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ENCAPSULING DEVICE FOR EXPANDERS, COMPRESSORS OR THE LIKE

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4 Sheets-Sheet 1

FIG. 1

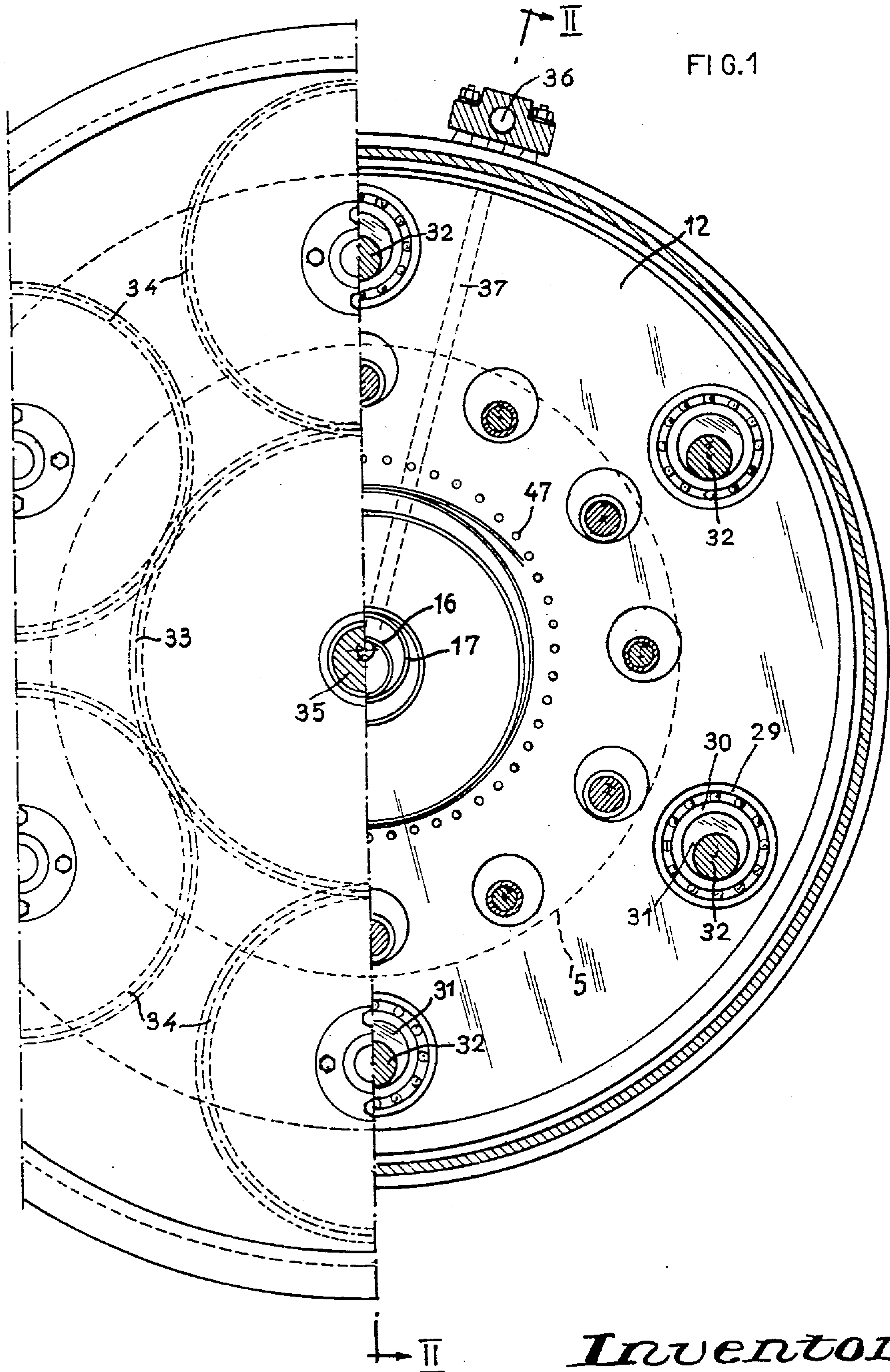

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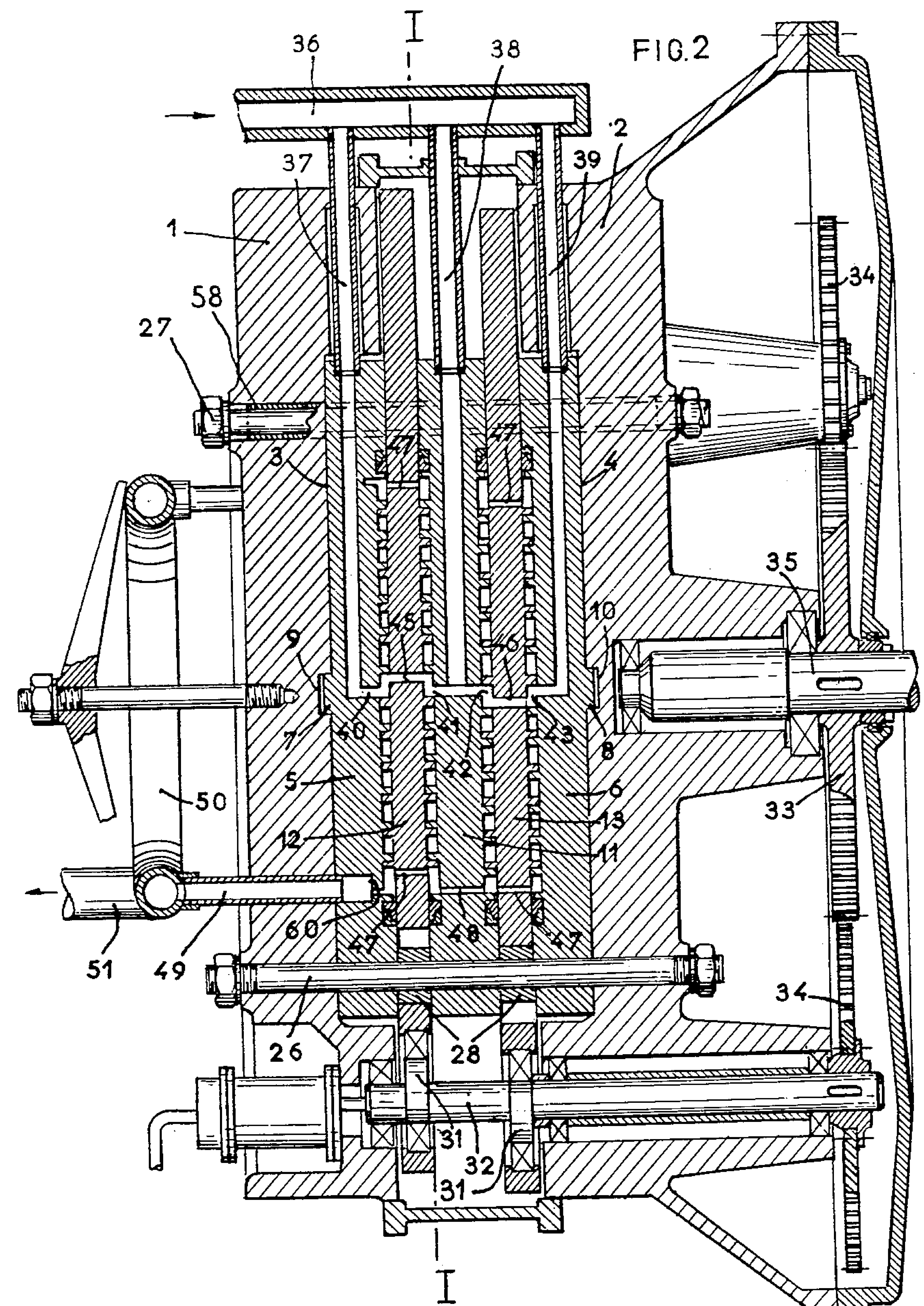
FIG. 2



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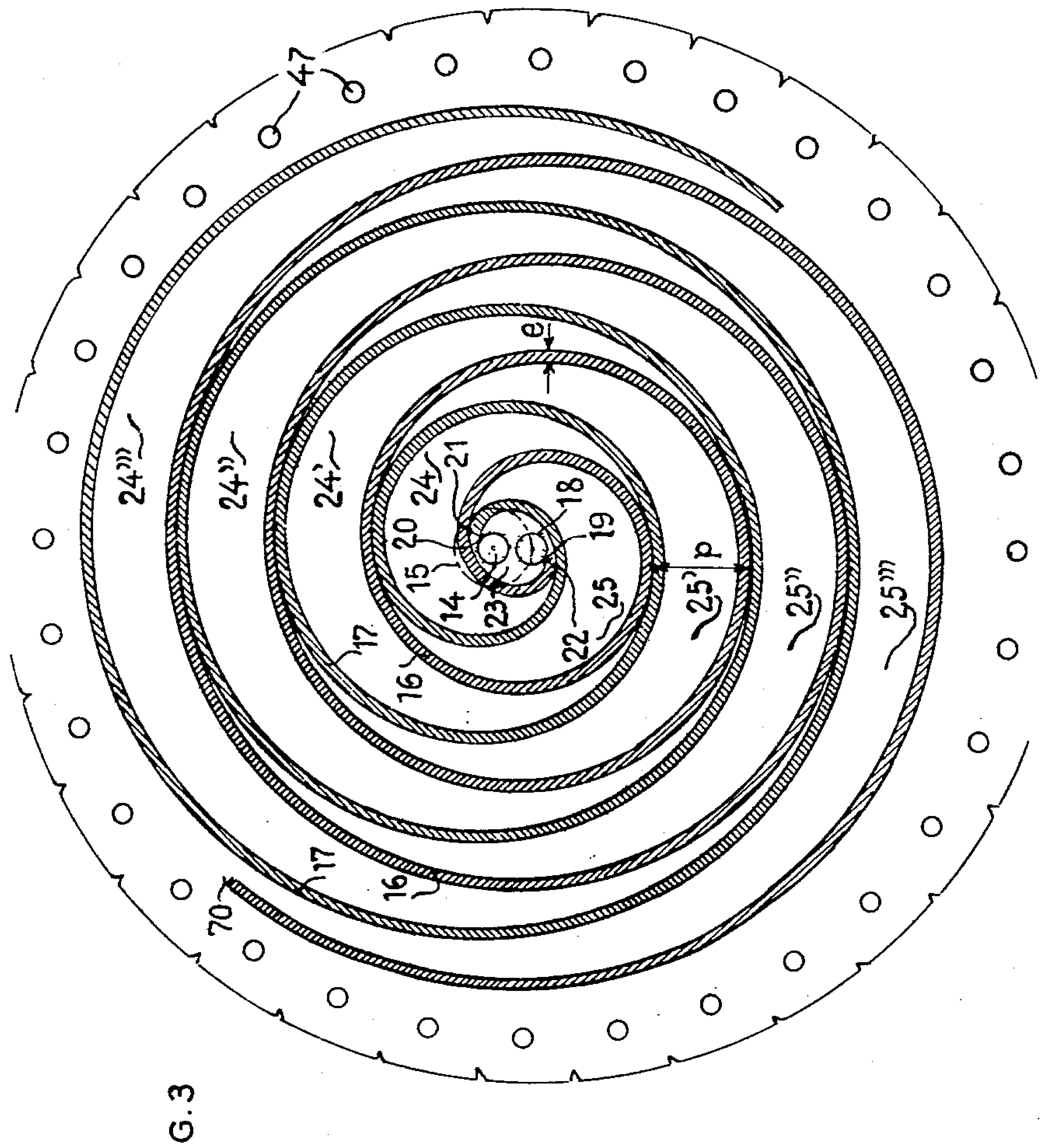

FIG. 3

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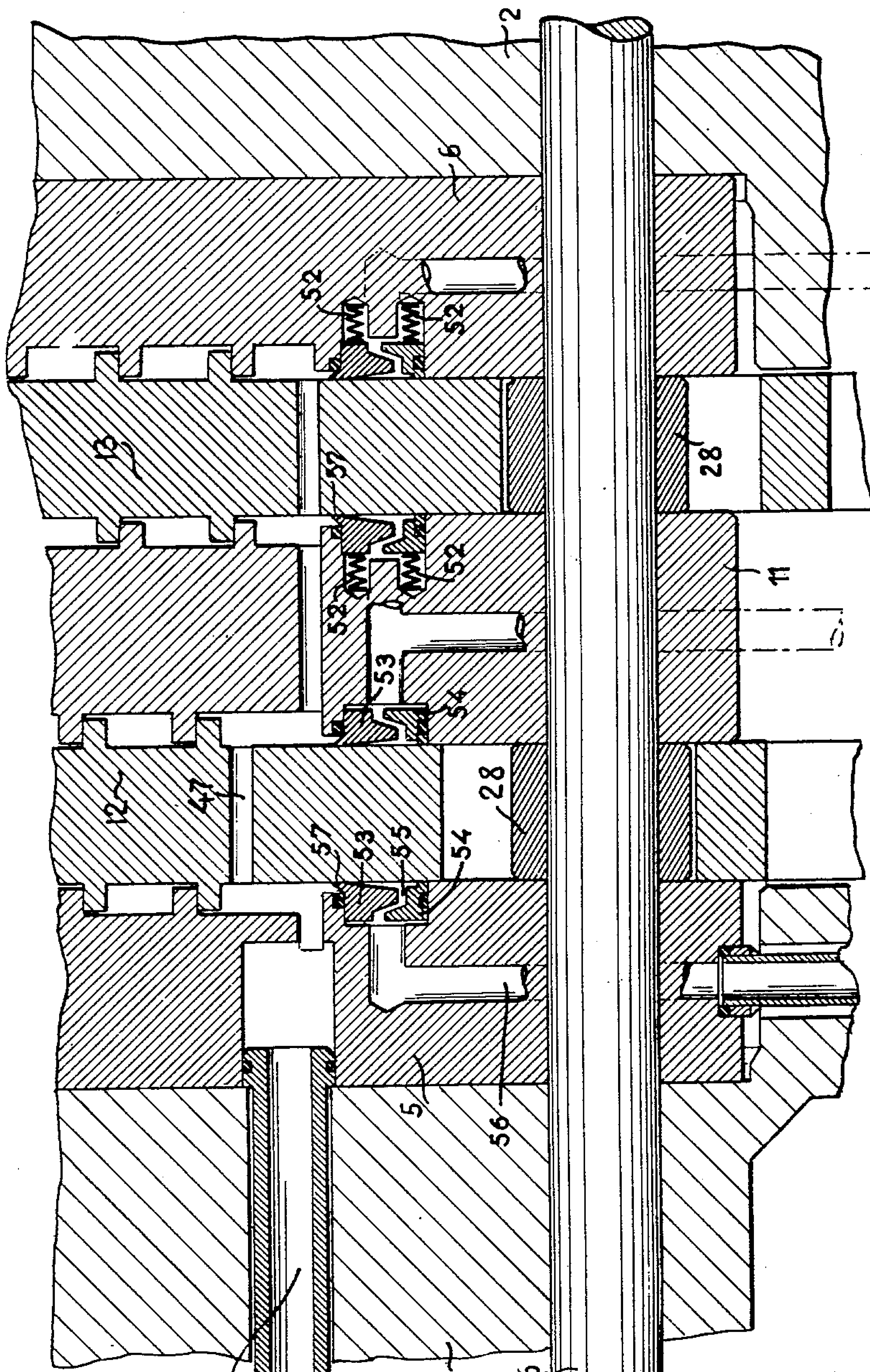

FIG. 4

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ENCAPSULING DEVICE FOR EXPANDERS, COMPRESSORS OR THE LIKE

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1 Claim. (Cl. 230—146)

This invention relates to rotary machines such as rotary engines and pumps, for example, a rotary engine operated by expansion of an elastic fluid under pressure or operable as a pump to compress said fluid. In the French Patent No. 980,737, a rotary machine, more particularly for expanding or compressing gas, is disclosed which comprises two parallel plates or discs and, interposed therebetween, two volute partitions, one carried by each plate, which bear against the surface of the opposite plates, the spirals or volutes being such that if they are moved so that their relative movement corresponds to homokinetic rotations around suitably eccentric axes, they always remain tangential to one another at two points of each of their convolutions.

In the embodiment described in the aforesaid French specification the two discs were rotated homokinetically i.e. at the same speed at any instant, around two offset centres. However, the description therein also stated that one of the discs could remain stationary and the required relative movement could be produced by a translational movement of the other disc over an appropriate path.

One of the disadvantages of this known machine is that the fluid is compressed between the two discs and therefore tends constantly to separate the same from one another, leading to a considerable axial reaction on the shaft or shafts of the device. This disadvantage is all the more noticeable because this kind of machine usually has to deal with very highly compressed fluids.

A number of earlier machines of the same kind are known wherein endeavours have been made to reduce the axial reaction by using a flat rotor which is spirally ribbed on both its surfaces and which is received in a stator chamber subdivided by spiral partitions conjugated with the rotor ribs.

All the known machines, however comprise a central driving mechanism which has a number of disadvantages.

First, the very presence of a central mechanism makes it impossible to originate the spirals near the axis; yet, as is well known and as will be referred to later in the detailed description of the present invention, the efficiency of this kind of machine increases rapidly towards its axis, both for compression or expansion.

Also, gas pressure is highest near the axis, and so a driving mechanism which extends through the casing near the axis leads to very difficult problems of sealing tightness. Finally, such a mechanism is at least partly subjected to the action of the fluid which may in some cases by dangerous to satisfactory operation.

This invention has as its subject matter an encapsuling device of the kind previously mentioned comprising a double-surface moving disc, the transmission mechanism consisting solely of means disposed beyond the periphery of the spirals. The moving disc will hereinafter be referred to as a "rotor" by an extension of the sense of that word, although the movement of the disc is actually a circular translational movement.

The device can therefore be rendered highly effiecient by originating the spirals at a distance from the axis limited in practice only by the diameter of the central fluid inlet or outlet aperture. The problems of sealing tightness in the high-pressure area are thus obviated. Finally, trans-

mission mechanisms connected to the rotor beyond peripheral sealing means are, of course removed from any action by the fluid. This latter advantage is particularly interesting in an application for which the invention is more particularly but not exclusively intended, i.e. the expansion of corrosive gases at the exit of wells, with recuperation of some of their energy.

In a preferred embodiment of the invention, the rotor spirals and stator spirals consist of involutes of identical circles, the rotor spirals being offset by 180° relatively to the stator spirals, and the rotor movement is transmitted by at least one eccentric combined with guide means, the assembly forcing the rotor to move translationally along a circular path on a diameter equal to the pitch of the spirals less twice the constant thickness of the partitions. Each of the spiral partitions of the rotor is therefore constantly tangential to the associated spiral partition of the stator at two points of each of its convolutions.

The aforesaid guide means can be unitary with the eccentrics if the same are provided to a sufficient number (at least two).

In a preferred embodiment of the invention the rotor is formed on each side with two central orifices supplying the stator chamber, such orifices constantly communicating with one another by way of a gap extending from one side of the rotor to the other.

The apertures can therefore be of half the cross-section of the conventional single aperture. Also, the rotor is completely balanced in the area of maximum pressure. To improve balance still further, the rotor is formed with a number of apertures which extend through the rotor preferably near the periphery of its ribs.

For instance, where gases issuing from a well at a very high pressure are to be expanded, the forces applied by the rotors to the eccentrics or vice versa are very high and the shafts of the eccentrics are subjected to considerable radial forces. According to the invention, to obviate this disadvantage two twin rotors are used which are out of phase with one another by 180° so that the radial forces applied to the shafts largely compensate for one another.

Of course, this arrangement is not limitative and n rotors offset by

$$\frac{360^\circ}{n}$$

could be provided. Where at least two rotors are used, the adjacent compartments of the two stators can be supplied through a single duct.

Without departing from the scope of the invention a number of compression or expansion stages can be provided each formed by a device as hereinbefore described, the periphery of the chamber or chambers of each stage communicating with the central apertures of the following stage possibly by way of a cooler or pre-heater.

The invention also relates to a number of particular constructional steps concerning, inter alia, the peripheral sealing means, the manner of deriving a movement from the eccentric or eccentrics or the mechanism for driving such eccentric or eccentrics.

Other objects and advantages of the invention will be hereinafter described with reference to the accompanying drawings, given merely by ways of example.

In the drawings:

FIG. 1 is a partial profile view, with the casing removed, of a rotary machine according to the invention, a partial section being taken along the line I—I of FIG. 2;

FIG. 2 is a sectional view taken along the line II—II of FIG. 1; it will be noted that this section line is staggered at the top relatively to the vertical in order to show clearly the central supply system for the machine;

FIG. 3 is a partial view corresponding to FIG. 1, but on an enlarged scale, of the spiral partitions of the machine, and

FIG. 4 is a sectional view on an enlarged scale of the lower part of FIG. 2.

The machine illustrated, which is intended for expanding gases, has a frame which comprises two members **1, 2** formed with circular recesses **3, 4** respectively receiving stationary discs **5, 6** each forming one of the walls of one of the two stators of the machine. In the example illustrated, the stators and the rotors are in the form of circular discs. This circular shape is very advantageous, particularly in connection with the transmission of the movement to the eccentrics. The discs **5, 6** are centered on the members **1, 2** of the framework by means of projections **7, 8** received in locating sockets **9, 10** in the frame. The stators are completed by a common central stationary disc **11.** A rotor consisting of a moving disc is received in each of the chambers formed between the adjacent surfaces of the end discs **5** and **6** of the stators and their common central disc **11.** The two rotors are designated by numerals **12** and **13.** In the example illustrated each face of the stators and rotors bears a spiral partition formed by an involute of a circle. However, suitable spirals of the kind hereinbefore specified could be produced by other constructional methods, more particularly in the form of involutes of convex geometrical figures other than a circle.

As previously stated, since there is no transmission mechanism in the central part of the device, the spirals can originate at a very much reduced distance from the axis. FIG. 3 approximately illustrates spirals in the form of involutes of a circle which uses this possibility to the maximum.

Referring to FIG. 1, the outline of a few central convolutions and of a few peripheral convolutions of the two spirals are shown.

In FIG. 3, it will be immediately apparent that the two spirals **16, 17** are tangential to one another at two points of each of their convolutions. For instance, so far as the first convolution is concerned, the two spirals are tangential at **21** and **22.** In the position illustrated these two points of tangency bound a closed chamber **23** communicating with the central aperture **14** of the stator. The high-pressure gases entering through the aperture **14** tend to increase the volume of the chamber **23,** so that there is a tendency for that part of the rotor turn lying between the two tangency points **21, 22** to be separated from that part of the stator turn lying between the same two points. The rotor is thus moved in translation and moves along its circular path clockwise. After some circular translational movement from the position shown in FIG. 3, the inner end of the spiral **17** of the rotor engages with that of the stator spiral **16** and divides the chamber **23** into two equal compartments. Immediately after a new chamber similar to **23** is formed, which communicates with the aperture **14.** The mass of gas which was in the preceding chamber **23** is now enclosed in two completely closed chambers **24, 25** wedging in each other, the volume of which continues to increase as the translational movement of the rotor continues. After two revolutions of the rotor the procedure hereinbefore described is repeated and a third central chamber, as **23,** is formed, surrounded by two other completely closed chambers, as **24, 25,** while the latter, still closed have taken up the positions **24′, 25′,** whereafter the same chambers take up seriatim the positions **24″, 25″** and finally **24‴** and **25‴** until their outer ends open as shown at **70.** The expanded gases are then collected along the periphery of the device by apertures **60.** Within the machine, therefore, there is always a central chamber in which the gases act on the rotor to which they impart a continuous circular translational movement, the central chamber being surrounded by a plurality of expansion chambers in which all the

energy of the gases helps to drive the rotor. It will therefore be readily apparent that with such a machine, which takes up little space, a very considerable amount of energy can be recovered and a considerable expansion of the gases can be provided. For instance, using a specific design very similar to the one illustrated here and taking up a total amount of space of the order of 1 m. in diameter and 2 m. in length, machines have been built which recuperate almost 1500 H.P. while expanding 24 litres of gas per second from 400 to 80 kg./cm.^{2}.

The five discs of the embodiment illustrated in FIGS. 1 and 2 are held together by two rows of bolts **26, 27,** the first of which bears spacing rings **28** for maintaining the discs **5, 6** and **11** of the stator far enough apart from one another so as not to jam the rotor discs **12, 13.** The other bolts **27** have centering sleeves **58** and ensure rigid assembly of the whole.

Each of the discs **12, 13** is rigidly secured to the outer races **29** of eccentric ballbearings, the inner races **30** of which are fitted around eccentrics **31** rigidly secured to shafts **32.**

In the example illustrated six shafts **32** are each provided with two eccentrics, the shafts **32** being regularly spaced on the same circumference around the axis of the device. This arrangement is not essential since the movement concerned is not a rotation but a circular translational movement. However, this arrangement is convenient for transmission of the movement, as it enables a number of identical pinions **34** to be placed around a central gearwheel **33,** each pinion **34** engaging with the central wheel **33** and being secured to one of the shafts **32.** Transmission of the movement starts from the central wheel **33** which is secured to a central shaft **35.** The compressed gas which it is required to expand is supplied through a duct **36** and three inlet pipes **37, 38, 39** connecting the duct **36** to the central apertures **40—43** of the stators. It will be noted that the pipe **38** has twice the cross-section of the pipes **37** and **39** so as to distribute the incoming gas uniformly between the four stator apertures. The axial holes **45, 46** of the rotors also help to balance the gases between the two surfaces of the rotors. Also, the peripheral holes **47** help to balance the pressures at the exit of the gases. One of the stators (the right-hand stator in FIG. 2) communicates with the other by peripheral holes **48;** the expanded gases are collected by a number of pipes **49** communicating with peripheral apertures **60** disposed near the periphery of the left-hand stator; the gases flow into an annular collector **50** and are exhausted through an exhaust pipe **51.** Peripheral sealing is provided by two sets of concentric rings which are constantly applied to the surface of the rotor discs by springs **52** separated from one another by equal angular intervals. The inner rings **53** are separated from the outer rings **54** by an annular chamber **55** which communicates with ports **56** for leakage removal or oil injection. The transmission mechanisms, which are entirely outside the rings **54,** are thus fully protected by this arrangement, for even if there is slight leakage of the inner rings **53,** the gas escapes more readily through the annular chamber **55** and ports **56** than along the outer rings **54.** The inner rings **53** improve their effectiveness still further, and are provided with inclined lips **57** resting on the rotor discs only by their thinned inner edges.

This step makes it possible to predetermine the bearing pressure of the rings **53** by suitably positioning the lips **57.**

While the invention has been described with particular reference to a preferred embodiment, it is not intended to limit the scope of the invention to the embodiment illustrated, nor otherwise than the terms of the subjoined claim.

What is claimed is:

In a rotary machine, the combination with a circular frame provided with two ports for a fluid to be translated, a pair of discs disposed in said frame in parallel spaced relation with respect to each other, one of said discs being stationary and the other disc being mounted for circular movement of translation with respect to the stationary disc, the diameter of said movable disc being larger than that of said stationary disc, two cooperating spiral bands carried each by one of said discs, one engaged in the other so as to be tangent at two points of each convolution of each band to provide a central fluid working chamber of variable volume and lateral working chambers which move during circular translation movement of said movable disc, and conduit means to establish a communication between said central working chamber and one of said ports, the other said port being connected to a port adjacent the periphery of said movable and stationary discs, guiding means for said movable disc including a plurality of circular orifices formed through said movable disc and distributed therearound between the periphery of said movable disc and the periphery of said stationary disc, a plurality of rotatable shafts each provided with an eccentric and supported by said frame to extend through one of said orifices, with said eccentric

positioned in the corresponding orifice so that rotation of said shafts will compel said movable disc to undergo a circular translatory movement without rotation with respect to said stationary disc, and a driving connection including a common central drive shaft drivingly connected to each of said rotatable shafts.

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