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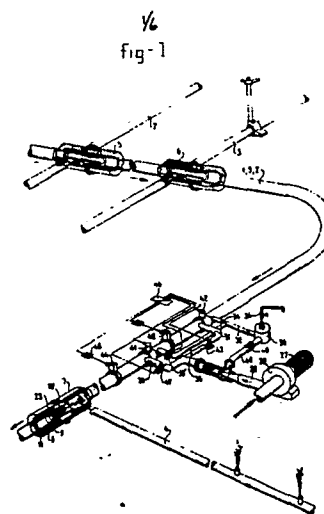
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(64) A distribution device for a fluid such as water.

(57) A distribution device for a fluid, particularly for water, comprising a main conduit (1) communicating with outlet members each adapted to be individually closed by a valve (5,6,7), and a plug body (10) adapted to move through the conduit (1) for opening and closing said valve (5,6,7) for a period of time depending upon the retention time of the plug body (10) at a valve (5,6,7), wherein said plug body (10) and each valve station (5,6,7) have mutually co-operating means for determining the opening period of each valve (5,6,7), including means for the optional adjustment of said period of time individually for each valve (5,6,7).



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TITLEA distribution device for a fluid such as water.

The invention relates to a distribution device, particularly for water, comprising a main conduit communicating with outlet members each adapted to be individually closed by a valve and a plug body adapted
5 to move through the conduit for opening and closing said valve for a period of time depending upon the retention time of the body at a valve. Such a distribution device is disclosed in French patent specification 2.088.763 as a raining system.

- 10 Opening and closing of successive valves in the conduit is performed by causing a ball to circulate in said conduit, in which the period of time for which a valve remains open and the period of time elapsing between the actuation of successive valves are dependent upon the
15 circulation speed of the ball in the conduit. A disadvantage of the known device is that each valve is opened for the same period of time. When the device is employed as a raining system, this means that each area to be sprinkled receives the same quantity of water.
- 20 Particularly in the case of an extensive distribution mains this is not acceptable, since frequently different kinds of crop have to be rained upon, which each require a different quantity of water. Therefore, such systems cannot be used especially in arid areas, where only a
25 small quantity of water is available. Another disadvantage is that in this known system the opening time for each

valve is liable to vary unreliably by accidental differences in resistance for the ball at each valve.

5 The invention has for its object to obviate said disadvantages. According to the invention this is achieved in that the body and each valve station comprise mutually cooperating means for determining the opening period of each valve in said valve stations, including means to adjust said opening period individually for each valve. In one embodiment the plug body comprises radially expandable means and each valve station comprises actuation means extending partly into the path of the plug body to be contacted by said radially expandable means for opening the valve in each valve station by the pressure of the fluid in the main conduit acting on said plug body, and 10 means for radially contracting said expandable means, governed by said opening period determining means to allow the plug body to leave the valve station and to move to a next station.

20 The control of the valve may be achieved by the action of an electro-magnetic field. The plug body or each valve station may comprise a programmable memory for determining the opening period of each valve station. The plug body may furthermore comprise an address counter whose contents are incremented by one at each outlet member, whilst the memory location is selected and read 25 on the basis of the state of the address counter.

30 The conveying conduit is preferably a ring conduit with a closed circuit in which the body is propagated by the pressure of the liquid or other fluid to be distributed. A liquid reservoir may communicate with the ring conduit for temporarily storing the liquid pushed on by the body, the liquid being withdrawn from said reservoir to be fed to the main conduit again in a later stage.

35 This invention also relates to particular embodiments of the general idea given above, which will become apparent from the following description of several prefer-

red embodiments shown in the attached drawings and from the appended claims. The electric source of the body may be formed by a battery and/or a generator driven by the fluid pressure in the plug body.

5 The invention will be described more fully with reference to the drawing showing one embodiment. In the drawing:

Fig. 1 is a perspective view of part of a ring conduit mains with distribution ducts communicating there-
10 with;

Fig. 2 is a somewhat diagrammatic longitudinal section of the ring conduit and the plug body moving therein in a valve station in a first embodiment;

Fig. 3 shows a longitudinal section as Fig. 2 but of
15 a different embodiment;

Fig. 4 is a block diagram of part of the control-circuitry and of means for programming the control-memory;

Fig. 5 is a block diagram of the control-circuitry;

Fig. 6 shows a longitudinal section through a plug
20 body according to the invention in a different embodiment, present in a valve in the conduit;

Fig. 7 shows a longitudinal section through such a body in a further embodiment;

Fig. 8 shows a transverse section through the body of
25 Fig. 7 in a plane through the line VIII-VIII in Fig. 7;

Fig. 9 shows a longitudinal section through another embodiment of such a body according to the invention, and

Fig. 10 shows a transverse section along the line X-X in Fig. 9.

30 The ring conduit 1 of Fig. 1 extends in a closed loop and communicates with a plurality of distribution ducts 2, 3 and 4. The path from the ring conduit to the distribution ducts can be blocked by means of valves at stations 5, 6 and 7. The valves are formed by tubular valve bodies adapted to slide in the ring conduit across the outlet
35 opening from conduit 1 to the distribution duct 2, 3 or 4.

to be described in more detail below.

Each valve body 8 has an inwardly directed annular portion 9 (Fig. 2). A plug body 10 is movable in and through conduit 1. When this body 10 reaches a station 5, 6 or 7, it enters a valve body 8 and pushes it towards the open position, being the top position in Fig. 2, since the plug body 10 has a portion 12 of larger diameter such that the plug body cannot move past the annular part 9. Pushed by the fluid pressure in conduit 1, the valve body 8 is thus moved into the top position of Fig. 2 up to the stop 11. The portion of larger diameter of the plug body 10 is formed by an expandable, flexible envelope 12. The envelope 12 expands radially because the duct 13 establishes an open communication between the interior thereof and a hydro-accumulator 14. The hydro-accumulator 14 comprises a reservoir of a fluid pressurized by a piston 17 biased by the tension spring 16. The duct 13 includes a valve 18. The bias pressure on the piston 17 is chosen so that the envelope 12 constantly engages the inner side of the duct 1 or the valve body 8. The pushing power of the fluid in the conduit 1 is such that at a constriction of the conduit as at 9 the envelope is compressed and the fluid is pressed back towards the accumulator provided, of course, the valve 18 is open. The plug body 10 is thus able to pass this constriction 9.

The valve 18 can be closed by means of an electric signal. This signal emanates from an electro-magnetic signal generator 25 disposed close to a valve and surrounding the conduit. The valve 18 is actuated by means of the electro-magnetic coil 22. The plug body 10 includes a memory 24 having an address counter. The memory may have a plurality of locations, for example 100, in which a defined, coded time interval is stored. When the signal generator formed by the magnet ring 25 is passed by, it supplies the starting signal for building up the magnetic field, whilst at the same time the address counter is

incremented by one. Moreover, a time generator is started, which counts the encoded time interval of the memory location concerned.

5 The plug body 10 may be energized by a battery 62 or, as the case may be, from a generator 26 shown diagrammatically, with a driving propeller 80 rotated by the stream of fluid. The memory may be programmed from the outer side of the plug body 10 by actuating appropriate control-members. In this way a time interval for the opened condition can
10 be selected for each memory location or valve.

When the magnetic field disappears at the termination of the energization of the coil 22, valve 18 is opened, the plug body 10 is moved on by the fluid pressure, since the envelope 12 can again be compressed by annular part 9,
15 so that the fluid flows back through the duct 13. Under the action of the spring 23 the valve body moves downwardly as seen in Fig. 2 and the duct 4 is blocked. In this way the identical valves 5, 6 and 7 and possibly other such valves are actuated in order of succession so that
20 each time one of the distribution ducts receives fluid such as water whilst the other ducts are closed.

Fig. 3 shows an embodiment in which two expandable members 50 and 51 are provided instead of one. These members are annular inflatable envelopes 50 and 51, which
25 engage, in the expanded state, a stop formed by the edge 52 of the annular recess 53 of the valve body 81. The envelopes 50 and 51 communicate through ducts 82 with the hydro-accumulators 54 and 55. Each duct 82 can be closed by means of a valve 83, actuated electro-magnetically by a
30 signal generator 56 in the memory means. The signal generator 56 supplies a signal when the pistons 57 and 58 in the hydro-accumulators have performed a predetermined stroke. This occurs when the envelopes 50 and 51 are allowed to expand strongly when a distribution duct is
35 passed by offering the rather wide annular recess 53. The pistons 57 and 58 each actuate a relay 59 and 60 respectively.

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ively. When the two relays are energized, the signal generator in the memory 56 applies a pulse to the coils 70 and 71 so that the two valves 83 are simultaneously closed. After the termination of the retention time a
5 second pulse is supplied for opening these valves.

It should be noted that it is also possible to programme a retention time zero in the memory. In this case, when the concerning valve station 5, 6 or 7 is passed by, no signal is applied to and no force is applied on the
10 valve control. The plug body moves past the valve without causing the opening thereof and so there is no distribution of water or the like at this station.

The water or the like is supplied, for example, (Fig. 1), through the supply duct 29 by means of a pump 28
15 driven by a motor 27. The supply duct splits up into two branches 30 and 31, which can supply water to the ring conduit 1 at relatively spaced points. The ring conduit furthermore communicates with an outlet duct 32, which can withdraw water from the ring conduit 1 by means of the
20 branch lines 33 and 34 at two points. The duct 32 is connected with the reservoir 35 including a safety valve or relief valve 36 for allowing an excess quantity of water and air to escape therefrom. In this reservoir there may be means not shown to avoid air from being fed there-
25 from into the system through duct 40. During its travel through the ring conduit the plug body pushes the water in front of it and the water is temporarily stored in the reservoir 35. Through the duct 40 the outlet side of the reservoir communicates with the supply duct 29 by a
30 suitable injector as shown. At the connecting points of the supply ducts 30 and 31 valves 41 and 42 are provided. The ducts 30 and 31 can be closed by the magnetic valves 43 and 47. Viewed in the direction of travel of the plug body 10, which is from left to right in the top of Fig. 1
35 and from the right hand upper part to the left hand lower part in the remainder of Fig. 1, the switch 44 is disposed

in front of the supply duct 30, which switch can actuate the relay 46 through a coil 45, which relay can actuate the valves 41 and 42 as well as the valve 47 in the duct 30 and the valve 43 in the duct 31. In the position of the plug body 10 (in the valve station 7) shown in Fig. 1 the valve 41 is closed and the valve 42 is opened, the valve 47 is opened and the valve 43 is closed. This means that during the travel of the plug body 10 by the water supplied by the duct 30 into the ring conduit the water displaced in front of the body 10 is conveyed through the outlet ducts 33 and 34 towards the reservoir 35. When the switch 48 is passed by body 10, relay 46 is actuated as a result of which the valve 41 is opened, the valve 42 is closed and a valve 33' in duct 33 is closed. Moreover, the valve 43 is opened and the valve 47 is closed. The water supplied flows on through the duct 31 to the back of the plug body 10, so that this is conveyed further and the water pushed out in front of the body is conveyed through the duct 34 towards the reservoir 35. As soon as the plug body 10 continuing its movement then passes the switch 44, the relay 45 is actuated through the coil 45 so that the valve 41 is closed and the valves 42 and 33' are opened. Moreover, the valve 47 opens and the valve 43 closes so that the water supplied is again supplied through the duct 30 to the ring conduit 1 and the water pushed out in front of the body 10 is supplied through the ducts 33 and 34 to the reservoir 35. Subsequently the plug body arrives at the valve station 7, where the valve body 8 is thus opened, while the further valves in the ring conduit 1 remain closed. The pumped water is thus now supplied to the distribution duct 4.

An embodiment of a combined programming-unit/delay-unit (see Figs 4 and 5) constitutes a system by which some hundred delay times can be stored in a digital memory for subsequent use in a fixed order of succession and dependence upon given conditions. The delay periods may be

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freely chosen between zero and 99 minutes. Obviously systems with other ranges of delay periods can be used instead.

5 The programming unit supplied from the electric mains comprises the circuits by which all the memory positions can be written or read, an accumulator charging device for the delay unit and circuits for the data transmission from and towards the delay unit. The delay unit is fed from a built-in voltage source, preferably an accumulator and
10 comprises apart from the delay time generator with its corresponding control-circuits a Charging Current Regulator 128, a Battery Check 127, one or two Solenoid Drivers 132 (depending upon the design), a Ring Magnet Position Detector 130, a Programmed Delay Memory 133 for storing in each
15 address one of the possible 100 delay digits, data-transmission- and control-circuits.

Programming Unit (Fig. 4):

By means of the Address thumb wheel switches 100 and 101 an address is supplied and one memory location in the
20 delay unit is selected, whose contents have to be become known. At the end of a delay period of $\frac{1}{2}$ to 1 second after the setting of the thumb wheel switches, the Number Change Detector 102 applies a trigger signal to the Controller 103 in order to start a read cycle, by which through the
25 transmission circuits a memory address is serially applied to the Delay Unit (Fig. 5), which responds by transmitting back the memory contents (i.e. the stored delay time). This information appears on the Delay Displays 104 and 105, leaving the information in the memory unchanged. If it is
30 desired to change the information at the selected memory location the desired delay time is set on the Delay thumb wheel switches 106 and 107 and the Write contact 108 is closed. During the subsequent write cycle the information at the relevant memory location is replaced by the new
35 selected delay time. For data transmission purposes a parallel-series/series-parallel shiftregister 109 is used

to convert eight parallel supplied bits into a serial information burst of eight bits and vice versa. The input signals from the thumb wheel switches are supplied to a Multiplexer 110, which converts the total of 16 input bits (4 x 4) into 2 x 4 output bits. The transmission clock signal is indirectly derived from the Transmission Oscillator 111. The entire unit is governed by the Controller 103.

The coupling of the Programming Unit (Fig. 4) and the Delay Unit (Fig. 5) is established by means of two transmitter/receiver units, for instance containing LED photo-diode pairs 112, 113, 114, 115, 116, 117, 118, 119 and 120, 121. Only the charging circuit supplying a d.c. charging current for the batteries can be connected through a direct lead.

Delay Unit (Fig. 5):

The Delay Unit has two operating modes:

1. a programming mode during which the stored information in the memory can be read or new information can be stored with the aid of the programming unit;
2. a delay mode during which control-signals are generated to solenoid drivers depending on the programmed delay times, the position of the ring magnet, the accumulator voltage and the like.

In the programming mode the delay unit (Fig. 5) is mechanically coupled with the programming unit (Fig. 4). If the coupling is correct, this is detected in the delay unit by means of the "programmer attached and ready" switch 122, after which the programming mode is automatically selected.

The data transmission from and to the delay unit is controlled by the programming unit by means of the clock signal, the read/write signal and stroke signal. The controller 123 interprets the received information and supplies internal control-signals. In the delay mode the desired delay time is selected in that the parallel load

counter 124, the contents of which is incremented by 1 at each station by means of an instruction "select next delay time" (address inc. clock). At each address a parallel load delay counter 125 is loaded with the contents of said address, and after that the minutes generator 126 receives a start instruction and delivers 1 minute clock pulse to the delay counter, the contents of which is stepped down to zero. When the zero state is reached, the delay time has elapsed.

Battery check circuit 127 supplies information to the controller 123 about the loading state of the accumulator 131 and the charging current regulator 128 indicates whether the generator 129 supplies sufficient current and the ring magnet detector 130 provides a position indication of the ring magnet. The solenoid driver 132 controls the electro-mechanical converters.

The programming unit can be positioned in one of the valve stations. As soon as the plug body reaches this station the operator is able to change the delay times stored in the memory unit if necessary. The coupling between the programming unit in the station and the delay unit in the plug body is realized by the transmitter/receiver unit 140 in the programming unit and the transmitter/receiver unit 142 in the plug body (see Figs 4 and 5). Although in the Figs 4 and 5 light emitting diodes and photo-sensitive diodes are used in this transmitting/receiving unit it will be clear that also other means like ultrasonic transducers or electromagnetic transducers can be used instead of these diodes.

According to a further embodiment of the invention photo-sensitive cells are positioned on the outside of the plug body, and in at least one of the valve stations the conveying conduit is replaced by a tube section of light transparent material. During the period the plug body is retained in said station equipped with said light transparent tube section light from the environment is trans-

mitted through said light transparent tube section and received by the photocells. The current delivered by these photocells can be used for recharging the batteries in case the generator doesnot generate a sufficient charging
5 current or in case the plug body is not equipped with a generator at all.

In the embodiment shown in Fig. 6 there is again a duct 1 with a valve body 8 controlling an opening to a distribution duct such as 4 and a spring 23 tending to
10 close this opening. The valve body again has an annular part 9 protruding inwardly.

The plug body 10 has a head 133 filled with a pressure fluid such as water. The interior is in communication, by a duct 136, with a bellows 137 acting as an accumulator
15 and kept under pressure by a spring 138. Between duct 136 and bellows 137 there is a disc spring valve 84, operated by a solenoid 85. Spring 138 presses on bellows 137 through a disc 86 having a cilindrical sleeve 87 with a magnet ring 88 cast therein. At 89 there is an annular print connected
20 in a circuit to solenoid 85. The operating current is supplied by a battery 90, charged by generator 91, energized when propeller 90 is rotated by the fluid in duct 1. A rubber sealing ring 92 surrounds the plug body 10.

If this plug body, moved by liquid pumped through
25 duct 1 by pump 28, reaches this valve body 8, the head 133 is withheld by annular part 9 and the plug body 10 thus takes valve body 8 with it to the left, thus opening duct 4 for distributing fluid from duct 1 through duct 4 to one or more discharge points therein. The resistance offered by
30 spring 23 on valve body 8 and thus on plug body 10 gives some compression of head 133 and some flow of the liquid therein through duct 136 along disc valve 84 to bellows 137. This pushes disc 86 to the right until magnet ring 88 reaches a position opposite a reed contact mounted onto the
35 print 89, which causes an energizing of solenoid 85 to close valve 84. Further compression of head 133 is thus avoided

and head 133 is thus kept in place in the annular part 9 as shown to move valve body 8 further to the left into the fully open position as shown. As soon as the delay unit on print 89 gives a signal that the opening time for this particular valve body 8 has lapsed, it de-energizes solenoid 85 so that disc valve 84 opens by its own elasticity. The fluid from head 133 is now further pushed out therefrom by the forces acting thereon, the pushing force of the fluid in duct 1 from the right and the withholding and compressing action of annular part 9 to the right and inwardly, so that head 133 will soon be allowed to pass through the interior of part 9. Plug body 10 thus leaves this station, valve body 8 is closed by spring 23 and bellows disc 86 with magnet ring 88 return to their normal position.

In the electric circuit a signal may be derived from generator 91 to allow this normal operation only if, after opening valve body 8, there is sufficient flow in duct 1 to rotate propeller 80 sufficiently to generate a minimum voltage in generator 91. If this voltage is not reached in a predetermined time, e.g. in 30 seconds, solenoid 85 is not (or no more) energized. The circuit may be such that, if the fluid pressure is restored in duct 1, the normal sequence is continued where it was interrupted, or solenoid 85 is no more energized and the plug body 10 is allowed to leave this valve body 8 and move to the next valve station.

In Figs 7 and 8 a plug body 10 is shown adapted to move in both directions. It has, as the plug body of Fig. 6, a propeller 80, a generator 91, a battery 90, a printed circuit etc. 89, and a solenoid 85 operating disc spring valve 84. A magnetic coupling 93 connects propeller 80 to generator 91. Contrary to what is the case in Fig. 6, solenoid 85 when energized opens valve 84 by lifting its central disc from a seat nipple 94.

The valve body 8 in this case operates two sets of openings 4' and 4" to discharge lines 4, which may, how-

ever, be united to lead to a common discharge line. Valve body 8 has two springs 23 and 23', tending to keep it in a central position in which all the openings 4' and 4" are closed. At both ends this valve body 8 has a conical end face cooperating with a stop edge 11 at the left and 11' at the right, formed as a transition from a narrower to a wider cylindrical part of duct 1 in the concerning station. A wider part 53 in valve body 8 is adapted to take up protruding fins 95 to be described in more detail in order to stop and be moved by plug body 10. This body has sealing rings 96 and 97 to both sides of fins 95. A slidable disc 98 is prevented from rotation by keyways 98' and carries a short worm 99 engaging the worm thread within a rotating body 200, taking up in a diametrical slot 201 three rollers 202. The disc 98 has a central pin 203 carrying a hollow piston 204 movable sealingly in cylinder 205 and taking up in its center a stud 206 of a casing 207. The nipple 94 gives fluid connection to a central bore 208 through casing 207, opening in piston 204. Pin 203 has a bore 209 extending from its left front face in piston 204 to openings in its outer surface. A spring 210 urges disc 98 to the right. Bore 208 has a branch bore 211 with a ball check valve 212, opening in the space 213 within cylinder 205. A further bore 214 extends between the space around nipple 94 and space 213. A pressure operated switch 215 moves a magnet 216 if put under fluid pressure from outside. Piston 204 carries a magnet ring 217.

In valve body 8 there are one or more slots or grooves 218 at the left hand transition from the narrower bore therein to the wider part 53.

The operation of this embodiment is as follows. If from pump 28 (Fig. 1) water or other fluid to be distributed is pumped into duct 1, it pushes the plug body 10 forward, say from left to right in Fig. 7. As soon as this body 10 reaches a valve body 8, sealing ring 97 passes groove 218 when reaching widened part 53. The pressure of

the fluid between sealing rings 96 and 97 thus drops to the level of the pressure in front of (to the right of) the plug body. This makes disc 98 tend to move to the right by spring 210, tending to rotate body 200 by worm 99. As long as fins 95 have not reached the widened part 53 to a sufficient extent, body 200 remains in the position 219 of Fig. 8 with the rollers 202 pushing against inner edges of the fins 95. As soon as fins 95 have sufficiently reached this part 53, body 200 now becomes free to be rotated by worm 99 to the position of Fig. 6 while pushing these fins outwardly. Disc 98 moves to the right, to the position shown in Fig. 7, and this places magnet ring 217 opposite a reed contact on printed circuit 89 to start the counting sequence to keep body 10 in valve body 8 during the desired time interval. The plug body is pushed on to the right, until the fins contact the right end of the widened part 53 and it is then pushed on, taking the valve body with it to the right until duct 4' is fully opened. During this movement of the plug body the back sealing ring 96 reaches the zone of the groove(s) 218 and the front sealing ring 97 leaves the widened part 53 and gives sealing of the plug body in that area. The fluid pressure from the left, in the ^{conduit} main reaches the space between rings 96 and 97 through groove 218 and enters the plug body through bore 221. As disc 98 has pin 203, the total force from the right, by pressure on the full front face of said disc with worm 99, becomes higher than the force from left to right on this body, but it cannot move to the left as liquid left of piston 204 is entrapped in space 213 and between stud 206 and pin 203.

As soon as ^asignal is received from the delay unit on print 89 indicating that the opening time of 4' has lapsed, the solenoid 85 is energized thereby, opening disc valve 84. Disc 98 is now allowed to move to the left by the said resultant force to the left on disc 98 as liquid may now flow from left to right of piston 204 through bores 214,

208 and 209. This movement from right to left rotates body 200 to bring slot 201 with rollers 202 back to position 219, so that fins 95 are pushed inwardly by the right hand edge of wider part 53 and plug body 10 is again moved on
5 through duct 1, valve body 8 closing openings 4' by spring 23'.

Duct 211 with ball check valve 212 serve to allow overflow of such liquid from right to left of piston 204 when disc 98 moves to the right.

10 A pressure switch 215 is provided, operated by the pressure of the fluid in duct 1, which reaches this switch through groove(s) 218. If compressed it moves a small magnet 216 operating a reed contact on the print 89, to allow energizing or continued energizing of solenoid 85
15 only if there is sufficient pressure in duct 1.

If the pressure in duct 1 operates from right to left, essentially the same occurs. The only differences are that the fins 95 contact the left hand end of wider part 53 of valve body 8 and opens it to the left, liberating ports 4",
20 that the fluid in duct 1 reaches pressure switch 215 by flowing around sealing ring 97 and propeller 80 is not rotated. In this case the station at the pump 29 (Fig. 1) should be changed to switch from pumping fluid into one end of the duct into discharging from this end to a reservoir
25 like 35 and from discharging from the duct at the other side of this station to pumping fluid into this other end, which may easily be done by hand or automatically with the same valves as already present therein in Fig. 1 or by more simple means.

30 It is ^{to be} remarked that, if the compressible heads or bodies 12 of Fig. 2 and 133 of Fig. 6 would be made sufficiently elastic and the correct pressures of springs or elastic properties of bellows or accumulators such as 14 in Fig. 2 and 137 in Fig. 6 would be chosen, such plug
35 bodies may well cooperate with a valve body 8 as given in Figs 3, 7 and 8, having a widened part 53 instead of a

narrower part 9.

In Figs 9 and 10 a valve station with plug body 10 in it are shown, intended to have the plug body 10 move in one direction only. In a widened part 224 of duct 1 there is a
5 helical groove 225 terminating in an axial groove part 226, which at its end merges gradially into the duct 1 again, i.e. becomes gradually more shallow. The plug body 10, having a propeller 80, generator 91 and in this case no battery, has a radially outwardly movable pin 227 urged
10 outward by a spring 228.

The valve body 8 is longer than in the previous embodiments, is urged by spring 23 to the left and is urged to the right by fins 95 contacting terminal edge 229 of said valve body. These fins are radially movable and
15 kept in their outward position by rollers 230 in body 231. This body 231 is united with piston 232 and is urged to the left by a leaf spring 233.

Solenoid 85 operates, if energized, disc valve 84 which is closed in its unloaded condition. Printed circuit
20 89 with reed contacts etc. is energized by generator 91 and adapted to energize solenoid 85. Bores 234 and 235 extend through the plug body, bore 234 terminating at valve 84 and bore 235 having a check valve 236 at its right end opening to the left. An opening 237 connects bore 235 to the out-
25 side of the plug body through a suitable filter. Sealing rings 238 and 239 are in this case made easily deformable, e.g. from soft cellular rubber, to bridge the difference between the inner diameter of the duct 1 and the wider part 224 thereof and give good sealing in both diameters.

30 In casing 240, e.g. from a non-magnetizable material such as a copper alloy, there are a number of weak iron discs 241, in this case 12, and around these an annular body 242, e.g. from a plastic material, is rotatable and carries a magnet 243. The body 242 has means to keep it in
35 the required axial position and has an arresting spring loaded ball 244 to arrest it in any of 12 angular positions.

The operation of this embodiment is as follows. Plug body 10 enters the widened part 224 with fins 95, which are thus allowed to move radially outwardly. They do so as rollers 230 move to the position shown by leaf spring 233. In moving this way, check valve 236 opens to allow fluid to be expelled by the left side of piston 232. This fluid may leak along front sealing ring 239 through groove 225 to the front of the plug body. On further movement of the plug body, fins 95 engage end 229 of valve body 8 and move this to the right, thus opening distribution duct 4. Meanwhile, pin 227 reaches helical groove 225 in some position depending on the accidental angular position of plug body 10, and thus pin 227 moves outwardly to engage in this groove, so that further axial movement of the plug body also causes a rotation thereof until the pin 227 reaches the axial part 226 of the groove so that body 10 is always retained exactly in the same angular position.

As soon as duct 4 is opened, generator 91 is energized by propeller 80 and the counting sequence of the retention time starts as soon as a minimum voltage is generated thereby. Ring body 242 takes up an adjusted angular position in which magnet 243 through one of the twelve iron discs 241 closes one of the twelve reed contacts on print 89, which reed contact determines a specific delay time stored in the memory on print 89. In this case there are twelve different retention times possible, one for each angular position of magnet 243. Of course, there may be more than one magnet 243 giving combinations to increase the number of possible retention times. At the end of the chosen retention time, the generator voltage is allowed to energize solenoid 85 thus opening valve 84. In the position shown in Fig. 9 the fluid pressure in duct 1 acting from the left is allowed to enter bores 237 and 235 through helical groove 225 along sealing ring 223. This pressure passes from bore 235 along valve 84, now open, to bore 234, and thus it pushes piston 232 to the right, moving rollers 230

to the right to liberate the fins 95, which are now pushed inward by edge 229. The plug body 10 is thus allowed to continue its movement through the duct and valve body 8 closes port 4. Pin 227 is automatically pushed inward from groove 225.

In all the embodiments showing a propeller such as 80 to drive a generator it is possible to determine the retention time depending on the number of revolutions of this propeller. This number may be counted as such or the voltage generated by the generator may be used as a measure for the propeller speed to be time integrated to find the total number of revolutions. In such systems the opening time at each valve station may not be at a constant value but be proportional to the quantity of fluid pumped into the main conduit per unit time, so that always the same quantity of fluid is discharged at a certain valve station.

CLAIMS

1. A distribution device for a fluid such as water, comprising a main conduit communicating with outlet members each adapted to be individually closed by a valve and a plug body adapted to move through the conduit for opening and closing said valve for a period of time depending upon the retention time of the body at a valve, c h a r a c t e r i z e d i n that the plug body and each valve station comprise mutually cooperating means for determining the opening period of each valve in said valve stations, including means to adjust said opening period individually for each valve.

2. A distribution device according to claim 1, c h a r a c t e r i z e d i n that the plug body comprises radially expandable means and that each valve station comprises actuation means extending partly into the path of the plug body to be contacted by said radially expandable means for opening the valve in each valve station by the pressure of the fluid in the main conduit acting on said plug body, and means for radially contracting said expandable means, governed by said opening period determining means to allow the plug body to leave the valve station and to move to a next station.

3. A distribution device as claimed in claim 2, c h a r a c t e r i z e d i n that the radially expandable means are formed by one or more flexible envelopes

expandable and compressible by the entry or exit of a pressure fluid into or from such envelopes respectively.

4. A distribution device as claimed in claim 3, in which the flexible envelope or envelopes has or have an own elasticity such that it tends to return to a shape with an outer diameter about equal to the inner diameter of the main conduit.

5. A distribution device according to claim 3 or claim 4, characterized in that a fluid accumulator in the plug body is provided, being under resilient pressure and being in fluid communication with the interior of the flexible envelope(s) through a valve operated by the opening period determining means.

6. A distribution device according to claim 5, characterized in that the actuation means in each valve station comprise a narrower part in a valve body axially slidable in the valve station and preventing the flexible envelope(s) in the plug body to pass with closed valve therein, opening of said valve in the plug body allowing the fluid in the main conduit^{to} compress the flexible envelope(s) by contact with said narrower part to expell pressure fluid from said envelope(s) into said fluid accumulator.

7. A distribution device according to claim 6, characterized in that the narrower part in the valve body in each valve station is formed by the terminal narrowing edge of a widened part in said valve body, said widened part having a diameter greater than the inner diameter of the main conduit, said flexible envelope(s) being adapted to take up such a greater diameter.

8. A distribution device according to any of claims 2 to 7, characterized in that the flexible envelope(s) surround(s) the plug body between its ends.

9. A distribution device according to any of claims 2 to 7, characterized in that the flexible envelope forms the front of the plug body.

10. A distribution device according to any of claims 2 to 9, characterized in that the plug body has two sealing parts for sealing it in the main conduit in two points at an axial distance, that there is an inlet
5 for fluid from the main conduit into the plug body between said sealing parts and that said inlet gives access to a movable surface to urge the radially expandable means in one direction, there being a by-pass groove or the like in each valve station which when passed by the sealing rings
10 when the plug body enters the valve station brings this inlet in communication first with the pressure of the fluid in the main conduit downstream of the plug body and, on further movement thereof, with said pressure upstream of the plug body.

11. A distribution device according to claim 2, characterized in that the radially expandable means are radially movable fins driven outwardly from the plug body by operating means in the plug body under control for movement in at least one direction of
20 movement by said opening period determining means.

12. A distribution device according to claim 11, characterized in that said operating means include a piston or bellows, which, when sliding in the axial direction of the plug body, cooperates with a
25 key structure, in one axial position of said piston or bellows penetrating between the fins and forcing or keeping them radially expanded to keep the plug body in position in a valve station, and in another axial position allowing the fins to move radially inwards to liberate the
30 plug body from the valve station for further movement through the main conduit.

13. A distribution device according to claim 12, characterized in that the said piston or bellows is provided with a screw-threaded part engaging
35 the key structure to rotate it about the axis of the plug

body to move it between a position keeping the fins radially expanded and a position allowing them to move radially inwards.

14. A distribution device according to claim 10 and
5 claim 12 or claim 13, characterized
in that the pressure of the fluid in the main conduit,
if allowed to the space between the two sealing parts and
acting on the said movable surface, urges this surface to
10 a position liberating the fins for radially inward movement and moves this surface to this position if a valve
operated by the opening period determining means is
operated to allow this.

15. A distribution device according to claim 14,
c h a r a c t e r i z e d i n that a spring operates
15 on the key structure to urge it towards the position to
keep the fins radially expanded, there being a check valve
for the fluid to one side of the movable surface to allow
flow of fluid therethrough to allow for this spring to
move the key structure to said position, said flow of
20 fluid through the check valve being in a direction
opposite to the direction of the flow of fluid if said
valve operated by the opening period determining means is
opened.

16. A distribution device according to claim 15,
25 c h a r a c t e r i z e d i n that the check valve is
mounted to open the fluid path between two sides of the
movable surface.

17. A distribution device according to claim 15,
c h a r a c t e r i z e d i n that the check valve is
30 mounted to open the fluid path from one side of the movable
surface towards the space around the plug body between the
sealing parts if the pressure in said space is the pressure
downstream of the plug body.

18. A distribution device according to any of claims
35 12 to 17, characterized in that the key
structure carries freely rotatable rollers in a slot to

contact the fins and each other.

19. A distribution device according to any of the preceding claims, characterized in that the means for determining the opening period comprise a programmable delay unit carried by the plug body.

20. A distribution device according to any of the preceding claims, characterized in that each valve station has addressing means selectively cooperating with counting means such as a programmable delay unit carried by the plug body to determine the opening period.

21. A distribution device according to claim 20, characterized in that at each valve station there is a helical guide member in the wall thereof, that the plug body has a cooperating guide member so as to move the plug body to an angular position accurately determined by said guide members when moving into the valve station, and that the addressing means in the valve station are adjusted by selecting an angular position thereof.

22. A distribution device according to claim 21, characterized in that said addressing means are constituted by an annular body rotatable about its axis coincident with the axis of the plug body and carrying a magnet structure to select magnetically from a number of opening periods stored in the plug body around its periphery.

23. A distribution device according to any of the preceding claims, characterized in that the plug body has a fluid pressure sensitive switch allowing operation of the opening period determining means only if the fluid pressure in the main conduit is at least at a minimum value.

24. A distribution device according to any of claims 2 to 23, characterized in that a fluid valve, electromagnetically operated by means of a solenoid, controls the supply or discharge of a pressure fluid to or

from the radially expandable means or operating means therefor.

5 25. A distribution device according to claim 24, characterized in that the solenoid is energized or de-energized to operate the fluid valve under delay control of the opening period determining means.

10 26. A distribution device according to any of the preceding claims, characterized in that the plug body carries an electric generator for supplying a voltage to the electric means therein, operated by a propeller rotated by the fluid passing from the main conduit through the opened valve in a valve station in which the plug body is retained.

15 27. A distribution device according to claim 26, characterized in that the retaining means for the plug body in each valve station will only be allowed to function if the voltage supplied by the generator is above a predetermined threshold level.

20 28. A distribution device according to claim 19 and any of the other preceding claims, characterized in that the programmable delay unit comprises a memory with a number of addressable positions loaded with delay time values corresponding each with a specific valve station, a time counting circuit with a presettable counter and a clock pulse generator which delivers clock pulses of fixed repetition rate for stepping the counter down from the preset value to zero, and a controller for addressing in each valve station the position in the
25 memory corresponding with said valve station to read the delay time value stored in said position, and means for delivering said delay time value as preset value to the presettable counter.
30

35 29. A distribution device according to claim 19 and any of the other preceding claims, characterized in that a programming unit is installed in a separate

programming station or in one of the valve stations in which the plug body if necessary will be retained for storing new delay time values into the memory or changing stored delay time values.

5 30. A distribution device according to claim 29.

c h a r a c t e r i z e d i n that data are transmitted between the programming unit in said station and the delay unit in the plug body by means of photo-sensitive and light emitting devices, or ultrasonic trans-
10 ducers or electromagnetic transmitters and receivers.

31. A distribution device according to any of the preceding claims, c h a r a c t e r i z e d i n that in one or more parking stations for the plug body the duct containing it is transparent and that the plug body has
15 photo-sensitive means to charge a battery in the plug body.

32. A distribution device according to any of the preceding claims, c h a r a c t e r i z e d i n that a movable wall in the plug body, moved by a fluid depending on the entry of the plug body into a valve station, carries
20 a magnet reporting this entry to electric means in the plug body to mark the beginning of counting of the retention time therein.

33. A distribution device according to any of the preceding claims, c h a r a c t e r i z e d i n that the
25 main conduit has a pressure source for pumping fluid under pressure into the conduit to move the plug body and distribute the fluid if the plug body opens a valve at a valve station.

34. A distribution device according to claim 33,
30 c h a r a c t e r i z e d i n that the main conduit forms a closed loop and that it has a reservoir near the pump taking up fluid displaced from the main conduit by the front of the moving plug body, there being switching means to allow passage of the plug body from the discharge opening to the said reservoir to and past the inlet opening of
35 the pump into the main conduit while being moved by the

pressure of the fluid from the pumping means and means to feed the fluid from the reservoir to the pumping means.

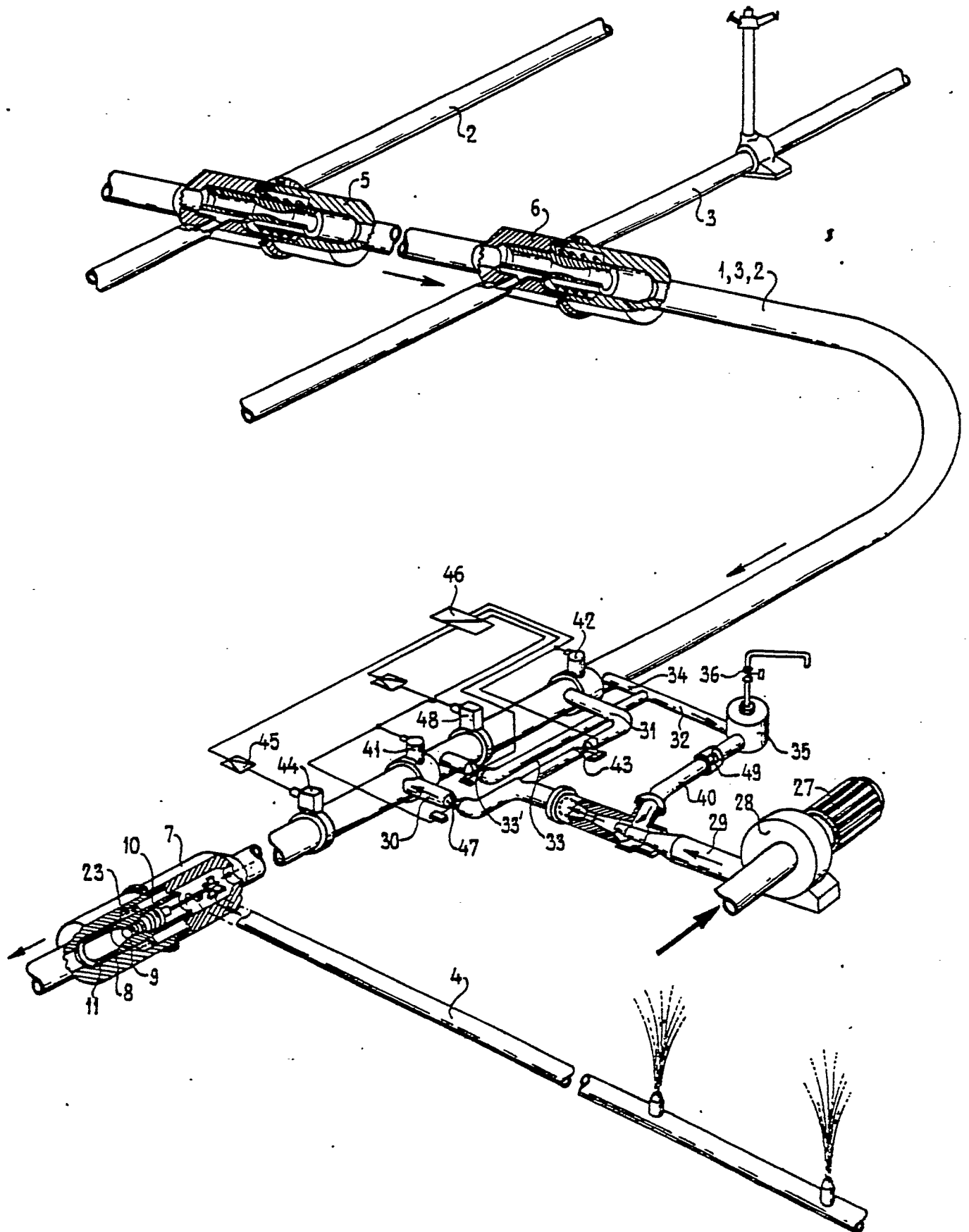
35. A distribution device according to claim 34, characterized in that there are two discharge openings from the main conduit to the said reservoir and two inlet openings for the fluid from the pump into the main conduit, at distances from each other and with valves and switching means so that the plug body is allowed to pass an upstream discharge opening and inlet opening while they are closed and the more downstream inlet and discharge openings are open, after which the downstream openings are closed and the upstream openings are opened.

36. A distribution device according to claim 35, characterized in that sensing means in the main conduit determine the position of the plug body to operate valves both in the main conduit to separate the two upstream or the two downstream openings and in the said inlet and discharge openings to open and close them.

37. A distribution device according to claim 26, with or without any of claims 27 to 36, characterized in that the plug body is provided with counting means for the number of revolutions of the propeller in the opening period determining means to determine this period by this number of revolutions.

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fig-1

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fig-3

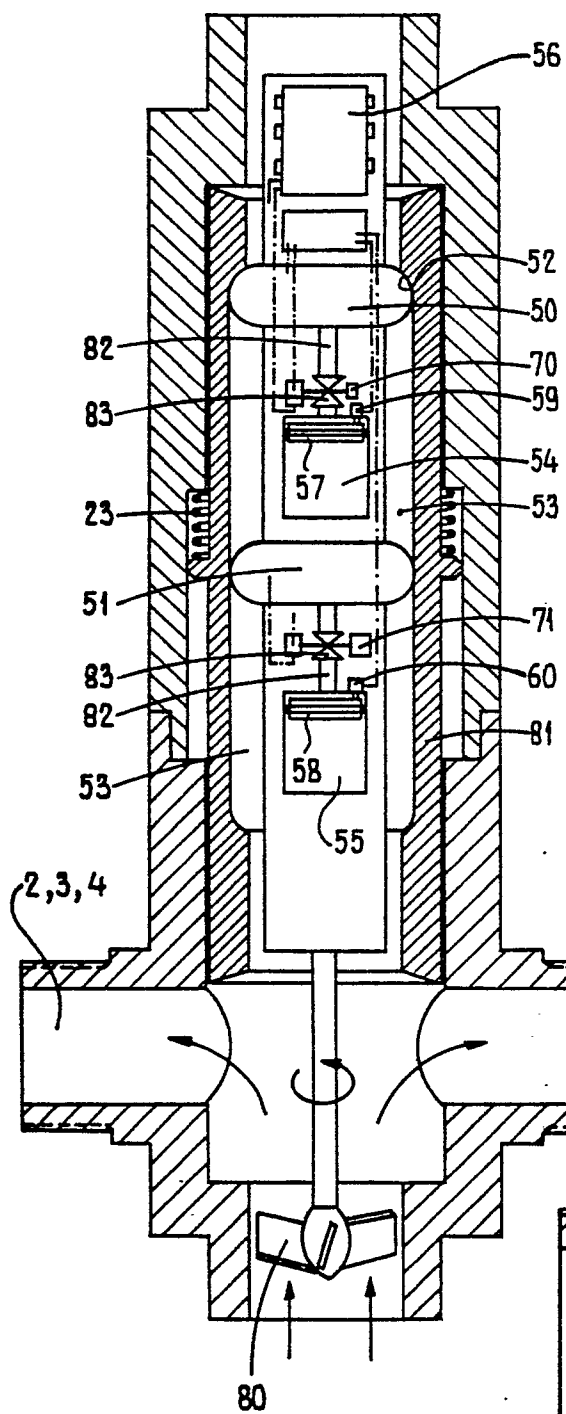


fig-2

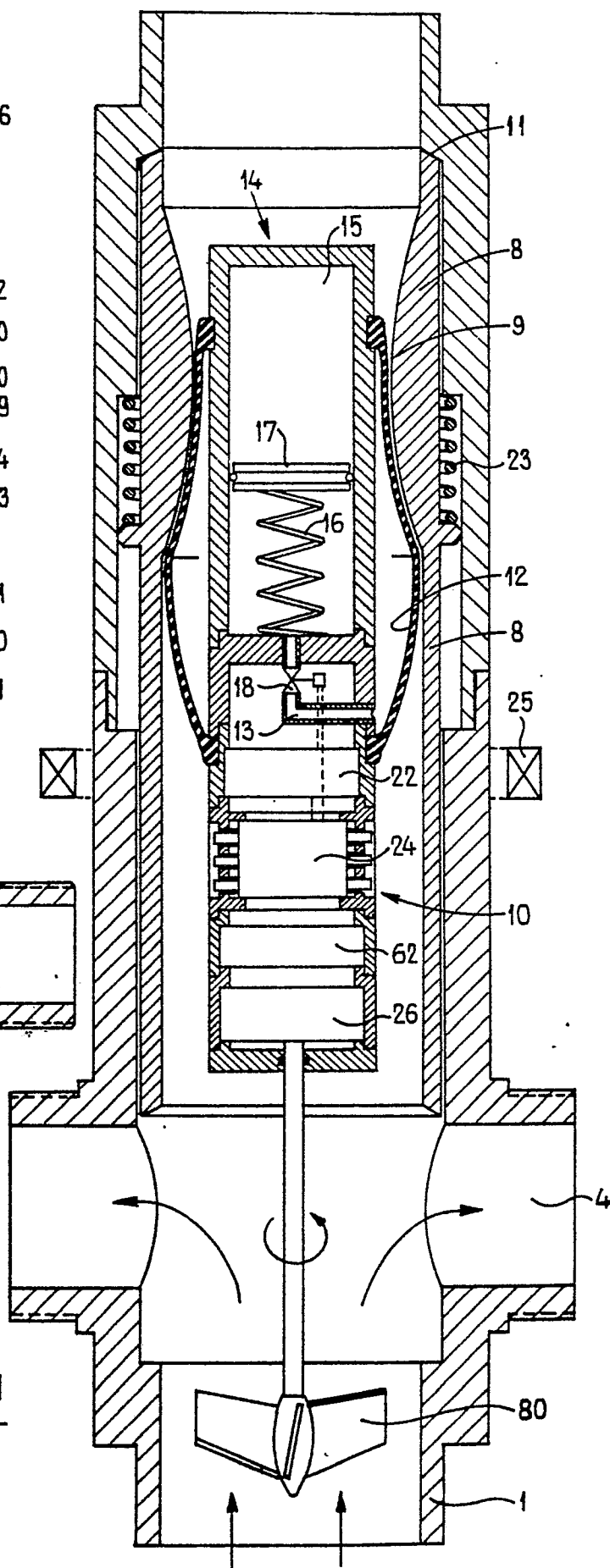


fig-5

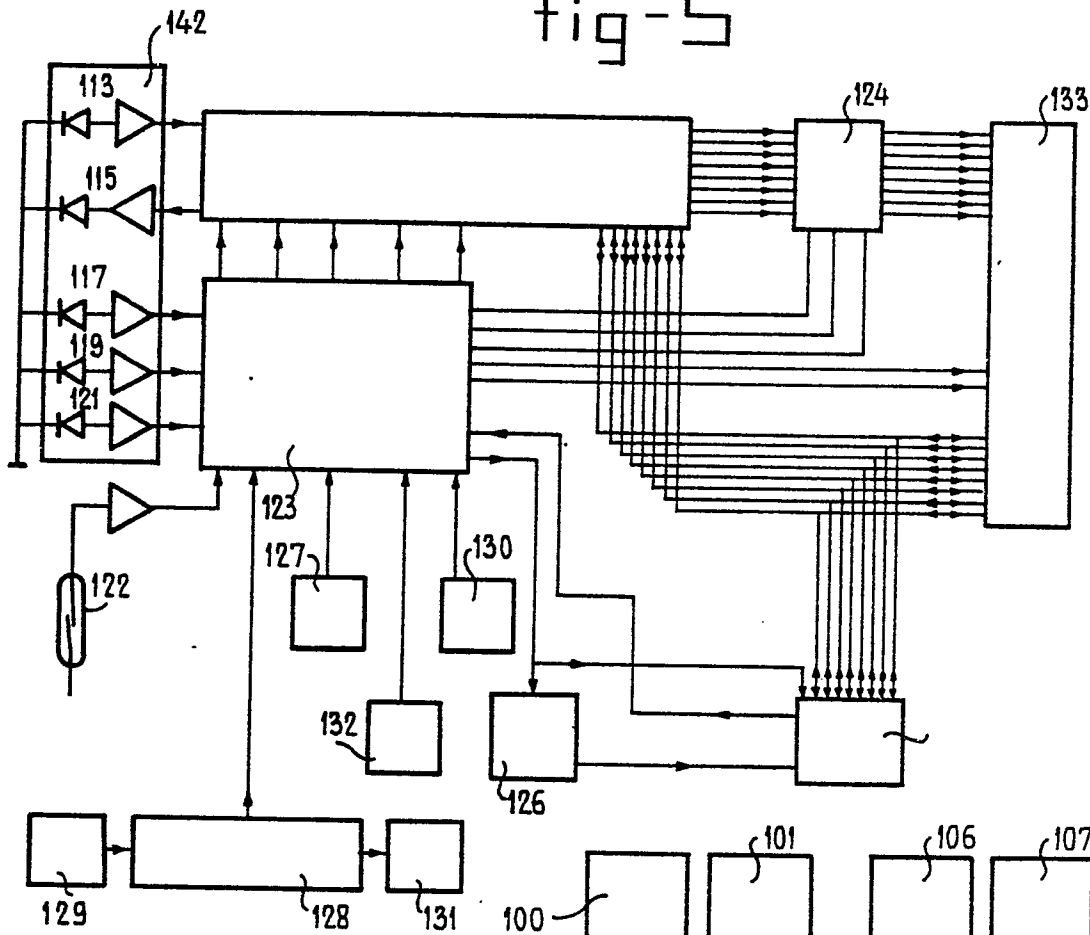
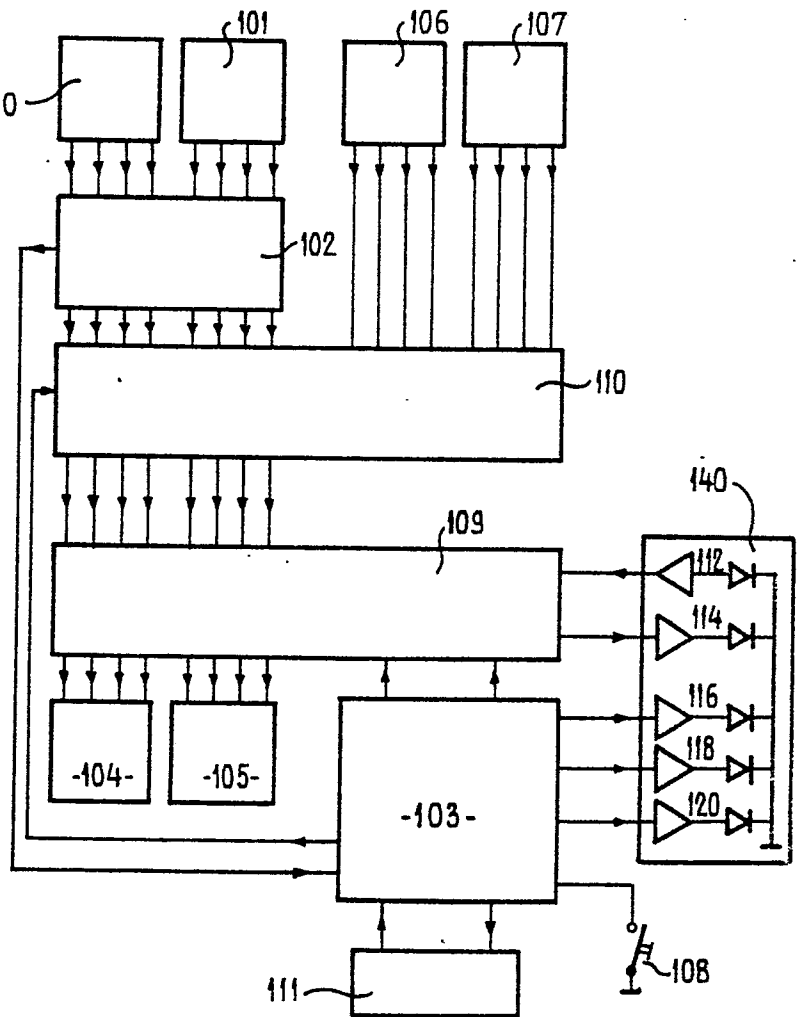
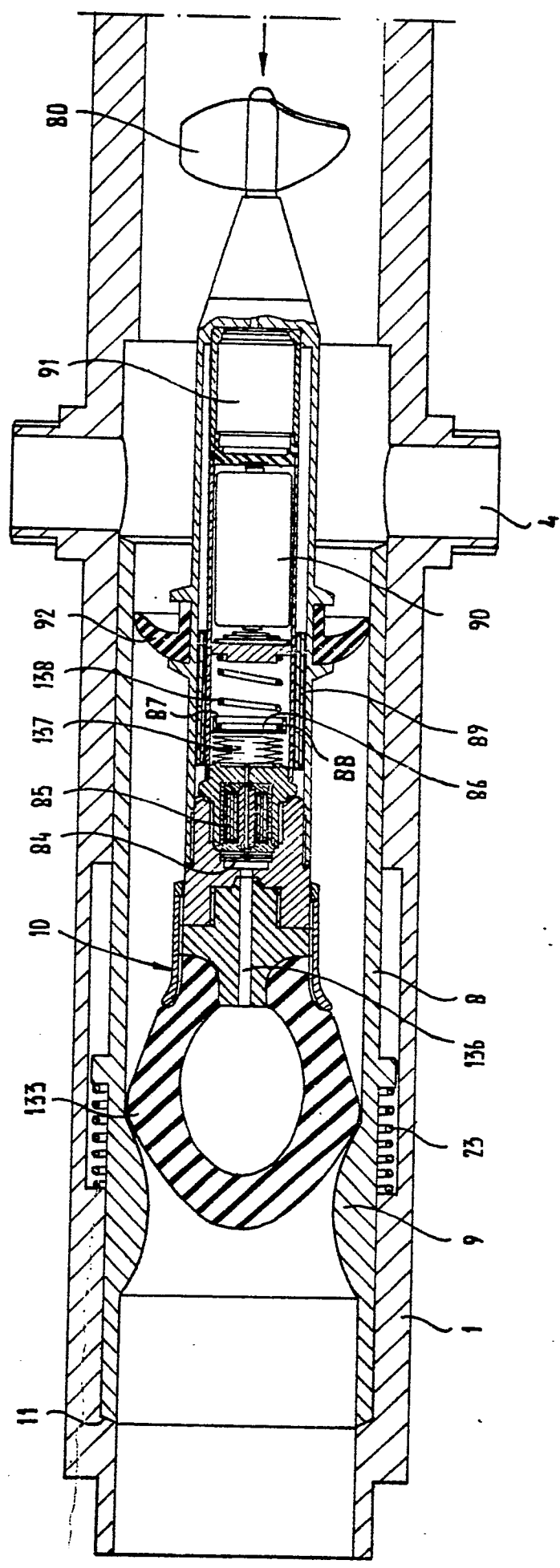


fig-4



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fig-6



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fig-7

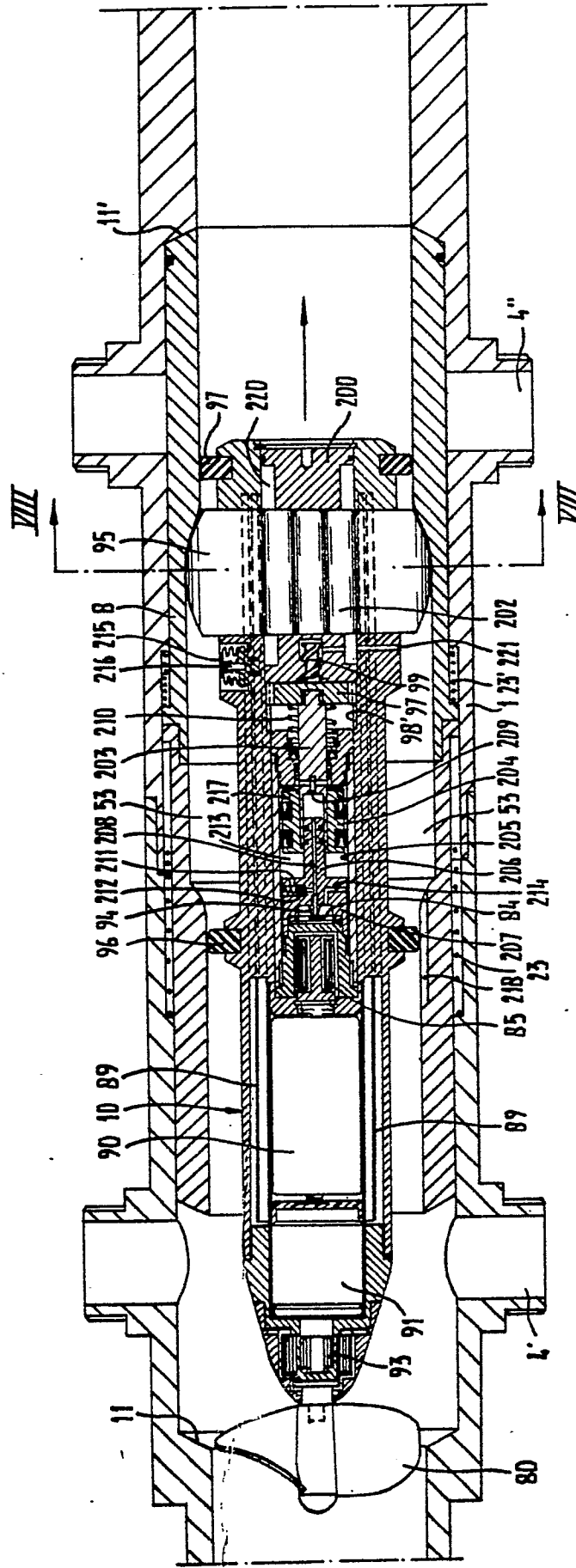
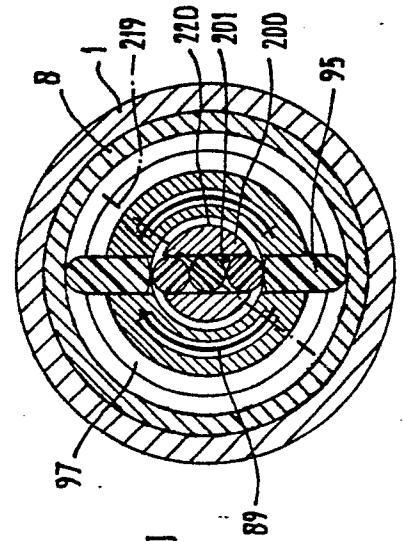


fig-8





DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)
X	<u>FR - A - 2 304 843 (VAN HAAFTEN)</u> * Page 7, lines 6-40; pages 8-11; page 12, lines 1-28; figures 1-4 *	1-8, 11, 12, 34	B 05 B 12/04 A 01 G 25/16 G 05 B 19/10 F 16 K 31/00
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	<u>US - A - 3 140 720 (GRISWOLD)</u> * Columns 1,2,3; column 4, lines 1-8; column 5, lines 68-75; column 6, lines 1-21; fi- gures 1,2 *	19	
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A,D	<u>US - A - 3 196 686 (COLE)</u> * Complete Patent *	23,30, 32,37	TECHNICAL FIELDS SEARCHED (Int.Cl.) B 05 B 12/04 A 01 G 25/16 F 16 K 31/00 F 17 D 3/02 G 05 D 7/00 G 05 D 7/01 F 17 D 3/04 G 01 M 3/08 G 01 M 3/28
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	<u>US - A - 3 191 713 (GREEN)</u> * Complete Patent *	26	
	--		
A,D	<u>FR - A - 2 088 763 (SOGREAH)</u> * Complete Patent *	1	

			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	05-10-1978	COLPAERT	