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(54) Rotary compressor.

(57) A rotary compressor comprising two rotors (18a,18b) which have inter-engaging lobes and which rotate in a housing (10) having two laterally intersecting bores defining variable volume compression chambers (12a,12b) which merge cyclically into one as the rotors rotate, one chamber (12b) containing an inlet port (16) adapted to be coupled to a suction pipe and the other chamber containing an outlet port arrangement. The outlet port arrangement comprises at least one exit passage (20) controlled by a valve means (22) whose operation is responsive to the gas pressure across it.

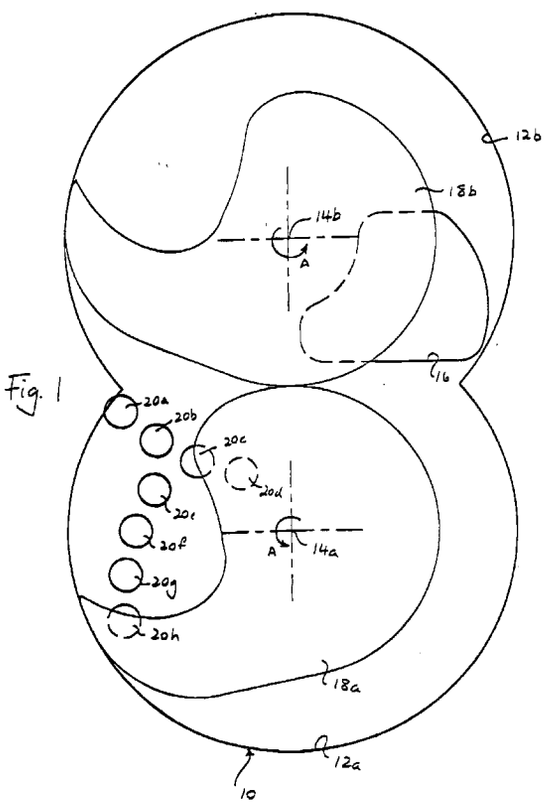

Fig. 1

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The present invention relates to rotary compressors of the type comprising two rotors which have inter-engaging lobes and which rotate in a housing having two laterally intersecting bores defining variable volume compression chambers which merge cyclically into one as the rotors rotate.

During the compression part of the cycle of known compressors of the latter type, one of the two rotors covers up an outlet port in one of the two bores until the pressure reaches approximately two-thirds of the design pressure. The outlet port is then progressively uncovered and the compressed gas contents of the chamber are discharged via the outlet port into a delivery pipe.

A disadvantage of the known compressors of this type is that the built in compression is essentially fixed. When the pressure in the delivery pipe is high, the gas expands back into the compression chamber; When the pressure in the delivery pipe is low, the gas in the compression chamber expands into the delivery pipe.

Both cases of over or under compression result in a substantial deviation from the desired polytropical compression cycle and thus in an increase in power consumption and an increase in gas outlet temperature.

Furthermore, the delivery pipe is not hermetically sealed from the compression chamber when the rotor covers the outlet port because of necessary running clearance. This causes flow-back of gas from the delivery pipe to the suction (inlet) pipe.

It is an object of the present invention to achieve a true polytropical compression cycle and to keep the delivery (outlet) port hermetically sealed from the delivery pipe when covered by said one of the two rotors.

In accordance with the present invention, there is provided a rotary compressor of the type comprising two rotors which have inter-engaging lobes and which rotate in a housing having two laterally intersecting bores defining variable volume compression chambers which merge cyclically into one as the rotors rotate, one chamber containing an inlet port adapted to be coupled to a suction pipe and the other chamber containing an outlet port arrangement comprising at least one exit passage controlled by a valve means whose operation is responsive to the gas pressure across it.

In one embodiment, there is a plurality of such exit passages each of which has a respective valve means associated therewith.

Preferably, the or each said valve means comprises a reed valve, or the like, having a flexible strip what normally covers the associated exit passage but which can be deformed by different gas pressures thereacross whereby to uncover that exit passage and allow gas to pass through it.

Advantageously, the reeds associated with several valves can be commonly connected at one end to an integral common portion which is fixed rigidly to the compressor housing.

Advantageously, the exit passages are arranged in two or more groups, with the exit passage in one said group lying along a first arc centred on the axis of that one of the two housing bores containing the inlet port, and with the exit passages in a second group lying along a second arc centred at a point in the other housing bore but spaced laterally of the longitudinal axis of that bore.

In a preferred embodiment, the outlet port arrangement comprises an outlet valve disposed on the rotational axis of the rotor which rotates in the compression chamber containing said outlet port arrangement.

Preferably, the outlet valve is a circular plate valve having mutually opposed discs which are spring biassed together but which can be relatively displaced axially by a predetermined gas pressure thereacross to permit gas flow from the inlet chamber to the outlet passage.

In order to provide a gas passage to the valve, the rotor in the inlet chamber can have a cut-out portion at its one end adjacent the valve.

Advantageously, the face of the inlet rotor opposed to the housing has a peripheral groove containing a sealing strip which engages a surface of the compressor housing.

Preferably there is disposed within the peripheral groove beneath the sealing strip a flexible tube which energises and biasses the sealing strip towards said surface of the housing.

Preferably, the inlet port is likewise disposed on the rotational axis of the rotor which rotates in the compression chamber containing said inlet port.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic view illustrating the shapes and relative positions of the two rotors and the compression chamber of one embodiment of a rotary compressor in accordance with the present invention;

Fig. 2 is a diagrammatic view of one end of the inside of the compression chamber showing the single inlet port and multiple outlet ports;

Fig. 3 is an external diagrammatic view of said one end of the compression chamber;

Fig. 4 is a section on line X-X in Fig 3; and

Fig. 5 is a section on line Y-Y in Fig 3 (to an enlarged scale);

Fig. 6a is a sectional view, taken on the line x-x of Fig. 6b of a modified outlet valve in accordance with a second embodiment of a rotary compressor in accordance with the present invention;

Fig. 6b is a plan view of the outlet rotor of Fig. 6a;

Fig. 6c is a section on Y-Y in Fig 6b; and

Fig. 7 is a sectional view of a detail of Fig. 6a to an enlarged scale showing the arrangement of sealing strips and expanders.

Referring first to Fig.1 of the drawings, there is shown very diagrammatically a compressor housing 10 defined by two cylindrical bores 12a, 12b which intersect and overlap laterally whereby to define a chamber of generally figure 8 peripheral configuration. The longitudinal axes of the two chambers are located at 14a and 14b, respectively, and are parallel and extend perpendicularly to the plane of the drawing. One or both end walls 15 of the chamber has an inlet port 16 communicating with the bore 12b, through which gas is drawn into the compression chamber by suction. Rotating on respective axes corresponding to the longitudinal axes 14a, 14b of the housing bores 12a 12b are two lobed rotors 18a, 18b. The lobed rotors rotate in a synchronised manner as indicated by the arrows A to cyclically draw air, or other gas, into the housing, and to compress it ready for discharge via an outlet. The latter principle of operation is well known.

Usually, in a rotary compressor of this general type, the other housing bore 12a would have a simple discharge port which is arranged to be periodically uncovered by the rotor 18a at a point in the cycle where the gas is fully compressed whereby the compressed gas is driven out, by the continued rotation of the rotors, into a discharge pipe coupled to the discharge port.

In the present embodiment, the single discharge port of the prior art is replaced by a plurality of discharge holes 20a...20h in the end wall 15 of the chamber, each of which communicates with the housing bore 12a and is controlled by a respective external reed valve, or similar type of valve, (of the kind commonly used in piston-type compressors). One such reed valve is illustrated by way of example in Fig 5 and comprises a flexible metal or plastic strip 22 which normally blocks the exit to the associated hole 20 but which can be distorted by pressure within the compression chamber as shown in Fig 5 to allow gas to pass out of the hole 20. In this embodiment, the holes 20a-20d are located in a first group along a first arc centred on the axis 14b and the holes 20e-20h are located in a second group along a second arc centred at a point 24 which is not coincident with the axis 14a but displaced therefrom. The holes 20a-20d in the first group are controlled by a group of four flexible strips 22a-22d connected integrally by a first common base portion 22i and the holes 20e-20h in the second group are controlled by a group of four flexible strips 22e-22h connected integrally by a second common base portion 22j. The base portions 22i and 22j are fixed rigidly to the end wall of the housing by pairs of screws/bolts 26.

Thus, in this embodiment, the sealing of the delivery pipe (not shown) from the suction pipe (not shown) is not achieved by respective ones of the two rotors 14a, 14b covering these two ports as in the prior art, but rather by the use of the multiplicity of reed valves (or the like).

The pressure in the outlet pipe keeps the valves closed until the pressure in the compression chamber has reached the same value. Discharge of the gas commences and continues via each valve until the associated port is covered by a rotor lobe or is exposed to a lower pressure than the outlet pipe pressure whereupon that particular valve closes and shuts off the associated port.

This operation enables a true polytropical compression to be achieved. Furthermore, the delivery port(s) is hermetically sealed when the pressure in the compression chamber is lower than in the delivery pipe.

Although it is preferred to use a multiplicity of outlet holes and valves, in principle only one could be used.

Referring now to Figs. 6 and 7, there is shown a second embodiment in which the outlet valves 20 on the valve plate in the first embodiment have been moved from the side position to the centre of the outlet rotor and now comprise a single valve 30 of circular configuration. The shape of the rotor chambers 12a,12b is exactly the same as in the first embodiment, as is also the basic shape of the two rotors. The profile of the outlet rotor 18c of the second embodiment is seen in Fig. 6b. The profile of the inlet rotor of the second embodiment, although not illustrated, is identical to that of the outlet rotor 18c.

As best seen in Fig. 6a, the outlet valve 30 is disposed in an exit passage 33 in a valve plate 32 formed by or located on the compressor housing 10 and lies on the axis of rotation 34 of the outlet rotor 18c. The valve 30 comprises in this embodiment an apertured disc 6, which is clamped to the valve plate 32 by an annular collar 38 and a solid disc 40 which is normally biassed against the apertured disc by a spring means (not shown), the two discs 30,40 and spring means being held together in the axial direction by a nut 42 engaging on a threaded rod (not visible in Fig. 6). Sufficient gas pressure in the chamber 12a pressure upstream of the valve 30 (beneath it in Fig. 6a) causes the solid movable valve disc 40 to lift from the fixed apertured plate to allow gas flow therebetween and hence through the valve 30 and outlet passage 33.

The rotor 18c, which is journalled at its other end in the housing 10 presents at its end adjacent the valve 30 a surface 44 which faces the valve plate 32. This surface 44 contains a peripheral groove 46 housing a sealing strip 48 (see Fig. 7) which is energised and biassed into sliding engagement with surface 47 of the valve plate 32 by a flexible tube 50 therebeneath. The rotor 18c itself is biassed away from direct contact with the valve plate by means of a curved spring plate 52 contained in a central recess 54 of the

rotor surface 44 and engaging a portion of the valve plate 32 or a fixed member engaged with the valve plate 32. A similar sealing strip 48 and energising tube 50 can be provided at the opposite end of the rotor (not shown). The provision of the sealing strips 48 and tubes 50 reduces gas slippage back to the suction side and also improves the volumetric efficiency.

In order to provide a gas passage shown by arrow B through the rotor 18c for feeding gas to the valve 30, the rotor 18c is formed with a cut-out portion 56.

The positioning of the outlet valve 30 at the centre of the outlet rotor 18c has enabled the free valve passage area to be increased and the pressure loss across the valve 30 to be reduced.

In the second embodiment, the inlet rotor (not shown) is identical to the outlet rotor 18c, with an inlet valve fitted to the valve plate at the centre of the rotor. The only difference is that the inlet valve is of reversed orientation so that it opens to permit gas to flow into the inlet chamber or as compared to the outlet valve which is of orientation to permit gas to flow out of the outlet chamber. The purpose and function of the inlet valve is, in addition to allowing gas to enter the inlet chamber 12b, to prevent the dead volume of the outlet rotor cut-out and the outlet valve to expand back into the inlet feed pipe at the end of a compression cycle. The enables improved volumetric efficiency to be attained.

Claims

1. A rotary compressor of the type comprising two rotors (18a,18b) which have inter-engaging lobes and which rotate in a housing (10) having two laterally intersecting bores defining variable volume compression chambers (12a,12b) which merge cyclically into one as the rotors rotate, one chamber (12b) containing an inlet port (16) adapted to be coupled to a suction pipe and the other chamber (12a) containing an outlet port arrangement, characterised in that the outlet port arrangement comprises at least one exit passage (20) controlled by a valve means (22) whose operation is responsive to the gas pressure across it.

2. A rotary compressor as claimed in claim 1, wherein there is a plurality of such exit passages (20a,20b), each of which has a respective valve means (22) associated therewith.

3. A rotary compressor as claimed in claim 1 or 2, wherein the or each said valve means comprises a reed valve, having a flexible strip (22) which normally covers the associated exit passage (20) but which can be deformed by differential gas pressures thereacross whereby to undercover that exit passage (20) and allow gas to pass through it.

4. A rotary compressor as claimed in claim 3, in which the reeds (22) associated with several valves are commonly connected at one end to an integral common portion which is fixed rigidly to the compressors housing.

5. A rotary compressor as claimed in claim 2, wherein the exit passages (20) are arranged in two or more groups, with the exit passages in one said group lying along a first arc centred on the axis of that one of the two housing bores containing the inlet port, and with the exit passages (22) in a second group lying along a second arc centred at a point in the other housing bore but spaced laterally of the longitudinal axis of that bore.

6. A rotary compressor as claimed in claim 1, wherein the outlet port arrangement comprises an outlet valve (30) disposed on the rotational axis (34) of the rotor (18c) which rotates in the compression chamber (12a) containing said outlet port arrangement.

7. A rotary compressor as claimed in claim 6, wherein the outlet valve (30) is a circular plate valve having mutually opposed discs (36,40) which are spring biassed together but which can be relatively displaced axially by a predetermined gas pressure therecross to permit gas flow from the outlet chamber (12a) to the exit passage (33).

8. A rotary compressor as claimed in claim 6 or 7, wherein in order to provide a gas passage to the valve (30), the rotor (18c) in the outlet chamber (12a) has a cut-out portion (56) at its one end adjacent the valve (30).

9. A rotary compressor as claimed in claim 6, 7 or 8, wherein the face (44) of the outlet rotor (18c) opposed to the housing has a peripheral groove (46) containing a sealing strip (48) which engages a surface (47) of the compressor housing.

10. A rotary compressor as claimed in claim 9, wherein there is disposed within the peripheral groove (46), beneath the sealing strip (48), a flexible tube (50) which energises and biasses the sealing strip (48) towards said surface (47) of the housing.

11. A rotary compressor as claimed in any of claims 6 to 10, wherein the inlet port is disposed on the rotational axis of the rotor which rotates in the compression chamber containing said inlet port.

Fig. 1

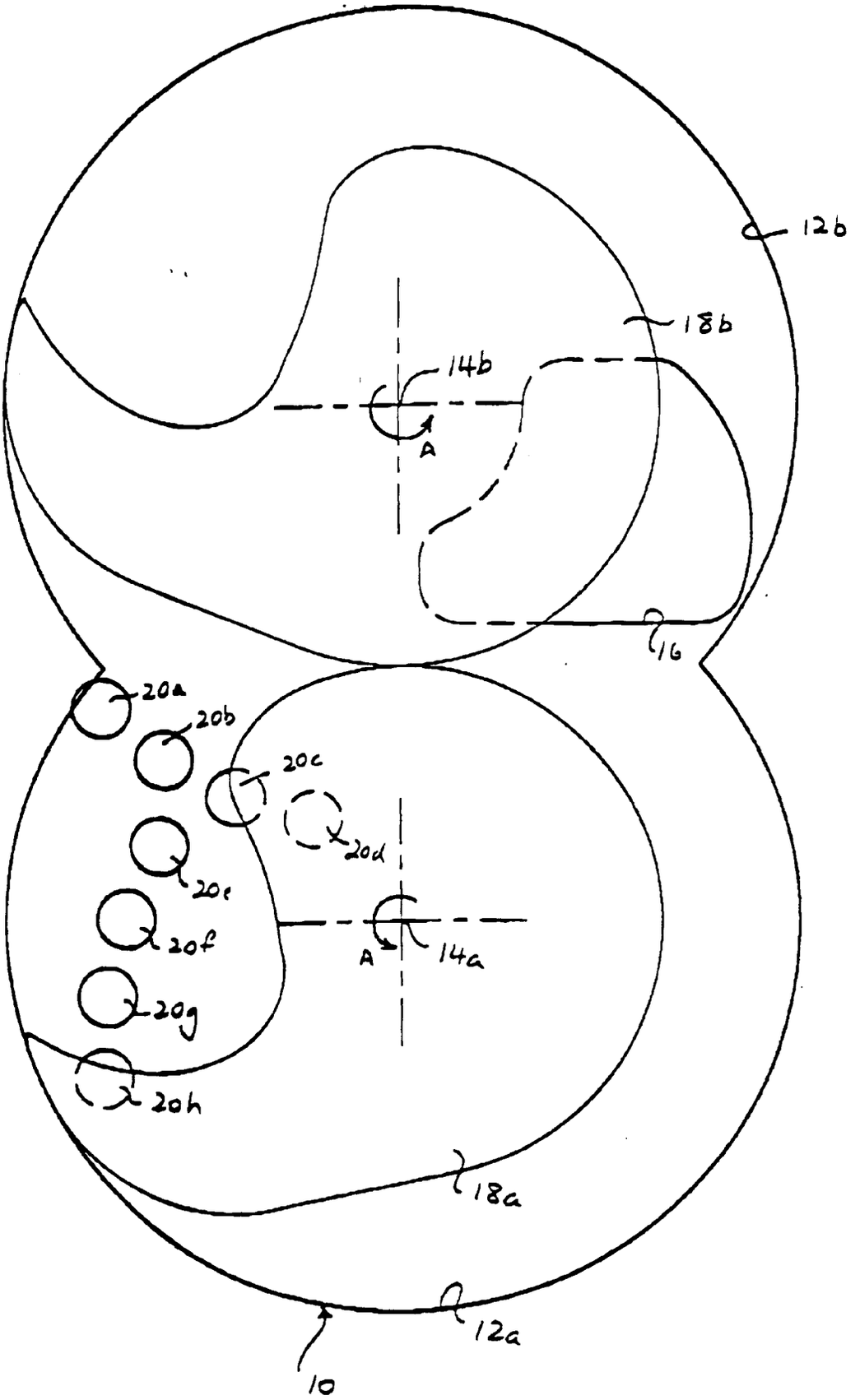
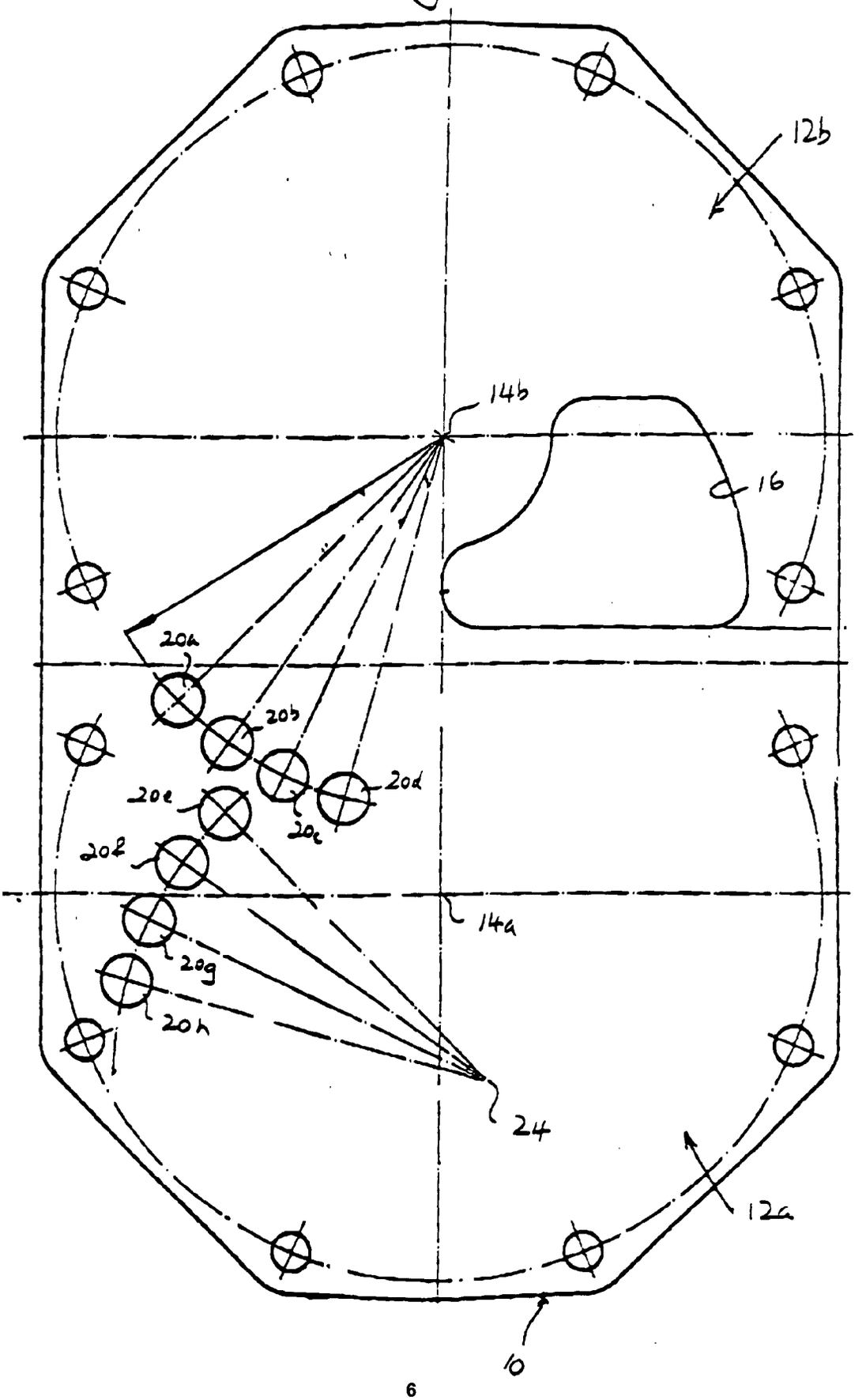


Fig. 2



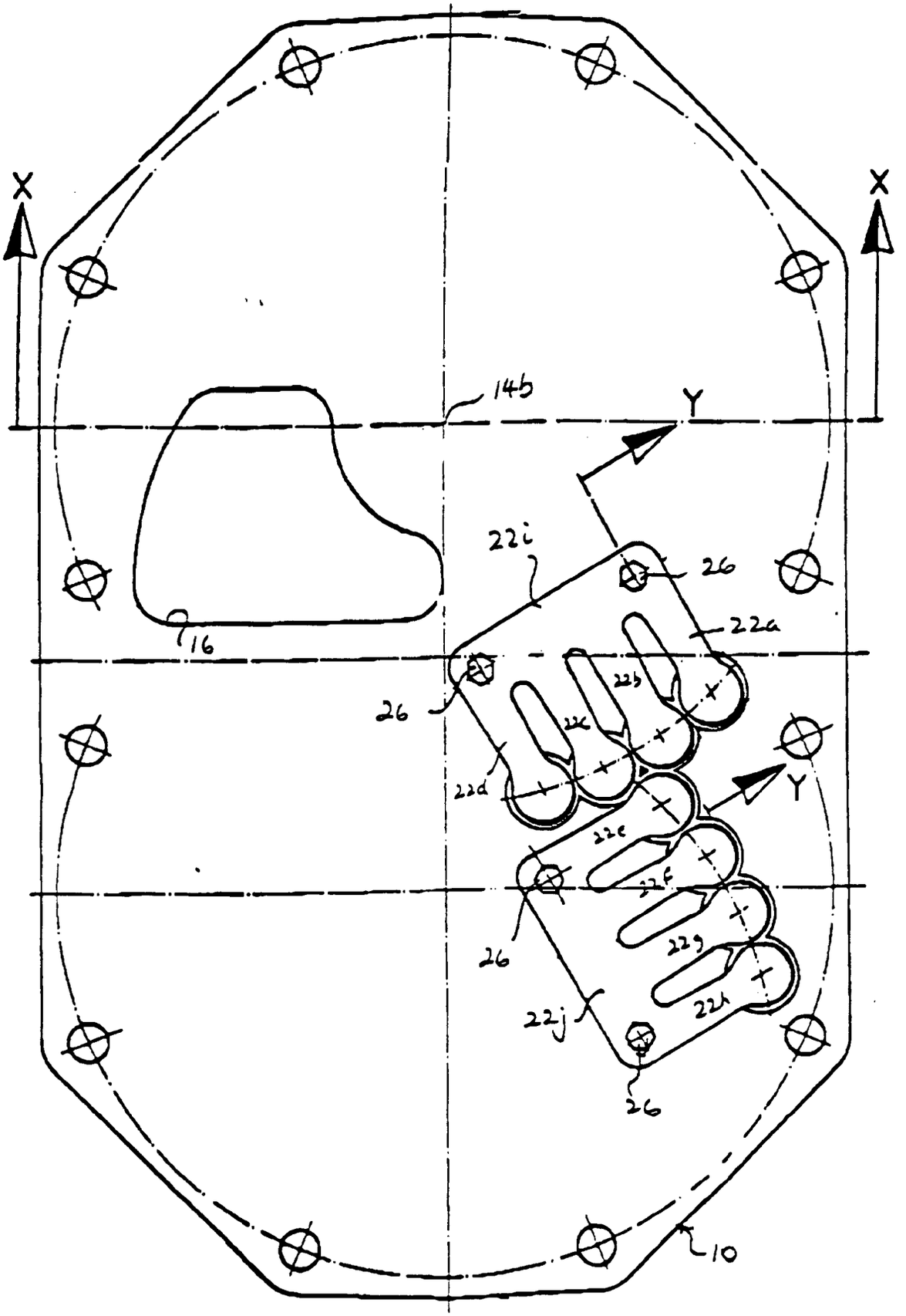
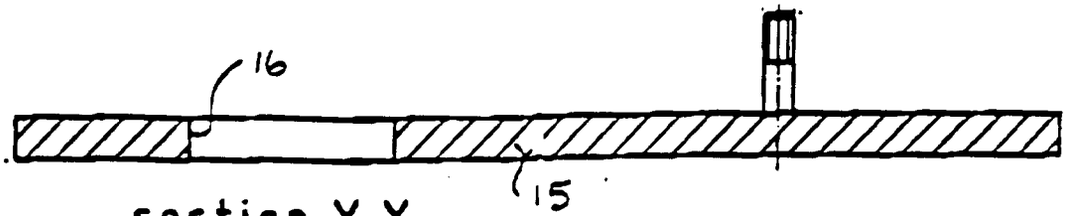
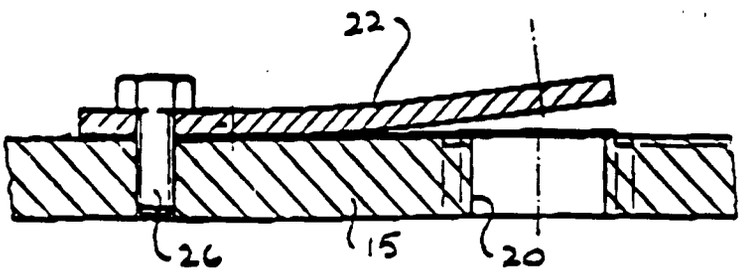


Fig. 3



section X-X

Fig 4



section Y-Y

Fig 5

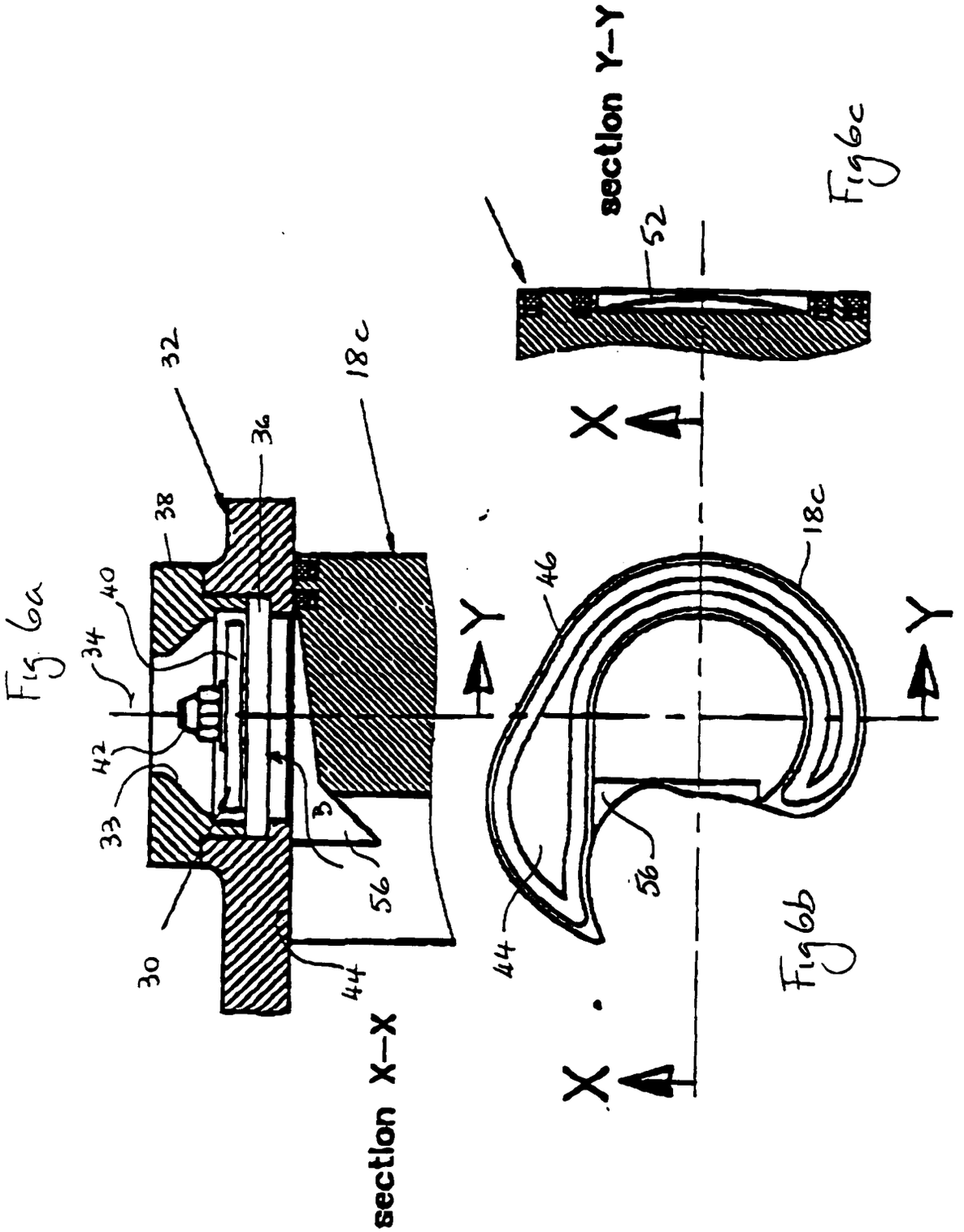


Fig 6a
section X–X
32
36
38
40
34
42
33
30
18c
56
44
B
Fig 6b
X
Y
46
18c
56
44
Fig 6c
section Y–Y
52

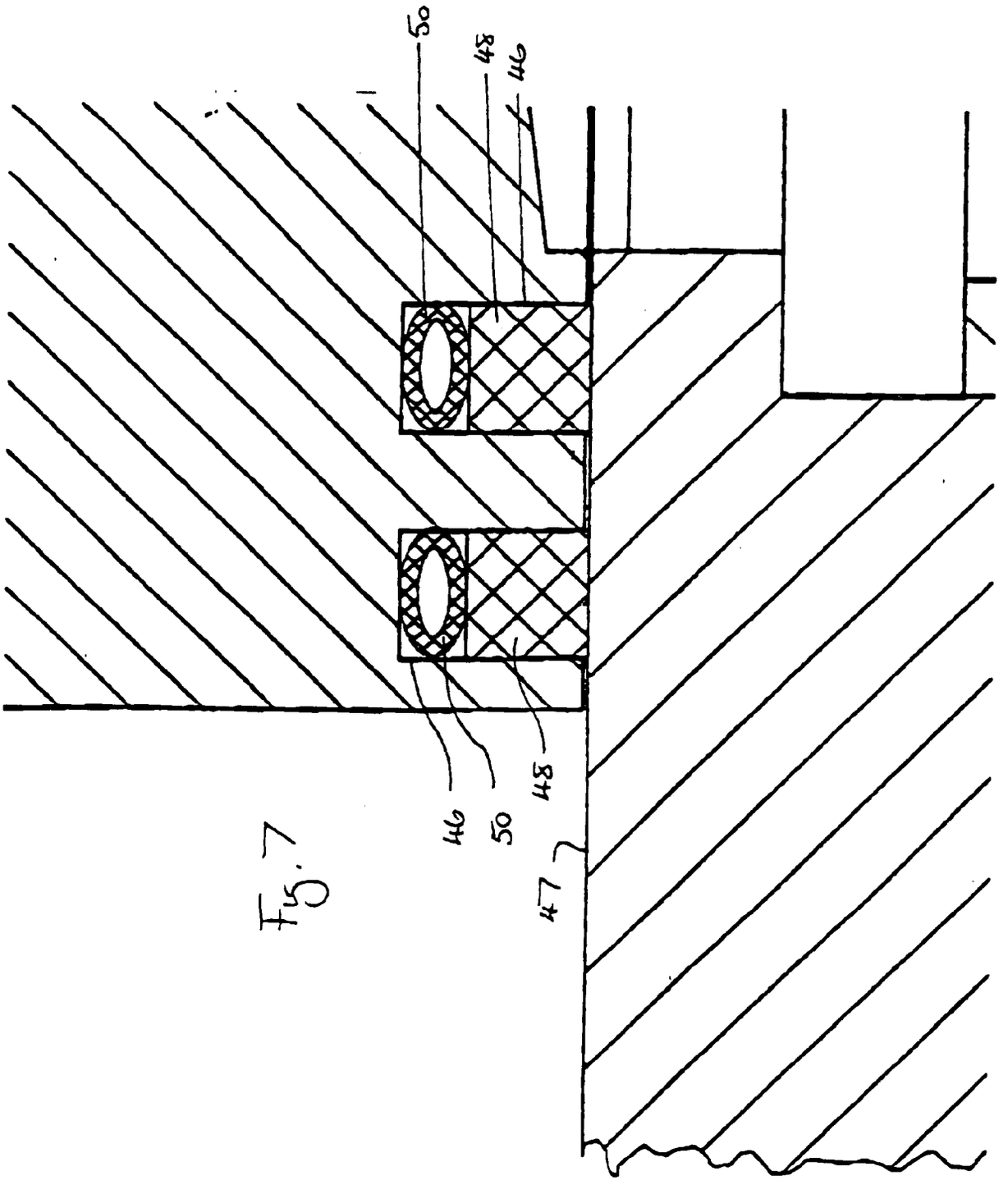


Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5851

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.6)
X	DE-C-721 523 (SCHEIDER) * the whole document *	1-5	F04C18/12 F04C29/08
X	US-A-2 690 869 (BROWN) * the whole document *	1,6	
X	DE-C-923 450 (NATIONAL RESEARCH DEVELOPMENT CO.) * page 2, line 90 - line 93; figures 3,6,7 *	1,6,11	
A	FR-A-2 259 258 (BORSIG GMBH) * the whole document *	3,4	
A	GB-A-616 485 (THOMAS)		
A	EP-A-0 048 095 (BRITISH NUCLEAR FUELS LTD.)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F04C F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 November 1994	Dimitroulas, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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