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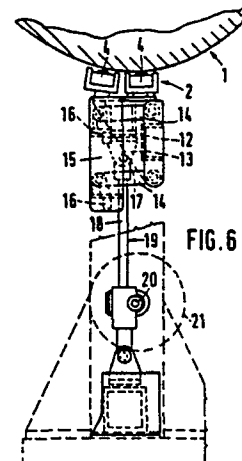
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54 Apparatus for heating the cylindrical wall of a rotary cylinder of a paper making machine.

57 Apparatus for heating the cylindrical wall of a rotary cylinder of a paper making machine is described, in particular a drying cylinder for sheet paper in a machine of this type, including drive means for the cylinder operable to make it rotate with a predetermined speed of rotation, at least one magnetic flux generator device and means for supporting this device at a predetermined distance from the said cylinder; the cylindrical side wall of the cylinder is made of a metal material and the said predetermined distance is chosen in such a way that the magnetic flux generated by the device intersects at least part of the side wall itself.



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APPARATUS FOR HEATING THE CYLINDRICAL WALL OF A ROTARY
CYLINDER OF A PAPER MAKING MACHINE

The present invention relates to apparatus for heating
5 the cylindrical wall of a rotary cylinder of a paper making
machine, in particular a sheet paper drying cylinder of a
machine of this type.

In paper making machines there are very often used
rotary cylinders the cylindrical side walls of which must be
10 suitably heated to drive off water vapour from the layer of
material or from the paper sheet which is deposited on it, or
for imparting particular characteristics to this sheet; in
such machines the final drying of the sheet produced there-
by is obtained by means of at least one rotary drying cylin-
15 der over which the sheet is partially wound and the outer
wall of which is suitably heated. Steam is normally used for
heating the walls of the said cylinders, which steam is con-
tinuously supplied to the interior cavity of the cylinder,
whilst the water constituted by the condensation which forms
20 following the cooling of the steam is carried away.

Apparatus necessary for obtaining the heating of a cylin-
der in the manner indicated have numerous disadvantages.

First of all, they are constructionally very complex and
therefore expensive. In fact, the apparatus must include a
25 boiler for generating the steam, and since it is supplied to
the interior cavity of the cylinder, this latter constitutes
in effect a pressure vessel which must be perfectly sealed and
must have a mechanical strength sufficient to resist the pres-
sure of the said steam. Moreover, for removal of the conden-
30 sation which forms in this cavity there are required sucker
means which include numerous parts and members such as
tubing, pumps and sealing elements; and then, normally on
the surface of the inner wall of the cylinder, there must be
formed annular grooves operable to collect the condensation.

35 Again, with the apparatus described, a certain
portion of the thermal energy provided by the steam is also
transmitted to parts thereof, in particular parts of the
cylinder itself which would not themselves require to be
heated, so that this energy is not utilised in an entirely
40 correct manner. Moreover, the transmission of heat from the

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interior cavity of the cylinder, which takes place above all by conduction, is hindered by the layer of water which is deposited on the inner surface of the wall of the cylinder
5 itself, with the consequence that the coefficient of thermal conduction is rather low; also the temperature distribution over the outer surface of the cylinder is not very regular.

Finally, the temperature adjustment required to satisfy the various conditions of use is not easy nor very
10 rapid and for such adjustment complex and expensive means are required; also the normal maintenance and repair operations of the apparatus are rather long and complex because of the described structure of the apparatus itself, which makes it necessary to dismantle various members and parts in
15 order to gain access to those on which the operations are to be performed.

The object of the present invention is that of providing apparatus for heating the cylindrical wall of a rotary cylinder for a paper making machine, in particular
20 a drying cylinder for the sheet paper of such a machine, which will be free from the above mentioned disadvantages.

The apparatus of the invention is characterised by the fact that it comprises at least one magnetic flux generator device, means for supporting this device at a
25 predetermined distance from the said cylinder, and drive means operable to generate movement at a predetermined relative angular speed between the cylinder and the said magnetic flux generator device, the said cylindrical side wall of the said cylinder being made of a metal material
30 and the said predetermined distance being chosen in such a way that the magnetic flux generated by the said device intersects at least part of the said side wall.

For a better understanding of the invention there will now be given, by way of example, a more detailed
35 description with reference to the attached drawings, in which:

Figures 1 to 5 schematically represent various parts of five different embodiments of the apparatus;

Figures 6 and 7 are two constructional side views

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of various means and members of the apparatus corresponding to the diagrams of Figures 1 and 2;

Figures 8 and 9 are two sections, taken on planes
5 orthogonal to one another, of various means and members of the apparatus corresponding to the diagram of Figure 5.

With reference to the diagrams of Figures 1 and 2, the apparatus of the invention is intended to heat the cylindrical side wall of a rotary cylinder 1 which may form
10 part of a paper making machine; in particular this cylinder can be a sheet drying cylinder and the said side wall is made of a metal material. The apparatus of the invention includes means (not illustrated) for driving the cylinder 1 to rotate, comprising, for example, an electric motor. Conveniently,
15 for purposes which will be indicated, this motor is a motor the speed of which is continuously adjustable.

The apparatus includes magnetic flux generator means, indicated 2, which can simply comprise permanent magnets 3 as shown in the embodiment of Figure 1, or electro
20 magnets 4 as shown, on the other hand, in Figure 2, the windings of which are connected, by means of conductors 5, to a suitable source of dc or ac electrical energy.

Also forming part of the apparatus are support means, generally indicated 6, operable to support the flux
25 generator means and to hold them at a predetermined distance from the cylinder 1; these can comprise, for example, one or more arms 7, axially movable on guides 8 of the base (not illustrated) of the apparatus.

The support means 6 are preferably provided with
30 adjustment means for the purpose of being able to arrange the magnets 3 (or the electro magnets 4) in a predetermined position with respect to the cylinder 1, this position being chosen in such a way that the magnetic flux generated by these magnets, (or electro magnets) intersects at least part
35 of the side wall of the cylinder 1.

In Figures 6 and 7 the structure of the support
6 is shown in more detail. Two rows of electro magnets 4 are supported by a beam 12 the ends of which are fixed to

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triangular plates 13; these are pivoted, by means of a pair of link rods 14, to plates 15 of a bracket 16 fixed to the base of the apparatus in such a way as to form two parallelo-
5 gram linkages operable to allow substantially parallel displacements of the beam 12 normal to the surface of the cylinder. The beam 12 is connected, by means of cylindrical pivots 17, to a bar 18 forming part of a rack and pinion mechanism connected to an operating shaft 20 to which there
10 is fixed an operating wheel 21 and/or a drive motor 21a. The lower ends of the said rod are pivoted, by means of further cylindrical pivots 22, to the base of the machine.

It is therefore evident that by operating the hand wheel 21 (or the drive motor 21a) vertical displacement
15 of the rod 18, and therefore vertical displacement of the beam 12 and of the electro magnets rigidly connected to it is caused.

The heating of the wall of the cylinder 1 takes place in the following way.

20 The electric motor makes the cylinder 1 rotate at a predetermined speed and the magnets 3 (or the electro magnets 4) are carried, by acting on their support means 6, closely adjacent to the said wall at a distance such as to make the magnetic flux generated by the magnets intersect
25 part of the said wall. It is apparent that in order to generate this magnetic flux, in the case of the electro magnets 4 (Figure 2) ac or dc electrical energy is supplied to the associated windings.

There is therefore established on the wall of the
30 cylinder 1 (or on a part thereof) a magnetic flux the intensity of which, within certain limits, depends on the magnetisation of the magnets 3 or on the current which circulates in the windings of the electro magnets 4. During the rotation of the cylinder there occurs at each point in
35 its wall, and in each unit of time, a variation of magnetic flux ϕ , which generates an electromotive force proportional to the said variation; this electromotive force causes an electric current to circulate in the wall of the cylinder,

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thus heating the wall itself by the Joule effect. It has been established that, in this way, with magnets of relatively small dimensions, it is possible to heat the cylindrical side wall of a large cylinder, such as the drying cylinder of the paper making machine, in a very short time, raising the outer surface of this wall to the temperature which is considered convenient for obtaining the said drying.

During the rotation of the cylinder 1 there is transmitted to the electro magnets 4 forces which are both tangential and normal and which are borne by the support means 6. When permanent magnets 3 (Figure 1) are utilised in the apparatus, instead of the electro magnets 4 (Figure 2) supplied with dc current, the heating energy is provided only at the expense of the energy supplied to the cylinder drive motor. In this case the adjustment of the quantity of heat transmitted to the cylinder wall can be effected by acting on the speed of the motor itself. In fact, by increasing this speed the variation $\frac{d\phi}{dt}$ of the magnetic flux per unit time increases whilst the flux itself is maintained constant.

This characteristic can be particularly advantageous in a drying cylinder of a paper making machine in which, for correct drying of the sheet, heating energy proportional to the tangential velocity of the sheet on the cylinder is required; in fact, if a certain magnetic flux sufficient to cause an effective heating at a predetermined speed of rotation of the cylinder is established the system thus adjusted is also self regulating since by increasing the speed of the cylinder the energy required for drying is also increased.

It is, however, apparent that, in this case, the adjustment of the quantity of heat transmitted to the cylinder wall can also be effected by acting on the distance of the magnets 3 from the wall itself or by varying the current in the dc electro magnets, rather than on the speed, thus generating in this way a different magnetic flux ϕ and therefore obtaining a dif-

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ferent value of the flux variation $\frac{d\phi}{dt}$.

When the electro magnets 4 (Figure 2) are supplied with ac current, on the other hand, the magnetic flux at each point of the cylinder wall varies not only by the action of the speed of rotation of the cylinder itself, but also by the action of the variation of current, and therefore in order to adjust the thermal energy transmitted to the wall itself it is possible to act not only on the distance of the electro magnets 4 from the cylinder and on the speed of rotation of this latter, but also on the current and supply frequency of the electro magnets themselves.

In the diagram of Figure 3 the electro magnets 4 are arranged in the same diametral plane of the cylinder 1 and on opposite sides thereof; in this way the resultant of the forces of attraction generated by the electro magnets on the side wall of the cylinder, and which act on the shaft of the cylinder itself, is nil, with the advantage that the shaft bearings carry only the weight of the cylinder; it is evident that more than two electro magnets can be arranged peripherally around the cylinder, angularly displaced by the same amount, in such a way as to obtain the above mentioned effect, that is a zero resultant on the cylinder shaft.

The apparatus of the invention can include means for distributing electrical current to the electro magnets 4 and these can have the arrangement as shown in Figure 4 such as to be uniformly spaced from one another around the periphery of the cylinder 1 so that these electro magnets constitute the stator of an electric motor the rotor ring of which is formed by the cylindrical side wall of the cylinder itself; in this case such wall is made of a ferromagnetic material.

It is therefore evident that with this latter constructional arrangement the electro-magnets 4 generate not only the magnetic flux which allows the heating of the side wall of the cylinder 1, but also a magnetic

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flux capable of driving the cylinder itself to rotate.

To obtain this latter object the apparatus must be provided with known means with which electric motors are provided, which function on the basis of the indicated principal.

The apparatus of the invention can also be formed according to the diagram of Figure 5, that is to say by arranging the electro magnets 4 (or the magnets 3) within the cylinder 1; in this case these will be supported by suitable support means 30 which also allow radial displacement of each of these with respect to the cylindrical wall 1.

In Figures 8 and 9 there is shown a constructional arrangement for obtaining the said system of Figure 5. The support means 30 include a hollow drum 31 the ends of which are rigidly connected to side walls 33 of the base of the apparatus. The cylinder 1, coaxial with the drum 31, has a bottom wall 32 and is supported by the base itself via interposed rolling element bearings 32a.

The electro magnets 4 are carried by beams 34 (Figure 8) each of which is connected, by means of pivoted link rods (Figure 9) to radial plates 36 in turn carried by the drum 31. The radial movement of the beams 34 is controlled by mechanical jacks 37 pivotally connected both with the beams and with the drum 31 and driven by electric motors 38 via a suitable transmission including shafts 39.

It is therefore evident that the described apparatus avoids the first mentioned disadvantages of the apparatus which utilises steam for heating the cylinder.

In fact, the apparatus of the invention is constructionally very simple; it is not necessary to provide a steam generator for its operation, and the cylinder does not have to be provided with sealed internal cavities, nor must it have a high mechanical strength to resist the steam pressure.

All the members and parts which in the prior apparatus were necessary to carry away the condensation which forms in the cylinder are not necessary, nor must the internal walls of this be provided with grooves for the

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collection of the condensation.

Moreover, a correct utilisation of the thermal energy generated is obtained since this is transmitted
5 only to the side wall of the cylinder and directly onto the outer surface of the said wall so that the temperature of this wall decreases radially from the outside towards the inside thereof, as is preferable for a correct heating of the sheets contacting the outer surface of the cylinder.

10 Even the regulation of the temperature of this wall can be effected in a very simple and rapid manner and with considerable precision, it being sufficient, for this purpose, to vary the distance of the magnets 3 (or the electro magnets 4) from the cylinder 1, or to vary
15 the speed of rotation of the control motor, or alternatively when electro magnets 4 are utilised, to vary the current supplied to these or the frequency of this current.

It is apparent that to obtain adjustment of this temperature it is also possible to vary the position of
20 the cylinder with respect to the magnets (rather than the other way round as in the case illustrated and described), by providing suitable means for this purpose.

Although systems and constructional arrangements in which the cylinder 1 rotates and the magnets 3, (or
25 the electro magnets 4) do not rotate with respect to the cylinder have been considered, arrangements in which both the cylinder and the magnets (or the electro magnets) are rotatable about the same axis, with different angular velocities, fall within the scope of the invention.

30 There can be provided means for regulation of the flux generated by each magnet, or by several of these (for example those which lie on the same plane orthogonal to the axis of the cylinder), in such a way as to obtain a predetermined flux distribution intersecting the side
35 wall of the cylinder 1; it is apparent that, in this way, it is possible to obtain any desired distribution of energy transmitted from the magnets to the cylinder for the purpose of satisfying particular operating requirements. Such requi-

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rements can be directed, for example, to obtaining a desired temperature distribution in the transverse direction of the sheet which passes over the cylinder, or to
5 satisfy the energy requirements which can be different in the various regions of the sheet. By proceeding in this way it is therefore possible, with the apparatus of the invention, to transmit to the sheet being treated quantities of energy which can be different from region
10 to region and which are comensurate with those necessary to satisfy the requirements of the treatment in each of these regions; the advantage is obtained, therefore, of having an optimum result of the treatment with the least possible expenditure of energy.

15 Finally, it is evident that the apparatus can include control means provided for effecting in an entirely automatic manner the distribution of the magnetic flux in the above described way.

It will be apparent that other variations and
20 modifications are possible without departing from the scope of the invention. In particular, for heating the side wall of the rotary cylinder there can also be used other means and apparatus which are able to provide such heating in association with the apparatus of the
25 invention.

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Claims:

1. Apparatus for heating the cylindrical wall of a rotary cylinder for a paper making machine, in particular a drying cylinder for the paper sheet of a paper making machine, characterised by the fact that it comprises at least one magnetic flux generator device, means for supporting such device at a predetermined distance from the said cylinder and drive means operable to generate movement, at a predetermined relative angular velocity between the said cylinder and the said magnetic flux generator device, the said cylindrical side wall of the said cylinder being made of metal material, the said predetermined distance being chosen in such a way that the magnetic flux generated by the said device intersects at least part of the said side wall.
2. Apparatus according to claim 1, characterised by the fact that the said magnetic flux generator device includes at least one permanent magnet.
3. Apparatus according to claim 1 or claim 2, characterised by the fact that the said magnetic flux generator device includes at least one electro magnet magnetisable by the action of an electric current coming from a current source.
4. Apparatus according to claim 3, characterised by the fact that the said electric current source is a dc source.
5. Apparatus according to claim 3, characterised by the fact that the said electric current source is an ac source.
6. Apparatus according to any preceding claim, characterised by the fact that the said magnetic flux generator device is arranged externally of the said cylindrical wall of the said cylinder.
7. Apparatus according to any of Claims 1 to 6, characterised by the fact that the said magnetic flux generator device is arranged internally of the said cylindrical wall of the said cylinder.
8. Apparatus according to any preceding claim,

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characterised by the fact that it includes means for adjusting the position of the said magnetic flux generator device with respect to the said cylinder, operable to vary
5 the said predetermined distance from the said cylinder.

9. Apparatus according to any of claims 1 to 7, characterised by the fact that it includes means for the adjustment of the position of the said cylinder with respect to the said magnetic flux generator device.

10 10. Apparatus according to any preceding claim, characterised by the fact that the said drive means comprise a motor the speed of which is continuously adjustable, operable to drive the said cylinder to rotate.

11. Apparatus according to any of the preceding
15 claims, characterised by the fact that it includes means for adjustment of the said current in such a way as to vary the magnetisation of the said device.

12. Apparatus according to any of the preceding claims, characterised by the fact that the said magnetic
20 flux generator devices are angularly displaced with respect to one another by the same angle.

13. Apparatus according to any preceding claim, characterised by the fact that it includes means for the adjustment of the magnetic flux generated by each of
25 the said devices for the purpose of obtaining a predetermined distribution of the said flux intersecting the said side part of the cylinder, and therefore a predetermined distribution of the energy transmitted between the devices and the said wall.

30 14. Apparatus according to any preceding claim, characterised by the fact that the said magnetic flux generator devices are arranged peripherally about the said cylinder in such a way that the resultant of the force generated magnetically by these and the other forces
35 acting on the cylinder itself is substantially zero with respect to the axis of the cylinder itself.

15. Apparatus according to any preceding claim, characterised by the fact that there are provided means for distributing the said electric current to the said

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magnetic flux generator devices, and such devices are arranged about the said cylinder in such a way that these constitute the stator of an electric motor the rotor ring
5 of which is constituted by the said side wall of the said cylinder.

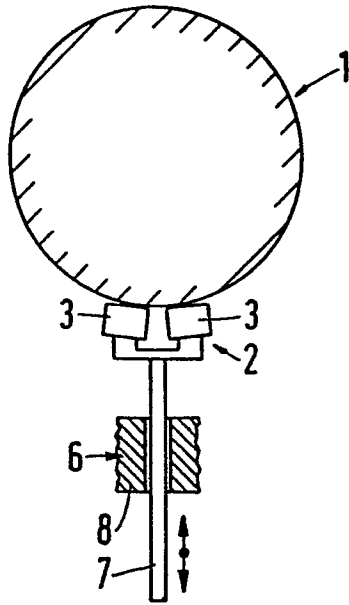


FIG. 1

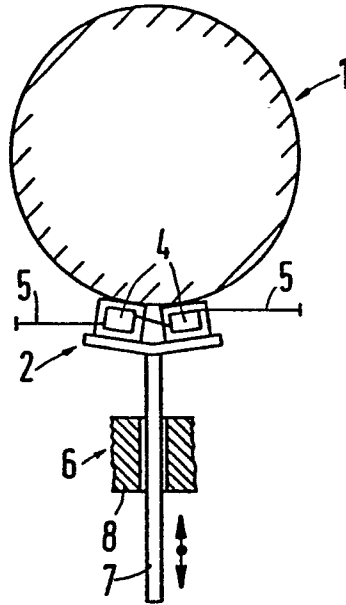


FIG. 2

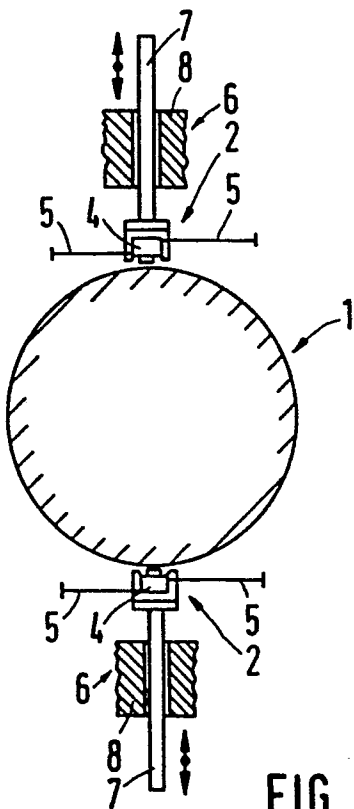


FIG. 3

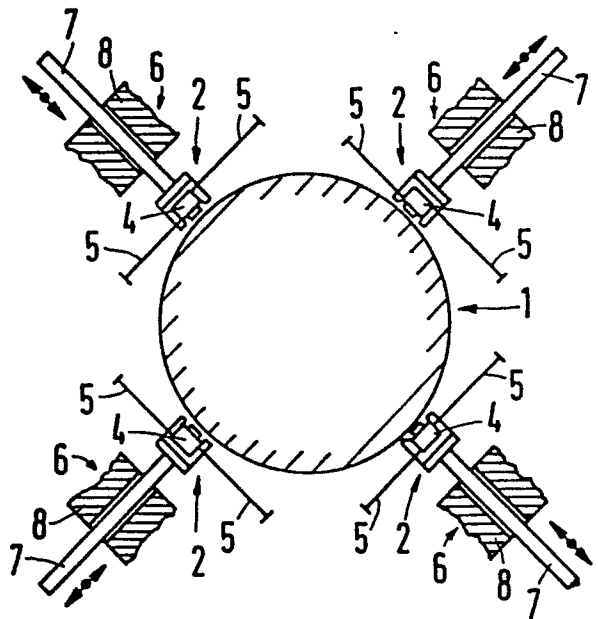


FIG. 4

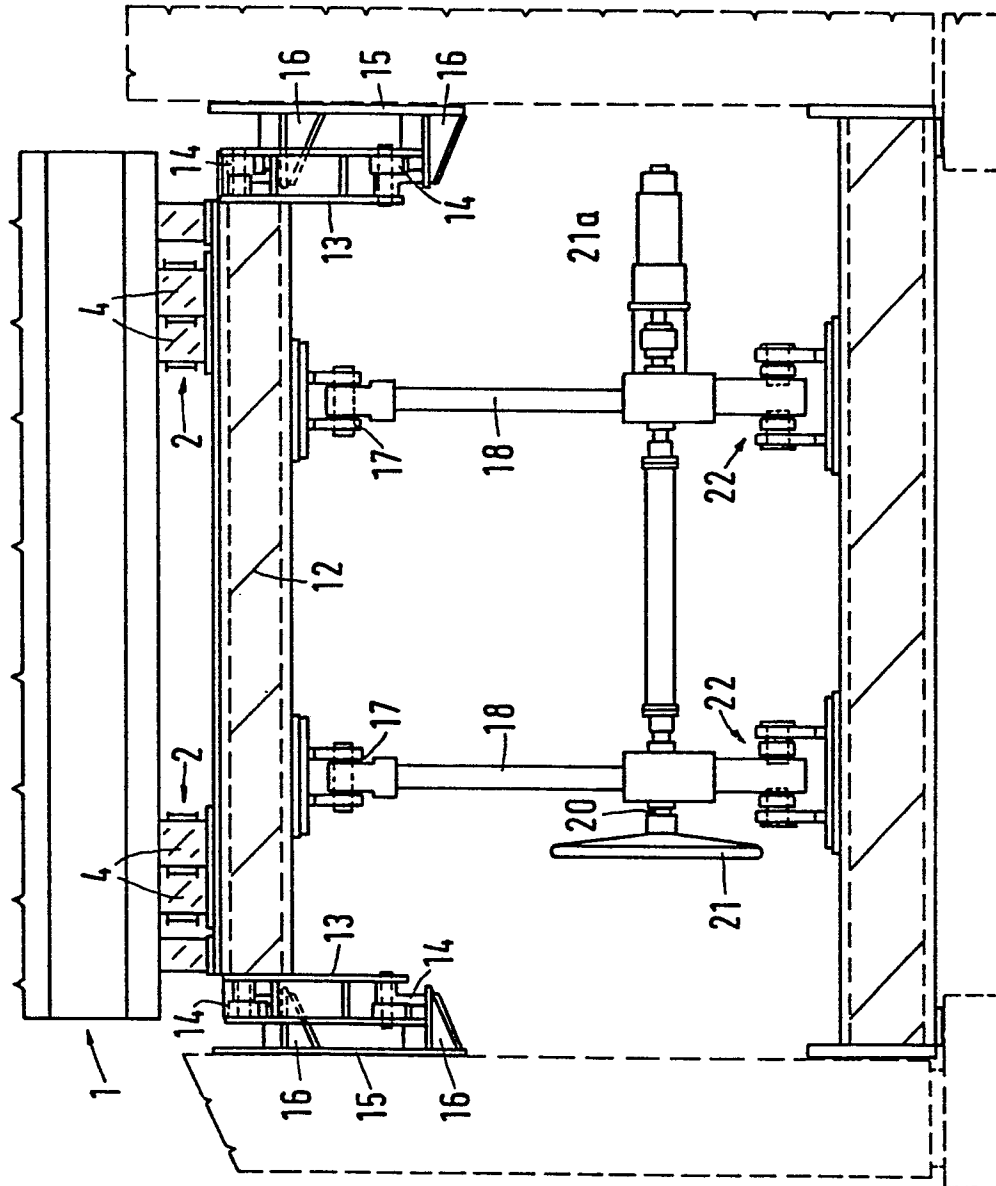


FIG. 7

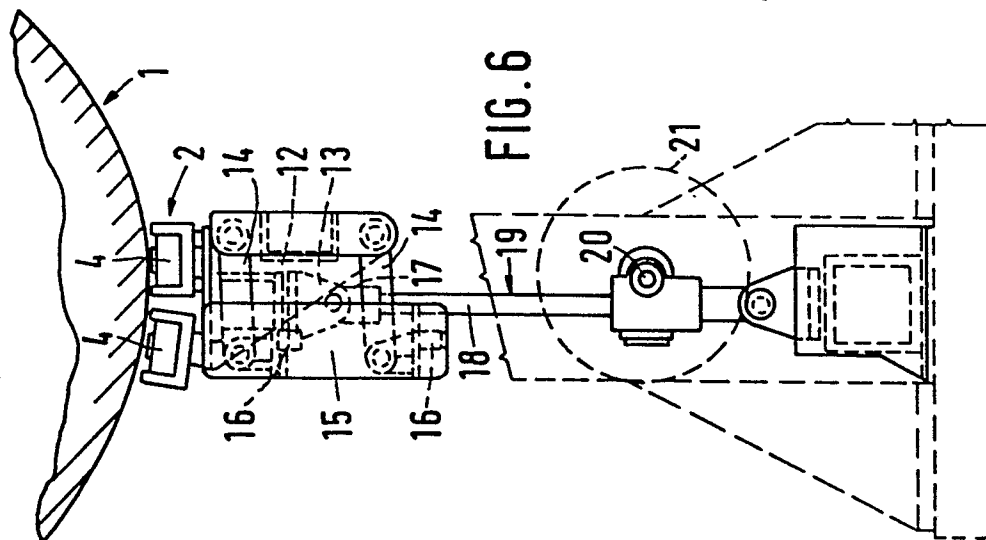


FIG. 6

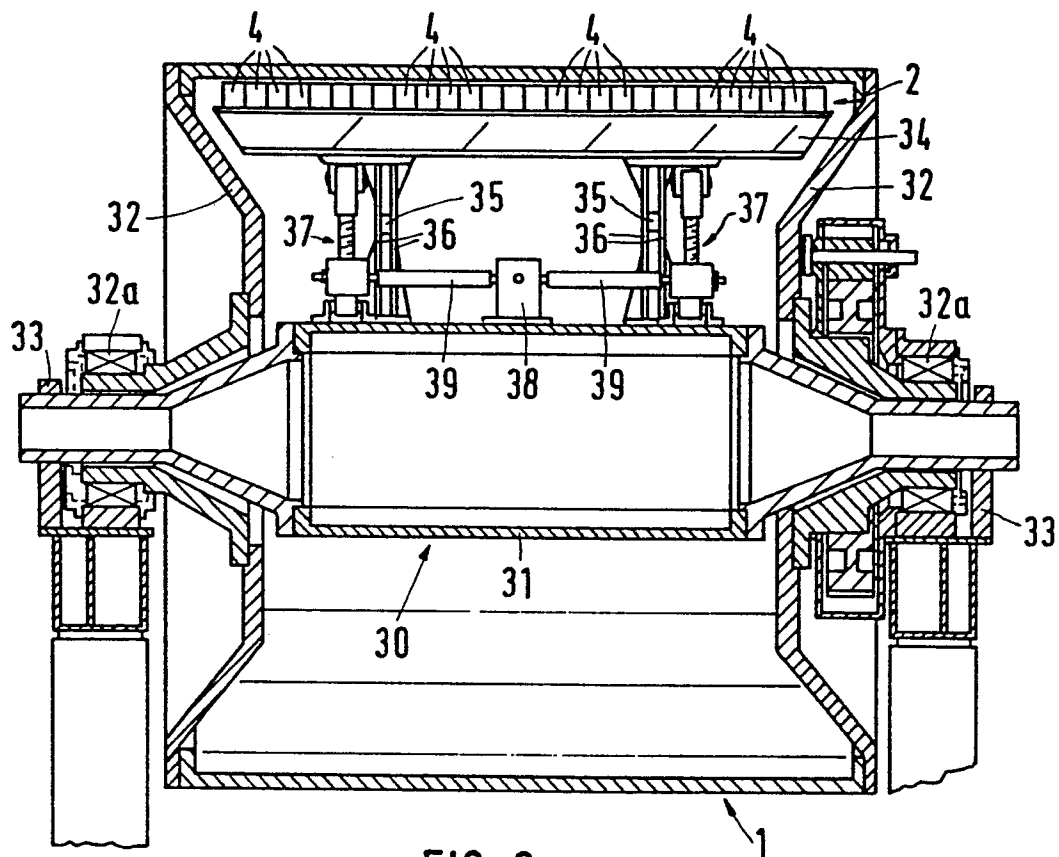


FIG. 8

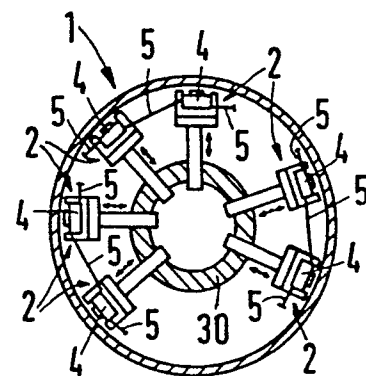


FIG. 5

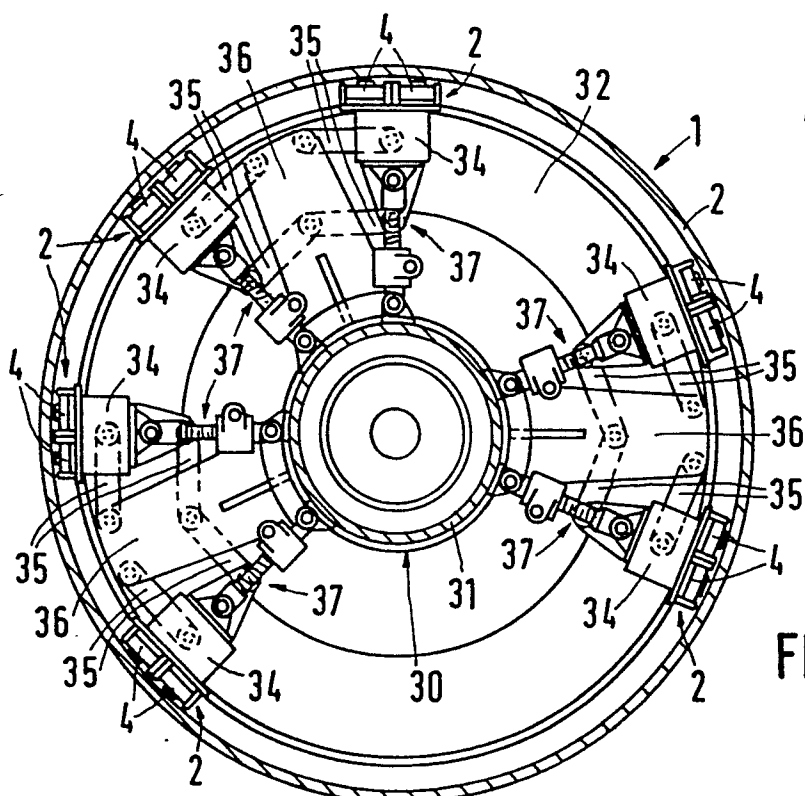


FIG. 9