July 22, 1969 R. LEGRAND 3,456,673

LARGE-CAPACITY BELLOWS-TYPE HYDRAULIC RESERVOIR

Filed Nov. 1, 1967 3 Sheets-Sheet 1

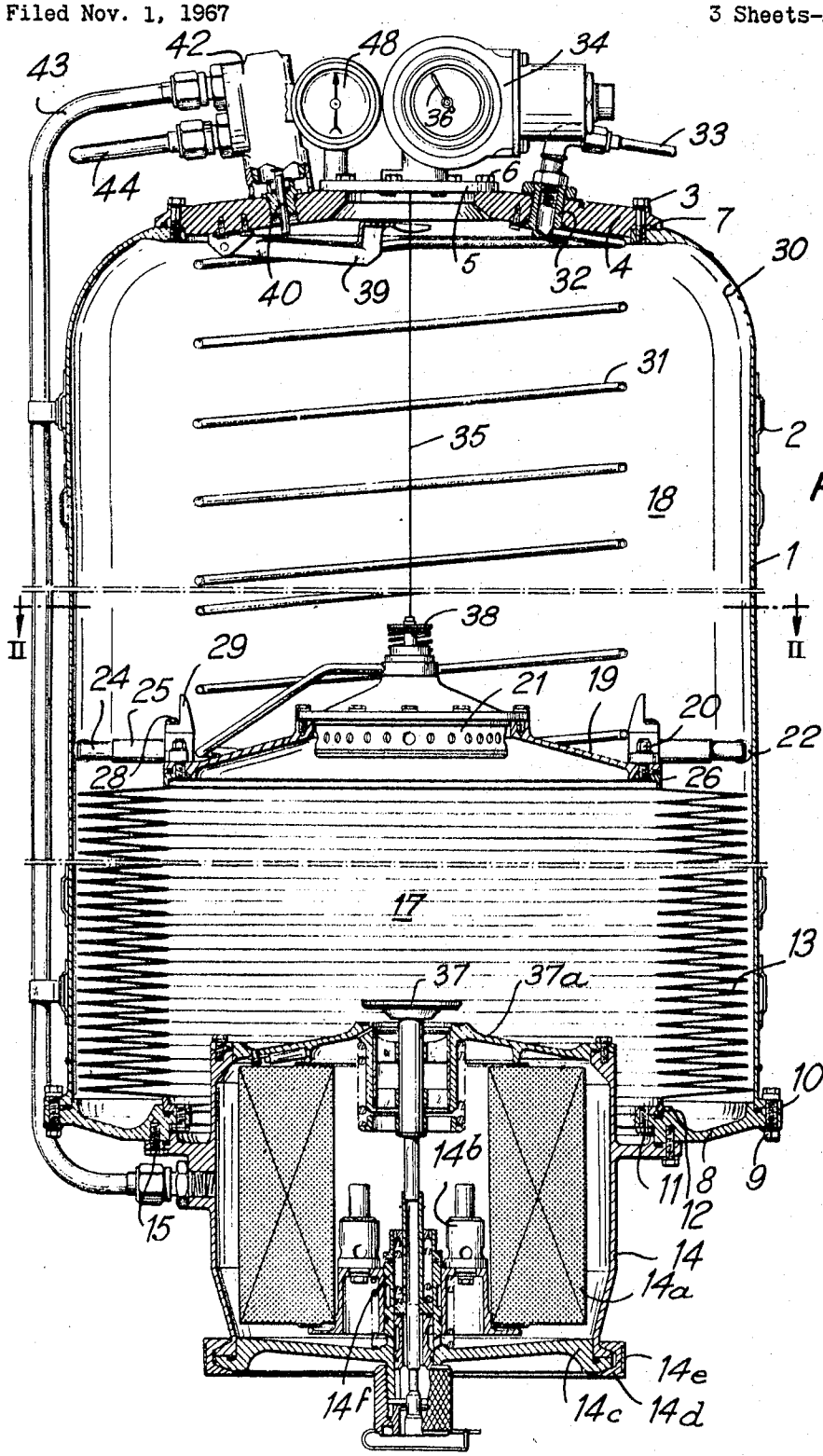


Fig. 1.

LARGE-CAPACITY BELLOWS-TYPE HYDRAULIC RESERVOIR

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Fig.2.

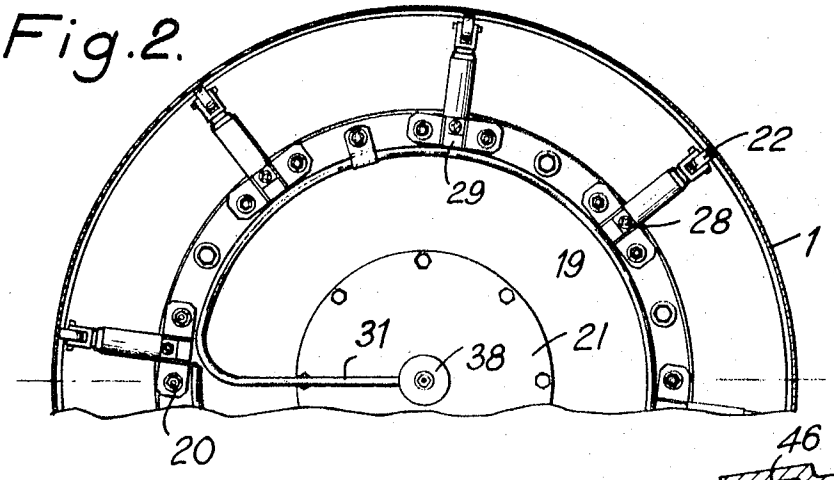
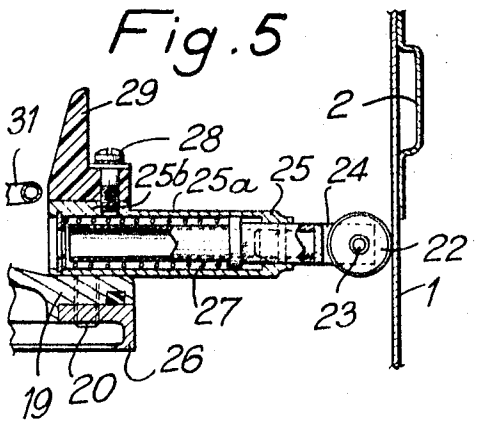


Fig.5



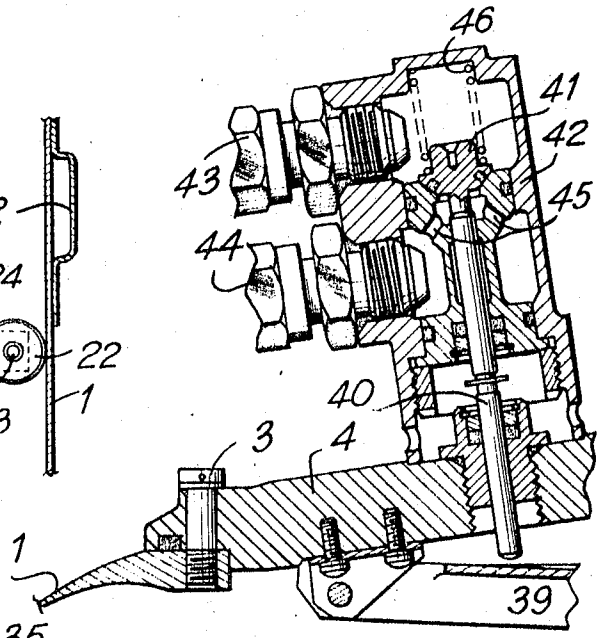
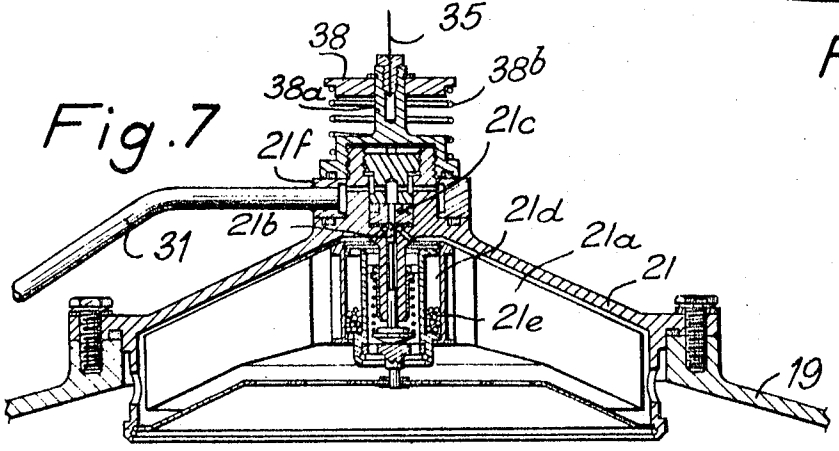


Fig.6

Fig.7



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LARGE-CAPACITY BELLOWS-TYPE HYDRAULIC RESERVOIR

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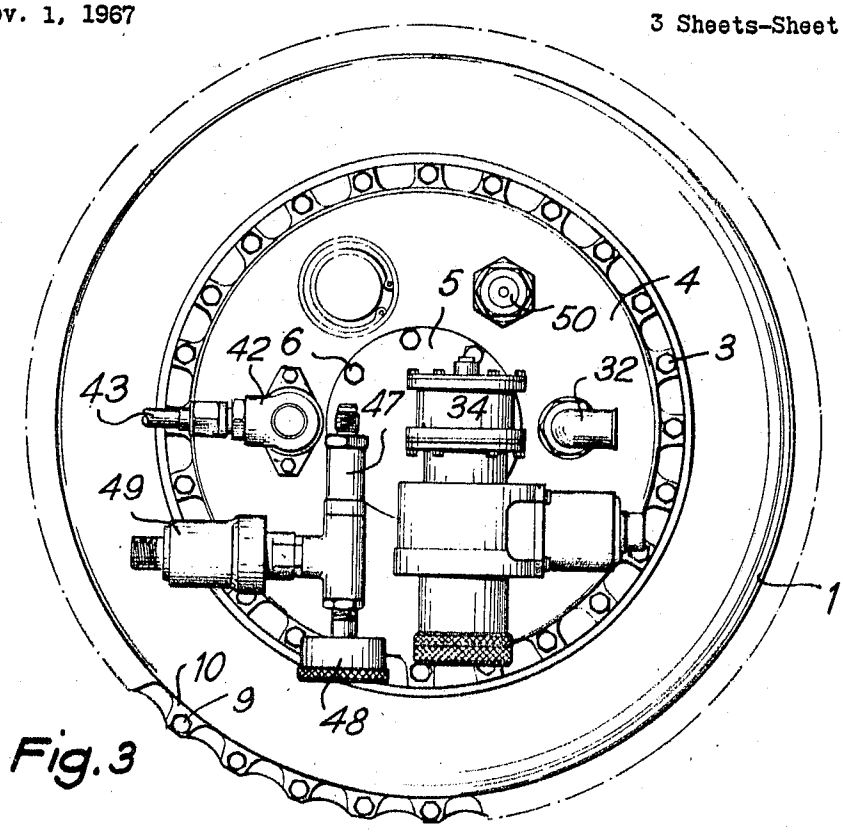


Fig. 3

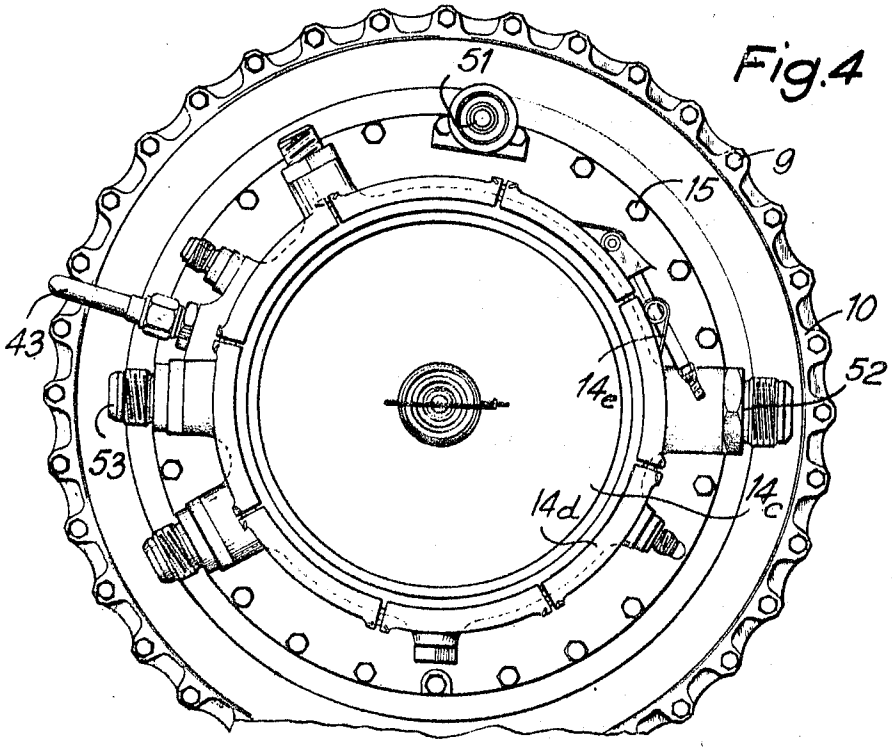


Fig. 4

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LARGE-CAPACITY BELLOWS-TYPE HYDRAULIC RESERVOIR

Roger Legrand, Toulouse, France, assignor to Sud-Aviation Société Nationale de Constructions Aéronautiques, Paris, France

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Int. Cl. F15b 1/04
U.S. Cl. 137—202 8 Claims

ABSTRACT OF THE DISCLOSURE

A large size hydraulic reservoir for accumulating a fluid usable in a hydraulic circuit, particularly though not exclusively on board an aircraft, wherein the reservoir comprises a hydraulic chamber separated from a pneumatic chamber formed by the outer casing of the reservoir by an internal bellows made of an elastic material and having a first end leaktightly attached to a corresponding end of the casing and a second end freely movable within the casing. A degassing device is coupled to the second end of the bellows for movement therewith and this movement is guided by radial roller devices which engage the inner surface of the outer casing and an end closure at the second end of the bellows. A gauge is supported on the casing for indicating the volume of the hydraulic chamber in accordance with the position of the second end of the bellows in the casing. A safety valve is also supported on the casing for depressurizing the hydraulic chamber in response to travel of the second end of the bellows beyond a limit position in the casing wherein an actuator device for the safety valve is contacted. Also supported on the casing is a depressurizing bleeder indicator for depressurizing the pneumatic chamber.

The present invention relates to a hydraulic fluid reservoir for accumulating a fluid usable in a hydraulic circuit, more particularly though not exclusively aboard an aircraft, the reservoir being characterized by the fact that it is of large size and comprises a hydraulic chamber segregated from a pneumatic chamber consisting of the outer reservoir casing by means of an internal bellows made of an elastic material and having one of it sends leaktightly connected to one end of said casing and its other end, which is movable within said casing, associated with guiding means, degassing means, coupling means, control means of a gauge supported by said casing and with control means of a safety valve, said casing further comprising a depressurization bleeder-indicator.

This invention relates to a hydraulic reservoir for accumulating a fluid usable in hydraulic circuits, more particularly though not exclusively on aircraft, and this large-capacity reservoir comprises a hydraulic chamber separated from a pneumatic chamber constituting the outer casing of the reservoir by an internal bellows made of elastic material and having one of its ends leaktightly connected to one end of said casing and its other end, which is free in said casing, associated with guiding means, degassing means, coupling means, control means of a gauge carried by said reservoir casing and control means of a safety valve, the reservoir casing itself comprising in addition a depressurizing bleeder-indicator.

The purpose of this arrangement is to ensure, by means of the bellows and the degassing means, correct segregation of the hydraulic fluid and the air, protection of the bellows itself against deterioration, freedom for volumetric changes taking place in the bellows, and correct operation of the ancillary devices associated to the bellows and referred to above.

In one particular form of embodiment, the reservoir is further equipped with a pressurizing check-valve, a direct-reading pressure gauge, a warning pressure-switch for sensing pressure drops, an air overpressure valve and a filter the casing of which contains the corresponding protection and check valves.

The fitting of such a reservoir into a hydraulic circuit is well known, and indeed its use is by no means restricted to aeronautical environments. The fluid it contains is sucked out by a pump and drains back into it after it has been used in the different hydraulic devices of the hydraulic circuits.

A reservoir of this kind has multiple functions.

In an aircraft hydraulic circuit, for instance,

The reservoir acts a reserve of liquid in the circuit and makes it possible to compensate for the slight seepage which occurs in service, especially in flight;

The reservoir makes it possible to compensate for changes in volume of the circuit fluid in the course of aircraft operations, for with an aircraft in supersonic flight, for example, the temperature may vary between −20° C. and +125° C. (and exceptionally +150° C.), which causes large changes in fluid volume as a result of the different coefficients of expansion of the fluid and the casing; these changes in temperature may also be due to the aircraft operating conditions, as for instance when flying from a hot climate to a cold climate, or vice versa; further, the conversion into heat of the energy spent in the circuit, for example by the pumps, the hydraulic actuators and the servo-controls, will also result in changes of temperature;

The reservoir compensates for changes in the volume of the circuit fluid during operation of such servo-systems as the retractable landing-gear and its associated doors, and the like, which do not as a rule employ actuators with equal chambers;

By means of its bellows, the reservoir segregates the fluid and the air at low pressure, say at 5.8 bars of absolute pressure; this segregation is necessary in order to avoid oxidation of the hydraulic fluid; the continuous degassing by means of the degassing device fixed to the bellows helps to prevent such oxidation while at the same time improving the dynamic response of the servo-controls;

In addition to guiding the bellows by its upper end, the guiding means avoids any error in the indications given by the gauge or incorrect operation of the safety valve or its control elements, and invariably ensures that the top of the bellows presents itself correctly in relation to the various components cooperating with it.

The various structural parts are designed to ensure minimum weight consistent with good durability and fatigue strength.

The description which follows with reference to the accompanying non-limitative exemplary drawing will give a clear understanding of how the invention can be carried into practice.

In the drawing:

FIGURE 1 shows a reservoir according to the present invention in axial section and with partial cutaway.

FIGURE 2 is a partial section through the line II—II of FIGURE 1.

FIGURE 3 is a top view corresponding to FIGURE 1.

FIGURE 4 is an underneath view corresponding to FIGURE 1.

FIGURE 5 is a sectional view on an enlarged scale of one of the devices for guiding the bellows against the inside face of the reservoir casing.

FIGURE 6 is a sectional view on an enlarged scale of the disposition of the safety valve.

FIGURE 7 is a similar view of the disposition of the degassing means.

In the specific constructional form illustrated in the drawing, the reservoir consists of a cylindrical casing 1

made of titanium or stainless steel and is lined internally with a metallized material such as the polytetrafluoroethylene-based material known as Teflon, in order to protect the bellows (to be described hereinafter) in the course of its movements. Four spot-welded hoops **2** enable the hydraulic reservoir to be secured in the vertical position by means of a cradle and two straps.

To one end of the casing is welded a reinforced rim to which there is secured, by means of screws **3**, a ring **4** which receives in turn a cover **5** secured in position by means of screws **6**, sealing joints **7** being accommodated in associated grooves for ensuring leaktightness between the reinforced rim and the ring **4** and between the latter and the cover **5**.

The lower end-closure of casing **1** consists of a collar **8** secured by means of screws **9** to a flange **10** welded to casing **1**. To the inner face of collar **8**, on the inward side thereof, there is fixed, by means of screws **11**, the terminal flange **12** of a bellows **13**. To the outside face of collar **8** is fixed a filter housing **14**, through the medium of a securing flange formed thereon and a set of screws **15**. Sealing gaskets are interposed between these various parts.

The bellows **13**, which has a large diameter of the order of 350 mm., is made of a material such as that known under the trade name "Inconel X 750," which possesses great mechanical strength (in excess of 100 hectobars after treatment) and segregates the hydraulic fluid contained in the space **17** within the bellows from the pressurization air contained in the chamber **18** within the casing **1** but outside the bellows **13**.

The top of bellows **13** bears a flange **26** to which there is fixed, by a set of screws **20**, the support **19** for the degasser housing **21** and a set of guiding devices **22** for the bellows. These guiding devices **22** are roller-mounted in radial-fashion equidistantly on the perimeter of support **19**, as shown in FIGURE 2. The rollers are preferably chromium-plated. As FIGURE 5 clearly shows, each roller **22** is mounted on an axle **23** carried in a clevis **24** formed with a shank which is slidable inside a support **25** formed with a cylindrical portion **25***a* terminating in a reinforcement **25***b* secured in position by screws **20**. These reinforcements **25***b* are thus rigidly united with the degasser support **19** and the flange **26**. Inside cylindrical portion **25***a* a spring **27** is inserted between a circlip positioned at the bottom of the cylinder and a collet integral with the shank extension of clevis **24**. These several springs help to take up any play and ensure continuous contact between rollers **22** and the inner lining of cylindrical casing **1**, thus protecting the bellows not only against shocks on the casing during handling or while in service but also against accidental lop-sided positioning of the top of the bellows, which would cause friction between said lining and the edges of the folds in the bellows, thereby impairing freedom of movement.

Each reinforcement **25***b* is surmounted by a guide **29** secured by a screw **28**, and these guides jointly ensure correct stacking of the turns of a coil **31** which will be described in greater detail hereinafter.

The degasser contained in housing **21** is of known design and it comprises a float **21***a* adapted to operate a needle **21***b* whereby to apply the same against an associated seat **21***c*. Float **21***a* is designed to withstand high temperatures of the order of 150° C. and an absolute pressure of the order of 6 bars; it is accordingly made of an epoxy-resin/hollow-microball complex; it is rigid with a housing **21***d* contained in the body of the float, which can be loaded adjustably with granules **21***e* so as to fix the weight of the float according to the density of the fluid being used.

Any gas or gas emulsion in the hydraulic fluid being used which should happen to fill the frusto-conical space formed by the perforated housing of float **21***a* beneath cover **21** would cause a drop in the level of the liquid and a descent of float **21***a*, causing the needle **21***b* to open and the said gas or emulsion to escape. The seat **21***c* is contained in the top of cover **21**, which cover comprises an arrangement of ducts and grooves extending up to a union **21***f* joined to a coil-shaped degassing tube **31** beneath a screwed plug **38***a*. The spiral form of coil **31** does not hinder freedom of movement of the bellows despite the fact that it extends up to a fixed union **32** which passes through the ring **4** and is joined to a gas or gas emulsion discharge tube **33**.

The hydraulic reservoir has associated with it a gauge **34** the case of which is fixed to the cover **5**. This gauge measures the level reached by the top of the bellows containing the hydraulic fluid and consequently measures the accumulated volume by noting the height of the bellows, by means of a cable **35** which is attached by a cable clamp or a cable ferrule to an extension of screwed plug **38***a* fitted to the top of the degasser cover **21**, said cable passing through the upper cover **5** via a suitable opening therein and being wound on to the drum of a capstan enclosed leaktightly within the case of gauge **34**. The rotation of the capstan is transmitted, through a reduction gear, to the gauge needle **36** which moves behind a transparent window over a graduated dial, and to a synchro-transmitter, for example for remote-display purposes. This transmission mechanism includes a cam (not shown) for operating two microswitches (not shown) the function of which is to identify two determinate levels. The cam and the microswitches are contained in the leaktight housing of the gauge.

Since the degasser ensures complete absence of any air, the displacement of the bellows and the indications given by the gauge therefore correspond exactly to changes in volume of the hydraulic fluid, for the tie **35** invariably extends exactly below the capstan since the top of the bellows is never askew.

Within the filter housing **14** is a cylindrical and hollow filtering element **14***a* retained elastically between a fixed support and a spring-loaded annular movable support which comprises safety valves **14***b* designed to protect the filtering element **14***a* in the event of clogging.

The filter housing includes a cover **14***c* fitted with a sealing joint, and this cover is retained in position by a girdle formed by the links of a chain **14***d* which hug the matching oblique bearing surfaces of housing **14** and cover **14***c* the chain links being additionally surrounded and tightly gripped by a flat metal strap **14***e* the ends of which are drawn together by a screw-tensioner.

The cover **14***c* is provided internally with a tubular extension **14***f* over which are guided the support for valve **14***b* and the bottom of the filtering element. Within this extension is a leaktightly slidable unit controlled by an externally accessible knurled thumbscrew locked in position by a pin, and, within the filter housing itself, a tubular pushrod into which is abuttingly socketed the end of the stem of a valve **37** which is located inside the bellows and is urged by a spring on to a seat formed at the center of an inner end closure **37***a* of housing **14**.

The valve **37** obviates the need to drain the bellows when the filtering element requires to be cleaned or replaced.

Mounted at the top of the reservoir, on the ring **4**, is a safety valve **42** which becomes operative as soon as the bellows **13** oversteps a critical filling point as it dilates. This valve is activated as soon as a washer **38** which forms part of the assembly surmounting the degasser housing **21** and which is slidably mounted on the extension of the cable attachment **35** and is urged against an upper stop by a spring **38***b*, actuates the terminal fork of a lever **39** pivotally connected to a support screwed to the interior of the ring **4**, this lever cooperating with a pushrod **40** extending leaktightly through bearings provided with sealing glands fixed to ring **4** and within valve housing **42**. The top of pushrod **40** is fitted with a valve-head **41** which is urged by a spring **46** onto a seat which

separates the outlet of a conduit **43** leading from the filter housing **14** from a discharge conduit **44** and from holes **45** formed beneath the seat in the guide for rod **40** to ensure the required flow. As soon as bellows **13** reverts to a normal position, contact ceases between washer **38** and the arms of the terminal fork of lever **39**, causing spring **46** to return valve **41** onto its seat and thereby ensure leaktightness in all normal positions of the bellows.

On ring **4** are additionally mounted a direct-reading pressure-gauge **48** equipped with a pressure switch **49** which closes an alarm circuit if there is a drop in the pressurization pressure, and a pressurizing check-valve **47** and an air overpressure valve **50**.

At the lower end of the reservoir is mounted a depressurizing bleeder-indicator **51** having its knurled opening thumbscrew suitably locked and which, when opened, enables the reservoir to be depressurized while at the same time making the traces of a possible internal leak of hydraulic fluid visible.

The housing **14** is provided with the required number of connections, and notably with a connection **52** to a pump intake and with connections **53** to the outlets from hydraulic devices utilizing the hydraulic fluid.

What I claim is:

1. In a large-size hydraulic reservoir for accumulating a fluid usable in a hydraulic circuit, the combination comprising an outer casing defining a pneumatic chamber therein, a bellows in said chamber defining a hydraulic chamber therewithin which is separated from said pneumatic chamber, said bellows being constituted of an elastic material and having a first end leaktightly attached to a corresponding end of said casing and a second end freely movable within said casing, degassing means coupled to said second end of the bellows for movement therewith, guiding means between said second end of said bellows and said outer casing for guiding the movement of said second end, a gauge on said casing for indicating the volume of the hydraulic chamber, means coupled to said bellows at the second end thereof to operate said gauge in accordance with the position of said second end in said casing, a safety valve on said casing for depressurizing the hydraulic chamber, means coupled to said safety valve for actuating the same in response to travel of the second end of the bellows beyond a limit position in said casing, and a depressurizing bleeder indicator on said casing for depressurizing said pneumatic chamber.

2. In a reservoir as claimed in claim **1**, a pressurizing check-valve in communication with said pneumatic chamber, a pressure-gauge in communication with said pneumatic chamber for giving direct readings of the pressure therein, an alarm pressure-switch for sensing a drop in pressurization in said pneumatic chamber, an overpressure valve in communication with said pneumatic chamber and a filter for liquid in said hydraulic chamber including a filtering element which comprises associated protection and check valves.

3. In a reservoir as claimed in claim **1** wherein said guiding means comprises a plurality of rollers arranged radially and elastically urged against the inner surface of said casing, an axle supporting each roller, a slide with a clevis thereon supporting a respective axle, a slideway slidably receiving said slide, and a spring acting

on said slide to urge the roller against the inner surface of the casing.

4. In a reservoir as claimed in claim **3**, a coil shaped degassing tube coupled to said degassing means for discharging the substances liberated by said degassing means, said coil tube being in communication with the hydraulic chamber and the atmosphere external of said casing, and guide members on the slideways for positioning the turns of the coil tube.

5. In a reservoir as claimed in claim **4**, a movable end-closure for the second end of said bellows, said means for operating said gauge comprising a cable connected to said end-closure and to said gauge itself leaktightly connected to said casing, said means for actuating the safety valve comprising a resilient pushrod for actuating said valve, and a pivotally mounted lever with a terminal fork for actuating said pushrod and the valve for discharging surplus liquid from the bellows when the same has reached a pre-determined maximum dilation.

6. In a reservoir as claimed in claim **5** wherein said degassing means comprises a housing disposed within said bellows and including perforated internal walls, a float consisting of a complex of plastic and hollow microballs mounted movably within said housing, a chamber for receiving weighting granules associated with said float, a needle-valve stem coupled to said float by contact, an upper seat for receiving said needle-valve, said coil shaped degassing tube being connected to said seat and being flexible with one end fixed to the housing of the degassing means and the other end attached to a fixed union member extending through an upper part of said casing.

7. In a reservoir as claimed in claim **6**, a lower removable filter housing cover, a check-valve for disconnecting communication between the bellows and the filter when the housing cover is removed, a thumbscrew on said cover for closing and opening said check-valve, said check-valve having a guide and a seat disposed on one end-closure of said filter housing and projecting within said bellows, said thumbscrew being coupled by contact with a stem of said valve whereby to permit separation therefrom when removing said lower cover of said filter housing.

8. In a reservoir as claimed in claim **7** wherein said filter housing is provided with a wall having connection members of which one is connected to a pump suction conduit and others to return-flow conduits from hydraulic devices utilizing said hydraulic fluid, and a further connection member for receiving pipe means for interconnection with said safety valve.

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HENRY T. KLINKSIEK, Primary Examiner

U.S. Cl. X.R.

137—549, 553, 593; 138—30; 220—85