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(54) Hydraulic pressure device.

(57) Hydraulic pressure device to be fitted to a housing (11) of a rolling stand (10) that rolls wide flat plate and sheet and flat products in general, the hydraulic device being able to cooperate also with a main screwdown bolt (13) in keeping constantly at a required value the value of the interspace between rolling rolls (14) and comprising in reciprocal cooperation:

- two opposed plates (23) containing at least one respective toroidal cylindrical hollow (24), which includes specific surfaces (40) on its outermost side,
- a toroidal element (38) comprising at least one bellows (21) interposed between two toroidal cylindrical extensions (22), each of which has a specific surface (39) on its outermost side,

in which device the toroidal cylindrical extensions (22) are inserted into the toroidal cylindrical hollows (24) and the specific surfaces (39-40) of the extensions (22) and of the hollows (24) respectively achieve at least a degree of tight reciprocal coupling, the depth of the toroidal cylindrical hollows (24) being at least substantially the same as the length of the toroidal cylindrical extensions (22), a seam weld (41) being made in the zone of separation of the curved portions (30) of the toroidal element (38) from the respective curved portions (29) of the plates (23).

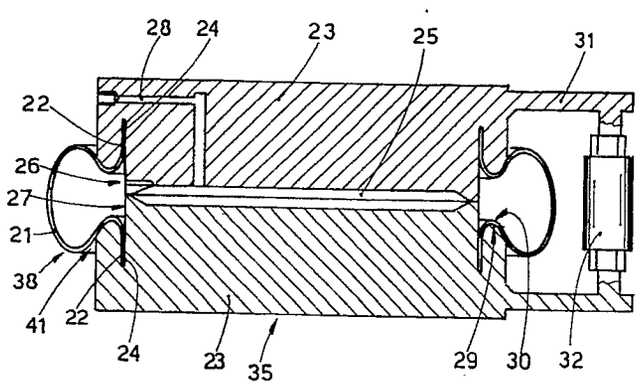

fig.4a

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This invention concerns a hydraulic pressure device having the function of an actuator according to the main claim. To be more exact, the invention concerns a hydraulic device that performs the function of an actuator which can be fitted to rolling stands for the rolling of wide flat plate or sheet or flat products.

The invention concerns a hydraulic device that governs continuously the value of the interspace (clearance) between the working rolls of rolling stands that roll wide flat plate, sheet or strip.

The invention tends to provide a hydraulic device suitable for fitting to new rolling mills or rolling mills already at work without any need to reconstruct or alter the stand substantially.

To be more exact, one hydraulic device is provided for each housing and can be made to cooperate with the main screwdown bolt in adjusting the value of the interspace between rolls.

The hydraulic device can be fed from any source of fluid under pressure.

In rolling stands 10 rolling flat products, for instance stands of the type shown in the diagram of Fig.1, a hydraulic device 12 is provided in each housing 11 and can cooperate with a main screwdown bolt 13 in regulating continuously and in a servocontrolled manner the value of the interspace between rolling rolls 14. This value of the interspace conditions the thickness of the product leaving the stand and the continuity of that thickness.

The working of the hydraulic device 12 is controlled by pressure transducers 15 and 16 by means of suitable control, regulation and actuator assemblies.

The hydraulic device 12 can be located directly between the main screwdown bolt 13 and the upper chock 17, as shown in the diagram of Fig.2, or between the lower chock 18 and the base of the respective housing 11, as shown in the diagram of Fig.3.

The hydraulic devices 12 employed for this task are of a type having a piston, that is to say, they include a jacket 19 with a relative chamber and a piston 20 able to slide therein.

The jackets 19 and pistons 20 may be made in various ways according to the various producers. All of the above is contained in the state of the art.

The hydraulic devices 12 including pistons, however, entail the shortcomings of the traditional pistons with packings undergoing severe continuous working conditions at high pressures.

Problems of displacement, event at an angle, of the axis of the piston 20 in relation to the axis of the jacket 19; problems of hydraulic seal engagement; problems of speed of response; problems of wear and continuous maintenance - these are some of the typical mechanical and hydraulic problems which have an unfavourable effect on such hydraulic devices 12 comprising a piston.

Document SU-A-863032 discloses two opposed plates with at least one respective cylindrical toroidal hollow, which comprises outer surfaces, and with a toroidal element including at least one bellows placed between two cylindrical toroidal extensions, each of which has one outer cylindrical surface.

These cylindrical toroidal extensions are inserted into the cylindrical toroidal hollows, and the cylindrical surfaces have at least a degree of tight reciprocal contact that contributes greatly to the solution of the above problems.

However, the teaching of this document involves the drawback that the contact yields to high pressures, and there are drawing of the extensions and loss of power. Moreover, the contact fails with use and leads to the above unfavourable results.

To obviate these shortcomings and achieve further advantages which will become clear in the description that follows, the present applicant has designed, tested and embodied this invention.

The hydraulic pressure device according to the invention is set forth and characterized in the main claim, while the dependent claims describe variants of the idea of the embodiment.

According to the invention the hydraulic device comprises a closed working chamber formed by a toroidal surface, which can be deformed resiliently and closed hermetically.

As compared to the known piston-type hydraulic devices, the above hydraulic device provides a minimum dispersion of power by friction since there are no packings. Moreover, there are no losses of fluid under pressure with this new hydraulic device.

Furthermore, this new device is not affected by any misalignments, even at an angle, which may occur either during working or during installation.

Besides, this new hydraulic device may be embodied with heights, or overall vertical extents, which are considerably less than those required for the piston-type hydraulic devices.

A further advantage of the new hydraulic device is its quicker speed of response.

According to the invention the operational chamber is provided by means of a bellows-wise toroidal surface which connects two plates normal to the axis of the bellows. This toroidal surface is connected to the respective plates by two respective toroidal extensions the ends of which have a substantially cylindrical conformation.

These toroidal terminal cylindrical extensions cooperate with two toroidal lodgement hollows which act with an engagement seal at least against the outermost sidewall of the toroidal cylindrical extensions.

A part of the connection between the toroidal cylindrical extensions and the bellows element co-operates with a mating connecting surface located between the outermost wall of the toroidal lodgement hollow and the lateral surface of the plate.

The bellows normally has a section with a loop development.

According to a variant the bellows has a section with an egg-shaped development.

According to another variant the section of the bellows has a toroidal development.

The bellows and the relative toroidal extensions may be made of a metal having a substantially constant thickness. This means that the bellows and relative extensions may be made of a specially shaped sheet, rolled and welded along an axial generating line or along a generating line at an angle to the axis, or may consist of a machine-shaped tubular element or may be made with processes of deformation under pressure on a gauge (by means of a fluid, explosive forming, etc.).

The metallic material which can be used to make the bellows and relative toroidal cylindrical extensions may be a copper-based alloy or a chrome-nickel based alloy, or an alloy based on iron or analogous materials together with alloying metals to provide the alloy with suitable mechanical properties.

According to a variant the bellows and relative toroidal extensions may be made of a thin shaped metallic sheet bent in a spiral with its coils tightly in contact.

According to a further variant the bellows will be made of thin concentric metallic rings.

By means of these two latter variants it is possible to reduce the aptitude of the metal to resilient deformation, while achieving at the same time at least an equal capacity of resilient deformation of the bellows.

In the hydraulic device according to the invention the seal engagement is achieved mechanically by the tight contact which the outermost surface of the relative toroidal cylindrical extensions exerts against the outermost surface of the toroidal lodgement hollow.

According to a variant the toroidal lodgement hollow has a width which is greater by a few percentage points than the thickness of the walls of the toroidal cylindrical extensions, so that a certain hydraulic seal engagement is achieved also against the innermost sidewall of the toroidal cylindrical extensions.

Installation at least in this case is carried out with an apparatus which, by acting on the bellows, enables the whole to be stiffened and the installation to be performed very simply on a press.

According to a variant a travel limiting means is included between the two plates of the device and enables the two plates to be displaced axially and reciprocally by a few millimetres according to the requirements of the specific rolling stands to which the device is fitted.

Let us now see a preferred embodiment of the invention in the attached figures, which are given as a non-restrictive example and show the following:-

Fig.1	shows diagrammatically a generic method of use of a hydraulic device;
Figs.2 and 3	are two possible installations of hydraulic devices and are the piston-type hydraulic devices employed heretofore;
Fig.4a	shows a hydraulic device according to the invention;
Fig.4b	shows a variant of the bellows;
Fig.5	is a diagram of two possible conformations of the device suitable for installation according to the invention;
Fig.6	gives a diagrammatic plan view of a section of the hydraulic device together with the installation apparatus;
Fig.7	shows the behaviour of the components during installation;
Fig.8	shows a variant of the device of Fig.4;
Fig.9	shows a detail of the travel limiting means of Fig.8.

The invention is described with reference to Fig.4 and the following figures.

A hydraulic device 35 embodied according to the invention comprises two facing plates 23 substantially coaxial to each other.

The two plates 23 are connected together by a toroidal element 38 which includes a bellows 21 and two toroidal cylindrical extensions 22; a connecting curved portion 30 is located between the bellows 21 and each extension 22.

In the example of Fig.4b the bellows 21 has a loop development, whereas it has an oval development in the example of Fig.4a.

In these examples each of the two plates 23 includes a toroidal cylindrical hollow 24 within which the respective toroidal cylindrical extension 22 is lodged.

The toroidal cylindrical hollow 24 includes a connecting curved portion 29 which is the twin of, and mates with the connecting curved portion 30 of the toroidal element 38, so that the curved portion 30 of the element fits perfectly against the curved portion 29 of the hollow 24.

The dimensions of the outermost surface 39 of the toroidal cylindrical extension 22 and those of the outermost surface 40 of the relative toroidal

cylindrical hollow 24 are such as to create at least a tight reciprocal grip or, rather, a slight contact between the same.

The finish of the two outermost surfaces 39-40 of the element 38 and hollow 40 respectively is such as to ensure a hydraulic seal engagement, which is enhanced during working according to the pressure of the fluid under pressure.

The toroidal element 38 may be held on the plates 23 by a seam weld 41 made in the area of separation of the curved portion 30 of the element 38 from the curved portion 29 of the relative hollow 24. The seam weld 41, if made continuous, exerts a further hydraulic seal engagement action.

The width of the toroidal cylindrical hollow 24 in this example is a few percentage points greater than the thickness of the relative toroidal cylindrical extension 22.

In other words, if the thickness of the toroidal cylindrical extension 22 is 5 mm., then the cylindrical toroidal hollow 34 will have a width between 5.1 and 6 mm.

According to a variant the relative differences between the above width and thickness may be much greater, so that the width of the hollow 24 may even be several times greater than the thickness of the extension 22.

In this example the small difference between the width of the hollow 24 and the thickness of the extension 22 has the effect of creating a mechanical obstacle to the passage of the fluid under pressure, thus enhancing the hydraulic seal engagement between the surface 39 of the extension 22 and the surface 40 of the hollow 24.

In this case a terminal portion 33 of the toroidal cylindrical extension 22 will advantageously be rounded.

According to a variant the outermost surface 39 of the toroidal cylindrical extension 22 is coated with a soft metal (copper, aluminium, etc.) or with a suitable plastic material (Teflon, for instance) so as to enhance the hydraulic seal engagement of a mechanical type.

Moreover, during installation a ring of Teflon or another suitable material may be placed at the inner end of the hollow 24 and is deformed by the end portion 33 of the extension 22 when the latter has been inserted properly into the hollow 24.

Instead of the ring of Teflon or another solid material, it is also possible to introduce a momentarily liquid material (molten lead or also two-component resins, for instance) which, when the extension 22 has been properly lodged in the hollow 24, solidifies and takes up at least part of the free interspace between the walls of the hollow 24 and the extension 22 itself.

The bellows 21 will have its height and diameter dimensioned in proportion to the travel which the plates 23 of the device 35 are allowed to carry out in relation to each other in a substantially axial direction. It should be noted that this travel will normally consist of a few millimetres and may reach about fifteen to twenty millimetres.

Furthermore, the type of metal employed to make the toroidal element 38 will affect the geometric dimensions.

Each plate 23 will comprise advantageously a toroidal supporting ring 27 that delimits a half chamber 25, which is fed from the exterior through a feed conduit 28 and also comprises radial conduits, such as the conduits 26, which connect the half chamber 25 to the inside of the bellows 21 when the device 35 has its support rings 27 supported.

According to an evolutive variant shown as an example in Fig.8, auxiliary toric rings 46 cooperate with the plates 23 and are anchored to the respective plates 23 by means of abutments 47. In this case these auxiliary toric rings 46 are welded continuously at 50 to the plates 23 so as to ensure a hydraulic seal engagement; the welding can be carried out when the auxiliary toric rings 46 complete with the toroidal element 38 have been installed.

The toroidal element 38 in turn is fitted beforehand on the two auxiliary toric rings 46 and is welded continuously thereto at 48.

A copper ring 49 which cooperates with the weld area 48 and with the neighbourhood thereof is included advantageously to reduce the thermal shock of the welding.

The auxiliary toric rings 46 may have a lodgement curve 64 in prolongation of the curved portion 29 of the hollow 24. The lodgement curve 64 may be close 64b to the profile of the bellows 21 or may have a very enlarged development 64a, which is advantageous.

According to the example of Fig.8 the bellows 21 has a section with a substantially circular development; moreover, in the example of Fig.8 the toroidal element 38 is embodied with a plurality of appropriate thin concentric rings.

The bellows 21 is protected with a hard rubber diaphragm 51 secured to anchorage rings 52 by means of catches 53, which also position an outer metallic shield 54 guided by a guide ring 55.

In Fig.8 a travel limiting means 65 is provided to limit the reciprocal travel 62 of the plates 23 to a desired maximum value. The travel limiting means 65 comprises a plurality of segments 56, which are thrust resiliently by a spring means 59 outwards in a radial direction and cooperate with upper 57 and lower 58 opposed inclined surfaces.

A general inclined surface 60 which cooperates with an inverted wedge 61 actuated by a screw 63 is provided for clamping purposes.

Suitable hydraulic seal engagement packings 66 are included. The inclusion of the spring means 59 facilitates the initial assembly since the segments 56 can be retracted towards the centre to achieve the assembly.

In the example of Fig.8 the toroidal hollow 24 is substantially made mainly only in one of the two plates 23.

Load cells 32 and/or reciprocal position transducers 32 may be included at one or more peripheral points of the device 35 by means of prolongations 31 so as to be able to control the behaviour of the device 35 itself.

To carry out assembly of the toroidal element 38 and, in particular, of the circumferential toroidal extensions 22 in their respective circumferential toroidal hollows 24, an apparatus 42 is employed which comprises a toric ring 43, possibly divisible into two or more portions, and a plurality of thrust elements 34-134 driven by jacks 44 in a direction radial to the bellows 21 (see Figs.5 and 6).

One of the thrust elements 134 comprises further thrust elements 37, levers in this example, which are actuated by jacks 36.

The thrust elements 34 and 134, by acting on the bellows 21, prevent the occurrence of the condition, shown in Fig.7 in a deformed manner to make it more evident, whereby the toroidal cylindrical extension 22, owing to the obstruction by the outermost surface 40 of the toroidal hollow 24, takes on a tapered conformation by rubbing against the innermost wall 45 of the toroidal hollow 24.

In fact, the action of the thrust elements 34-134 is such that it keeps always substantially circular the circular toroidal extension 22, or rather the action is such that it tends to obtain a tapered conformation which is the reverse of that shown in Fig.7.

When the apparatus 42 is actuated, the plates 23, if they are to be fitted at the same time, are positioned with their respective toroidal cylindrical hollows 24 coinciding with the respective toroidal cylindrical extensions 22, and installation proceeds with the use of an axially acting press; thereafter, if so required, the seam welds 41 are applied.

Claims

1. Hydraulic pressure device to be fitted to a housing (11) of a rolling stand (10) that rolls wide flat plate and sheet and flat products in general, the hydraulic device being able to cooperate with a main screwdown bolt (13) in keeping constantly at a required value the value of the interspace between rolling rolls (14) and comprising in reciprocal cooperation:
   - two opposed plates (23) containing at least one respective toroidal cylindrical hollow (24), which includes specific surfaces (40) on its outermost side,
   - a toroidal element (38) comprising at least one bellows (21) interposed between two toroidal cylindrical extensions (22), each of which has a specific surface (39) on its outermost side,

   in which device the toroidal cylindrical extensions (22) are inserted into the toroidal cylindrical hollows (24) and the specific surfaces (39-40) of the extensions (22) and of the hollows (24) respectively achieve at least a degree of tight reciprocal coupling, the depth of the toroidal cylindrical hollows (24) being at least substantially the same as the length of the toroidal cylindrical extensions (22), the device being characterized in that a seam weld (41) is made in the zone of separation of the curved portions (30) of the toroidal element (38) from the respective curved portions (29) of the plates (23).

2. Hydraulic device as claimed in Claim 1, in which at least the outermost surfaces (39-40) of the toroidal extension (22) and toroidal hollow (24) respectively are coated with a soft metal.

3. Hydraulic device as claimed in Claim 1, in which at least the outermost surfaces (39-40) of the toroidal extension (22) and toroidal hollow (24) respectively are coated with a plastic material.

4. Hydraulic device as claimed in any of Claims 1 to 3 inclusive, in which a ring made of a material which can be deformed by an end portion (33) of the toroidal cylindrical extension (22) is inserted beforehand into the toroidal cylindrical hollow (24).

5. Hydraulic device as claimed in any of Claims 1 to 3 inclusive, in which, before the toroidal cylindrical extension (22) is inserted, a material momentarily in a liquid state is introduced beforehand into the toroidal cylindrical hollow (24).

6. Hydraulic device as claimed in any claim hereinbefore, in which the width of the toroidal cylindrical hollow (24) is a few percentage points greater than the thickness of the respective toroidal cylindrical extension (22).

7. Hydraulic device as claimed in any of the claims hereinbefore, in which the toroidal element (38) consists of metallic sheet wound in a spiral with coils tightly rested against each

other.

8. Hydraulic device as claimed in any claim hereinbefore, in which the bellows (21) has a section with a loop-wise development.

9. Hydraulic device as claimed in any of Claim 1 to 7 inclusive, in which the bellows (21) has a section with a substantially oval development.

10. Hydraulic device as claimed in any claim hereinbefore, in which a copper ring (49) to distribute tensions cooperates with the weld area (48) and with the neighbourhood thereof and is located on the end portion of the toroidal extension (22).

11. Hydraulic device as claimed in any claim hereinbefore, in which is included an outer protective diaphragm (51) made of a resilient material.

12. Hydraulic device as claimed in any claim hereinbefore, in which is included an outer metallic shield (54).

13. Hydraulic device as claimed in any claim hereinbefore, in which a travel limiting means (65) is included between the plates (23).

14. Hydraulic device as claimed in any claim hereinbefore, in which the travel limiting means (65) is thrust resiliently (59) into position.

15. Hydraulic device as claimed in any claim hereinbefore, in which the toroidal element (38) cooperates during installation with an installation apparatus (42) which comprises a plurality of thrust elements (34-134) that act radially on the bellows (21) and towards the centre of the same (21).

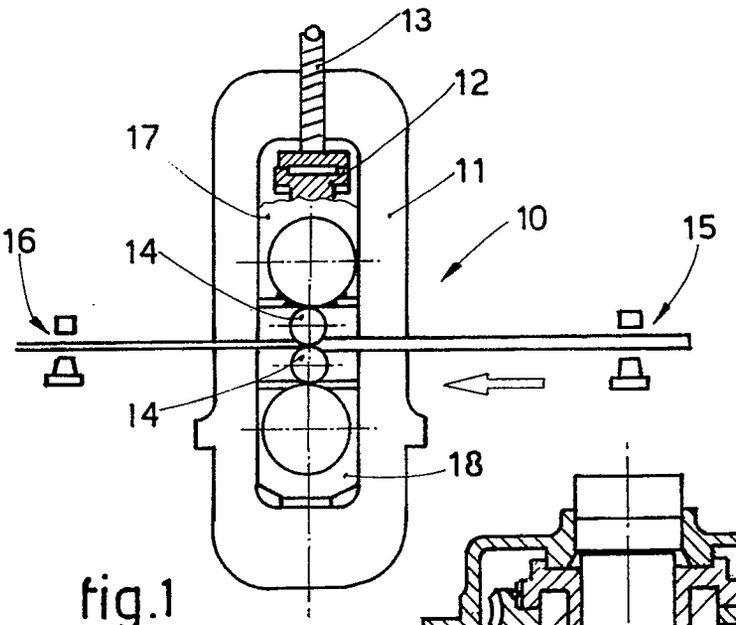

fig.1

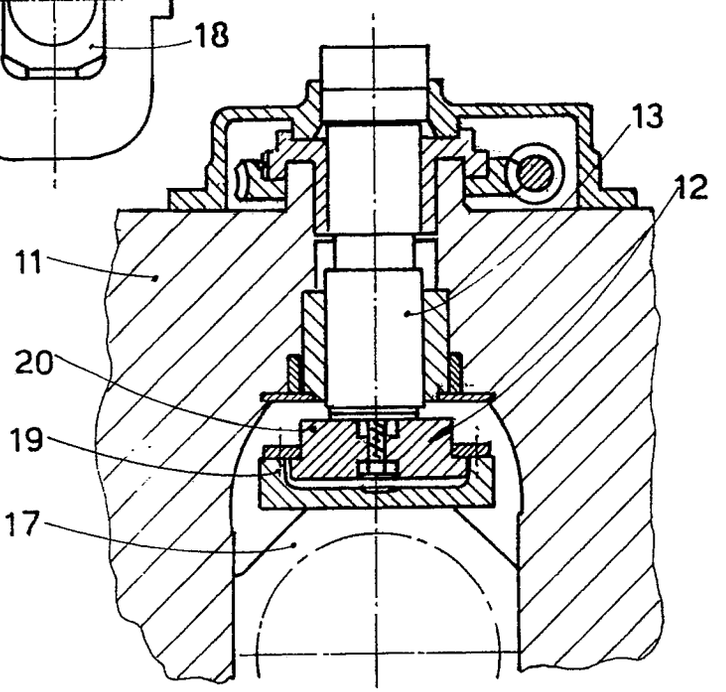

fig.2

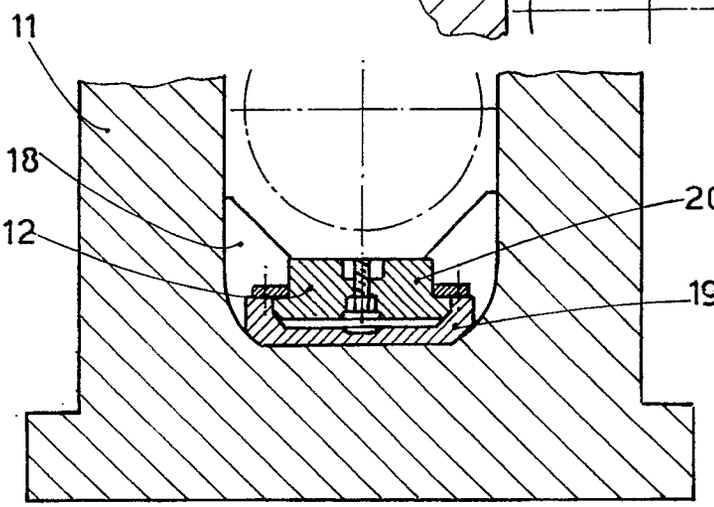

fig.3

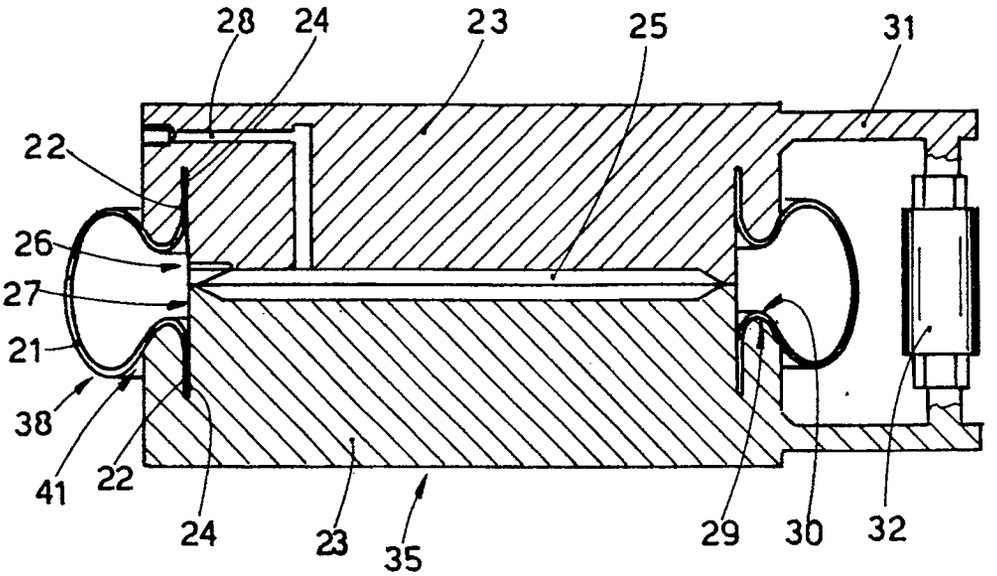

fig.4a

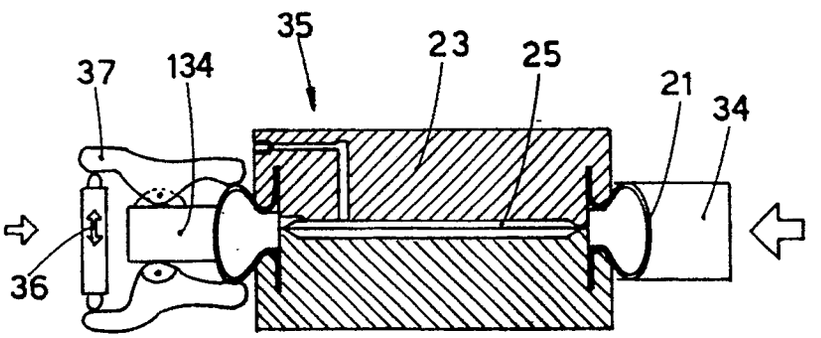

fig.5

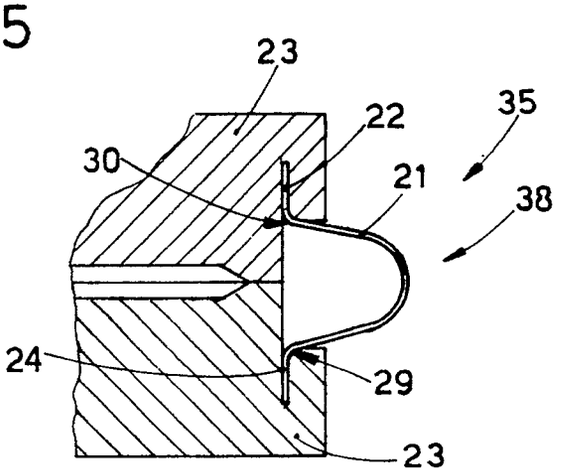

fig.4b

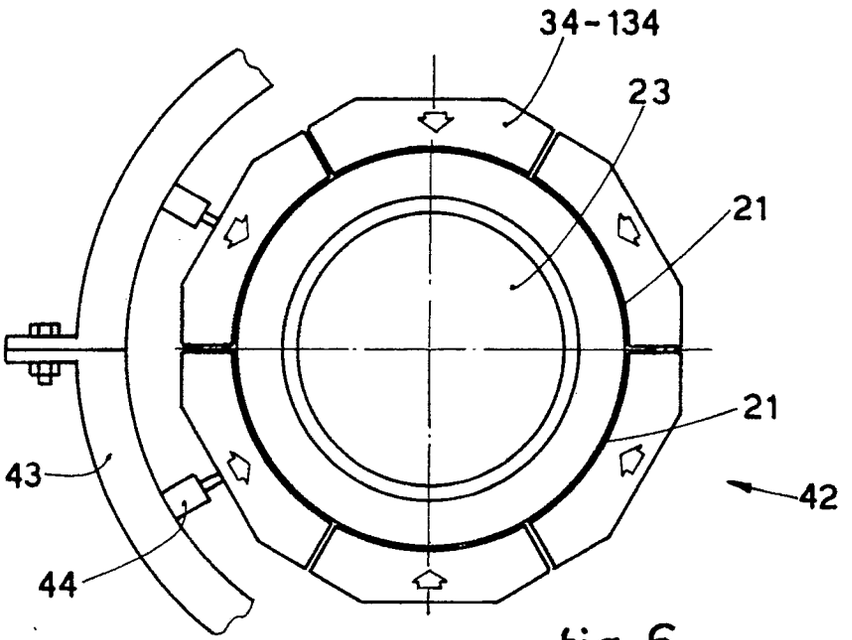

fig.6

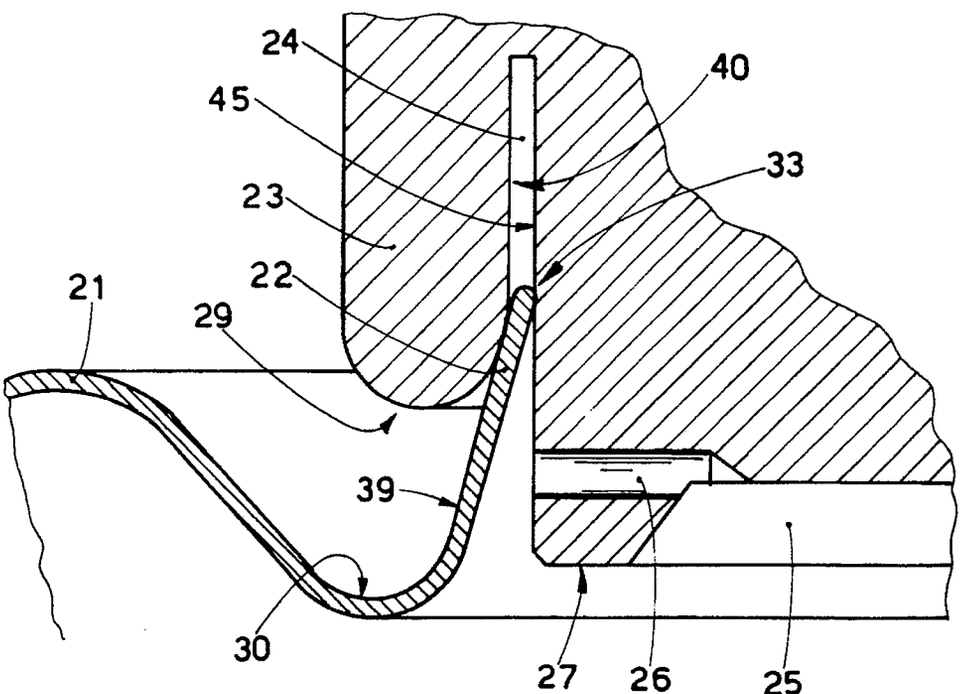

fig.7

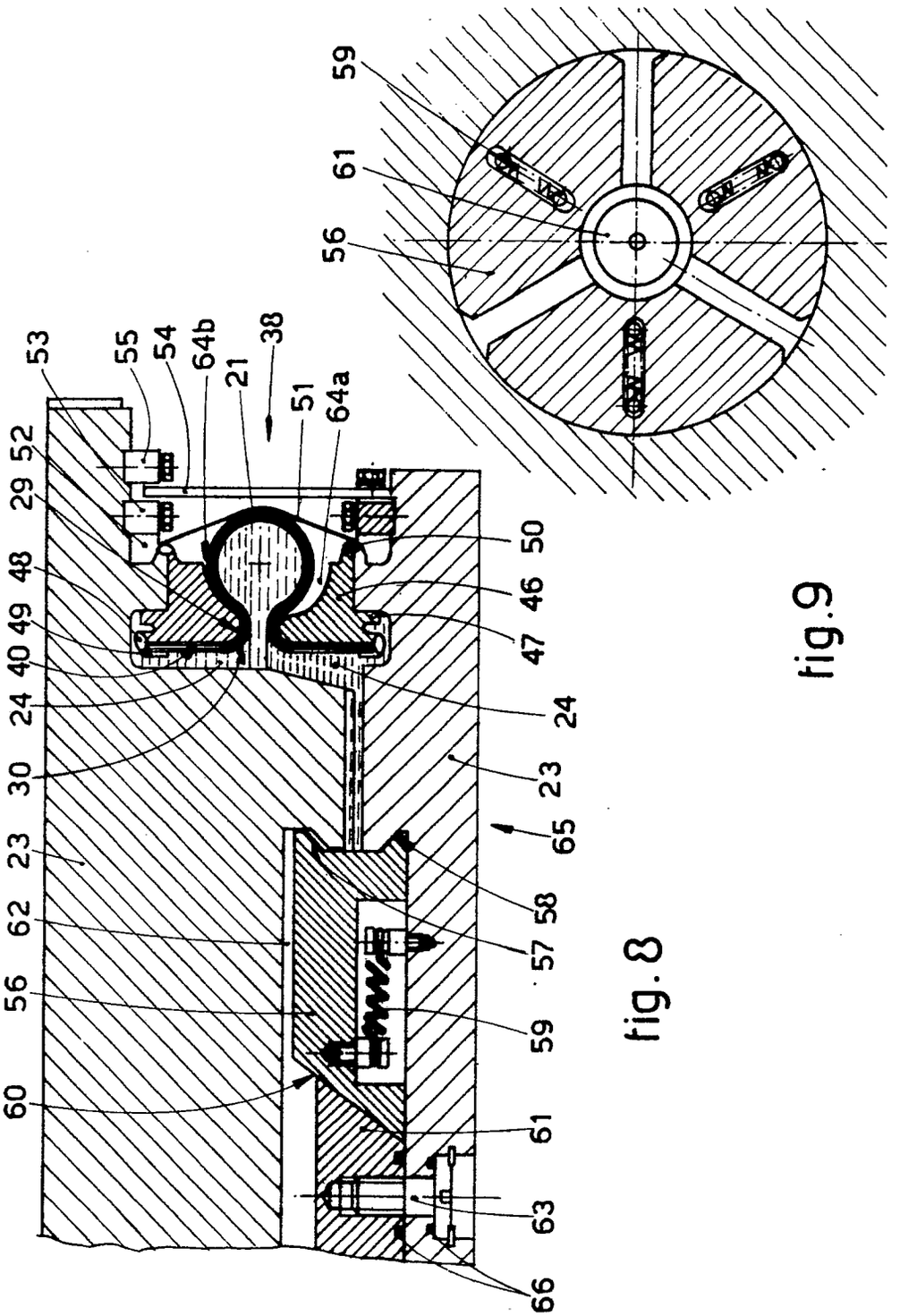
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fig.9

fig.8

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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 1014

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.5)
D,A	SOVIET INVENTIONS ILLUSTRATED, week E27, 18th August 1982, section General/Mechanical, accession no. 56865E/27, Derwent Publications, Ltd, London, GB; & SU-A-863 032 (FERR. METALLURGY AUTOMN.) 25-09-1981 * Abstract; figures *	1,6	B 21 B 31/32
A	FR-A-9 754 57 (CALORSTAT) * The whole document *	1	
A	FR-A-7 384 10 (FRANK) * The whole document *	1	
A	FR-E-4 454 4 (FRANK) * The whole document *	1	
A	K. TRUTNOVSKY: "Berührungsdichtungen an ruhenden und bewegten Maschinenteilen", vol. 17, 2nd edition 1975, pages 100-101, Springer Verlag, Berlin, DE; K. KOLLMANN: "Konstruktionsbücher" * Pages 100,101; figure 7.3 *	1	
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A	NL-A-6 604 318 (KALMEIJER) * Figures 3,4 *	1,12,13	
A	SOVIET INVENTIONS ILLUSTRATED, week 8507, 27th March 1985, section General/Mechanical, accession no. 85-043536/07, Derwent Publications Ltd, London, GB; & SU-A-1103 916 (CHERMETAVTOMATIKA) 23-07-1984 * Figure *	1	

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The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	07 May 91	ROSENBAUM H.F.J.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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T: theory or principle underlying the invention

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D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

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A	SOVIET INVENTIONS ILLUSTRATED, week K50, 1st February 1984, section General/Mechanical, accession no. 83-843622/50, Derwent Publications Ltd, London, GB; & SU-A-997 874 (FERR. METALLURGY AUTOMN.) 23-02-1983 * Figure *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	07 May 91	ROSENBAUM H.F.J.

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- 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

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