Our invention is a self-propelled tool for use in bores in the earth, such as oil or gas well bores, the tool being dropped freely into the well and descending at a controllable rate to the bottom, at which time a charge is set off in the lower end of the tool body creating a high-rate gas discharge which passes through a downwardly directed jet nozzle to propel the tool back up to the surface whereas it may be caught by any suitable means.

The principal object of our invention is to provide a tool capable of carrying any desired type of measuring and testing equipment, the tool being provided with mechanisms whereby it may be dropped freely into the bore of a well, preferably a cased bore, whereupon the tool will travel downwardly at a metered rate, or at controlled different rates of descent, the downward travel of the tool actuating a recording chart driving mechanism. The tool is provided with a time delay mechanism which sets off a charge in the bottom of the tool so that the tool is returned to the surface by jet propulsion, thereby eliminating the necessity of lowering the tool on a cable and, in turn, eliminating the need for a hoisting winch on the surface of the ground.

In particular, our tool is intended to carry temperature measuring and recording equipment. It is well known that, during the cementing operation of a well, heat is generated as the cement sets which heat warms the casing in the vicinity of the cement and likewise warms the adjacent well liquids within the casing.

It is frequently desirable to know exactly where the upper end of the cement ends so that the operator of the well will know how much of the casing can be salvaged after the well has been worked, the information as to where the cement ends being also useful for other purposes, as, for instance, knowing where holes may be milled in the casing in order to expose the well strata.

Our tool is also provided with means for controlling the rate-of-descent of the tool after it has been dropped into the well, such means being useful in saving time during the logging of the well temperatures, as hereinbefore explained. For instance, in a well which is 5000 feet deep, the operator will be able to estimate that the top of the cement is at about 4000 feet, and therefore it would save considerable time if the tool could be made to descend quickly, say to 3500 feet, and then slow its rate of descent from 3500 feet down so as to give the temperature-measuring mechanism greater time to react and thereby provide more accurate logging of the temperature in the vicinity of the cemented portion of the well.

In order to provide the tool with a dual rate of descent, we have provided therein spring-loaded arms which carry friction wheels at their outer ends which friction wheels travel on the inner surface of the well casing as the tool descends. The rotation of these friction wheels during descent of the tool is utilized to drive a set of gears within the tool, which gears actuate a lost-motion mechanism and also drive a recording chart.

The lost-motion mechanism is in turn connected to an hydraulic drag which, in the embodiment shown in this invention, includes a housing filled with a viscous liquid, and paddle wheels journaled within the housing to provide the necessary drag. The aforementioned lost-motion mechanism is adjustable so as to control the tool to drop uninhibited by the hydraulic drag for the predetermined distance, in the case of this example, 3300 feet. Experiment has shown that the uninhibited rate of descent of the tool in an oil well will be in the neighborhood of 200 to 300 feet per minute. However, when the lost-motion mechanism has reached the end of its travel, the hydraulic drag will be connected to the gear train so as to retard the rotation of the friction wheels engaging the casing and, according to tests run to determine a desirable rate of descent of the tool, approximately 40 feet per minute has been found satisfactory. The amount of liquid in the housing and its viscosity may be adjusted to determine the amount of retardation imposed upon the friction wheels by the hydraulic drag.

An important advantage of our device is that after the tool has reached the last section of the casing and the timing clock explodes the jet-propulsion charge, the escape of the gas from the jet nozzle will stir up any heavy mud or cement slurry at the bottom of the casing so as to free the tool therefrom and assist it to start on its way toward the surface and toward a suitable latch mechanism which may be provided at the head of the well or casing string to engage a fishing head on the top of the tool so as to retain it in an easily accessible position. The use of the jet charge to return the tool to the head of the casing thus prevents the tool from getting stuck in the settled out mud or cement slurry at the bottom of the casing.

The tool itself is constructed of lightweight materials such as aluminum or manganese, and, in addition, provided with a light-weight buoyancy section which may be filled with any suitable material such as cork so as to, at least partially, counteract the weight of the tool and make it more buoyant, so that when the charge has burned out the tool will become buoyant with respect to the well liquids, the buoyancy section serving to ease the load which the jet propulsion must overcome in returning the tool toward the surface.

Another object of our invention is to provide the tool with a casing-joint counter, which counter also actuates a recording means for recording on the rotating chart a suitable index of the time the tool descends through the joint, thereby double-checking the depth to which the tool descends. As stated above, the chart is driven by the friction wheels and gearing associated therewith, and a gear ratio is provided such that for instance one inch of chart will equal fifty feet of depth. A ratchet clutch mechanism is provided in the portion of the gear train which drives the recording chart so that the chart will be rotated only during downward travel of the tool in the well, and will stand motionless during upward travel thereof.

The recording on the chart is performed by two stylus members, one of which is actuated by a mercury-filled temperature-measuring element, and the other of which is actuated by hydraulic means which transmits from the casing counter an impulse every time the casing counter passes a joint.

Another object of our invention is to provide the tool with a self-centering feature as follows: The inside of the well casing is contacted by a pair of oppositely-disposed friction wheels, and is also contacted by another pair of oppositely-disposed casing-counter rollers, the rollers of the casing counter being disposed ninety degrees out of alignment with the friction rollers, as to maintain the tool substantially centered in the well casing.

Another very important object of our invention is to provide a tool of the type above specified wherein the re-
cording chart chamber may be quickly and easily opened for the purpose of changing the chart, and wherein the explosive jet propulsion portion of the tool may be quickly and easily disconnected from the main body of the tool and disassembled so as to place therein a new propulsion charge and so as to facilitate setting of the time clock mechanism.

The described and advantages of our invention will become apparent during the following discussion of the drawings wherein:

Figure 1 is a cut-away view through the bore of a well, showing the casing and casing joints therein, and showing the recording chart measuring and recording tool descend ing within the casing.

Fig. 2 is a view similar to Fig. 1 but showing the tool rotated through ninety degrees.

Fig. 3 is a section view through the body of the tool, showing the friction-wheel drive mechanism and a portion of the gearing associated therewith.

Fig. 4 is an elevation view of the same portion of the tool as shown in Fig. 3 but rotated through ninety degrees, the lower end of the figure being broken away to show the gearing associated with the friction wheels.

Fig. 5 is a section view of the lost-motion and hydraulic-drag mechanisms and the outer wall of the housing, all of which mechanisms are driven by the friction wheels.

Fig. 6 is a section view similar to Fig. 5, but rotated through ninety degrees.

Fig. 7 is a detail elevation view showing the inner casing which houses the lost-motion and hydraulic-drag mechanisms and the chart mechanism.

Fig. 8 is an elevation view partially in section of the portion of the body of the tool which houses the mercury temperature-measuring mechanism, the view also showing the outer portion of the casing-joint counter mechanism.

Fig. 9 is a section view similar to Fig. 8 but rotated ninety degrees of the body of the tool being broken away to show the temperature-measuring mechanism, the casing-joint counter mechanism, and the stylus-actuating tubes associated therewith.

Fig. 10 is an elevation view of the lower portion of the tool body which houses the timing and jet-propulsion mechanism.

Fig. 11 is a section view through the timing and jet-propulsion portion of the tool to show a more detailed assembly of these mechanisms.

Referring now to the drawings, Figs. 1 and 2 show a well W having a casing C sunk therein, the casing having lost-motion and jet-propulsion mechanisms 30 and 20 which in turn is connected to the lost-motion and hydraul ic-drag mechanisms 30 by a threaded collar 40. Below the lost-motion and hydraulic-drag mechanisms 30 is located a recording-chart section 40 including two recording-stylus members, one of which is actuated by a mercury temperature and the other of which is actuated by a casing joint counter 70. Below the casing joint counter 70 is located a timing clock and percussion-cap firing mechanism 80 it depends from the jet propulsion and jet nozzle means 90. Each of the above members will be hereinafter described in greater detail.

In our particular invention shown in the drawings the buoyancy member 10 is shown in Figs. 1 and 2 comprises a slotted cylinder 11, at the upper end of which is located a fishing tip 12 which may be used in conjunction with any suitable latch mechanism (not shown) which may be located at the upper end of the well W for the purpose of catching the tool when it has propelled itself back to the surface. The slotted cylinder 11 is filled with a light material, such as cork, for the purpose of counteracting some of the weight of the tool, this material not being shown in detail in the drawings since the particular material is not of importance. As shown in Fig. 4, the lower end of the slotted cylinder 11 is internally threaded as at 13 to engage complementary external threads 20a at the upper end of the casing 20b which houses the friction-wheel mechanism 20.

As shown in detail in Figs. 3 and 4, the friction-wheel mechanism includes upper arms 21 which are forked at their upper ends as at 21a and joined together thereat by a pin 21b which rides in a pair of slots 20c on each side of the casing 20b. A yoke 21c is journaled on the pin 21b and is actuated by a spring 21d to a tension spring 21d which is in turn anchored at its lower end to the casing 20b by a pin 21e. The lower end of each of the arms 21 is forked as at 21x, the forks 21x being connected, respectively, to two pairs of bearing plates 21y through which are passed a plurality of axles 21z on which are journaled a plurality of friction wheels 22, each having V-slotted peripheries adapted to receive rubber V-belts 22a which engage and travel on the casing C of the well and are rotated thereby. The respective lower friction wheels 22 each carries a scoop wheel 22b, the scoop wheels 22b respectively engaging drive chains 22c for the tool as hereinbefore described.

The lower ends of the respective bearing plates 21y are confined between the upper forked ends 23c of the lower arms 23, the lower ends 23b of which are connected together and pivoted to the housing 20b by a pin 23c. The lower ends of the drive chains 22c are respectively connected to lower scoop wheels 23d and 23e, which scoop wheels are connected through oppositely-directed ratchet drives (not shown) to small gears 24 which, as shown best in Fig. 3, drive gear trains 240, the lower gears of which are connected to two shafts 24b carrying gears 24c at their inner ends. These gears in turn drive a beveled gear 25 connected to a vertically disposed shaft 26 mounted, as shown in Figs. 5 and 6, in ball bearings 27, the ball bearings 27 being maintained in place by a threaded ring 27a.

At the lower end of the casing 20b are internal threads 28 adapted to engage the external threads 41 of a connecting member 40. At the lower end of the connecting member 40 is another set of external threads 42 which engage internal threads 30a of the next lower casing 30b.

The shaft 26 extends below the ball bearing 27 and terminates at its lower end in a splined or flattened tip 26a which fits into a complementary socket 31a at the top of the shaft 31 so as to transmit rotation from the friction wheels 32 to the shaft 31 through the gear 24—25. The shaft 31 is supported at its upper end in a ball bearing 31b which is removably held in place by a nut 31c. The shaft 31 has a threaded portion 31d on which is located a traveling nut 31e having two outward extending pins 31f which travel in oppositely-directed slots 32a in the upper wall of the casing 32.

The pins 31f prevent rotation of the walking nut 31e so long as the pins are engaged in the slots 32a, but it will be noted in Figs. 5 and 6 that the casing 32 enlarges in internal diameter at 32c so that when the nut travels 31e has reached the lower limit of the threaded section 31d of the shaft 31, the pins 31f will disengage from the slots 32a and permit the walking nut to rotate freely with the shaft 31. The lower end of the walking nut 31e abuts against a shoulder 31g on the shaft 31, at which time the lower end of the walking nut engages rubber rollers 33 mounted on axles 33c which pass through the wall of the casing 32 on which they are journaled, and which axles 33a support paddle wheels 33b which are immersed in a liquid L which fills a housing 32c supported on the casing 32. By reference to Fig. 7 it will be seen that the housing 32c is divided into upper and lower sections to permit disassembly of the housing 32c from the casing 32, the upper and
lower sections of the housing 32c being maintained in place on the casing 32 by set screws 32d, Fig. 7.

As shown in Figs. 5 and 6, the shaft 31 extends downwardly through a bearing 31m, and supports at its lower end a gear 31n, which in turn drives a gear 31p to actuate a chart-feeding roller 34 having at each end a collar with chart-driving pins 34a adapted to engage perforated holes along the upper and lower edges of a chart (not shown).

The casing 32 connects at its lower end with the upper end of the casing 50 as at 50a, the shape of which casing 50 is also shown in Fig. 7. Within the casing 50 is a chart-supply spool 36a and a chart-takeup spool 36o, the supply spool 36 being journaled on bearings within the casing 50, and the takeup spool 36o being also journaled therein but being driven by a friction drive 36e, which is in turn rotated by a belt 36c to which rotational motion is supplied from a gear 31p.

The outside casing 30b is internally threaded at its lower end as at 30c and engages the external threads at the upper end 60a of the next lower casing 60b.

Near the lower end of the casing 50 is a web 51 which serves to journal the lower end of the chart-drive rollers 34 and which is apertured as at 51a to permit the lower ends of the spools 36 and 36o to pass therethrough. Below the web 51 is a removable plate 52, which plate is removably maintained in the lower end of the casing 50 by a snap-spring lock 53. The plate 52 has on its upper surface two bearings 54 in which are journaled the lower ends of the spools, a portion of the plate 52 being cut away as at 52a for the purpose hereinafter explained.

Referring now to Figs. 8 and 9, the casing 60b which is connected to the casing 50b, as shown in Figs. 5 and 6, houses a set of temperature cylinders 61 which are filled with mercury and are connected to an annular ring 61a which screws into the complementary threads 60c in the casing 60b. The upper end of the cylinder assembly 61 is connected with a tube 61b which extends upwardly through the upper end of the casing 60b into the casing 50 wherein is located the recording chart. The upper end of the tube 61b has a piston-and-rod assembly 61c which carries at its upper end a spring-loaded stylus 61d which engages the chart (not shown) as it passes over the chart-feeding roller 34.

The tube 61b and the cylinder 61 are filled with mercury which expands and contracts according to temperature changes in the well-fluids flowing therethrough and causes the stylus 61d to fluctuate up and down on the chart in accordance with the temperature variations. In order to insure efficient circulation of well-liquids past the temperature-measuring cylinders 61 we have provided the casing 60b with a plurality of slots 60d, and, in addition, have provided the casing 70b with slots 70c, the well-liquids entering the lower end of the casing 70b, as shown by the arrow 70x, and passing upwardly past the temperature-measuring cylinders 61, and outwardly through the slots 60d and 70c, the cylinders 60b and 70b being secured together by complementary threads 60m and 70m.

Within the casing 70b is located the casing-joint counter mechanism 70 which includes a vertically disposed rod 71 having a shoulder 71a and having a washer 71b with a coil spring 71c compressed therebetween, the washer 71b being capable of vertical motion on the rod 71 and being pressed upwardly by the spring 71c. Within the casing 70b is a web 70k which supports an internally-threaded boss 70p into which the rod 71 is screwed.

The upper end of the rod 71 supports a housing 72 which is a pair of transversely-disposed plungers 72a, 72c reciprocally mounted therein. Each of the plungers 72a has a shoulder 72b thereon against which a pair of forks 73 and 73a press outwardly, the forks being pivotally supported on rod 71 by pin 73b, and the lower ends of the forks pressing against the washer 71b as at 73c so that upward motion of the ring 71 will produce transverse outward motion of the plungers 72a. At the outer ends of the plungers 72a are located roller carriers 72b carrying rollers 72d which engage the inner wall of the well casing C. The plungers 72a are given further support by bearings 72e which are supported in the wall of the casing 70b. Within each of the plungers 72a is located a small piston 74 having a well casing engaging roller 74a at its outer end, which roller is caused to reciprocate each time a well casing-joint is passed, the plungers 72a engaging inwardly into the housing 72. The fluctuations of the pistons 74 cause hydraulic fluid to fluctuate within the tubing 74b which extends upwardly past the temperature-recording cylinder 61 and into the recording chart casing 50, the tubing 74b having in its upper end a piston rod 74e which carries at its upper end a recording stylus 74d adapted to contact the chart (not shown) as it passes over the chart-feeding roller 34, the stylus placing thereon a small pulse mark each time a well casing-joint is encountered by a roller 74a at the outer end of a piston 74.

The lower end of the rod 71 is supported by a second sleeve 75 which in turn is held rigidly by a web 75a similar to the web 70k and boss 70p.

Referring now to Figs. 10 and 11 it will be seen that the vertically-disposed rod 71 extends downwardly beyond the lower end of the casing 70b and is threaded at its lower end 71a to receive a coupling ring 76 which has a shoulder 76a at its lower end on which is captivated a coupling sleeve 77. The coupling sleeve 77 is internally threaded as at 77a to engage complementary external threads 80a on the upper end of the timing casing 80b.

Inside the casing 80a at the upper end thereof is a timing clock mechanism 81 having an electric contact therein which grounds the upper end of the batteries B to the casing 80b after a predetermined time for which the clock is set has elapsed. The lower end of the casing 80b contains the firing mechanism which includes a firing-pin 82 in contact with the lower end of the batteries B and insulated from the casing 80a by insulation 82a. The lower end of the firing-pin 82 carries a contact 82b which contacts the upper end of a firing-cap 82c, the outside casing of which is in electrical contact with the casing 80a.

The lower end of the cap 82c is directed downwardly through an orifice 83a in the plug 83 which is screwed into the lower end of the casing 80b as at 83b. At the lower end of the timing casing 80b are threads 80k which engage complementary threads 90a of the charge casing 90b. Within the casing 90b is located the main gas-generating charge 91, the upper end of which faces the orifice 83a so that the downward discharge of the cap 82c will be directed onto the top of the gas-generating charge 91 to ignite the latter. The charge 91 is contained in the bore 90c in the casing 90b which has a shoulder near the lower end of the bore 90c to support the charge 91, the shoulder having an orifice 90d through its lower end. At the lower end of the casing 90b are internal threads 90b which engage complementary external threads at the upper end 92a of the nozzle-carrying plug 92.

In the bore of the nozzle-carrying plug 92 is a partition 92a which has a plurality of apertures 92b around its outer periphery to permit the gas generated by the charge 91 to pass downwardly in the direction of the nozzle 93 at the bottom of the plug 92. The partition 92a has in its upper side a socket 92c adapted to receive the complementarily-shaped lower end of the plug 94, which plug normally seals the bore 94a through the nozzle-carrying plug 92 and serves the purpose hereinafter explained. The nozzle 93 screws into an axially-disposed threaded opening 92m at the lower
end of the plug 92 so that the nozzle may be easily changed when worn.

**Operation**

In the drawings, Figs. 1 and 2, are shown views of the complete measuring tool and propulsion means, showing the tool located within the well casing, the lower end of the tool extending downwardly within the portion of the casing adjacent the top of the cement. As shown in these views, the tool is still in the process of descending, the body of the tool being centered within the casing by means of the friction wheels near the upper end of the tool and the casing-joint counter rollers near the lower end of the tool.

The tool includes propulsion means and measuring means, the propulsion means including the friction wheel drive 20, the hydraulic drag means 30, the timing means 80 and the jet propulsion means 90, as well as the buoyancy section 10 which tends to counteract some of the weight of the tool.

At the top of the tool is a fishing head 12 to cooperate with latch means adapted to catch the tool as it reaches the end of its upward travel by latching on to the fishing head 12 so as to retain the tool in an easily accessible position to be retrieved by the well operators.

In operating the tool, it is first inserted into the upper end of the casing of the well, the friction-wheel 20 being self-adjusting so as to move transversely outwardly of the tool until it contacts the inner periphery of the casing.

As shown in Fig. 3, the actual drive assembly, including the wheels 22 and the belts 22a, is supported on upper arms 21 and lower arms 23. The casing is actually contacted by the belts 22a, which in turn transmit the drive to the friction wheels 23 and to the sprocket wheels 22b. The drive from these sprocket wheels is transferred to the chains 22c which drive the lower sprocket wheels 23a and 23b which have associated therewith oppositely operating ratchet means whereby drive from the belts 22a will be transferred to the gears 24 only during descent of the tool in the casing, said ratchet means slipping during ascent of the tool in the well casing so as to permit the drive gears 24 and 24a to stand still as well as the entire chart drive mechanism when the tool is ascending.

As the tool descends in the well casing, drive from the belts 22a is furnished to the beveled gear 25 and thence to the shaft 26, which shaft is journaled in ball bearings 27, as shown in Figs. 5 and 6. The drive from the shaft 26 is furnished through coupling 26c—31a to the shaft 31, which shaft extends downwardly through the lost-motion mechanism casing 32.

The lost-motion mechanism casing 32 supports on its outer surface a hydraulic drag housing 32c, which housing is filled with a liquid wherein is immersed the paddle wheels 33b. The upper end of the casing 32 has two slots 32a disposed longitudinally on each side thereof, the slots being located opposite the threaded portion 31d of the shaft 31. The walking nut 31e travels on the threaded section 31d of the shaft and has a pair of oppositely disposed pins 31f which travel in the slot 32a down as far as the internal shoulder 32b of the casing 32.

A set of calibrations 32x is provided along the length of the slot 32a, which calibrations correspond to feet-of-depth of the well.

Before the tool is dropped into the well it is disassembled at the threaded joint 30a—42, and the casing 32 is pulled upwardly out of the casing 30b, in which position the slot 32a and the calibrations 32x are plainly visible. In this position an electric motor or other means may be used to rotate the shaft 31 to travel the walking nut 31e upwardly until the pins 31f appear in the slots 32a opposite the calibration 32x representing a predetermined depth. The setting of the walking nut 31e at such predetermined position in the slot 32a determines the depth to which the tool will descend before the hydraulic drag means will become operative and slow down its rate of descent.

This function is accomplished in the following manner: As the tool descends in the well casing, drive is furnished to the shaft 31 through the gear train 24 from the belts 22a. As the shaft 31 rotates, the walking nut 31e travels downwardly on the threaded portion 31d until the pins 31f disengage from the slots 32a at the shoulder 32b. In this position the traveling nut 31e engages the shoulder 31g on the shaft 31 and the lower portion of the walking nut 31e engages the rubber drive wheels 33. At the time when the walking nut engages the rubber drive wheels 33, the tool will have traveled downwardly in the well casing a distance equal to the predetermined setting of the pins 31f opposite the chosen calibration 32x. When the walking nut 31e engages the rubber wheels 33, the pins 31f will have disengaged from the slots 32a, and the walking nut 31e will then rotate with the shaft 31, and in so doing will drive the paddle wheels 33b within the liquid in the housing 32c. The amount of drag caused by the liquid on the paddle wheels 33b may be predetermined by the viscosity of the liquid and by the level thereof in the housing 32c. In any event the drag imposed on the paddle wheels 33b by the liquid is transferred through the rubber wheels 33 to the walking nut 31f and thence to the shaft 31, shaft 26, gear train 24 and belts 22a. As a result of this drag, the rate of downward travel of the tool in the well casing will be greatly reduced.

The drive furnished to the shaft 31 from the belts 22a is also transferred downwardly through the gears 31a and 31b to drive the chart-feeding roller 34 and the takeup reel 36a, the latter being driven by the belt 36c through a friction clutch 36b. This assembly is located in the casing 50, Fig. 7, which casing is normally enclosed within the outer body casing 36b of the tool.

In order to gain access to the casings 32 and 50, the outer body casing 36b is unsecured from the connecting casing 40 at 36b—42, and the casings 32 and 50 are pulled upwardly out of the casing 36b, at which time the chart and chart drive assemblies will be exposed to view through the opening 50c in the casing 50, Fig. 7. The lower-ends of the chart reels 36 and 36c are supported in bosses 54 which are a part of the removable plate 52 secured in the lower end of the casing 50 by the spring latch mechanism 53, Fig. 5. When the casing 50 is removed from the outer casing 36b the latch means 53 may be easily released to remove the plate 52 and thereby free the lower ends of the chart reels 36a and 36c to facilitate removal of the chart reels from the casing 50.

Since the sprockets 23d and 23e drive the gear trains 24 only during descent of the tool in the well casing, the shaft 31 rotates only during descent thereof, and the chart is advanced from the storage reel 36 over the chart drive drum 34 and on to the takeup reel 36c only during descent of the tool in the well casing, this assembly standing still during ascent of the tool.

The chart is marked by the stylus 61d located at the upper end of the piston 61c which travels in the tube 61b in accordance with fluctuations in the volume of the mercury located within the temperature measuring cylinder 61. The chart is also marked by the stylus 74d carried by the upper end of the piston 74c which travels in the tube 74b in accordance with variations in the hydraulic fluid filling the tube 74b and actuated by the casing-joint counter 70.

The housing 72 is filled with a liquid such as oil, which is compressed or expanded by the fluctuations of the pistons 74 which are coaxially mounted within the plungers 72. The plungers are urged outwardly by the outward pressing of the upper ends of the forks 73—73a against the collars 72b, the forks being pivoted on a pin 73b at a point near the upper end of the vertical rod 71, which rod supports at its upper end the housing 72.

Near the lower end of the rod 71 is a coupling collar.
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2,776,564 76 secured to the rod 71 and secured to the timing housing 80b of the propulsion means by the sleeve 77, a spacing being left between the lower end of the casing 70b and the rod 71, as at 70a, so as to permit well-fluids to circulate upwardly through the space 70c and outwardly through the slots 70c and 60d so as to insure good circulation of well-fluids past the temperature-measuring cylinder 61.

Within the timing casing 80b is located a clock 81 which acts as a switch to furnish electric power from the batteries B through the firing pin 82 to the cap 82c, the clock 81 being set for a time interval somewhat greater than the time estimated to be required by the tool to descend within the well casing, so that when the tool has reached bottom the electric circuit will be made from the batteries B to the cap 82c, which cap is exploded and fires a high-temperature cap downwardly through the orifice 83c onto the upper end of the main propulsion charge 91. When this propulsion charge 91 is ignited the gas pressure therefore forces the piston plug 92 downwardly into the socket 82e so as to open the way for the gas pressures from the burning charge 91 to pass through the openings 92b and outwardly through the jet nozzle 93 located at the lower end of the plug 92.

This assembly is connected together in such a manner that it may be quickly and easily disassembled so as to permit resetting of the clock and replacement of the cap 82c and the main propulsion charge 91. When the collar 77 is unscrewed from the body 80b, as at 77c—80b, the clock may be withdrawn upwardly out of the upper end of the timing body 80b. At the same time, the timing body 80b may be unscrewed from the charge-holding body 90b, as at 80b—90a, so as to place a new charge 91 into the bore 90c of the body 90b. By unscrewing the plug 83 from the threaded section 83b, the cap 83c may be replaced.

In addition, the plug 92 may be unscrewed from the body 90b as at 90b—92d, and the piston 94 may be unscrewed from the socket 92c and moved upwardly to again plug the passageway 94e, the piston 94 being a tight fit in the passage 94c.

It is highly desirable to prevent the entry of the well-fluid into the body of the tool except as above stated at 70a—70c—60d, and at the upper end of the tool around the friction-wheel assembly. Therefore, all of the various joints in the casings of the tool are provided with rubber O-rings fitting into the rectangular grooves shown in the drawings, this means of sealing a joint being well known in the prior art.

We do not limit our invention to the exact form shown in the drawings, for obviously changes may be made therein within the scope of the claims.

We claim:

1. A self-propelled tool to be sent below the ground surface in a well bore having walls, comprising a body of smaller diameter than said bore; rate-of-descent controlling means comprising friction wheels transversely reciprocally attached to said body and yieldably urged outwardly thereof to maintain said wheels in frictional contact with said walls, drag means in said body and drive means connecting said drag means and said friction wheels for applying drag to said wheels to retard the descent of the tool; and timing and propulsion means comprising a delayed action igniter and a gas generating propulsion charge in said body, the charge being in communication with a downwardly directed nozzle in the bottom of the body, whereby when said charge is ignited the gas generated thereby will discharge downwardly through the nozzle and propel the tool back up toward the ground surface.

2. In a tool as set forth in claim 1, said drive means including lost-motion coupling means connected between said wheels and said drag means, said lost-motion coupling means delaying the coupling of said drag means to said wheels for an adjustable interval to permit the wheels to turn freely during the initial descent of the tool in the well; and one-way clutch means in said drive means to disengage the latter during upward travel of the tool in the well.

3. In a tool as set forth in claim 1 for use in a well having jointed casing, a chart in said body; means to rotate said chart and connected to said drive means; and well-characteristic measuring devices each actuating a stylus in contact with said chart, said devices including a casing joint counter.

4. In a tool as set forth in claim 1, a quick-disconnect joint in said body above said timing and propulsion means to facilitate separation of the latter from the upper part of the tool.

5. In a tool as set forth in claim 1, body having a passageway between said charge and said nozzle; and a plug in said passageway normally sealing the latter, the plug being dislodged by the generated gas to clear the passageway when the charge is ignited.

6. A self-propelled tool to be sent below the ground surface in a well bore having walls, comprising a body of diameter smaller than said bore; rate-of-descent controlling means comprising annularly spaced sets of vertically spaced wheels, bearing plates rotatably supporting the wheels of each set to travel along the walls of the bore in a direction axial thereof, an upper arm and a lower arm connected at their outer ends to each bearing plate, the inner ends of the lower arms being pivotally attached to the body and the inner ends of the upper arms being connected together and secured to said body by a pivot capable of sliding axially of said body, spring means urging said pivot downwardly toward the pivotal connection of the inner ends of the lower arms, said upper and lower arms forming toggle supports to urge said wheels outwardly against said walls, controllable hydraulic drag means, and drive means connecting the drag means to the wheels of each set to retard the descent of the tool; and upward propulsion means comprising a downwardly directed nozzle at the lower end of said body, a gas generating charge in said body above said nozzle, and a time-delayed igniter in communication with said charge and adapted to ignite the charge after the tool has reached the bottom of the well so that the generated gas will discharge downwardly through the nozzle and propel the tool upwardly toward the ground surface.

7. In a tool as set forth in claim 6, said drive means including lost-motion coupling means connected between said wheels and said drag means, said lost-motion coupling means delaying the coupling of said drag means to said wheels for an adjustable interval to permit the wheels to turn freely during the initial descent of the tool in the well; and one-way clutch means in said drive means to disengage the latter during upward travel of the tool in the well.

8. In a tool as set forth in claim 6 for use in a well having jointed casing, a chart in said body; means to rotate said chart and connected to said drive means; and well-characteristic measuring devices each actuating a stylus in contact with said chart, said devices including a casing joint counter.

9. In a tool as set forth in claim 6, said body having a passageway between said charge and said nozzle; and a plug in said passageway normally sealing the latter, the plug being dislodged by the generated gas to clear the passageway when the charge is ignited.

10. In a tool as set forth in claim 6, said hydraulic drag comprising a housing within said body; paddle wheel means journalized in said housing and connected with said drive means to be rotated thereby; and a viscous liquid in said housing, the level and viscosity of the liquid determining the amount of drag.

11. A self-propelled tool to be sent below the ground surface in a liquid filled well-bore having walls, com-
prising a body of smaller diameter than said bore and having a buoyancy section to reduce the effective weight of the tool in said liquid; rate-of-descent controlling means comprising friction wheels transversely reciprocably attached to said body and yieldably urged outwardly thereof to maintain said wheels in frictional contact with said walls, drag means in said body and drive means connecting said drag means and said friction wheels for applying drag to said wheels to retard rotation thereof; and timing and propulsion means comprising a delayed action igniter and a gas generating propulsion charge in said body, the charge being in communication with a downwardly directed nozzle in the bottom of the body, whereby when said charge is ignited the gas generated thereby will discharge downwardly through the nozzle and propel the tool back up toward the ground surface, the tool becoming buoyant in said liquid when said charge has burned out.

12. In a tool as set forth in claim 11, said drive means including lost-motion coupling means connected between said wheels and said drag means, said lost-motion coupling means delaying the coupling of said drag means to said wheels for an adjustable interval to permit the wheels to turn freely during the initial descent of the tool in the well; and one-way clutch means in said drive means to disengage the latter during upward travel of the tool in the well.

13. In a tool as set forth in claim 11, a quick-disconnect joint in said body above said timing and propulsion means to facilitate separation of the latter from the upper part of the tool.

14. In a tool as set forth in claim 11, said body having a passageway between said charge and said nozzle; and a plug in said passageway normally sealing the latter, the plug being dislodged by the generated gas to clear the passageway when the charge is ignited.

15. A self-propelled tool to be sent below the ground surface in a well bore having walls, comprising a body of diameter smaller than said bore and having a buoyancy section to reduce the effective weight of the tool in said liquid; rate-of-descent controlling means comprising annularly spaced sets of vertically spaced wheels, bearing plates rotatably supporting the wheels of each set to travel along the walls of the bore in a direction axial thereof, an upper arm and a lower arm connected at their outer ends to each bearing plate, the inner ends of the lower arms being pivoted to the body and the inner ends of the upper arms being connected together and secured to said body by a pivot capable of sliding axially of said body, spring means urging said pivot downwardly toward the pivotal connection of the inner ends of the lower arms, said upper and lower arms forming toggle supports to urge said wheels outwardly against said walls, controllable hydraulically drag means, and drive means connecting the drag means to the wheels of each set to retard the rotation of said wheels; and upward propulsion means comprising a downwardly directed nozzle at the lower end of said body, a gas generating charge in said body above said nozzle, and a time-delayed igniter in communication with said charge and adapted to ignite the charge after the tool has reached the bottom of the well so that the generated gas will discharge downwardly through the nozzle and propel the tool upwardly toward the ground surface, the tool becoming buoyant in said liquid when said charge has burned out.

16. In a tool as set forth in claim 15, said drive means including lost-motion coupling means connected between said wheels and said drag means, said lost-motion coupling means delaying the coupling of said drag means to said wheels for an adjustable interval to permit the wheels to turn freely during the initial descent of the tool in the well; and one-way clutch means in said drive means to disengage the latter during upward travel of the tool in the well.

17. In a tool as set forth in claim 15, a quick-disconnect joint in said body above said timing and propulsion means to facilitate separation of the latter from the upper part of the tool.

18. In a tool as set forth in claim 15, said body having a passageway between said charge and said nozzle; and a plug in said passageway normally sealing the latter, the plug being dislodged by the generated gas to clear the passageway when the charge is ignited.

19. A self-propelled tool to be sent below the ground surface in a well bore having walls, comprising a body receivable in said bore; drag means on said body and contacting said walls to slow the descent of the tool in the bore; and retrieving means in said body comprising charge means for generating a downwardly directed fluid jet; a nozzle through the lower end of the body below said charge means; a passageway between said charge means and said nozzle; a plug in said passageway normally sealing the latter, the plug being dislodged to clear the passageway by the generation of said fluid jet; and control means for initiating the generation of said jet when said tool has descended to the desired depth.

20. In a tool as set forth in claim 19, said well being filled with a liquid, said retrieving means including a buoyant section in said body to reduce the effective weight of the tool in said liquid whereby said fluid jet will propel the tool back up toward the surface and the tool will become buoyant in said liquid when said charge has burned out.

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