

March 1, 1938.

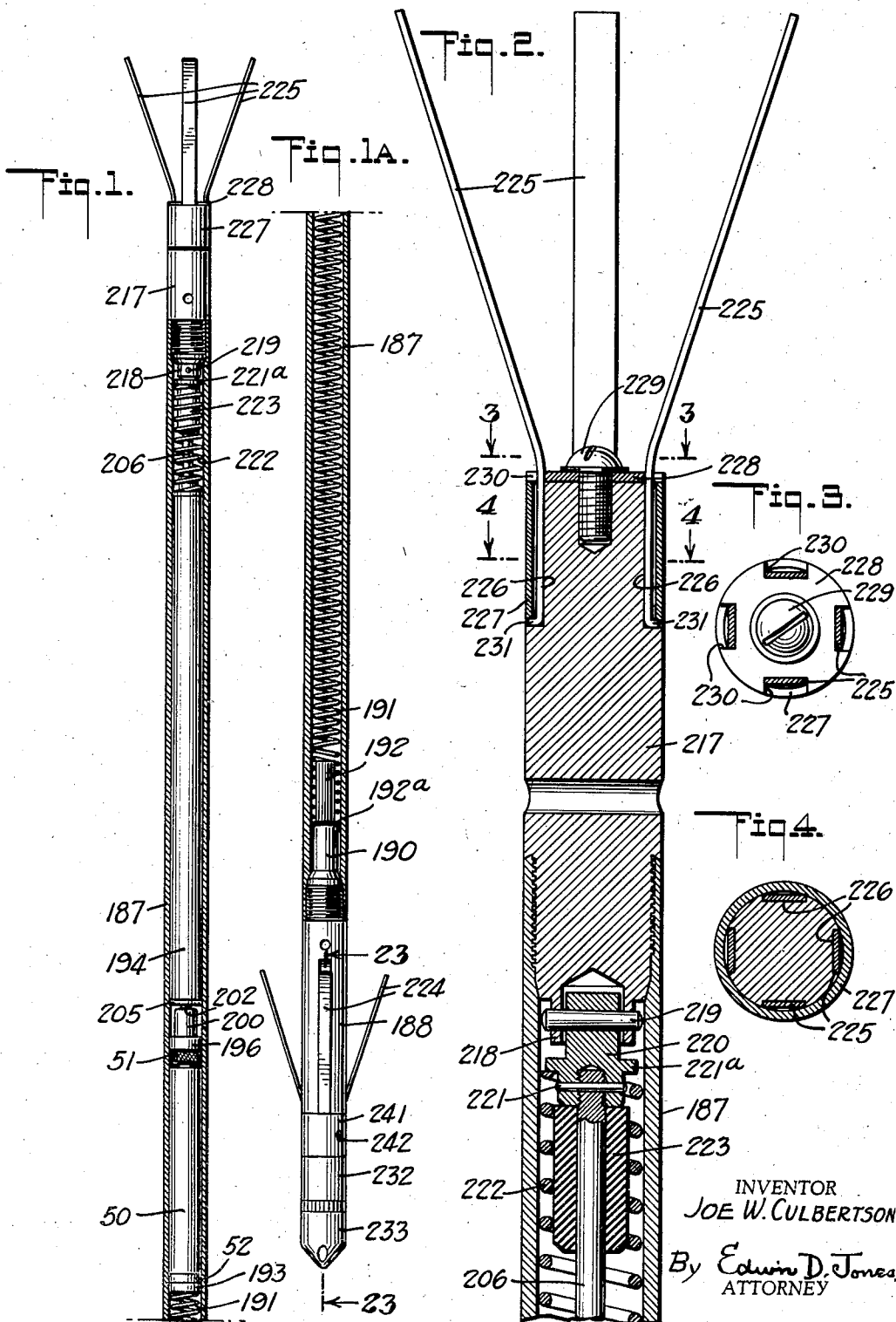
J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 1



March 1, 1938.

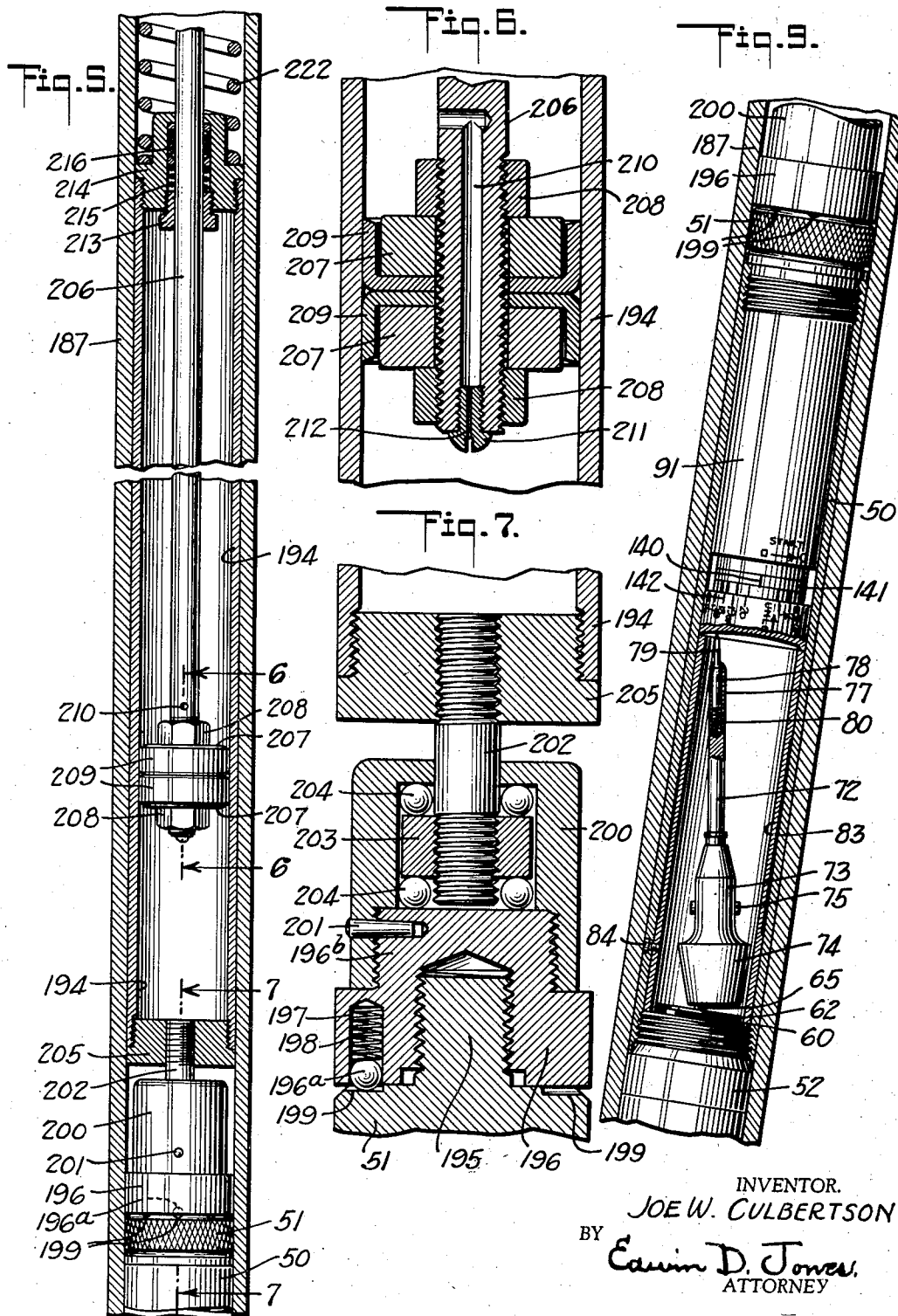
J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 2



INVENTOR.
JOE W. CULBERTSON
BY
Eugene D. Jones,
ATTORNEY

March 1, 1938.

J. W. CULBERTSON
DRIFT RECORDING APPARATUS

2,109,690

Filed April 3, 1935

8 Sheets-Sheet 3

Fig. 8.

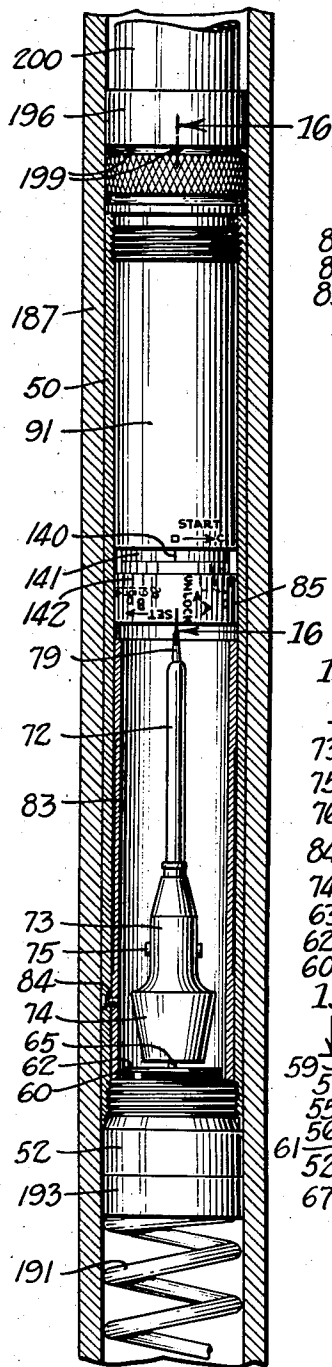


Fig. 10.

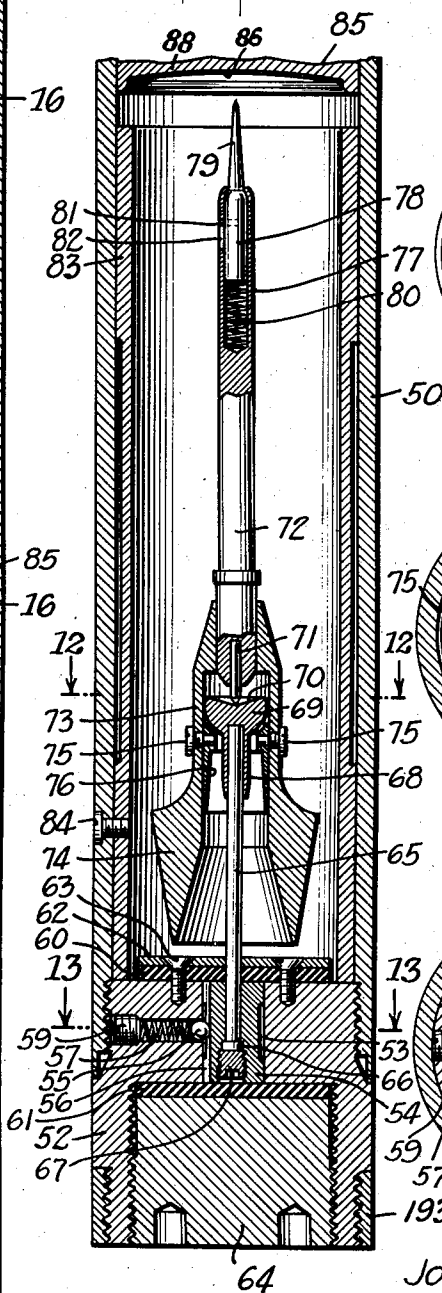


Fig. 11.

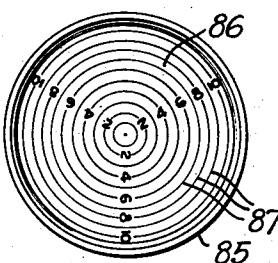


Fig. 12.

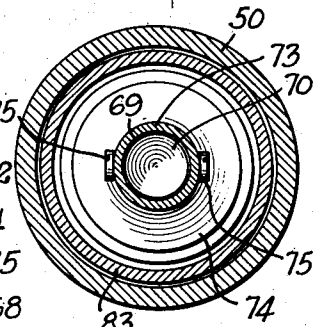
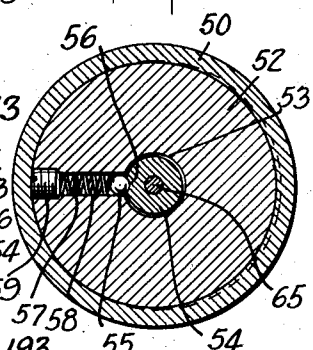


Fig. 13.



INVENTOR
JOE W. CULBERTSON
BY
Edwin D. Jones,
ATTORNEY

March 1, 1938.

J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 4

Fig. 14.

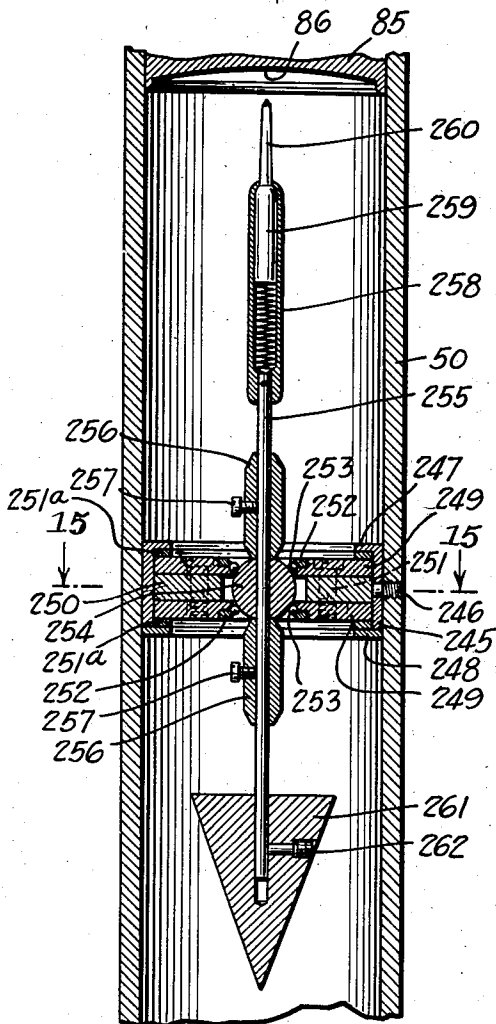
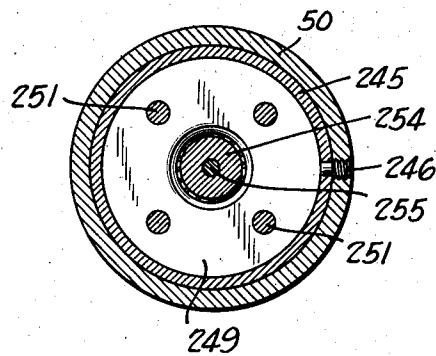


Fig. 15.



INVENTOR
JOE W. CULBERTSON
BY *Edwin D. Jones*
ATTORNEY

March 1, 1938.

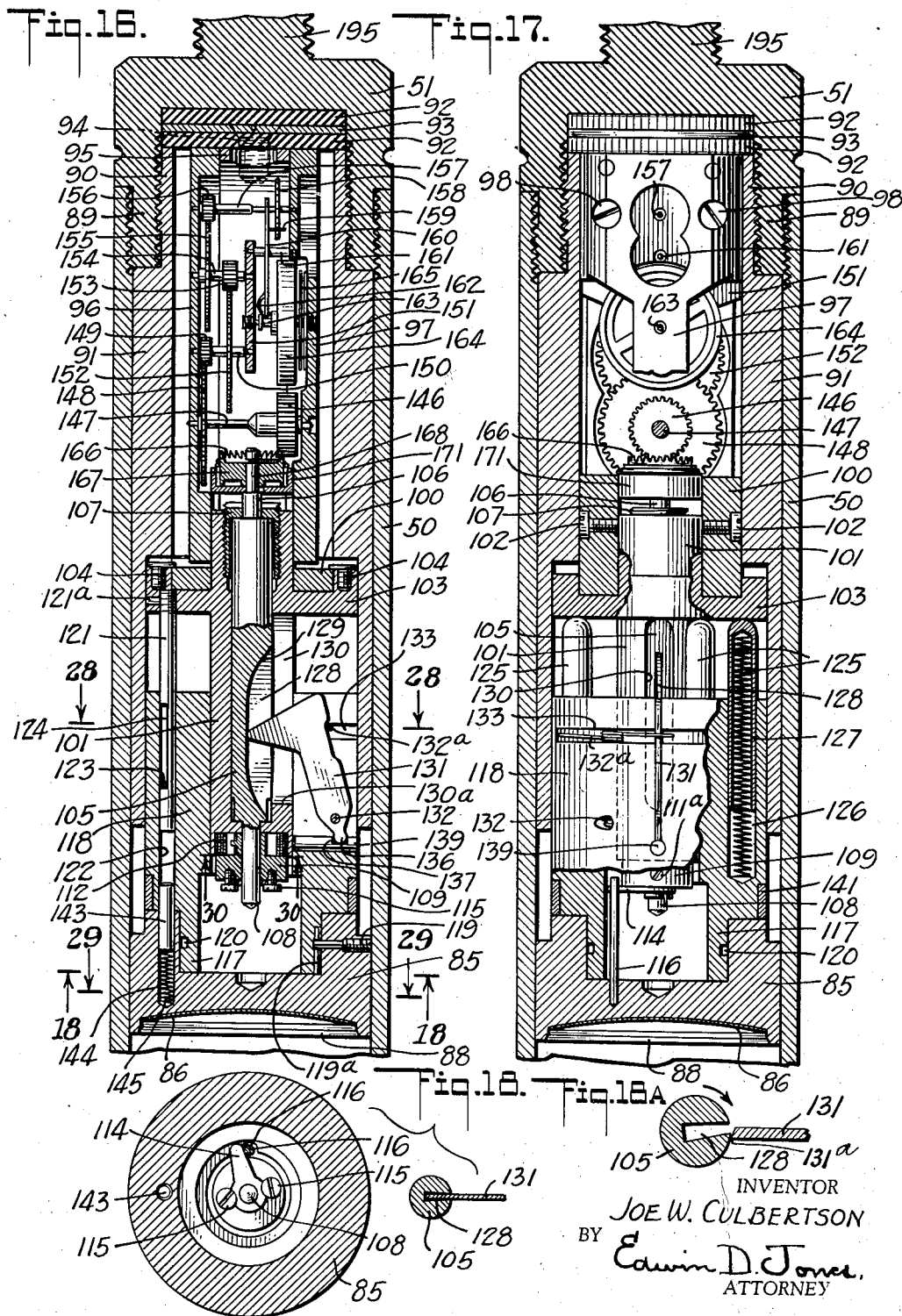
J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 5



March 1, 1938.

J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 6

Fig. 19.

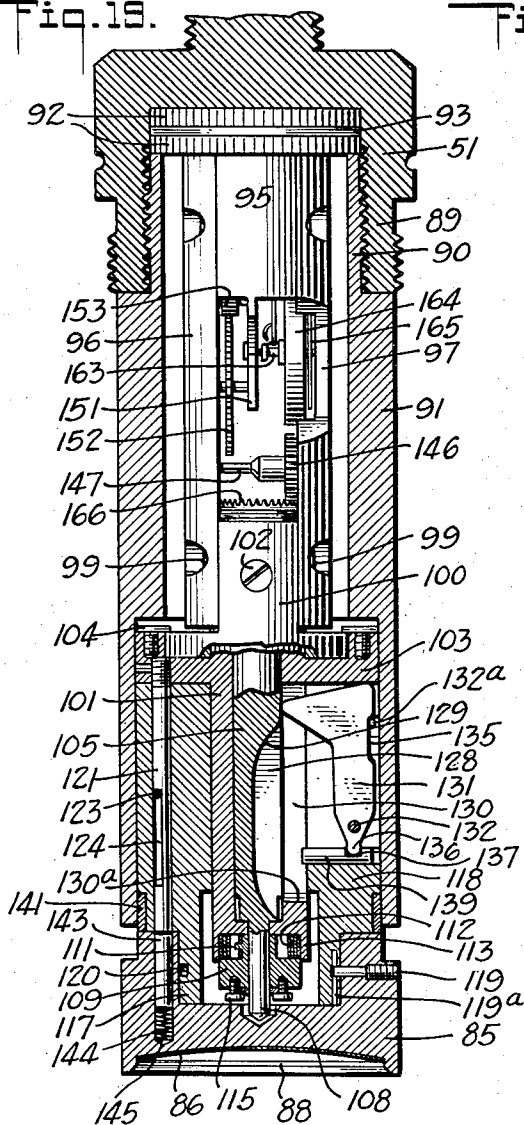


Fig. 20.

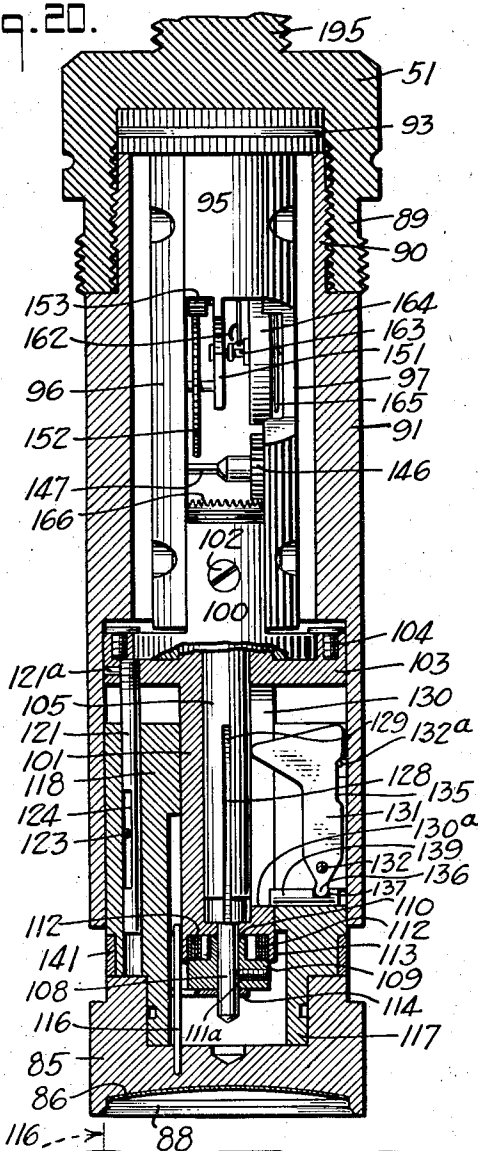


Fig. 21.

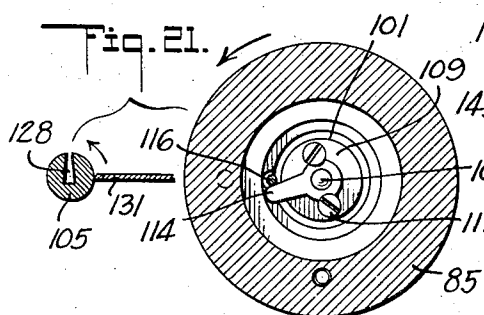
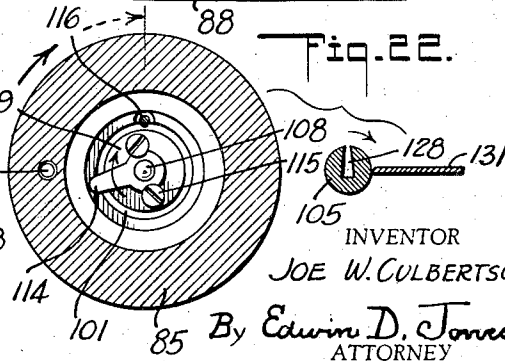


Fig. 22.



INVENTOR
JOE W. CULBERTSON
By Edwin D. Jones,
ATTORNEY

March 1, 1938.

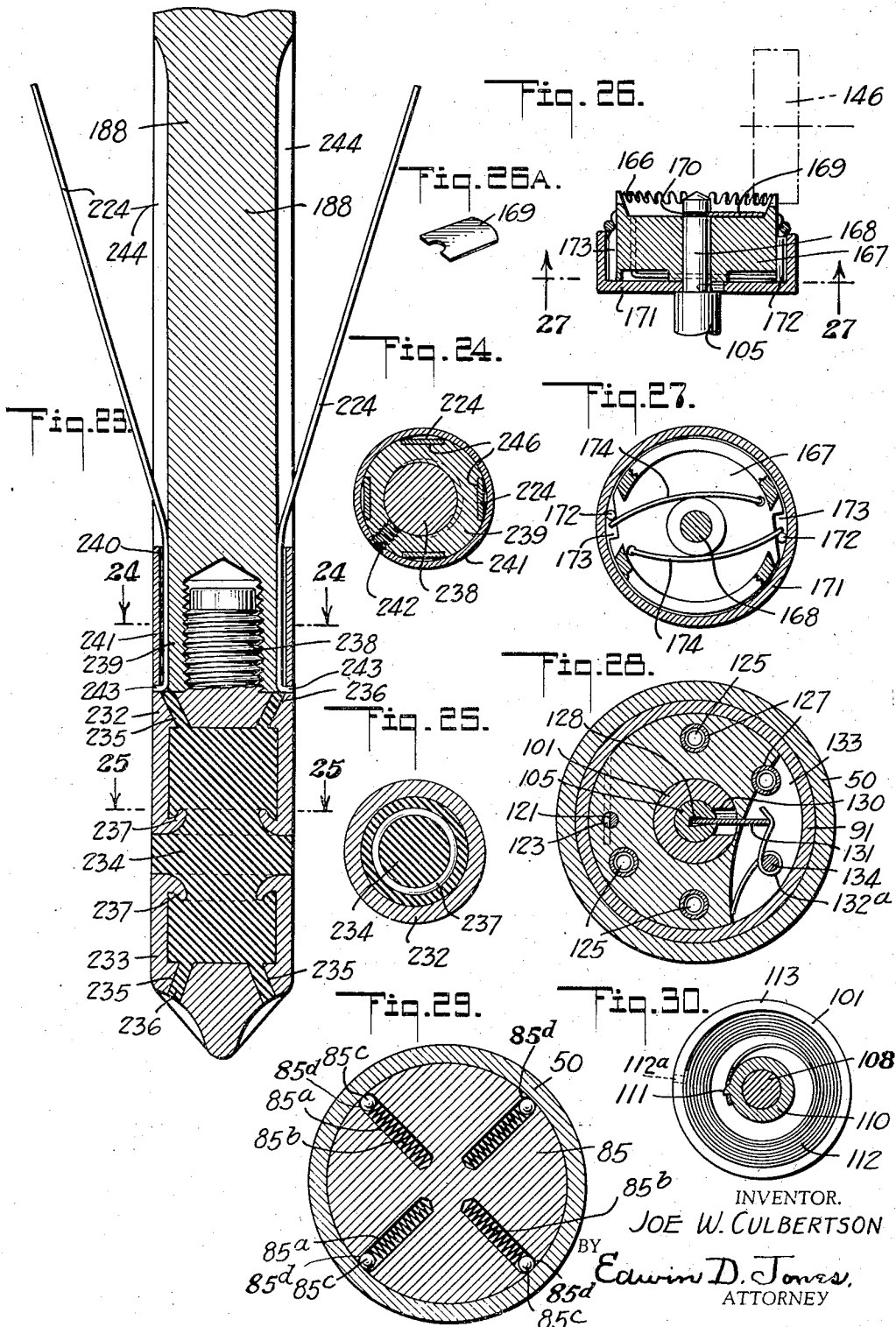
J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 7



March 1, 1938.

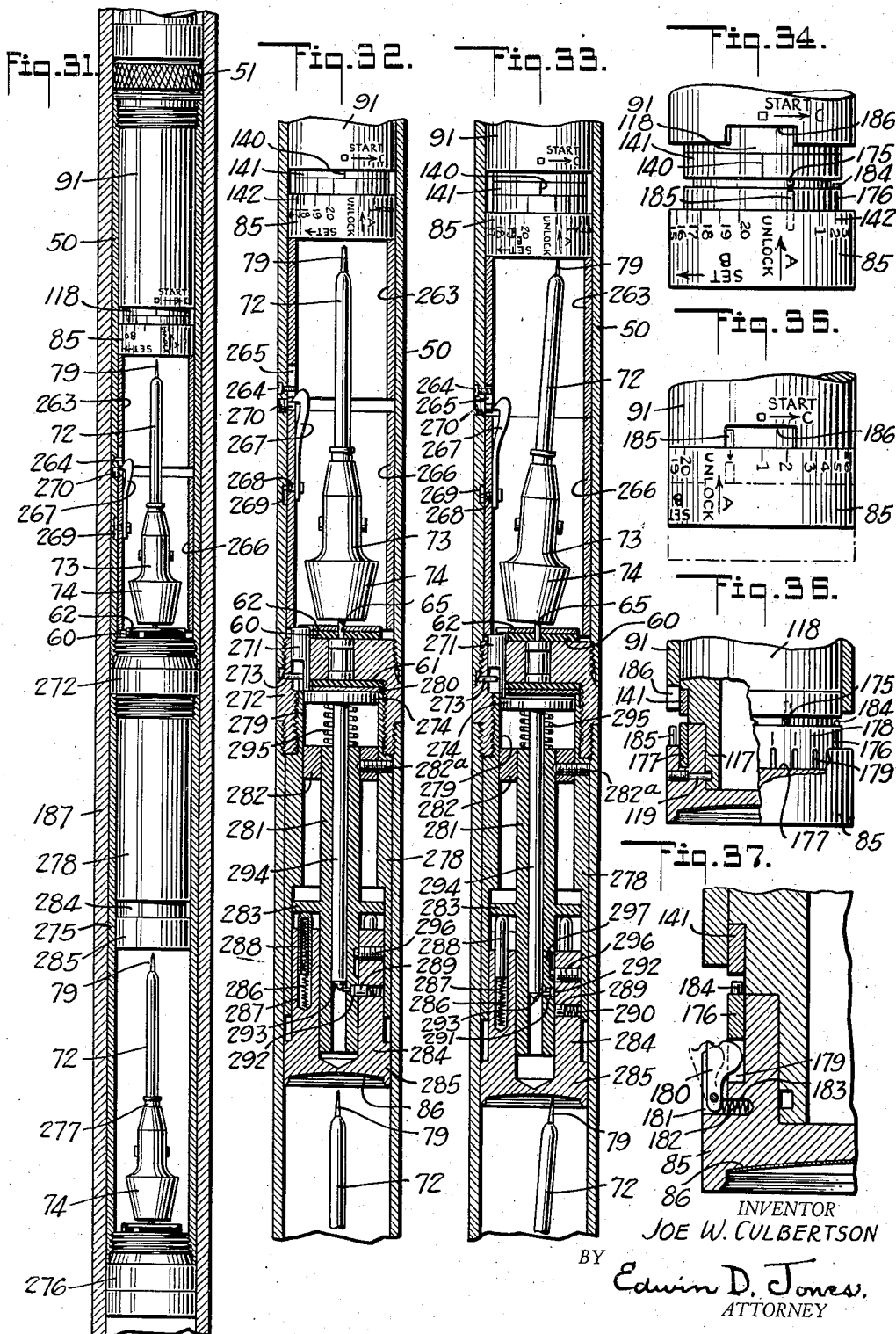
J. W. CULBERTSON

2,109,690

DRIFT RECORDING APPARATUS

Filed April 3, 1935

8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

2,109,690

DRIFT RECORDING APPARATUS

Joe W. Culbertson, West Hollywood, Calif., assignor to Technical Oil Tool Corporation, Ltd., a corporation of California

Application April 3, 1935, Serial No. 14,479

24 Claims. (Cl. 33—205.5)

My invention relates to apparatus for use in oil wells and similar earth bores for recording the degree of drift or inclination of a hole from the vertical, and it has particular reference, although not necessarily, to that form of drift recording apparatus which is characterized by being dropped or lowered into a drill pipe or open hole, and upon reaching the desired position therein the drift measuring and recording instrument thereof becomes operative automatically under the action of a previously set time-control mechanism, to record the degree of drift of the hole from the vertical.

My invention has for a purpose the general structure and functional refinement of such a drift recording apparatus to the end of producing an apparatus which withstands, without damage, thereto, the severe blows to which it is subjected when in use; which renders the measuring and recording of inclination extremely accurate under any and all conditions; and permits accurate setting of the timing mechanism to effect tripping of the measuring and recording mechanism at a predetermined time.

It is also a purpose of my invention to provide a drift recording apparatus which embodies two or more drift recording instruments design to permit one to check or compare the recordation made by one, upon that made by the other to the end of determining if the recordation made by either instrument is false because, due to improper setting, the instrument was tripped before the angle marker thereof came to complete rest. In this particular form of my apparatus, the operation of one instrument is dependent upon that of the other so that both instruments are operated at a predetermined time, and, further, the angle markers of the two instruments are designed to travel different distances for a given angle of deviation so that by the provision of suitably scaled charts one instrument operates to record angles of deviation in degrees and the other in minutes.

I will describe only two forms of drift recording apparatus, two forms of angle markers, two forms of setting gages, and one form of shock absorbing means, all embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings:

Figs. 1 and 1—A are views, one a continuation of the other, showing in side elevation with the casing thereof in section, one form of drift recording apparatus embodying my invention.

Fig. 2 is an enlarged fragmentary view show-

ing in longitudinal section the upper portion of the apparatus shown in Fig. 1.

Figs. 3 and 4 are transverse sectional views taken on the lines 3—3 and 4—4, respectively, of Fig. 2.

Fig. 5 is a view similar to Fig. 2 and is a continuation thereof, the two views showing a complete shock absorbing means embodied in the apparatus.

Figs. 6 and 7 are enlarged fragmentary sectional views taken on the lines 6—6 and 7—7, respectively, of Fig. 5.

Fig. 8 is a view similar to Fig. 5 and is a continuation thereof, showing one form of drift recording instrument embodied in my apparatus, with the container therefor in section.

Fig. 9 is a view similar to Fig. 8 showing the drift recording instrument in recording or tripped position as distinguished from the non-recording or set position as shown in Fig. 8.

Fig. 10 is an enlarged longitudinal sectional view of the recording mechanism shown in Fig. 8.

Fig. 11 is a plan view of the chart and holder embodied in the drift recording instrument.

Figs. 12 and 13 are transverse sectional views taken on the lines 12—12 and 13—13 of Fig. 10.

Fig. 14 is an enlarged fragmentary longitudinal sectional view of another form of angle indicator embodying my invention.

Fig. 15 is a transverse sectional view taken on the line 15—15 of Fig. 14.

Fig. 16 is an enlarged sectional view taken on the line 16—16 of Fig. 8 showing the chart actuating and time regulating mechanisms of the drift recording instrument with the chart actuating mechanism in tripped position.

Fig. 17 is a view similar to Fig. 16 looking in a direction at right angles thereto.

Fig. 18 is a transverse sectional view taken on the line 18—18 of Fig. 16 and also showing in transverse section the shaft and cam lever of the chart actuating mechanism shown in Fig. 16.

Fig. 18—A is another transverse sectional view of the shaft and cam lever enlarged and showing that position of the shaft just preceding the entry of the cam lever into the shaft.

Figs. 19 and 20 are views similar to Fig. 16 showing other positions which the chart actuating mechanism is adapted to occupy.

Figs. 21 and 22 are views similar to Fig. 18 showing other positions of the elements shown in Fig. 18.

Fig. 23 is an enlarged longitudinal sectional view taken on the line 23—23 of Fig. 1—A.

Figs. 24 and 25 are transverse sectional views taken on the lines 24—24 and 25—25 of Fig. 23.

Fig. 26 is an enlarged view of the clutch shown in section in Fig. 16.

Fig. 26A is a detail view showing in perspective the key shown in Fig. 26.

Fig. 27 is a transverse sectional view taken on the line 27—27 of Fig. 26.

Figs. 28, 29, and 30 are transverse sectional views taken on the lines 28—28, 29—29, and 30—30 of Fig. 16.

Fig. 31 is a view similar to Fig. 8 showing another form of drift recording apparatus in which two recording instruments are embodied.

Fig. 32 is an enlarged sectional view similar to Fig. 31 but showing the chart actuating mechanism for one of the instruments in section.

Fig. 33 is a view similar to Fig. 32 but showing the tripped positions of the instruments.

Figs. 34 and 35 are views showing in side elevation a setting gage for the chart actuating mechanism.

Fig. 36 is a view similar to Fig. 35 with a portion thereof in section.

Fig. 37 is an enlarged fragmentary sectional view showing a latching means embodied in the setting gage.

Drift recording instrument

Referring to Figs. 8, 9, and 10, a tubular receptacle 50 is closed at its upper end by a cap 51, and at its lower end by a plug 52, both of which are threaded in the receptacle. The plug 52 is provided centrally with an opening 53 in which a support 54 is movable axially but held against rotation by a ball 55 urged into a groove 56 in the support by a spring 57 confined in a radial opening 58 by a screw plug 59. The support 54 is yieldingly confined within the plug 52 by rubber plates 60 and 61, the upper one of which is secured in spanning relation to the upper end of the opening 53 by a metal plate 62 secured to the plug 52 by screws 63. The lower rubber plate 61 is confined in spanning relation to the lower end of the opening 53 by a metal plug 64 threaded in the lower end of the plug 52.

The support 54 is formed with an axial opening in which is received the lower end of a stem 65, such stem being formed with a head 66 to confine the stem against upward movement, and such head is engaged at its lower side by a screw plug 67 for securing the stem against downward movement in the support. The stem 65 projects upwardly through the plates 60 and 63 where its upper end is secured in a sleeve 68 on a socket member 69 constructed of hardened steel. The upper surface 70 of this socket member is of inverted conical form so that the apex thereof is situated at the exact center of the socket member. A relatively small and pointed pin 71 constructed of hardened steel bears at its pointed end on the apex of the surface 70. This pin 71 is fixed axially within the lower end of a rod 72, while the lower end of the rod is, in turn, fixed in a tubular extension 73 of a weight 74, the latter carrying, by means of screws 75, a skirted ring 76 which normally has a very slight clearance with respect to the rounded under surface of the socket member 69, but which is adapted to abut such surface to confine the extension 73 and the rod 72 against upward displacement from the socket member.

The rod 72 is bored axially at its upper end to form a sleeve 77 in which is slidably received the body 78 of a marking element 79. The marking element 79 is in the form of a pointed instrument

which is adapted to punch a chart so as to permanently mark the latter. The marking element 79 is formed integral with the body 78, and the body together with the marking element is urged upwardly by a spring 80, such urging movement being limited by means of a pin 81 working within a slot 82. This pin and slot connection also serves to limit downward movement of the marking instrument when it is forced downwardly by engagement with a chart, as will be more fully described hereinafter.

The weight 74 and the rod 72 together with the mounting means therefor, constitute one form of angle marker embodying my invention. As will be understood, the arm is poised to oscillate about the socket member 69 as a center, and that under the counter-balancing action of the weight the rod constantly tends to assume a vertical position. The rubber plates 60 and 61 provide means for cushioning movement of the support 54 axially in either direction in order that shocks to which the parts of the angle marker and its mounting are subjected when in actual use, are effectively absorbed to prevent distortion of such parts and mounting.

As best shown in Fig. 10, the metal sleeve 83 is secured in the receptacle 50 by means of a screw 84, the lower end of the sleeve abutting the plug 52, while its upper end is positioned to form a stop for limiting movement downwardly of a head 85. This head 85 carries a chart 86 which is of disk form and preferably made of celluloid. As shown in Fig. 11, the lower or exposed surface of the chart 86 has inscribed thereon concentric circles 87 representing degrees from the vertical as indicated by the numerals thereon. As shown in Fig. 10, the lower side of the head 85 is cupped to form a pocket 88 in which the chart is received and removably secured therein by reason of the fact that to insert the chart into the pocket it is necessary to flex the latter so that its periphery is urged toward the side wall of the pocket, as will be understood.

Chart actuating mechanism

In describing this mechanism, reference will be had to Figs. 16 to 22, inclusive. As shown in Fig. 16, the cap 51 is provided with a collar 89 threaded within the upper end of the receptacle 50. Threaded into the collar 89 is a collar 90 on the upper end of a barrel 91, this barrel being of such diameter as to have a sliding fit within the receptacle 50 and to be suspended therein from the cap 51. Interposed between the collar 90 and the body of the cap 51 are a pair of rubber disks 92 between which is interposed a metal plate 93. By means of screws 94 (one of which is shown in dash lines in Fig. 16) the upper head 95 of a frame is secured to the plate 93 in such manner that the lower disk 92 is interposed between the head and the plate. In this manner the entire frame of which the head forms a part is suspended so that it is yieldingly supported to allow the rubber disks to absorb shocks transmitted to the frame in order to protect against injury the mechanism carried by the frame.

The frame is made up of side plates 96 and 97 secured at their upper ends to opposite sides of the head 95 by screws 98. By means of screws 99 the lower ends of the plates 96 are secured to opposite sides of a lower head 100. This head 100 is provided with a central bore into which extends the upper end of a sleeve 101, and this sleeve is fixed against movement therein by

means of screws 102, as best illustrated in Fig. 17. At a point spaced from its upper end the sleeve is formed with a flanged disk 103 on which the head 100 is fitted and secured by the heads of the screws 104 (Fig. 16). In order to accommodate the disk 103 within the barrel 91 the latter is counter-bored, as best shown in Fig. 16.

The sleeve 101 constitutes a bearing in which a shaft 105 is rotatably fitted with the upper portion of the shaft formed with a journal 106 of reduced diameter and rotatable in a thrust bearing 107 which is screw-threaded in the bore of the sleeve 101. The lower end of the shaft is reduced to provide a pintle which projects below the lower end of the sleeve to accommodate a disk-shaped head 109. This head 109 is provided with a collar 110 to which is secured by means of a lug 111, the inner end of a coiled main spring 112. By means of a screw 112^a the outer end of the spring is secured to an annular flange 113 formed on the lower end of the sleeve 101. A screw 111^a serves to secure the head 109 to the pintle 108 for rotation with the shaft 105, and thus it will become apparent that with the spring 112 under tension, it will tend to rotate the shaft 105 in a counter-clockwise direction, as when viewed in Fig. 30.

An arm 114 is fixed to the head 109 by means of two screws 115 (Figs. 16 and 18), and this arm projects from the periphery of the head to be engaged by a pin 116 extending upwardly from and fixed to the chart carrying head 85 (Figs. 17 and 18). The head 85 is rotatably mounted on a collar 117 of a body 118, and by means of a screw-pin 119 in the head, engaging within an annular groove 120 in the collar, the head is secured against displacement from the body. This pin 119 is adapted to abut a stop pin 119^a extending across the groove 120, for limiting rotation of the head rearwardly or in a counter-clockwise direction as when viewed in Fig. 18 to less than a complete revolution, for a purpose to be described hereinafter.

While the chart head 85 has a sliding fit within the receptacle 50, the body 118 has a similar fit within the enlarged bore of the barrel 91. To take up any play of the chart head in the barrel, and positively center the head therein, radial pockets 85^a are formed in the head (Fig. 29) containing springs 85^b for urging balls 85^c outwardly to bear against the wall of the receptacle 50. To confine the balls against displacement from the pockets after they have been inserted with the springs, the outer ends of the pocket walls are flanged as indicated at 85^d in Fig. 29.

The body 118 is bored axially to accommodate the sleeve 101, and thus the body is slidable on the sleeve. However, the body is secured against rotative movement relative to the barrel and sleeve by the provision of a rod 121 (Fig. 16) threaded at its upper end in the disk 103 and secured by a pin 121^a, and extending downwardly into an opening 122 in the body. Axial movement in either direction of the body in the barrel is limited by a stop-pin 123 extending into the body so that its medial portion is disposed in a recess 124 in the rod. Of course, movement of the body inwardly of the barrel is also limited by the body abutting the disk 103, as will be understood.

By means of a plurality of springs 125 (Fig. 17) disposed in pockets 126 in the body 118, and sleeves 127 in the pockets, the body is yieldably urged downward to the lower extreme position shown in Fig. 17, which position of the body is

defined by the stop-pin 123 abutting the lower end wall of the rod recess 124 (Fig. 16).

The shaft 105 is formed with a slot 128 shaped to provide within and at the upper end thereof, a cam 129, and similarly, the sleeve 101 is formed with a slot 130. The body 118 is slotted to accommodate a cam lever 131 which is fulcrumed on a pin 132 secured in the body, to occupy the advanced position shown in Fig. 16, or the retracted position shown in Fig. 20. In the advanced position, the pointed nose of the lever extends into the slot 128 to bear against the bottom or inner wall thereof under the action of a spring 132^a. As shown in Figs. 17 and 28, the spring 132^a is disposed in a slot 133 of the body 118 and mounted on a pin 134 to engage the outer recessed edge 135 of the lever 131.

The cam lever 131 is provided at its lower end with a rounded head 136 which engages within a socket 137 of a latch bolt 139 slidable in the body 118 to engage and disengage the lower end wall 130^a of the slot 130 so that such wall functions as a keeper. In consequence of this connection between the lever and bolt, it will be clear that according as the lever occupies advanced or retracted position, the bolt is moved to disengage or engage the keeper 130^a. When in engagement with the keeper, the latch bolt serves to latch the body 118 in the intermediate position shown in Fig. 20 and against the tendency of the springs 125 to move the body to the outer or lower position shown in Fig. 16.

In addition to carrying the chart 86, the head 85 functions as a setting gage by which the chart actuating mechanism can be set to release the head at a predetermined time and thus permit the head to engage the marking element 79. This setting operation is accomplished through rotational adjustment of the head 85 from a normal or non-gaging position as determined by the pins 119 and 119^a and an index mark 140 (Fig. 8) on a ring 141, to any of several gaging positions as determined by graduations 142 on the head 85. These graduations are calibrated in minutes of time and are consecutively numbered from 1 to 20 in the present instance. The ring 141 is capable of circumferential adjustment on the body 118 to precisely position the index mark 140 with relation to the graduation numbered 1 in order that timing of the instrument as determined by adjustment of the head will be rendered extremely accurate. Arrows marked A, B, C, and the legends "Unlock", "Set", and "Start", are imprinted on the head 85 and the body 118 for purposes of instruction, as will be more fully described hereinafter.

The chart or gage head 85 is adapted to be locked automatically in the normal or non-gaging position by a bolt 143 movable in a pocket 144 of the head (Fig. 16) and urged by a spring 145 to a position in which it extends into the opening 122 of the body 118. To release the head and permit rotational adjustment thereof, it is necessary to force the body 118 inwardly to the inner extreme position shown in Fig. 19 when the bolt 143 abuts the rod 121 and is thus moved by the rod outward until its inner end is flush with the adjacent surface of the head. Thus the head is now free to be turned on the body to any gaging position of adjustment, and it will be clear that it is unnecessary to maintain the body 118 in the inner extreme position during such adjustment, for once the bolt is moved out of registration with the opening 122, it can no longer function to lock the head. However, upon

return of the head to its normal position, the bolt 143 again functions to engage within the opening 122 and thus lock the head against rotation.

Timing mechanism

Turning movement of the shaft 105 under the action of the spring 112 is regulated by a timing mechanism of any suitable form, and, hence, I do not wish to be restricted or limited to the mechanism herein shown and which I will now describe.

Referring to Figs. 16 and 17, the timing mechanism is carried wholly within and by the frame composed of the heads 95 and 100 and the side plates 96 and 97. It comprises a spur gear 146 fixed to a shaft 147 journaled in the side plates 96 and 97. Fixed to the shaft 147 is a larger gear 148 meshing with a pinion 149 fixed to a shaft 150 journaled in one side plate and a bridge 151 of the upper head 95. A second gear 152 is fixed to the shaft 150 and meshes with a second pinion 153 fixed on a shaft 154 mounted as the shaft 150. A third gear 155 fixed on the shaft 154 meshes with a third pinion 156 fixed on a shaft 157 journaled in the two side plates. To the shaft 157 is fixed an escapement wheel 158 engaged by pallet pins 159 carried by an arm 160 fulcrumed on an arbor 161 supported by the other side plate and the bridge 151. The lower end of the arm is provided with the usual fork and roller pins 162 which operatively connect the arm to a shaft 163 journaled in suitable bearings carried by one side plate and the bridge. A balance wheel 164 and a balance spring 165 are mounted on the shaft 163 to control oscillation of the arm 160 under the driving action of the escapement wheel, as will be understood.

The gear 146 constantly meshes with a crown gear 166 formed on the upper side of a driven member 167 rotatable on a pintle 168, the latter being formed integral with and constituting an extension of the shaft 105. As best shown in Fig. 26, the driven member is retained upon the pintle by a flat key 169 having a recessed end engaging within a groove 170 of the pintle. A cup-shaped driving member 171 is suitably fixed to the pintle 168 for rotation therewith, and this driving member is adapted for operative connection with the driven member 167 only when the former is rotated in that direction in which the spring 112 tends to drive the shaft 105.

The means employed for this purpose consists of rollers 172 disposed in peripheral and tapered recesses 173 (Fig. 27), and springs 174 in the recessed underside of the member 167. These springs have one end secured in the driven member and the other end bent to engage the rollers 172 for urging the latter toward the narrow end of the recesses 173. The arrangement and operation of these elements is such that when the driving member 171 is rotated in a clockwise direction as when viewed in Fig. 27, the rollers operatively connect the driving member to the driven member so that the latter is rotated therewith. Conversely, when the driving member is rotated in the opposite direction the rollers rotate about their own axes so that the driven member is no longer rotated by the driving member.

From the foregoing description it will be apparent that a one-way clutch is provided between the timing mechanism and the shaft 105 by which the shaft can be rotated in one direction from a normal position independently of the timing

mechanism to permit rotation of the shaft to what may be termed a set position. Conversely, when the shaft is rotated in the other direction under the action of the spring 112, the clutch functions to operatively connect the shaft to the spur gear 146, thereby setting into operation the entire timing mechanism so that the latter functions to regulate rotational movement of the shaft 105 back to normal position.

Operation of chart actuating and timing mechanisms

In describing the operation of these mechanisms, I will assume that the cap 51 has been screwed into the receptacle 50 so that the barrel 91 occupies the position shown in Fig. 8 in which the chart carrying head 85 is positioned above the sleeve 83 and spaced from the marking element 79 so that the chart 86 is out of engagement with the marking element. Such a position of the head 85 is what may be termed a retracted or non-recording position as against an advanced or recording position in which the chart is advanced into engagement with the marking element to be punched by the latter. In Fig. 20 the head 85 is shown in retracted position, and the parts of the chart head actuating mechanism set for operation to move the head to advanced position at a predetermined time after manual setting thereof. In Fig. 16 the head 85 is in advanced position, and the mechanism is in what may be termed the normal or tripped position, with the parts thereof locked and at rest.

As shown in Fig. 16, the shaft 105 is in what may be termed a normal circumferential position wherein the slot 128 thereof is in registration with the slot 130 of the sleeve 101. The chart head 85 is in normal or non-gaging position on the body 118 wherein it is locked against rotation by the bolt 143. Such locking of the head prevents rotation of the shaft by the spring 112 because the pin 116 which is fixed to the head, cannot move and the arm 114 which is fixed to the shaft, abuts the pin. Thus, with the parts of the mechanism positioned as described, the setting thereof is accomplished as follows:

It will, of course, be understood that the setting operation is performed before placing the barrel in the receptacle. The barrel is gripped in one hand, while the palm of the other hand is pressed against the chart side of the head 85 to force the latter and the body 118 inwardly of the barrel against the tension of the springs 125. This initial operation is to effect unlocking of the chart head, and the direction of movement incident thereto, as well as the purpose thereof is clearly indicated on the head by the arrow "A" and the legend "Unlock". By this operation, the body 118 is moved from the position shown in Fig. 16 to that shown in Fig. 19 or to what may be termed its inner extreme position. As a result of such movement the lever 131 is carried inwardly with its nose bearing on the shaft until it reaches the cam 129 when it is moved thereby outwardly of the slot 128 onto the periphery of the shaft, as shown in Fig. 19.

Once the lever is removed from the slot, the operator, while still pushing inwardly on the head 85, turns the head rearwardly in the direction of the arrow "B" in Fig. 8 through an angle sufficient to move the latch bolt 143 to one side of the opening 122, thus unlocking the head. With the head unlocked, inward hand pressure can be

removed to allow the operator to leisurely adjust or set the head to any gaging position desired.

From a consideration of the relation of the pin 116 and the arm 114 as shown in Fig. 18, it will be clear that when the head 85 is turned to unlock it, the pin, which the arm normally abuts, is rotated with the head to impart a similar movement to the arm. As the arm is fixed to the shaft 105, rotation of the latter also occurs, and through such an angle as to move the slot 128 to one side of the cam lever 131. Thus, when the chart head is relieved of hand pressure and the springs 125 act to move the body 118 outwardly of the barrel, the nose of the lever 131 remains upon the periphery of the shaft 105 and cannot reenter the slot. However, the springs 125 only move the body 118 to the intermediate or latched position shown in Fig. 20, for at this point the latch bolt 139 abuts the keeper 130^a, as shown in Fig. 20 to restrain it against further movement.

Through the pin 119 adjoining the pin 119^a the possibility is prevented of accidentally rotating the head 85 rearwardly a complete revolution or to a position in which the lever 131 would return to the shaft slot 128 and prevent further operation of the mechanism.

Once the chart head has been turned to a position in which its release is effected, it remains in that position, for the tension of the spring 112 is insufficient to rotate the head, and thus the pin 116 maintains the arm 114 against reverse rotation. Rotation of the shaft 105 to eject the cam lever as well as for further setting, is independent of the timing mechanism inasmuch as the aforesaid one-way clutch is operative to connect the shaft to the crown gear 116 only when the shaft is rotated in the other direction.

From a consideration of the operation of the mechanism as thus far described, it will be clear that the chart head 85 is now ready for setting. As indicated by the arrow "B" and the legend "Set" on the head 85, the head is adapted to be set by turning it in the same direction as for unlocking and to any gaging position desired as precisely determined by preselecting any one minute graduation 142 and positioning such graduation exactly opposite the index mark 140. The graduation selected is determined by the sum total time in minutes required to assemble the complete apparatus, place it in the well hole, allow it to descend to the point therein at which a record is desired to be taken, and permit the angle marker to come to rest.

Concurrently with such setting of the head 85, the shaft 105 is rotated rearwardly still further because of the concurrent rotation of the arm 114 by the pin 116, as will be clear from a consideration of Fig. 21. Thus, the angular position of the shaft with respect to the lever 131 is further increased to a degree directly in keeping with the gaging position of the head 85. Such turning movement of the shaft 105 being against the tension of the spring 112, increases the tension thereof, but it will be understood that in assembling the chart actuating mechanism the spring is wound sufficiently to restore the shaft to its latched position without relying upon the increased tension given it in setting the shaft.

Once the chart head has been set as described, it is adapted to be turned forwardly as indicated by the arrow "C" and the legend "Start" on the barrel, until it reaches its original circumferential position when the latch bolt 143 moves into the body opening 122 to again lock the head

against rotation on the body. Such rotation of the chart head restores the pin 116 to normal position, as shown in Fig. 22, thus releasing the arm 114 so that the spring 112 now functions to rotate the shaft 105 back to normal position. With inception of this starting movement, the one-way clutch now operatively connects the shaft to the crown gear so that the timing mechanism is set into operation to regulate turning movement of the shaft precisely in accordance with the minute graduations upon the chart head.

The shaft 105 proceeds to rotate under control of the timing mechanism until the arm 114 abuts the pin 116, and as the pin is now secured against rotation because of previous locking of the head 85, further rotation of the shaft is checked upon engagement of the arm with the pin. In this normal or final position of the shaft, the slot 128 is brought into registration with the cam lever 131 so that the latter is now projected into the slot under the action of the spring 132^a. With such movement of the cam lever, the latch bolt 139 is moved free of the keeper 130^a releasing the body 118 to permit the springs 125 to project the chart head and body to the advanced position shown in Fig. 16, and thus cause the chart 86 to engage the marking element 79 and be punched thereby for effecting a recordation, as shown in Fig. 9. Thus, all parts of the chart actuating mechanism are restored to normal or starting positions for a succeeding operation when and as desired through the same sequence of manual operations.

An important feature of my chart actuating mechanism is the manner in which the shaft 105 and cam lever 131 coact to effect instantaneous actuation of the latch bolt 139 so that the chart head is tripped or released to produce a drift recordation in conjunction with the marking element, concurrently with expiration of the time interval for which the mechanism has been set. As best shown in Figs. 18 and 18^a, the slot 128 is of dove-tail form in cross section so that it is undercut from its side edges inwardly. Such construction prevents contact of the sides of the cam lever with the side walls of the slot as the lever moves into the slot, and thus such lever movement is unimpeded. Also such undercutting produces at the leading side of the slot a relatively sharp edge or corner off of which the lever is adapted to drop into the slot.

As shown in Fig. 18^a, the nose of the lever is beveled to produce a relatively fine edge or corner 131^a which normally bears against the periphery of the shaft 105 and drops into the slot 128 concurrently with the leading edge of the slot passing the edge 131^a to effect instantaneous release of the lever. Such method of release acts to move the latch bolt 139 to unlatched position with corresponding rapidity so that the chart head is tripped at the precise instant at which the time interval expires for which the mechanism was set.

Before proceeding to describe the other elements of my drift recording apparatus, I will describe a setting gage for the head 85 by which a particular minute graduation 142 on the head 85 can be selected prior to setting of the head to the gaging position thus defined, so that when the head is subsequently moved thereto, it cannot be moved accidentally or otherwise beyond the preselected graduation. In this manner, the possibility is prevented of oversetting the head. This setting gage also includes a means for defining the angle through which the head 85 is rotatable

to effect unlocking thereof prior to actual setting of the head.

As shown in Figs. 34 to 37, inclusive, the setting gage comprises a stop pin 175 fixed to and projecting from the lower edge of the ring 141, as when viewed in Fig. 34, and disposed to the right of the index mark 140. A gage ring 176 is rotatably fitted in a groove 177 of the head 85 to occupy any circumferential position of adjustment. On the ring 176 is a circular series of graduations 178 spaced to correspond to the graduations of the series 142. The ring 176 is formed with slots 179 aligned with the graduations 178, and in any one of which a latch lever 180 pivoted in a slot 181 of the head 85, is adapted to engage under the action of a spring 182 in a pocket 183 (Fig. 37) to lock the ring in any position of adjustment on the head.

The latch lever is notched as shown, to permit easy withdrawal thereof from any slot 179 against the tension of the spring 182. On that edge of the ring 176 confronting the ring 141 is a gage pin 184 which is adapted to abut the stop pin 175. A third pin 185 is fixed to and projects inwardly from the head 85 at such a point circumferentially thereof as to extend into a recess 186 in the confronting edge of the barrel 91, that is, when the head is pushed inward to its inner extreme position.

In operation of the setting gage, the gage pin 184 is moved into alignment with any preselected graduation 142 by first unlocking the ring through movement of the latch lever 180 to released position. The latch is now released so that it again engages the gage ring in one of the slots to secure the ring in this newly adjusted position. The head 85 is now forced inward in the usual manner to effect unlocking thereof, and under such movement the pin 185 is advanced into the recess. In this manner, rotational movement of the head necessary to effect unlocking thereof, is actually prescribed by the pin 185. In other words, the operator of the instrument is definitely instructed and physically limited in respect to the amount of rotation of the head 85 necessary to release the latter preparatory to moving it to gaging position.

Once the head 85 has been unlocked as just described, it is released to allow it to move to the intermediate position in which the pin 185 is withdrawn from the recess 186. Thus, the head is now free to be rotated to gaging position. As the ring 176 is now locked to the head 85 through the latch 180, it will be clear that when the head is rotated to the preselected gaging position as defined by the prior adjustment of the pin 184, such pin will be rotated with the head until it abuts the stop pin 175 to prevent further rotation of the head. In this final position of the pin 184, the head is positioned so that the preselected graduation 142 is opposite the index mark 140. Obviously, the head cannot be rotated beyond this position, and hence, over-setting of the head is prevented. In the final operation, the head 85 is returned to its normal locked position to permit the chart actuating mechanism to run, as has been described.

Should the head 85 be released accidentally by operation of the latch 180, after the cam lever has been projected from the shaft slot and moved to the position shown in Fig. 20, the pins 119 and 119^a will act to prevent the lever returning to the slot through rearward rotation of the head a complete revolution.

Referring to Figs. 1 and 1—A, the receptacle

50 containing the drift recording instrument previously described, is adapted to be placed in an elongated tubular metal housing 187. For the purpose of effectively protecting the drift recording instrument against damage resultant of the forces of impact produced by striking the tool joints during descent and the final impingement of the apparatus at the point of stoppage, whether the apparatus is dropped or lowered on a line into an open hole or drill pipe, the following devices are embodied in my apparatus:

Screwed into the lower end of the housing 187 is a solid metal stem 188 formed at its upper end with an extension 190 which projects into the lower end of a coiled expansible spring 191. A rubber buffer block 192 reposes on the inner end of the extension 190 and extends into the lower end of the spring 191. This block 192 is provided for the purpose of preventing full compression of the spring 191 and thus avoiding the resultant metal to metal contact of its convolutions and the consequent transmission of shock to the elements connected to and contacting with the spring. A leather cup 192^a is secured to the lower end of the block 192, and this cup is of such diameter as to frictionally retain itself within the housing 187 to prevent the spring 191 from dropping out of the housing.

Above the spring 191 is arranged the container or receptacle 50 so that the upper end of the spring bears against the plug 52. At this point it is well to mention a collar 193 threaded on the plug 52, as best shown in Fig. 10, and which collar is provided for the purpose of covering the exterior threads of the plug. The aforesaid threads are provided for the purpose of permitting a second container or receptacle 50 to be attached to the plug 52. Obviously, by removing the plug 64 the interior threads of the plug 52 can be used to connect a second barrel 91 containing a second drift recording instrument, to the plug 52. It will be understood that in some instances it is desirable to employ two or more drift recording instruments in a single apparatus, and the construction just described provides such a means.

The cap 51 is adapted for connection to the lower end of a cylinder 194 through the medium of a stud 195 (Fig. 7) formed on the cap and upon which is threaded a cup-shaped nut 196. This nut is releasably locked against accidental unscrewing by means of a ball 196^a in a pocket 197 of the nut and a spring 198 pressing the ball into any one of a plurality of radial grooves 199 in the confronting face of the cap 51. The nut 196 has a reduced portion 196^b upon which a cap 200 is threaded and locked by a pin 201.

Extending into the cap 200 is a coupling pin 202 having a collar 203 threaded therein and rotatably mounted in the cap by means of balls 204. Thus, the coupling pin is rotatable relative to the cap 200 and the elements connected thereto. The upper end of the coupling pin is threaded into a head 205 threaded, in turn, into and closing the lower end of the cylinder 194. The elements just described constitute a rotatable connection between the cylinder and the container 50, which prevents unscrewing of the container from the cylinder during application or removal of the latter.

The cylinder 194 constitutes part of a pneumatic shock absorber designed to effectively absorb longitudinal shocks to which the drift recording instrument is subjected incident to descension of the apparatus into a well. Extend-

ing downwardly into the cylinder is a rod 206 having on its lower end, a piston made up of a pair of rings 207 (Fig. 6) through which the rod extends. A pair of nuts 208 are threaded on the rod for securing the rings in clamping relation to a pair of reversely disposed cup washers 209 made of leather. The rod 206 is bored to form a duct 210 which functions to by-pass air from one side of the piston to the other, and the amount of air so by-passed is controllable by a metering screw 211 threaded in the lower end of the rod and formed with a port 212, the diameter of which determines the rate of air flow. By substituting similar screws having ports of other diameters the rate of flow can be controlled as required.

As best shown in Fig. 5, the piston rod 206 extends upwardly through a stuffing box comprising a packing nut 213 and a gland 214 threaded in the cylinder 194 for receiving a spring 215 which is adjustable by the nut to compress packing 216 therein. At its upper end, the rod 206 is connected to an upper stem 217 formed of solid metal and threaded in the upper end of the housing 187 (Fig. 2) through the medium of a collar 218 formed on the lower end of the stem, a pin 219 extending through the collar and a head 220, to provide a pivotal connection between the two. This pivotal connection allows the requisite freedom of movement of the cylinder 194 to permit self-aligning thereof in the housing 187. The rod 206 is threaded in the lower end of the head 220 and secured by a pin 221, while the head is formed with a flange 221^a against which the upper end of a spring 222 abuts. A buffer sleeve 223 formed of rubber surrounds the rod 206 contiguous to the head 220 to prevent complete contraction of the spring.

For centering the apparatus within a drill pipe, the stems 188 and 217 are provided with spring arms 224 and 225, respectively, which, from their points of connection with the stems, extend outwardly to have contact with the wall of the drill pipe to maintain the apparatus spaced therefrom and centered therein to prevent the stems and housing from striking the tool joints and thereby damaging the drift recording instrument.

In Figs. 2, 3, and 4, the manner of mounting the arms 225 is shown. As illustrated, the upper end of the stem 217 is formed with circumferentially spaced grooves 226 in each of which is arranged the lower end of one arm 225. Such arm ends are secured in the grooves by a sleeve 227 and a plate 228 secured on the upper end of the stem by a screw 229. This plate has notches 230 therein in which the arms are received, while the sleeve 227 spans the grooves. The lower extremities of the arms are bent to form angular lips 231 which engage beneath the lower edge of the sleeve 227. In order that the addition of the sleeve to the stem shall not increase the diameter of the stem, the stem is reduced in diameter for the thickness and length of the sleeve and the thickness of the lips.

The construction just described functions to secure the several arm ends against movement on the stem in any direction, while the remainder of the arms are free to flex in performing their function of maintaining the stem spaced from the wall of the drill pipe, and yet not impeding descent of the apparatus into the hole. Although the arms are attached with the requisite security, they are readily detachable should they become broken to permit substitution of new arms.

Referring to Figs. 1—A and 23, the lower stem

188 carries a spear made up of a body section 232 and a head section 233, both formed of metal. These two sections are joined to each other by a connector 234 constructed of a single body of resilient rubber. As shown, the sections are hollow to receive the end portions of the rubber connector, while the intermediate portion of the connector is interposed between the two sections to cushion movements of the sections toward each other for the purpose of absorbing shocks created by the spear striking the bottom of the well hole or the drill bit when used in a drill pipe.

The connector 234 is secured in the spear sections by pouring the rubber, when in a liquid state, into the sections. In such a process, air vents are necessary and have been provided in the spear sections as indicated at 235, and into these vents portions of the rubber flow and form tits 236 which serve as additional means for securing the connector within the sections. Also, the confronting edges of the sections are interturned to form annular lips 237 around which the rubber is molded to interlock the two against separation.

The body section 232 is formed with a pin 238 threaded in a box 239 in the lower end of the stem 188 so that the upper wall of the section abuts the stem. The spring arms 224 are of the same construction as the upper arms 225, and similarly their lower ends are secured in grooves 240 of the stem 188 by a sleeve 241 fixed to the stem by a set screw 242 (Fig. 24). The angular lips 243 on the lower ends of the arms 224 are interposed between and embraced by the lower edge of the sleeve 241 and the top wall of the spear body section 232.

To detach the arms 224 should they become broken, it is necessary only to remove the set screw and detach the spear, when the sleeve can be withdrawn from the stem to release the arms. Longitudinal grooves 244 are provided in the stem 188 to receive the arms 224 should they otherwise interfere with passage of the stem through a restricted part of the drill pipe.

In the operation of the apparatus, let it be assumed that the drift recording instrument has been set and started, and that all parts of the apparatus have been assembled to occupy the respective positions shown in Figs. 1 and 1—A. Thus, the apparatus is now ready to be lowered on a line into a drill pipe, or dropped therein. In either event, the arms 224 and 225 function to center the apparatus in the tubing as it descends therein, but it will be understood that when using my apparatus in an open hole the arms cannot be used because they would abut the jagged walls of the hole and thus prevent the apparatus from being withdrawn. As the spear strikes each tool joint, it is momentarily checked in its descending movement which reacts to move the cylinder 194 downward in the housing 187.

As the piston is fixed against movement lengthwise in the cylinder, it will be clear that such downward movement of the cylinder is resisted by the air above the piston. However, the resistance so offered is a yielding one to gradually decelerate movement of the cylinder in such manner as to prevent sudden and damaging movement of the parts of the drift recording instrument. This is attained by the air above the piston being compressed with each downward movement of the cylinder, and allowed to bleed at a predetermined rate through the metering port 212 to the lower side of the piston. The spring 191 likewise resists movement of the cylinder

downward, but its primary purpose is to constantly act to restore the cylinder to its normal elevated position so that after each descending movement the cylinder is elevated. However, such elevating movement is resisted by the air below the piston to decelerate such movement in accordance with the bleeding of air to the upper side of the piston. This upward movement of the cylinder is also resisted by the spring 222. Should the apparatus be subjected to an extremely severe shock such as when striking the rocky bottom of a relatively deep well, the spring 191 would tend to be completely compressed under the sudden and maximum downward thrust of the cylinder, but such complete spring compression is prevented by the plug 64 striking the block 192.

Thus, it becomes apparent that the shock absorber is double acting to restrain movement of the drift recording instrument in either direction within the housing and to the extent of protecting it against severe shocks as a result of the spear striking well hole and drill tubing obstructions.

Upon the apparatus reaching its limit of descent, the spear strikes whatever device has been interposed in its path to predetermine the depth at which a recording is to be made, with a force that under ordinary conditions would be damaging to the drift recording instrument. However, by the provision of the rubber connector, the springs, the pneumatic shock absorber, and the rubber elements employed in the mounting for the angle marker and timing mechanism, the possibility of such damage as to render the instrument inoperative or inaccurate as to recording the precise angle of drift of the hole from the vertical, and at the predetermined time for which the chart actuating mechanism has been set, is all prevented. Once the apparatus reaches its destination and the angle marker comes to rest, the chart head is automatically moved into engagement with the marking element to effect recordation of the angle of drift as indicated by the angle marker.

It will be understood that when using the apparatus in an open hole, it is lowered on a line, and hence, may be withdrawn by the line. However, when in use in a drill pipe the apparatus can be dropped into the pipe and removed with the pipe.

In Figs. 14 and 15, I have shown another form of angle marker which may be substituted for the angle marker shown in Fig. 10. This angle marker is characterized by its adjustability to vary its responsiveness to deviation from the vertical so that it can be used to indicate on the chart, angles at greater or less scale for a given deviation, and particularly the former in order that small fractions of a degree can be more easily and accurately read when recorded on a chart 86 calibrated in degrees and fractions thereof on a larger scale.

This angle marker comprises an annular support 245 of a diameter to have a sliding fit within the container 50 to be secured in a predetermined position therein by a set screw 246. The upper and lower edges of the support are provided with annular flanges 247 and 248, the former being formed integral with the support while the latter is separately formed and secured to the support. Between these flanges, a pair of metal plates 249 are arranged and spaced one from the other by a plate 250, and all plates are secured together by screws 251. Resilient rubber rings 251a

are interposed between the plates 249 and the flanges 247 and 248 to cushion vertical movements of the plates relative to the flanges.

The plates are formed with axial openings, and the walls of the openings of the plates 249 are shaped and have rings 252 threaded therein to form races for balls 253. Thus, a ball bearing socket is formed to receive and support a ball 254 for universal rotation therein. Extending through the ball 254 so as to be adjustable lengthwise therein, is an arm 255 which is adapted to be fixed in any position of longitudinal adjustment by sleeves 256 secured by set screws 257 on the arm above and below the ball so as to abut the latter. The upper end of the arm 255 carries a tubular extension 258 in which is received a spring pressed body 259 of a marking element 260 identical to the marking element 79 for the other angle indicator. At its lower end, the arm 255 carries a conical shaped weight 261 which is detachably and adjustably secured thereon by a set screw 262 therein. As will be understood, the weight serves to urge the arm and marking element to vertical position.

By virtue of the adjustability of the arm 255 lengthwise in the ball 254, the distance through which the marking element travels with respect to the chart for a given angle of deviation can be increased or decreased at will according as the arm is adjusted to increase or decrease its length above the ball 254. To compensate for such adjustment, the support 245 can be positioned and secured lengthwise in the container 50 to properly space the point of the marking instrument from the chart so as to mark the latter when the chart is moved thereagainst.

Referring now to Figs. 31, 32, and 33, I have here shown positioned within the same housing 187 two drift recording instruments arranged one above the other, and wherein mechanism is provided for tripping the chart head of the lower instrument through tripping of the chart head of the upper instrument so that the lower instrument effects a recordation of drift at a predetermined time after setting of the upper instrument and substantially concurrently with tripping thereof. As previously explained herein, the two instruments are provided for the purpose of checking the correctness of recordation made by one instrument upon that made by the other, and, although I have shown and will describe each instrument as including the angle marker shown in Fig. 10, it will be understood as constituting a part of my invention that the adjustable angle marker shown in Fig. 14 can be substituted for either angle marker. When so using the adjustable angle marker, it is adjusted so that its marking element travels through a greater arc for a given deviation than the marking element of the angle marker for the other instrument. Thus, by using therewith, a chart calibrated in minutes of degrees as against the other chart which is calibrated in degrees only, drift recordations on fine and coarse scales, respectively, are given by the two instruments and irrespective of whether such instruments are actuated by a common timing mechanism or not.

When using the two instruments, the sleeve 83 is removed from the container 50 and a short sleeve 263 substituted therefor, which is movable downwardly within the container from the position shown in Fig. 32 to that shown in Fig. 33. The circumferential position of the sleeve is fixed by a screw 264 threaded into the container and projecting into a slot 265 in the sleeve. Below

the sleeve 263 is a lower sleeve 266 likewise slidable in the container from the elevated position shown in Fig. 32 to the lowered position shown in Fig. 33. A spring latch 267 is secured to the inner side of the sleeve 266 by a screw 268, and this screw projects into a recess 269 for fixing the circumferential position of the sleeve. Normally, the sleeve 266 is retained in the elevated position by means of the latch 267, the bill thereof engaging a keeper 270 screw-threaded in the container 50.

Movement of the latch 267 to release the sleeve 266 is effected by downward movement of the sleeve 263, such sleeve normally reposing on the head of the latch so that its downward movement cams the latch free of the keeper. With continued downward movement of the sleeve 263, the sleeve 266 is moved to its lowermost position for actuation of a bolt 271. This bolt is movable lengthwise in a coupling plug 272, and it will be noted that the plug corresponds to the plug 52 of the first drift recording instrument. The bolt 271 is secured against rotative movement by a pin 273, and the lower end of this bolt normally engages and when actuated, moves a head 274. The bolt and head constitute that part of the mechanism for tripping the chart head of the lower drift recording instrument, but before describing the remainder of the mechanism, I will describe the manner in which the lower instrument is housed and associated with the upper instrument.

As shown in Fig. 31, the housing 187 receives a second container 275, and screwed into the lower end of the container is a plug 276 similar to the plug 52. Upon this plug is supported the angle marker 277 of the lower instrument. Above the marker is a barrel 278 provided at its upper end with a collar 279 threaded in the plug 272. This collar serves as a cylinder in which the head 274 moves, and also as a means for confining a metal plate 280 against the underside of the lower rubber plate 61. At this point, it will be noted that plates 60, 61, 62, and 280 are recessed to accommodate the bolt 271 so that the latter may have contact with the head 274.

The barrel 278 contains a guide sleeve 281 centered therein by a ring 282 secured in position by a set screw 282a, and an annular flange 283 formed integral with the sleeve at a point medially of its length. Below this flange within the barrel is slidably fitted a body 284 on the lower end of which is formed a chart carrying head 285. As with the head 85 of the upper instrument, it is urged downwardly by springs 286 mounted in pockets 287 and sleeves 288, the latter abutting the flange 283.

The body 284 is tubular to receive and be movable on the lower end of the guide sleeve 281, but normally, the body, together with the chart head is latched in the elevated position shown in Fig. 32 by means of a latch bolt 289. This bolt is mounted in the body and urged by a spring 290 into a recess 291 of the sleeve 281. Movable in the recess is an actuator 292 for the bolt 289 which projects into the bore of the sleeve 281 to be engaged by a cam 293 on the lower end of a rod 294 which is movable in the sleeve. The upper end of this rod is secured to the head 274, and a spring 295 urges the head and rod upwardly to the elevated position shown in Fig. 32. Downward movement of the body 284 under the action of the springs 286, is limited by means of a screw pin 296 in the body engaging within a recess 297 in the sleeve 281. In this position of the body, the chart carried by the head 285

engages the marking element 79 to be punched thereby, as has been described.

In describing the operation of the mechanism by which the chart head 285 of the lower instrument is tripped or released by the chart head of the upper instrument, let it be assumed that the parts of the mechanism are in the position shown in Fig. 32. Upon movement of the chart head 85 downwardly to the recording position shown in Fig. 33, the sleeve 263 is forced downwardly to move the latch 267 out of engagement with the keeper 270, and by continued movement of the upper sleeve the lower sleeve 266 can now be forced downwardly to the position shown in Fig. 33 wherein the bolt 271 is forced downward to impart a corresponding movement to the head 274 against the tension of the spring 295. With lowering of the head, the rod 294 is moved downwardly to cause the cam 293 to move the actuator 292 radially outward until the inner end of the latch bolt 289 is flush with the surface of the sleeve 281, when the body 284 is tripped to permit the springs 286 to force the chart head 285 downwardly against the marking element and thus effect a recordation of the angle of deviation upon the chart.

Although I have herein shown and described only two forms of drift recording apparatus, two forms of angle markers, two forms of setting gages, and one form of shock absorbing means, all embodying my invention, it is to be understood that various changes and modifications may be made herein without departing from the spirit of my invention, and the spirit and scope of the appended claims.

I claim:

1. In a drift recording instrument, a chart carrying element; means for mounting said element for rotation about a fixed axis to occupy a starting position and any one of several gaging positions and for movement axially to occupy either of two axial positions; urging means for biasing said element to one of said axial positions; a latch movable to latching position for securing said element in the other of said axial positions against the action of said urging means, and movable to a releasing position in which said element is free to move to the first mentioned axial position under the action of said urging means; actuating means for said latch having a part movable from a normal position in which said latch occupies releasing position, to any one of several other positions in which said latch is held in latching position; means operatively connecting said element to said part of said latch actuating means so that by rotation of the element from starting position to any gaging position, movement of said part is effected from said normal position to any one of said other positions; and means for returning said part of said actuating means to normal position from any one of said other positions whereby said latch is moved to released position to allow said element to occupy the first mentioned axial position.

2. In a drift recording instrument; a chart carrying element; means for mounting said element for rotation about a fixed axis to occupy a starting position and any one of several gaging positions, and for axial movement to occupy either of two extreme axial positions; urging means for biasing said element to one of said axial positions; a shaft supported for rotative movement and having a slot therein, a portion of which constitutes a cam; a spring so correlated with said shaft as to tend to drive the latter in

one direction; a latch mechanism comprising a stationary keeper and a bolt movable to engage and disengage said keeper and so correlated to said element that when engaging the keeper
 5 said element is latched in the other axial position against the action of said urging means; a lever; means for mounting said lever for bodily movement axially with said element and for
 10 pivotal movement transversely of said shaft so that when the element is moved from said other axial position to the first mentioned axial position said lever, when in said slot, will be cammed
 15 out of said slot onto the periphery of said shaft; means for urging said lever toward said shaft so as to bear upon the periphery of said shaft
 20 or extend into said slot when registering therewith; an operative connection between said bolt and said lever by which said bolt is moved to
 25 keeper engaging and disengaging positions according as the lever bears upon the periphery of said shaft or projects into said slot; a connection
 30 between said spring and said element by which, through rotation of the latter in one direction from the starting position to a predetermined
 35 gaging position, the shaft, when said lever is withdrawn from said slot, will be rotated in the opposite direction.

3. In a drift recording instrument; a shaft; means for supporting said shaft for rotation from
 30 a starting position circumferentially thereof; means for returning said shaft to said starting position when rotated away therefrom; a chart
 35 carrying element movable axially of said shaft to occupy either of two positions; means for urging said element to one of said positions; a latch
 40 for retaining the element in the other of said positions against the action of said urging means; means for actuating said latch to release the element
 45 when said shaft is in starting position, and to retain the element in latched position when the shaft occupies any other than a starting
 50 position; and a connection between said element and said shaft by which said shaft can, by rotation of said element, be rotated away from starting
 55 position a predetermined angle.

4. In a drift recording instrument; a sleeve having a slot longitudinally therein a portion of
 50 which constitutes a cam; a shaft having a slot longitudinally therein; said shaft rotatable in said sleeve and normally occupying a position
 55 therein in which the slot thereof registers with the slot of said sleeve; a body movable axially on said sleeve to occupy either of two extreme
 60 positions and an intermediate position; a recording chart carried by said body; means for urging said body to one of said extreme positions;
 65 a latch mounted on said body to extend into or be withdrawn from the sleeve slot; a lever fulcrumed on said body and urged towards said
 70 shaft to extend into the shaft slot through the sleeve slot when said body is in the first mentioned extreme position and said shaft is in normal
 75 position, to be moved out of the shaft slot by said cam upon movement of said body from the latter
 position to the other extreme position so that said lever bears on the periphery of said shaft, and to remain upon the periphery of said shaft
 following rotation of the shaft to move the slot thereof out of registration with said lever; means
 by which said shaft can be rotated; a connection between said lever and said latch for moving the latch into or out of the sleeve slot according as
 the lever is on the periphery of said shaft or within the slot thereof so that when said body is moved
 to the intermediate position, said latch will en-

gage said sleeve to secure the body against movement to the latter position by said urging means; and means for urging said lever towards said shaft so that when the latter is returned to normal position, said lever will move back into the
 5 shaft slot.

5. In combination; a shaft; means for mounting said shaft for rotation; means by which said shaft can be rotated through a predetermined
 10 angle from a predetermined circumferential position; a body surrounding and movable axially of said shaft to occupy two positions; means for yieldably urging said body to one of said positions; a latch operable to secure said body in the
 15 other of said positions against the action of said urging means; means so connecting said latch with said shaft that said latch is actuated to secure or release said body according as said shaft
 20 is rotated away from said predetermined circumferential position or returned thereto; and means for returning said shaft to said circumferential position when rotated away therefrom by reversing
 25 rotating thereof.

6. In a drift recording instrument; a shaft having a slot longitudinally therein a portion of
 25 which constitutes a cam; a body having a recording chart thereon; a lever mounted on said body to move into and out of said slot and means for supporting said body for movement axially of
 30 said shaft from one position in which said lever extends into said slot, to another position in which said cam functions to move said lever out of said
 35 slot.

7. In a drift recording instrument; a chart element; means for mounting the chart element to
 40 occupy a recording position in which it is adapted to engage a marking element, and a non-recording position in which it is adapted to be spaced from the marking element; means for urging the
 45 chart element to recording position, a latch for securing the chart element in non-recording position, latch actuating means including a shaft
 50 having a slot therein, and a lever connected to said latch for moving the latter to latching or non-latching position according as the lever is
 55 without or within said slot; a spring for rotating said shaft to cause said lever to move into said slot; and means for regulating rotative movement
 60 of said shaft under the action of said spring.

8. In a drift recording instrument; a shaft having a slot axially therein a portion of which
 65 constitutes a cam; a body movable lengthwise of said shaft to occupy either of two extreme positions or an intermediate position; a recording chart carried by said body a lever mounted on said
 70 body for movement into and out of said slot and urged toward said shaft so that when said body is moved from one extreme position to the other, said cam operates to move said lever out of said
 75 slot; a latch for releasably retaining said body in said intermediate position; and a connection between said latch and lever by which said latch is moved to retain or release said body according
 as said lever is without or within said slot.

9. In a drift recording instrument; a shaft; means for mounting said shaft for rotation; said
 80 shaft having a slot longitudinally therein undercut to provide a relatively sharp edge at the leading side of said slot when the shaft is rotated in one direction; a lever of less thickness than the
 85 width of said slot and having a nose tapered to form a relatively sharp edge at one side thereof; means for mounting said lever for movement radially of said shaft; a recording chart connected
 90 to said lever; and means for urging said lever

towards said shaft so that said nose edge bears upon the periphery of said shaft when the shaft is so positioned circumferentially that said slot is out of registration with said nose, and to move said nose into said slot concurrently with movement of said slot edge past said nose edge.

10. In a drift recording instrument; a shaft; means for mounting said shaft for rotation; said shaft having a slot longitudinally therein undercut to provide a relatively sharp edge at the leading side of said slot when the shaft is rotated in one direction a portion of said slot constituting a cam; a lever having a nose of a thickness less than the width of said slot and tapered to form a relatively sharp edge at one side thereof; means for mounting said lever for movement lengthwise and radially of said shaft; means for urging said lever towards said shaft so that said nose edge bears upon the periphery of said shaft when the shaft is so positioned circumferentially that said slot is out of registration with said nose, and to move said nose into said slot concurrently with movement of said slot edge past said nose edge; means by which said lever can be moved lengthwise of said shaft to cause said nose when within said slot, to engage said cam and be moved by the latter out of said slot and a recording chart carried by the last mentioned means.

11. In a drift recording instrument, a container; a sleeve fixed in the container; a shaft rotatable in the sleeve and having a slot radially therein, a portion of which constitutes a cam; a body movable in the container axially of said shaft to occupy retracted and advanced positions; a chart-carrying head rotatable on said body and movable axially therewith; a spring associated with said shaft for rotating the latter; a latch carried by and movable in the body to engage said sleeve for securing the body in retracted position; a lever mounted on the body to occupy one position in which it is disposed within said shaft slot and another position in which it engages the periphery of said shaft; means for urging said lever toward said shaft; said cam being arranged to move said lever out of said slot when said body is moved to retracted position; an operative connection between said lever and said latch to cause the latter to be moved to latching or non-latching position according as said lever occupies the second and first mentioned positions; means for urging said body to advanced position; and an operative connection between said shaft and said head whereby rotation of the head in one direction will rotate said shaft against the action of said spring to cause said slot to be angularly spaced from said lever.

12. In a drift recording instrument; a sleeve having a slot longitudinally therein; a shaft having a slot longitudinally therein, a portion of which constitutes a cam; said shaft rotatable in said sleeve and normally occupying a position therein in which the slot thereof registers with the sleeve slot; a body movable axially on said sleeve to occupy either of two extreme positions and an intermediate position; means for urging said body to one of said extreme positions; a latch mounted on said body to extend into or be withdrawn from said sleeve slot; a lever mounted on said body and urged towards said shaft to extend into the shaft slot through the sleeve slot only when said body is in the first mentioned extreme position and said shaft is in normal position, said cam operating to move said lever out of said shaft slot upon movement

of said body from the last mentioned extreme position to the other extreme position so that said lever now bears upon the periphery of said shaft, and to remain upon the periphery of said shaft following rotation of said shaft to move the slot thereof out of registration with said lever; a connection between said lever and said latch for moving the latch into or out of the sleeve slot according as the lever is on the periphery of said shaft or within the slot thereof so that when said body is moved to the intermediate position from said other extreme position with the shaft turned so that its slot is out of registration with said lever, said latch will engage said sleeve to hold said body in intermediate position; a chart carrying head rotatably mounted on said body; a bolt mounted on said head and engaging said body to lock said head in a predetermined or starting position circumferentially on said body; means on said body for moving said bolt to release said head when said body is moved to said other extreme position so that said head can be turned to a second predetermined or gaging position; a spring secured to said shaft and sleeve at one end for rotating said shaft in one direction; a connection between said head and shaft by which, through rotation of said head from starting position to gaging position, said shaft, when released, is rotated to circumferentially space said shaft slot a corresponding distance from said lever; means for regulating the return of shaft to normal position; and a one-way clutch operatively connecting said last mentioned means to the other end of said shaft so that said regulating means is disconnected from said shaft when the latter is rotated in a direction opposed to the rotating action of said spring.

13. In a drift recording instrument; a chart carrying element; means for mounting said element for rotation about a fixed axis to occupy a starting position and any one of several gaging positions and for movement axially to occupy either of two positions; urging means for biasing said element to one of said two positions; a latch movable to latching position for securing said element in the other of said two positions against the action of said urging means, and movable to a releasing position in which said element is moved to the biased position by said urging means; actuating means for said latch having a part movable from a normal position in which said latch occupies releasing position to any one of several other positions in which said latch is held in latching position; means operatively connecting said element to said part so that by rotation of the element from starting position to any one gaging position, movement of said part is effected from said normal position to any one of said other positions; means correlated with said element for selecting a predetermined gaging position thereof in advance of moving the element thereto, and operating to prevent over-setting of the element beyond the preselected position when moved thereto; and means for returning said part of said actuating means to normal position from any one of said other positions to move said latch to released position.

14. In a drift recording instrument; a container; a body movable axially in the container to occupy an inner extreme position, an outer extreme position, and an intermediate position; means for urging said body to the outer extreme position; a latch for retaining said body

in the intermediate position against the action of said urging means; a chart carrying element carried by said body to occupy corresponding positions and rotatable relative thereto to occupy a non-gaging position and a plurality of gaging positions; locking means on said body and element for retaining the element in non-gaging position on said body, but movable to release the element upon movement of the latter to the inner extreme position, whereby the element can be turned to any gaging position desired; means for actuating the latch to release said body; and a connection between said element and said means for moving said means by movement of said element to a gaging position.

15. In a drift recording instrument; a shaft; a body movable axially of said shaft to occupy inner and outer extreme positions and an intermediate position; a chart carrying element carried by and rotatable on said body to occupy a non-gaging position and any one of several gaging positions; coaxing means on said body and element for locking the element against rotation on the body only when the element is in non-gaging position; means operable to actuate said locking means upon movement of said element to the inner extreme position when said element is in the non-gaging position and to thereby permit said element to be rotated to any gaging position; a spring tending to rotate said shaft in one direction; a latch for securing said body in said intermediate position; means for urging said body to said outer extreme position; a connection between said element and said shaft by which the shaft can be rotated against the action of said spring and means responsive to rotation of said shaft by said spring for moving said latch to release said body.

16. In a drift recording instrument; a barrel; a sleeve fixed in the barrel and having a slot longitudinally therein; a shaft rotatable in said sleeve and having a groove lengthwise therein a portion of which constitutes a cam; a body mounted on said sleeve for axial movement to occupy inner and outer extreme positions and an intermediate position; means for limiting axial movement of said body in said barrel including a rod and a pin engaging the rod; said body having an opening to permit movement of the body relative to the rod; a cam lever pivoted on said body to move into and out of said groove and when in said groove to be moved outwardly thereof by said cam upon movement of said body to said inner extreme position; yieldable means for urging said body to the outer extreme position; a second yieldable means for urging said cam lever into said groove; a latch on said body operatively connected to said cam lever so that when said lever is moved out of said groove said latch will engage said sleeve to secure said body in the intermediate position; a spring secured to said shaft and sleeve and tending to rotate said shaft in one direction; an arm fixed to said shaft; a head rotatable on said body and movable axially therewith; a pocket in said head; a spring pressed bolt in said pocket urged outwardly thereof and adapted for extension into said opening when the head is in one circumferential position on said body for locking said head against rotation; and a pin secured to said head to move said arm for rotating said shaft.

17. An angle marker including a support; a ball universally movable in said support; a rod extending through said ball; and members secured to said rod so as to abut said ball at oppo-

site sides thereof for detachably securing the rod against movement lengthwise in the ball, whereby the effective length of the rod can be varied.

18. In a drift recording instrument; a body; a chart carrying element; means for mounting said element for movement on said body to occupy a starting position and various gaging positions; means correlated with said element and body adjustable to define a predetermined gaging position of the element in advance of moving the element thereto, in a manner to prevent over-setting thereof, said means comprising a pin, a ring carrying said pin and adjustable circumferentially on said element to move the pin to any circumferential position with respect to the element for indicating on the latter a preselected gaging position, a latch on the element for releasably securing the ring to the element in any circumferential position of adjustment, and a stop pin arranged on the body to be engaged by the first mentioned pin for limiting movement of the element to the preselected position.

19. In a drift recording mechanism; a support; a body movable axially on the support springs for urging the body outwardly on the support; a chart carrying head movable with and rotatably mounted on the body; and holding means for securing the head against rotation, said means being operable by forcing the head inwardly against the action of said springs to release the head for turning movement thereof on the body.

20. In a drift recording mechanism as embodied in claim 19, wherein said means comprises a bolt movable in the head, a spring for urging the bolt into the body, and a rod fixed to the support, extending into the body and of a length to move the bolt upwardly of the body when the body is moving inwardly on the support.

21. In a drift recording instrument; a receptacle; a body movable axially in the receptacle to occupy an inner position and an outer position; means for urging the body to the outer position; means responsive to movement of the body to the inner position for latching the body in said position; a chart carrying head rotatable on said body to occupy various time-gaging positions and movable with the body to occupy inner and outer positions; means connected to said latching means by which said body is unlatched to permit movement thereof to the outer position a predetermined time after moving the body to the inner position and means so connecting the last mentioned means to said head that the time required to release the body is varied in accordance with the time-gaging position to which said head is adjusted.

22. In a drift recording instrument as embodied in claim 10 wherein the slot in said shaft is of dove-tail form in cross section with its greatest width at the bottom thereof.

23. In a drift recording instrument; a body; a chart carrying element; means for mounting said element for rotational movement on said body to occupy a starting position and various time-gaging positions; and means correlated with said element and body which is rotatable to define a predetermined time-gaging position of said element in advance of rotating the element thereto, in a manner to prevent over-setting thereof.

24. In a drift recording instrument having a chart carrying element; means for mounting said element for movement to occupy either of two positions; urging means for biasing said element to one of said positions; a latch movable to latch-

ing position for securing said element in the other of said positions against the action of said urging means, and movable to a releasing position in which said element is free to move to the first mentioned position under the action of said urging means; a rotatable member for actuating said latch movable from a normal position in which said latch occupies releasing position, to any one

of several other positions in which said latch is held in latching position; and means for returning said member to normal position from any one of said other positions whereby said latch is moved to released position to allow said element to occupy the first mentioned position.

JOE W. CULBERTSON.