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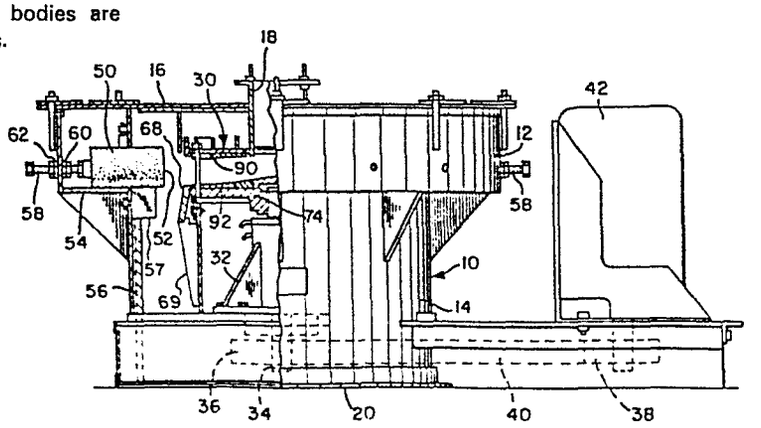
(54) Impact crusher.

(57) An anvil (50) for use in a centrifugal impact rock crusher is disclosed. The crusher includes a cylindrical housing (10) with a vertically disposed central axis. A plurality of the anvils (50) are supported radially around the interior of the housing (10) in a band transverse to the central axis, and an impeller (30) is disposed for rotation concentrically within the housing (10) and is adapted to throw rock to be crushed against the anvils. Each anvil (50) includes a substantially cylindrical body having an end (52), and is secured within the housing (10) such that the rock thrown thereagainst impinges substantially on the end (52). The anvil bodies are selectively rotated about their cylindrical axes.

FIG—1



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IMPACT CRUSHER

The present invention relates to impact-type crushers, and more particularly, to those which utilize centrifugal force to hurl the rocks to be crushed against a plurality of anvils.

Impact-type crushers utilizing centrifugal force to hurl rocks to be crushed against anvils are generally known. Several examples of such devices are disclosed in U. S. Patents Nos. 4,126,280; 3,767,127; 3,652,023; and 3,578,254. In designing these types of devices, a primary consideration is providing for a sufficient useful lifespan of the apparatus, particularly those portions of the apparatus which come in contact with the rock as it is hurled. For example, portions of the device such as the impeller vanes and upper and lower wear plates are subject to a great deal of wear while they are accelerating the rock. It is therefore anticipated that such portions will require periodic replacement, since substantial wearing will occur.

Of course, the wear problem is very severe on the anvil surfaces, since the rock is specifically directed thereagainst as it is hurled. In impact crushers such as those disclosed in the above-noted patents, the rock is thrown by the impeller against the anvils in a generally horizontal plane, which results in a horizontal wear path along the end surface of each anvil.

Typically, as shown for example in U. S. Patent No. 4,126,280, the anvils are rectangular or square in cross-section and present such a shaped surface to the rock impacting on each anvil. Due to the horizontal plane within which the rock is thrown, each anvil gradually acquires a horizontal, concave wear path across its end surface. This tends to produce projecting lips at the top and/or bottom edges of the anvil surface. As wear continues, these lips

will frequently break off and be carried along with the crushed rock. Not only do such broken pieces result in impurities in the rock, but far more importantly, they pose a serious threat of damage to rock-handling machinery downstream from the crusher.

In order to avoid such problems, some operators purposely break off projecting lips that appear to be fragile. In any case, loss of these lips wastes anvil material and discourages use of long anvils which may require attention to lips several times before discarding anvil stubs. In addition, the anvils have generally been arranged in a staggered manner so that their ends create stepped surfaces for most effective crushing of the rock which is hurled toward the anvil surfaces with a substantial tangential component of velocity. The formation of a horizontal concave wear path diminishes those steps and reduces crushing performance.

What is needed, therefore, are anvils for use within an impact crusher that are less subject to breakage as the anvils wear, that can reasonably be made and used in long lengths, and that can be adjusted to maintain stepped surfaces. Such anvils should be usable, however, without requiring changes in the operation or general configuration of the crusher itself.

The present invention provides an improved anvil for use in a centrifugal impact rock crusher that overcomes the breakage problem described above, can reasonably be made and used in long lengths, and can be adjusted to maintain stepped surfaces. Such an anvil is designed for use within a centrifugal impact rock crusher having a cylindrical housing with a vertically disposed central axis, and an impeller assembly disposed within the housing for rotation about the central axis. A plurality of the rock-crushing anvils are

removably secured radially about the outer periphery of the impeller in a band transverse to the central axis. The impeller is adapted to throw rock to be crushed against the anvils, each of which includes a substantially cylindrical body having a substantially circular end and means for securing the body with respect to the housing. Each body is secured such that the rock thrown thereagainst impinges on the substantially circular end. Additionally, means for rotating the body about its cylindrical axis is provided.

The method for crushing rock within a centrifugal impact rock crusher as described above includes rotating the impeller assembly about the central axis within the housing. Rock to be crushed is fed into the impeller assembly, whereby rotation of the impeller throws the rock against the cylindrical anvils. The crushed rock is collected following its impingement upon the anvils. During operation of the crusher, each of the anvils is rotated about its cylindrical axis.

Rotation of the cylindrical anvils may be performed periodically during or between operations of the crusher. Between such times, the anvils remain stationary within a particular orientation. Alternatively, the anvils may be rotated continuously during crusher operation.

Accordingly, it is an object of the present invention to provide an anvil for use in an impact crusher having a rotatable impeller with rotation of the impeller causing rock to be hurled against the anvils, in which each anvil includes a substantially cylindrical body positioned within the crusher such that the rock impinges upon a substantially circular end of the anvil; to provide such an anvil that may be rotated about its cylindrical axis to prevent the formation of lips thereon due to wear; and to provide such anvils that may be mounted within existing impact crushers without

significant modification thereto.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:

Fig. 1 is an elevational view in partial cross section of a preferred embodiment of the present invention;

Fig. 2 is a top plan view with portions broken away of the embodiment of Fig. 1;

Fig. 3 is an enlarged cross-sectional elevational view of a portion of the impeller assembly of the embodiment taken along line 3--3 of Fig. 5;

Fig. 4 is a fragmentary cross-sectional elevational view of the impeller assembly taken alone line 4--4 of Fig. 5 illustrating a portion of the landing cone and upper and lower wear surfaces adjacent an impeller vane member;

Fig. 5 is a view generally along line 5--5 of Fig. 3 with portions broken away;

Fig. 6 is a fragmentary cross-sectional elevational view of a portion of the impeller assembly looking in the direction of line 6--6 of Fig. 5;

Fig. 7 is a fragmentary view of the cylindrical housing and anvils disposed adjacent the impeller assembly of the preferred embodiment;

Fig. 8 is an elevational view taken generally along line 8--8 of Fig. 7;

Fig. 9 is a sectional view taken generally along line 9--9 of Fig. 7; and

Fig. 10 is an end view of an anvil body, showing an alternative embodiment therefor.

As best illustrated in Figs. 1 and 2, the rock crusher with which the anvils of the present invention are used includes cylindrical housing 10 with concentric upper and lower portions 12 and 14. Upper portion 12 is of somewhat larger diameter than lower portion 14 and is provided with a top capping plate 16 carrying a central cylindrical feed tube 18 through which rock to be crushed is fed into the apparatus. The smaller diameter lower portion 14 of housing 10 is open at the bottom 20 in order to permit rock to be discharged from the apparatus once it has been crushed. The cylindrical housing 10 is usually positioned on top of a framework (not shown) which permits the rock to fall from the open bottom 20.

Disposed concentrically within housing 10 beneath the feed tube 18 is the impeller assembly 30 which is mounted for rotation in bearing support membr 32. The impeller assembly 30 is driven by a central drive shaft 34 having one end extending down through bearing support member 32 into the lower portion of housing 10 where it is connected by pulleys 36 and 38 and V-belt 40 to the drive motor 42.

Disposed concentrically around the impeller assembly 30 within the upper portion 12 of housing 10 are a plurality of adjustably positionable anvils 50. The anvils are disposed in two concentric rows with adjacent anvils being in different rows to provide a staggered positioning as seen in Fig. 2. The end faces 52 of the anvils form a band of crushing surfaces around the impeller assembly 30 against which the rock to be crushed is centrifugally thrown by the impeller assembly.

Each anvil 50 is supported by a shelf 54, and a cylindrical liner member 56 is positioned within the housing 10 to protect the wall of housing 10 from wear. In addition, fixed anvils 57 are mounted to the inner wall of lower

housing 14, providing further protection for housing 10 and partially supporting anvils 50.

As will be discussed in detail below, a threaded bolt 58 is secured to the rear portion of the body of each anvil 50 and extends through a corresponding hole in the wall of upper portion 12. Inner and outer nuts 60 and 62 threadably engage the bolt 58 on each side of the wall of upper portion 12 in order to position each anvil 50 in a desired radial location and hold the anvil in that position. Nuts 60 and 62 are in turn secured by jam nuts 64 and 66, respectively.

A conical shield ring 68 is mounted within lower housing 14 adjacent impeller assembly 30, supported by a plurality of brackets 69. The conical shape of ring 68 facilitates direction of crushed rock toward the open bottom 20 to prevent jamming of impeller assembly 30 by pebbles and other rock particles working to the inside of ring 68.

Referring to the impeller assembly 30 as best seen in Figs. 3-6, a landing cone 70 of circular horizontal cross section is disposed concentrically within the impeller assembly and secured to the upper portion of drive shaft 34 for rotation therewith. Landing cone 70 is positioned directly beneath the central feed tube 18 through which the rock to be crushed is delivered onto the surface 71 of the landing cone.

An upper disc-shaped member 72 and a lower disc-shaped member 74 are disposed in vertically spaced relation concentrically with the drive shaft 34. Lower disc-shaped member 74 is secured to the drive shaft 34 for rotation therewith and upper disc-shaped member 72 is secured to the lower disc-shaped member by a plurality of bolts 76. The central portion of upper disc-shaped member 72 defines a cylindrical opening 78 through which the rocks to be crushed

can pass to impinge on the landing cone 70.

A plurality of impeller vanes 80 of generally triangular horizontal cross section are disposed in equally spaced relation about the impeller assembly between upper and lower disc-shaped members 72 and 74 and are held between these members by the bolts 76 which extend through the impeller vanes 80. The apexes of vanes 80 extending radially inward towards landing cone 70 are rounded at 82 to reduce the wear on the vanes that otherwise occurs due to impingement of rocks thereon as they are centrifugally thrown outwards from the landing cone 70. The opposite sides 84 and 86 of each vane 80 are of equal length and with the walls of adjacent vanes form vertical side walls of the channels in the impeller assembly 30 through which the rock passes.

Forming a roof and floor of the channels are, respectively, upper and lower wear plates 90 and 92. As can be seen in Fig. 6, upper and lower wear plates 90 and 92 are held in position by engagement with corresponding grooves in the top and bottom of each vane 80 so that when bolts 76 are tightened they hold the upper and lower wear plates in position in engagement with the upper and lower disc-shaped members 72 and 74. The outer surfaces 94 and 96 of upper and lower wear plates 90 and 92, respectively, are angled downwardly from a horizontal plane and outwardly from the central axis of the impeller assembly in order to direct the rock on appropriate trajectories to be hurled from the impeller assembly against the anvil faces 52.

As best seen in Fig. 4, the upper surface of the lower wear plate 92 which forms the floor of a channel has its outermost portion at an angle parallel to the outer surface 94 of the upper wear plate 90, and has its innermost portion 98 disposed at an angle substantially the same as the angle of the uppr surface 71 of cone 70. The angle of the

outer surfaces 94 and 96 relative to the horizontal plane is not great, but is sufficient to insure that rock being hurled from the impeller assembly 30 has a relatively flat trajectory and impinges on the anvils 50 centrally thereof, causing more even wear and increasing anvil life.

The upper surface 71 of landing cone 70 is slanted at an angle to the horizontal in order to cause rock being delivered through the feed tube 18 to migrate outwardly into the channels of the impeller assembly from which they are thrown against the anvil faces. The angle of the surface 71 is important in that if it is too great the rocks will move radially outward too quickly and cause substantial wear on the apexes and side surfaces of the vanes 80. On the other hand, if the angle is too slight, such as a flat plate, it has been discovered that the rocks delivered from the feed tube tend to stay on the landing cone 70 and wear grooves therein which inhibit the flow of rocks outwardly through the channels defined in the impeller.

By having the innermost portion 98 of the outer surface of lower wear plates 92 with the same angle as the surface 71 of cone 70, a smooth transition surface is provided between the cone and the wear plates so that the flow of rock is not disturbed.

Referring now to Fig. 7, anvils 50 may be seen in greater detail. Each anvil 50 includes a substantially cylindrical body 100 oriented so that the anvil 50 presents a substantially circular face 52 to the rock impinging thereon. Anvils 50 are arranged in staggered fashion, so as to present to the rock a stepped functional crushing surface area, as seen in Fig. 8.

Each anvil 50 is supported as shown in Fig. 1 by shelf 54, and is secured within the housing 12 by bolt 58. A sleeve 102 is mounted within the body 100 opposite face 52

and a nut 104 is fastened by welding or the like to the end of sleeve 102. Bolt 58, which passes through upper portion 12, is engaged with nut 104 and driven into the interior of sleeve 102 until bolt 58 bottoms against the body 100. A jam nut 106 may be fastened against nut 104 on bolt 58 to jam bolt 58 to prevent rotation or vibration of bolt 58 from impact forces.

In order to prevent the formation of lips on the edges of anvil face 52 as anvil 50 is worn, body 100 is rotated about its cylindrical axis. Since bolt 58 is driven into sleeve 102 so as to bottom against body 100, or may be fixedly secured to sleeve 102 by nut 104 and jam nut 106, it will be seen that rotation of bolt 58 in a clockwise direction will not cause bolt 58 to advance with respect to body 100, but rather will rotate body 100. The amount of such rotation necessary at any one time is usually quite small, less than one-quarter a revolution.

During operation of the rock crusher, it will be necessary to change the circular orientation of each anvil 50 only periodically. Of course, the actual period will vary widely, depending upon factors such as the particular material from which the anvils are formed and the type of rock being crushed. It is anticipated that the period between rotation will typically be determined by simple observation for wear of the faces of the anvils. It should be recognized, however, that continuous slow rotation of each anvil body 100 during crusher operation by appropriate apparatus will also prevent the formation of lips.

As the faces 52 of anvils 50 wear down due to use, the anvils 50 may require periodic radially inward adjustment towards the impeller assembly 30. An anvil 50 is advanced inwardly by loosening jam nut 106 and rotating bolt 58 in a counterclockwise direction. Since bolt 58 is held in

relative position with respect to upper housing portion 12, body 100 is moved inwardly. Nut 104 and jam nut 106 are then retightened. Since jam nut 106 provides a fixed connection between bolt 58 and anvil 50, it is unnecessary to bottom bolt 58 against body 100.

Alternatively, it may not be necessary to include jam nut 106 for prevention of rotation or vibration of bolt 58. In such case, following inward advancement of body 100 by rotation of bolt 58, the bolts must be re-bottomed. Accordingly, outer nut 62 and outer jam nut 66 are loosened, bolt 58 is rotated in a clockwise direction to bottom it within body 100, and nuts 60 and 62 and jam nuts 64 and 66 are retightened.

With either method, there may be sufficient friction between body 100 and shelf 54 and other parts in contact with body 100 to prevent unwanted rotation of body 100 while it is advanced. In the event the friction is not sufficient, nut 104 can be engaged with an open-ended wrench to hold body 100 while bolt 58 is rotated.

The anvil securing means also provides for easy changing of anvil bodies 100 when worn out. Loosening of inner nut 60 and jam nut 64 followed by rotation of bolts 58 in a counterclockwise direction will disengage each bolt 58 from its corresponding nut 104, freeing the body 100 for replacement.

To maintain the most effective rock crushing within the impact crusher, it is necessary to maintain the anvils 50 in their staggered relationship. As the anvils 50 wear, the steps created between the staggered faces 52 are gradually worn down such that the steps are significantly reduced. It should be noted that with the previously known rectangular anvils used within the impact crusher, the staggered steps can be regained after wear occurs only by moving every other

anvil 50 radially inward.

With anvils having a square cross section, the staggered steps can be regained not only by moving every other anvil radially inward, but also to a partial extent by rotating each anvil 90 degrees about its axis. This procedure, however, is cumbersome and time consuming in the typical arrangement wherein the square anvil must be removed for rotation and then reinstalled. Moreover, after 90° rotation, a square anvil will wear in a manner that creates four projecting spikes that are more fragile than the lips produced by the first wear pattern and are therefore more troublesome.

With the cylindrical anvils of the present invention, the steps can be regained by moving every other anvil radially inward, of course, and also to a partial extent by rotating each anvil about its axis by some amount determined by the operator, which can be done quickly and easily. The amount and frequency of rotation can be controlled by the operator to completely avoid formation of any fragile lips or spikes while at the same time maintaining well defined steps for longer periods between inward adjustments than is possible with rectangular or square anvils.

The cylindrical anvils 50 therefore provide a number of advantages. The formation and breakage of lips or spikes and problems resulting therefrom can be avoided by anvil rotation. The stepped surfaces can also be partially regained by rotation, and inward advance adjustments to compensate for wear can be less frequent. Anvil material which otherwise would have been wasted as broken lips or spikes is put to use in crushing rocks so that more rock is crushed per pound of anvil material used. Further, lack of difficulties with lips or spikes encourages the manufacture and use of substantially longer anvils, which will provide

more crushed rock per pound of original anvil material because the discarded stub end will be a smaller fraction of the entire anvil. This latter advantage, however, will require revising various elements of the impact crusher such as housing 10 and its components.

It should be noted that the substantially cylindrical bodies 100 of the anvils 50 are not limited to bodies which are truly cylindrical, i. e., those that have a circular cross-section as shown in Fig. 9. While it is expected that truly cylindrical bodies will be typically used, it is to be understood that the term "substantially cylindrical" encompasses body shapes having other cross-sections, such as a regular polygon having a sufficiently large number of sides to allow rotation of the anvil about its axis while positioned in said housing, similar to that shown in Fig. 10. Other examples may include a polygonal cross-section with rounded corners, or any other shape which results in anvil bodies which may be rotated as described herein, and such embodiments should be understood to be within the scope of the present invention.

Referring to the manner of operation of the present invention, rocks are deposited through the feed tube 18 at a predetermined rate of supply and impinge upon the surface of landing cone 70. From there they progress outwardly due to centrifugal force created by rotation of the impeller assembly 30 via motor 42 through drive shaft 34. The rocks progress into the channels formed between the impeller vanes 80 and upper and lower wear plates 90 and 92. As the impeller assembly rotates and rocks progress outwardly, the tangential velocity of the rocks is accelerated due to engagement with the vertical side surfaces of the vanes and they are then flung outwardly against the faces 52 of anvils 50 where they are crushed. The crushed rocks then drop

through the bottom 20 of the housing 10 and are collected.

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus and that changes may be made in either without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A centrifugal impact rock crusher including a generally cylindrical housing (10) with a vertically disposed central axis, a plurality of rock crushing anvils (50) positioned radially around the interior of said housing (10) in a band tranverse to said central axis, and impeller means (30) disposed for rotation concentrically within said housing (10) and adapted to throw rock to be crushed against said anvils (50), characterized by:

each of said anvils (50) including a substantially cylindrical body (100) having an end,

means (58) for securing said body (100) within said housing (10), each said body (100) being secured such that the rock thrown thereagainst impinges substantially on said end,

means (58) for rotating said body (100) about its cylindrical axis, and

means (60, 62) for selectively causing radial inward advancement of said body (100) toward said impeller means (30).

2. A rock crusher as defined in claim 1, wherein said rotating means includes a bolt (58) engageable with an opening defined in said body (100) so that, upon full engagement of said bolt (58) within said opening, rotation of said bolt (58) in a first direction causes rotation of said body (100).

3. A rock crusher as defined in claim 1, wherein said rotating means includes a bolt (58) engageable with an opening defined in said body (100) and jam nut means (104, 106) engageable with said bolt for fixedly securing said bolt to said body (100) so that rotation of said bolt (58) in a first direction causes rotation of said body (100).

4. A rock crusher as defined in claims 2 or 3, wherein said body securing means and said inward advancement means include said bolt (58) engageable with said opening in said body (100), said housing (10) having an opening adapted for passage of said bolt (58) therethrough, said body securing means and said inward advancement means (64, 66) further including means for securing said bolt within said housing opening for rotation therein while maintaining fixed relative positions between said bolt (58) and said housing, so that rotation of said bolt (58) in a second, opposite direction causes inward radial advancement of said body (100) toward said impeller means (30).

5. A rock crusher as defined in claim 4, wherein said means for securing said bolt (58) within said housing opening includes a pair of nut means (60, 62) engageable one each on said bolt on each side of and adjacent to said housing opening, and a pair of jam nut means (64, 66), one each engageable on said bolt (58) against each one of said pair of nut means (60, 62).

6. A rock crusher as defined in any preceding claim, wherein each of said anvils (50) is circular in cross section.

7. A rock crusher as defined in any preceding claim 1 to 5, wherein each of said anvils (50) has a cross section of a regular polygon with a sufficiently large number of sides to allow rotation of said anvil about its axis while positioned in said housing (10).

8. A rock crusher as defined in claim 7, wherein each of said anvils (50) has a cross section of a regular polygon having substantially rounded corners with a combination of a sufficiently large number of sides and sufficiently rounded corners to allow rotation of said anvil (50) about its axis while positioned in said housing (10).

9. An anvil (50) for use in a centrifugal impact rock crusher having a generally cylindrical housing (10) with a plurality of said anvils (50) supported in a band around the interior of said housing (10) and impeller means (30) disposed within the housing (10) and adapted to throw rock to be crushed against said anvils (50), each of said anvils being characterized by:

a substantially cylindrical body (100) having an end;

means (58,102) mounted thereto for securing said body (100) within said housing (10), each said body (100) being secured such that the rock thrown thereagainst impinges substantially on said end; and

means (58) for rotating said body (100) about its cylindrical axis.

10. A method for crushing rock within a centrifugal impact rock crusher having a cylindrical housing (10) with a vertically disposed central axis, a plurality of cylindrical anvils (50) positioned radially around the interior of said housing in a band transverse to said central axis, and impeller means (30) disposed for rotation concentrically within said housing, comprising the steps of:

rotating said impeller means (30);

feeding the rock to be crushed into said impeller means (30), whereby rotation of said impeller means throws the rock against said cylindrical anvils (50);

collecting the crushed rock following impingement thereof upon said anvils (50); and

rotating each of said anvils (50) about its cylindrical axis.

11. A method as defined in claim 10, wherein rotation of each of said anvils (50) is non-continuous.

12. A method as defined in claim 10 or 11, comprising the further step of advancing at least one of said anvils (50) radially inward toward said impeller means (30).

13. The method as defined in claim 10,11 or 12, wherein each of said cylindrical anvils (50) includes a cylindrical body (100) and a bolt (58) engaged therewith for extension along the cylindrical axis of said body and through said housing (10) to the exterior thereof, and wherein rotation of said anvil (50) is performed by rotating said bolt (58) in a first direction.

14. The method as defined in claims 12 and 13, wherein inward advance of said anvil (50) is performed by rotating said bolt (58) in a second, opposite direction.

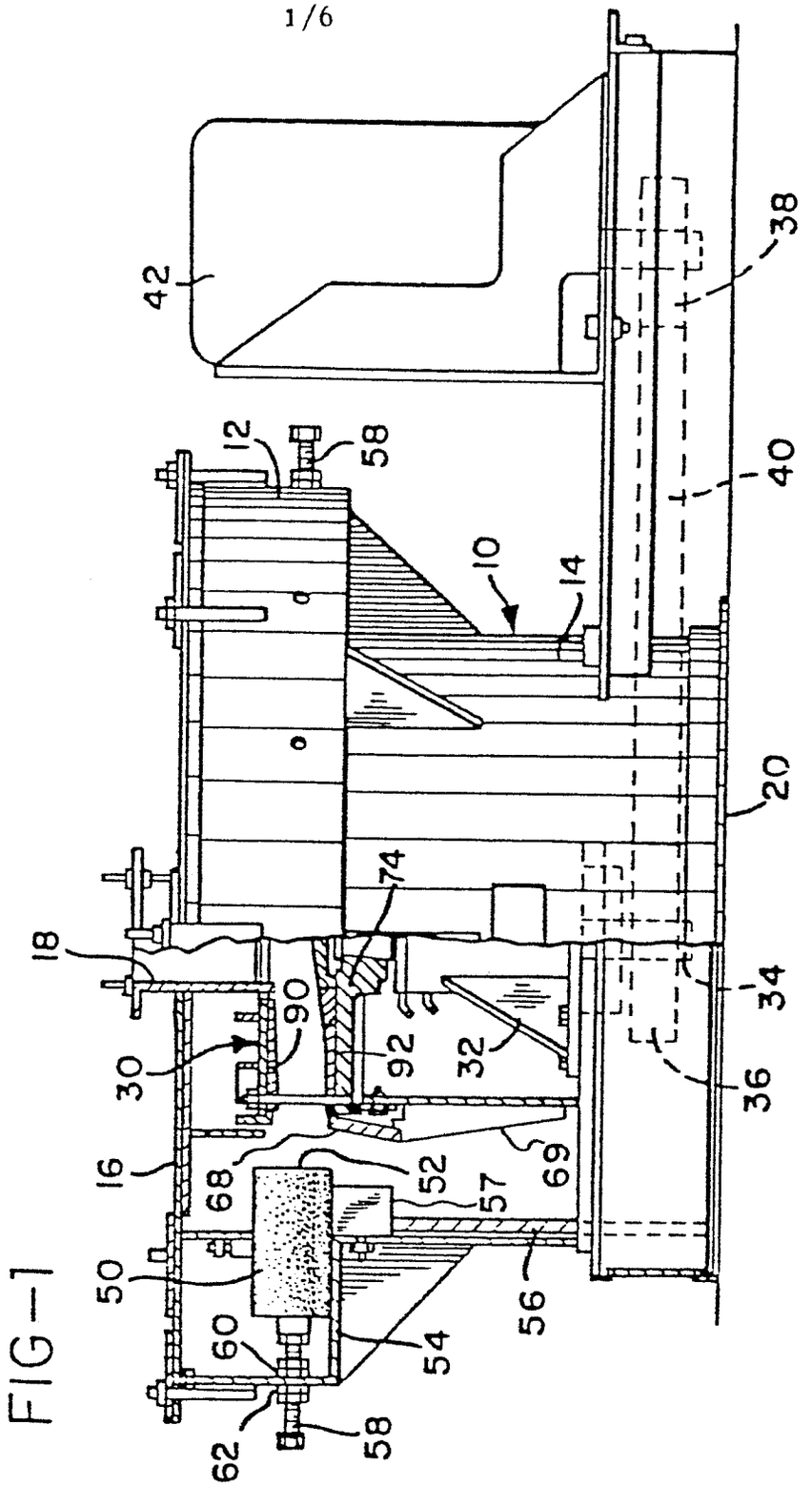
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FIG-1

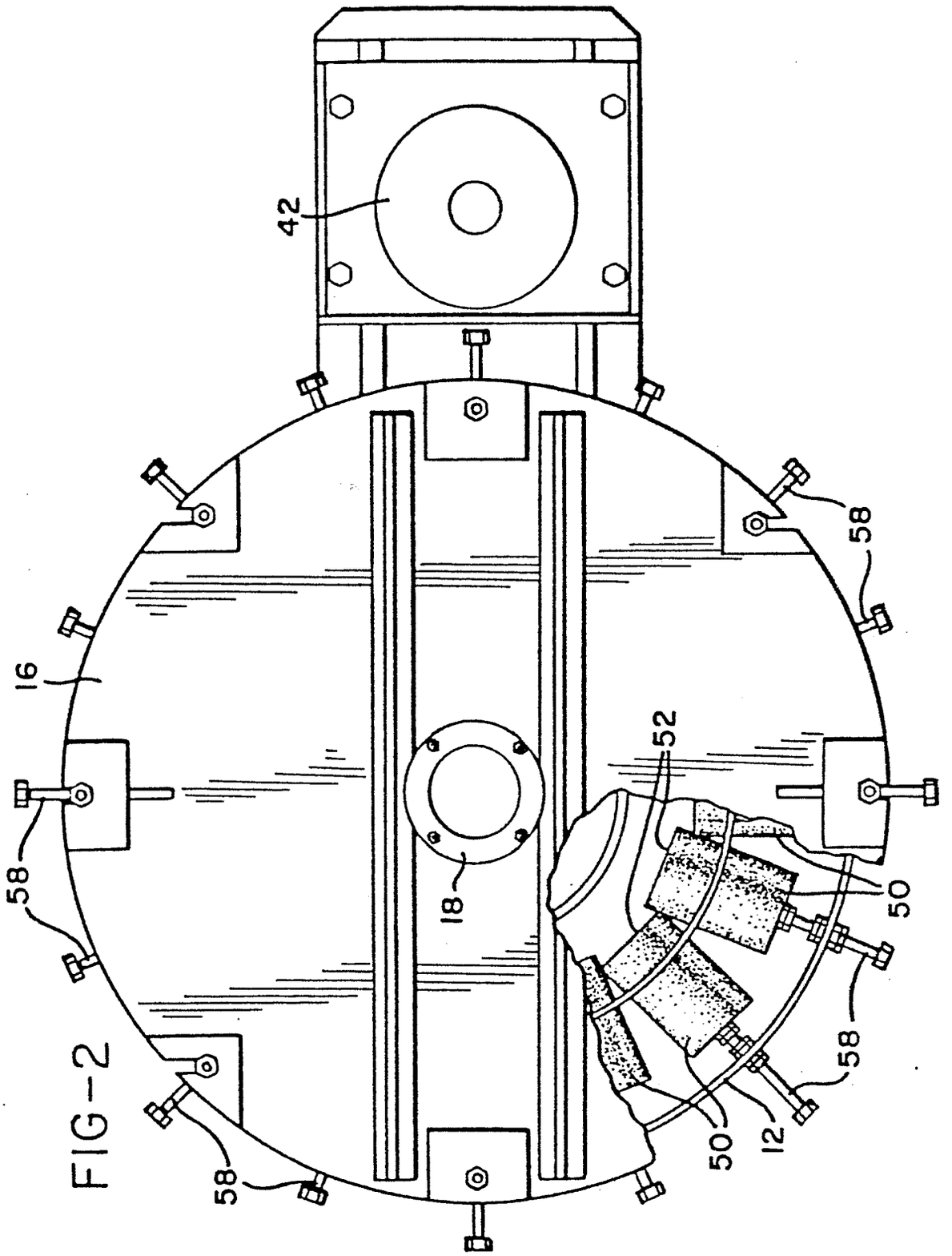

FIG-2

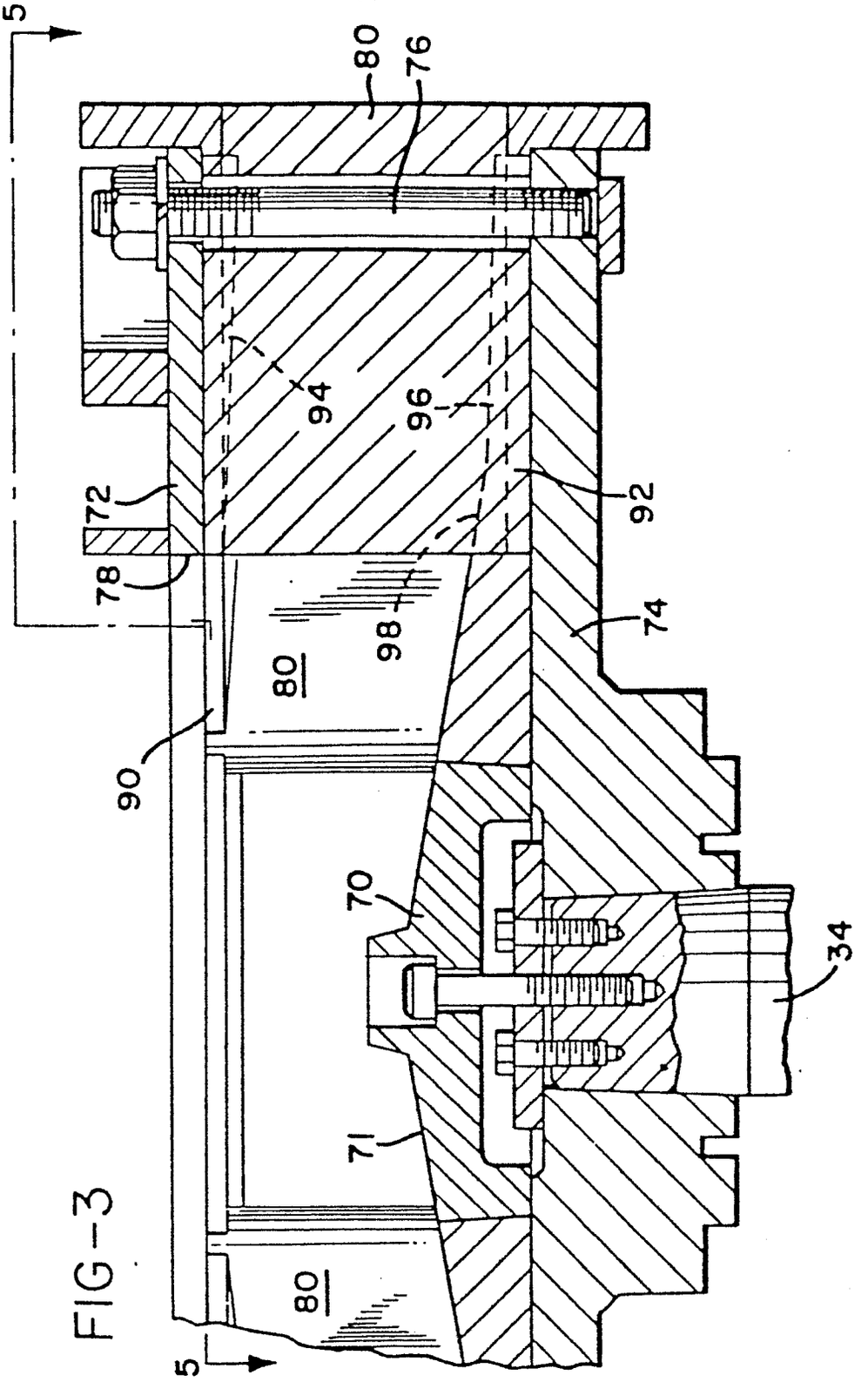

FIG-3

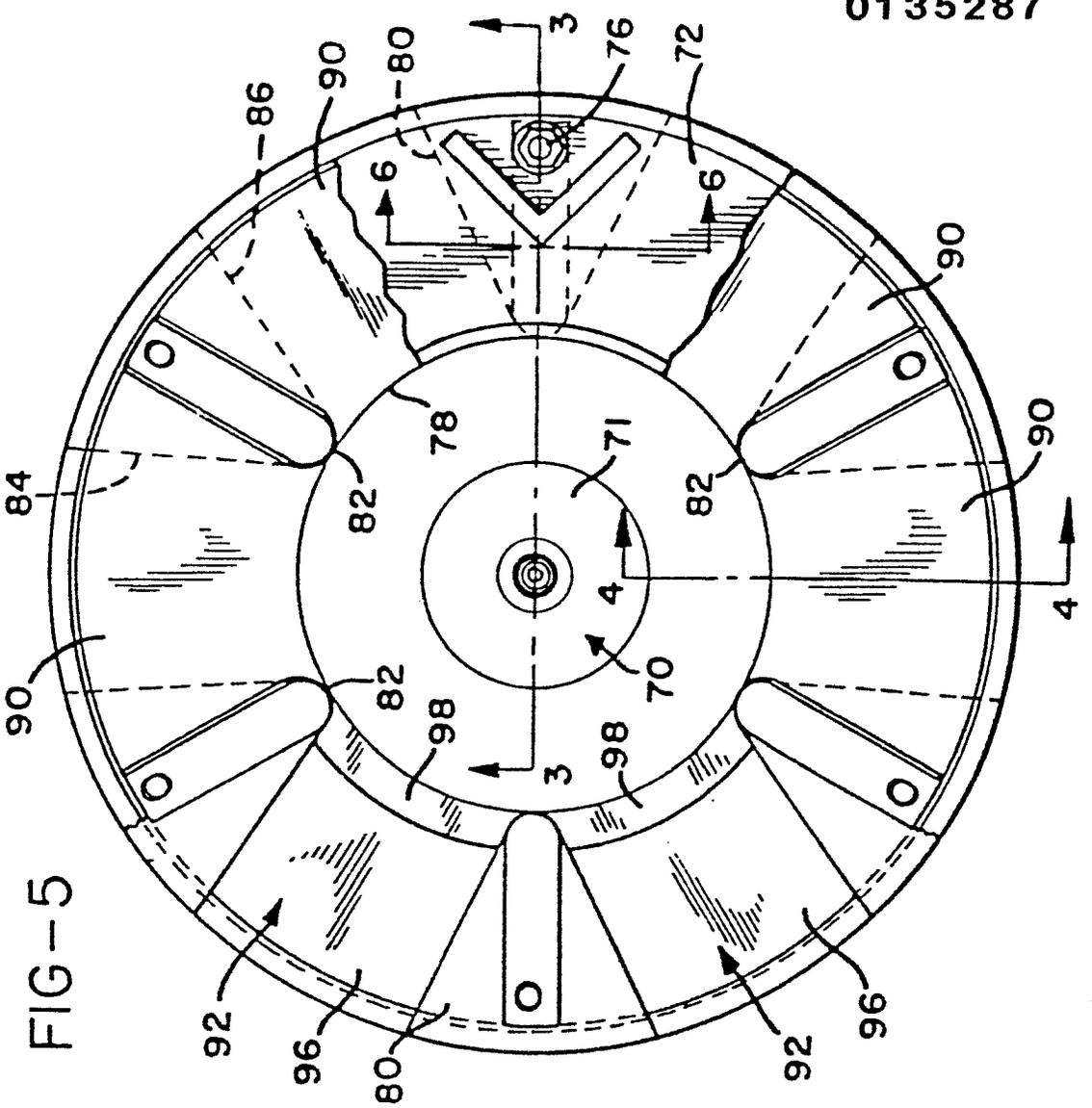
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FIG-5

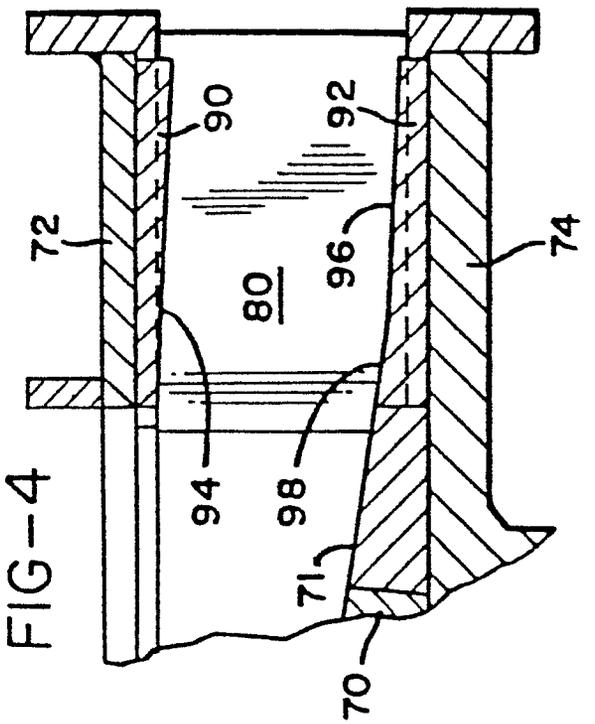
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FIG-4

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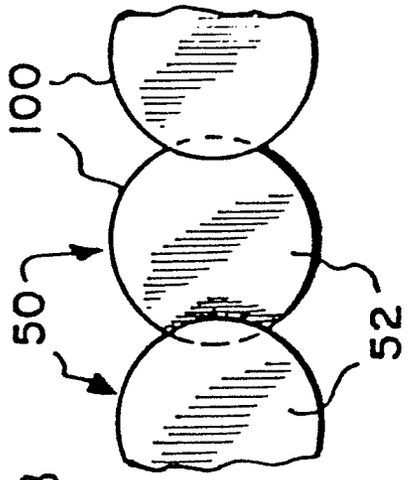

FIG-8

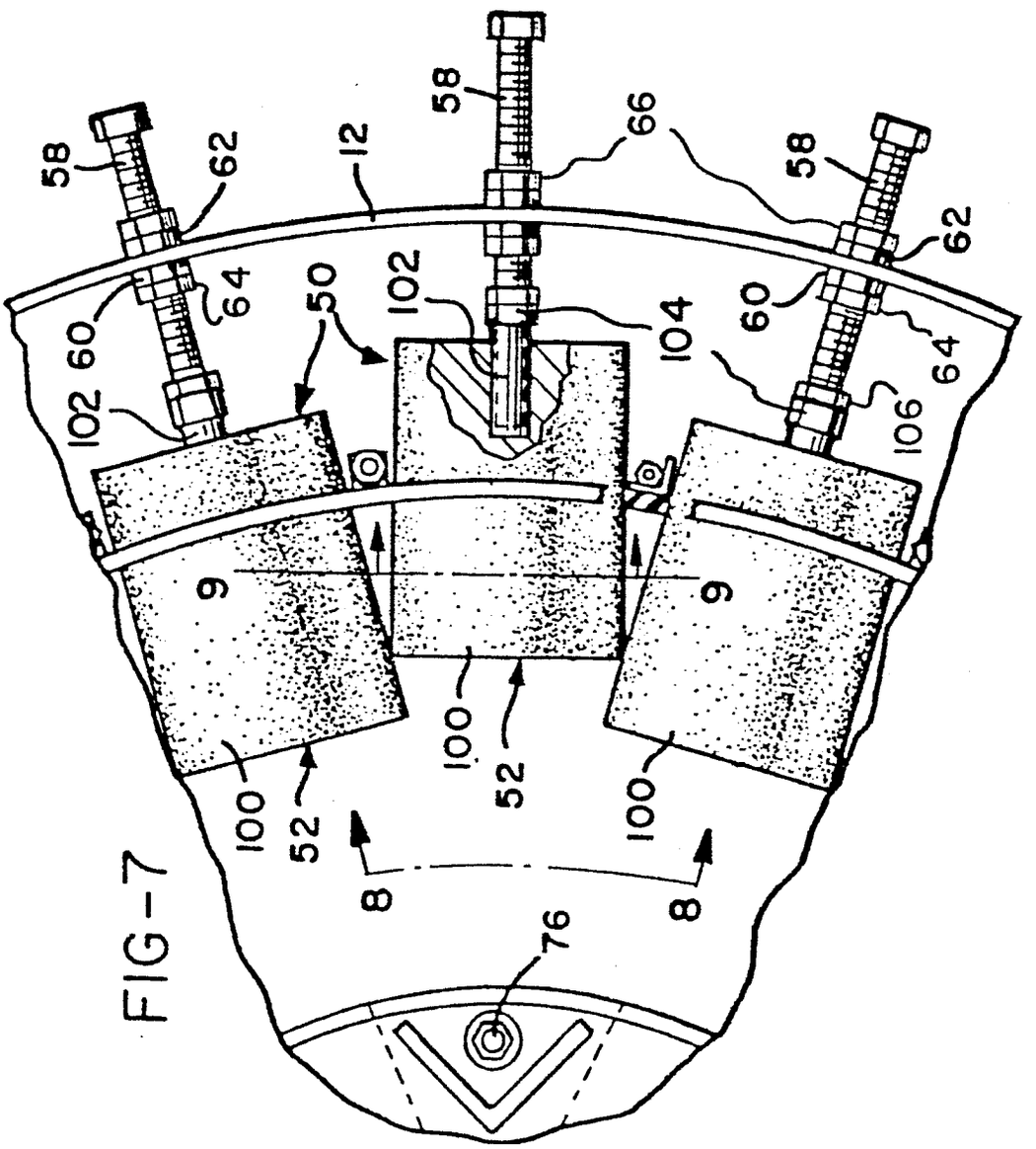

FIG-7

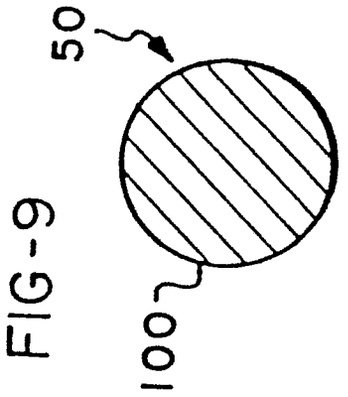

FIG-9

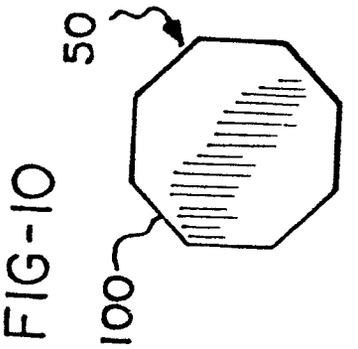

FIG-10

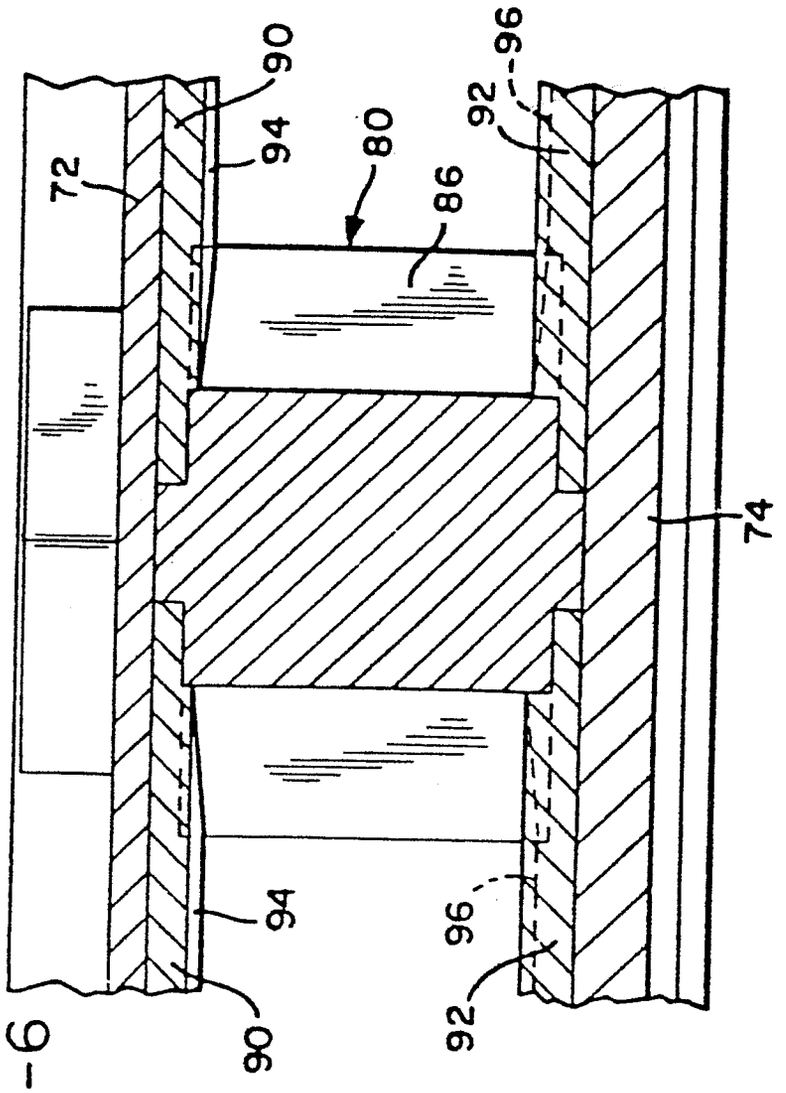

FIG-6