United States Patent [19]

Whitten

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[54] **APPARATUS FOR TESTING EARTH FORMATIONS**

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[73] Assignee: **Schlumberger Technology Corporation,** New York, N.Y.

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[52] **U.S. Cl.** **73/155,** 166/100

[51] **Int. Cl.** **E21b 49/00**

[58] **Field of Search** ..... 73/155, 421 R, 151, 73/152; 166/100

[56] **References Cited**

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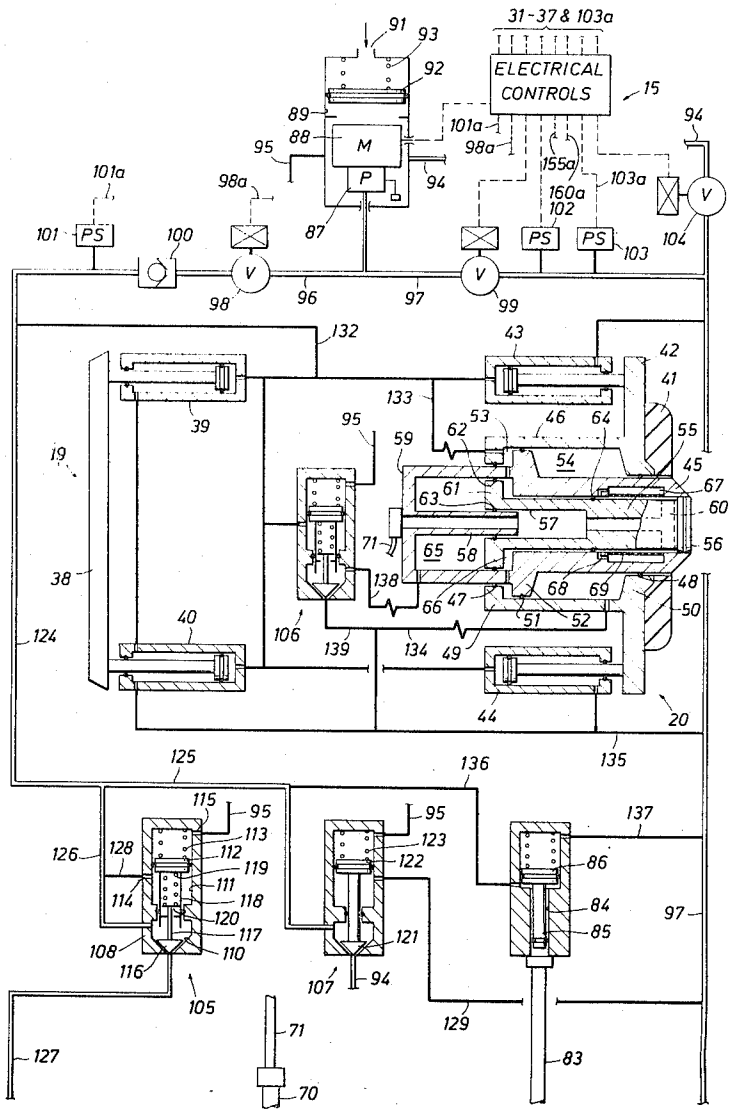
Primary Examiner—Jerry W. Myracle

Attorney—Ernest R. Archambeau, Jr. et al.

[57] **ABSTRACT**

In the representative embodiment of the new and improved apparatus for testing earth formations disclosed herein, fluid-admitting means are selectively extended into sealing engagement with a potentially-producible earth formation and a selectively-operable valve on the fluid-admitting means is opened to place a filtering medium arranged on the fluid-admitting means into communication with the isolated formation without inducing the erosion of loose formation materials as the testing is conducted. Then, when the testing is completed, the fluid-admitting means are retracted and the valve is reclosed in readiness for subsequent testing operations.

21 Claims, 7 Drawing Figures



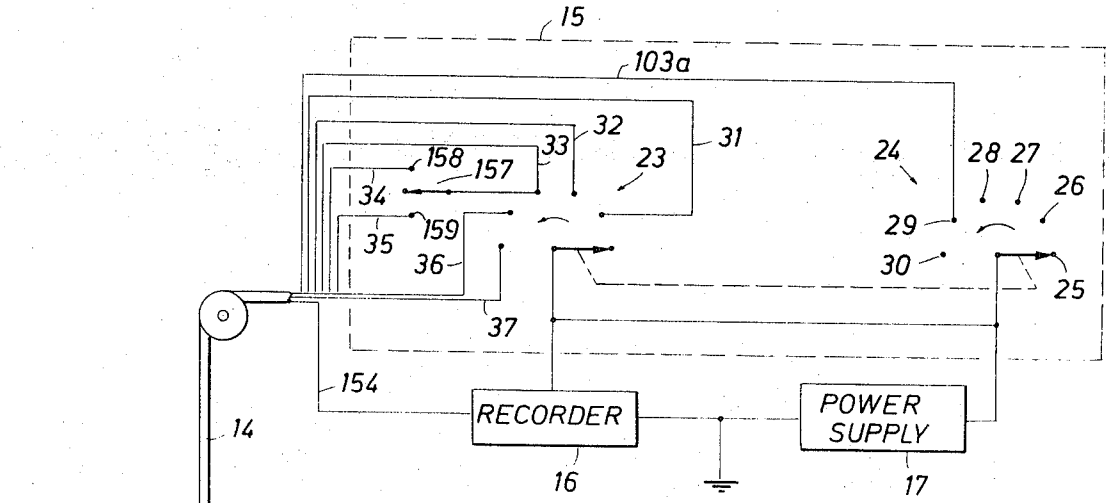

15
103a
32
31
33
23
158
157
34
159
35
36
37
24
28
27
26
29
30
25
154
RECORDER
POWER SUPPLY
16
17
14

FIG. 1

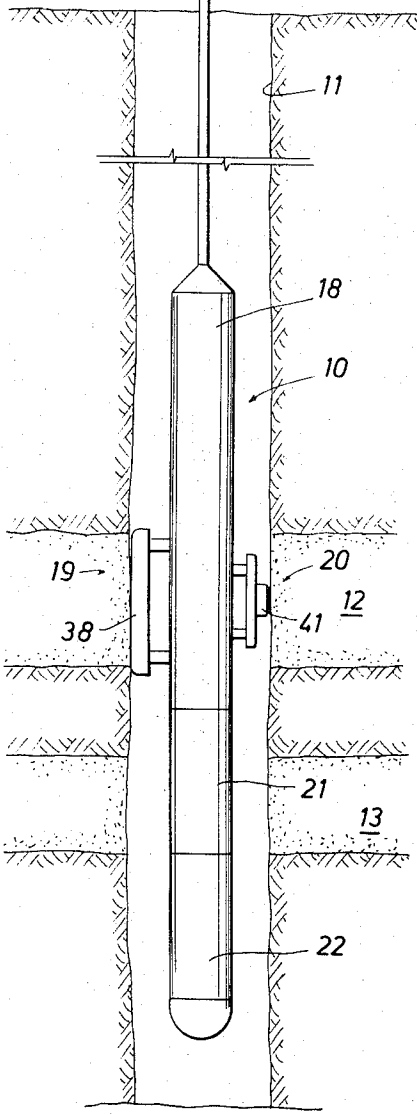

11
18
10
19
20
12
38
41
21
13
22

FIG. 5B

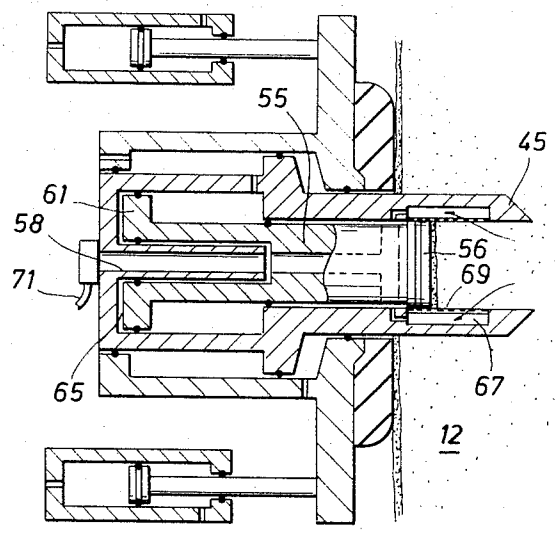
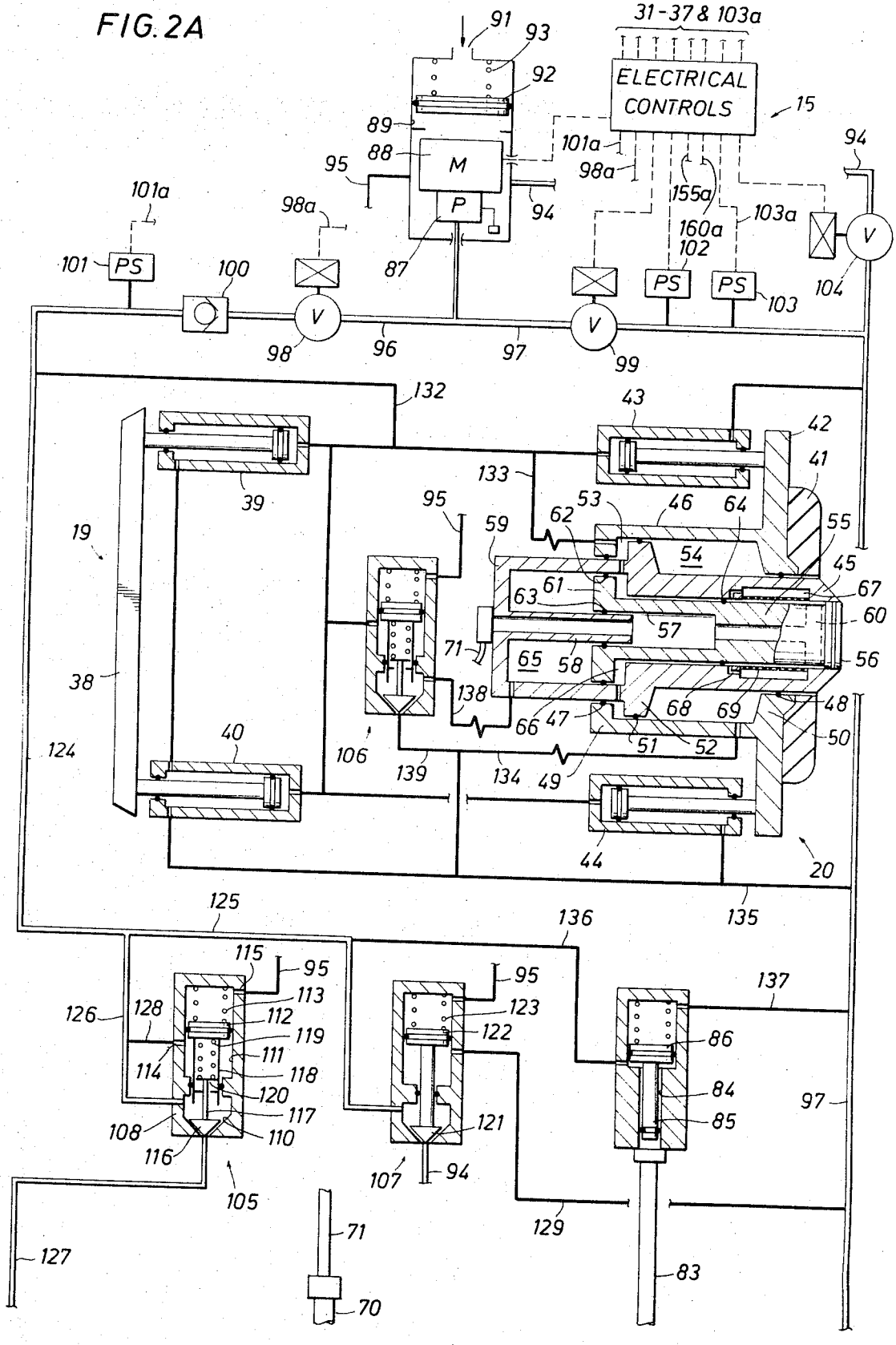

55
45
61
58
56
71
69
65
67
12

FIG. 2A


31-37 & 103a
ELECTRICAL CONTROLS
15
91
93
92
89
88
M
P
95
94
101a
98a
155a
160a
102
103a
PS
V
101
100
87
98
96
97
99
104
103
132
43
42
41
133
39
53
46
64
55
62
59
54
45
67
61
63
60
57
71
65
58
56
38
138
68
69
48
66
47
51
52
50
124
40
106
139
134
49
44
20
135
125
136
137
115
113
112
119
111
118
120
117
110
126
128
114
108
116
105
123
122
121
107
86
84
85
97
129
127
71
70
83

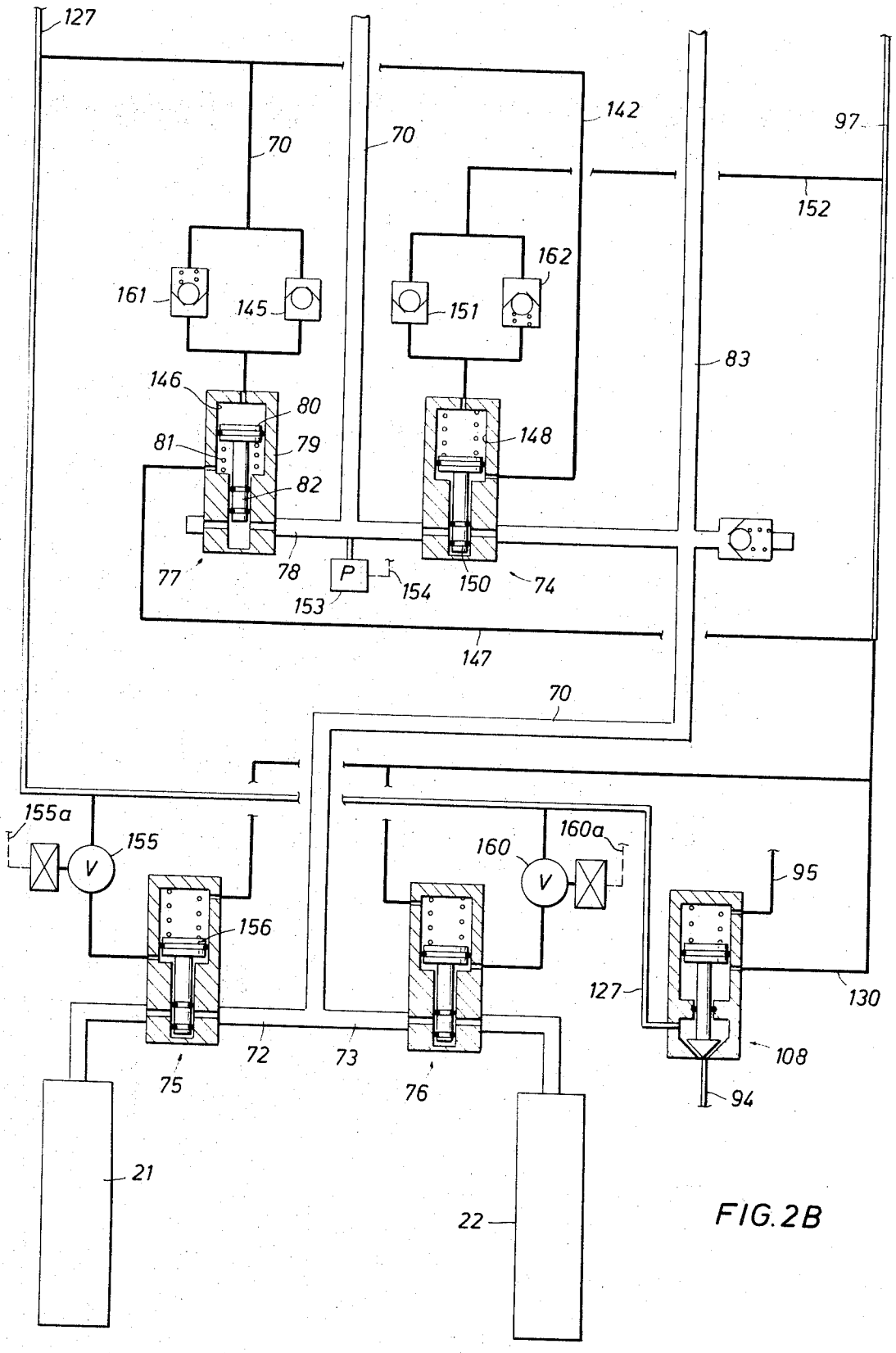

127
70
70
142
97
152
161
145
151
162
83
146
80
81
79
148
82
77
78
P
153
154
150
74
147
70
155a
155
V
156
160a
160
V
95
127
130
72
73
75
76
108
94
21
22

FIG. 2B

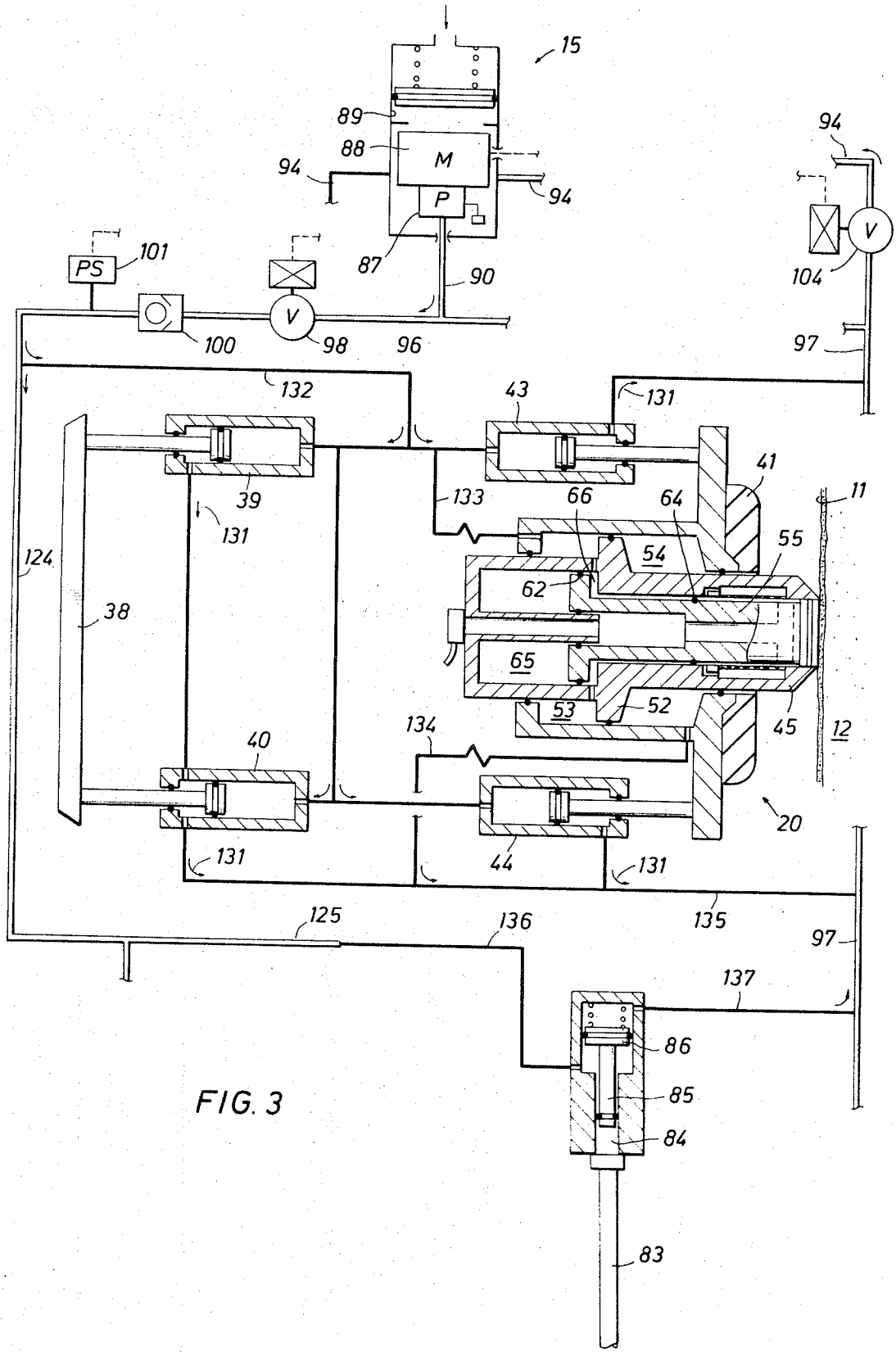

15
89
88
M
P
94
94
87
90
PS
101
100
V
98
96
94
V
104
97
132
43
131
41
11
39
131
133
66
64
54
55
124
38
62
65
53
52
45
12
40
134
20
131
44
131
135
125
136
97
137
86
85
84
83

FIG. 3

FIG. 4

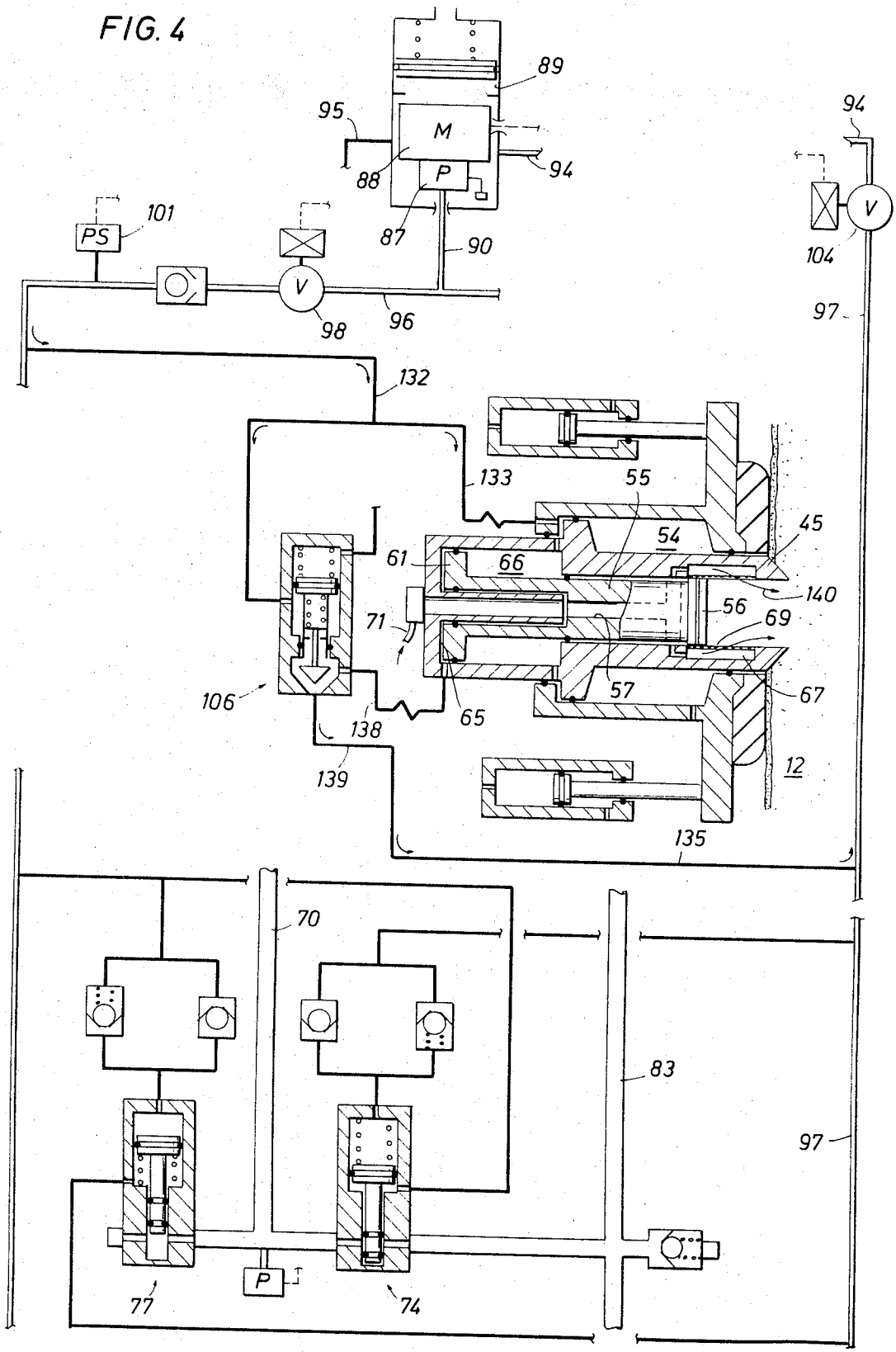
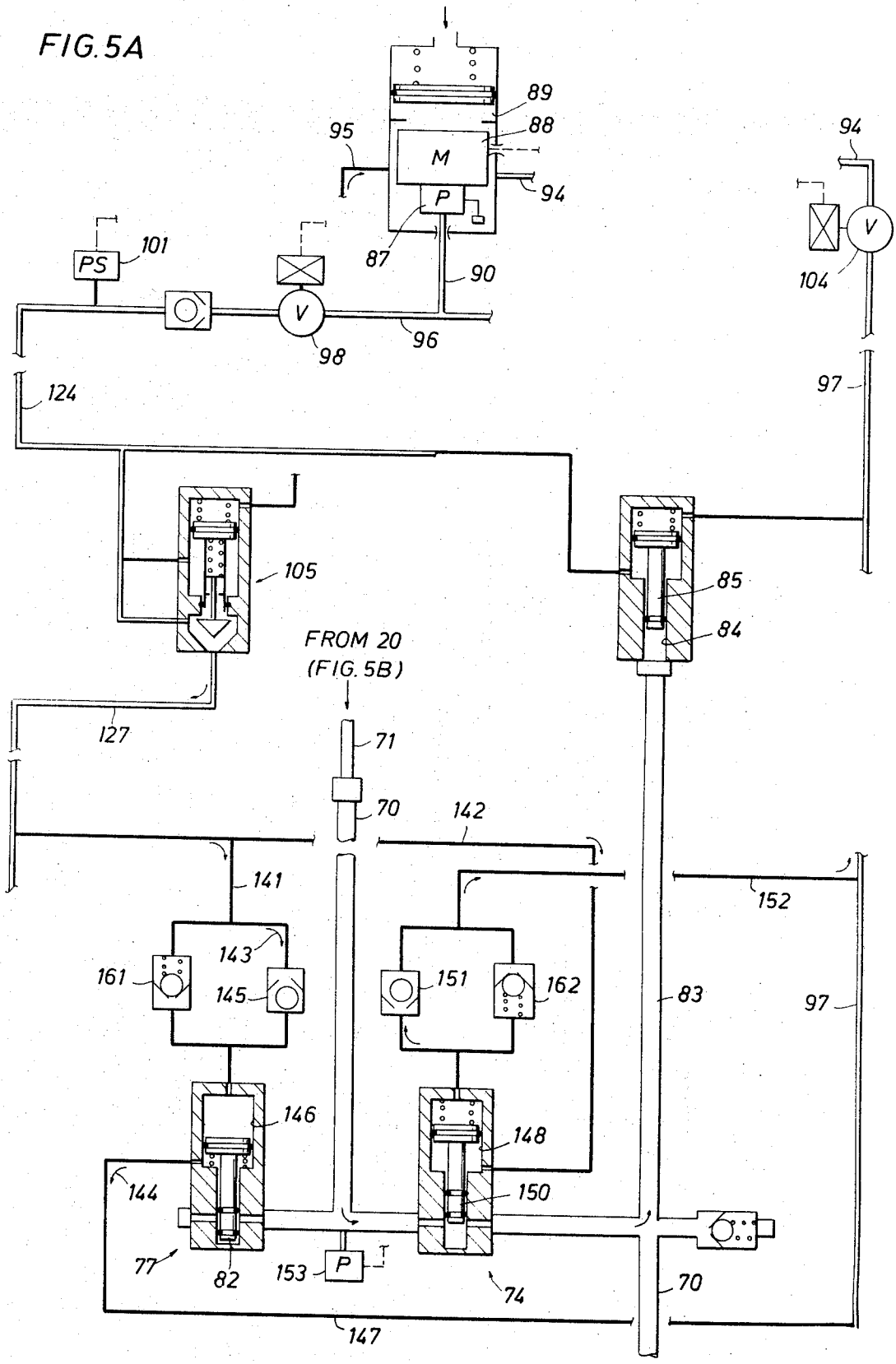

89
95
M
94
88
P
87
90
101
PS
V
98
96
94
V
104
97
132
133
55
45
54
61
66
140
56
69
71
57
67
106
65
138
139
12
135
70
83
97
77
P
74

FIG. 5A


89
88
95
M
94
P
87
90
101
PS
V
98
96
94
V
104
124
97
105
85
84
FROM 20
(FIG. 5B)
127
71
70
142
141
152
143
161
145
151
162
83
97
146
148
144
150
77
82
153
P
74
70
147

APPARATUS FOR TESTING EARTH FORMATIONS

Heretofore, the typical wireline formation testers (such as the tool disclosed in U.S. Pat. No. 3,011,554) which have been most successful in commercial service have been limited to attempting only a single test of one selected formation interval. Those skilled in the art will appreciate that once one of these typical tools is positioned in a well bore and a sample or testing operation is initiated, the tool cannot be again operated without first removing it from the well bore and reconditioning various tool components for another run. Thus, even should it be quickly realized that a particular sampling or testing operation already underway will probably be unsuccessful, the operator has no choice except to discontinue the operation and then return the tool to the surface. This obviously results in a needless loss of time and expense which would usually be avoided if another attempt could be made without having to remove the tool from the well bore.

One of the most significant problems which have heretofore prevented the production of a commercially successful repetitively-operable formation-testing tool has been in providing a suitable arrangement for reliably establishing fluid or pressure communication with incompetent or unconsolidated earth formations. Although the several new and improved testing tools respectively shown in U.S. Pat. No. 3,352,361, U.S. Pat. No. 3,530,933, U.S. Pat. No. 3,565,169 and U.S. Pat. No. 3,653,436 are especially arranged for testing unconsolidated formations, for one reason or another these tools are not adapted for performing more than one testing operation during a single run in a given well bore. For example, as described in these patents, each of these new and improved testing tools employs a tubular sampling member which is cooperatively associated with a filtering medium for preventing the unwanted entrance of unconsolidated formation materials into the testing tool.

Accordingly, it is an object of the present invention to provide new and improvded formation-testing apparatus for reliably obtaining multiple measurements of one or more fluid or formation characteristics as well as selectively collecting one or more samples of connate fluids, if desired, from earth formations of any nature.

This and other objects of the present invention are attained by providing formation-testing apparatus having selectively-extendible fluid-admitting means adapted for movement into sealing engagement with a potentially-producible earth formation to isolate a portion thereof from the well bore fluids. To limit loose formation materials which may be present in the isolated formation from plugging the fluid-admitting means, filtering means are disposed in the fluid-admitting means. Selectively-operable valve means are cooperatively arranged in the fluid-admitting means for selective movement between an open position to open communication between an isolated earth formation and the filtering means and a normal closed position blocking the filtering means.

The novel features of the present invention are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may be best understood by way of the following description of exemplary apparatus employing the

principles of the invention as illustrated in the accompanying drawings, in which:

FIG. 1 depicts the surface and downhole portions of new and improved formation-testing apparatus including a preferred embodiment of fluid-admitting means incorporating the principles of the present invention;

FIGS. 2A and 2B together show a somewhat-schematic representation of the formation-testing tool illustrated in FIG. 1 as the tool will appear in its initial operating position; and

FIGS. 3–5 respectively depict the successive positions of various components of the new and improved tool shown in FIGS. 2A and 2B during the course of a typical testing sand sampling operation to illustrate the operation of the fluid-admitting means of the present invention.

Turning now to FIG. 1, a preferred embodiment of a new and improved sampling and measuring tool **10** incorporating the principles of the present invention is shown as it will appear during the course of a typical measuring and sampling operation in a well bore such as a borehole **11** penetrating one or more earth formations as at **12** and **13.** As illustrated, the tool **10** is suspended in the borehole **11** from the lower end of a typical multiconductor cable **14** that is spooled in the usual fashion on a suitable winch (not shown) at the surface and coupled to the surface portion of a tool-control system **15** as well as typical recording and indicating apparatus **16** and a power supply **17.** In its preferred embodiment, the tool **10** includes an elongated body **18** which encloses the downhole portion of the tool control system **15** and carries selectively-extendible tool-anchoring means **19** arranged on opposite sides of the body from new and improved fluid-admitting means **20** as well as one or more tandemly-coupled fluid-collecting chambers **21** and **22.**

As is explained in greater detail in a copending application Ser. No. 313,235 filed Dec. 8, 1972. by Harold J. Urbanosky filed simultaneously herewith, the new and improved formation-testing tool **10** and the control system **15** are cooperatively arranged so that, upon command from the surface, the tool can be selectively placed in any one or more of five selected operating positions. As will be subsequently described briefly, the control system **15** will function to either successively place the tool **10** in one or more of these positions or else cycle the tool between selected ones of these operating positions. These five operating positions are simply achieved by selectively moving suitable control switches, as schematically represented at **23** and **24,** included in the surface portion of the system **15** to various switching positions, as at **25–30,** so as to selectively apply power to different conductors **31–37** in the cable **14.**

Turning now to FIGS. 2A and 2B, the entire downhole portion of the control system **15** as well as the tool-anchoring means **19,** the fluid-admitting means **20** and the fluid-collecting chambers **21** and **22** are schematically illustrated with their several elements or components depicted as they will respectively be arranged when the new and improved tool **10** is fully retracted and the switches **23** and **24** are in their first or "off" operating positions **25.** In the preferred embodiment of the selectively-extendible tool-anchoring means **19** schematically illustrated in FIG. 2A, an upright wall-engaging anchor member **38** along the rear of the tool body **18** is coupled in a typical fashion to a longitudi-

nally-spaced pair of laterally-movable piston actuators **39** and **40** of a typical design mounted transversely on the tool body **18.** As will be subsequently explained, the lateral extension and retraction of the wall-engaging member **38** in relation to the rear of the tool body **18** is controlled by the control system **15** which is operatively arranged to selectively admit and discharge a pressured hydraulic fluid to and from the piston actuators **39** and **40.**

The fluid-admitting means **20** of the present invention are cooperatively arranged for sealing-off or isolating selected portions of the wall of the borehole **11**; and, once a selected portion of the borehole wall is packed-off or isolated from the well bore fluids, establishing pressure or fluid communication with the adjacent earth formations. As depicted in FIG. 2A, in the preferred embodiment, the fluid-admitting means **20** include an annular elastomeric sealing pad **41** mounted on the forward face of an upright support member or plate **42** that is coupled to a longitudinally-spaced pair of laterally-movable piston actuators **43** and **44** respectively arranged transversely on the tool body **18** for moving the sealing pad in relation to the forward side of the tool body. Accordingly, as the control system **15** selectively supplies a pressured hydraulic fluid to the piston actuators **43** and **44,** the sealing pad **41** will be moved laterally between a retracted position adjacent to the forward side of the tool body **18** and an advanced or forwardly-extended position.

By arranging the annular sealing member **41** on the opposite side of the tool body **18** from the wall-engaging member **38,** the lateral extension of these two members will, of course, be effective for urging the sealing pad into sealing engagement with the adjacent wall of the borehole **11** and anchoring the tool **10** each time the piston actuators **39, 40, 43** and **44** are extended. It will, however, be appreciated that the wall-engaging member **38** as well as its piston actuators **39** and **40** would not be needed if the effective stroke of the piston actuators **43** and **44** would be sufficient for assuring that the sealing member **41** can be extended into firm sealing engagement with one wall of the borehole **11** with the rear of the tool body **18** securely anchored against the opposite wall of the borehole. Conversely, the piston actuators **43** and **44** could be similarly omitted where the extension of the wall-engaging member **38** alone would be effective for moving the other side of the tool body **18** forwardly toward one wall of the borehole **11** to place the sealing pad **41** into firm sealing engagement therewith. However, in the preferred embodiment of the formation-testing tool **10,** both the tool-anchoring means **19** and the fluid-admitting means **20** are made selectively extendible to enable the tool to be operated in boreholes of substantial diameter. This preferred design of the tool **10,** of course, results in the overall stroke of the piston actuators **39** and **40** and the piston actuators **43** and **44** being kept to a minimum so as to reduce the overall diameter of the tool body **18.**

To conduct connate fluids into the new and improved tool **10,** the fluid-admitting means **20** of the present invention further include an enlarged tubular member **45** having an open forward portion coaxially disposed within the sealing pad **41** and a closed rear portion which is slidably mounted within a larger tubular member **46** secured to the rear face of the plate **42** and extended rearwardly therefrom. By arranging the nose of the tubular fluid-admitting member **45** to normally protrude a short distance ahead of the forward face of the sealing pad **41,** extension of the fluid-admitting means **20** will engage the forward end of the fluid-admitting member with the adjacent surface of the wall of the borehole **11** just before the annular sealing pad is also forced thereagainst for isolating that portion of the borehole wall as well as the nose of the fluid-admitting member from the well bore fluids. The significance of this sequence of engagement will be subsequently explained. To selectively move the tubular fluid-admitting member **45** in relation to the enlarged outer member **46,** the smaller tubular member is slidably disposed within the outer tubular member and fluidly sealed in relation thereto as by sealing members **47** and **48** on inwardly-enlarged end portions **49** and **50** of the outer member and a sealing member **51** on an enlarged-diameter intermediate portion **52** of the inner member.

Accordingly, it will be appreciated that by virtue of the sealing members **47, 48** and **51,** enclosed piston chambers **53** and **54** are defined within the outer tubular member **46** and on opposite sides of the outwardly-enlarged portion **52** of the inner tubular member **45** which, of course, functions as a piston member. Thus, by increasing the hydraulic pressure in the rearward chamber **53,** the fluid-admitting member **45** will be moved forwardly in relation to the outer tubular member **46** as well as to the sealing pad **41.** Conversely, upon the application of an increased hydraulic pressure to the forward piston chamber **54,** the fluid-admitting member **45** will be retracted in relation to the outer member **46** and the sealing pad **41.**

Pressure or fluid communication with the fluid-admitting means **20** of the present invention is controlled by means such as a generally-cylindrical valve member **55** which is coaxially disposed within the fluid-admitting member **45** and cooperatively arranged for axial movement therein between a retracted or open position and the illustrated advanced or closed position where the enlarged forward end **56** of the valve member is substantially, if not altogether, sealingly engaged with the forwardmost interior portion of the fluid-admitting member. To support the valve member **55,** the rearward portion of the valve member is axially hollowed, as at **57,** and coaxially disposed over a tubular member **58** projecting forwardly from the transverse wall **59** closing the rear end of the fluid-admitting member **45.** The axial bore **57** is reduced and extended forwardly along the valve member **55** to a termination with one or more transverse fluid passages **60** in the forward portion of the valve member just behind its enlarged head **56.**

To provide piston means for selectively moving the valve member **55** in relation to the fluid-admitting member **45,** the rearward portion of the valve member is enlarged, as at **61,** and outer and inner sealing members **62** and **63** are coaxially disposed thereon and respectively sealingly engaged with the interior of the fluid-admitting member and the exterior of the forwardly-extending tubular member **58.** A sealing member **64** mounted around the intermediate portion of the valve member **55** and sealingly engaged with the interior wall of the adjacent portion of the fluid-admitting member **45** fluidly seals the valve member in relation to the fluid-admitting member. Accordingly, it will be appreciated that by increasing the hydraulic pressure in

the enlarged piston chamber 65 defined to the rear of the enlarged valve portion 61 which serves as a piston member, the valve member 55 will be moved forwardly in relation to the fluid-admitting member 45. Conversely, upon application of an increased hydraulic pressure to the forward piston chamber 66 defined between the sealing members 62 and 64, the valve member 55 will be moved rearwardly along the forwardly-projecting tubular member 58 so as to retract the valve member in relation to the fluid-admitting member 45.

Those skilled in the art will, of course, appreciate that many earth formations, as at 12, are relatively unconsolidated and are, therefore, readily eroded by the withdrawal of connate fluids. Thus, to prevent any significant erosion of such unconsolidated formation materials, the fluid-admitting member 45 is arranged to define an internal annular space 67 and a flow passage 68 in the forward portion of the fluid-admitting member, and a tubular screen 69 with slits or apertures of suitable fineness is coaxially mounted around the annular space. In this manner, when the valve member 55 is retracted, formation fluids will be compelled to pass through the exposed forward portion of the screen 69 ahead of the enlarged head 56, into the annular space 67, and then through the fluid passage 60 into the fluid passage 57 and the tubular member 58. Thus, as the valve member 55 is retracted, should loose or unconsolidated formation materials be eroded from a formation as connate fluids are withdrawn therefrom, the materials will be stopped by the exposed portion of the screen 69 ahead of the enlarged head 56 of the valve member thereby quickly forming a permeable barrier to prevent the continued erosion of loose formation materials once the valve member halts.

A sample or flow line 70 is cooperatively arranged in the formation-testing tool 10 and has one end coupled, as by a flexible conduit 71, to the fluid-admitting means 20 and its other end terminated in a pair of branch conduits 72 and 73 respectively coupled to the fluid-collecting chambers 21 and 22. To control the communication between the fluid-admitting means 20 and the fluid-collecting chambers 21 and 22, normally-closed flow-control valves 74–76 of a similar or identical design are arranged respectively in the flow line 70 and in the branch conduits 72 and 73 leading to the sample chambers. For reasons which will subsequently be described in greater detail, a normally-open control valve 77 which is similar to the normally-closed control valves 74–76 is cooperatively arranged in a branch conduit 78 for selectively controlling communication between the well bore fluids exterior of the tool 10 and the upper portion of the flow line 70 extending between the flow-line control valve 74 and the new and improved fluid-admitting means 20.

As illustrated, the control valve 77 is comprised of a valve body 79 cooperatively carrying a typical piston actuator 80 which is normally biased to an elevated position by a spring 81 of a predetermined strength. A valve member 82 coupled to the piston actuator 80 is cooperatively arranged for blocking fluid communication between the inlet and outlet fluid ports of the control valve whenever the valve member is moved to its lower position. The control valves 74–76 are similar to the control valve 77 except that a spring of selected strength is respectively arranged in each for normally biasing each of these valve members to a closed position.

As shown in FIGS. 2A–2B, a branch conduit 83 is coupled to the flow line 70 at a convenient location between the sample chamber control valves 75 and 76 and the flow-line control valve 74, with this branch conduit being terminated at an expansion chamber 84 of a predetermined volume. A reduced-diameter displacement piston 85 is operatively mounted in the chamber 84 and arranged to be moved between selected upper and lower positions therein by a typical piston actuator shown generally at 86. Accordingly, it will be appreciated that upon movement of the displacement piston 85 from its lower position as illustrated in FIG. 2A to an elevated or upper position, the combined volume of whatever fluids that are then contained in the branch conduit 83 as well as in that portion of the flow line 70 between the flow-line control valve 74 and the sample chamber control valves 75 and 76 will be correspondingly increased.

As best seen in FIG. 2A, the preferred embodiment of the control system 15 further includes a pump 87 that is coupled to a driving motor 88 and cooperatively arranged for pumping a suitable hydraulic fluid such as oil or the like from a reservoir 89 into a discharge or outlet line 90. Since the tool 10 is to be operated in well bores, as at 11, which typically contain dirty and usually corrosive fluids, the reservoir 89 is preferably arranged to totally immerse the pump 87 and the motor 88 in the clean hydraulic fluid. Inasmuch as the formation-testing tool 10 must operate at extreme depths, the reservoir 89 is provided with an inlet 91 for well bore fluids and an isolating piston 92 is movably arranged in the reservoir for maintaining the hydraulic fluid contained therein at a pressure about equal to the hydraostatic pressure at whatever depth the tool is then situated. A spring 93 is arranged to act on the piston 92 for maintaining the pressure of the hydraulic fluid in the reservoir 89 at an increased level slightly above the well bore hydrostatic pressure so as to at least minimize the influx of well bore fluids into the reservoir. In addition to isolating the hydraulic fluid in the reservoir 89, the piston 92 will also be free to move as required to accommodate volumetric changes in the hydraulic fluid which may occur under different well bore conditions. One or more inlets, as at 94 and 95, are provided for returning hydraulic fluid from the control system 15 to the reservoir 89 during the operation of the tool 10.

The fluid outlet line 90 is divided into two major branch lines which are respectively designated as the "set" line 96 and the "retract" line 97. To control the admission of hydraulic fluid to the "set" and "retract" lines 96 and 97, a pair of normally-closed solenoid-actuated valves 98 and 99 are cooperatively arranged to selectively admit hydraulic fluid to the two lines as the control switch 23 at the surface is selectively positioned; and a typical check valve 100 is arranged in the "set" line 96 downstream of the control valve 98 for preventing the reverse flow of the hydraulic fluid whenever the pressure in the "set" line is greater than that then existing in the fluid outlet line 90. Typical pressure switches 101–103 are cooperatively arranged in the "set" and "retract" lines 96 and 97 for selectively discontinuing operation of the pump 87 whenever the pressure of the hydraulic fluid in either of these lines reaches a desired operating pressure and then restarting the pump whenever the pressure drops below this value so as to maintain the line pressure within a selected operating range.

Since it is preferred that the pump **87** be a positive-displacement type to achieve a rapid predictable rise in the operating pressures in the "set" and "retract" lines **96** and **97** in a minimum length of time, the control system **15** also provides for temporarily opening the outlet line **90** until the motor **88** has reached its rated operating speed. Accordingly, the control system **15** is cooperatively arranged so that each time the pump **87** is to be started, the control valve **99** (if it is not already open) as well as a third normally-closed solenoid-actuated valve **104** will be temporarily opened to bypass hydraulic fluid directly from the output line **90** to the reservoir **89** by way of the return line **94.** Once the motor **88** has reached operating speed, the bypass valve **104** will, of course, be reclosed and either the "set" line control valve **98** or the "retract" line control valve **99** will be selectively opened as required for that particular operational phase of the tool **10.** It should be noted that during times that the "retract" line control valve **99** and the fluid-bypass valve **104** are opened to allow the motor **88** to reach its operating speed, the check valve **100** will function to prevent the reverse flow of hydraulic fluid from the "set" line **96** when the "set" line control valve **98** is open.

Accordingly, it will be appreciated that the control system **15** cooperates for selectively supplying pressured hydraulic fluid to the "set" and "retract" lines **96** and **97.** Since the pressure switches **101** and **102** respectively function only to limit the pressures in the "set" and "retract" lines to a selected maximum pressure range commensurate with the rating of the pump **87,** the new and improved control system **15** is further arranged to cooperatively regulate the pressure of the hydraulic fluid which is being supplied at various times to selected portions of the system. Although this regulation can be accomplished in different manners, it is preferred to employ a number of pressure-actuated control valves such as shown schematically at **105–108** in FIGS. **2A** and **2B.** As shown in FIG. **2A,** the control valve **105,** for example, includes a valve body **109** having a valve seat **110** coaxially arranged therein between inlet and outlet fluid ports. The upper portion of the valve body **109** is enlarged to provide a piston cylinder **111** carrying an actuating piston **112** in coincidental alignment with the valve seat **110.** A spring **113** of a predetermined strength is arranged for normally urging the actuating piston **112** toward the valve seat **110** and a control port **114** is provided for admitting hydraulic fluid into the cylinder **111** at a sufficient pressure to overcome the force of this spring whenever the piston is to be selectively moved away from the valve seat. Since the control system **15** operates at pressures no less than the hydrostatic pressure of the well bore fluids, a relief port **115** is provided in the valve body **109** for communicating the space in the cylinder **111** above the actuating piston **112** with the reservoir **89.** A valve member **116** complementally shaped for seating engagement with the valve seat **110** is cooperatively coupled to the actuating piston **112** as by an upright stem **117** which is slidably disposed in an axial bore **118** in the piston. A spring **119** of selected strength is disposed in the axial bore **118** for normally urging the valve member **116** into seating engagement with the valve seat **110.**

Accordingly, in its operating position depicted in FIG. **2A,** the control valve **105** (as well as the valve **106**) will simply function as a normally-closed check valve. That is to say, in this operating position, hydraulic fluid can flow only in a reverse direction whenever the pressure at the valve outlet is sufficiently greater than the inlet pressure to elevate the valve member **116** from the valve seat **110** against the predetermined closing force imposed by the spring **119.** On the other hand, when sufficient fluid pressure is applied to the control port **114** for elevating the actuating piston, opposed shoulders, as at **120,** on the stem **117** and the piston **112** will engage for elevating the valve member **116** from the valve seat **110.**

As shown in FIGS. **2A** and **2B,** it will be appreciated that the control valve **107** (as well as the valve **108**) is similar to the control valve **105** except that in the first-mentioned control valve, the valve member **121** is preferably rigidly coupled to its associated actuating piston **122.** Thus, the control valve **107** (as well as the valve **108**) has no alternate checking action allowing reverse flow and is simply a normally-closed pressure-actuated valve for selectively controlling fluid communication between its inlet and outlet ports. Hereagain, the hydraulic pressure at which the control valve **107** (as well as the valve **108**) is to selectively open is governed by the predetermined strength of the spring **123** normally biasing the valve member **121** to its closed position.

The "set" line **96** downstream of the check valve **100** is comprised of a low-pressure section **124** having one branch **125** coupled to the fluid inlet of the control valve **107** and another branch **126** which is coupled to the fluid inlet of the control valve **105** to selectively supply hydraulic fluid to a high-pressure section **127** of the "set" line which is itself terminated at the fluid inlet of the control valve **108.** To regulate the supply of hydraulic fluid from the low-pressure section **124** to the high-pressure section **127** of the "set" line **96,** a pressure-communicating line **128** is coupled between the low-pressure section and the control port of the control valve **105.** Accordingly, so long as the pressure of the hydraulic fluid in the low-pressure section of the "set" line **96** remains below the predetermined actuating pressure required to open the control valve **105,** the high-pressure section **127** will be isolated from the low-pressure section **124.** Conversely, once the hydraulic pressure in the low-pressure line **124** reaches the predetermined actuating pressure of the valve **105,** the control valve will open to admit the hydraulic fluid into the high-pressure line **127.**

The control valves **107** and **108** are respectively arranged to selectively communicate the low-pressure and high-pressure sections **124** and **127** of the "set" line **96** with the fluid reservoir **89.** To accomplish this, the control ports of the two control valves **107** and **108** are each connected to the "retract" line **97** by suitable pressure-communicating lines **129** and **130.** Thus, whenever the pressure in the "retract" line **97** reaches their respective predetermined actuating levels, the control valves **107** and **108** will be respectively opened to selectively communicate the two sections **124** and **127** of the "set" line **96** with the reservoir **89** by way of the return line **94** coupled to the respective outlets of the two control valves.

As previously mentioned, in FIGS. **2A–2B** the tool **10** and the sub-surface portion of the control system **15** are depicted as their several components will appear when the tool is retracted. At this point, the wall-engaging member **38** and the sealing pad **41** are respectively retracted against the tool body **18** to facilitate

passage of the tool 10 into the borehole 11. To prepare the tool 10 for lowering into the borehole 11, the switches 23 and 24 are moved to their second or "initialization" positions 26. At this point, the hydraulic pump 87 is started to raise the pressure in the "retract" line 97 to a selected maximum to be certain that the pad 41 and the wall-engaging member 38 are fully retracted. As previously mentioned, the control valves 99 and 104 will be momentarily opened when the pump 87 is started until the pump motor 88 has reached its operating speed. At this time also, the control valve 77 is open and that portion of the flow line 70 between the closed flow-line control valve 74 and the fluid-admitting means 20 will be filled with well bore fluids at the hydrostatic pressure at the depths at which the tool 10 is then situated.

When the tool 10 is at a selected operating depth, the switches 23 and 24 are advanced to their third positions 27. Then, once the pump 87 has reached its rated operating speed, the hydraulic pressure in the output line 90 will rapidly rise to its selected maximum operating pressure as determined by the maximum or "off" setting of the pressure switch 101. As the pressure progressively rises, the control system 15 will successively function at selected intermediate pressure levels for sequentially operating the several control valves 105–108 as described fully in the aforementioned copending application Ser. No. 313,235 filed Dec. 8, 1972.

Turning now to FIG. 3, selected portions of the control system 15 and various components of the tool 10 are schematically represented to illustrate the operation of the tool at about the time that the pressure in the hydraulic output line 90 reaches its lowermost intermediate pressure level. To facilitate an understanding of the operation of the tool 10 and the control system 15 at this point in its operating cycle, only those components which are then operating are shown in FIG. 3.

At this time, since the control switch 23 (FIG. 1) is in its third position 27, the solenoid valves 98 and 104 will be open; and, since the hydraulic pressure in the "set" line 96 has not yet reached the upper pressure limit as determined by the pressure switch 101, the pump motor 88 will be operating. Since the control valve 105 (not shown in FIG. 3) is closed, the high-pressure section 127 of the "set" line 96 will still be isolated from the low-pressure section 124. Simultaneously, the hydraulic fluid contained in the forward pressure chambers of the piston actuators 39, 40, 43 and 44 will be displaced (as shown by the arrows as at 131) to the "retract" line 97 and returned to the reservoir 89 by way of the open solenoid valve 104. These actions will, of course, cause the wall-engaging member 38 as well as the sealing pad 41 to be respectively extended in opposite lateral directions until each has moved into firm engagement with the opposite sides of the borehole 11.

It will be noticed in FIG. 3 that hydraulic fluid will be admitted by way of branch hydraulic lines 132 and 133 to the enclosed annular chamber 53 to the rear of the enlarged-diameter portion 52 of the fluid-admitting member 45. At the same time, hydraulic fluid from the piston chamber 54 ahead of the enlarged-diameter portion 52 will be discharged by way of branch hydraulic lines 134 and 135 to the "retract" line 97 for progressively moving the fluid-admitting member 45 forwardly in relation to the sealing member 41 until the nose of the fluid-admitting member 45 engages the wall of the borehole 11 and then halts. The sealing pad 41 is then urged forwardly in relation the now-halted tubular member 45 until the pad sealingly engages the borehole wall for packing-off or isolating the isolated wall portion from the well bore fluids. In this manner, mudcake immediately ahead of the fluid-admitting member 45 will be displaced radially away from the nose of the fluid-admitting member so as to minimize the quantity of unwanted mudcake which will subsequently be admitted into the fluid-admitting means 20. Those skilled in the art will appreciate the significance of this unique arrangement.

It should also be noted that although the pressured hydraulic fluid is also admitted at this time into the forward piston chamber 66 between the sealing members 62 and 64 on the valve member 55, the valve member is temporarily prevented from moving rearwardly in relation to the inner and outer tubular members 45 and 46 inasmuch as the control valve 106 (not shown in FIG. 3) is still closed thereby temporarily trapping the hydraulic fluid in the rearward piston chamber 65 to the rear of the valve member. The significance of this delay in the retraction of the valve member 55 will be subsequently explained.

As also illustrated in FIG. 3, the hydraulic fluid in the low-pressure section 124 of the "set" line 96 will also be directed by way of a branch hydraulic line 136 to the piston actuator 86. This will, of course, result in the displacement piston 85 being elevated as the hydraulic fluid from the piston actuator is returned to the "retract" line 97 by way of a branch hydraulic conduit 137. As will be appreciated, elevation of the displacement piston 85 in the expansion chamber 84 will be effective for significantly decreasing the pressure initially existing in the isolated portions of the branch line 83 and the flow line 70 between the still-closed flow-line control valve 74 and the still-closed chamber control valves 75 and 76 (not shown in FIG. 3). The purpose of this pressure reduction will be subsequently explained.

Once the wall-engaging member 38, the sealing pad 41 and the fluid-admitting member 45 have respectively reached their extended positions as illustrated in FIG. 3, it will be appreciated that the hydraulic pressure delivered by the pump 87 will again rise. Then, once the pressure in the output line 90 has reached its second intermediate level of operating pressure, the control valve 106 will open in response to this pressure level to now discharge the hydraulic fluid previously trapped in the piston chamber 65 to the rear of the valve member 55 back to the reservoir 89.

As illustrated in FIG. 4, once the control valve 106 opens, the hydraulic fluid will be displaced from the rearward piston chamber 65 by way of branch hydraulic lines 138, 139 and 135 to the "retract" line 97 as pressured hydraulic fluid from the "set" line 96 surges into the piston chamber 66 ahead of the enlarged-diameter portion 61 of the valve member 55. This will, of course, cooperate to rapidly drive the valve member 55 rearwardly in relation to the now-halted fluid-admitting member 45 for establishing fluid or pressure communication between the isolated portion of the earth formation 12 and the flow passages 57 and 60 in the valve member by way of the filter screen 69. This unique flexibility of operation provided by the fluid-

admitting means **20** of the present invention is, of course, highly significant.

Although this is not fully illustrated in FIG. **4**, it will be recalled from FIGS. **2A** and **2B** that the control valves **74–76** are initially closed to isolate the lower portion of the flow line **70** between these valves as well as the branch line **83** leading to the pressure-reduction chamber **84**. However, the flow-line pressure-equalizing control valve **77** will still be open at the time the control valve **106** opens to retract the valve member **55** as depicted in FIG. **4**. Thus, as the valve member **55** progressively uncovers the filtering screen **69**, well bore fluids at a pressure greater than that of any connate fluids which may be present in the isolated earth formation **12** will be introduced into the upper portion of the flow line **70** and, by way of the flexible conduit member **71**, into the rearward end of the tubular member **58**. As these high-pressure well bore fluids pass into the annular space **67** around the filtering screen **69**, they will be forcibly discharged (as shown by the arrows **140**) from the forward end of the fluid-admitting member **45** for washing away any plugging materials such as mudcake or the like which may have become deposited on the internal surface of the filtering screen when the valve member **55** first uncovers the screen. Thus, the control system **15** is operative for providing a momentary outward surge or reverse flow of well bore fluids for cleansing the filtering screen **69** of unwanted debris or the like before a sampling or testing operation is commenced.

It will be appreciated that once the several components of the formation-testing tool **10** and the control system **15** have reached their respective positions as depicted in FIG. **4**, the hydraulic pressure in the output line **90** will again quickly increase to its next intermediate pressure level. Once the pump **87** has increased the hydraulic pressure in the output line **90** to this next predetermined intermediate pressure level, the control valve **105** will selectively open as depicted in FIG. **5A**. As seen there, opening of the control valve **105** will be effective for now supplying hydraulic fluid to the high-pressure section **127** of the "set" line **96** and two branch conduits **141** and **142** connected thereto for successively closing the control valve **77** and then opening the control valve **74**.

In this manner, as depicted by the several arrows at **143** and **144**, hydraulic fluid at a pressure representative of the intermediate operating level will be supplied by way of a typical check valve **145** to the upper portion of the piston cylinder **146** of the normally-open control valve **77** as fluid is exhausted from the lower portion thereof by way of a conduit **147** coupled to the "retract" line **97**. This will, of course, be effective for closing the valve member **82** so as to now block further communication between the flow line **70** and the well bore fluids exterior of the tool **10**. Simultaneously, the hydraulic fluid will also be admitted into the lower portion of the piston cylinder **148** of the control valve **74**. By arranging the biasing spring **81** for the normally-open control valve **77** to be somewhat weaker than the biasing spring **149** for the normally-closed control valve **74**, the second valve will be momentarily retained in its closed position until the first valve has had time to close. Thus, once the valve **77** closes, as the hydraulic fluid enters the lower portion of the piston chamber **148** of the control valve **74**, the valve member **150** will be opened as hydraulic fluid is exhausted from the upper portion of the chamber through a typical check valve **151** and a branch return line **152** coupled to the "retract" line **97**.

It will be appreciated, therefore, that with the tool **10** in the position depicted in FIG. **5**, the flow line **70** is now isolated from the well bore fluids and is in communication with the isolated portion of the earth formation **12** by way of the flexible conduit **71**. It will also be recalled from the preceding discussion of FIG. **3** that the branch flow line **83** as well as the portion of the main flow line **70** between the flow-line control valve **74** and the sample chamber control valves **75** and **76** were previously expanded by the upward movement of the displacement piston **85** in the reduced-volume chamber **84**. Thus, upon opening of the flow-line control valve **74**, the isolated portion of the earth formation **12** will be communicated with the reduced-pressure space represented by the previously-isolated portions of the flow line **70** and the branch conduit **83**.

Of particular interest to the present invention, it should be further noted that should the formation **12** be relatively unconsolidated, the rearward movement of the valve member **55** in cooperation with the forward movement of the fluid-admitting member **45** will allow only those loose formation materials displaced by the advancement of the fluid-admitting member into the formation to enter the fluid-admitting member. This is to say, the fluid-admitting member **45** can advance into the formation **12** only by displacing loose formation materials; and, since the space opened within the forward end of the fluid-admitting member by the rearward displacement of the valve member **55** is the only place into which the loose formation materials can enter, further erosion of the formation materials will be halted once the fluid-admitting member has been filled with loose materials as shown in FIG. **5B**. On the other hand, should a formation interval which is being tested be relatively well-compacted, the advancement of the fluid-admitting member **45** will be relatively slight with its nose making little or no penetration into the isolated earth formation. It will, of course, be appreciated that the nose of the fluid-admitting member **45** will be urged outwardly with sufficient force to at least penetrate the mudcake which typically lines the borehole walls adjacent to permeable earth formations. In this situation, however, the forward movement of the fluid-admitting member **45** will be unrelated to the rearward movement of the valve member **55** as it progressively uncovers the filtering screen **69**. In either case, the sudden opening of the valve **74** will cause mudcake to be pulled to the rear of the screen **69** to leave it clear for the subsequent passage of connate fluids.

As best seen in FIGS. **5A** and **5B**, therefore, should there by any producible connate fluids in the isolated earth formation **12**, the formation pressure will be effective for displacing these connate fluids by way of the fluid-admitting means **20** into the flow line until such time that the lower portion of the flow line **70** and the branch conduit **83** are filled and pressure equilibrium is established in the entire flow line. By arranging a typical pressure-measuring transducer, as at **153** (or, if desired, one or more other suitable transducers) in the flow line **70**, one or more measurements representative of the characteristics of the connate fluids and the formation **12** may be transmitted to the surface by a conductor **154** and, if desired, recorded on the recording apparatus **16** (FIG. **1**). The pressure measurements

provided by the transducer **153** will, of course, permit the operator at the surface to readily determine the formation pressure as well as to obtain one or more indications representative of the potential producing ability of the formation **12.** The various techniques for analyzing formation pressures as well known in the art and are, therefore, of no significance to understanding the present invention.

The measurements provided by the pressure transducer **153** at this time will indicate whether the sealing pad **41** has, in fact, established complete sealing engagement with the earth formation **12** inasmuch as the expected formation pressures will be recognizably lower than the hydrostatic pressure of the well bore fluids at the particular depth which the tool **10** is then situated. This ability to determine the effectiveness of the sealing engagement will, of course, allow the operator to retract the wall-engaging member **38** and the sealing pad **41** without having to unwittingly or needlessly continue the remainder of the complete operating sequence.

Assuming, however, that the pressure measurements provided by the pressure transducer **153** show that the sealing pad **41** is firmly seated, the operator may leave the formation-testing tool **10** in the position shown in FIGS. **5A** and **5B** as long as it is desired to observe as well as record the pressure measurements. As a result, the operator can determine such things as the time required for the formation pressure to reach equilibrium as well as the rate of increase and thereby obtain valuable information indicative of various characteristics of the earth formation **12** such as permeability and porosity. Moreover, with the new and improved tool **10,** the operator can readily determine if collection of a fluid sample is warranted.

Once the several components of the tool **10** and the control system **15** have moved to their respective positions shown in FIGS. **5A** and **5B,** the hydraulic pressure will again rise until such time that the "set" line pressure switch **101** operates to halt the hydraulic pump **87.** Inasmuch as the pressure switch **101** has a selected operating range, in the typical situation the pump **87** will be halted shortly after the control valve **77** closes and the control valve **74** opens. At this point in the operating cycle of the tool **10,** once a sufficient number of pressure measurements have been obtained, a decision can be made whether it is advisable to obtain one or more samples of the producible connate fluids present in the earth formation **12.** If such samples are not desired, the operator can simply operate the control switches **23** and **24** for retracting the wall-engaging member **38** as well as the sealing pad **41** without further ado. This freedom of action is, of course, possible by virtue of the flexibility of operation of the new and improved fluid-admitting means **20.**

On the other hand, should a fluid sample be desired, the control switches **23** and **24** (FIG. **1**) are advanced to their next or so-called "sample" positions **28** to open, for example, a solenoid valve **155** for coupling pressured hydraulic fluid from the high-pressure section **127** of the "set" line **96** to the piston actuator **156** of the sample chamber control valve **75.** This will, of course, be effective for opening the control valve **75** to admit connate fluids through the flow line **70** and the branch conduit **72** into the sample chamber **21.** If desired, a "chamber selection" switch **157** in the surface portion of the system **15** could also be moved from its "first sample" position **158** to its so-called "second sample" position **159** (FIG. **1**) to energize the solenoid valve **160** for opening the control valve **76** to also admit connate fluids into the other sample chamber **22.** In either case, one or more samples of the connate fluids which are present in the isolated earth formation **12** can be selectively obtained by the new and improved tool **10.**

Upon moving the control switches **23** and **24** to their so-called "sample-trapping" positions **29,** the pump **87** will again be restarted. Once the pump **87** has reached operating speed, it will commence to operate much in the same manner as previously described and the hydraulic pressure in the output line **90** will again begin rising with momentary halts at various intermediate pressure levels.

Accordingly, when the control switches **23** and **24** have been placed in their "sample trapping" positions **29,** the solenoid valve **99** will open to admit hydraulic fluid into the "retract" line **97.** By means of the electrical conductor **103***a*, however, the pressure switch **103** is enabled and the pressure switch **102** is disabled so that in this position of the control switches **23** and **24** the maximum operating pressure which the pump **87** can initially reach is limited to the pressure at the operating pressure level determined by the pressure switch **103.** Thus, by arranging the control valve **108** to open in response to a hydraulic pressure corresponding to this predetermined pressure level, hydraulic fluid in the high-pressure section **127** of the "set" line **96** will be returned to the reservoir **89** by means of the return line **94.** As the hydraulic fluid in the high-pressure section **127** returns to the reservoir **89,** the pressure in this portion of the "set" line **96** will be rapidly decreased to close the control valve **105** once the pressure in the line is sufficient to hold the valve open. Once the control valve **105** closes, the pressure remaining in the low-pressure section **124** of the "set" line **96** will remain at a reduced pressure which is nevertheless effective for retaining the wall-engaging member **38** and the sealing pad **41** fully extended.

As the hydraulic fluid is discharged from the lower portion of the piston actuator **156** by way of the still-open solenoid valve **155** and fluid from the "retract" line **97** enters the upper portion of the actuator by way of the branch line **161,** the chamber control valve **75** will close to trap the sample of connate fluids which is then present in the sample chamber **21.** Similarly, should there also be a fluid sample in the other sample chamber **22,** the control valve **76** can also be readily closed by operating the switch **157** to reopen the solenoid valve **160.** Closure of the control valve **75** (as well as the valve **76**) will, of course, be effective for trapping any fluid samples collected in one or the other or both of the sample chambers **21** and **22.**

Once the control valve **75** (and, if necessary, the control valve **76**) has been reclosed, the control switches **23** and **24** are moved to their next or so-called "retract" switching positions **30** for initiating the simultaneous retraction of the wall-engaging member **38** and the sealing pad **14.** In this final position of the control switch **24,** the pressure switch **103** is again rendered inoperative and the pressure switch **102** is enabled so as to now permit the hydraulic pump **87** to be operated at full rated capacity for attaining hydraulic pressures greater than the first intermediate operating level in the "retract" cycle. Once the pressure switch **103** has again

been disabled, the pressure switch **102** will now function to operate the pump **87** so that the pressure will now quickly rise until it reaches the next operating level.

At this point, hydraulic fluid will be supplied through the "retract" line **97** and the branch hydraulic line **147** for reopening the pressure-equalizing control valve **77** to admit well bore fluids into the flow line **70.** Opening of the pressure-equalizing valve **77** will admit well bore fluids into the isolated space defined by the sealing pad **41** so as to equalize the pressure differential existing across the pad. Hydraulic fluid displaced from the upper portion of the piston chamber **146** of the control valve **77** will be discharged through a typical relief valve **161** which is arranged to open only in response to pressures equal or greater than that of this present operating level. The hydraulic fluid displaced from the piston chamber **146** through the relief valve **161** will be returned to the reservoir **89** by way of the branch hydraulic line **141,** the high-pressure section **127** of the "set" line **96,** the still-open control valve **108,** and the return line **94.**

When the hydraulic pressure in the output line **90** has either reached the next operating level or, if desired, a still-higher level, pressured hydraulic fluid in the "retract" line **97** will reopen the control valve **107** to communicate the low-pressure section **124** of the "set" line **96** with the reservoir **89.** When this occurs, hydraulic fluid in the "retract" line will be admitted to the "retract" side of the several piston actuators **39, 40, 43** and **44.** Similarly, the pressured hydraulic fluid will also be admitted into the annular space **54** in front of the enlarged-diameter piston portion **52** for retracting the fluid-admitting member **45** as well as into the annular space **66** for returning the valve member **55** to its forward position. hydraulic fluid exhausted from the several piston actuators **39, 40, 43** and **44** as well as the piston chambers **54** and **66** will be returned directly to the reservoir **89** by way of the high-pressure section **124** of the "set" line **96** and the contron valve **107.** This action will, of course, retract the wall-engaging member **38** as well as the sealing pad **41** against the tool body **18** to permit the tool **10** to be either repositioned in the well bore **11** or returned to the surface if no further testing is desired.

It should be noted that although there is an operating pressure applied to the upper portion of the piston cylinder **148** for the flow-line control valve **74** at the time that the control valve **77** is reopened, a normally-closed relief valve **162** which is paralleled with the check valve **151** is held in a closed position until the increasing hydraulic pressure developed by the pump **87** exceeds the operating level used to retract the wall-engaging member **38** and the sealing pad **41.** At this point in the operating sequence of the new and improved tool **10,** the flow-line control valve **74** will be reclosed.

The pump **87** will, of course, continue to operate until such time that the hydraulic pressure in the output line **90** reaches the upper limit determined by the setting of the pressure switch **102.** At some convenient time thereafter, the control switches **23** and **24** are again returned to their initial or "off" positions **25** for halting further operation of the pump motor **88** as well as reopening the solenoid valve **104** to again communicate the "retract" line **97** with the fluid reservoir **89.** This completes the operating cycle of the new and improved tool **10.**

Accordingly, it will be appreciated that the fluid-admitting means **20** of the present invention enable the new and improved tool **10** to be selectively operated as required for meeting any situation which may be reasonably expected to occur during a formation-testing operation. For example, with the formation-sampling apparatus disclosed in U.S. Pat. No. 3,653,436, once operation of the tool shown there is initiated, further sampling operations cannot be conducted with removing the tool and reconditioning various components thereof. This is, of course in clear contrast to the versatility permitted by the selectively-operable fluid-admitting means **20** of the present invention and the new and improved tool **10.**

While only a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects; and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. Formation-testing apparatus adapted for suspension in a borehole traversing earth formations and comprising:

a body having a first fluid passage adapted to receive connate fluids;

fluid-admitting means on said body and including a fluid-sampling member having a tubular forward portion adapted to be engaged with a borehole wall for isolating a surface thereof from well bore fluids;

means selectively operable for positioning said fluid-sampling member against a borehole wall to establish communication with earth formations therebeyond;

first means adapted for limiting the entrance of plugging materials into said first fluid passage including a second fluid passage in said fluid-sampling member and coupled to said first fluid passage, and filtering means cooperatively arranged on a wall of said fluid-sampling member between said second fluid passage and with tubular forward portion for retaining plugging materials within said fluid-sampling member as filtered connate fluids pass through said filtering means and enter said second fluid passage;

second means adapted for controlling the entrance of plugging materials and connate fluids into said fluid-sampling member and including a valve member coaxially arranged in said fluid-sampling member for movement between an advanced position within said tubular forward portion blocking communication into said fluid-sampling member and a retracted position to the rear of said tubular forward portion for uncovering said filtering means and defining a space for receiving plugging materials entering said tubular forward portion; and

valve-control means cooperatively arranged for selectively moving said valve member back and forth between its said advanced and retracted positions.

2. The formation-testing apparatus of claim **1** wherein said second fluid passage includes an annular chamber formed around an intermediate interior wall portion of said fluid-sampling member between said advanced and retracted positions of said valve member; and said filtering means include a tubular screen coaxi-

ally mounted in said fluid-sampling member around said annular chamber.

3. The formation-testing apparatus of claim 1 further including:

sealing means cooperatively arranged on said fluid-admitting means around said tubular forward portion and adapted for packing-off a borehole wall around said tubular forward portion.

4. The formation-testing apparatus of claim 1 further including:

means cooperatively mounting said fluid-sampling member on said body for movement relative thereto between a laterally-extended position and a retracted position; and

control means cooperatively arranged for selectively moving said fluid-sampling member back and forth between its said extended and retracted positions.

5. The formation-testing apparatus of claim 1 further including:

sample-receiving means on said body and adapted for receiving filtered connate fluids entering fluid passages; and

control means cooperatively arranged for selectively coupling said sample-receiving means to said first fluid passage.

6. Formation-testing apparatus adapted for suspension in a borehole traversing earth formations and comprising:

a body having a chamber adapted to receive connate fluids;

fluid-admitting means on said body and including a tubular fluid-sampling member having a forward portion adapted to be engaged with a borehole wall for isolating a surface thereof from well bore fluids and receiving connate fluids from earth formations therebeyond;

means selectively operable for positioning said fluid-sampling member against a borehole wall and including first piston means cooperatively arranged on said body for movement between a first position to engage said fluid-sampling member with a borehole wall and a second position to disengage said fluid-sampling member from a borehole wall;

means coupling said fluid-sampling member to said chamber and including fluid-passage means between said chamber and an intermediate portion of said fluid-sampling member, and filtering means cooperatively arranged on said intermediate portion of said fluid-sampling member for limiting the entrance of loose materials into said fluid-passage means;

means for controlling the admission of connate fluids and loose materials into said fluid-sampling member and including a valve member coaxially arranged in said fluid-sampling member for movement between an advanced position in said forward portion for blocking communication into said fluid-sampling member and a retracted position to the rear of said intermediate portion for exposing said filtering means, and second piston means cooperatively coupled to said valve member and adapted for movement between a first position to place said valve member in its said advanced position and a second position to place said valve member in its said retracted position; and

control means cooperatively coupled to said first and second piston means for selectively moving said first and second piston means back and forth between their respective positions.

7. The formation-testing apparatus of claim 6 further including:

pressure-monitoring means for providing indications at the surface indicative of the pressure of connate fluids in said chamber.

8. The formation-testing apparatus of claim 6 further including:

valve means in said fluid-passage means and cooperatively coupled to said control means for selectively entrapping connate fluids in said chamber.

9. The formation-testing apparatus of claim 6 further including:

a wall-engaging member movably mounted on said body on the opposite side thereof from said forward portion of said fluid-sampling member and cooperatively coupled to said first piston means for movement thereby between an extended wall-engaging position and a retracted position against said opposite body side.

10. The formation-testing apparatus of claim 6 further including:

means cooperatively coupling said fluid-sampling member to said body for movement relative to one side thereof between a laterally-extended position and a retracted position; and

means cooperatively coupling said fluid-sampling member to said first piston means for movement thereby between its said laterally-extended position and its said retracted position upon movement of said first piston means between said first and second positions thereof.

11. The formation-testing apparatus of claim 10 further including:

a wall-engaging member movably mounted on said body on the opposite side thereof and cooperatively coupled to said first piston means for movement thereby between an extended wall-engaging position and a retracted position against said opposite body side upon movement of said first piston means between said first and second positions thereof.

12. Formation-testing apparatus adapted for suspension in a borehole traversing earth formations and comprising:

a body having a chamber adapted to receive connate fluids;

fluid-admitting means on said body and including a tubular fluid-sampling member cooperatively arranged for lateral movement in relation to said body between retracted and extended positions, fluid-passage means between said fluid-sampling member and said chamber, a tubular filter coaxially arranged on said fluid-sampling member covering said fluid-passage means for limiting the entrance of loose materials into said fluid-passage means, and first piston means coupled to said fluid-sampling member and cooperatively arranged for moving said fluid-sampling member back and forth between its said retracted and extended positions;

means for controlling the admission of connate fluids and loose materials into said fluid-sampling member and including a valve member coaxially disposed in said fluid-sampling member and cooperatively arranged for movement through said tubular filter between an advanced closed position where

said valve member is substantially sealingly engaged with the forward portion of said fluid-sampling member ahead of said tubular filter and a retracted open position to the rear thereof where said tubular filter is in communication with said forward portion, and second piston means coupled to said valve member and cooperatively arranged for moving said valve member back and forth between its said open and closed positions; and

control means cooperatively arranged for selectively operating said first and second piston means to move said fluid-sampling member and said valve member between their respective said positions.

13. The formation-testing apparatus of claim **12** further including:

a wall-engaging member movably mounted on said body on the opposite side thereof from said fluid-admitting means and cooperatively arranged for movement between a retracted position against said opposite body side and an extended wall-engaging position for urging said fluid-admitting means against a borehole wall; and

third piston means cooperatively coupled to said wall-engaging member and said control means for selectively moving said wall-engaging member between its said retracted and extended positions.

14. The formation-testing apparatus of claim **12** wherein said fluid-admitting means further include:

packoff means cooperatively mounted on said body and around said forward portion of said fluid-sampling member for establishing sealing engagement with a borehole wall to isolate said forward portion of said fluid-sampling member from borehole fluids.

15. The formation-testing apparatus of claim **14** further including:

a wall-engaging member movably mounted on said body on the opposite side thereof from said fluid-admitting means and cooperatively arranged for movement between a retracted position against said opposite body side and an extended wall-engaging position for urging said fluid-admitting means against a borehole wall; and

third piston means cooperatively coupled to said wall-engaging member and said control means for selectively moving said wall-engaging member between its said retracted and extended positions.

16. The formation-testing apparatus of claim **14** further including:

means including a movable member cooperatively coupling said packoff means and said fluid-sampling member to said body for movement relative to one side thereof between a laterally-extended position and a retracted position; and

third piston means cooperatively coupled to said movable member and said control means for selectively moving said movable member between its said retracted and extended positions.

17. The formation-testing apparatus of claim **16** further including:

a wall-engaging member movably mounted on said body on the opposite side thereof from said fluid-admitting means and cooperatively arranged for movement between a retracted position against said opposite body side and an extended wall-engaging position for urging said fluid-admitting means against a borehole wall; and

fourth piston means cooperatively coupled to said wall-engaging member and said control means for selectively moving said wall-engaging member between its said retracted and extended positions.

18. The formation-testing apparatus of claim **17** wherein said control means are cooperatively arranged for operating said third and fourth piston means in unison.

19. The formation-testing apparatus of claim **16** wherein said forward portion of said fluid-sampling member projects outwardly beyond said packoff means in said retracted position of said fluid-sampling member for engaging a borehole wall in advance of said packoff means.

20. The formation-testing apparatus of claim **12** further including:

pressure-monitoring means for providing indications at the surface indicative of the pressure of connate fluids in said chamber.

21. The formation-testing apparatus of claim **12** further including:

valve means in said fluid-passage means and cooperatively coupled to said control means for selectively entrapping connate fluids in said chamber.

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