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(12) # EUROPEAN PATENT SPECIFICATION

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Description

The present invention relates to a mixing machine in which a rotor in the form of a circular rotary platform cooperates with a stator in the form of a stationary wall which encircles the periphery of the rotor and extends above its rim. As the rotor rotates, materials to be mixed are flung centrifugally outwards and upwards by the rotor against the stator which deflects the materials inwards again onto the platform so that the materials to be mixed are formed into a moving toroidal mass extending around the platform with individual particles of the mixture travelling helically around the toroid.

A mixing machine that operates on the above mentioned principle has been described by Milik—see UK Patent Specification No. 1365685 (assigned to Evans and Ryder). The use of that machine has been described by the same inventor in relation to fibrous materials (Patent Specification No. 1365686), granular materials having a density below 70 lb per cubic foot which is less than the normal density of concrete (Patent Specification No. 1375943) and for the treatment of seed (Patent Specification No. 1417694). The stator part of the machine is a substantially vertically directed stationary wall that surrounds and extends directly upwards from the rim of the rotor with an obtuse sharply defined angle between the wall and the rim of the platform. But the mixer described by Milik is difficult to use for the mixing of concrete in which water has to be mixed with a non-homogeneous mixture of particles ranging in size from very fine particles of cement to particles of gravel and coarse aggregates that are retained by a 5 mm mesh BS sieve. The blend of water or other liquid with such a complex mixture of particles is liable to adhere to the inner surface of the stator at or adjacent to sharp angulations to build up a static boundary layer with the result that complete and uniform mixing is not achieved and the mixing operation may have to be prematurely discontinued. Furthermore, sharp angulations in the circulation path of the particles being mixed result in high rates of inter-particle impact and damage to the particles being mixed. In concrete, the effect of inter-particle impacts during mixing is that the individual particles become more rounded, and the cube strength developed by the resulting cured concrete is less than would otherwise be obtained. A similar situation prevails for other types of material to be mixed or blended. In the mixing of wood pulps during processing to make paper it is necessary to avoid high material shear rates if product damage and energy consumption are to be minimised and a similar situation prevails in the mixing and blending of pigments.

The present invention is based on the realisation that more satisfactory results are obtained by using a stator having a concave curved inner face to which the rim of the rotor is tangential. With such an arrangement the particles to be mixed are positively guided along an appropriate toroidal path and there is no sharp angulation giving rise to a dead space for slow moving particles that could promote static boundary layer formation. Uniform mixing can be achieved very rapidly without build up of an unacceptable layer of incompletely mixed material at the stator wall and with a minimum of particle damage and with minimum energy consumption.

Broadly stated the invention provides a mixing machine comprising a dished circular rotary platform that is smoothly curved towards an upwardly and outwardly inclined rim, and a concave stationary wall which closely surrounds and extends upwardly from the rim of the rotary platform characterized in that:

- the rotary platform is in the form of a shallow dish; and
- the stationary wall has a concave part toroidal surface defined by rotating a generating vertical segment of an arc about the axis of rotation of the platform, the rim of the rotary platform being tangential to the concave surface and the concave surface having a smaller radius of curvature than the dish.

Swiss Patent No. 455555 (Meier) shows a mixer in which a generally toroidal circulation is produced by a deeply dished rotary platform in combination with a static lid having a curved surface defining the remainder of a closed toroidal space for material circulation. But Meier's mixer requires the lid to maintain a closed circulation path whereas in the present invention it is the concave part toroidal surface acting as a sidewall that produces the toroidal circulation independent of the presence of a lid.

An embodiment of the invention will now be described way of example only with reference to the accompanying drawings in which:

Figure 1 is a diagram illustrating the principles of operation of the rotary mixer;

Figure 2 is a fragmentary view of the rotor and part of the stator showing a "breaker bar" and a "drive-off" bar;

Figure 3 is a fragmentary view illustrating the variation of stator radius at substantially constant rotor radius;

Figures 4 to 6 are respectively vertical sectional, front elevation, and left half plan views of a practical embodiment of the rotary mixer;

Figure 7 is a view in horizontal section on the line A-A of Figure 4;

Figure 8 is a horizontal section of the right-hand half of the rotary mixer on the line B-B of Figure 5; and

Figure 9 is a plan view of the right-hand half of the rotary mixer showing a door mechanism.

In Figure 1 a mixing machine comprises a dished rotor *a* that is rotated by suitable drive means in the direction of arrow *b*. Its top face is smoothly curved towards its rim and although such smooth curvature is not essential and may be undesirable at its centre, the intermediate and

rim regions should be smoothly curved and devoid of sharp angularities if damge to the material being mixed is to be avoided. It is important that there should be sufficient friction between the rotor and the material being mixed to drive the mix across the gap between the rotor *a* and the stator *c*. The transfer of momentum may be improved by providing radially directed drive bars *d* (Figure 2) at equal angular intervals around the rim of the rotor and for example there may be six such drive bars disposed at 60° intervals. The top face of the rotor may also be coated with a plastics material such as a polyurethane. If the rotor is covered with Linatex, however, which is a hard wearing rubber material having good wet friction properties, there may be no need to use drive-off bars.

The stator *c* is formed with a concave inner face as shown that may be provided with a plurality of "breaker bars" *e* also disposed at equal angular intervals about the axis of rotation of the rotor *a*. In the absence of breaker bars the particles in the material being mixed follow generally circular rather than toroidal paths, and there is a tendency for material to adhere to the upper region of the curved part of the stator. The function of the breaker bars which are vertically directed and made of steel or other wear-resistant material is to prevent material sticking to the stator and to encourage development of a toroidal circulation pattern. It will be noted that the stator and rotor together define a smoothly curved surface with only a small gap between them: Loss of fine material can be prevented by directing an upward current of air *f* through the gap at a pressure of typically less than 172 kN/m^2 at a flow rate of 1.5 m^3/min. This is in relation to a production size mixer of overall diameter 1.0 metre. In such a mixer, as is apparent from Figure 3 the radius of curvature of the part-toroidal inner face of the stator which is circular in profile ranges typically from 0.127 metre to 0.203 metre, the size being selected to give the desired mixing capacity. In the table accompanying Figure 3, S represents the diameter of the vertical circle of which the concave inner face of the stator (c) is an arc and D represents the furthest distance from the axis of the platform (a) to the inner face of the stator (c).

In Figures 4 to 7 a motor 1 drives rotor 13 through gearbox 2 via a shaft 9 that is covered by a domed cover 27. The rotor 13 cooperates with a dished stator 21 as previously described. Also mounted beneath the rotor 13 is a compressor 3 that discharges air through pipe 20 to the space beneath rotor 13. Air flows upwards into a chamber 30 defined between a false floor the rotor 13 and the walls of the housing of the machine and thence upwards under appropriate pressure between the rotor 13 and the stator 21. Portions of the upper part of the housing define a hinged discharge door 12 for mixed cement that may be opened and closed by means of a piston and cylinder device 4, 6 to permit the contents of the mixer to be discharged when required.

It will be appreciated that modifications may be made to the embodiment described above without departing from the invention, the scope of which is defined in the appended claims. For example, instead of using breaker bars on the inner face of the stator, it is possible that an equivalent effect might be achieved by appropriately arranging the air flow.

Claims

1. A mixing machine comprising a dished circular rotary platform (a) that is smoothly curved towards an upwardly and outwardly inclined rim, and a concave stationary wall (c) which closely surrounds and extends upwardly from the rim of the rotary platform, characterised in that:

the rotary platform (a) is in the form of a shallow dish; and

the stationary wall (c) has a concave part toroidal surface defined by rotating a generally vertical segment of an arc about the axis of rotation of the platform, the rim of the rotary platform being tangential to the concave surface and the concave surface having a smaller radius of curvature than the dish.

2. A machine according to claim 1, characterised in that the rotary platform (a) is surfaced with a high wet friction wear resistant material.

3. A machine according to claim 1 or 2, wherein vertically directed bars (e) are provided on the inner face of the stationary wall (c) to promote toroidal circulation and prevent build up of a static boundary layer.

4. A machine according to any preceding claim, wherein a compressor is arranged to discharge gas (f) under pressure into a closed chamber defined by portions of a machine housing beneath the rotary platform (a), whereby escape of gas upwards through the annular gap between the rotary platform (a) and the wall (c) opposes the escape of material being mixed therethrough.

5. A mixing machine according to any preceding claim wherein the rotary platform has a raised zone coinciding with its axis of rotation to inhibit local build-up of material.

Patentansprüche

1. Mischmaschine mit einer runden Drehschale (a), die zu einem, auf- und auswärts ansteigenden Randbereich hin sanft gebogen ist, und einer feststehenden konkaven Wandung (c), die den Randbereich der Drehschale eng umgibt und sich davon aufwärts erstreckt, dadurch gekennzeichnet, daß die Drehschale (a) die Form einer flachen Schale aufweist und daß die feststehende Wandung (c) eine konkave teil-toroidale Außenfläche aufweist, die durch Rotieren eines im allgemeinen vertikalen Bogensegmentes um die Rotationsachse der Drehschale definiert ist, wobei der Randbereich der Drehschale tangential zu der konkaven Außenfläche verläuft und die konkave Außenfläche einen kleineren Kurvenradius als die Schale aufweist.

2. Mischmaschine nach Anspruch 1, dadurch gekennzeichnet, daß auf die Drehschale (a) ein hoch gegenüber Naßreibung verschließfestes Material aufgebracht ist.

3. Mischmaschine nach Anspruch 1 oder 2, in der vertikal gerichtetete Streben (e) auf der inneren Fläche der feststehenden Wandung (c) angeordnet sind, um eine toroidale Zirkulation zu unterstützen und einen Aufbau einer statischen Grenzschicht zu verhindern.

4. Mischmaschine nach einem der vorangehenden Ansprüche, in der ein Kompressor angeordnet ist, um Gas (f) unter Druck in eine geschlossene Kammer einzublasen, die durch Bereiche eines Maschinengehäuses unterhalb der Drehschale (a) gebildet ist, wodurch der Durchtritt von Gas nach oben durch die ringförmige Lücke zwischen der Drehschale (a) und der Wandung (c) dem Durchtritt von Material, das gemischt wird, dort hindurch entgegenwirkt.

5. Mischmaschine nach einem der vorangehenden Ansprüche, in der die Drehschale eine erhabene Zone aufweist, die sich mit der Rotationsachse der Drehschel deckt um einen örtlichen Aufbau von Material zu unterbinden.

Revendications

1. Machine de mélange comprenant une plate-forme rotative circulaire creusée en forme de cuvette (a) présentant une courbure douce en direction d'un rebord incliné vers le haut et vers l'extérieur, et une paroi concave fixe (c) entourant étroitement le rebord de la plate-forme rotative et venant au-dessus de celle-ci, machine de mélange caractérisée en ce que la plate-forme rotative (a) se présente sous la forme d'une cuvette peu profonde, et en ce que la paroi fixe (c) présente une surface toroïdale partiellement concave obtenue en faisant tourner un segment d'arc généralement vertical autour de l'axe de rotation de la plate-forme, le rebord de la plate-forme rotative étant tangent à la surface concave, et cette surface concave présentant un rayon de courbure plus faible que celui de la cuvette.

2. Machine selon la revendication 1, caractérisée en ce que la plate-forme rotative (a) est recouverte en surface d'un matériau résistant à l'usure et présentant un coefficient de frottement élevé en milieu humide.

3. Machine selon l'une quelconque des revendications 1 et 2, caractérisée en ce que des barres dirigées verticalement (e) sont placées sur la face intérieure de la paroi fixe (c) pour produire une circulation toroïdale et ampêcher la formation d'une couche de limite statique.

4. Machine selon l'une quelconque des revendications précédentes, caractérisée en ce qu'un compresseur est monté de manière à envoyer du gaz sous pression (f) dans une chambre fermée définie par différentes parties du carter de la machine au-dessous de la plate-forme rotative (a), de façon que l'échappement de ce gaz vers le haut, à travers l'intervalle annulaire entre la plate-forme rotative (a) et la paroi (c), s'oppose à l'échappement, par cet intervalle annulaire, du matériau en cours de mélange.

5. Machine de mélange selon l'une quelconque des revendications précédentes, caractérisée en ce que la plate-forme rotative comporte une zone relevée coïncidant avec son axe de rotation, pour empêcher l'accumulation locale de matériau.

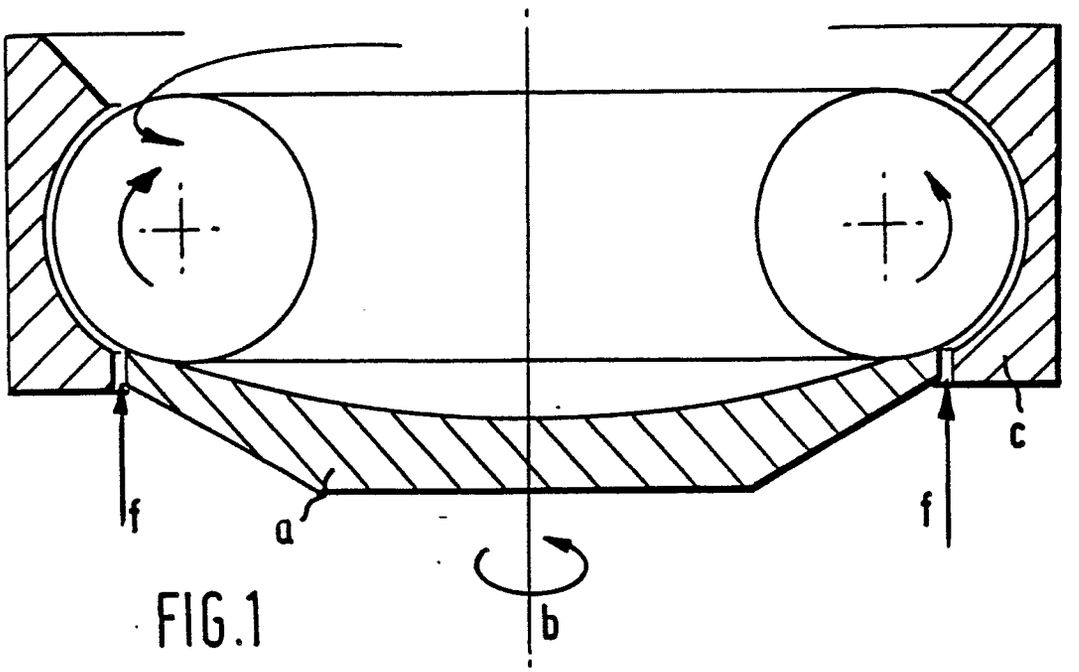


FIG.1

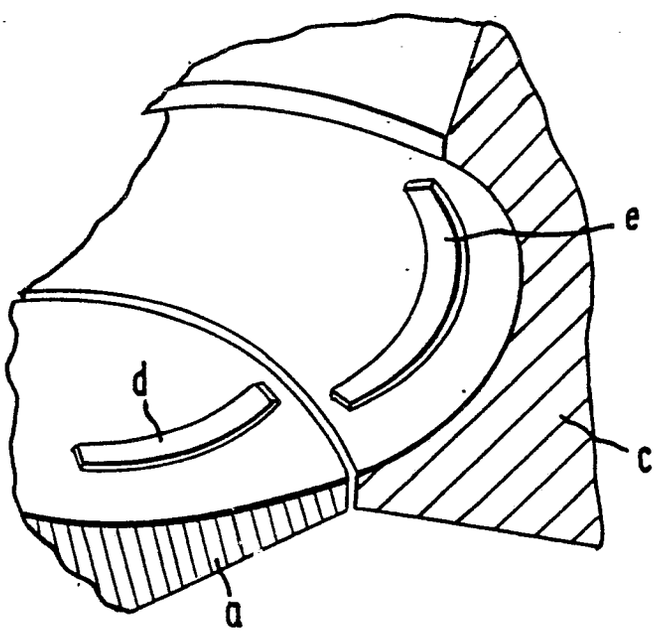
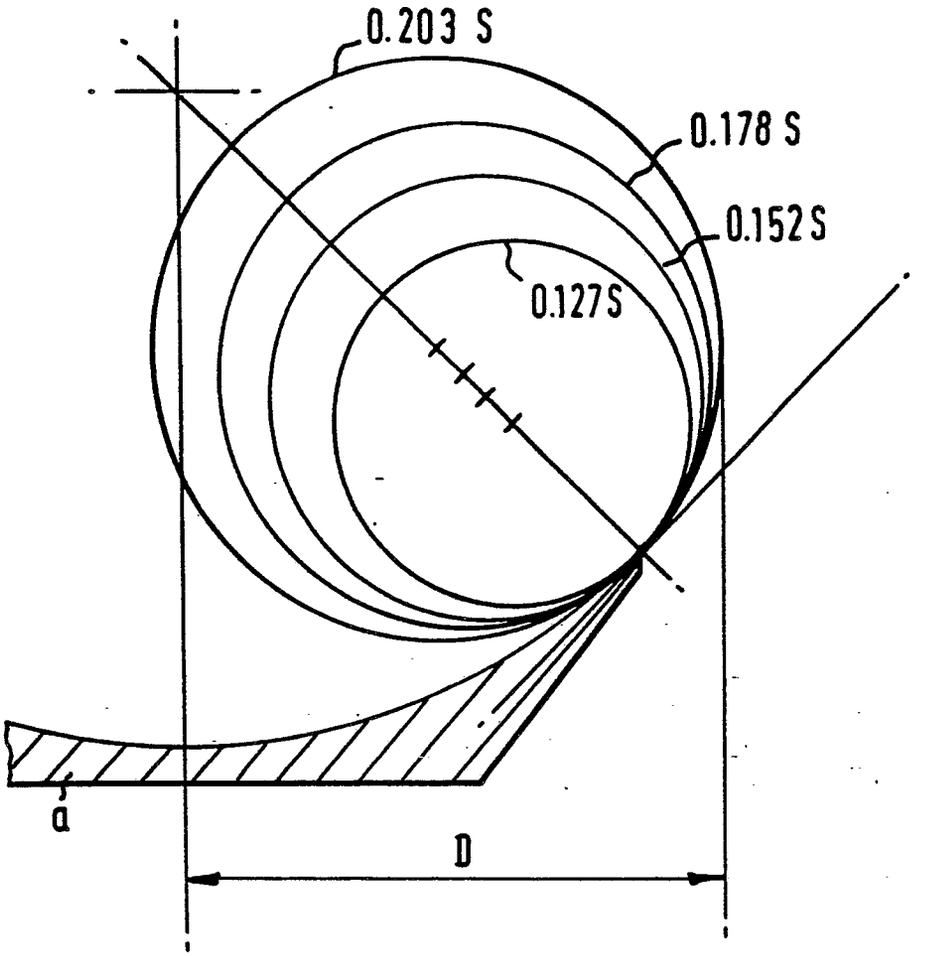


FIG.2



S	D
0.127	0.366
0.152	0.373
0.178	0.380
0.203	0.388

FIG.3

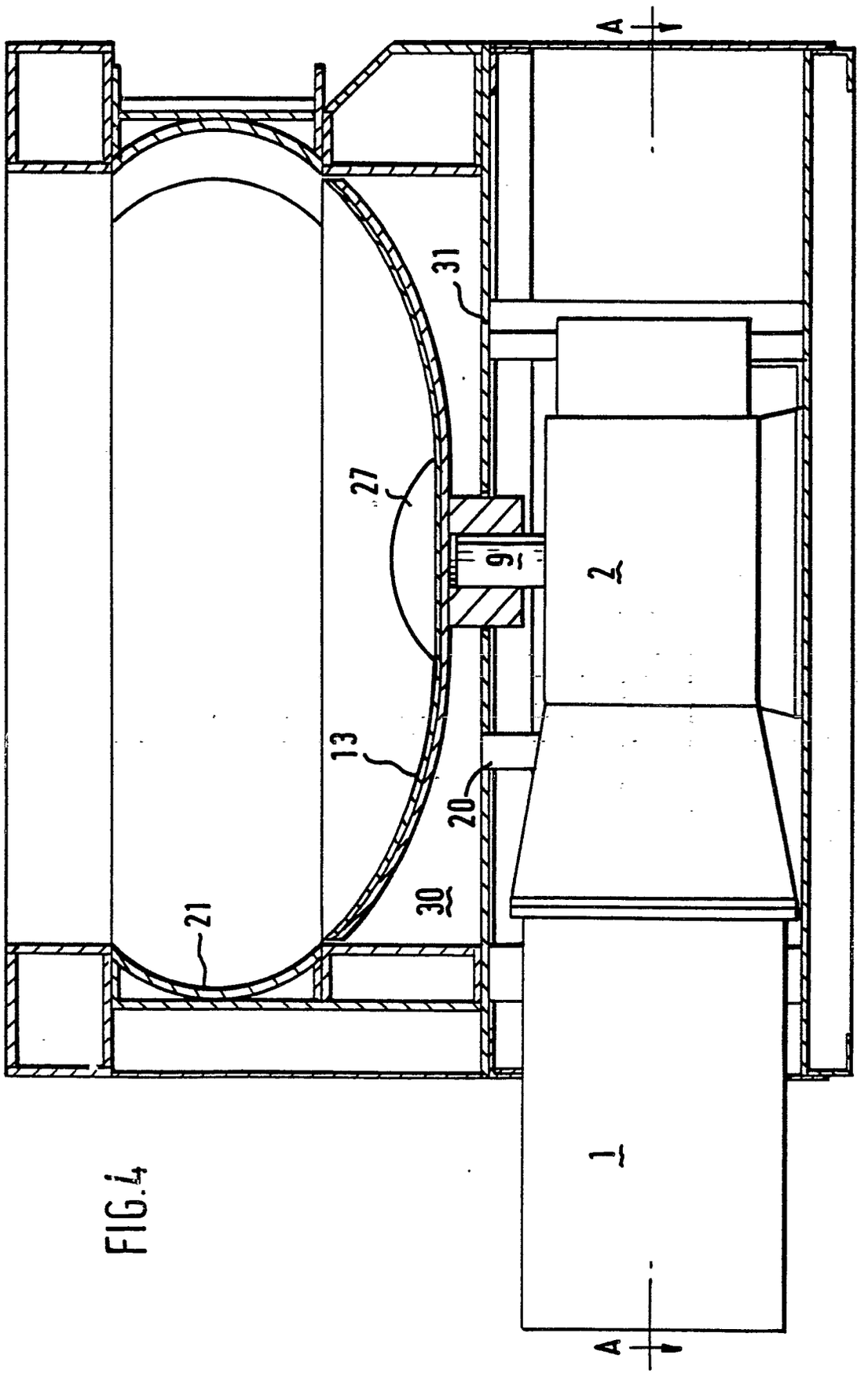


FIG.4

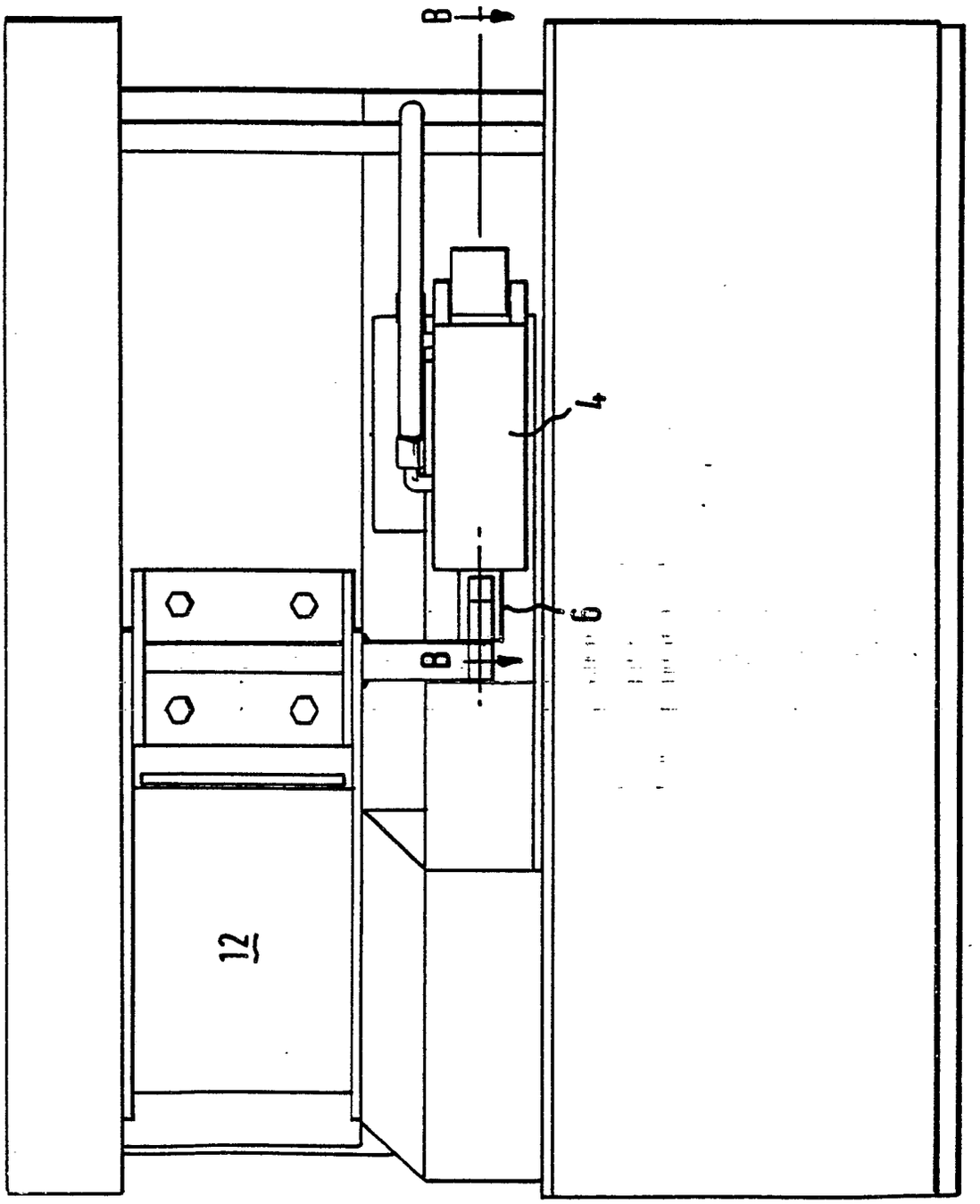


FIG.5

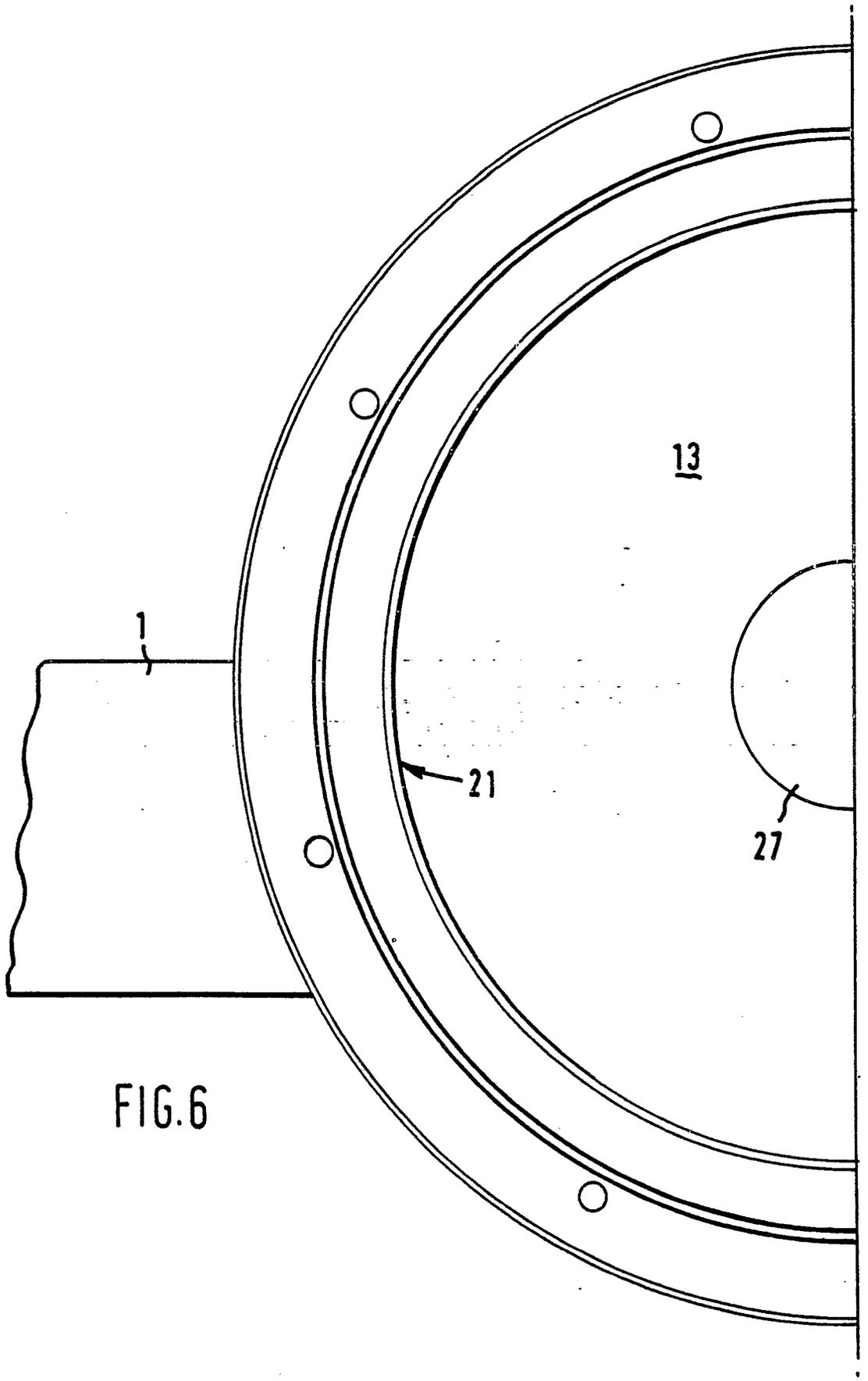


FIG.6

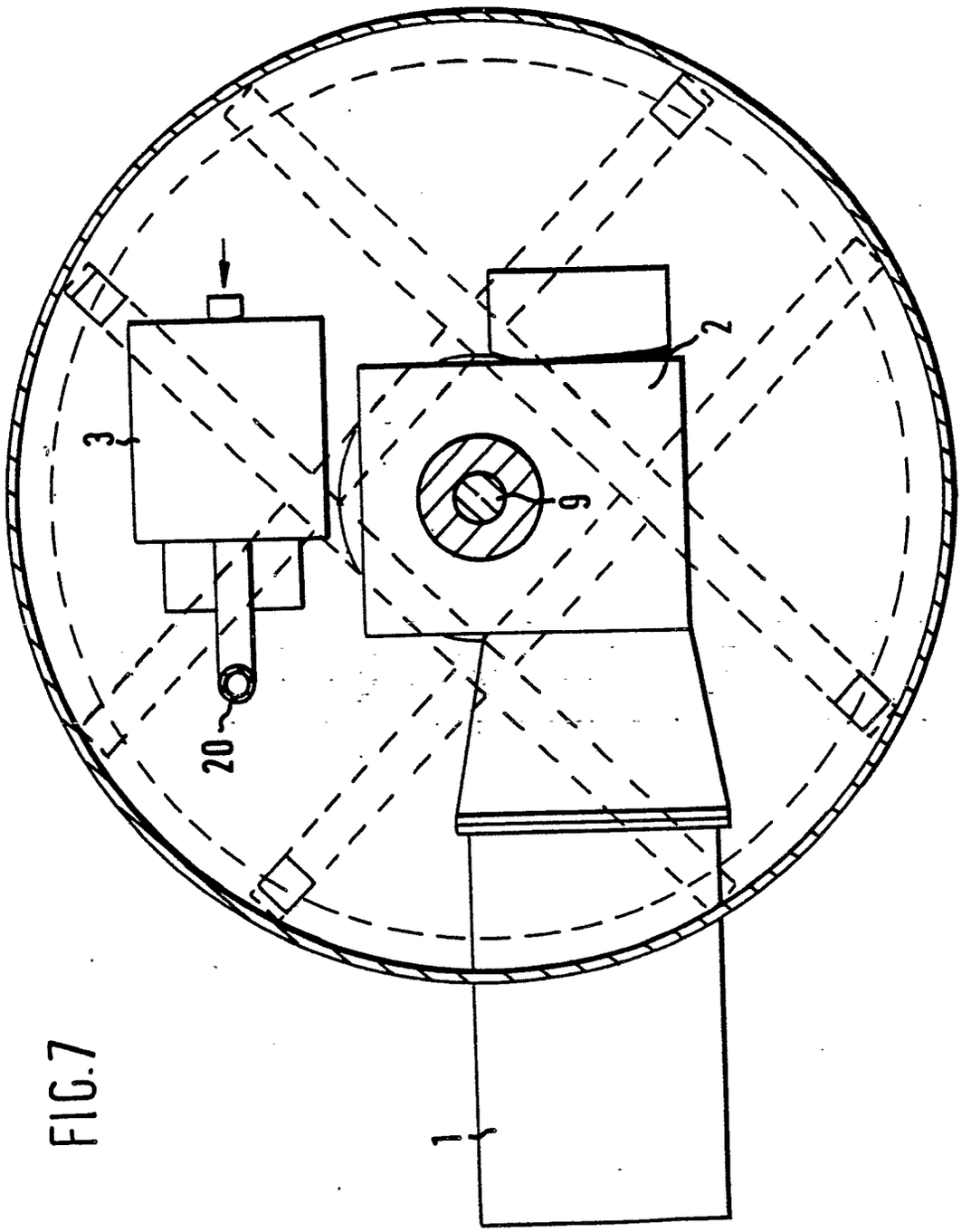


FIG.7

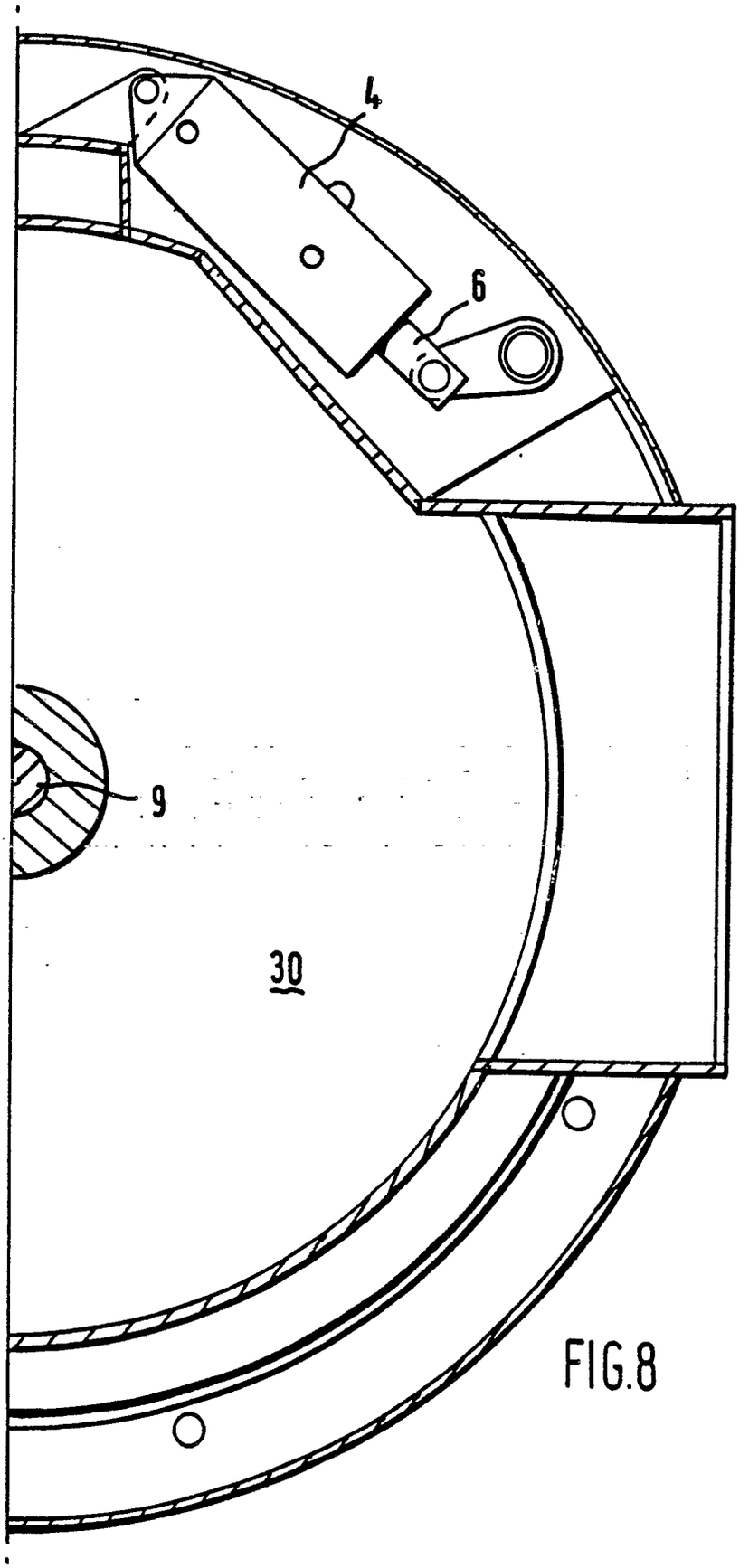


FIG.8

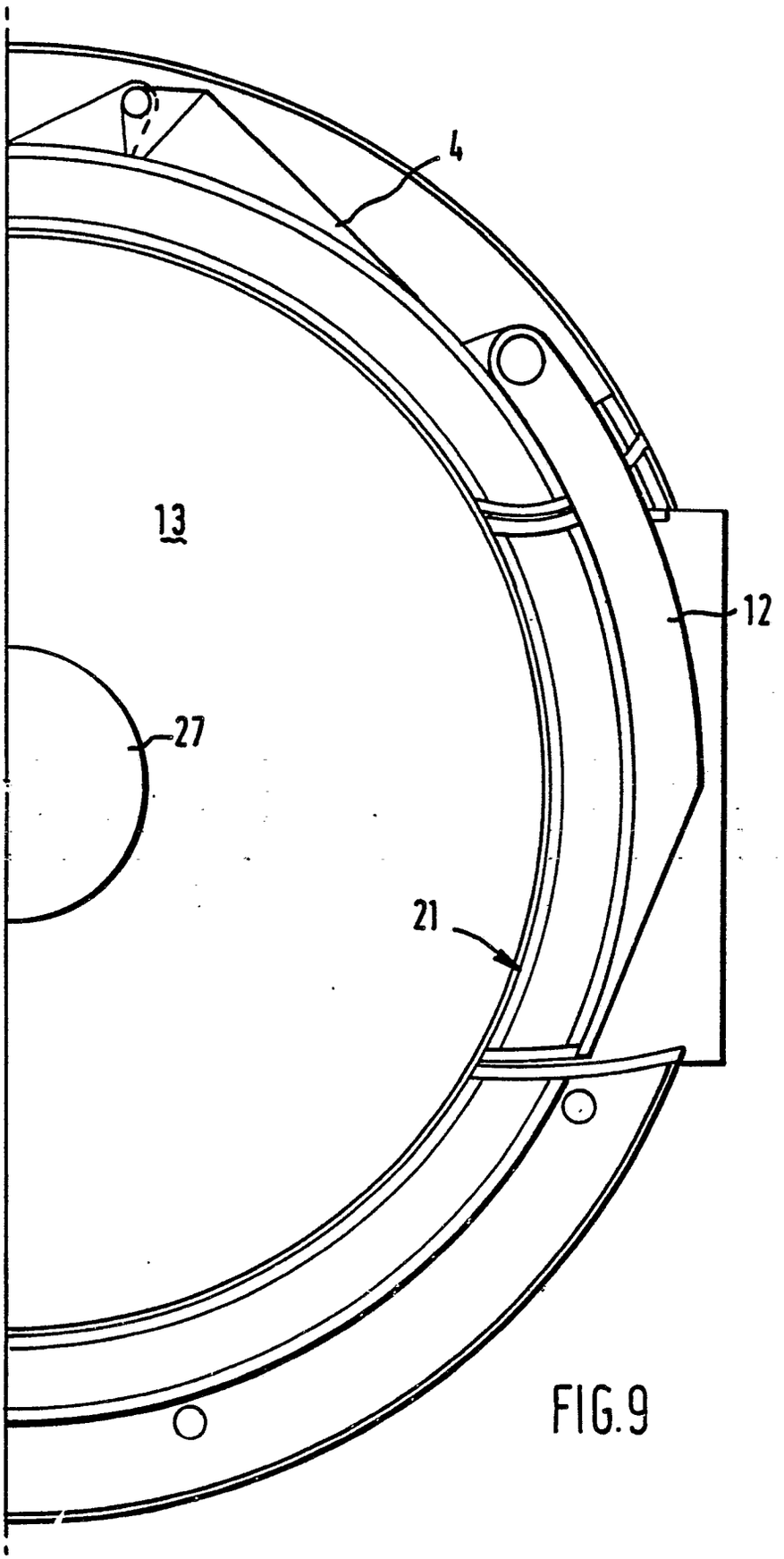


FIG.9