202 from collector 188 to base 204 and from collector 190 to base 206, respectively. Collectors 208 and 210 are connected to emitters 212 and 214 with emitters 216 and 218 connected to ground terminal 52 respectively. The output at collector 188 is connected to the input of a three stage common emitter amplifier, generally shown at transistors 220, 222 and 224, at base 226 through resistor 228 and base 181 is connected through capacitor 230 to lead 235. Collector 232 is connected to supply terminal 60 through resistor 236 with emitter 238 connected directly to ground terminal 52. The output of first stage amplifier of transistor 220 is taken from collector 232 and fed to second stage transistor 222 at base 240, with emitter 242 connected directly to ground terminal 52, and collector 244 connected to supply terminal 60 through resistor 246. The output of second stage transistor 222 is fed from collector 244 to base input 247 of third stage transistor 224 which has its collector 248 connected to supply terminal 60 through a pair of serially connected load resistors 250 and 252 and its emitter 254 connected directly to ground terminal 52. Resetting diode 25 has its anode 256 connected to base 240 of second stage transistor 222 and its cathode 257 to resetting switch 168 which is connected to ground terminal 52, resetting switch 168 being operative to clamp base 240 positively to ground potential.

In pulse generator 32 a flip flop circuit 400 is shown

as comprising switching transistors 404 and 406 being triggered by input transistors 408 and 410 which are respectively connected in the emitter circuits of transistors 404 and 406 respectively. Base 402 of transistor 410 is coupled to lead 235 by means of capacitor 412, to thereby interconnect base 402 and base 181 with the output of flip flop 14. The output of flip flop 400 is taken from collector 414 of transistor 406 and applied to the input of a three stage amplifier generally shown at transistors 416, 418 and 420, with collector 414 being connected to base 422 of transistor 416 through resistor 424. The output of the aforementioned three stage amplifier is taken from the junction of resistors 426 and 428 in the circuit of collector 430, by means of lead 31 and is applied to base 258 of transistor 262. Lead 401 is connected to the collector of the left hand side switching transistor (not shown) of flip flop 14 which corresponds to collector 116 of flip flop 12 by means of diode 403.

Converter circuit 35 is operative to alternately apply suitable driving pulses derived from pulse generators 30 and 32 to electro-magnetic coil 33, the inputs to converter circuit 35 being applied thereto by leads 29 and 31 from pulse generators 30 and 32 respectively. Converter circuit 35 is shown generally as driving transistors 260 and 262 having their collectors 264 and 266 connected to opposite end terminals 268 and 270 of coil 33. A pair of transistors 272 and 274, in the common emitter configuration, are connected in the collector circuits of transistors 260 and 262. Emitters 300 and 302 of transistors 272 and 274 respectively are connected to ground terminal 52, and emitters 312 and 314 of transistors 260 and 262 respectively are connected to supply terminal 60. Collectors 286 and 284 are respectively interconnected with bases 292 and 294 by means of resistors 306 and 304 respectively with bases 292 and 294 being further connected to ground terminal 52 by means of resistors 296 and 298 respectively.

Referring to the waveform diagrams of FIGS. 4a, b and c, the dual pulse output i.e. waveforms A and B comprise a pair of synchronized pulse trains having a period of 2 seconds so that pulses of A or B occur at intervals of 1 pulse per second and are alternately applied to coil 33 at end terminals 268 and 270 respectively. In accordance with the above, in ordinary operation the second hand of the timepiece (not shown) is advanced by a single position increment once every second.

Switch 168 is operative to stop the indicator hand of the timepiece for a controllably variable period of time in the following manner. Switch 168 is manually closed at a point in time indicated by point P on FIG. 4c, thus resetting flip flops 16, 18, 20 and 22 by clamping collector 160 and others similarly situated in the last mentioned flip flops to ground potential through diodes 15, 17, 19, 21 and 23 and also clamping the output of transistor 220 at collector 232 through diode 25. Accordingly, transistor 260 clamps end terminal 268 to a steady unipotential level M as indicated in FIG. 4b, thus interrupting the supply of driving pulses from coil 33 to the electro-magnet of the electro-mechanical converter thereby stopping the timepiece indicator hand. When switch 168 is subsequently opened, at a time indicated by point Q in FIG. 4b, a driving pulse R will be shortly thereafter applied at end terminal 270 since collector 166 of transistor 152 will have been reset to the level for providing a pulse by virtue of the prior reset condition of switch 168. Since the input frequency of flip flop 16, in the instant configuration, is typically 16 pulses per second, the time lag between the opening of switch 168 at time Q and the leading edge of pulse R will be less than $\frac{1}{16}$ second. The characteristics of waveforms A and B subsequent to the initiation of pulse R will be identical to the waveforms of FIG. 4a which represent normal uninterrupted operation of the timepiece. It is thus seen by opening switch 168 for a selectively variable time, the supply of driving pulses to the timepiece electro-mechanical converter and hence

the movement of the timepiece indicator arm may be selectively controlled.

FIG. 4c illustrates the waveforms produced by rapidly opening and closing switch 168 to advance the indicator arm by a preselected number of position increments. Thus, by closing switch 168 at time P and opening it at time Q successive pulses R are generated, each R pulse advancing the indicator arm by a single increment.

A clearer understanding of the operation of pulse generators 30 and 32 may be had by reference to the waveform diagrams shown in FIGS. 4d-4n in conjunction with the schematic diagram of FIG. 3. Flip-flop circuit 175 is shown as comprising a pair of switching transistors 172 and 174 which are triggered by input transistors 176 and 178 respectively. As shown in FIG. 4l, the potential signal applied by lead 403 from flip flop 14 to bases 181 and 402 of transistors 178 and 410 in generators 30 and 32 respectively, comprise a series of negative going spike pulses such that transistor 174 is normally in the "OFF" condition, and transistor 172 is normally in the "ON" condition. When base 180 of transistor 176 receives a negative going spike pulse 177 as shown in FIG. 4k, transistor 172 is rendered "OFF" thus inverting the conductive state of flip flop 175. $\frac{1}{32}$ of a second after the occurrence of pulse 177, a subsequent spike pulse 179 shown in FIG. 4l, is applied to base 181 thus inverting the conductive state of flip flop 15 to reset it to its previous normal condition. Accordingly, the waveform at collector 188 of transistor 172 as shown by FIG. 4n, is such that the potential on collector 188 rises upon the occurrence of pulse 177 and falls to the quiescent level $\frac{1}{32}$ of a second later.

While there has been shown a particular embodiment of the present invention it will be understood that it is not wished to be limited thereto since modifications can be made both in the circuit arrangements and in the instrumentalities employed and it is contemplated in the appended claims to cover any such modifications as fall within the true scope and spirit of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Timepiece adjustment apparatus comprising a pulse source for producing a first series of pulses of selectively variable pulse repetition rate and a second series of pulses of selectively variable pulse repetition rate having a selectively variable phase relationship with respect to said first pulse series; said first and second series of pulses being operative to drive an electric timepiece electro-mechanical converter; said converter being operative in response to said first and second series pulses to advance the indicator arm of said timepiece by single increments of position for each pulse applied thereto; control means in circuit with said pulse source for selectively varying the duration of a preselected pulse of said first series of pulses; and means operatively connected with said control means and said pulse source for selectively inhibiting the occurrence of pulses of said second series for a period of time corresponding to the duration of said preselected pulse of said first series thereby interrupting the supply of driving pulses to said electro-mechanical converter and thus maintaining said indicator arm in a rest position for a period of time corresponding to said duration of said preselected first series pulse.

2. Apparatus as defined in claim 1 and further including switching means for selectively producing pulses of said second series at a selectively variable point in time to thereby advance said indicator arm in accordance with the occurrence of said selectively produced second series pulses.

3. Apparatus as defined in claim 1 wherein said pulse source comprises an oscillator of selectively variable frequency; a first series of serially arranged bistable multivibrators in circuit with said oscillator; a second series of serially arranged bistable multivibrators said first and second multivibrator series in serial arrangement; means

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for simultaneously resetting said multivibrators of said second multivibrator series; first and second pulse generators; the end positioned multivibrator of said second series having a dual pulse output, said dual pulse output being respectively connected to said first and second pulse generators to thereby provide said first and second pulse series respectively.

4. Apparatus as defined in claim 3 wherein said electro-mechanical converter comprises an electro-magnetic coil having a pair of end terminals, said first pulse series being applied to one end terminal of said coil end terminals and said second pulse series being applied to the other end terminal of said coil end terminals.

5. Apparatus as defined in claim 4 including a source of D.C. potential having a pair of terminals wherein each of said bistable multivibrators comprise a pair of switching transistors operative to be rendered alternately conductive and non-conductive in response to trigger pulses applied thereto; a pair of coupling resistors interconnecting the collectors of each of said switching transistors to the base of the corresponding opposite transistor respectively; a pair of commutating capacitors respectively connected across said coupling resistors; a pair of load resistors respectively interconnecting said collectors and one of said D.C. source terminals; the emitters of said switching transistors being interconnected; a third transistor having its collector connected to said emitters of

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said switching transistors, the emitter of said third transistor being connected to the other of said D.C. source terminals; and means for applying input trigger pulses to the base of said third transistor to thereby cause each of said pair of switching transistors to invert their conducting state.

6. Apparatus as defined in claim 5 wherein said switching means comprises a switch having a pair of terminals, and a plurality of diodes each of said diodes having its anode connected to the collector of one of said switching transistors of said second multivibrator series and its cathode connected to one terminal of said switch, the other of said switch terminals being connected to the other of said D.C. source terminals.

7. Apparatus as defined in claim 6 and further including an inhibiting diode having its anode connected to said first pulse generator and its cathode connected to said one terminal of said switch; said switch being operative upon being rendered conductive to maintain said one end terminal of said coil at a constant potential to thereby inhibit the supply of pulses from said first and second generators to said coil of said electro-mechanical converter.

No references cited.

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