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A request for correction of claim 1 has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 2.2).

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54 **Fuel injection pump with elastic pressure exchanger.**

57 In order to isolate the injection pumping element (2) in a conventional high pressure fuel injection system from the fuel, a pressure exchanger, consisting of two chambers interconnected by an elastic member (14) such as a membrane or bellows, is installed in the delivery conduit between pumping element (2) and injector (9). This allows the pumping element (2) to work with any suitable fluid, e.g. one with better lubrication properties than the fuel itself. The pressure impulses from the pumping element (2) are thus transmitted through the elastic member (14) to the fuel which, through suitable check valve means, (17, 18) is pumped to the injector (9).

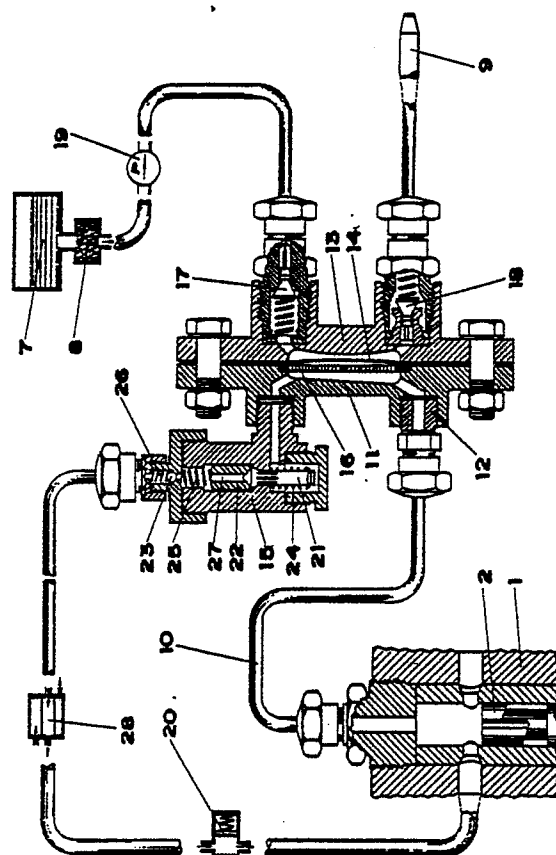


Fig. 2

Fuel Injection Pump with Elastic pressure exchanger.

This invention consists of an improvement on some systems used at the present time for direct fuel injection in internal combustion engines.

The system used at the present in industry that served as the basis for developing this invention consists of pump of a kind which moves little pistons of adjustable stroke by means of eccentrics or cams, or consists of pistons of constant stroke but revolving and with helicoidal rabbit. These pistons operate in both cases by confining a controllable fuel amount and, by taking into account needs of the engine compress that fuel amount so that it is forced through an injector into an air mass.

The modification of the present system has its beginning in the outlet of conventional pumps, on the site of consecutive retaining valves with each piston. In my invention these valves are eliminated in order that the liquid with which the pump works flows in both directions with the pistons.

The displacement of liquid produced by each piston is led through its respective pipe line toward a hermetically sealed space, so that the liquid displacement by the pump in each direction produces defacing of one elastic accessory locked within the hermetically sealed space. Such elastic accessory divides at once the hermetically sealed space into two smaller spaces, so that the flow variations produced on one side of the elastic accessory cause identically the same flow variations on other side.

Therefore when liquids of any kind totally fill each one of the smaller spaces, flow variations that the pump produces in one of the liquids are transmitted to the other liquid, without mixing the two liquids.

The foregoing is the essence of the modification that I propose. I believe these same pumps will have superior efficiency, longer durability, less maintenance cost and the capability to use other fuels not useable in present injection pumps.

This improvement is explained in these four figures:

Fig. 1 shows an example of the present conventional system. This system consists of one hypothetical injection pump seen in perspective with the removal of a portion of the casing showing the interior mechanism. This figure also includes symbolically basic accessory elements placed before and behind the pump.

Fig. 2 show improvement or midification that I propose for one piston of pump, showing by a cross section the discharge portion of the existing pump and also, by a partial cross section, the

auxiliar mechanism described below. This last cross section is passed through the plane of symmetry of the auxiliary mechanism.

Fig. 3 show the improvement that I propose for the present system. This figure show the present pump in perspective and with the auxiliary mechanisms also in perspective. Lastly this figure show symbolically the basic accessory elements placed before and behind the pump.

Fig. 4 shows a purge appliance.

The system used at the present is shown in Fig. 1 wherein has been chosen a hypothetical pump 1 of three pistons 2 which are operated in this case by cams 3 joined to the axle 4. The mentioned pump of revolving pistons is shown with its standard auxiliary elements 5 and 6 for adequate control of piston revolutions. The modification part that I propose has been removed and only is shown as reference with dotted lines. This system has been complemented with fuel chamber 7 and filter 8 on the suction site of pump, and injectors 9 on the side of the pump's discharge. These complements are shown in graphical symbols.

The invention is shown in Figures 2 and 3. It consists of the use of this same injection pump by utilizing its variable volumetric displacement mechanism except that instead of working with fuel, this mechanism will utilize other fluid that will not reach the injectors. To continue with the explanation, I will call this other liquid as "liquid A".

The "liquid A" displacement produced by each piston is led through its respective 10 pipe line towards a hermetically sealed space which must be made up of parts 11 and 13.

Between 11 and 13 must be fastened a membrane 14, by means of bolts and gasket. Piece 11 has a connection 12 from the incoming tube 10 and a constant purge appliance 15, which besides expelling the air during the "liquid A" filling-up process, allows the continuous change of it, avoiding this fluid to remain without renewal next to the membrane. Piece 11 also supports a disk 16 with multiple small holes, in order to maintain the membrane 14 in its initial position at each cycle start.

To accomplish this purpose, the mentioned membrane, must be of impervious material and of a degree of controllable deformation. Such a membrane must be enclosed within a hermetically seales space, in such a way as to divide that space into two smaller spaces. "Liquid A" must fill one of these smaller spaces, without gas bubbles. Likewise, the other smaller space must be filled with fuel.

The number of holes and the diameter of each hole in disk 16 fundamentally depend on the consistency and resiliency of the membrane 14.

The 13 piece carries two retaining valves in opposite positions as admission valve 17 and discharge valve 18. These valves must be adequate for high-pressure performance and will have their guides, pressure springs and gaskets like retaining valves placed on the discharge of each piston in the conventional injection pumps.

Admission valve 17 receives the fuel from fuel chamber 7 and carries it on filter 8. Then the pump 19 impels the fuel while avoiding negative pressure on it, and makes the membrane to return to its initial position when "liquid A" is aspirated by the respective piston of pump 1.

From what has been explained hitherto, it can be observed that any variations of pressure that the injection pump produces on the "liquid A" are transmitted to the fuel by the membrane deformation, whereby discharge valve 18 will open by the effect of the great pressure increase that the injection pump will produce through the membrane, letting the fuel to flow towards the injector 9.

If lubricating oil for motor cars is used as "liquid A", it is necessary that such oil does not heat. To avoid its heating, its continuous rotating becomes necessary through appliance 15. The functioning of appliance 15 is described below:

Fig. 2 shows how the oil, as soon as piston 2 is displaced, reaches the membrane chamber and from there flows to appliance 15. Valve 21 that is located inside appliance 15 has two seatings, and some peripheral grooves in the same direction as its shaft. Valve 21 presses the plunger shaped body 22 on its upper seat, driving it towards the top formed by the change of section of its respective cylinder, such as Fig. 4 shows. In this way the quantity of oil from displacement of part 22 is forced to pass through the valve 23. On continuing the displacement of piston 2 the oil can not then pass to appliance 15 and consequently displacement of membrane 14 is produced, as has previously been described.

When piston 2 is returning, the pressure is reduced and spring 24 forces valve 21 to return to its former position while spring 25 forces piece 22, which has a hole 27 along its shaft, to return to its original position. This comes about from the circulation through the mentioned hole of the oil that has been standing below. This is caused by the vacuum that is produced in the space where spring 25 is, because the spring 26 that is pressing valve 23 prevents the oil from returning. This has the effect that the inside assembly of appliance 15 comes back to its original position.

In the foregoing case, the pump 1 has to force through each of its pistons 2 in each cycle an oil volume which is larger than the necessary volume of the displaced fuel. This volume difference will pass through appliance 15.

A mechanical accumulator 20 and eventual cooling appliance 28 complete my system so as to maintain always a correct pressure and temperature on the "liquid A" at entrance into pump 1.

Different from most conventional diaphragm pumps, in which the diaphragm movement is counteracted by the action of a spring to make the diaphragm return to its initial position, a hydraulic action is used in the present mechanism.

Fig. 3 shows how the injection system that I am proposing totally varies the conventional system showed in Fig. 1, for a hypothetical case of an injection pump with three injectors.

I hope that this invention can be industrially exploited because it has the advantage that the volumetric variations that the injection pump produces on the "liquid A" are transmitted by effect of the membrane deforming the fuel, without mixing the two liquids, the "liquid A" will not become consumed, "liquid A" will be suitable for this use with regard to its viscosity, lubricating features and absence of contamination. Consequently, the pump pistons will suffer less attrition and for that reason will last longer without maintenance. On the other hand, the fuel used can be very much lighter and without lubricating quality. For example gasoline can be used as fuel; also liquid gas can be used whenever it is maintained at correct pressure.

Claims

1.-Modification of the existing system of fuel injection pumps for internal combustion engines, in such a manner that the pump instead of directly impelling the fuel toward the injector by means of each piston, impels an auxiliary liquid, which will flow in both directions and nearly in accordance with each piston displacement, these flow variations will produce simultaneous pulsations of an elastic membrane locked within a casing containing a space divided by this membrane, one of these two spaces formed by this division becomes totally filled with auxiliary liquid and the other space totally filled with fuel, at the side of the auxiliary fluid space the membrane leans back at the start of each cycle against a rigid piece, such piece has multiple small holes, through which it is not possible that the elastic membrane penetrates, but the auxiliary fluid to give elasticity to such membrane will pass, this space has an auxiliary fluid draining appliance in constant volume for each displacement cycle of the respective piston of the pump,

said piston does not reach to block out the admission hole of the draining appliance allowing a continuous change of the auxiliary fluid and avoiding this fluid to remain without renewal next to the membrane, said pump must be provided with pistons whose displacement volume is the same as the amount of fuel equivalent volume needed to be injected plus the draining volume.

2.-Modification of the existing system of fuel injection pumps for internal combustion engines, in such a manner that the pump instead of directly impelling the fuel toward the injector by means of each piston, impels an auxiliary liquid, which will flow in both directions and nearly in accordance with each piston displacement, these flow variations will produce simultaneous pulsations of an elastic membrane locked with a casing containing a space divided by this membrane, one of these two spaces formed by this division becomes totally filled with auxiliary liquid and the other space totally filled with fuel, at the side of the auxiliary fluid space the membrane leans back at the start of each cycle against a rigid piece, such piece has multiple small holes, through which it is not possible that the elastic membrane penetrates, but the auxiliary fluid to give elasticity to such membrane will pass, this space has an auxiliary fluid draining appliance in constant volume for each displacement cycle of the respective piston of the pump, said pump must be provided with pistons whose displacement volume is the same as the amount of the fuel equivalent volume needed to be injected plus the draining volume, such draining appliance has two valves, one after the other, the first valve in the fluid direction closes against a sliding cylinder, the second valve prevents flow in the opposite direction.

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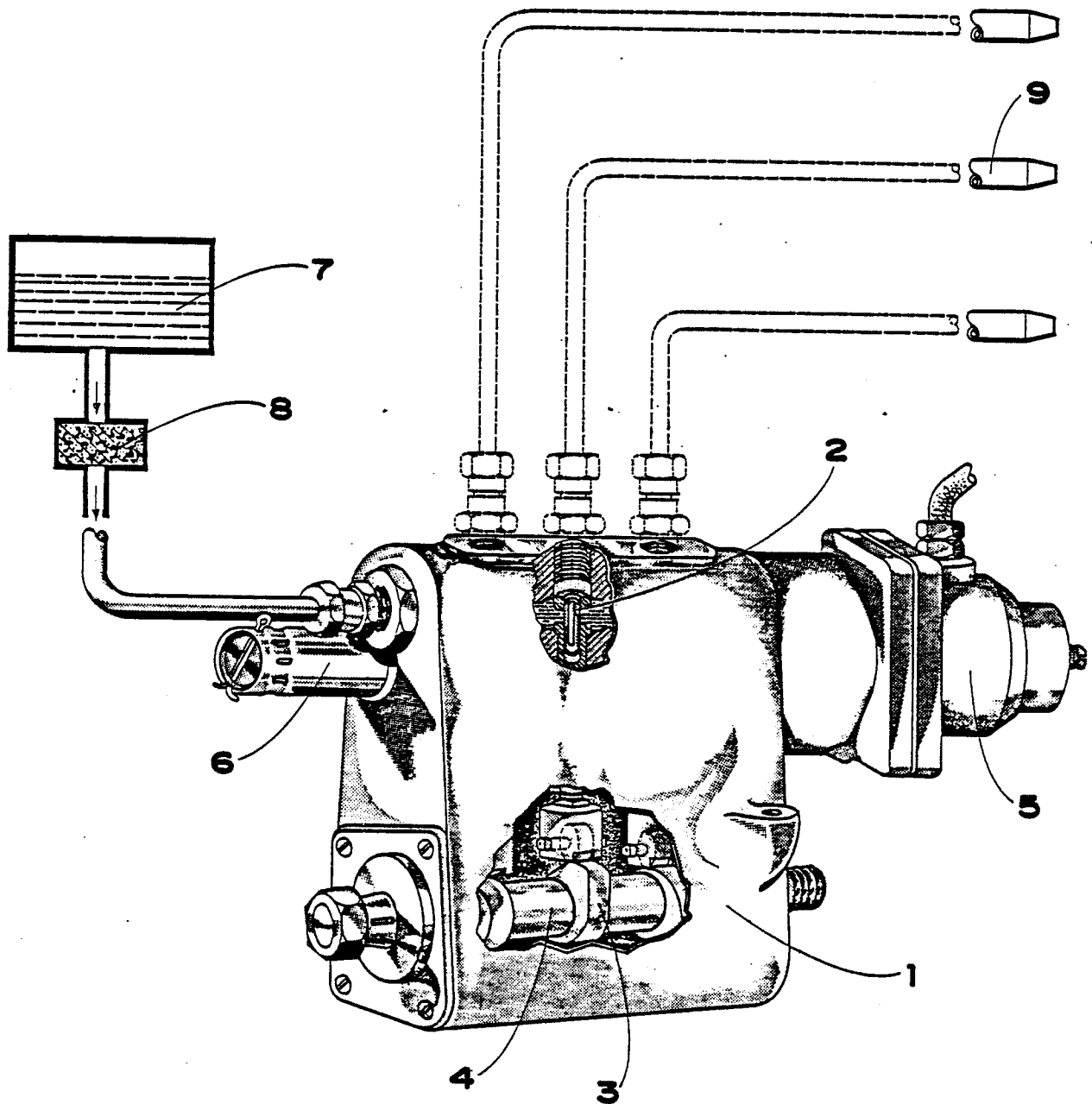
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**Fig. 1.**

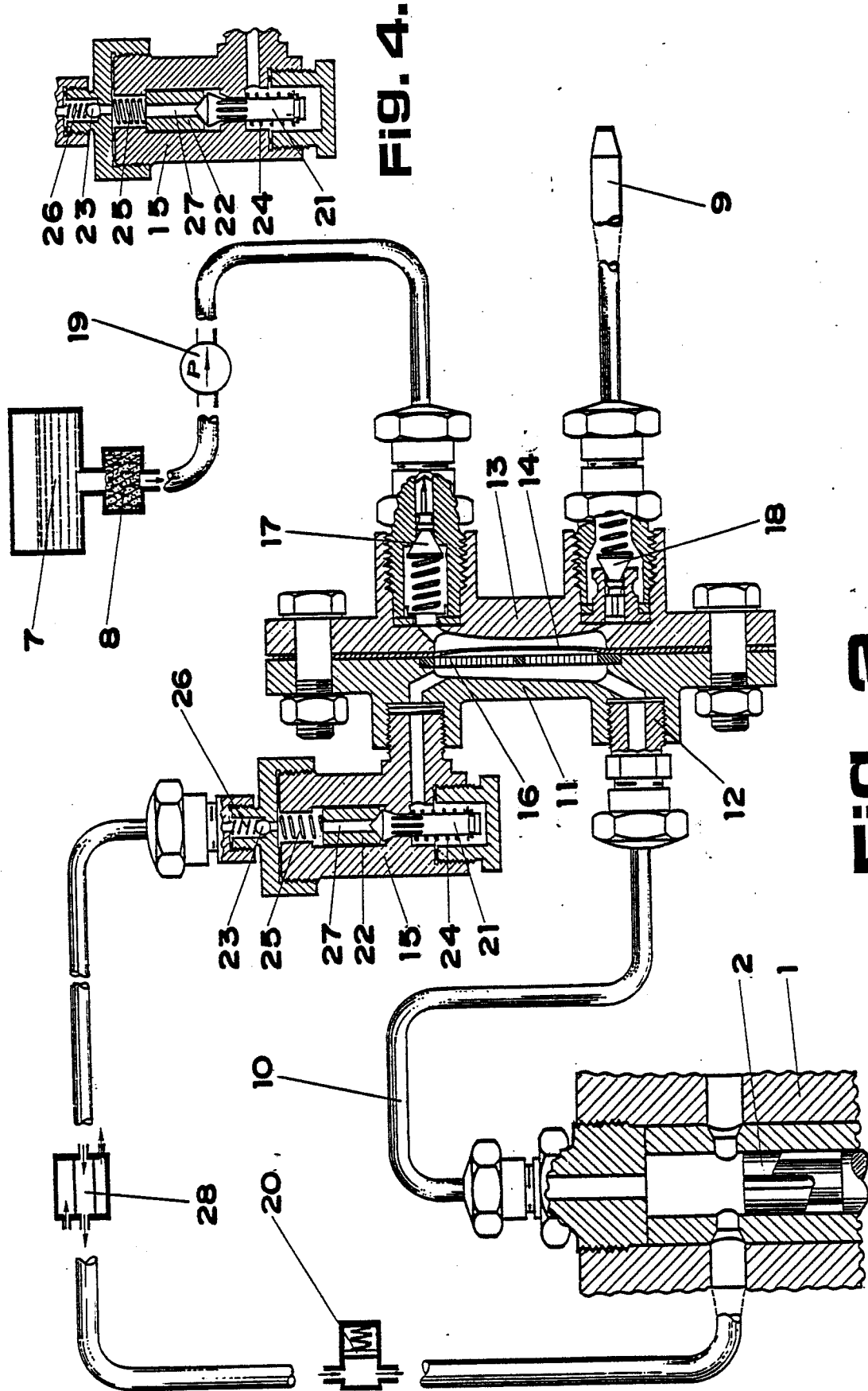
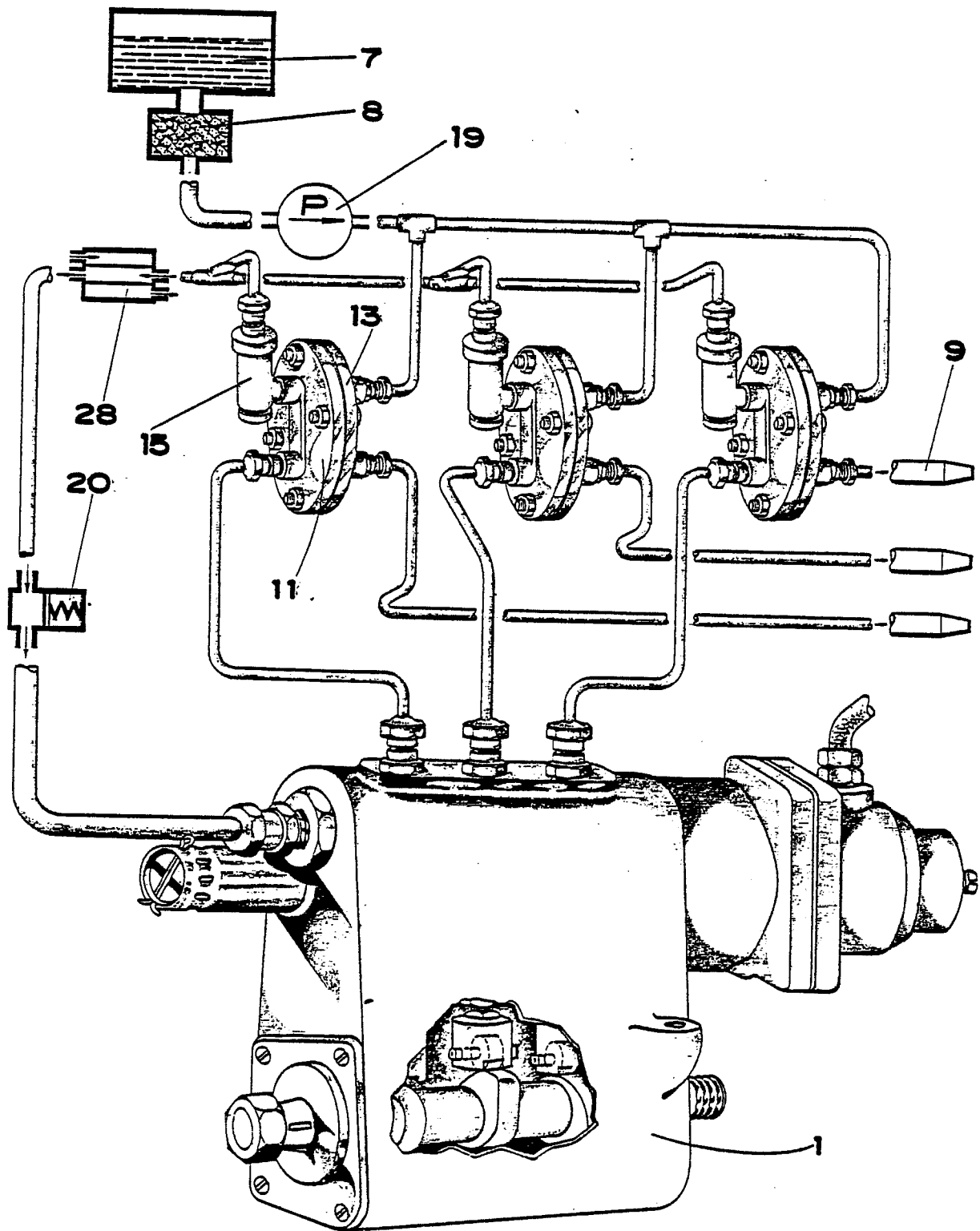


Fig. 2

Fig. 4.

**FIG. 3**



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.4)
X	DERWENT - WPI, Derwent Publications Ltd., London, GB; & AU-A-33 808/84 (TAPIA) 1st May 1986 - & US-A- 4 662 828	1,2	F 02 M 59/14
A	--- US-A-4 008 009 (KOVACS) * Column 2, line 6 - column 4, line 59; figures 1,2 *	1,2	
A	--- US-A-2 395 330 (HOUSER) * Page 2, left-hand column, line 44 - page 5, left-hand column, line 2; figures 1-6 *	1,2	
A	--- FR-A-1 251 087 (BARAT) * The whole document *	1,2	
A	--- FR-A-1 586 774 (GRIMAULT) * Page 1, line 18 - page 2, line 38; figures *	1,2	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22-05-1987	Examiner HAKHVERDI M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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Ihre Nachricht vom:

Tag: April 2, 1987

Re.: EPO Patent-Application Nr. 86113028.4 from Sept., 22 1986
Applicant: Héctor L. Tapia P.

The applicant begs to amend a typographical error at page 7
(claim 1) of the abovementioned patent application.

Line 19 of page 7 (claim 1) reads: ..to block out the admission.."
correctly it should read: .. To block out an admission ..."

The applicant enclose an amended page 7 and begs to replace
the previous page 7 by the correctly amended page 7.

Gert Berg
Gert Berg
professional representative

encl.: amended page 7 (3x)