Jan. 27, 1959 C. C. LAVAL, JR 2,870,989

SAMPLING APPARATUS

Filed Sept. 7, 1954

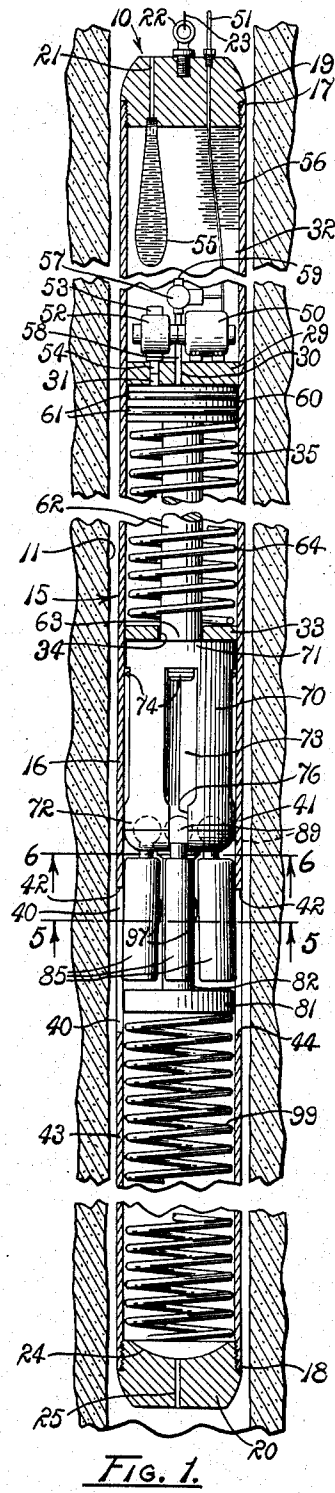


FIG. 1.

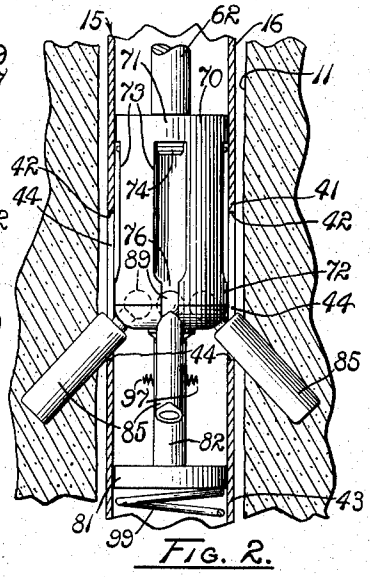


FIG. 2.

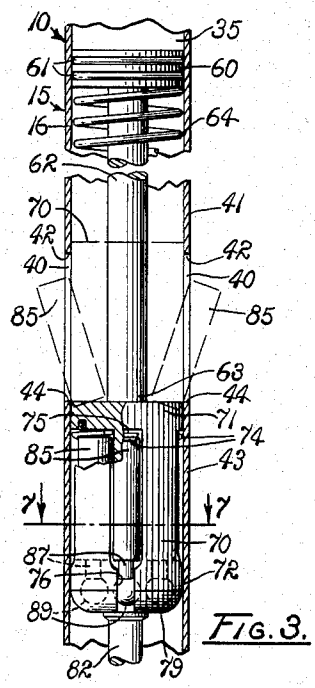


FIG. 3.

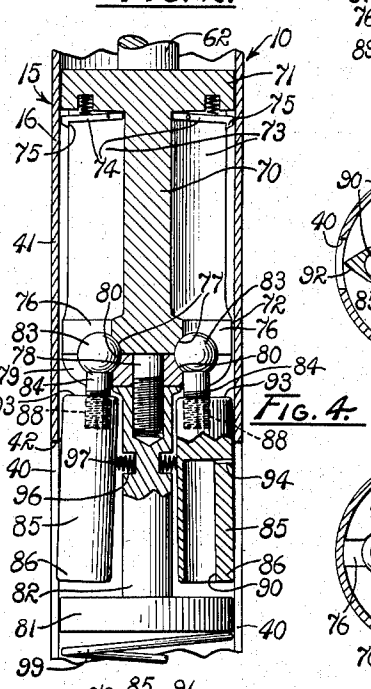


FIG. 4.

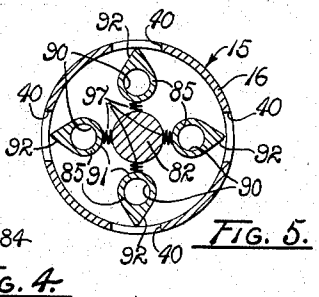


FIG. 5.

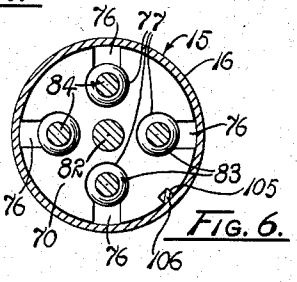


FIG. 6.

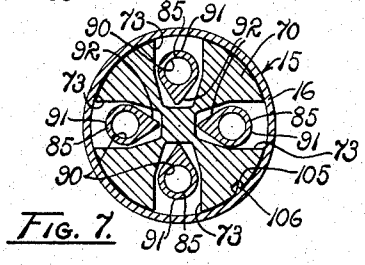


FIG. 7.

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United States Patent Office 2,870,989 Patented Jan. 27, 1959

2,870,989

SAMPLING APPARATUS

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Application September 7, 1954, Serial No. 454,543

12 Claims. (Cl. 255—1.4)

The present invention relates to geological apparatus and more particularly to an apparatus for use in obtaining samples of earth formations at sub-surface levels.

Preparatory to certain geological operations, such as the drilling of wells or the laying of foundations for dams or buildings, it is necessary to make an analysis of earth formations at considerable depths below the earth's surface. Apparatus for accomplishing this purpose has long been known, one of the earliest of these being shown in the U. S. patent to Williston, No. 1,683,642.

Though differing in structural detail and manner of operation, most apparatus in this field consists of an elongated member which is lowered into a hole in the earth and which carries a tool adapted to penetrate into the side walls of the hole for collecting therein earth samples. Various means have been employed for thrusting or otherwise causing the tool to penetrate the earth. In the Williston patent, cited above, this is accomplished merely by vertical movement of the elongated member. In others, explosive means have been used and in still others, such as shown in the more recent U. S. patent to Spencer, No. 2,326,405, hydraulic pressure or a jack screw is employed to operate a rack gear which engages a segment gear carrying the sampling tool.

Several problems have been encountered in this field of endeavor, some of which the above cited patents serve to illustrate. In an effort to simplify the apparatus used, the sampling tool, such as that in the Williston patent, has been left in an inverted position after swinging through the formation. As the tool is withdrawn from the hole in dangling fashion, much, and frequently all of the collected sample is lost. Although some apparatus, as exemplified by the Spencer patent, provide for up-ending the tool after collection of a sample, generally the driving arrangements for the tools, to permit such positioning, have limited the extent of pressure that can be employed. Thus, such geared constructions, as in Spencer, have broken under high pressures, either failing to enter hard formations or becoming immovably anchored in the formation, due to partial operation.

Even with structures providing for upright positioning of the tools subsequent to coring action, little or no protection has been given to the open end of the sampling tool, thus subjecting the sample to contamination as the apparatus is lifted out of the hole. The present invention seeks to overcome many of these problems existing in conventional structures by minimizing sample loss and contamination and by permitting greatly increased thrusting force, thereby enabling deeper, positive penetration of the tool into much harder formation than heretofore possible.

Accordingly an object of this invention is to improve the action of a geological sampling apparatus.

Another object is to provide positive driving action

for thrusting an earth sampling tool into earth penetrating engagement.

Another object is to minimize breakage and anchoring of a sampling tool used for collection of earth samples by penetration of earth formations.

Another object is to provide a sampling tool apparatus adapted to utilize high pressure for thrusting the tools into very hard formations.

Another object is to minimize sample loss and contamination in an earth sampling operation.

Another object is to provide an earth sampling apparatus providing a sampling tool movable from an empty downward position through an upward arc in earth penetrating engagement for collection of an earth sample and thence into upright position.

Another object is to provide an apparatus operable, as in the foregoing paragraph, under hydraulic pressure.

Another object is to provide an apparatus for housing the tool in upright locked position after soil collection thereof.

Another object is to provide an hydraulic system for operation of a sampling tool apparatus and mounting arrangement therefor which can be inserted into a bore hole by cable or the like and which is adapted to operate under even extreme hydraulic pressures without strain on the cable.

Another object is to provide an arrangement as set forth in the preceding paragraphs submersible in fluid containing boreholes and which is relatively unaffected in operation by environmental pressures.

Another object is to provide an earth sampling apparatus adapted to operate a plurality of sampling tools simultaneously.

Another object is to provide an earth sampling apparatus capable of establishing the angle of sub-surface strata or faults by the simultaneous collection of samples at the same elevation.

Another object is to provide an earth sampling apparatus as in the preceding paragraphs which is adapted for mounting in a self-contained unit submersible within fluid containing or dry boreholes and which is remotely controllable.

Other objects are to provide a sampling apparatus, durable in construction, positive in action, relatively simple to manufacture and highly effective for its intended purposes.

These and other objects will become more fully apparent upon reference to following description.

In the drawings:

Figure 1 is a longitudinal cross section taken through the sampling apparatus of the present invention and showing it positioned within a borehole.

Figure 2 is a fragmentary longitudinal cross section similar to that of Figure 1 but showing the apparatus in a successive state of operation.

Figure 3 is a longitudinal cross section showing the sampling apparatus in a further successive stage of operation.

Figure 4 is a somewhat enlarged longitudinal cross section showing the construction of the mounting block and the sampling tools and also the disposition of the mounting tools within the housing in one position of operation.

Figures 5 and 6 are transverse cross sections taken respectively on lines 5—5 and 6—6 of Figure 1 showing various details regarding the shape and mounting of the sampling tools.

Figure 7 is a transverse section taken on line 7—7 of Figure 3 showing the sampling tools fitted in the mounting block.

Referring more particularly to the drawings:

As shown in Figure 1, the sampling apparatus of this invention, generally indicated by the numeral **10**, is adapted for elevational movement within a borehole or other cavities and exploratory holes, indicated generally at **11**.

The sampling apparatus **10** provides a housing **15** having a substantially cylindrical wall **16** with upper and lower ends **17** and **18** respectively and a pair of end walls or caps **19** and **20** threadably received on said upper and lower ends, respectively. The upper end wall **19** is provided with a fluid passage **21** extending longitudinally therethrough. An eyelet **22** is threadably fitted in the upper end wall for attaching on cable **23**, thus providing means for raising or lowering the housing within the borehole **11**. The lower end wall **20** has an inner concavity **24** and a port **25** leading to the outside of the housing. Dirt, sludge and foreign particles which collect in the cavity **24** may be flushed through the port **25**. The housing **15** is provided with an upper transverse partion **29** attached to the cylindrical wall **16** in spaced relation beneath the upper end wall **19**. The upper partition is provided with a pair of fluid passages **30** and **31** longitudinally extending therethrough for a purpose to be described. The upper end wall **19** and the upper partition define a fluid chamber or reservoir **32** therebetween. A lower transverse partition **33** is also provided in the housing having a concentric bore **34** therein and positioned in parallel spaced relation beneath the upper partition. A piston chamber **35** is defined between the upper and lower partitions.

The wall **16** is provided with a plurality of longitudinally disposed substantially rectangular slots **40** intermediate the lower partition **33** and the lower end wall **20**. For descriptive convenience, that portion of the cylindrical wall **16** above the slots is referred to as the upper wall section **41**, which provides upper slot edges **42**. In like manner, that portion of the wall **16** below the slots is hereinafter referred to as the lower wall section **43** providing lower slot edges **44** oppositely disposed from upper slot edges **42** in their respective slots.

A prime mover **50**, such as an electric motor, is mounted in rigid position on the upper partition **30** and within the fluid chamber **32**. Suitable control wires, indicated at **51**, are connected to the motor and extended upwardly through the upper end wall **19** for extension along with cable **23** to a remote control station, not shown. A fluid pump **52**, such as a gear pump, is also mounted on the upper partition adjacent to the motor and is connected thereto by a suitable drive shaft. The pump is provided with an inlet port **53** in fluid communicating relation with chamber **32** and an outlet port **54** connected to passage **31** in the upper partition. An elastic or other distendible bag **55** is connected to the fluid passage **21** in the upper end wall and also is disposed within the chamber **32**. This chamber is fluid tight and is filled with a quantity of fluid **56** for supplying the pump **52**.

An hydraulic system somewhat similar to that shown and described in my co-pending application S. N. 384,229, filed October 5, 1953, Patent No. 2,740,456, is also provided in chamber **32**. Briefly described, it includes a solenoid-operated pass valve **57** having a fluid conduit **58** connected to the fluid passage **30** and an inlet port **59** in fluid communicating relation with fluid chamber **32**. The valve is electrically controlled from line **51** together with motor **50**. As such, the valve is adapted to close during energization of the motor permitting fluid entry into chamber **35** only through passage **31**. Upon de-energization of the motor, valve **57** opens and permits flow of fluid from chamber **35** back into chamber **32** through passage **30**, conduit **58**, now open valve **57** and port **59**.

A piston **60** is mounted within the housing **15** in the piston chamber **35** for slidable reciprocation between the

upper partition **29** and the lower partition **33**. The piston is provided with a plurality of O-rings **61** in circumscribing relation therearound for bearing against the cylindrical wall **16** for sealing purposes. Cup leathers or other equivalents may, of course, be employed for the purpose, or the piston fit with such precision to the chamber as to avoid any objectionable leakage.

A piston rod **62** is connected to the piston and is provided with an extended end **63** slidably extendible through the bore **34** in the lower partition **33**. A large coil spring **64** is disposed within the piston chamber around the piston rod and bears against the lower partition and the piston for yieldably urging the piston into abutting relation with the upper partition.

A substantially cylindrical elongated sampling tool mounting block **70** having upper and lower ends **71** and **72** respectively, is slidably mounted within the housing beneath the lower partition **33**. The upper end **71** of the mounting block is connected to the end **63** of the piston rod but alternatively need not be connected thereto. The mounting block is provided with a plurality of longitudinally disposed peripherally spaced grooves **73** in the outer surface thereof. These grooves face outwardly from the mounting block toward the wall **16** at diametrically opposed position on the block. In the illustrated embodiment these grooves are disposed around the mounting block in positions spaced approximately 90° from each other but are not limited to such angular spacing. Latch members **74** having catch fingers **75** on their outer ends are pivotally mounted in the upper end of each groove, spring pressed downwardly but being pivotal upwardly upon inward camming action on the fingers. The grooves are constructed with lower restricted sections **76** and ball-bearing socket halves **77**.

A threaded stud **78** extends endwardly from the lower end **72** of the mounting block **70**. A plate **79** having a central opening is fitted over the stud **78** and provides ball-bearing socket halves **80** mating with corresponding socket halves **77**. A disk **81** is slidably mounted within the housing below mounting block **70** having a shank **82** upwardly extended therefrom threaded on the stud **78**. This arrangement holds the plate **79** on the mounting block and forms complete ball-bearing sockets from the joined socket halves **77** and **80**.

Balls **83** having integrally attached threaded pins **84** are rotatably received in corresponding socket halves **77** and **80**. The pins are limited to substantially longitudinally arcuate movement relative to the housing in the restricted sections **76** of grooves **75**. A plurality of sampling tools or tubes **85** having core-receiving ends **86** are threadably received at their inner ends **88** on the pins **84**. Thus mounted, the tools are adapted for pivotal movement on axes collectively lying in circumscribing relation to the mounting block **70**. The core-receiving ends of the tools provide a substantially cylindrical bore or barrel **90** opening endwardly of the tool. The core-receiving ends may assume a variety of shapes but as illustrated in the present embodiment are provided with a rounded back **91**, a streamlined substantially V-shaped front cutting edge **92** and a flat upper end **93**. Although not shown, the mouth of bore **90** may be bevelled if desired. An air and fluid escape port **94** is provided in each of the core-receiving ends permitting communication between the inner end of the bore **90** and the exterior of the tool.

The shank **82** is provided with radially disposed recesses **96** for the reception of spring elements **97** which are held at their inner ends within their respective recesses. The recesses and thus the springs are individually aligned with the core-receiving ends **86** of the sampling tools and are adapted to urge the tools outwardly of the shank. A large coil spring **99** is received in the housing between disk **81** and the lower end wall **20** and is constructed in much the same manner and for a similar purpose as spring **64**.

A longitudinal key way **105** is provided in the mounting block **70** for receiving a mating key **106** disposed along the interior of wall **16** of the housing for rotationally aligning the sampling tools **85** individually with the slots **40**. It will be readily apparent that upon longitudinal and rotational alignment or registration of the tools with the slots, the tools are released for outward pivotal movement through the slots. As the mounting block descends through the housing past the slots, the tools are forced into the grooves. This will be explained in greater detail during the discussion of the operation of the invention. It should be noted at this point, however, that the sampling tools, slots, and grooves are operatively associated and must be constructed for corresponding operative relation. The size, number and location of these members may be varied to suit particular needs. As shown, two pairs of tools are provided and are mounted so as to extend from the housing at diametrical opposed positions. Other arrangements will be readily apparent to those skilled in the art.

Operation

The operation of this invention is believed to be readily apparent and is briefly summarized at this point. As explained above, the present invention is adapted for use in boreholes such as those formed in the drilling for oil, water, gas or other minerals. It is also excellently suited for the determination of subterranean characteristics prior to the setting of foundations for dams, buildings or like construction. In such applications the tool is used to make a geological analysis of earth formations at considerable depths by the extraction of soil or rock samples.

The sampling apparatus **10** of this invention is lowered within the hole on a cable **23**. The housing is positioned in the hole at the desired depth and with the slots **40** adjacent to that portion of the wall of the borehole from which it is desired to take a sample. With the apparatus thus positioned, the various elements thereof are in an inoperative condition, as shown in Figure 1, being urged into such condition by springs **64** and **99**. As such, it is to be noted that the sampling tools **85** are held in a collapsed position endwardly extended from the mounting block **70** and are retained within the upper wall section **41** of the housing **15**. The flat upper ends **93** of the tools all lie substantially above the upper slot edges **42** whereby the tools are pressed outwardly against the upper wall section by springs **97**. The motor **50** and pump **52** are, of course, in an inoperative condition and by-pass valve **57** is open.

The apparatus is placed into operative condition by energization of motor **50** through closure of a switch, not shown, connected to wire **51**. At the same time, the solenoid operated by-pass valve **57** closes. The motor operates pump **52** and fluid **56** is forced from the chamber **32** through inlet port **53**, the pump and outlet port **54**, through passage **31** into chamber **35** above piston **60**. Considerable fluid pressure is obtainable through the pump and thus the piston is forced downwardly in chamber **35** thereby extending the piston rod through the lower partition **33**. As is quite evident, this moves the mounting block **70** downwardly in the upper section **41** of the housing thus carrying the sampling tools **85** downwardly into positions of alignment with the slots **40**.

When the sampling tools **85** have reached a position where their upper ends **93** are just below the upper slot edges **42**, as shown in Figure 2, springs **97** thrust the tools outwardly through the slots **40** into penetrating engagement with the walls of the borehole adjacent to the slots. If the earth formation is of a relatively soft nature, the tools will obviously enter the borehole walls with ease. Even with extremely hard rock formation, however, the features of the present invention enable forcible cutting entry of the tools therein. The forward V-shaped edges **92** of the tools are knife-like and have been provided to facilitate such an entry. More significantly, however, is the driving pressure imparted to the tools by hydraulic actuation. Thus, as the tools are thrust initially outwardly, the lower forward knife-like edges of the tools bite into the formation. With the tools thus initially gripping the walls of the formation, the mounting block is held against further downward movement and further application of pressure through pump **52** serves to urge the housing upwardly relative to the block. During this action, the cable **23** is slack and the apparatus is supported on the tools extended into the borehole walls. When the lower slot edges **44** transversely abut the rounded backs **91** of the tool, further application of pressure leverages the tools in the upward arcs through the formation around the lower slot edges as fulcrums.

As each tool **85** swings upward through the formation, a sample of earth is received by the tools within each of the bores **90** of their core-receiving ends. The ports **94** prevent gas pockets or the collection of fluid from blocking inward movement of the samples. As the mounting block slides past the slots **40** into lower wall section **43**, each of the tools is forced into upwardly extended positions in housed relation within their respective grooves **75**. In this regard, it is to be noted that the tools are leveraged into upright position around the lower slot edges. An additional impact may be given the tools **85** to force them through the formation by relieving and applying hydraulic pressure, thus ramming the slot edge **44** successively against the tools. Such operation is not generally preferred to constant application of hydraulic pressure but is rendered possible by the present invention.

Although not shown, the lower slot edges could be provided with a reinforcing means such as a cushion or a roller, neither of which is shown, to facilitate entry of the tools into the block. Also, the back **91** of each tool could be made to mate with the lower slot edge to improve the coaction between these members. As each tool enters its grooves, it slides against the finger **75** therein whereby the respective latch **74** is lifted permitting entry of the tool. When each tool is entirely within its groove, the latch drops and the catch finger engages over its back **91** to hold it in upright position.

Thus, with all the bores **90** of the sampling tools **85** filled with samples and the tools locked in upright position within the block **70**, the apparatus is ready to be lifted from the borehole **11**. First, however, the motor **50** is deenergized turning pump **52** off and simultaneously opening valve **57**. Since this relieves the hydraulic pressure on the piston **60**, springs **99** and **64** expand and urge the mounting block upwardly past slots **40** into the upper wall section **41** of the housing. During this movement, the tools remain in upright positions within the mounting block, thus preventing any of the samples collected thereby from falling or spilling from bores **90**. With valve **57** open, fluid is permitted to pass from chamber **35** back into chamber **32**. The apparatus is then lifted from the borehole by hoisting the cable **22**.

When the apparatus **10** is at the surface of the hole **11**, the tools **85** are moved into registration with the slots **40** and pivoted outwardly from the grooves simply by lifting the catch fingers **75**. The tools are then unthreaded from the pins **84** and the sample jarred or otherwise pried loose from the bores for subsequent laboratory or other analysis or observation.

Although the foregoing operation provides for an upward arcuate movement of each tool through substantially 180°, partial movement of the tools through such an arc may be preferred. In such a case, the tools are thrust outwardly, as before, into positions such as shown in Figure 2. When sufficient penetration for an adequate sample has been obtained, hydraulic pressure is removed and the springs **64** and **99** urge the tools back into the housing. Such operation leaves the tools in inverted positions, thus permitting sample loss, and for this reason is not preferred over the full cycle of operation discussed above.

It has been found that pressures approximating 5000

pounds per square inch on the ram head are obtainable with the described apparatus utilizing a 1/20 horsepower motor **50** operating on approximately 2 amperes, 110 volts and fed by a cable **51** approximately 8000 feet long connected at the surface of the well to a 110 volt outlet. Because of size and power limitations at excessive depth, it has been found desirable to utilize a capacitor-start motor. For this purpose, a 50 microfarad condenser with a 150 volt rating is connected in series with the starting winding of the motor. The above parameters provide highly successful operation but the invention is not to be limited to such values only.

It is to be understood that the operation of the hydraulic system is unaffected by environmental fluid pressures at working depths. Not only does distension and collapse of bag **55** prevent gas pockets from developing in fluid chamber **32** but it also maintains a constant equilibrium of pressures between the fluid chamber and the surrounding environmental pressures.

The construction of the apparatus providing controlled outward expansion of the sampling tools under hydraulic pressure enables penetration of earth formations of far greater hardness than heretofore considered possible. Further, there is less sample loss because of the housed protection given the tools in upright position after receiving their samples. Also of significance is the positive connection of the tools to the mounting block thus eliminating anchoring of the tools in the formation by insuring their removal. The use of a ball bearing swivel joint connection of the tools to the mounting block not only provides for their upward swinging movements but also greatly strengthens the joint permitting the use of high pressures and minimizing breakage.

The utilization of a plurality of sampling tools under common control and swingable outwardly at opposed diametric positions imparts additional utility to the apparatus. Obviously more thorough analysis may be made since samplings may be obtained from radially spaced positions around the borehole wall. More rapid action is effected since there is no need to reposition the apparatus to take successive samples. A unique function is enabled by the plural tool feature inasmuch as the presence or absence of angularity of faults or strata can be determined by comparative analysis of the samples taken at any given elevation.

As above noted, the number, size and location of the tools **85**, slots **90** and grooves **73** may be varied, as desired, as long as individual cooperative relation is maintained. Further, the size of the bores **90** is variable depending on the quantity of sample to be collected.

It will be readily apparent that the sampling apparatus shown and described offers improved performance as well as additional advantages over conventional structures.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices and apparatus.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A borehole sampling apparatus comprising an elongated housing having opposite ends and a plurality of longitudinally disposed slots intermediate said ends, a mounting block mounted for slidable reciprocation in the housing past the slots and having longitudinal grooves therein adapted for registration with said slots, each of the grooves having latch means therein, a plurality of sampling tools mounted on the block individually associated with grooves and adapted for registration with the slots for pivotal movement between positions endwardly extended from the block and reversely pivoted positions within the grooves, means for thrusting the tools outwardly of the housing upon registration thereof with the slots, means in the housing urging the mounting block toward one end of the housing with the tools in their inwardly extended position out of registration from the slots, means for applying pressure to the mounting block urging it toward the other end of the housing for registration of the tools with the slots whereupon they are thrust outwardly of the housing, said pressure applying means further urging the mounting block past the slots toward said other end of the housing for drawing the tools into their position within the grooves of the mounting block, the latch means releasably retaining each of the tools in its respective groove, and means for relieving said pressure applying means to permit said yieldable means to urge the mounted block toward said one end of the housing back past the slots.

2. A geological sampling device comprising an elongated housing having opposite ends and a plurality of longitudinally disposed slots intermediate said ends, the slots being bounded at upper and lower ends thereof by the housing, a mounting block mounted for slidable reciprocation in the housing past the slots and having longitudinal grooves therein adapted for juxtaposition with the slots, a plurality of sampling tools mounted on the block individually associated with the grooves therein and adapted for registry with the slots for pivotal movement between positions endwardly extended from the block and upright positions within the grooves, means for thrusting the tools outwardly of the housing upon registry thereof with the slots, means in the housing urging the mounting block toward one end of the housing with the tools in their endwardly extended positions out of registry from the slots, means for applying pressure to the mounting block urging it toward the other end of the housing for registering the tools with the slots, said pressure applying means further being adapted to urge the mounting block past the slots toward said other end of the housing for bringing the tools into transverse engagement with the lower edges of the slots, said lower edges upon further movement of the block toward said other end of the housing forcing the tools into their positions within the grooves of the mounting block, and means releasably locking the tools in the grooves.

3. In a geological sampling apparatus for use in obtaining samples of earth formations providing an elongated housing, a sampling tool pivotally mounted in the housing for movement from a downwardly extended position through an upward arc into an upright position comprising an elongated body having core-receiving end and sample-receiving bore, the body having a laterally disposed knife edge extended longitudinally of the body in the direction of pivotal movement thereof adapted to cut through the formation during penetration thereof.

4. In a geological sampling apparatus for use in obtaining earth samples providing an elongated housing, a mounting block mounted in the housing for slidable reciprocation therein and providing a plurality of sockets, balls mounted individually in the sockets having pins outwardly extended therefrom adapted for movement in outward arcuate paths in planes longitudinal of the path of movement of the block, a plurality of sampling tools individually connected to the pins for movement therewith, means for thrusting the tools from the housing at selected positions therealong, the tools being held in the housing in positions endwardly extended from the mounting block except when in said selected positions, and means in the housing applying pressure to the block to move the tools into said selected positions and for swinging the tools into earth penetrating engagement through said outward arcuate paths.

5. In a geological sampling apparatus for use in obtaining earth samples providing an elongated housing having a plurality of elongated slots therein, a mounting block mounted in the housing for slidable reciprocation therein and providing a plurality of sockets, balls mount-

ed individually in the sockets having pins outwardly extended therefrom adapted for movement in outward arcuate paths in planes longitudinal of the path of movement of the block, a plurality of elongated sampling tools individually connected to the pins and being positioned for movement through the slots upon individual registry therewith, the tools and slots constraining the pins to movement in their respective longitudinal planes, means for thrusting the tools from the housing when in registry with their respective slots, the tools being held in the housing in positions endwardly extended from the mounting block except when in said positions of registration, and means in the housing applying pressure to the block to move the tools into said positions of registration and for swinging the tools into earth penetrating engagement through said upper arcuate paths.

6. A self-contained, remotely controlled submersible geological sampling apparatus comprising an elongated housing having opposite ends, a plurality of longitudinally disposed slots intermediate said ends and providing a piston chamber therein, a piston mounted for slidable reciprocation in the chamber between retracted and extended positions having a piston rod connected thereto, a spring bearing against the piston for urging the piston into retracted position toward one end of the housing, a mounting block connected to the piston rod for slidable reciprocation past the slots in response to reciprocation of the piston, the mounting block providing outwardly facing grooves disposed longitudinally therein for alignment with the slots upon movement of the mounting block thereby, a plurality of sampling tools mounted on the block individually associated with the grooves therein and adapted upon alignment with the slots for pivotal movement from positions endwardly extended from the block to upright positions within the grooves, means for thrusting the tools outwardly of the housing upon alignment thereof with the slots, means for applying hydraulic pressure to the piston to urge it into extended position thereby moving the mounting block toward and aligning the tools with the slots, said hydraulic means being further operable to move the mounting block past the slots permitting upward arcuate movement of the tools into housed position in their respective grooves of the mounting block, and means releasing the hydraulic pressure to permit movement of the piston into retracted position and the mounting block back past the slots.

7. A self-contained, remotely controlled submersible geological sampling apparatus comprising an elongated housing having opposite ends, a plurality of longitudinally disposed slots intermediate said ends and providing a piston chamber therein, a piston mounted for slidable reciprocation in the chamber between retracted and extended positions having a piston rod connected thereto, a spring bearing against the piston for urging the piston into retracted position toward one end of the housing, a mounting block connected to the piston rod for slidable reciprocation past the slots in response to reciprocation of the piston, the mounting block providing outwardly facing grooves disposed longitudinally therein for alignment with the slots upon movement of the mounting block thereby, a plurality of sampling tools mounted on the block individually associated with the grooves therein and adapted upon alignment with the slots for pivotal movement from positions endwardly extended from the block to upright positions within the grooves, means for thrusting the tools outwardly of the housing upon alignment thereof with the slots, a shank endwardly extended from the block having a disk mounted thereon transversely disposed in the housing for reciprocal movement with the block, a spring bearing against the disk for urging the disk toward said one end of the housing, means for applying hydraulic pressure to the piston to urge it into extended position thereby moving the mounting block toward the other end of the housing for aligning the tools with the slots, said hydraulic means being further operable to move the mounting block past the slots in the same direction permitting upward arcuate movement of the tools into housed position in their respective grooves of the mounting block, and means releasing the hydraulic pressure to permit movement of the piston into retracted position and the mounting block toward said one end of the housing in the opposite direction past the slots.

8. A self-contained, remotely controlled submersible geological sampling apparatus comprising an elongated housing having opposite ends, a plurality of longitudinally disposed slots intermediate said ends and providing a piston chamber therein, a piston mounted for slidable reciprocation in the chamber between retracted and extended positions having a piston rod connected thereto, a spring bearing against the piston for urging the piston into retracted position toward one end of the housing, a mounting block connected to the piston rod for slidable reciprocation past the slots in response to reciprocation of the piston, the mounting block providing outwardly facing grooves disposed longitudinally therein for alignment with the slots upon movement of the mounting block thereby, each of the grooves having latch means therein, a plurality of sampling tools mounted on the block individually associated with the grooves therein and adapted upon alignment with the slots for pivotal movement from positions endwardly extended from the block to upright positions within the grooves, means for thrusting the tools outwardly of the housing upon alignment thereof with the slots, means for applying hydraulic pressure to the piston to urge it into extended position thereby moving hte mounting block toward and aligning the tools with the slots, said hydraulic means being further operable to move the mounting block past the slots permitting upward arcuate movement of the tools into housed position in their respective grooves of the mounting block, the latch means releasably retaining each of the tools in its respective groove, and means releasing the hydraulic pressure to permit movement of the piston into retracted position and the mounting block back past the slots.

9. A borehole sampling apparatus comprising an elongated hollow housing having upper and lower end walls, means for elevationally positioning the housing in a borehole, an upper partition in the housing in spaced relation beneath the upper wall and defining a fluid-tight chamber therebetween, a lower partition in the housing in spaced relation beneath the upper partition and defining a piston chamber therebetween, a piston mounted in the piston chamber for slidable reciprocation therein, a piston rod connected to the piston having an end slidably extendible through the lower partition, a substantially cylindrical mounting block mounted for slidable movement in the housing beneath the lower partition having an upper end connected to the slidably extendible end of the piston rod and a lower end, a plurality of grooves longitudinally disposed in the surface of the block arranged in peripherally spaced diametrically opposed positions therearound, each of the grooves having a latch member therein, a plurality of sampling tools having upper ends individually pivotally mounted in the lower end of the mounting block and having core receiving ends disposed in longitudinal alignment with a corresponding groove in the mounting block, the core-receiving ends having substantially V-shaped outwardly disposed edges therein, there being at least a pair of sampling tools diametrically arranged relative to said housing, the housing having a plurality of longitudinally disposed slots, each having upper and lower edges, intermediate the lower end wall and the lower partition and individually associated with the sampling tools, a shank connected at the lower end of the block extended downwardly centrally of the sampling tools having a disc connected at the lower end thereof, spring means mounted on the shank individually bearing against each of the sampling tools adapted to thrust each tool outwardly of the housing upon alignment thereof with its respective

slot, the tools being adapted upon movement thereof from above to below the slots for individual pivotal movement between a downwardly directed position endwardly extended from the block, through the slots to upright positions within the grooves of the block associated therewith, springs mounted in the housing between the upper and lower partitions and between the disk and the lower end wall adapted yieldably to urge the mounting block and thereby the sampling tools into positions above the slots, hydraulic pressure means mounted on the upper partition in the fluid chamber for forcing fluid under pressure into the piston chamber for imparting downward sliding movement to the block whereby the sampling tools are brought into alignment with the slots for outward pivoting movement and upon further downward movement of the block are brought into engagement with said lower edges of the slots for forcing the tools into latched position within the grooves of the mounting block, means for releasing the hydraulic pressure, a quantity of fluid in the fluid-tight chamber for supplying the hydraulic means, a distendible bag mounted in the fluid-tight chamber communicating exteriorly of the housing and adapted for distention upon removal of fluid from the fluid-tight chamber by the hydraulic means, and contraction upon entry of such fluid in the chamber, and means for controlling the hydraulic means for application and release of hydraulic pressure on the piston.

10. A self-contained remotely operable borehole sampling apparatus comprising an elongated housing having opposite ends and a plurality of longitudinally disposed slots intermediate said ends, a mounting member mounted for slidable reciprocation longitudinally of the housing past the slots and having longitudinal grooves therein adapted for registration with said slots, a plurality of sampling tools mounted on the mounting member individually associated with the grooves and adapted for registration with the slots for pivotal movement between positions extended from the mounting member endwardly of the housing and reversely pivoted positions within the grooves extended toward the opposite end of the housing, means for thrusting the tools outwardly from the housing upon registration thereof with the slots, a reservoir within the housing, an expansible bag mounted within the reservoir in fluid communication with the exterior of the housing, an hydraulic ram having a piston therein operably associated with the mounting member and movable between retracted and extended positions, resilient means urging the piston into retracted position, an electrically driven pump mounted within the housing having an intake connected to the reservoir and a discharge connected to the ram for delivering hydraulic fluid to the ram to move the piston into extended position whereby the mounting member is first moved to bring the tools into registration with the slots whereupon they are thrust outwardly of the housing and further to urge the mounting member past the slots for pivoting the tools outwardly and upwardly into their positions within the grooves of the mounting member, and an electrical conductor connected to the electrically driven pump and having an end extended from the housing adapted for connection to a source of electrical energy remote from the housing whereby the pump is actuated and for disconnection therefrom to permit retraction of the piston by the resilient means.

11. A self-contained, remotely controlled submersible geological sampling apparatus adapted to be submersed in a fluid containing borehole comprising an housing having an enclosed fluid-tight reservoir therewithin, an expansible substantially fluid-tight bag mounted within the reservoir having an interior adapted to receive fluid in fluid communication with the exterior of the housing, an hydraulic ram mounted in the housing having a piston longitudinally reciprocally movable in the housing between predetermined retracted and extended positions, means yieldably urging the piston into retracted position, an electrically driven pump mounted within the housing having an intake connected to the reservoir and a discharge connected to the ram adapted upon energization to urge the piston into extended position, the bag receiving and releasing borehole fluid from and to the exterior of the housing during operation of the ram so as to equalize pressures in the reservoir, a coring tool connected to the ram for movement between a retracted position within the housing and an operable position extended from the housing incident to longitudinal reciprocation of the ram, and electrical conducting means connected to the electrically driven pump and extended from the housing adapted for connection to a source of electrical energy remote from the housing.

12. A self-contained, remotely controlled submersible geological sampling apparatus comprising an elongated housing having a slot longitudinally disposed therein and a fluid-tight reservoir therewithin, an expansible substantially fluid-tight bag mounted within the reservoir having an interior adapted to receive fluid and in fluid communication with the exterior of the housing, an hydraulic ram mounted in the housing having a piston longitudinally reciprocally movable in the housing between retracted and extended positions, means yieldably urging the piston into retracted position, an electrically driven pump mounted within the housing having an intake connected to the reservoir and a discharge connected to the ram adapted upon energization to urge the piston into extended position, a mounting member mounted in the housing for reciprocal movement longitudinally of the slot and having driven connection to the piston, an elongated tubular coring tool pivotally mounted on the mounting member for movement between an endwardly directed position within the housing when the piston is in retracted position, an operable position outwardly extended through the slot as the piston travels from retracted to extended position, and an oppositely endwardly directed position within the housing in the extended position of the piston, and electrical conducting means connected to the electrically driven pump and adapted for connection to a source of electrical energy remote from the housing.

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