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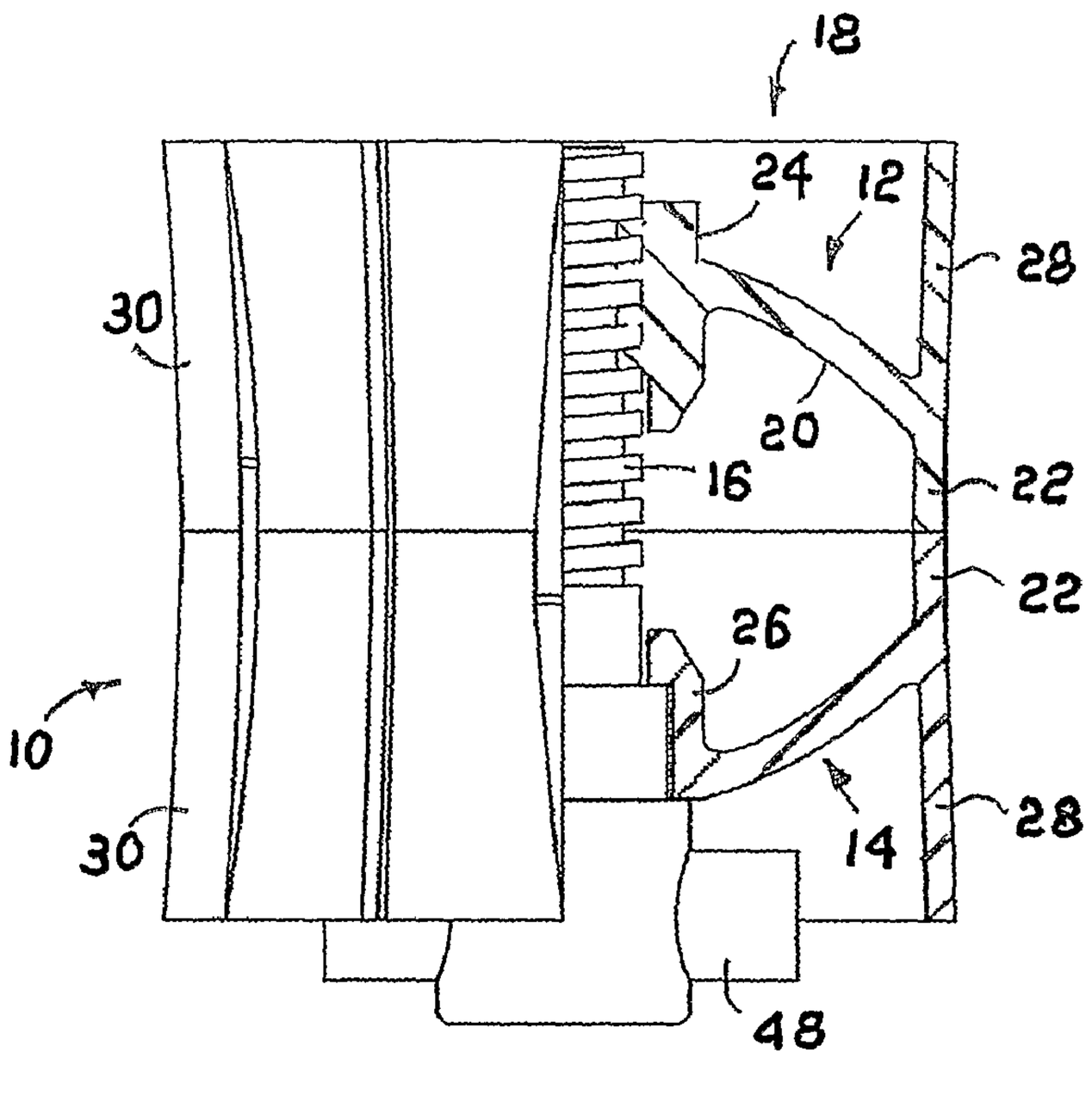

(57) Abrégé/Abstract:
The invention relates to a stemming plug (10) which is made from a suitably resilient plastic material and comprises two cup-shaped members (12,14) which face each other with their rims (22) in abutment and means, which extends between the centres of the base portions of the cups (20) in the plug (10) ,which is adapted to move the bases of the cups (20) towards each other to compress the cups (10) and cause a circumferential zone of the plug (10) on either side of the abutting faces of the cups (20) to increase in radial dimension to be brought into load bearing contact with the side of a predrilled hole (38) in which the plug (10) is to be located, in use, and to enable the bases of the cups (20) to be moved away from each other to allow the plug (10) to be withdrawn from the hole (38) in the event of a misfire of the explosive in the hole (38).

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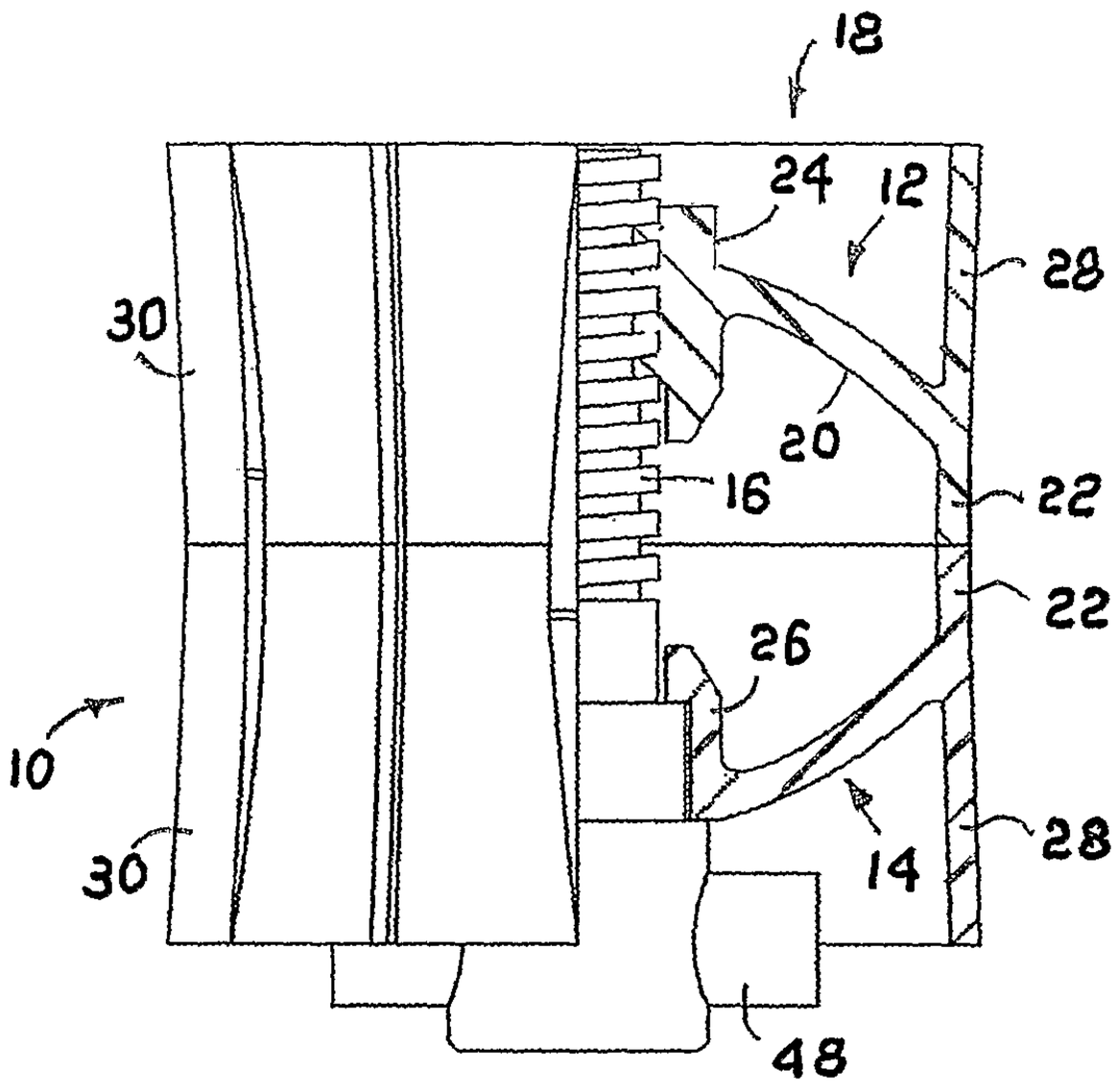

(57) Abstract: The invention relates to a stemming plug (10) which is made from a suitably resilient plastic material and comprises two cup-shaped members (12,14) which face each other with their rims (22) in abutment and means, which extends between the centres of the base portions of the cups (20) in the plug (10) ,which is adapted to move the bases of the cups (20) towards each other to compress the cups (10) and cause a circumferential zone of the plug (10) on either side of the abutting faces of the cups (20) to increase in radial dimension to be brought into load bearing contact with the side of a predrilled hole (38) in which the plug (10) is to be located, in use, and to enable the bases of the cups (20) to be moved away from each other to allow the plug (10) to be withdrawn from the hole (38) in the event of a misfire of the explosive in the hole (38).

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STEMMING PLUG

FIELD OF THE INVENTION

[0001] This invention relates to a stemming plug for confining explosive blast gasses in a blast hole in mining, tunnelling or like operations.

BACKGROUND TO THE INVENTION

[0002] A variety of stemming plugs are produced from natural rubber, synthetic rubber and other suitable polymers and have been used for the above application for many years. An unacceptably high degree of failure is, however, experienced by miners and the like as a result of the stemming plugs being expelled from blast holes during a blast. Difficulty in inserting existing plugs into holes and, when occasion requires, the removal of a plug are problems frequently encountered in blasting operations.

SUMMARY OF THE INVENTION

[0003] A stemming plug which is made from a suitable resiliently deformable plastics material according to the invention comprises two cup-shaped members which face each other with their rims in abutment and means, which extends between the centres of the base portions of the cups in the plug, which is adapted to move the bases of the cups towards each other to compress the cups and cause a circumferential zone of the plug on either side of the abutting faces of the cups to increase in radial dimension to be brought into load bearing contact with the side of a predrilled hole in which the plug is to be located, in use, and to enable the bases of the cups to be moved away from each

other to allow the plug to be withdrawn from the hole in the event of a misfire of the explosive in the hole.

[0004] A portion of the wall of each cup-shaped member from its rim may be substantially cylindrical around the axis of the plug which passes through the centres of the cup bases to define the circumferential load bearing zone of the plug.

[0005] Each cup-shaped member may include a substantially cylindrical skirt which extends from the substantially cylindrical portion of its wall away from the abutting rims of the cups to surround at least a portion of the cup wall.

[0006] The composite substantially cylindrical outer wall of the plug may be divided into segments by slots which are parallel to the plug axis.

[0007] The outer surface of each of the wall segments could include outwardly projecting formations for gripping the surface of a hole when the segments are brought into load bearing contact with the surface, in use.

[0008] The gripping formations may be ribs which are parallel to the segment defining slots.

[0009] The non-cylindrical wall material of each cup-shaped member may include a line of weakness on the inside of and against the wall of the cup across each of the wall segment slots. The line of weakness may be defined by arcuate slots with the ends of each slot being spaced from the ends of adjacent slots.

[0010] The non-cylindrical portion of each of the cup-shaped members may include a pleat which extends from the ends of each of the arcuate slots in a direction towards the plug axis to expedite expansion of the plug in a radial direction, in use. The pleated wall material of each cup-shaped member is preferably thinner than the adjacent cup wall material.

[0011] The pleats may be V or C-shaped in cross-section.

[0012] The non-cylindrical portion of each of the cup-shaped members may include an aperture through which a fuse or electrical detonator conductors may be passed.

[0013] Each of the cup-shaped members preferably includes a formation which is releasably engageable with a formation on the other cup to ensure that the fuse apertures are in register with each other and to prevent rotation of the cups relatively to each other about the plug axis.

[0014] The releasably engageable formations may be a plurality of circumferentially spaced sockets and spigots which are releasably engageable with the sockets and spigots of the other cup.

[0015] A first of the cup-shaped members may include a holed boss in its base and the second an aperture in its base and the cup base moving means could be a headed elongated element which passes axially through the plug cavity between the first and second cups with its head, which is adapted for rotation by a removable tool, bearing on the outer surface of the second cup around the aperture with a portion of its length from its unheaded end including formations which are movably engageable with

complementally shaped formations in the hole in the boss of the first cup member. The engageable formations on the end portion of the elongated element and in the boss hole may be helical thread formations.

[0016] In a variation of the above stemming plug a first of the cup-shaped members may include an aperture in its base around the plug axis, at least two outwardly projecting gripper formations which are attached to and project outwardly from the base of the cup to be biased towards the plug axis over the aperture and carry on their faces which face the plug axis ratchet teeth, the second cup-shaped member may carry an elongated element which passes through the aperture in the first cup and between the gripper formations and carries ratchet teeth which are oppositely directed to those on the faces of the gripper formations with the directions of the ratchet teeth being such that the end of the elongated element may be pulled outwardly from between the teeth of the gripper formations to draw the cup bases towards each other to set the plug, in use, when the pulling tension on the elongated element is relaxed. The plug could include two gripper formations which face each other from opposite sides of the aperture in the base of the cup and the portion of the elongated element which carries its ratchet teeth may be square or rectangular in cross-section with the ratchet teeth on two opposite sides of the element while the remaining opposite sides are flat so that the ratchet teeth on the gripper formations will, when the elongated element and the cup to which it is attached is rotated through 90°, be disengaged from the ratchet teeth on the elongated element to enable the base portions of the cup-shaped elements of the plug to move away from each other to reduce the radial dimension of the plug to enable it to be removed from a predrilled hole in the event of a misfire of the explosive in the hole.

[0017] Each of the gripper formations could include at its free end a surface which tapers from the end of the formation inwardly towards the plug axis for releasing its ratchet teeth from those on the elongated element by means of a suitable tool.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A number of embodiments of the invention are now described by way of non-limiting examples only with reference to the drawings in which:

Figure 1 is a half-sectioned side elevation of a first embodiment of the stemming plug of the invention,

Figure 2 is a plan view of the cup-shaped members of the Figure 1 stemming plug,

Figure 3 is a sectioned side elevation of the Figure 1 stemming plug, in use,

Figure 4 is an isometric view of a tool for setting the Figure 1 stemming plug,

Figure 5 is sectioned side elevation of a variation of the Figure 1 plug,

Figure 6 is a sectioned side elevation of a second embodiment of a cup-shaped formation of the stemming plug of the invention,

Figure 7 is a plan view of the Figure 6 cup-shaped member,

Figure 8 shows two fragmentary sectional views which illustrate the function of the pleats in the cup-shaped member of Figures 6 and 7,

Figure 9 is a sectioned side elevation of a typical cup-shaped member of the stemming plug,

Figure 10 is an under plan of the cup-shaped member of Figure 9,

Figure 11 is an under plan of the second cup-shaped member for use with that of Figure 9, and

Figure 12 is a sectioned side elevation of a third embodiment of the stemming plug of the invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0019] The first embodiment 10 of the stemming plug of the invention is shown in Figure 1 to include two cup-shaped members 12 and 14 with their rims abutting each other and a headed setting screw 16.

[0020] The cup-shaped members 12 and 14 are made from a suitable resilient plastic material such as polypropylene, a polyamide or the like. The screw 16 is made from a suitably rigid polyamide.

[0021] The upper cup-shaped member 18 in Figures 1 and 2 is shown to include an outwardly domed wall portion 20 with the rim portion 22 of the cup being inwardly directed to be almost cylindrical about the axis of the plug. The cylindrical portion 22 of each cup side wall is extended away from the portion 22 to provide cylindrical extensions 28 which surround the domed wall portions 20 and bases of the cups.

[0022] The base portion of the cup 20 carries a boss 24 which has a threaded bore which is engaged by the male helical thread formation on the screw 16.

[0023] The cup-shaped formation 14 is substantially identical to the cup 12 save that it carries in its base portion a holed recess formation 26 for accommodating and locating the head of the screw 16.

[0024] As shown on the left in Figure 1 and in Figure 2 the cylindrical portions 22 of the cup-shaped members 12 and 14 together with their cylindrical extensions 28 provide a substantially cylindrical composite wall which surround the remainder of the cups.

[0025] The composite stemming plug wall is shown in Figures 1 and 2 to be divided into segments 30 by vertical slots 32 which penetrate the domed portion 20 of the plug to allow for movement of the segments away from the plug axis and one another, in use. The outer surfaces of each of the wall segments 30 carry an outwardly projecting rib 34 the purpose of which is to be deformed under radial pressure against a wall of a hole in which the plug 10 is located, in use, to key into irregularities in the wall surface and so to prevent rotation of the plug as it is being set in the hole. The dome portion 20 of each of the plugs carries an aperture 36, shown only in Figure 2, for the passage of a fuse or the conductor leads to an electrically activated detonator.

[0026] Figure 3 illustrates the stemming plug 10 of Figures 1 and 2 set in a predrilled blast hole 38 with its cup-shaped members compressed towards each other by the screw 16 with at least the radially so-moved wall portions 22 of the cup segments 30 pressed hard up against the surface 40 of the hole 38.

[0027] The stemming plug 10 is set in the hole 40 by means of the tubular tool 42 shown in Figure 4. The tool includes, from one end, two opposed vertical slots 44 which terminate in round ended circumferential slots 46. The diameter of the bore of the tool 42 is slightly greater than the diameter of the outer portion of the screw 16 head and the width of the slots 44 and 46 are similarly slightly larger than the diameter of the trunnion formations 48 which project from opposite sides of the screw head. The tool

additionally carries a handle, at its opposite end to that at which the slots 44 and 46 are located, by means of which the tool is rotated in setting the stemming plug.

[0028] The Figure 5 variation 50 of the stemming plug of the invention is similar to that of Figures 1 to 3 except that the domed wall portions 20 of the Figure 1 plug is here replaced by frusto conical wall portions 52 and the boss 24 is replaced by a recessed formation 26, which is identical to the screw head recess formation 26 of Figure 1. The upper formation 26 in Figure 5 carries a threaded plug 54 in which the screw 16 is engaged. The plug carries a key, not shown, which is engageable with a key groove in the recess 26 to prevent rotation of the plug 54 during setting of the stemming plug.

[0029] The composite cylindrical wall of the Figure 5 stemming plug includes slots 32, ribs 34 and the fuse aperture 36 in its wall portions 52 which are identical to those described with reference to Figures 1 and 2.

[0030] The second embodiment 56 of the stemming plug of the invention is shown in Figures 6 and 7 to include six pleats 58 which are located in the domed or frusto conical wall portions of the cup-shaped members and extend across the segment 30 wall slots 32 as shown in Figure 7. The outer edges of the pleats 58 terminate in arcuate slots 60 which are made through the cup material to separate the outer wider edges of the pleats 58 from the wall segments 30.

[0031] The pleats 58 in this embodiment of the invention are outwardly V-shaped, as most clearly shown in Figures 7 and 8. The upper sketch in Figure 8 shows the shape of the edge of the pleat at its slot 60 in the unstressed condition of the stemming plug and the lower sketch illustrates the degree of stretch provided, by the six almost

flattened pleats, to enable the cup segments to separate circumferentially when the stemming plug is stressed and set as illustrated in Figure 3. The pleats need not necessarily have the V-shape shown in Figures 7 and 8 and could be C-shaped or have any suitable stretchable shape such as a plurality of tapered corrugations or the like. Whatever the cross-sectional shape of the pleats is the material of the pleats is made to be thinner than the remaining domed or frusto conical cup material adjacent them.

[0032] The pleats, and particularly those which are composed of a thinner material, facilitate outward radial and circumferential expansion of the segmented plug wall and markedly reduce the torque which is required to rotate the screw during setting of the stemming device.

[0033] Figures 9, 10 and 11 illustrate the currently preferred arrangement for preventing rotation of the stemming plug cup-shaped members relatively to each other during setting of the stemming plug. An arrangement of this sort is applicable to all of the stemming plug embodiments described in this specification.

[0034] The cup-shaped member of Figures 9 and 10 is shown to include two spigot formations 62 and four sockets 64 which are supported by and in protuberances 66 which project from the centres of the wall segments 30. The lower ends of the protuberances 66 are flush with the outer surfaces of the rims of the cup shaped members. The plan view of the opposite cup-shaped member of the stemming plug is shown in Figure 11 to include two spigots 62 on either side of the fuse or electrical cord aperture 36 and four sockets 64.

[0035] The sockets 62 and the spigot 64 of the two cup-shaped members are engaged with each other in the assembled stemming plug.

[0036] The arrangement of the sockets 64 and spigots 62 on the rim faces of each of the cup-shaped members is firstly to ensure that the two cups are connected in a specific circumferential relationship so that the fuse holes 36 will always be in axial register for the passage of a fuse or detonator conductors through the plug and, secondly, to hold the abutting cup faces together to avoid one segment face portion from being radially displaced from the other as the cups are activated by compression towards each other or by wall irregularities in the blast hole.

[0037] The third embodiment 68 of the stemming plug of this invention is shown in Figure 12 to include cup-shaped members 70 and 72, an actuator 74 and two gripper formations 76.

[0038] The substantially cylindrical wall of the stemming plug is the same segmented arrangement as that of Figure 1.

[0039] The actuator 74 is made integral with and projects from the base of the cup 72. The portion of the length of the actuator which carries ratchet teeth 78 is rectangular in cross-section with its non-toothed sides being smooth. The two gripper formations 76, without the actuator between them, are strongly biased by the resilience of the material from which they are made, over the aperture in the plug towards the plug axis. Each of the gripper formations 76 carries, when the actuator is located between them, ratchet teeth which are biased into engagement with the teeth 78 on the actuator. The tooth direction of the engaged ratchet teeth, as shown in the drawing, enable the actuator to

be pulled upwardly in the drawing from between the actuator ratchet teeth to compress the cup-shaped members, as does the screw of Figure 1, to move the wall segments into pressure bearing contact with a hole wall, in use. When the plug is set in a hole the outward tension on the actuator is relaxed to allow the ratchet teeth to lock the plug in its activated state in the hole.

[0040] To release the holding tension on the actuator to enable the plug to be removed from the hole, after use, a tool having opposite triangular formations is pressed into the triangular gaps between the upper ends of the gripper formations 76. Pressure on the tool forces the gripper teeth out of engagement with the actuator teeth to allow the tension on the actuator to draw the actuator back into the plug cavity and so release the wall segments from the hole wall.

[0041] The invention is not limited to the precise details as herein described and is limited only by the scope of the invention as defined by the claims in this specification.

CLAIMS

1. A stemming plug which is made from a suitable resiliently deformable plastic material, characterised in that the plug comprises two cup-shaped members which face each other with their rims in abutment and means, which extends between the centres of the base portions of the cups in the plug, which is adapted to move the bases of the cups towards each other to compress the cups and cause a circumferential zone of the plug on either side of the abutting faces of the cups to increase in radial dimension to be brought into load bearing contact with the side of a predrilled hole in which the plug is to be located, in use, and to enable the bases of the cups to be moved away from each other to allow the plug to be withdrawn from the hole in the event of a misfire of the explosive in the hole.

2. A stemming plug as claimed in claim 1 wherein a portion of the wall of each cup-shaped member from its rim is substantially cylindrical around the axis of the plug which passes through the centres of the cup bases to define the circumferential load bearing zone of the plug.

3. A stemming plug as claimed in claim 2 wherein each cup-shaped member includes a substantially cylindrical skirt which extends from the substantially cylindrical portion of its wall away from the abutting rims of the cups to surround at least a portion of the cup wall.

4. A stemming plug as claimed in claim 3 wherein the composite substantially cylindrical outer wall of the plug is divided into segments by slots which are parallel to the plug axis.

5. A stemming plug as claimed in claim 4 wherein the outer surface of each of the wall segments include outwardly projecting formations for gripping the surface of a hole when the segments are brought into load bearing contact with the surface, in use.

6. A stemming plug as claimed in claim 5 wherein the gripping formations are ribs which are parallel to the segment defining slots.

7. A stemming plug as claimed in any one of claims 4 to 6 wherein the non-cylindrical wall material of each cup-shaped member includes a line of weakness on the inside of and against the wall of the cup across each of the wall segment slots.

8. A stemming plug as claimed in claim 7 wherein the line of weakness is defined by arcuate slots with the ends of each slot being spaced from the ends of adjacent slots.

9. A stemming plug as claimed in claim 8 wherein the non-cylindrical portion of each of the cup-shaped members includes a pleat which extends from the ends of each of the arcuate slots in a direction towards the plug axis to expedite expansion of the plug in a radial direction, in use.

10. A stemming plug as claimed in claim 9 wherein the pleated wall material of each cup-shaped member is thinner than the adjacent cup wall material.

11. A stemming plug as claimed in either one of claims 9 or 10 wherein the pleats are V-shaped in cross-section.

12. A stemming plug as claimed in either one of claims 9 or 10 wherein the pleats are C-shaped in cross-section.

13. A stemming plug as claimed in any one of claims 2 to 12 wherein the non-cylindrical portion of each of the cup-shaped members includes an aperture through which a fuse or electrical detonator conductors may be passed.

14. A stemming plug as claimed in claim 13 wherein each of the cup-shaped members includes a formation which is releasably engageable with a formation on the other cup to ensure that the fuse apertures are in register with each other and to prevent rotation of the cups relatively to each other about the plug axis.

15. A stemming plug as claimed in claim 14 wherein the abutting face of each of the cup-shaped members includes a plurality of circumferentially spaced sockets and spigots which are releasably engageable with the sockets and spigots of the other cup.

16. A stemming plug as claimed in any one of the above claims wherein a first of the cup-shaped members includes a holed boss in its base and the second an aperture in its base and the cup base moving means is a headed elongated

element which passes axially through the plug cavity between the first and second cups with its head, which is adapted for rotation by a removable tool, bearing on the outer surface of the second cup around the aperture with a portion of its length from its unheaded end including formations which are movably engageable with complementally shaped formations in the hole in the boss of the first cup member.

17. A stemming plug as claimed in claim 16 wherein the engageable formations on the end portion of the elongated element and in the boss hole are helical thread formations.

18. A stemming plug as claimed in any one of claims 1 to 15 wherein, a first of the cup-shaped members includes an aperture in its base around the plug axis, at least two outwardly projecting gripper formations which are attached to and project outwardly from the base of the cup to be biased towards the plug axis over the aperture and carry on their faces which face the plug axis ratchet teeth, the second cup-shaped member carries an elongated element which passes through the aperture in the first cup and between the gripper formations and carries ratchet teeth which are oppositely directed to those on the faces of the gripper formations with the directions of the ratchet teeth being such that the end of the elongated element may be pulled outwardly from between the teeth of the gripper formations to draw the cup bases towards each other to set the plug, in use, when the pulling tension on the elongated element is relaxed.

19. A stemming plug as claimed in claim 18 including two gripper formations which face each other from opposite sides of the aperture in the base of the cup and the portion of the elongated element which carries its ratchet teeth is square or rectangular in cross-section with the ratchet teeth on two opposite sides of the element while the remaining opposite sides are flat so that the ratchet teeth on the gripper formations will, when the elongated element and the cup to which it is attached is rotated through 90°, be disengaged from the ratchet teeth on the elongated element to enable the base portions of the cup-shaped elements of the plug to move away from each other to reduce the radial dimension of the plug to enable it to be removed from a predrilled hole in the event of a misfire of the explosive in the hole.

20. A stemming plug as claimed in either one of claims 18 or 19 wherein each of the gripper formations includes at its free end a surface which tapers from the end of the formation inwardly towards the plug axis for releasing its ratchet teeth from those on the elongated element by means of a suitable tool.

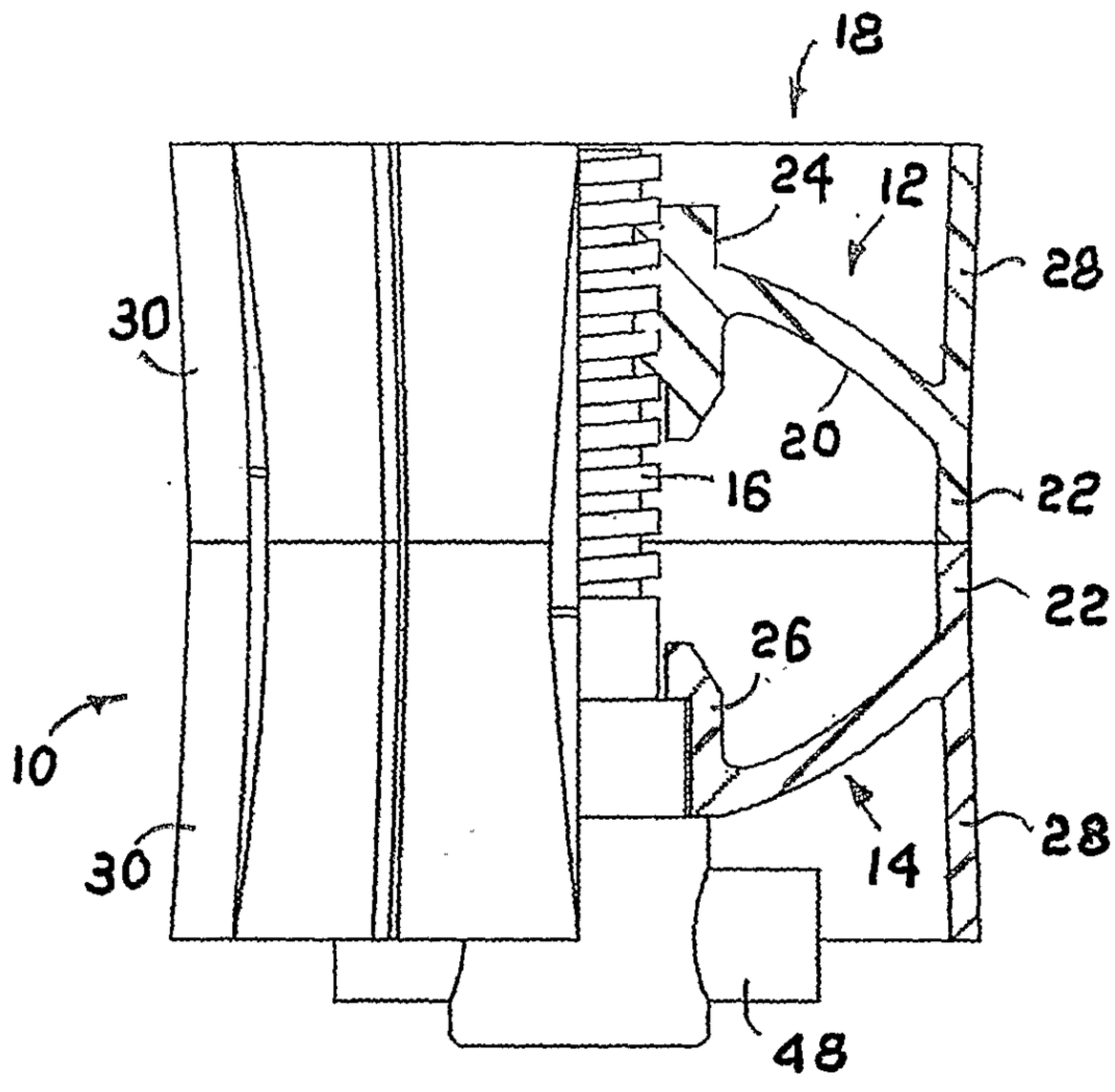


FIGURE 1

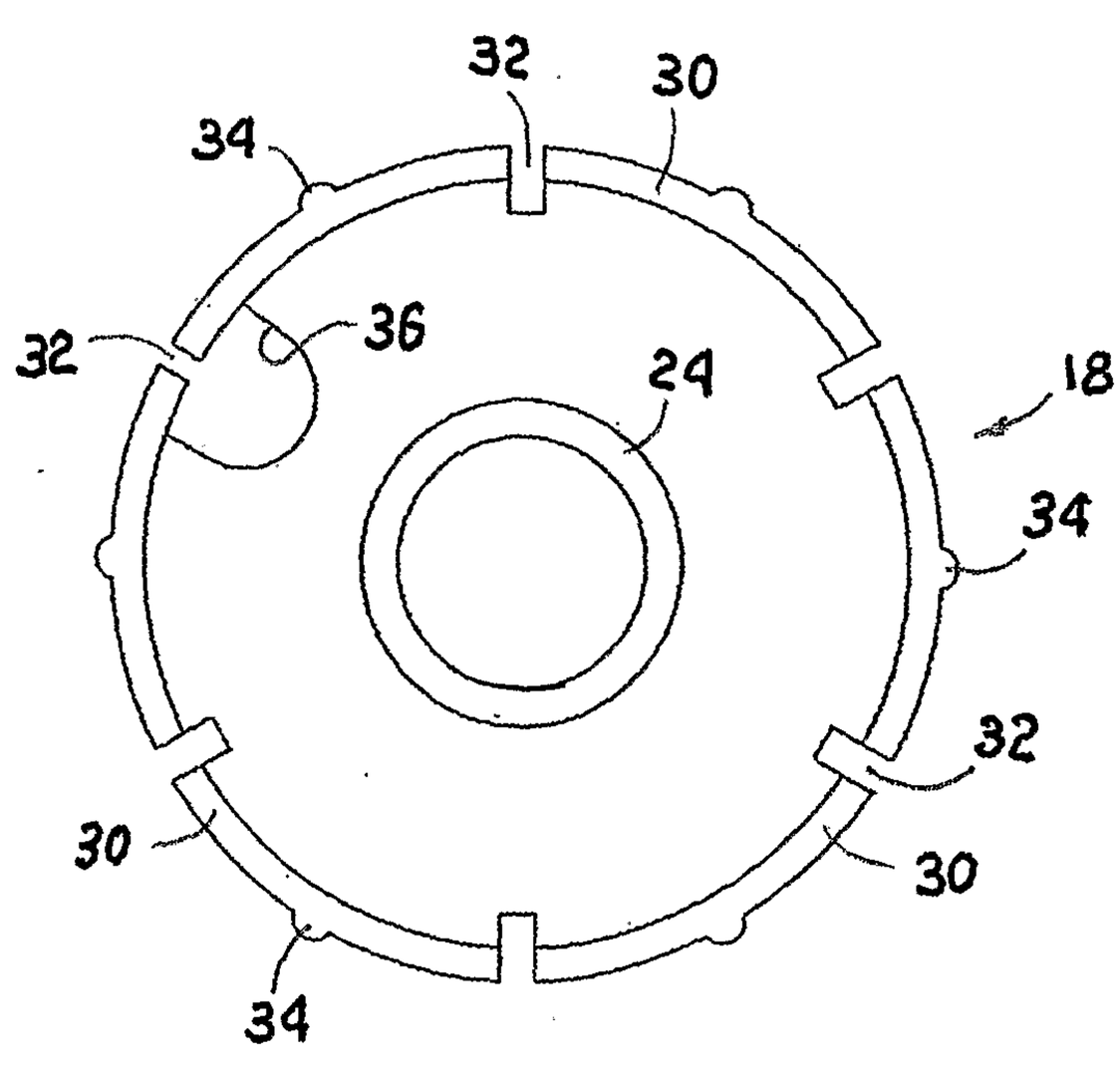


FIGURE 2

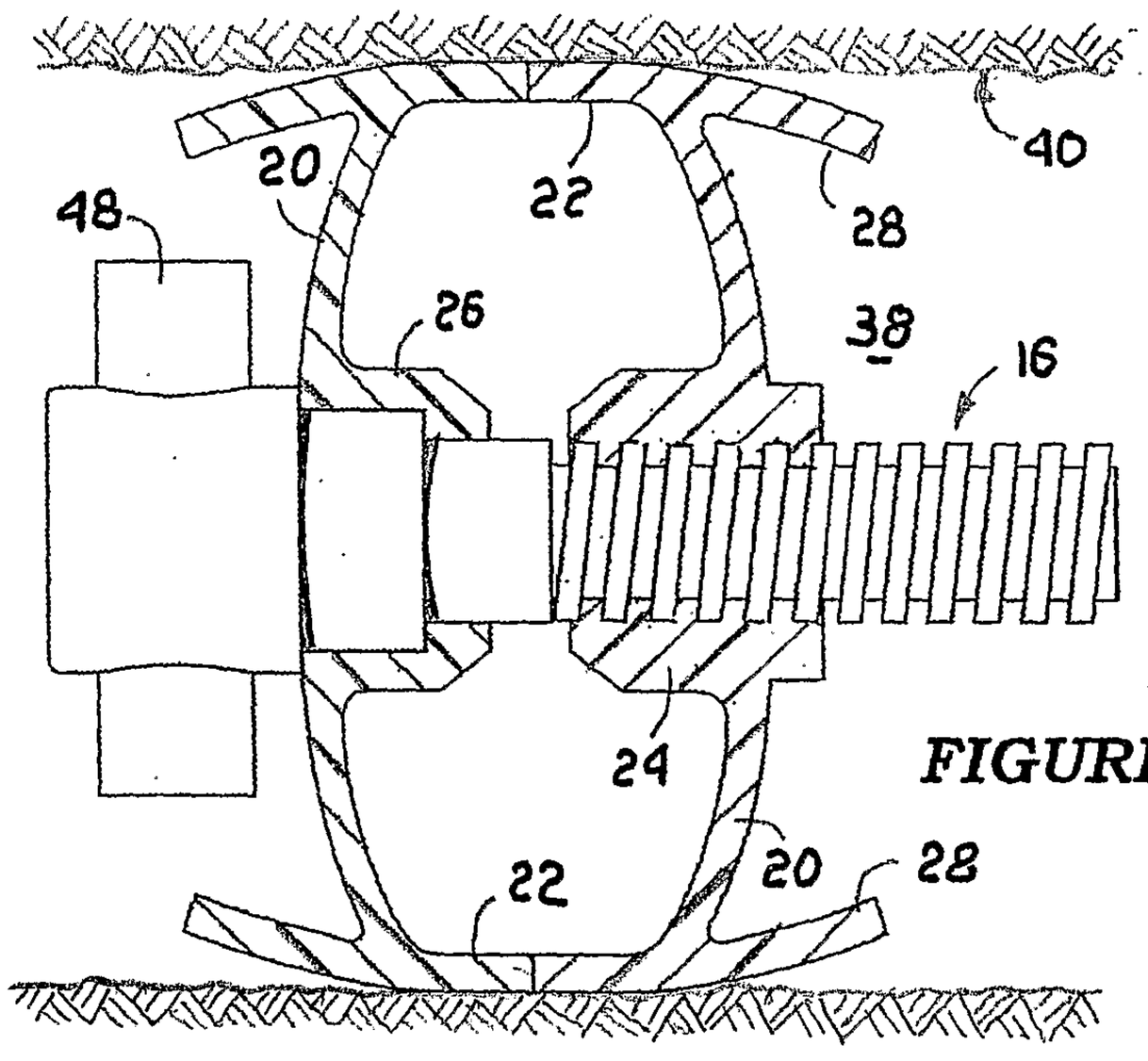


FIGURE 3

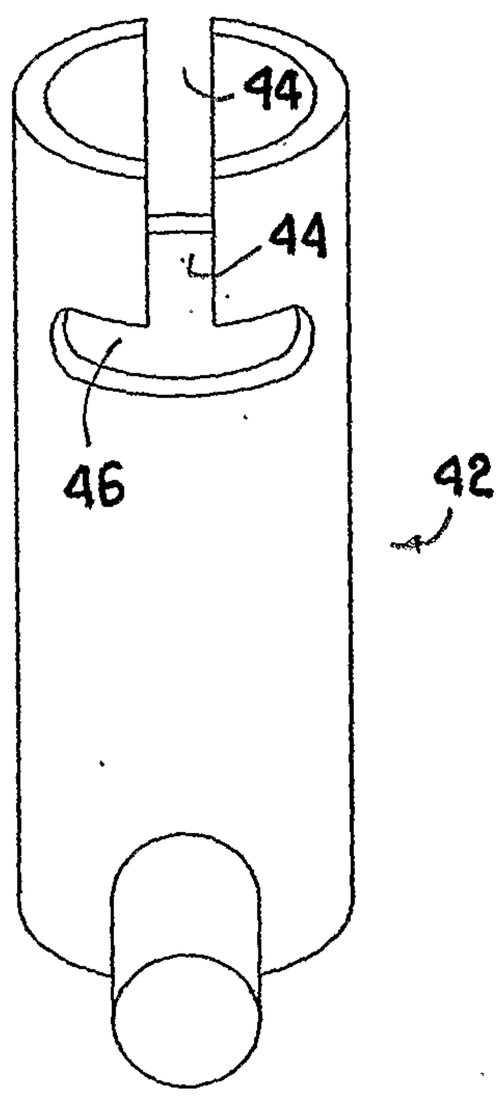


FIGURE 4

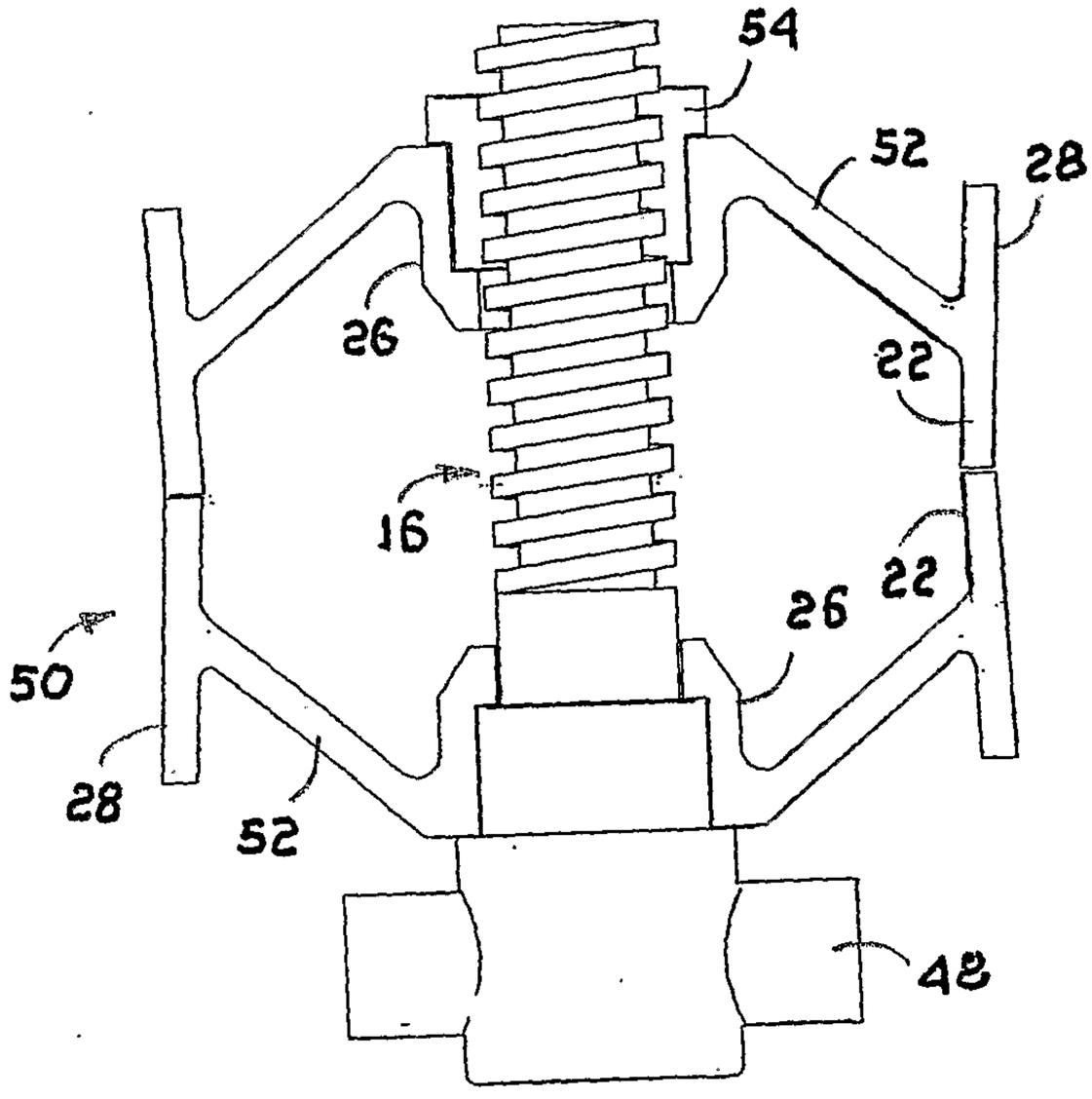


FIGURE 5

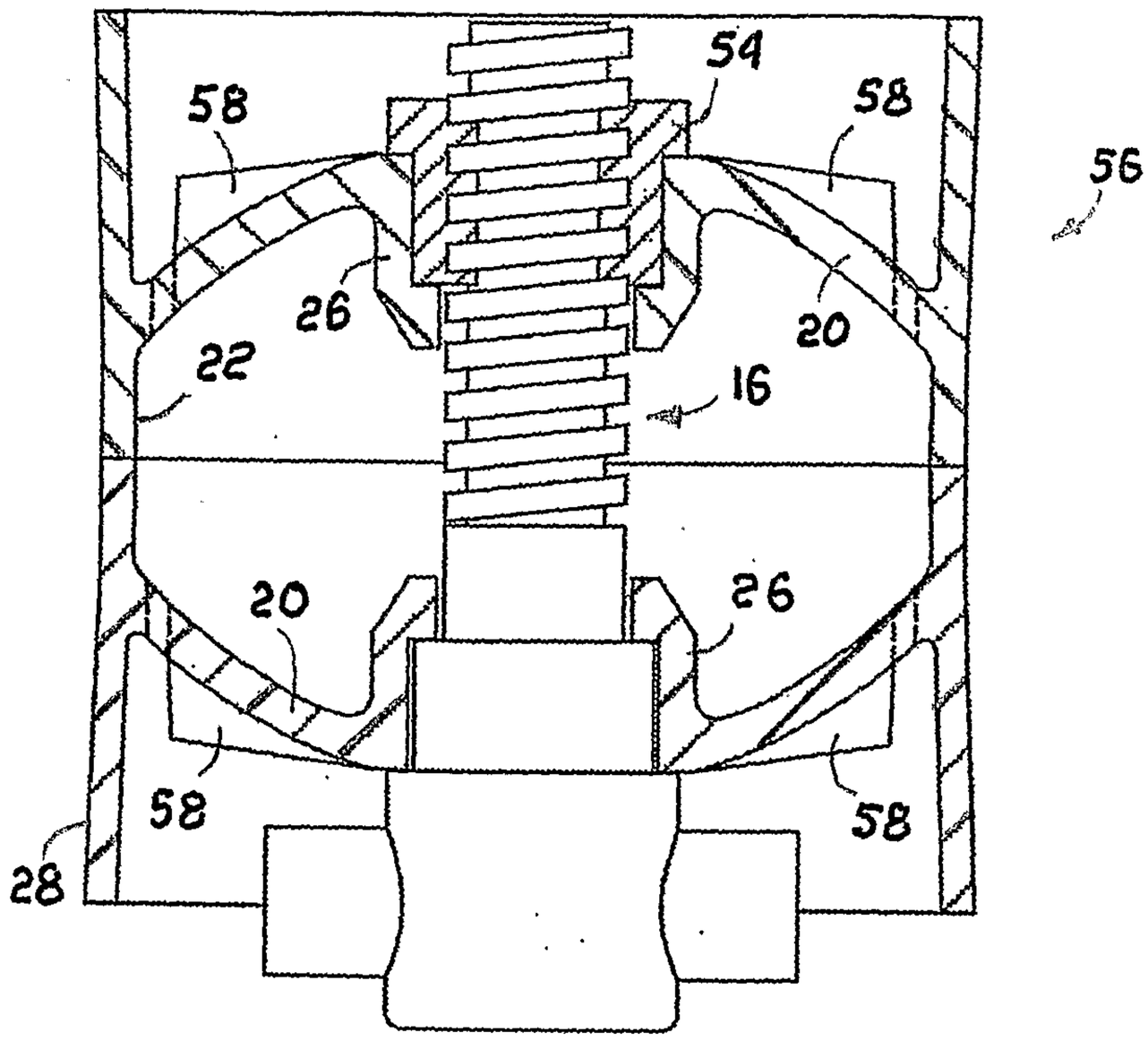
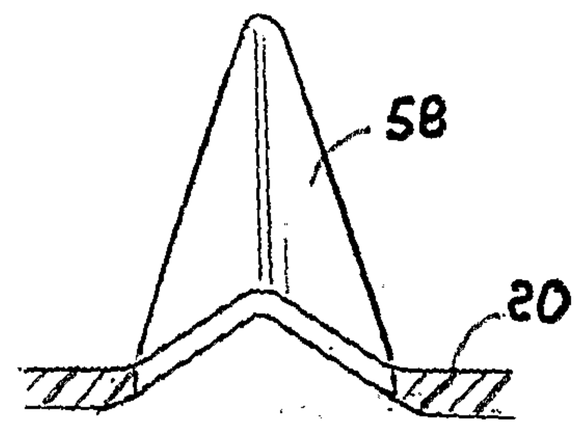


FIGURE 6



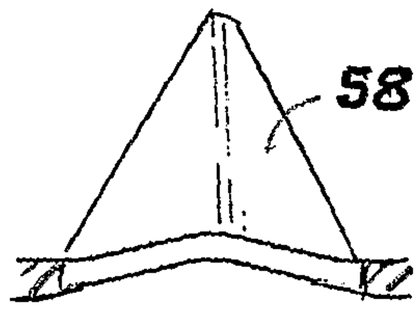


FIGURE 8

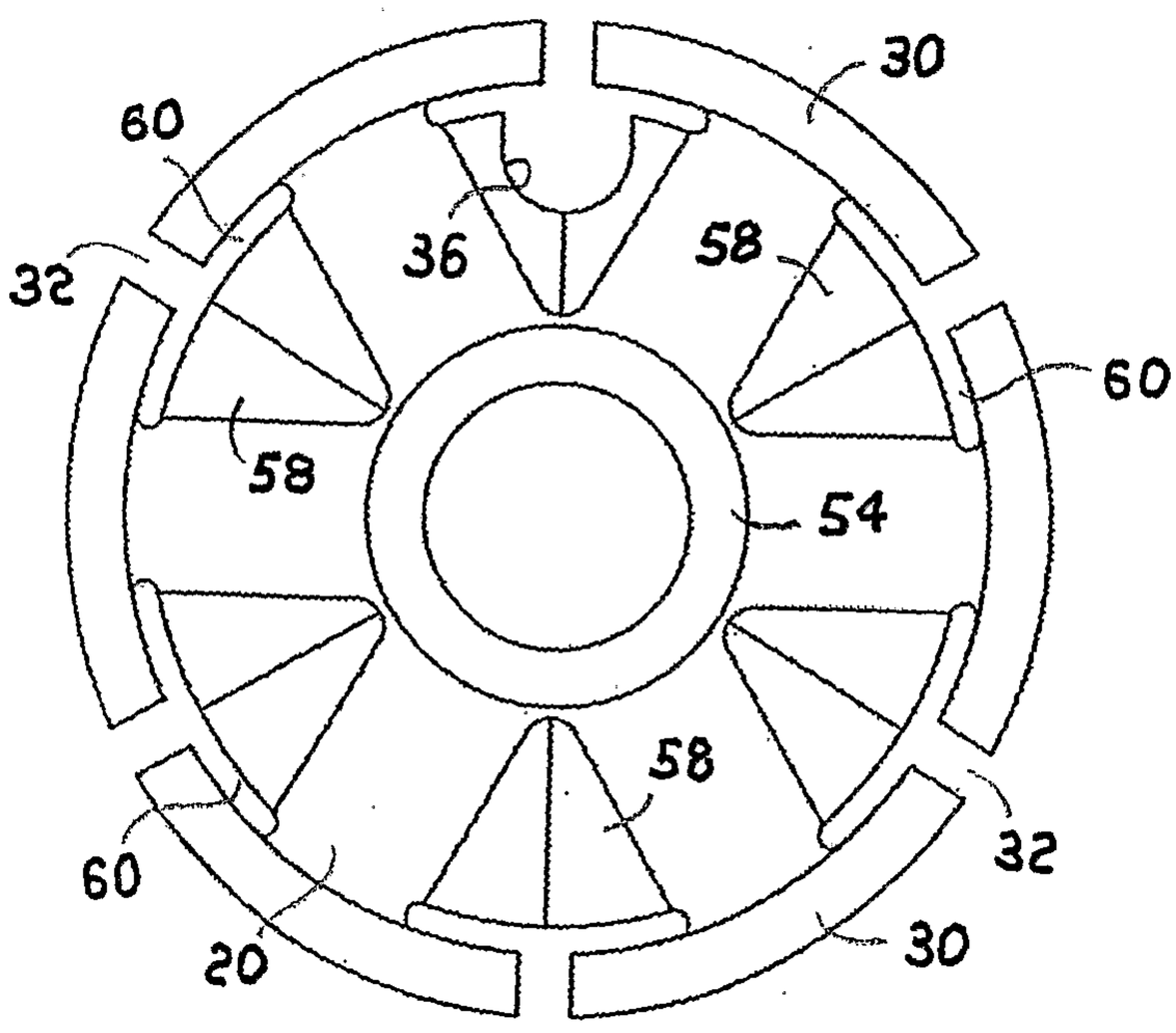


FIGURE 7

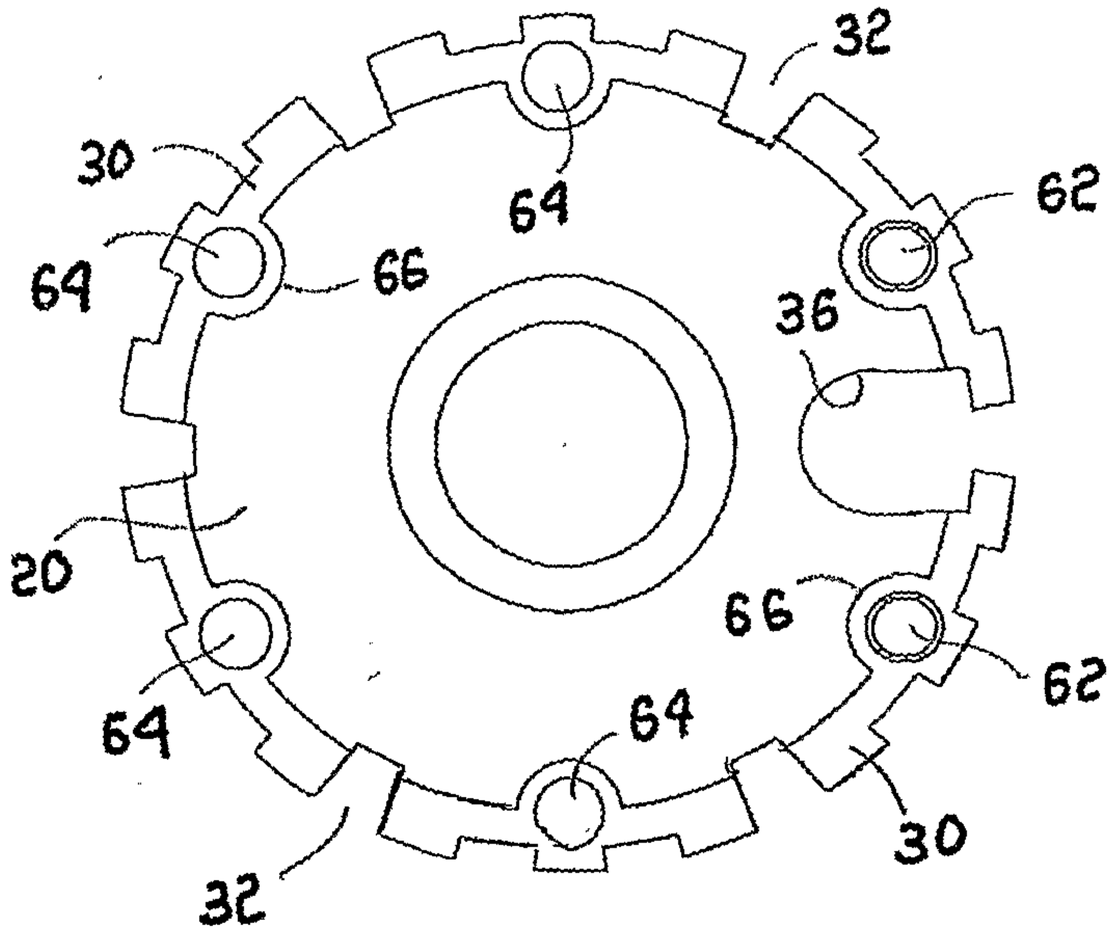


FIGURE 10

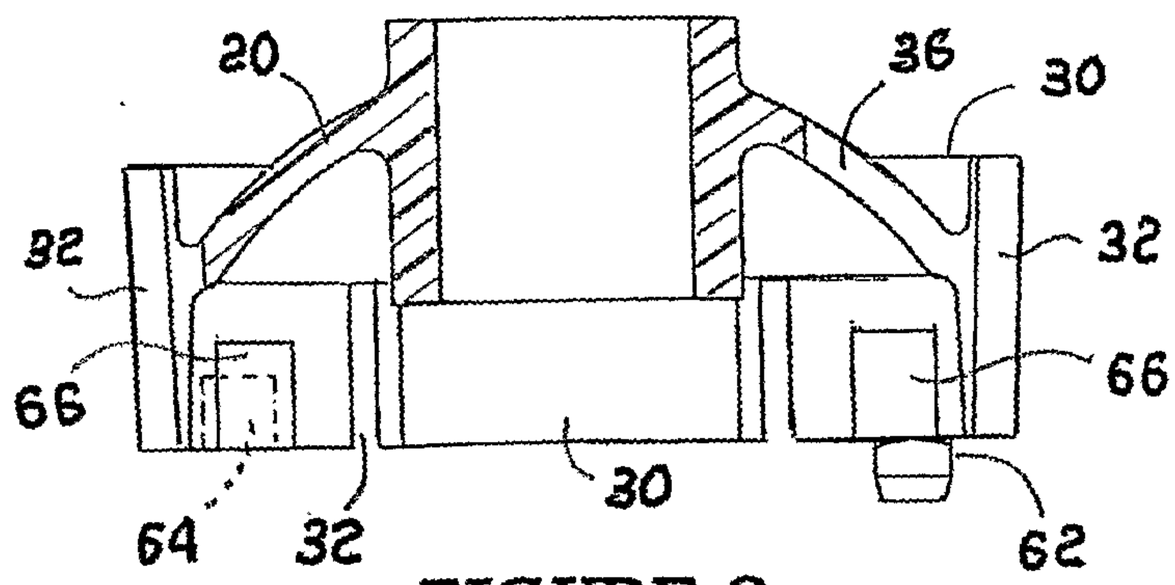


FIGURE 9

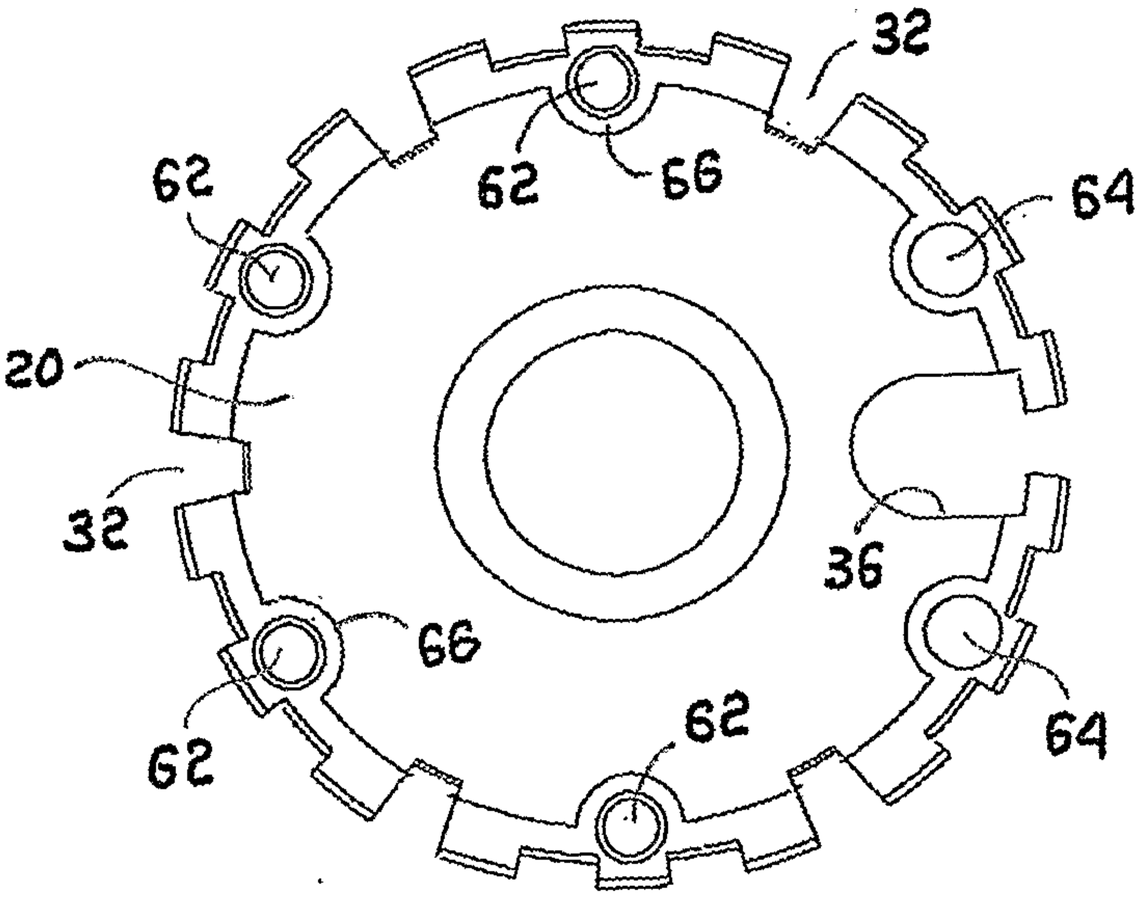


FIGURE 11

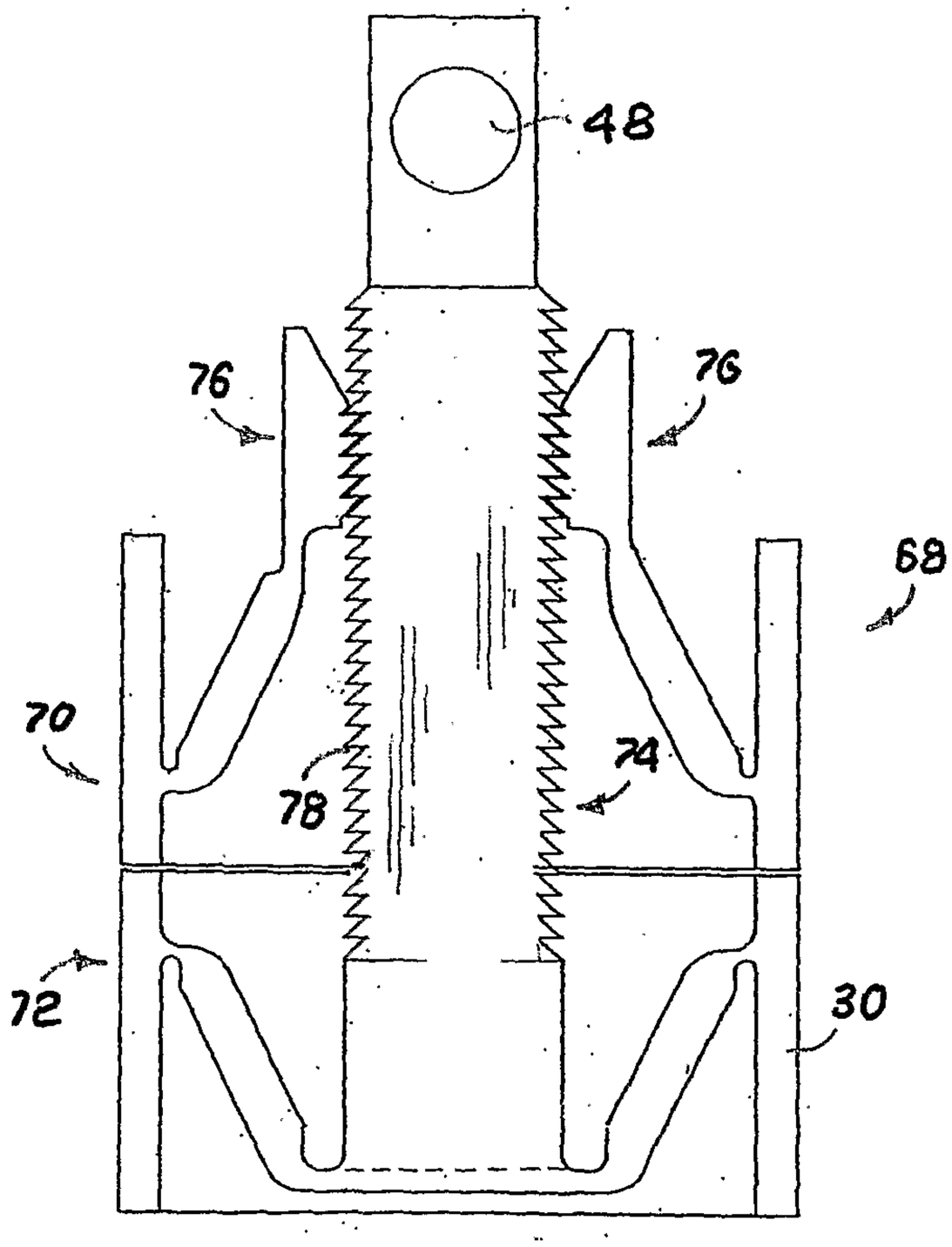
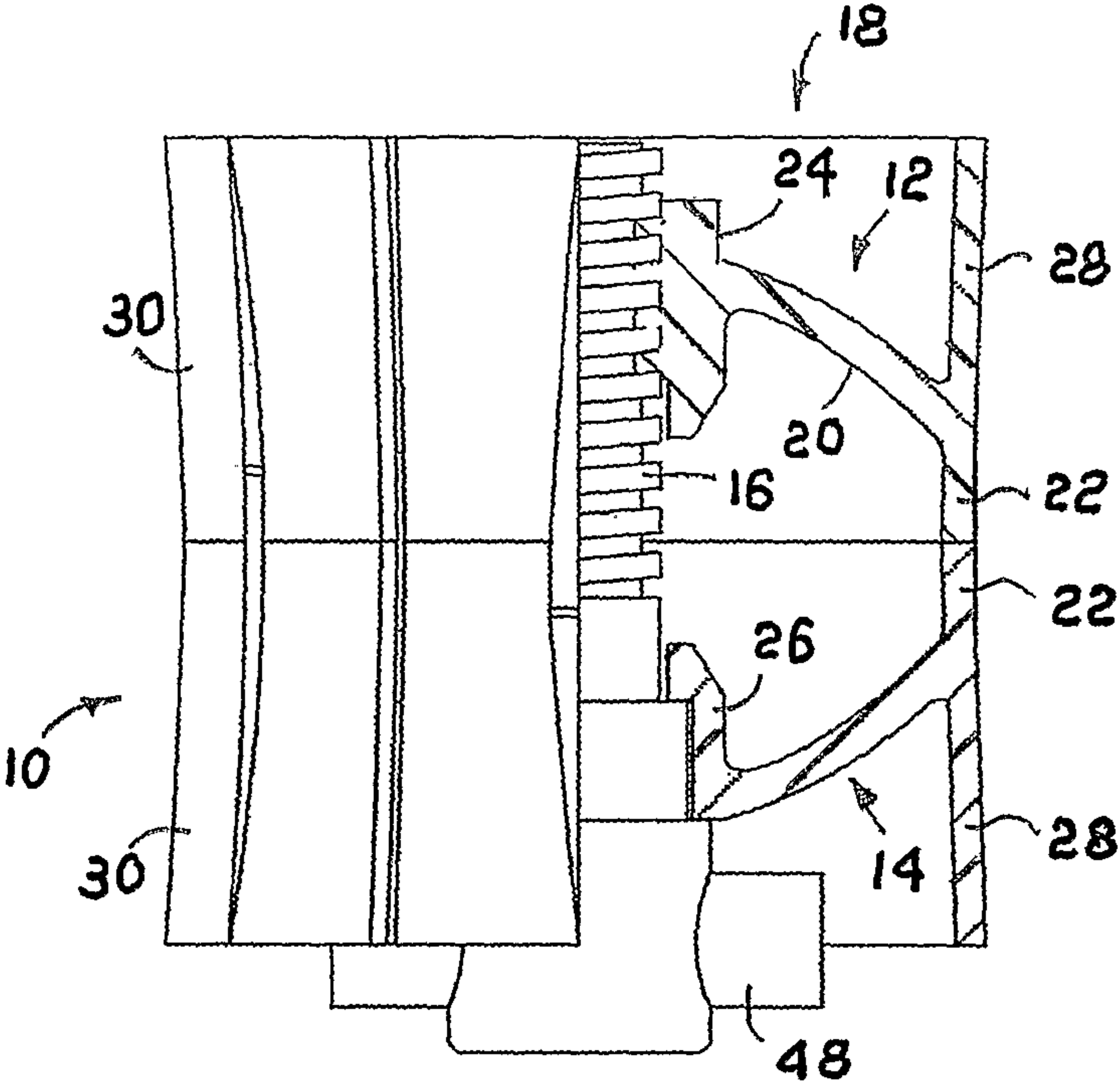


FIGURE 12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