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(54) **Valve for fuel gas cylinders.**

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Description

1. Generalities

The invention relates to a valve for a fuel gas cylinder

The fuel gases existing at present in the market are supplied to the consumers under one of the two following physical states:

—Gaseous state.

The distribution to the consumer is made through adequate pipe-lines.

— Liquid state.

The distribution to the consumer is made by using liquefied gas containers.

It is second case that one of interest to us, because our invention is for application in the referred containers.

The above mentioned containers are, generally, cylindrical steel bottles, commonly named "gas cylinders" or "gas bottles".

It is common knowledge that there are in the market a lot of cylinder models, of various sizes, generally constructed in steel-sheet, and are sold containing a certain quantity of liquefied fuel gas.

2. Description of prior art

The prior art will be explained in greater detail below by reference to drawings, wherein

Fig. 1 shows a lateral view of a fuel gas cylinder;

Fig. 2 shows a lateral view and a sectional view of a valve;

Fig. 3 shows a lateral view and a sectional view of a pressure regulator;

Figs. 4a to 4d show lateral views of the valve and the pressure regulator for the explanation of the connection thereof, and

Fig. 5 shows three variants of the valve.

The fuel gas cylinders are fitted with a valve A (Fig. 1), which is generally threaded in the upper part of the cylinder. This component part owing to its characteristics and through an adequate operation allows to establish a communication between inside and outside of the cylinder, allowing thus both the gas inlet into the cylinder (filling) and the gas outlet from the cylinder (consumption).

The valve A (Fig. 1) performs in full its function in the cylinder filling operation, but it is not enough to permit the normal consumption of the gas contained in the cylinder. This happens because the gas is not generally consumed at the pressure at which it is liquefied into the cylinder.

It will be therefore necessary to have another component part i.e. a pressure regulator B (Fig. 1) which is adjustable to the valve and receives through it the gas coming from the cylinder reducing its pressure to the values required by legal rules existing for the consumption of liquefied fuel gases.

The valve and the pressure regulator form together a necessary whole when it is required to use liquefied fuel gas from cylinders.

With regard to the valve it is convenient to emphasize that what will be exposed next is referring to "self-closing" valves and therefore it will not be of interest to refer here to "manual-closing" valves, as our invention is mainly useful in "self-closing" valves although it can be used too in "manual-closing" valves.

In Fig. 2 it is shown a "self-closing" valve composed of the following parts:

1—Body
2—Gas outlet and inlet canal
3—Valve plunger
4—Seat disc
5—Seat
6—Connection joint
7—"Self-closing" spring
8—Spring support
9—Retainer
10—Clamping system balls

In Fig. 3 it is shown a schematized pressure regulator widely used all over the world. It is composed of the following main parts:

11—Gas inlet connection
12—Clamping system spring
13—Handle
14—Stem
15—Gas outlet canal
16—Pressure reduction nozzle
17—Pressure reduction plunger
18—Pressure balancing lever
19—Pressure balancing diaphragm assembly
20—Pressure balancing spring
21—Regulator body
22—Regulator bonnet
23—On-off eccentric
24—Clamping ring

In Fig. 4a to 4d it is shown the sequence of operations leading to the connection of the regulator to the valve. Fig. 4a shows the two parts of the system in position before connection. In Fig. 4b the regulator was introduced in the upper part of the valve and the regulator inlet connection 11 can be seen introduced at the valve outlet canal 2 passing through the connection joint 6 the clamping system has not yet reached the final security position.

In Fig. 4c the regulator can be seen completely introduced in the valve and the security system (12 and 24) is already in the final position. However, the valve is still closed.

In Fig. 4d the handle 13 which makes the stem 14 to come down by intermediary of the eccentric 23 and opens the plunger 3 has already been turned round. Henceforth, the gas will pass inside the regulator until it will reach the outlet canal 15 for consumption.

From FR—A—1 074 398 is known a valve for a fuel gas cylinder wherein an elastic sealing disc is lodged in a gas inlet and outlet canal of a valve body. The sealing disc closes the canal. The pressure regulator has a hollow needle by which the sealing disc is pierced for the consumption of the gas.

3. Main inconveniences of the existing valve-regulator systems

The main inconveniences of the systems used at present are found in the sealing between the valve and the regulator and even in the own valve before the regulator being applied to it.

3.1—Any of the valves known (Fig. 2) has a canal 2 allowing the passage between the interior and exterior of the cylinder. This canal allows the cylinder to be filled with gas and it is also suitable (in the inverse direction) for the gas outlet for consumption.

The referred canal diameter, which varies according to the manufacturer, is usually of 6 to 8 mm.

This diameter has to be of this size so that the cylinder filling is made quickly (15 to 20 seconds) in order that the filling plants are profitable. However, the discharge capacity of this canal is very excessive in respect of the normal consumption requirements, as the average consumer would consume a cylinder content within 15 to 20 days. In this way, the relation between the filling speed and the normal consumption speed in the referred canal, assuming that the useful time of utilization is 10% of total time to empty a cylinder (15 days) at the consumer home, will be:

$$\frac{Vt}{vT} = 1$$

$$\frac{v}{V} = \frac{t}{T}$$

$$v = \frac{20V}{129000}$$

$$v = 1,5\times10^{-4}.V$$

V=Filling speed
v=Consumption speed
T=Consumption time
t=Filling time

The purpose of this simplified and not accurate calculation is just to have an idea of the difference between the gas speed to fill the cylinder and the gas speed at the connection joint area for consumption. We are considering here neither pressure losses nor effective pressures which are not identical for both cases.

In practice what is found by testing is that the necessary valve outlet canal diameter to guarantee the normal consumption gas flow is sized between 1.2 and 1.8 mm for cylinders internal pressures of 6,87 bar (7 kp/cm^2) and 0,49 bar (0.5 kp/cm^2) respectively.

In conclusion we can say that the inlet and outlet canal 2 (Fig. 2) existing in the conventional valves has the suitable diameter for a quick filling, but it is very excessive for the consumption. Thus, a gas leak can occur more easily during the consumption because larger diameters have to be used in the valve-regulator connection than those really necessary.

The probability to occur a gas leak at connection joint will be increasing with the diameter of canal 2 (Fig. 2).

3.2—In the valves existing actually in the market the upper area where is made the regulator connection (see Fig. 5) is subject not only to the entry of all kind of foreign matter, such as, sand, dust, etc., but also to deliberated or accidental mechanical actions with instruments that can effect the seat disc 4 (Fig. 2) and connection joint 6 (Fig. 2 and 5).

When this happens, the valve can stop guaranteeing a good gas sealing and cause danger situations and fuel gas losses.

This type of situation is frequent in practice because the cylinders are travelling from the filling plant to the consumer without the regulator fitted in the valve as the regulator is a consumer's property and is fitted when the consumer starts using a new bottle.

The efficiency of the transport plugs used in some valves is very discussible, because normally they are not duly fitted or have been lost during the transport.

In Fig. 5 are shown three types of valves well known in the market. The areas subject to foreign matters are shown in vertical broken lines.

In short, we can say that the main inconveniences of the existing valves are:

a) Just one canal for filling and consumption with an overdimensioned diameter for the consumption. A gas leak can happen more easily than if a reduced diameter would be used.

b) The principal sealing parts of the valves are easy to reach from the exterior, allowing that fuel losses occur purposely or accidentially during the cylinder transport from the filling plant to the consumer home and also that the referred leak continues at the consumption place with the inherent dangers.

c) As there are important areas of the valve respecting to the sealing which are subject to the entry of foreign matters (see Fig. 5) we cannot be sure that, when fitting the regulator, its gas inlet connection 11 (Fig. 3) will guarantee a good sealing in the connection joint 6 (Fig. 2) and it can happen that gas leaks occur, in that area, at the consumer home.

3.3—With regard to the regulators existing in the actual market, a description of which was already made in Fig. 3, there are not so much inconveniences, in respect to the regulator we are introducing, as in the case of the valves.

However, they have a common characteristic, which is not advisable, consisting in the fact of not allowing the consumption gas passage closing independently of the valve closing (see Fig. 4a—4d). There is, thus, the possibility of the volume of gas contained at the nozzle 16 downstream, to come back to the atmosphere when the regulator is removed from the valve.

Furthermore, all them dispose of a fixing system to the valve (see Fig. 3) very robust mechanically to resist to the big forces that, in the system, tend to remove the regulator from the valve (see Table No. I) which are due to the existing excessive sections.

There are also in the referred regulators inter-locking systems (see Fig. 4d) not allowing the regulator to be fitted or removed from the valve without closing previously the gas in the seat 5 (Fig. 4d).

Taking into account that the valves are self-closing type, these systems would be useless if it there would be smaller sections in the connecting area, what would reduce, as it can be seen in the Table I (Capsula System), the total ejection force exerted in the regulator to insufficient values to eject it.

4. Brief description of the invention

It is the object of the invention to provide a valve for a fuel gas cylinder, which allows the filling of the gas cylinder through a comparatively great diameter of the inlet canal in spite of a comparatively small diameter of the outlet canal for the gas consumption. Moreover, for the transport of the fuel gas cylinder the valve should be protected against arbitrary damage.

The invention proceeds from a valve for a fuel gas cylinder known from FR—A—1 074 398, comprising a filling canal and an outlet canal closed by a perforatable sealing means which in use is perforated by a hollow needle through which the gas is delivered.

In accordance with the invention, the object is accomplished in that a spring loaded check valve is provided in the canal and that the sealing means is provided with a cylindrical part having an axial bore, the cylindrical part being fitted within the canal, whereby on use the needle extends through the bore to open the check valve.

By means of the invention, the following advantages are achieved as against conventional valves and valve regulator systems:

Reduction of the diameter of the canal 2 (see Fig. 2) when the system is in gas consumption service without reduction of the filling canal diameter. This will strongly reduce the gas leak possibilities during connection of the regulator to the valve, in view of the small sections used.

The valve area (see Fig. 3) where the main sealing parts 5 and 6 (Fig. 5) are found cannot be easily reached from outside neither by foreign matters, that can be lodged in that area, nor by mechanical parts introduced purposely. This will lead to a great fuel economy and also to the reduction of accidents caused by gas leaks.

The valve is completely inviolable and consequently the cylinder, too, during the transport from the filling plant to the consumption place. This will guarantee fuel economy, will reduce accident risks and will guarentee the consumer the right quantity of gas he acquired.

The forces proceeding from the cylinder internal pressure action on the regulator connection 11 (Figs. 4a—4d) are insufficient to eject it. Any special mechanical fixing system between the valve and the pressure regulator may be avoided. This allows a great simplification in the regulator construction leading to lower cost prices.

Preferably, the consumption gas closing is made independently of the valve, this operation being carried out only in the regulator. Leaks of the gas contained downstream of the nozzle 16 (Figs. 4a—4d) would thus be avoided when the regulator is removed from the valve.

The gas closing inside the regulator will preferably be done automatically when the regulator is removed from its lodging in the valve and will be retained in that position if it is not opened manually. This will avoid that when the regulator is placed on the valve the gas will pass immediately to the outlet canal 15 (Fig. 3).

5. Detailed description of the invention

An embodiment of the invention will be explained in greater detail below by reference to further drawings, wherein

Fig. 6 shows a lateral view and a sectional view of a valve for a fuel gas cylinder in accordance with the invention;

Fig. 7 shows a lateral view and a sectional view of a pressure regulator connectable with the valve according to Fig. 6;

Figs. 8a to 8d show sectional views for the explanation of the filling operation;

Figs. 9a to 9c show sectional views of the valve and the pressure regulator for the explanation of the connection thereof; and

Figs. 10a to 10c show sectional views for the explanation of the dismounting of the valve.

5.1—Composition of parts A and B (Fig. 1)

5.1.1—Valve

The valve is composed as shown in Fig. 6 and the components are as follows:

25—Body
26—Joint
27—Upper body
28—Ball
29—Consumption seat
30—"Capsula"
31—Gas inlet canal
32—Emergency seat
33—Filling seat
34—Self-closing spring
35—Retainer

5.1.2—Regulator

The regulator is composed as shown in Fig. 7 in gas closed position. The components are as follows:

36—Gas inlet connection
37—Handle
38—Gas outlet canal
39—Pressure reduction nozzle
40—Pressure reduction plunger
41—Pressure balancing lever
42—Pressure balancing diaphragm assembly
43—Pressure balancing spring
44—Regulator body
45—Regulator bonnet
46—On-off helical ramp
47—On-off plunger
48—Gas chamber packings (O-Ring)
49—Plunger spring
50—Ramp pin
51—Gas chamber
52—Retainer

5.1.3—Valve-regulator system

In Fig. 9a—9c it is shown the Valve-Regulator system in its sequential connecting positions.

5.2—Operating principle

5.2.1—Filling (see Fig. 8a—8d)

The valve is threaded in the cylinder upper part and it is submitted to filling operation without the parts 29 and 30 (Fig. 8a). In this stage the ball 28 is actuated by the spring 34 against the seat 33.

In the filling plant it is adjusted to the part 27 a device 54 (Fig. 8b) specially studied for that purpose which is connected to the high pressure gas line.

The gas under pressure will pass into the canal 31 forcing the ball 28 to come down. Then the gas will pass between the seat 33 and the ball 28 to inside of the cylinder.

Once the cylinder is full of gas which can be proved through weighing devices already known, the filling device is removed and the ball 28 actuated by the spring 34 and the gas pressure in the cylinder comes back to the initial position guaranteeing the complete cylinder closing by sealing the seat 33 (Fig. 8c).

In the second station of filling plant the parts 29 and 30 are introduced in the upper part of the valve by means of a special device 55 (Fig. 8c) which effects not only this introduction but also clips firmly part 30 in the groove 53 existing in part 27 guaranteeing thus the complete tightness and inviolability of the gas cylinder.

At the same time, the ball 28 will be slightly pushed down when the bottom side of part 29 touches it loosing the contact with part 33 (Fig. 8d).

The part 30 being made in brass-sheet and having a central hole 56 and the part 29 (see Fig. 6 and 9a—9c) being designed with a special shape are allowing the introduction through them of the regulator gas inlet connection 36, which will be adjusted in the internal orifice of part 29 (2.5 mm diameter) as shown in Fig. 9a—9c).

It will be possible with this new system:

1) To use for filling the canal 31 with a diameter of the order of 6 mm.

2) To replace that canal by the canal of 2,5 mm diameter existing in part 29 for consumption.

3) That the ball 28 effecting the gas sealing in the seat 33 for filling purposes, will be pushed down slightly and, loosing the contact with the part 33, starts sealing the gas in the bottom of part 29 (2,5 mm diameter orifice). This orifice will be ready from now to operate as consumption seat (Fig. 8d).

4) That the valve area where the main sealing parts are found is completely protected from the entry of foreign matters.

5) That the valve-cylinder system is quite inviolable during the way from the filling plant to the consumer.

Thus, we reach the purposes exposed in 4.1, 4.2 and 4.3.

5.2.2—Gas consumption

Once effected the filling, as explained in 5.2.1, the cylinder is sent to the consumption place where the pressure regulator is adjusted to it (see Fig. 9a—9c).

In Fig. 9a it is shown how the regulator is applied. The needle-shaped gas inlet connection 36 with an outside diameter of 2,5 mm will be piercing (Fig. 9b) in the center of the part 29 through the hole 56 existing at the center of part 30 and it will be introduced in the referred part, jointing closely, in order to guarantee a good gas sealing between parts 29 and 36.

The part 36 on coming down inside the part 29 will be pushing down the ball 28 pressing the spring 34 opening thus the gas passage to the part 36 internal canal (1,8 mm diameter).

The ejection force exerted by the gas pressure on the part 36 owing to its small cross section (see Table I) is insufficient to expel the part 36 (and consequently the regulator) from its lodgement in the part 29 reason why it will not be necessary any fixing system between valve and regulator.

The gas will pass then up to the regulator chamber 51 but it will not reach the outlet canal 38 because the gas on-off system composed of parts 37, 46, 47, 48, 49, 50 and 52 is in the most advanced position, closing the chamber 51 owing to the action of spring 49 (Fig. 9b).

The user must then turn round the lever 37 which will make move the on-off plunger 47 by means of the helical ramp 46 and ramp pin 50 pulling the spring 49 to the most backward position (Fig. 9c) opening the chamber 51 and allowing the gas passage to the gas outlet canal through the nozzle 39 and thence to the gas consumption.

The on-off plunger 47 will be maintained at its most backward position by the gas pressure action in chamber 51 which actuates on the forward surface of on-off plunger. The two O-Rings 48 are operating now as piston rings.

Obviously, it is possible for the consumer to close the gas passage at any moment by using the lever in the inverse direction of that he used to open the gas as the chamber 51 receiving the gas from the gas inlet connection 36 is ring-shaped and on moving the plunger 47 ahead the chamber will be confined of both sides by the two O-Rings 48 existing in the stem end.

Should the regulator be removed wrongly from the valve before closing the gas, as indicated before, the pressure will break off at the forward plunger 47 surface and the spring 49 will move ahead automatically the plunger 47 and consequently the O-Rings 48 which will confine the chamber 51 as shown on Fig. 9b avoiding in this way that the volume of gas contained downstream can pass to the atmosphere through the gas inlet connection 36.

The automatic closing will avoid also that the regulator will be introduced in the valve in the "ON" position (gas opened) what could afford danger situations should the gas burner valves be opened.

It will be possible with this new system:

1) To guarantee that the gas pressure action will not eject the regulator from its lodging in the valve, becoming unnecessary any complex mechanical fixing systems.

2) To turn the gas flow off independently of the closing of the valve.

3) To obtain the automatic gas closing when the regulator is removed from the valve and maintain this situation while the consumer will not actuate voluntarily to open the gas.

Thus, it will be reached the purposes 4.4, 4.5 and 4.6.

5.2.3—Refilling (see Fig. 10a—10c)

Once the gas contained in the cylinder is consumed the consumer will remove the regulator from the valve and will send the cylinder with the valve to the filling plant.

The filling plant must remove the parts 29 and 30 from the valve so that the system comes back to the same position as indicated in 5.2.1 and according to Fig. 8a.

The parts removal operation is named "decapsulation".

The part 29 is made in synthetic rubber and its sizes studied in such a way that, when exerting a compression with a specially designed device 57 (Fig. 10a—10c) at its top the volume of the rubber contained between the parts 27 and 30 flows hydraulically to the periphery exerting an adequate force in the interior surface of the "capsula" 30 to extract it from the groove 53 (Fig. 10b).

The parts 29 and 30 are then removed from the top of part 27 and they must be scraped.

The valve will be now in conditions to allow a new filling operation and then a new cycle can start.

TABLE I
L.P.G. Valve and Regulator Systems
Dimensions of conventional systems at connection zone, compared with "Capsula system"

Systems	Ø Seat mm	Seat area cm^2	Ø Connection mm	Connection area cm^2	Connection perimeter mm	Expulsion force at connection (kp): From gas pressure (6,87 bar.)	From compression of rubber pieces	From compression of springs	Total
Petrogal	14,5	1,65	7	0,39	22	2,73	0	7	9,73
Shell	7,95	0,5	13	1,33	40	9,31	3,8	4,5	17,61
Rego clip-on	7,8	0,5	9,3	0,68	29	4,76	0	1,8	6,56
Click-Kosan	4	0,13	25,7	5,2	81	2,6	70	2,2	74,8
Compact Kosan	6,3	0,32	8,7	0,6	27	4,2	16	1,8	22
Capsula	3	0,07	2,3	0,04	7,2	0,28	0	0,05	0,33

Claims

1. A valve for a fuel gas cylinder including a filling (31) and outlet canal closed by perforatable sealing means (29), which in use is perforated by a hollow needle (36) through which the gas is delivered, characterised in that a spring loaded check valve (28, 34) is provided in said canal (31) and that said sealing means (29) is provided with a cylindrical part having an axial bore, said cylindrical part being fitted within said canal (31), whereby on use said needle (36) extends through said bore to open said check valve (28, 34).

2. A valve according to claim 1, characterised in that the sealing means (29) is tightly mounted to a valve body (25, 27) containing said canal (31) by means of a capsula (30) firmly clipped to the valve body (25, 27).

3. A valve according to claim 2, characterised in that the portion of the sealing means (29) outside the canal (31) has a volume and a geometry such that, when subjected to a mechanical deformation, it releases the capsula (30) from the valve body (25, 27).

4. A combination of a pressure regulator and the valve according to anyone of the claims 1 to 3, characterised in that the hollow needle (36) is mounted to the pressure regulator and has a diameter small enough to avoid means for mechanically clamping the pressure regulator to the valve.

5. A combination according to claim 4, characterised in that the pressure regulator comprises a gas pressure controlled device (47, 48, 49, 51) that automatically cuts the gas flow when the pressure regulator is removed from the valve and shuts off the gas flow when inserting the pressure regulator in the valve.

Patentansprüche

1. Ventil für einen Betriebsgaszylinder mit einer Füllung (31) und einem durch eine durchstoßbare Dichtungseinrichtung (29) geschlossenen Ausgangskanal, wobei die Dichtungseinrichtung im Gebrauch durch eine hohle Nadel (36), durch die Gas geführt wird, durchstossen wird, dadurch gekennzeichnet, daß im Kanal (31) ein federbelastetes Absperrventil (28, 34) vorgesehen ist, und daß die Dichtungseinrichtung (29) mit einem eine axiale Bohrung aufweisenden zylindrischen Teil versehen ist, das in den Kanal (31) eingepaßt ist, wodurch sich die Nadel (36) im Gebrauch zur öffnung des Absperrventils (28, 34) durch die Bohrung erstreckt.

2. Ventil nach Anspruch 1, dadurch gekennzeichnet, daß die Dichtungseinrichtung (29) mittels einer fest auf einen Ventilkörper (25, 27) geklemmten Kapsel (30) fest auf diesen den Kanal (31) enthaltenden Ventilkörper (25, 27) montiert ist.

3. Ventil nach Anspruch 2, dadurch gekennzeichnet, daß der Teil der Dichtungseinrichtung (29) außerhalb des Kanals (31) ein solches Volumen und eine solche Geometrie besitzt, daß es bei Einwirken einer mechanischen Deformation die Kapsel (30) vom Ventilkörper (25, 27) löst.

4. Kombination eines Druckreglers und des Ventils nach den Ansprüchen 1 bis 3, dadurch gekennzeichnet, daß die hohle Nadel (36) am Druckregler montiert ist und einen Durchmesser besitzt, der klein genug ist, um eine Einrichtung zum mechanischen Befestigen des Druckreglers am Ventil zu vermeiden.

5. Kombination nach Anspruch 4, dadurch gekennzeichnet, daß der Druckregler eine durch Gasdruck gesteuerte Einrichtung (47, 48, 49, 51) aufweist, die den Gasfluß automatisch unterbricht, wenn der Druckregler vom Ventil entfernt wird, und den Gasfluß absperrt, wenn der Druckregler in das Ventil eingesetzt wird.

Revendications

1. Robinet pour bouteilles à gaz combustible comprennant un canal de remplissage et de sortie du gaz (31) fermé par un joint d'étanchéité destiné à être percé par un aguille creuse (36) à travers de laquelle le gaz sortira pour l'usage, caracterisé par l'existence d'un clapet à retention actionné par un ressort (28, 34) dans le canal référé (31). Le joint d'étancheité ci-dessus référé (29) contient une partie cylindrique que s'ajuste à l'intérieur du canal (31) et contient un trou axial à travers du quel l'aguille référée (36) passera lorsqu'elle est utilisée et qui ouvrira le clapet (28) en pressant le ressort (34).

2. Robinet selon la revendication 1, caracterisé par le montage étanche du joint d'etancheité (29) dans le corps du robinet (25, 27) contenant le canal référé (31) au moyen d'une capsule (30) fixée fermement au corps du robinet (25, 27).

3. Robinet selon la revendication 2, caracterisé par le fait de la partie du joint d'étancheité (29) au dehors du canal (31) avoir un volume et géométrie tels qu'en étant sujette à une déformation mécanique, permet l'extraction de la capsule (30) du corps du robinet (25, 27).

4. La combinaison d'un régulateur de pression et du robinet selon quelqu'une des revendications 1 à 3, caracterisée per l'existence de l'aiguille creuse (36) montée dans le régulateur de pression et ayant un diamètre sufisament petit de façon à permettre la fixation du régulateur de pression au robinet sans besoin de recourir à des moyens mecaniques.

5. La combinaison selon la revendication 4, caracterisée par l'existence d'un système controlé par la pression du gaz (47, 48, 49, 51) dans le régulateur de pression, laquelle ferme automatiquement le passage du gaz lorsque le régulateur de pression est retiré du robinet en fermant aussi le passage du gaz quand le régulateur de pression est raccordé au robinet.

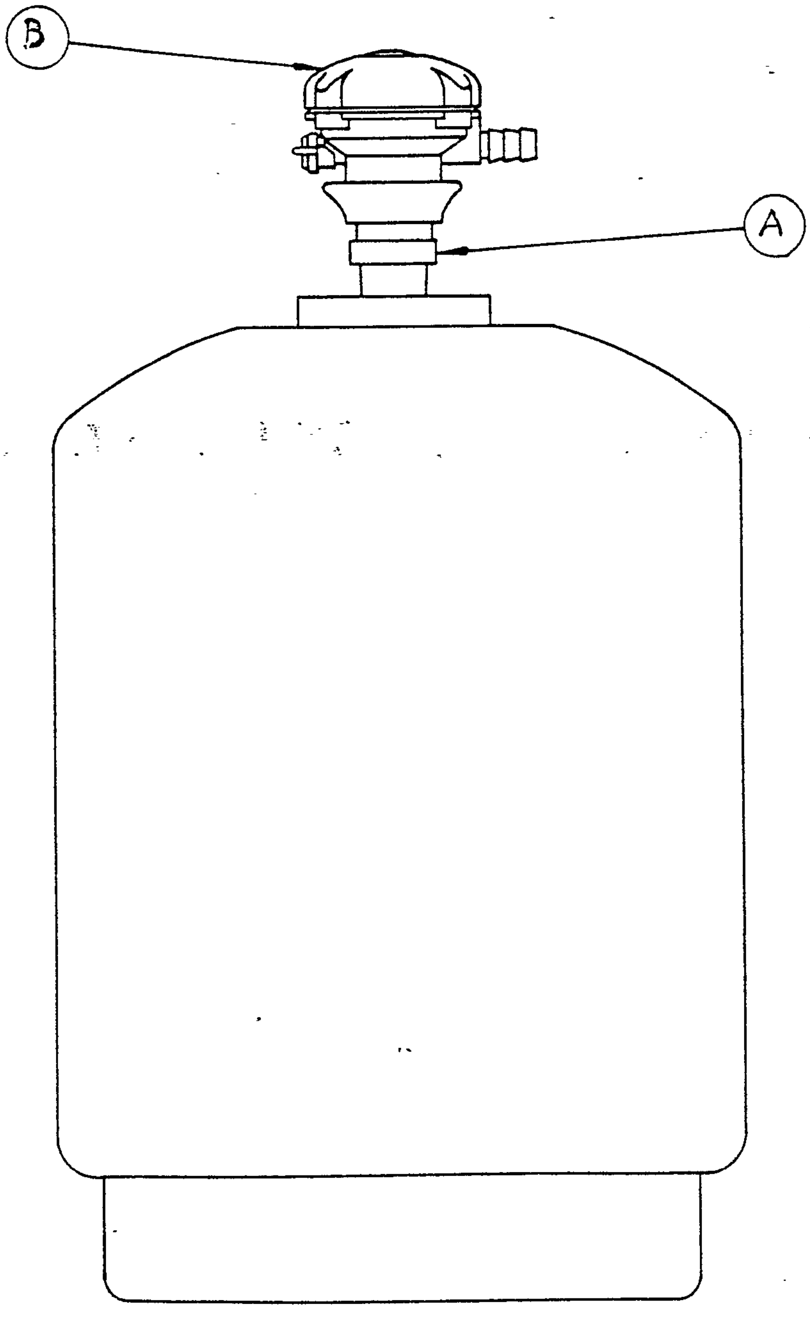


Fig. 1

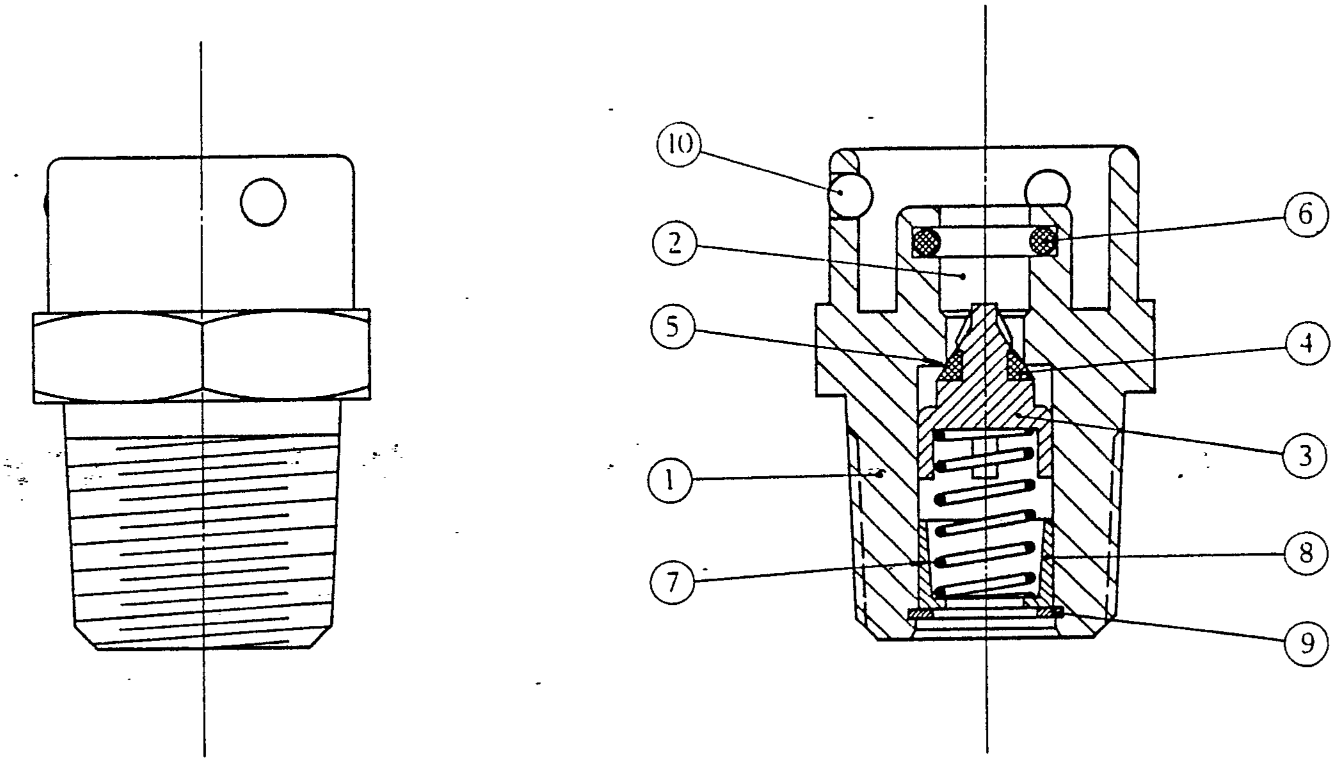


Fig. 2

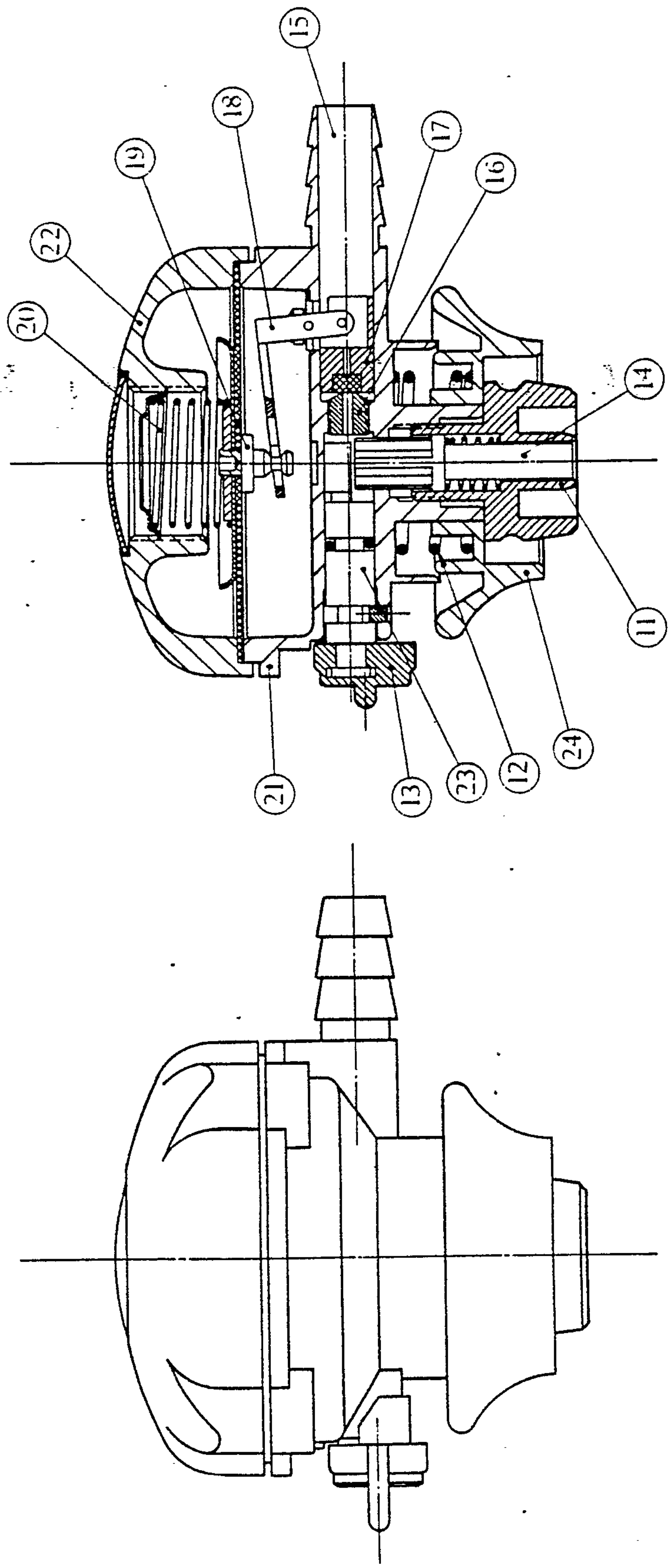


Fig. 3

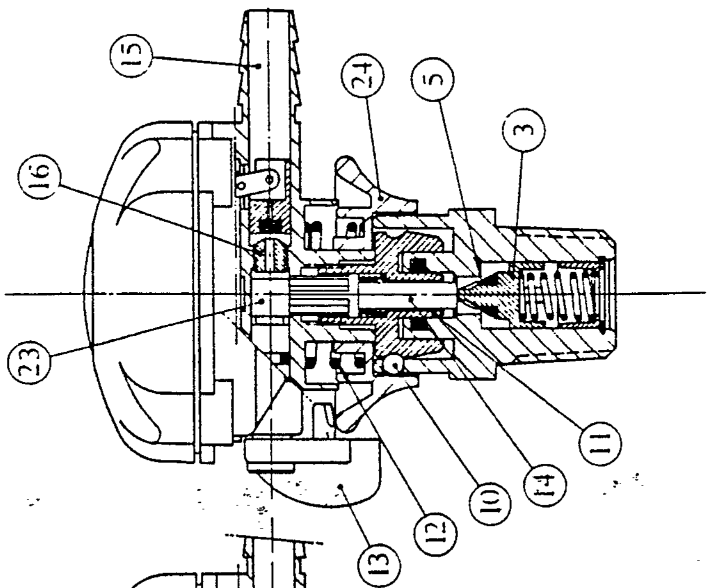


fig. 4d

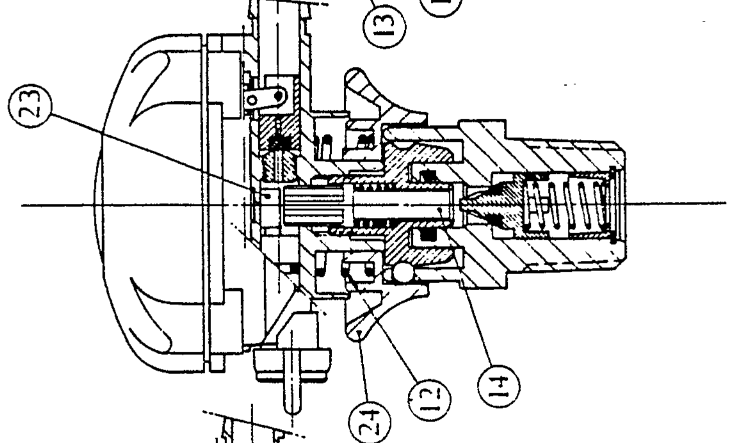


fig. 4c

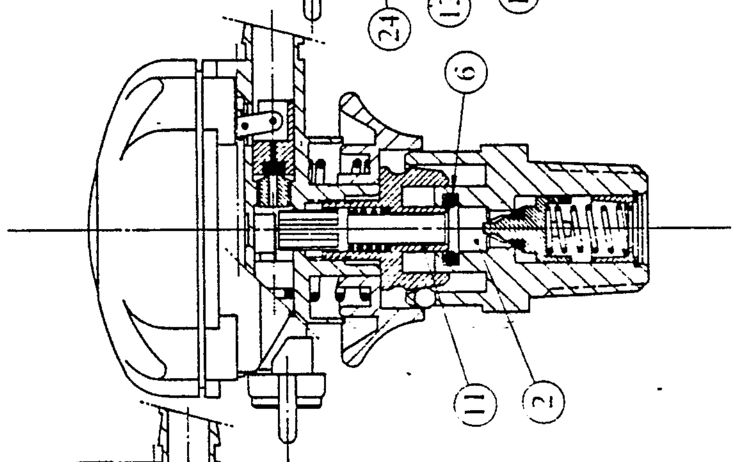


fig. 4b

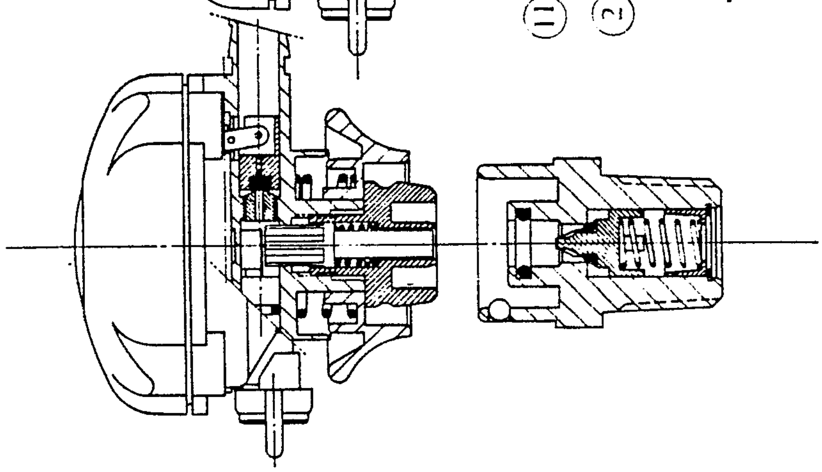


fig. 4a

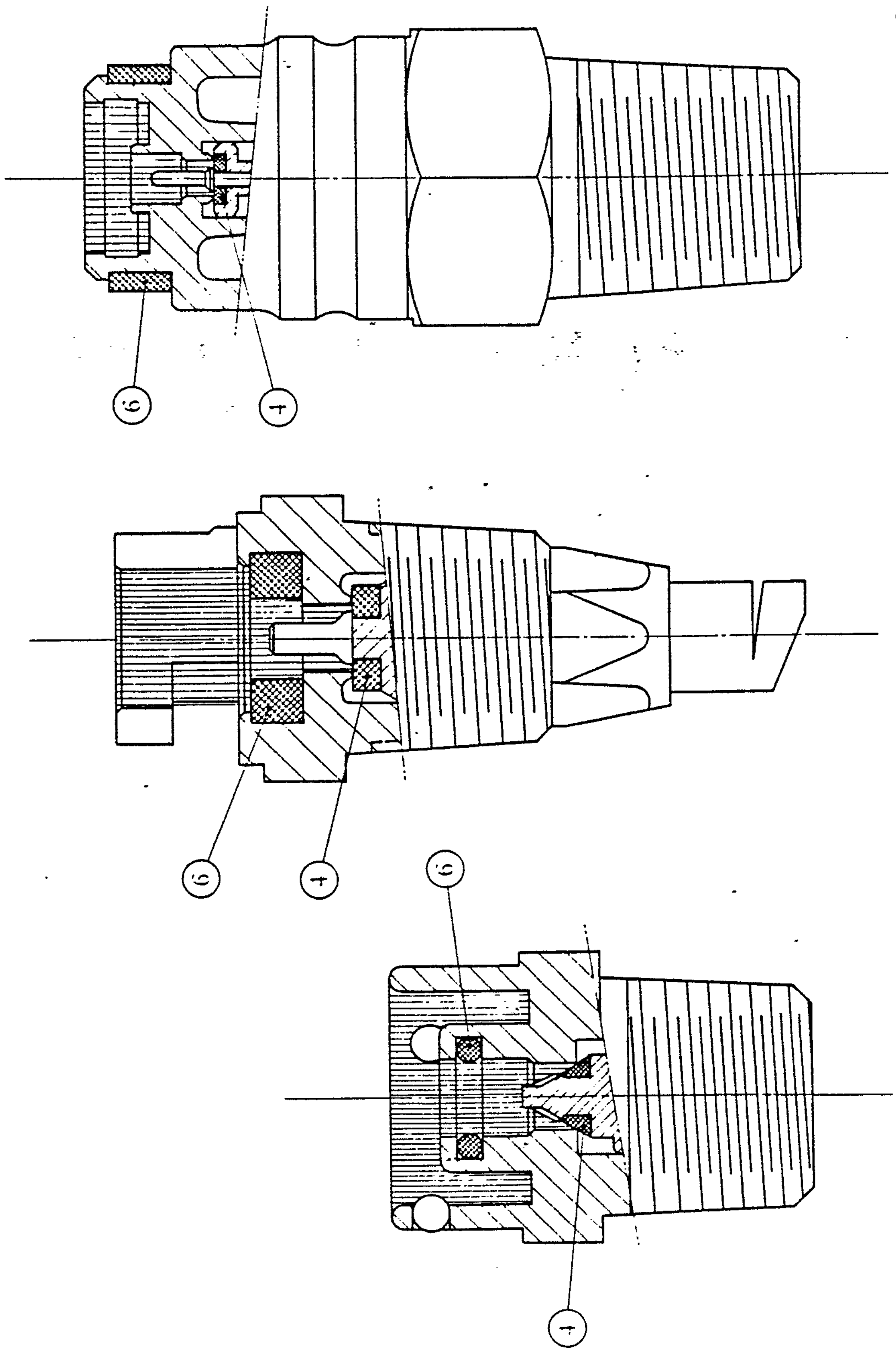


Fig. 5

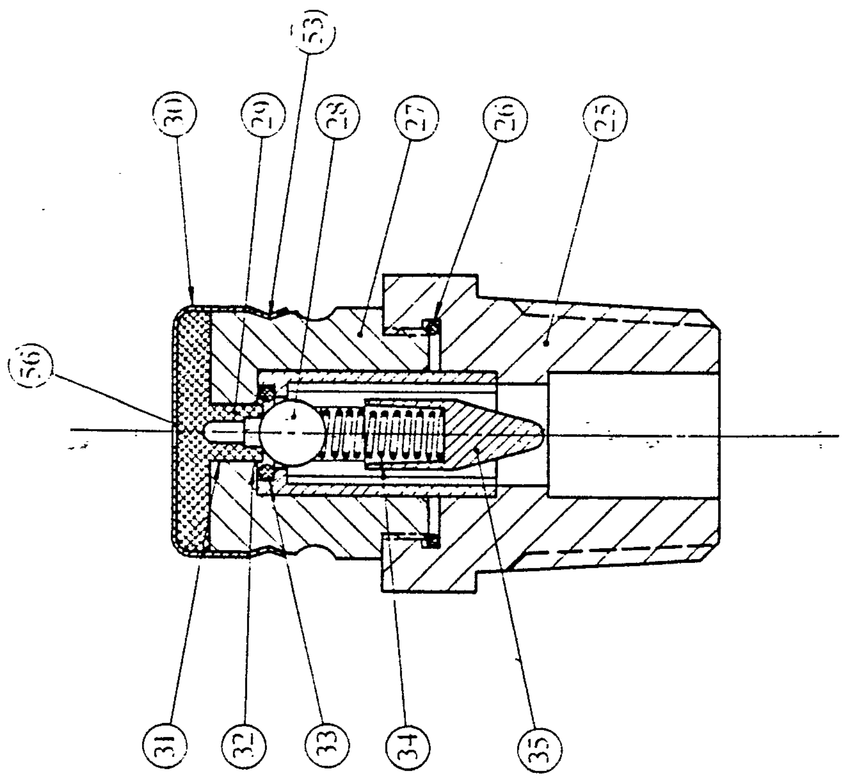
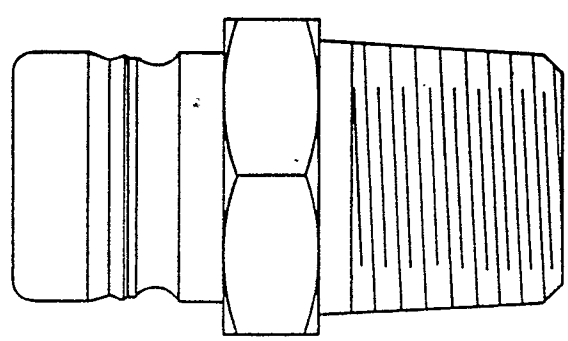


Fig. 6



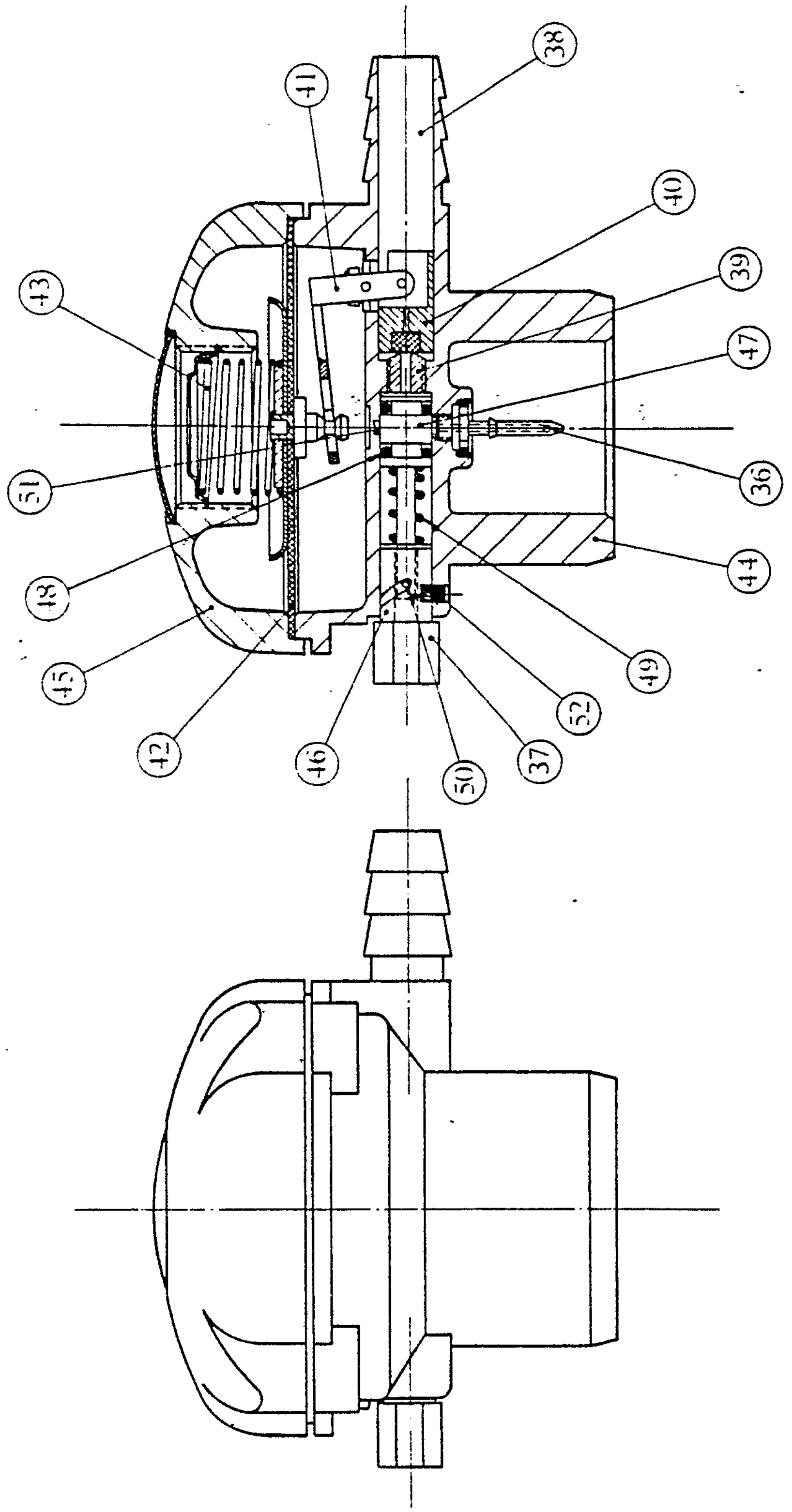


Fig. 7

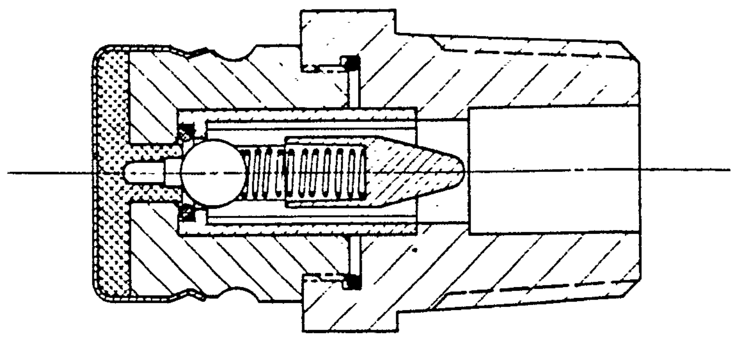


fig. 8d

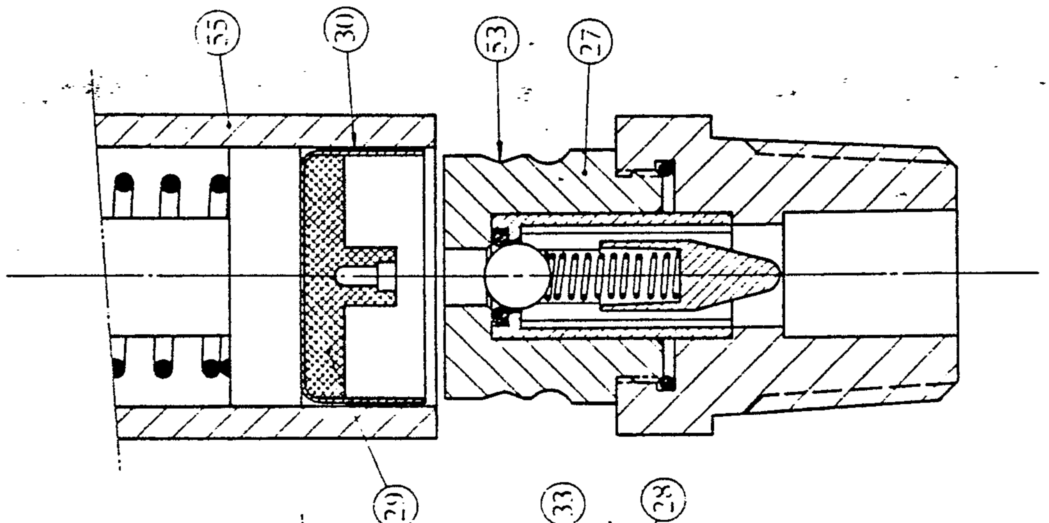


fig. 8c

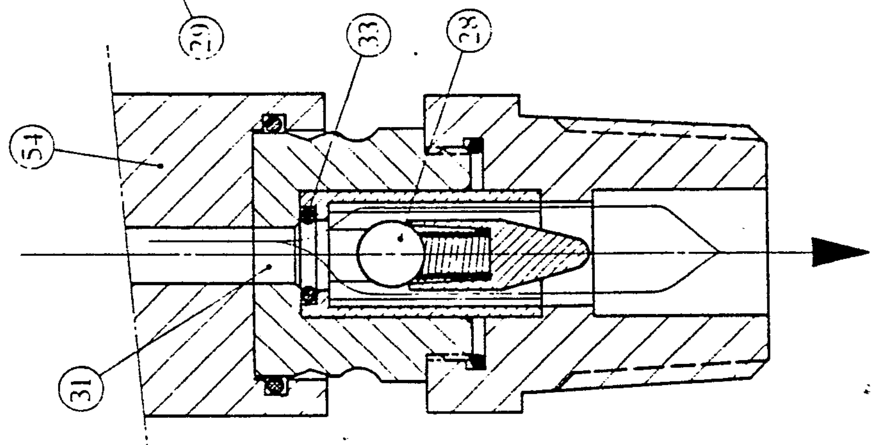


fig. 8b

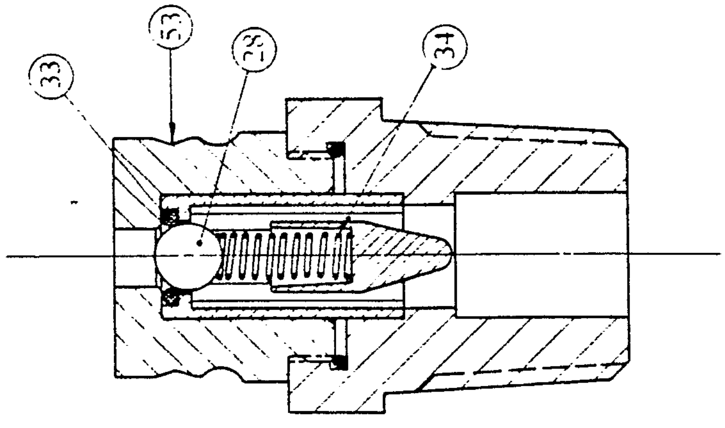


fig. 8a

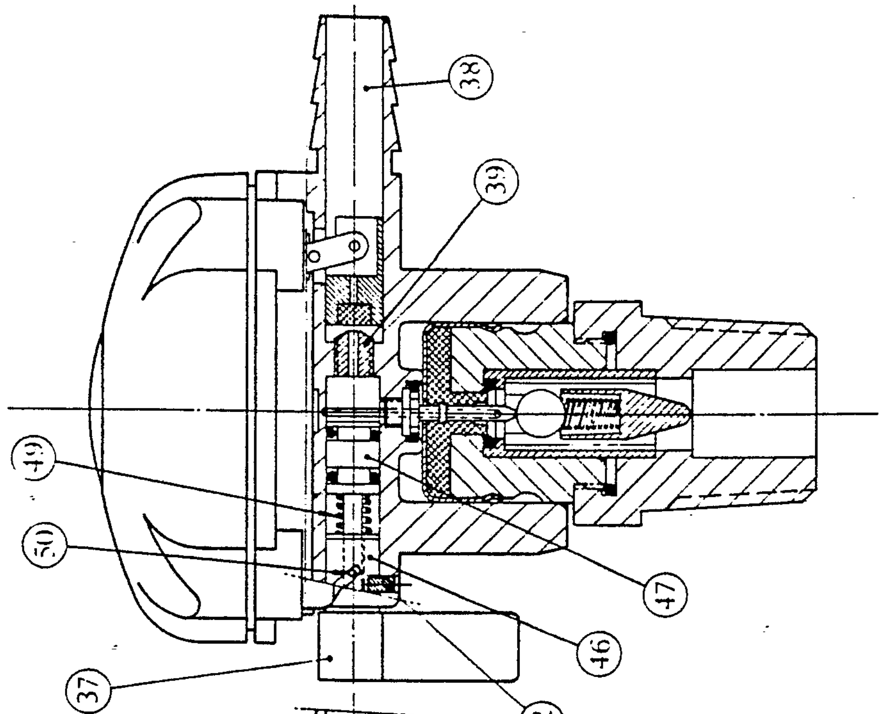


fig. 9c

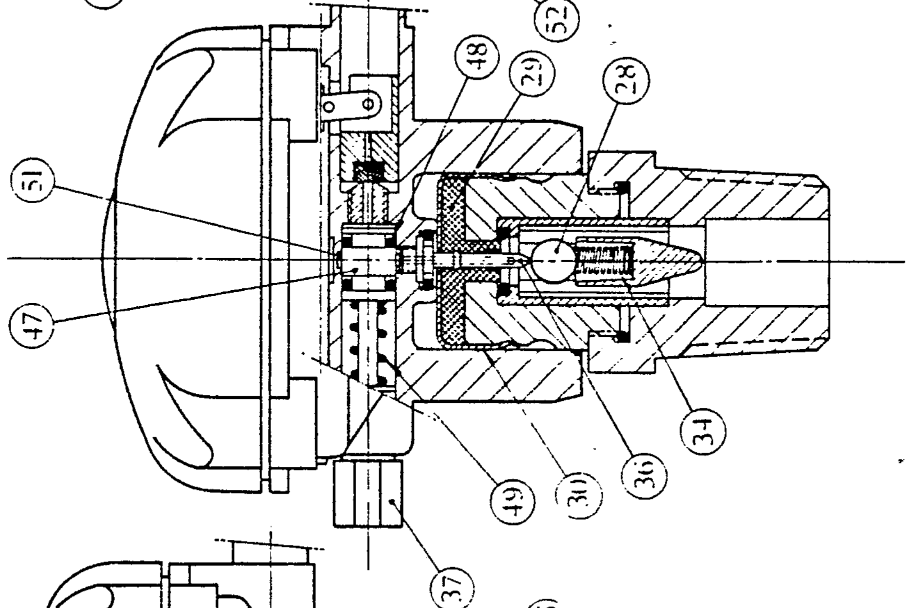


fig. 9b

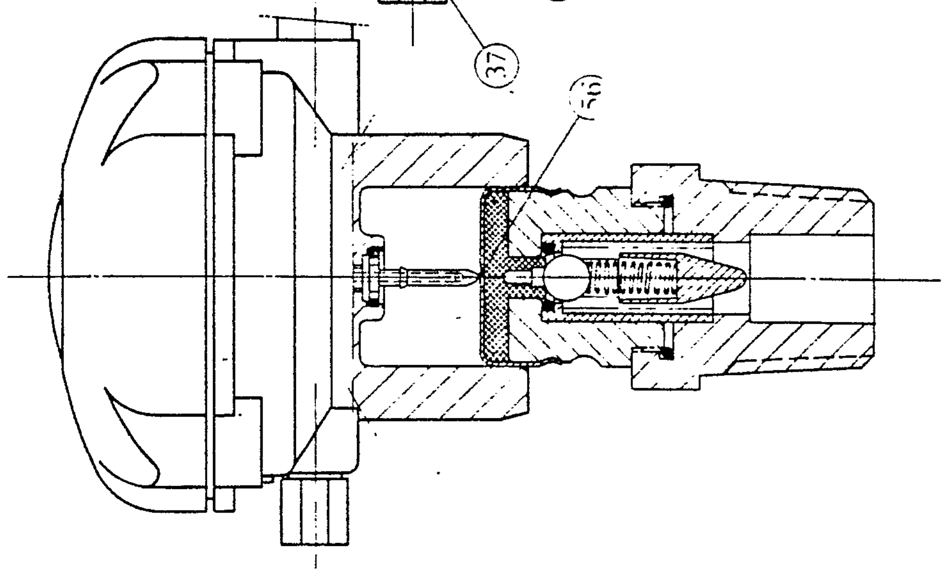


fig. 9a

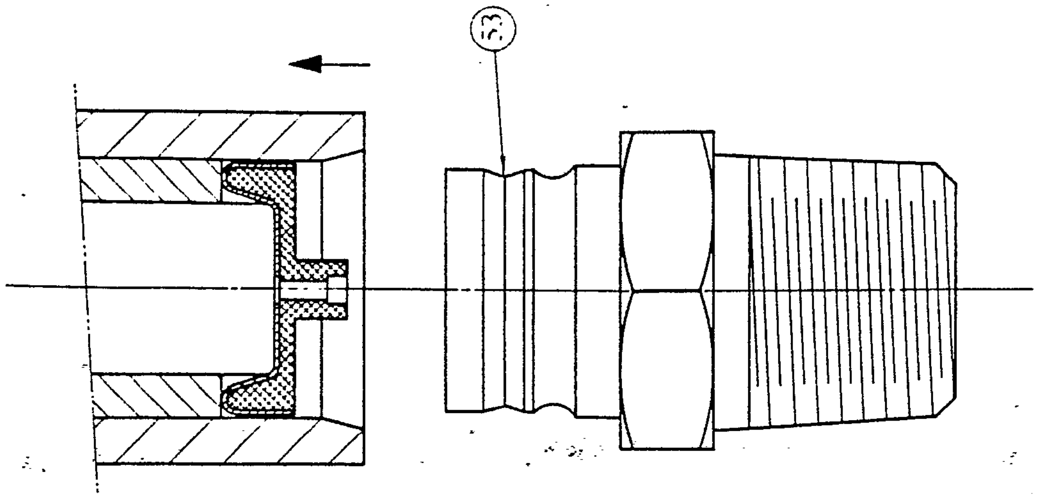


fig 10c

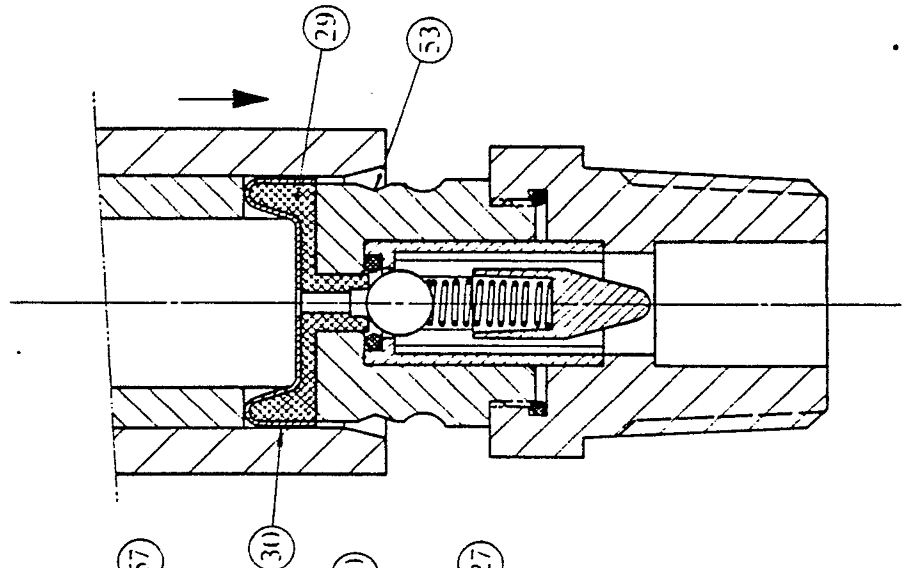


fig 10b

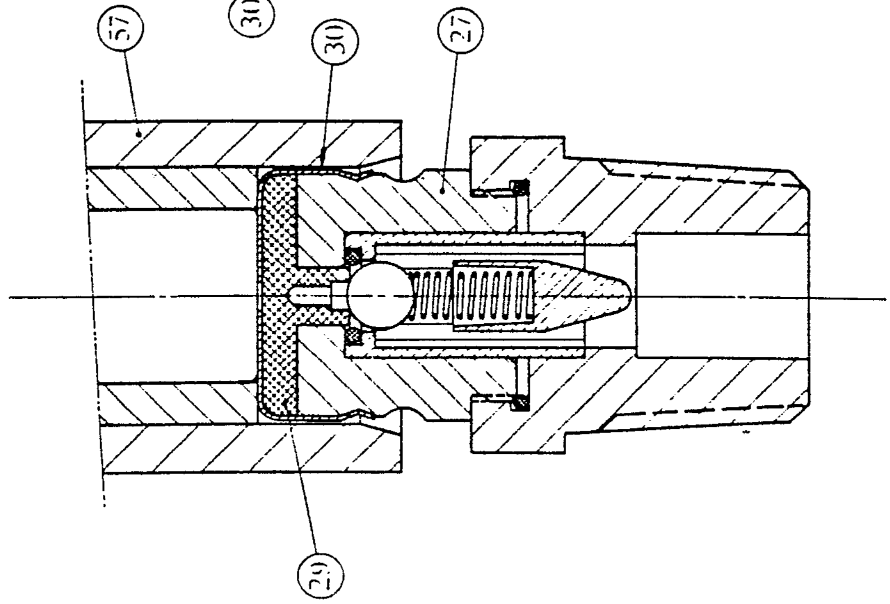


fig 10a