

2,238,756

Filed Nov. 19, 1936

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FIG. 1 is a schematic diagram of a three-channel electronic circuit. The circuit consists of three input sections, each with a sensor and an amplifier. The first section (201) includes a sensor (197) and an amplifier (231). The second section (202) includes a sensor (198) and an amplifier (232). The third section (69) includes a sensor (86) and an amplifier (233). Each section has a feedback loop (237, 238, 234) and a control line (241, 239, 94). The outputs are labeled 229, 227, and 228.

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April 15, 1941.

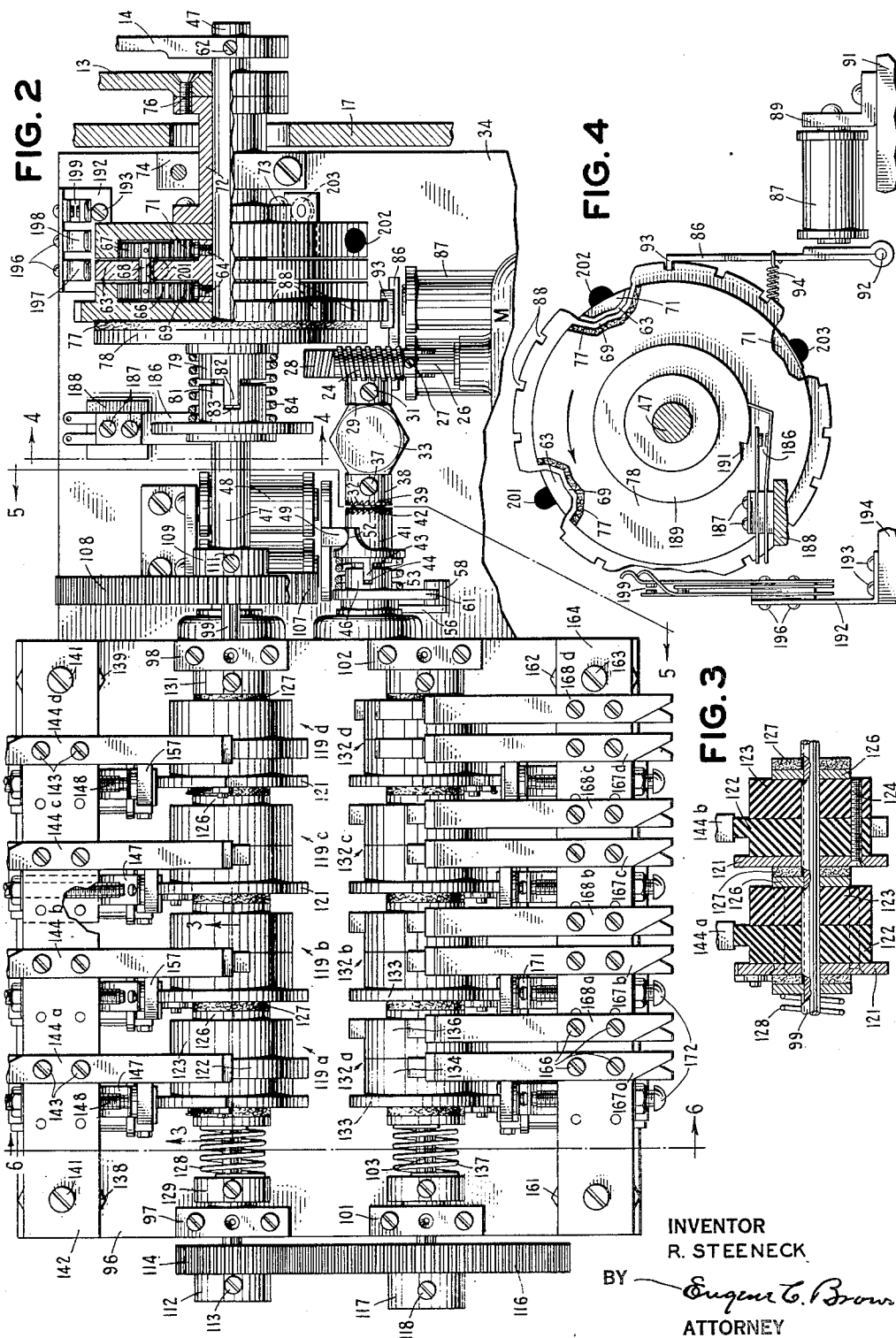
R. STEENECK

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SPORTS TIMER

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FIG. 5

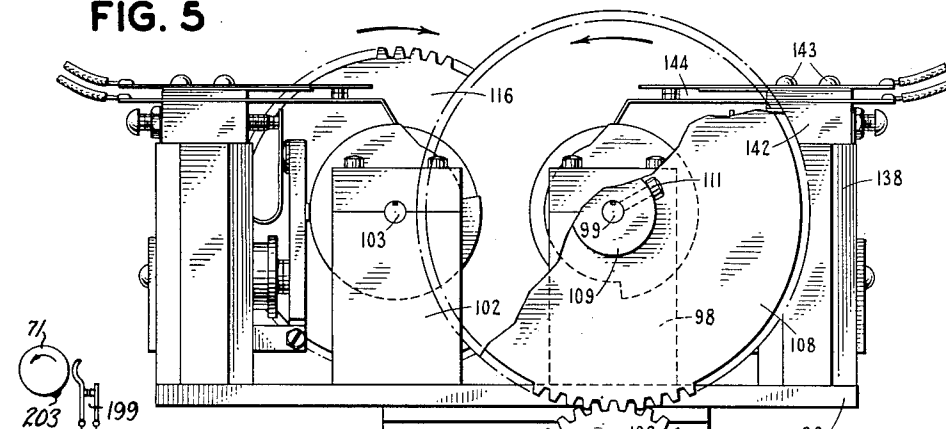
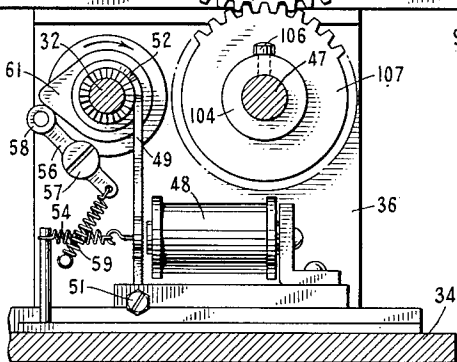
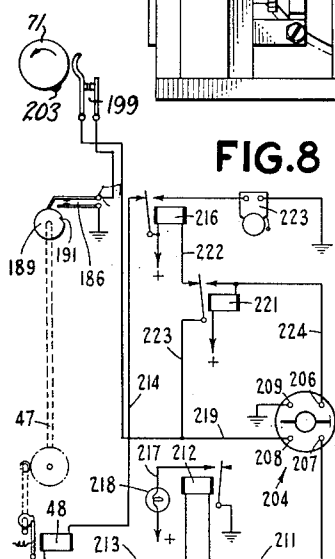


FIG. 8



UNITED STATES PATENT OFFICE

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SPORTS TIMER

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12 Claims. (Cl. 161—17)

This invention relates primarily to timing apparatus and more particularly to apparatus of this nature adapted for use in timing a contest or athletic event, such as for example, a hockey game.

In a large majority of the games or sport events which have large followings, time is an important element in determining the course of progress of the game or event. Heretofore the method usually employed in timing a game of this nature was for an official charged with that duty to use a stop watch or like device of which he was in full charge and at many times throughout the game was visible to no one except himself. As the audience or spectators are often times as interested in the elapsed playing time or the time remaining to play in timed contests, especially at nearing the end of a playing period, as they are in the skill displayed by the contestants or participants, large manually controlled clocks, visible to the spectators, indicating the approximate time played or to be played are sometime employed. These clocks are usually intermittently set by an attendant from a stop watch under his own control or as nearly as possible from the stop watch of the official timekeeper, and sometimes during the excitement of the game the attendant forgets or neglects to set the clock. Obviously, such methods lead to discrepancies in the official time and that indicated by the clock visible to the audience and are very annoying to the spectators and sometimes even to the contestants.

Therefore, the general object of this invention is to provide a large dial clock, or a plurality thereof, operating in synchronism which may be clearly visible to the spectators or those in attendance at the contest or event and which is operated by an official or officials of the contest or event.

Another object of the invention is to provide a large dial clock visible to an audience or spectators of an event operable by an official timekeeper or anyone else in substantially the same manner as an ordinary stop watch.

Another object is to automatically stop the time clock or clocks at the end of each period of play and to automatically operate a signal indicative of the termination of the period of play.

In professional hockey the regular period of play is twenty minutes while in usual amateur contests the period of play is but fifteen minutes and in the event of tie scores at the end of the last regular period of play, overtime periods of ten or some other number of minutes are usually played. As clocks timing such games are preferably adapted to indicate the time remaining in the period of play, it is desirable to have the end of all regular and overtime periods of play indicated at the same point on the clock.

It is, therefore, another object of this invention to provide a clock for timing and indicating predetermined variable periods of play in which the end of all periods of play are indicated at a common point on the clock.

The penalties imposed on a hockey team for various infractions of the rules of the game is to usually put one or more of the players out of the game for variable lengths of playing time. The usual time a player is "put off the ice" is either two or five minutes, at the end of which time he is again allowed to enter the contest. Several players at a time may be "off the ice" being put off together or during various stages of the game, and consequently each player may require a separate sub-official timekeeper to time his penalty period. Obviously, such practice lends itself to much confusion to the timekeepers, the contestants and the spectators, and especially when "time out" periods occur when one or more of the players are "off the ice," it being necessary for accurate timing of the penalty periods for the sub-official timekeepers to stop and start their stop watches in unison with the official timekeeper.

Therefore, still another object of this invention is to provide a timing apparatus visible to the spectators, such as for example, one for accurately timing individual, collective and/or overlapping penalty periods occurring in a period or periods of play wherein "time out" periods occurring during penalty periods do not affect the penalty periods relative to the length of the periods of play.

A further object of the invention in connection with the above object is to provide indicators such as lights which may be arranged in a plurality of two colored groups visible to the official timekeepers and/or spectators for indicating the length of a penalty by the number of lights in a group illuminated, the number of players penalized by the number of groups illuminated, the team penalized by the color of the lights illuminated and the elapse of a penalty period by progressively extinguishing the lights.

Another object of the invention is to provide a mechanism for timing an athletic game or contest wherein the human element is reduced to a minimum.

These and other more specific objects of the invention defined by the terms of the appended claims will be apparent from the following detailed description thereof taken in conjunction with the accompanying drawings in which:

Fig. 1 is an elevational view of a clock face or dial indicating device controlled by the present invention;

Fig. 2 is a view partly in plan and partly in section of the operating and control mechanism for the indicating elements of the clock face;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken substantially on line 4—4 of Fig. 2;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 2;

Fig. 6 is a sectional view taken on line 6—6 of Fig. 2;

Fig. 7 is an exploded view showing the arrangement of one set of elements employed in controlling one set of indicating elements on the clock face and a schematic arrangement of the electrical circuits therefor;

Fig. 8 is a diagrammatic view of the electrical circuits and the relationship of certain of the mechanical parts and the controls therefor employed in timing the periods of play of an event or contest;

Fig. 9 is a diagrammatic view of the electrical circuits and the relationship of certain of the mechanical parts and the controls therefor employed in reducing by a predetermined amount or amounts the periods of play of a contest.

Referring first to Fig. 1 which shows an elevational view of the clock face preferably employed with this invention, two hands 13 and 14 are employed to indicate the time remaining in a period of play although they could be equally well adopted to indicate elapsed time of a period of play. The clock face is preferably of such a size as to be clearly visible and perceptible to all the spectators and players but where this is impractical a plurality of adjacent or remotely disposed clock faces may be employed, the indicating elements being operated by a common means, or remotely disposed means operating in unison and controlled from a common means, as will be apparent in the following description. The larger hand 14 hereinafter referred to as the seconds hand is adapted, as will be more fully described, to rotate in a clockwise direction at the speed of one revolution per minute. The end of the hand 14 cooperates with divisions 16 on the face 17 of the dial to indicate the amount of rotation. The smaller hand 13 hereinafter referred to as the minutes hand is also arranged to rotate in a clockwise direction, making one complete revolution in the probable maximum length of time or periods of play into which a game is usually divided. Thus, the hand 13 will make one complete revolution in twenty minutes as this is the maximum length of a period of play employed in professional hockey. However, both of the hands 13 and 14 are adapted to cease rotation during "time out" periods as will be hereinafter explained in keeping with the characteristics of the game. The hand 13 is arranged to cooperate with an inner scale 18 or divisions on the clock face 17 and indicate the number of minutes left in a period of play. As the hand 13 rotates clockwise the divisions, of course, are numbered in reverse order from the progress of the hand.

The face 17 of the clock is preferably square or rectangular and prominently displayed at the four corners thereof are groups of lights indicated in general by reference numerals 19, 20, 21 and 22. Each group of lights comprises five lights arranged in a horizontal row and the groups 19 and 20 are preferably of one color and the groups 21 and 22 of another color, such as red and blue respectively. The manner in which these lights are illuminated and extinguished and the reasons therefor will be hereinafter described.

The driving mechanism for the clock hands and the timing control elements will now be described.

Referring to Fig. 2, a part of a normally constantly rotating motor M is shown, which may be a synchronous motor driven from a well regulated alternating current supply or any other type motor held at a substantially constant speed by governors or speed controlling means well known in the art. A worm gear 24 secured to the motor shaft 26 for rotation therewith by a screw 27 meshes with another gear 28 located directly below the worm gear. The gear 28 is secured to a hub 29 which in turn is secured by a set screw 31 for rotation therewith to a shaft 32. The shaft 32 is journaled adjacent its right hand end in a hexagonal bearing post 33 which is supported from a base plate 34. The left hand end of the shaft 32 is suitably journaled in a gear box 36, Fig. 5. Fixed to the shaft 32, Fig. 2, for rotation therewith by a set screw 37 at the left of the bearing post 33 is a collar 38. The collar has formed on its left hand face a series of radial teeth 39 and it forms the driving member of a hereinafter described clutch. Loosely mounted on the shaft 32 adjacent the collar 38 is another collar 41 which has teeth 42 formed on its right hand face similar to the teeth 39 in the collar 38. The collar 41 comprises the driven member of the clutch. Operatively connected to the collar 41 by means of interengaging tongues 43 and grooves 44 is a sleeve member 46. Connected to the sleeve 46 are gears (not shown) within the gear box 36 Fig. 5 whereby the speed of a shaft 47 extending from the gear box rotates at a three hundred to one reduction in speed from that of the sleeve 46. The speed of the motor M and the gears 24 and 28 are arranged in the preferred embodiment so that the shaft 32 will make three hundred revolutions per minute. Therefore, with a three hundred to one speed reduction in the gear box 36, the shaft 47 will rotate at a speed of one revolution per minute when the clutch members 41 and 38 are engaged.

The operation of the clutch will now be described. A clutch magnet 48, Figs. 2 and 5, mounted to the base plate 34 has an armature 49 pivoted on a screw 51. The upper end of the armature 49 is in operative relation with a side cam surface 52 formed on the collar or driven member 41. The armature 49 of the magnet 48 cooperating with the side cam surface 52 controls the operation of the clutch. With the magnet 48 deenergized and the collar 41 in its normal rest position as shown in Figs. 2 and 5, the teeth 42 and 39 are disengaged. Assume that the magnet 48 is subsequently energized causing its armature 49 to pivot about the screw 51 and move the end thereof out of engagement with the side cam surface 52. A spring 53 coiled about the sleeve 46 and disposed between flanges on the sleeve 46 and collar 41 thereupon forces the sleeve to the right, Fig. 2, to bring its teeth 42 into engagement with the teeth 39 of the rotating driving member 38. The collar 41, the sleeve 46 thereupon rotate with the shaft 32 at a speed of three hundred revolutions per minute and as the sleeve 46 and the shaft 47 are geared together at a ratio of three hundred to one, the shaft will rotate at a speed of one revolution per minute and continue to do so as long as the magnet 48 remains energized. When the magnet 48 is deenergized a spring 54 pivots the armature 49 in a counter clockwise direction, Fig. 5, to place the end thereof against the circumference of the rotating collar 41 and in the path of the side cam surface 52. As the collar 41 approaches its rest position, the side cam surface 52 engages with the curved end of the arma-

ture 49 and is forced to the left, Fig. 2, which brings its teeth 42 out of engagement with the teeth 39 of the driving member 38. The end of the armature 49 then engages the section of the side cam surface 52 parallel to the axis thereof and stops further rotation of the collar 41. A lever 56 pivoted on a shoulder screw 57 extending from the side of the gear box 36 has pivoted on one end thereof a jockey roller 58. A spring 59 attached to the lever 56 holds the jockey roller 58 in engagement with a cam 61 integral with the sleeve 46 and tends to hold the collar 41 in its cammed out position until the magnet 48 is again energized. The energization and deenergization of the magnet 48 is under the control of the official timekeeper whereby he controls the rotation of the shaft 47 in accordance with the rules of the game. As the clock is designed to indicate the time remaining in a period of play, it must be stopped during "time out" periods and this is accomplished by breaking the circuit to the clutch magnet 48 as will be hereinafter described. The clutch is on the shaft 32 rotation at three hundred revolutions per minute and therefore the clock can be stopped during any revolution thereof or within a fifth of a second.

The seconds hand 14 is secured adjacent the right hand end of the shaft 47 for rotation therewith by a screw 62 and with the clutch magnet 48 energized will make one revolution per minute. The minutes hand 13 is driven from the shaft 47 through a planetary gear system. A planet wheel mounting disc 63 is secured to the shaft 47 by set screws 64 and carries one or more, preferably two, sets of planetary gears 66 and 67 directly connected to each other by a shaft 68. The shaft 68 is free to rotate in the bearing furnished by the planet wheel mounting disc 63. Two internal gears 69 and 71, one on each side of the disc 63, loosely mounted on the shaft 47, mesh with the planetary gears 66 and 67, respectively. A sleeve 72 loosely mounted on the shaft 47 has the gear 71 secured thereto for rotation therewith by screws 73. The sleeve is pivotally supported in a bearing post 74 and also serves as a journal for the right hand end of the shaft 47. Secured by a screw 76 to the right hand face of the sleeve 72 is the above mentioned minutes hand 13. Thus the minutes hand 13 is adapted to rotate with the internal gear 71. The internal gear 69 is loosely mounted on the shaft 47 and a friction member 77, such as a felt disc, is disposed between the left hand face thereof and a disc member 78. The disc is fixed to a hub 79 loosely mounted on the shaft 47 and operatively connected to a collar 81 by means of interengaging tongues and grooves 82 and 83, respectively. The collar 81 is fixed to the shaft 47 for rotation therewith. A spring 84 coiled about the collar 81 and hub 79 presses the disc 78 and friction member 77 against the internal gear 69. Thus the gear 69 tends to rotate with the shaft 47 through the action of the friction member 77 but is normally prevented from doing so by the end of the armature 86, Fig. 4, of a so-called "cut time" magnet 87 engaging one of the notches 88 formed in the periphery of the internal gear 69. The "cut time" magnet 87 is supported by an angle bracket 89 which is secured to a magnet base 91 supported by the base plate 34. The "cut time" magnet armature 86 is pivotally supported on a pin 92 and the upper bent end 93 thereof is normally held in one of the notches 88 in the periphery of the gear 69 by a spring 94.

Each of the internal gears 69 and 71 have

seventy-two teeth and the planetary gears 66 and 67 each have twenty and nineteen teeth, respectively. Therefore, with this arrangement of gears and with the gears 69 held stationary and acting as a sun wheel, the gear 71 will make on revolution for every twenty revolutions of the shaft 47. The theoretical description of a similar planetary gear system is fully given in a U. S. Patent issued to R. Steeneck et al., October 17, 1939, No. 2,176,438, and is thought to be well enough known and understood in the art without requiring a more detailed description herewith. The reasons for employing a planetary gear system instead of a straight spur gear reduction of twenty to one will be apparent as the description of the invention proceeds.

Referring now to Figs. 2 and 5, a horizontal mounting plate 96 is secured to the top of the gear box 36. Two bearing posts 97 and 98 secured to the plate 96 have suitably journaled therein a shaft 99. Two other similar bearing posts 101 and 102 secured to the plate 96 have suitably journaled therein a second shaft 103. A hub 104, Fig. 5, secured to the shaft 47 for rotation therewith by a screw 106 has attached thereto a gear 107. The gear 107 meshes with another gear 108 located above. The gear 108, Fig. 2, is fixed to a hub 109 which in turn is secured by a screw 111 for rotation therewith to the right hand end of the shaft 99. A hub 112, Fig. 2, secured by a screw 113 to the left hand end of the shaft 99 for rotation therewith has attached thereto a gear 114. The gear 114 meshes with and drives a gear 116 attached to a hub 117 which is secured to the shaft 103 for rotation therewith by a screw 118. As hereinbefore described the shaft 47 is adapted to rotate whenever the clutch is engaged and adapted to be at rest when the clutch is disengaged. Therefore, with the shafts 99 and 103 directly connected, as described, to the shaft 47, they will rotate only when the shaft 47 is rotating. In the preferred embodiment of the invention the gears 107 and 108 are so arranged that their respective shafts 47 and 99 will rotate at a ratio of slightly more than two to one respectively. The ratio of slightly more than 2 to 1 between the shafts 47 and 99, respectively, is required so that two minutes will elapse before the shaft 99 has made one complete revolution for reasons hereinafter pointed out. Also the gears 114 and 116 are arranged so that their respective shafts 99 and 103 will rotate at a ratio of five to two respectively.

Loosely mounted on the shaft 99, in the preferred embodiment, are four similar commutator units indicated in general by reference numerals 119a to 119d. Normally each of these commutator units are held from rotation with the shaft 99, as hereinafter described, but each unit may be separately released at any time to rotate with the shaft. Each commutator unit 119 comprises a disc 121, Figs. 2 and 3, a disc cam 122 and a spacer 123 all clamped together and in relative position to one another by screws such as 124. The cams 122 and the spacers are preferably composed of electrically insulating material such as Bakelite. Between each commutator unit 119 and the next one is a metal disc 126 and a friction element 127 such as a felt disc. The metal discs 126 are adapted to slide along the shaft 99 but are keyed thereto for rotation therewith. A spring 128 coiled about the shaft 99 exerts a force along the axis of the shaft and keeps each disc 121 and spacer 123 of each commutator unit

119 engaged with a felt friction element 127 or a disc 126. Collars 129 and 131 secured to the shaft 99 serve as stops for the slidable elements on the shaft 99 and by adjusting the position of the collar 129 the force of the spring 128 may be varied. Thus it is evident that as the shaft 99 rotates each of the commutator units 119 will tend to rotate therewith through the frictional action of the disc 126 and felt washers 127. Loosely mounted on the shaft 103 are four commutator units indicated in general by reference numerals 132a to 132d. These commutator units 132 are substantially the same as the commutator units 119 and comprise a disc 133 and two cams 134 and 136. The commutator units 132 are adapted to be frictionally rotated from the shaft 103 in the same manner as the commutator units 119 are rotated from the shaft 99, a spring 137 in this case supplying the force to keep the rotating and rotatable elements frictionally engaged.

Two posts 138 and 139 extending vertically from the plate 96 have secured horizontally across the tops thereof by screws 141 a contact set mounting bar 142. Mounted horizontally on the top of the bar 142 by screws 143 are four sets of contacts 144a to 144d. The lower spring of each contact set 144 is in operative relation with the cam 122 on an associated commutator unit 119, each cam 122 having an associated contact set 144 and with the commutator unit in its normal position the cam 122 holds the associated contact set closed. Mounted on the underside of the bar 142 by screws 146, Fig. 6, are four single contact springs 147, one associated with each of the contact sets 144 and commutator units 119. The single contact springs 147 are U-shaped and the contact element thereon cooperates with the end of an associated adjustable screw 148 to make and break electrical contact therewith which in turn is supported in the insulating bar 142. A bar 149 mounted on the plate 96 beneath the insulating bar 142 has secured thereto by screws 151 four individual magnet brackets 152. Each bracket 152 has mounted thereon by a screw 153 a so-called "two minute penalty" magnet 154. Pivoted on a screw 156 in the bracket 152 is the magnet armature 157. Each commutator unit 119 has an associated magnet 154 and a projection 158 on the right hand side of the armature 157 as shown in Fig. 6 is in operative relation with the disc 121 of an associated commutator unit 119. Normally the projection 158 is in a notch 155 in the disc 121 and thereby holds the associated commutator unit 119 from rotating with the shaft 99. An insulating block 159 attached to the upper left hand side of the armature 157 cooperates with its associated U-shaped contact spring 147 to cause it to make and break the electrical connection between it and its associated screw 148 in a manner hereinafter described. Thus each commutator unit 119 has associated therewith a spring contact set 144 in operative relation with and adapted to be operated by the cam 122 on the commutator unit, a U-shaped contact spring 147 with an associated contacting screw 148, and a magnet 154 with an armature adapted to release the commutator 119 for rotation with the shaft 99 and concomitantly actuate the associated spring 147 to make and break contact with its associated contacting screw 148.

Two other posts 161 and 162 Fig. 2 extending vertically from the plate 96 have horizontally

mounted across the top by screws 163 an insulating bar 164. Attached by screws 166 to the top of the bar 164 are four groups of two spring contact sets such as 167a to 167d and 168a to 168d.

The contact springs extend horizontally and the lower contact spring of each group of the contact sets 167 and 168 are each in operative relation with the periphery of the hereinbefore mentioned cams 134 and 136 respectively on an associated commutator unit 132. Associated with each set of contacts 167 and 168 and mounted by screws 169 Fig. 6, to the underside of the bar 164 is a single U-shaped contact spring 171. Mounted horizontally in the bar 164 are screws 172 and the end of each one is in operative relation with the contact element on an associated U-shaped contact spring 171. A bar 173 mounted on the plate 96 beneath the insulating bar 164 has attached thereto by screws 174 four magnet brackets 176. Attached to each bracket 176 by a screw 177 is a so-called "five minute penalty" magnet 178. Associated with each magnet 178 is an armature 179 pivoted at the lower end thereof on a screw 181 in the bracket 176. An insulating block 182 attached to the upper right hand end of each armature 179 is in engagement with one of the associated U-shaped contact springs 171 and as hereinafter described the armature 179 actuates the contact spring whereby its contact element makes electrical connection between it and its associated screw 172. A projection 183 on the left hand side of each armature 179 is in operative relation with the disc 133 on each of the commutator units 132. Normally the projection 183 is in a notch 184 in the disc 133 and thereby holds the disc and the associated commutator unit from rotating with the shaft 103. From the above description it is evident that each commutator unit 132 has associated therewith two spring contact sets 167 and 168 in operative relation with the cams 134 and 136, respectively, on the commutator unit; a U-shaped contact spring 171 and associated contacting screw 172; and a magnet 178 with an associated armature 179 for releasing the commutator unit for rotation with the shaft 103, the armature also being adapted to operate the spring 171 to contact its associated contacting screw 172.

Referring to Figs. 2 and 4, a contact set 186 is mounted by screws 187 to a block 188 supported from the base plate 34. The lower contact spring of the contact set 186 is in operative relation with a disc 189 adapted to rotate with the shaft 47. When the disc 189 is rotated to a position which allows the end of the lower contact spring of contact set 186 to enter a notch 191 in the disc, the contact set 186 is adapted to be closed and for all other rotatable positions of the disc 189 the contact set 186 is opened. An angle bracket 192 is secured by screw 193 to a block 194 supported from the base plate 34. Attached to the bracket 192 by screws 196 are three vertically disposed contact sets 197, 198 and 199. The contact sets 197 and 198 are normally closed and the contact set 199 normally opened. An insulated lug 201 fixed to the planet wheel mounting disc 63 is adapted to engage a spring of the contact set 197 and open the same at a certain point in the rotation of the disc. Another insulated lug 202 fixed to the periphery of the internal gear 71 is adapted to engage a spring of the contact set 198 and open the same as at a predetermined point in the rotation of the gear 71 and a third lug 203 rotating with the internal gear 71 is in operative relation with the contact

set 199 and is adapted to close the same at another predetermined point in the rotation of the gear 71.

The manner in which the clock is manually started and automatically stopped at the beginning and ending respectively of periods of play and manually stopped and started at the beginning and ending respectively of time out periods will now be described. The above mentioned manual operations are performed by the official timekeeper operating a double pole switch 204, Fig. 8, having four terminals 206, 207, 208 and 209. At the beginning of a period of play the timekeeper operates the switch 204 to connect the terminals 207 and 209 which applies ground from terminal 209, over a conductor 211, through the coil of a relay 212, over a conductor 213, through the coil of the clutch magnet 48, over conductor 214 and through the back stop and tongue of a relay 216 to battery; thus energizing the magnet and relay 48 and 212 respectively. When the magnet 48 is energized the clutch is engaged and the shaft 47 operates the clock hands 13 and 14 as hereinbefore described. The energization of magnet 212 causes the completion of a circuit through its grounded tongue over a conductor 217 and through a lamp 218 to battery, thus causing the lamp 218 to be illuminated. The circuits to one or more lamps such as 218 may be completed by the energization of magnet 212 and one may be located adjacent to the clock and another in the direct view of the timekeeper which when illuminated indicate to the spectators and timekeeper that playing time is elapsing. The clock hands 13 and 14 continue to rotate until the end of the playing period at which time they are automatically stopped as hereinafter described or until the timekeeper operates the switch 204 in connection with a time out period. Assume that the clock is running and the timekeeper desires to stop it for a time out period. He thereupon operates the switch 204 to connect the terminals 206 and 208 thereof which opens the circuit completed on the previous operation thereof or the circuit to the relay and magnet 212 and 48 respectively. With the magnet 48 deenergized the clutch will be disengaged as hereinbefore described to stop the clock hands and with relay 212 deenergized, the circuit to the lamp 218 is opened, thus extinguishing the lamp. At the end of the time out period the switch 204 is operated to again connect the terminals 207 and 209 together whereupon the circuits to the clutch magnet 48 and to the lamp 218 are completed and the clock hands resume their movement. The time out periods may occur as often as necessary during which time the clock hands cease to move and the lamp 218 is extinguished. Thus when the lamp 218 is illuminated it indicates to the timekeeper, the players and the spectators that playing time is passing and the clock operating.

Every time the second hand 14 passes through its upright vertical position, the notch 191 in the disc 189 allows the contact set 186 to close. Just a degree or two before the minutes hand 13 reaches its upright vertical position, the lug 203 on the internal gear 71 directly connected to the minutes hand closes the contact set 199. When both contact sets 186 and 199 are closed simultaneously, a circuit is completed from ground through the two contact sets, over a conductor 219, through the tongue and break stop of a relay 221, over a conductor 222 and through the coil of relay 216 to battery. This circuit energizes the relay 216 which breaks the circuit through its tongue and break stop to the clutch

magnet 48 and the relay 212 and completes a circuit from battery at its tongue through its make contact to a gong 223 or other audible or visible signaling means. Thus the clock hands are automatically stopped, the light 218 extinguished and a signal given to the timekeeper and spectators that the end of the period of play has been reached. It is evident that the above circuit will be automatically closed only when the clock hands are both at their upright vertical position. At the end of each period of play the timekeeper operates the switch 204 to connect terminals 206 and 208 together, which prepares the circuits for the starting of the following period of play and completes a circuit from ground, through the at this time closed contact sets 186 and 199 over conductor 219 through the terminals 208 and 206 of the switch 204, over a conductor 224 and through the coil of the relay 221 to battery. This causes the energization of relay 221 which locks itself up through its tongue and make contact and breaks the circuit through its tongue and break stop to the coil of the relay 216. The deenergization of relay 216 causes the circuit to the gong 223 to be opened and completes the circuit from battery at the tongue of relay 216 through the coils of relays 48 and 212 to the terminal 207 of the switch 204. Thus the circuits are restored to their normal condition ready for the timekeeper to operate the switch 204 to connect ground to the terminal 207 of the switch at the beginning of the following period of play and concomitantly open the locking circuit to the relay 221.

The manner, the apparatus and the electrical circuits whereby the clock is adapted to automatically record variable periods of play and end each of such periods of play with both of the clock hands in their upper vertical position, will now be described. Three keys 227, 228 and 229, Fig. 9, called the "cut time" key, the ten minute period key and the fifteen minute period key, respectively, are each located in a keyboard adapted to be operated by the timekeeper. Each of the keys 227, 228 and 229 are normally open and each have one side thereof connected to ground by a conductor 231. The other side of the key 227 is connected by conductors 232 and 233 through the coil of the "cut time" magnet 87 to battery. The other side of the key 228 is connected by a conductor 234 in parallel to the tongue and one side of the coil of a relay 236. The other side of the coil of relay 236 is connected to the conductor 233. The side of the key 229 that is not grounded is connected by a conductor 237 in parallel to the tongue and one side of the coil of a relay 238. The other side of the coil of the relay 238 is connected to the conductor 233. The make contacts of relays 236 and 238 are connected by conductors 239 and 241 through the normally closed contact sets 198 and 197, respectively, to ground.

Assume that with a clock such as the one herein described designed primarily for use where the periods of play are ordinarily twenty minutes long, it is desired to have the clock time a period of play fifteen minutes long. Obviously, the length of shortened periods of play should be decided prior to the beginning of the period. If the period of play is to be fifteen minutes, the timekeeper, prior to the starting of the clock as hereinbefore described, operates the key 229. The key 229 needs to be operated only momentarily and its operation applies ground over conductor 237, through the coil of relay 238, over

conductor 233 and through the coil of the cut time magnet 87 to battery, causing the energization of the relay 238 and the magnet 87. As relay 238 operates, ground is applied through the contact set 197, over conductor 241, through the make contact set and tongue of the relay 238 and through its coil to keep it and the magnet 87 energized. With the hands of the clock in their normal zero position the contact set 198 will be closed. The energization of the magnet 87 causes the end of its armature 86, Figs. 2 and 4, to be withdrawn from a notch 88 in the periphery of the internal gear 69. The magnet 87 remains energized because the circuit thereto is completed through the locked up relay 238. Now when the timekeeper subsequently operates the switch 204 to start the clock into operation, the internal gear 69 or the sun wheel will rotate with the shaft 47 through the action of the friction member 77. As hereinbefore described, the disc 78 rotates with the shaft 47 and tends to rotate the gear 69 therewith through the friction member 77. With the internal gear 69 and the planet wheel mounting disc 68 both rotating with the shaft 47, there will be no relative rotation of the planet gears 66 and 67, hence the internal gear 71 will also rotate with the shaft 47 and at the same speed. As the minutes hand 13 is directly connected to the internal gear 71 and the seconds hand 14 to the shaft 47, the hands will rotate together. When the clock hands 13 and 14 have rotated together about eighty-five degrees from their normal position, the lug 201 on the periphery of the internal gear 71 opens the contact set 197. This breaks the locking circuit to the relay 238 and to the magnet 87. Thereupon the magnet 87 is deenergized and the end of the armature 86 rides on the periphery of the internal gear 69. When a notch 88 in the gear 69 is opposite the end of the armature 86, the spring 94 pulls it into the notch and thereby stops further rotation of the gear 69. As the shaft 47 continues to rotate the gear 69 acts as a sun wheel as hereinbefore described and thereafter causes the clock hand to rotate at a rate of twenty to one. The notch 88 that the armature 86 will drop into, for the above mentioned conditions, is so cut that when the seconds hand 14 completes its first revolution, the minutes hand will indicate fourteen minutes of the period of play left. Therefore, after an elapse of fifteen minutes of play the clock will automatically stop with its hands in their upright vertical position.

In substantially the same manner a period of play may be automatically shortened to ten minutes by the timekeeper operating the key 220. This causes the energization of the relay 236 which locks itself and the magnet 87 up until the clock hands have rotated a sufficient amount to allow the lug 202 to open the contact set 198 and the locking circuit to the relay 236 and thereafter cause the gear 69 to act as a sun wheel.

By closing the key 227 and holding it closed for predetermined lengths of time, the timekeeper may energize the time out magnet 87 to allow the minutes hand 13 to rotate with the seconds hand 14 to any one of a number of predetermined positions. The number of positions in this case is determined by the number of notches 88 in the periphery of the internal gear 69. In the preferred embodiment of the invention there are nineteen notches in the periphery of the internal gear 69. Thus the time-

keeper by holding the key 227 closed and watching the progress of the two hands rotating together around the face of the clock may by releasing the key 227 when the hands indicate any number of minutes left to play on the scale 18, adapt the clock to time a period of play containing that many minutes. The hands are not disengaged the moment the key 227 is released but continue to rotate together until the minutes hand 14 has rotated a fraction of one division on the scale 18 equal to substantially the fraction of a whole revolution that the seconds hand has rotated from normal position at the time the key is released. This, of course, is determined by the fact that there are only nineteen notches 88 in the periphery of the internal gear 69 and twenty divisions on the scale 18. Thus the minutes hand 13 is always in register with one of the minute indicating marks on the scale 18 when the seconds hand 14 passes through its upright vertical or zero position. This also insures that both of the hands reach their zero position together and automatically stop the operation of the clock at the end of a period of play as hereinbefore described. It is evident that with this arrangement the time out periods do not affect the time of the prearranged periods of play as the clock is stopped during the time out periods. Obviously, other keys such as 228 and 229 with associated relays 236 and 239, contact sets 198 and 197 and lugs 202 and 201, respectively, may be employed to automatically adapt the clock to register various predetermined periods of play and if the number of such keys were increased to nineteen, the key 227 would not be necessary.

The operation of the penalty timing apparatus will now be described. There are four separate penalty timing units in the preferred embodiment of the invention, two being provided for each contesting team of the contest. Thus four distinct penalty timing operations may occur at any time in a game. This number of units is considered to be sufficient to take care of the timing of all the penalties that might occur at any one time in a hockey game but it will be evident that more units could be very easily incorporated into the clock if desired. Each penalty timing unit consists of one of each of the commutator units 119 and 132 with their associated elements and one of the groups of lamps 19 to 22 on the clock face. Associated with each penalty timing unit and located at the official timekeeper's position is a two minute penalty key such as 244, Fig. 7, and a five minute penalty key such as 246. These keys 244 and 246 initiate the operation of their associated penalty timing units as will be described. Fig. 7 shows an exploded view of two of the commutator units such as 119b and 132b and the relation of their associated elements along with a diagrammatic view of the electrical connections therefor, the operation of which unit will be described. Assume that the referee decides to penalize a player by keeping him out of the game for two minutes. Such decisions usually occur during a time out period and therefore the clock will be stopped. As the player leaves the game, the timekeeper operates the key 244 to momentarily apply ground from the make stop thereof, through the key 244, over a conductor 249 and through the coil of its associated two minute penalty magnet 154 to battery. This causes the energization of magnet 154 which rocks its armature 157 to withdraw

the projection 158 from engagement with the notch 155 in the disc 121, and also causes the insulation 159 at the upper end of the armature to actuate the associated U-shaped contact spring 147 so that its contact element engages its associated screw 148. The armature 157 is prevented from returning to its normal position and allowing the contact spring 147 and screw 148 to be disengaged, although the magnet 154 may be immediately deenergized, by a small bell crank 248 which is pivoted on a screw 249 carried in the disc 121. As the armature 157 rocks to its energized position, the projection 158 thereon becomes disengaged with the notch 155 in the disc 121 and the top left hand end of the bell crank 248. Thereupon, a spring 251 is allowed to pivot the bell crank 248 a small amount to bring the left hand end into alignment with the projection 158 on the armature 157. Now when the magnet 154 is subsequently deenergized, the spring 147 rocks the armature 157 to bring the projection against the left hand end of the bell crank 149 and further pivoting of the armature is prevented. The movement of the armature, however, toward its normal position is not sufficient to allow the disengagement of the spring 147 and its screw 148. The screw 148 is grounded and when the U-shaped contact spring 147 makes contact therewith, three parallel circuits are completed therefrom; the first is over a portion of a conductor 252, through a lamp 20b and over a conductor 253 to battery, thus causing the lamp to be illuminated; the second circuit is from the grounded contact spring 147 over a section of conductor 252, over a conductor 254, through the normally closed contact set 144b, over a conductor 256, through the lamp 20a and over conductor 253 to battery, thus causing this lamp to be illuminated; the third circuit is from the grounded contact spring 147 over a portion of the conductor 252, through a lamp 257 and over conductor 253 to battery, thus causing this lamp to be illuminated. The lamps 20a and 20b are the first two lamps of the group indicated in general by reference numeral 20 in Fig. 1. The lamp 257, Fig. 7, is located at the timekeeper's position adjacent the two minute penalty key 244 and when illuminated indicates to the timekeeper that the associated penalty unit is in operation.

As stated above, time out is ordinarily called when a player is penalized. Therefore, the clock will be stopped and the shaft 99 at rest. When the game is again resumed and the clock started as hereinbefore described, the commutator unit 119b will no longer be prevented from rotating with the shaft 99, as the projection 158 normally holding the commutator from rotating is held out of the notch in the disc 121 by the bell crank 248. Thus the commutator unit 119b is free to rotate with the shaft 99 whenever it rotates, through the action of the friction elements 127. After the commutator unit 119b has rotated a few degrees from its normal position, the bell crank 248 rotates out of engagement with the projection 158 on the armature 157 and the projection rides on the periphery of the disc 121, during which time the armature continues to hold the contact spring 147 engaged with its screw 148. After the commutator unit 119b has rotated for exactly a minute with the shaft 99, or the clock has been in operation for one minute, the lower spring of the contact set 144b will drop into the cut away portion of the cam 122 and allow the

contact set to open. As the contact set 144b opens, it breaks the circuit to the lamp 20a and thereby causes it to be extinguished. This indicates to the spectators, the player penalized and the timekeeper that one minute of the two minute penalty has been served. Obviously, if time out is called during a penalty period, it is prolonged by an amount equal to the time out period or periods because during time out periods the clock is stopped and shaft 99 does not rotate during such times. After an elapse of two minutes of playing time the commutator unit 119b will have made nearly a complete revolution which allows the projection 158 on the armature 157 to drop into the notch in the disc 121. Such movement of the armature allows the spring 147 to be disengaged from the screw 148 and opens the circuits therefrom, previously described, to the lamps 20b and 257, causing said lamps to be extinguished. As the lamp 20b is extinguished, it indicates that the complete penalty period has been served and the penalized player is allowed to re-enter the game. As the lamp 257 is extinguished it indicates, as hereinafter provided, that the penalty unit is again capable of being operated. The notch 155 in the disc 121 is of such a length relative to the width of the projection 158 that the projection is allowed to enter before the disc has rotated a sufficient amount to bring the left hand end of the bell crank 248 opposite the projection. A slight amount of rotation of the disc 121 thereafter causes the upper left hand surface of the bell crank 248 to engage the projection 158 and then more rotation of the disc causes the bell crank to pivot about its mounting screw 249 to bring the lower edge of the leftwardly extending arm against a pin 258 in the disc. At this time the upper surface of the left arm of the bell crank 248 and the notch are in alignment and they both engage the projection 158 and prevent further rotation of the commutator unit 119b. The fact that a part of a revolution of the disc 121 is required to reset the latch 248 makes it necessary that it rotate at a speed somewhat less than one-half a revolution per minute as with the above arrangement the latch 248 cannot be reset, during the timing of a two minute penalty period. Thus the unit is returned to normal ready to be released to time another penalty period. There is a period after the lamps 20b and 257 are extinguished, equal to the time required for the commutator unit to rotate the length of the notch 155 in the disc 121, less the height of the projection 158, before the unit can be again released to time a penalty period. This period is preferably as short as possible and during this period the contact 144b is closed by its lower spring riding to the high part of the cam 122.

The timing of a five minute penalty period is substantially the same as timing a two minute period and is initiated by the operation of the five minute penalty key 246. As the key 246 is operated, it momentarily applies ground from its make contact over a conductor 259, through the coil of the five minute penalty magnet 178, over conductors 261 and 249 and through the coil of the two minute penalty magnet 154 to battery, thus momentarily energizing these magnets. As the magnet 154 operates, it causes the lamps 20a, 20b, and 257 to be illuminated as hereinbefore described and the operation of the magnet 178 causes a lamp 262 and the lamps 20c, 20d and 20e to be illuminated as hereinafter described. As the armature 179 of magnet 178 operates, it

causes ground from the screw 172 to be applied over its associated U-shaped contact spring 171, to complete four parallel circuits therefrom; the first circuit is from the spring 171 over a portion of a conductor 263, through the lamp 262 and over conductor 253 to battery; the second circuit is from the spring 171 over a portion of the conductor 263 and through the lamp 20e to battery; the third is from the spring 171 over a portion of the conductor 263, through the normally closed contact set 167b, over a conductor 264 and through the lamp 20c to battery; and the fourth is from the spring 171 over a portion of the conductor 263, through the normally closed contact set 168b, over a conductor 266 and through the lamp 20d to battery. This causes the illumination of the lamps 20c, 20d, 20e and 262 along with the illuminated lamps 20a, 20b and 257. The armature 179 is held in its operated position to keep the spring 171 in contact with the screw 172 by an associated bell crank 267 on the disc 133 in the same manner as the armature 151 is held operated. The lamp 20a and the lamps 20b and 257 are extinguished at the end of the first and second minutes of play respectively in the same manner as for a two minute penalty. At the end of three minutes of play the cam 134 of the commutator unit 132b will have rotated a sufficient amount to allow the associated contact set 167b to open and break the circuit to the lamp 20c, thus causing this lamp to be extinguished. After four minutes of play the cam 136 allows the contact set 168b to open, breaking the circuit to the lamp 20d and thus causing it to be extinguished. After an elapse of five minutes of playing time the disc 133 allows the armature 179 to return to its normal position and in so doing allows the spring 171 to open the circuits to the lamps 20e and 262 causing them to be extinguished. Thus the lamps 20a to 20e are progressively extinguished after the elapse of one to five minutes respectively of playing time. The commutator unit 132b is brought to rest in its normal position in the same manner as the commutator unit 130b and during the last few degrees of its rotation, the cams 134 and 136 cause the contacts 167b and 168b respectively to close.

As the clock does not ordinarily operate between periods incomplected penalty periods will extend into the next period as in accordance with the rules of the game.

The preferred embodiment of the invention employs three other penalty units which operate in exactly the same manner as the one described, and the penalties on the various units may overlap as each unit has independent operating and control means. Of course, more units could easily be added by lengthening the shafts 99 and 103 and providing additional groups of lights such as 19 to 22 on the clock face. It is also obvious that the number of lamps in a group such as 19 to 22 on the clock face could be varied and with slight modifications of the invention as shown, be adapted to time or indicate various other length penalty periods, the two and five minute penalty periods being chosen as the most apt to occur in a hockey game. As hereinbefore stated, two of the groups of lights on the clock face are of one color and the other two of another color. The two different colored groups are assigned to the two teams and thus the spectators can more readily distinguish when the players on each team are penalized.

As illustrated, the clock mechanism is designed to control but a single pair of hands but by pro-

viding a plurality of clock mechanisms, they could all be controlled from a common control board. It is also conceivable that the driving mechanism might be suspended from the center of an arena and control the hands on a plurality of opposed clock faces by directly connecting the hands of all the clock faces together and having the groups of lamps such as 19 to 22 connected in parallel.

It is obvious, of course, that various modification of the apparatus and circuits shown herein may be made without departing from the spirit or essential attributes of the invention and its is desired therefore, that only such limitations shall be placed thereon as are imposed by the prior art or are specifically set forth in the appended claims.

What is claimed is:

1. In a time clock movement embodying a time indicator and means for driving said indicator at a predetermined speed, a second time indicator and means for normally driving said second indicator at a relatively slower speed than said first mentioned indicator, means for moving said second named means at the speed of said first mentioned means, automatically controlled means for restoring the speed of said second mentioned means to normal at any one of a plurality of predetermined points in the course of its movement, and means operable prior to the starting of said clock movement for determining at which one of said predetermined points said automatically controlled means restores the speed of said second mentioned means to normal.

2. In a time clock movement embodying a time shaft and a time indicator rotatable therewith at a predetermined speed, a second time shaft and a second indicator rotatable therewith normally at a relatively slower speed than said first mentioned time shaft, manually controlled means for rotating said second mentioned shaft at the speed of said first mentioned shaft, automatically controlled means for restoring the speed of said second mentioned shaft to normal at any one of a plurality of predetermined points in the course of its rotation and means operable prior to the start of said clock movement for determining at which one of said predetermined points said automatically controlled means restores the speed of said second mentioned shaft to normal.

3. In a time clock having a pair of time indicators with means for normally rotating the time indicators at relatively different speeds for time measurement, means for rotating the slower one of said indicators at the start thereof at the normal speed of the other of said indicators, means operable prior to the start of said clock for choosing a setting point for said slower indicator from a plurality of predetermined setting points for setting the slower indicator and means whereby the slower one of said indicators automatically resumes its normal speed at the chosen one of the plurality of predetermined points in its rotation.

4. In combination with a game timing apparatus having a pair of hands for indicating the progress of a sports event, a plurality of signaling elements, manually controlled means for simultaneously operating a plurality of said signaling elements and means automatically operated by said game timing apparatus for progressively rendering said signaling elements unoperated.

5. In combination a clock for indicating the progress and termination of an event comprising periods of intermittent activity, such as sports events, time indicating means starting from a predetermined position for indicating the summation of intervals of activity as the event progresses, means for starting and stopping the clock to advance the time indicating means in accordance with the transpiration of each of said intervals, means for automatically stopping the clock when said time indicating means reaches a predetermined stopping position indicating the total expiration of an allotted time interval, means operative prior to the initial starting of said clock for automatically changing the length of an allotted time interval from a normal time to any one of predetermined changed time intervals, means whereby the termination of said normal and changed time intervals occur when said indicating means reaches said predetermined stopping position, a plurality of groups of signaling elements disposed adjacent said time indicating means, means for manually operating predetermined numbers of said signaling elements and automatic means controlled by said clock for progressively rendering said signaling element inoperative in a predetermined time relationship with respect to operation of said clock.

6. In a timing apparatus, a first time indicator and means for driving said indicator at a predetermined speed, a second time indicator and means for normally driving said second indicator at a relatively slower speed, each of said indicators normally being at rest, means for initiating the movement of said indicators, means for rotating said second indicator at the speed of said first indicator and means operable prior to the initiation of movement of said indicators for determining at which one of a plurality of predetermined points in its course of movement the speed of said second indicator is automatically restored to normal.

7. In a timing apparatus, a first time indicator and means for driving said indicator at a predetermined speed, a second time indicator and means for driving said second time indicator at a relatively slower speed whereby said second indicator normally makes one cycle of operation in a predetermined number of cycles of operations of said first indicator, said driving means normally operating to drive said indicators simultaneously at said respective speeds, means for starting said timing apparatus, means for moving said second indicator at the speed of said first indicator to any one of a plurality of predetermined points in its cycle whereby the number of cycles of operation of said first indicator for one cycle of operation of said second indicator is varied and means operable prior to the start of said timing apparatus for determining the point in the cycle of operation of said second indicator to which it is rotated at the speed of said first indicator.

8. In a time clock movement embodying a first time indicator movable at a predetermined speed, a second time indicator normally movable at a relatively slower speed, said second indicator moving a first predetermined distance on each cycle of operation thereof, said first indicator

normally moving a second predetermined distance during the movement of said second distance, means for moving said second indicator at the speed of said first indicator, means operable prior to the start of said clock movement for determining the amount of movement of said second indicator at the speed of said first indicator and means for automatically restoring the speed of said second indicator to normal after having moved the determined amount at the speed of said first indicator.

9. In a time clock movement embodying a first time indicator movable at a predetermined speed, a second time indicator normally movable at a relatively slower speed, means for moving said second indicator at the start of said clock movement at the speed of said first indicator and means operable prior to the start of said clock movement for determining at which one of a plurality of predetermined points in the course of its movement the speed of said second indicator is restored to normal.

10. In a time clock movement embodying a first time indicator movable at a predetermined speed, a second time indicator normally movable at a relatively slower speed, said first indicator normally rotating through a predetermined number of revolutions for one revolution of said second indicator, means for starting said clock movement, means for rotating said second indicator at the speed of said first indicator and means operable prior to the start of said clock movement and including rotating said second indicator with said first indicator to any one of a plurality of predetermined points for adapting said first indicator to make variable numbers of revolutions for one revolution of said second time indicator.

11. In a time clock for normally measuring and indicating the progress and termination of a predetermined time period, a time indicator and timing means for driving the same, a first manually controlled means for starting the time indicator from a normal starting position, a second manually controlled means operable prior to the starting of said time indicator from said normal starting position for automatically adapting the time clock to measure and indicate a predetermined one of a plurality of other predetermined time periods, and means whereby all of said time intervals terminate with said indicator at said normal starting position.

12. In a time clock for normally measuring and indicating the progress and termination of a predetermined time period, a time indicator and timing means for driving the same, a first manually controlled means for starting the time indicator from a normal starting position, a second manually controlled means operable prior to the starting of said time indicator from said normal starting position for automatically adapting the time clock to measure and indicate a predetermined one of a plurality of other predetermined time periods, and means for automatically stopping the indicator at the completion of all of said time intervals whereby said indicator indicates the termination of all of said time intervals at a common stopping point.

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