Feb. 6, 1951 W. H. AVERY ET AL 2,540,231

TUYÈRE

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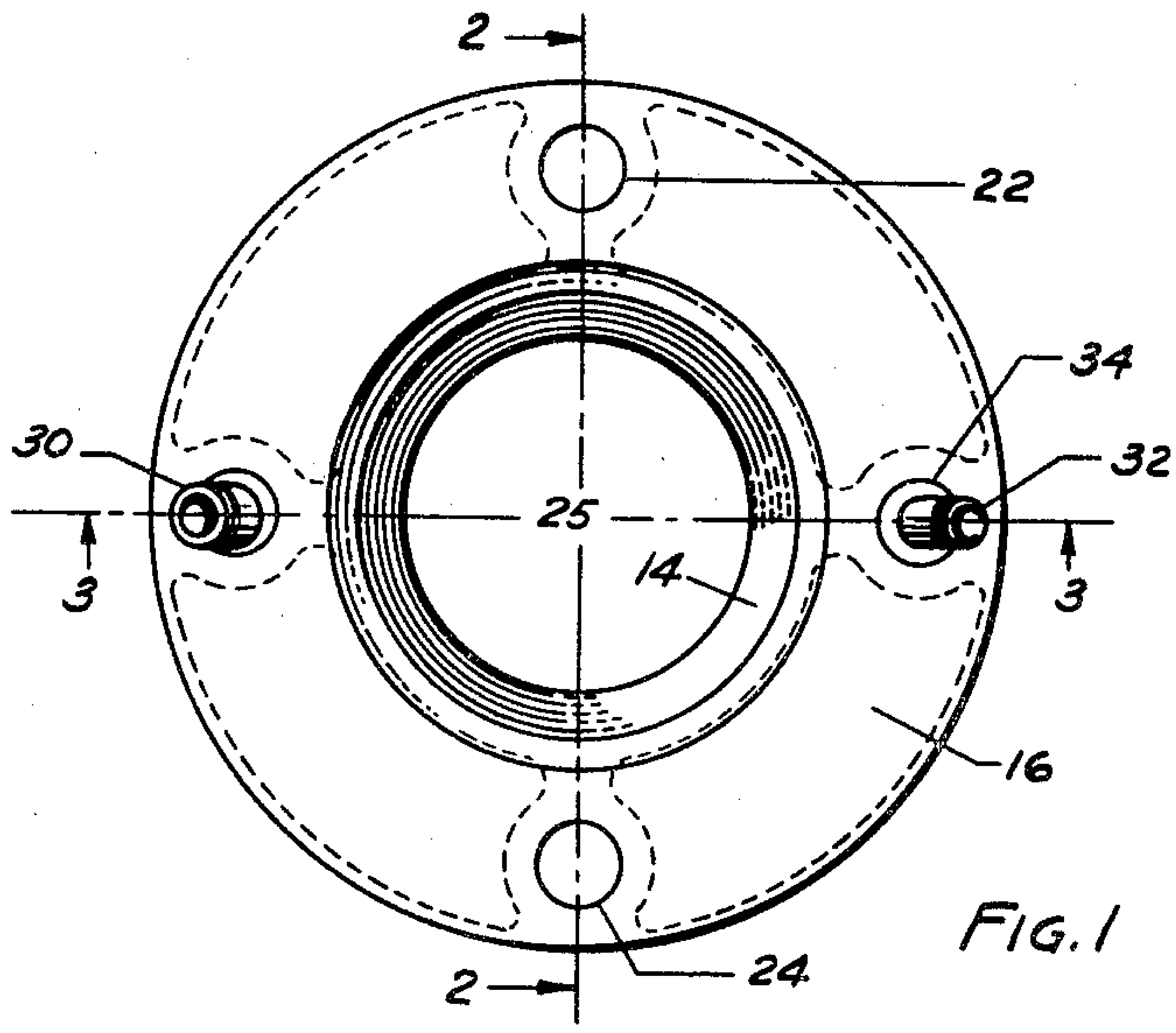

FIG. 1

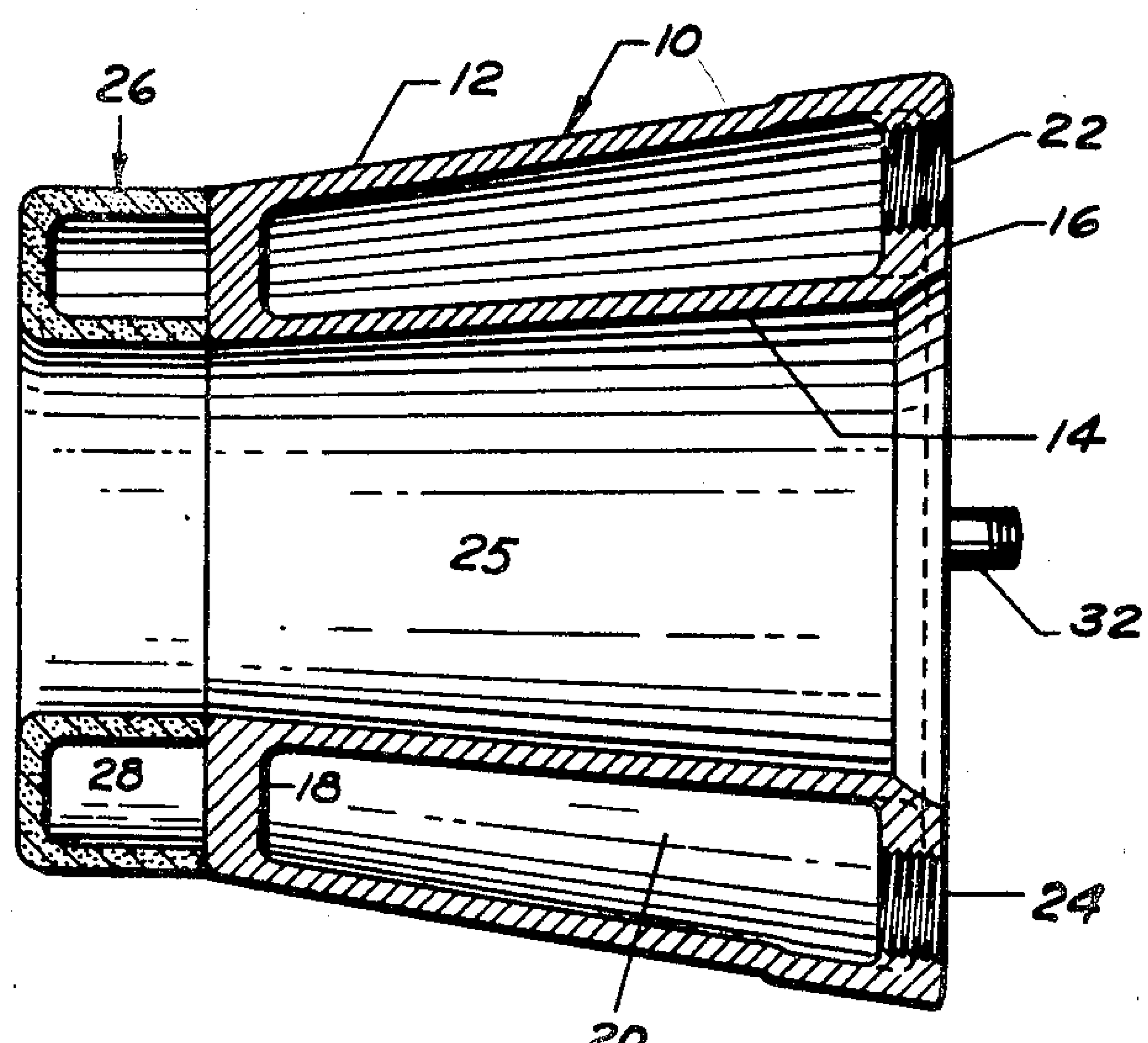

FIG. 2

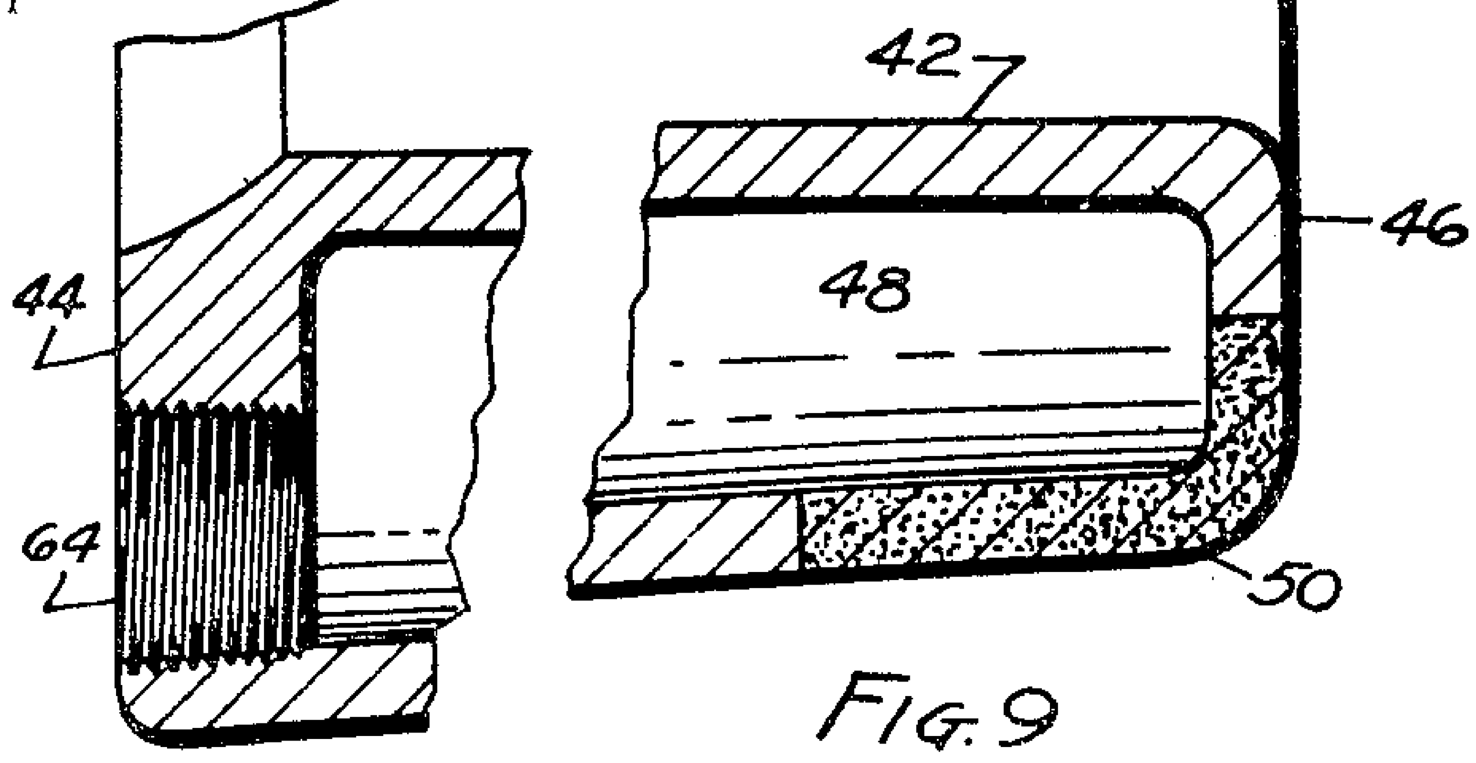

FIG. 9

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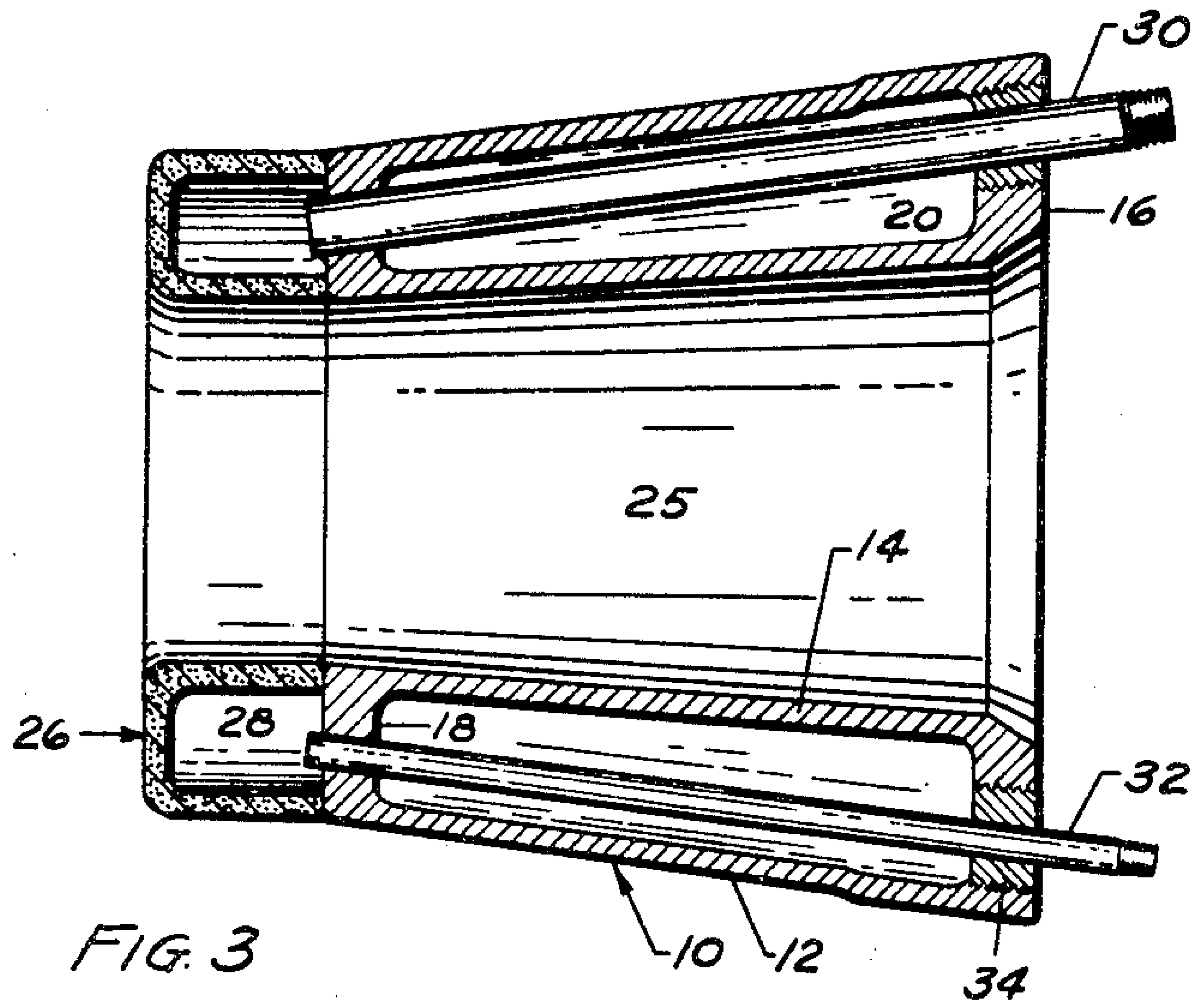

FIG. 3

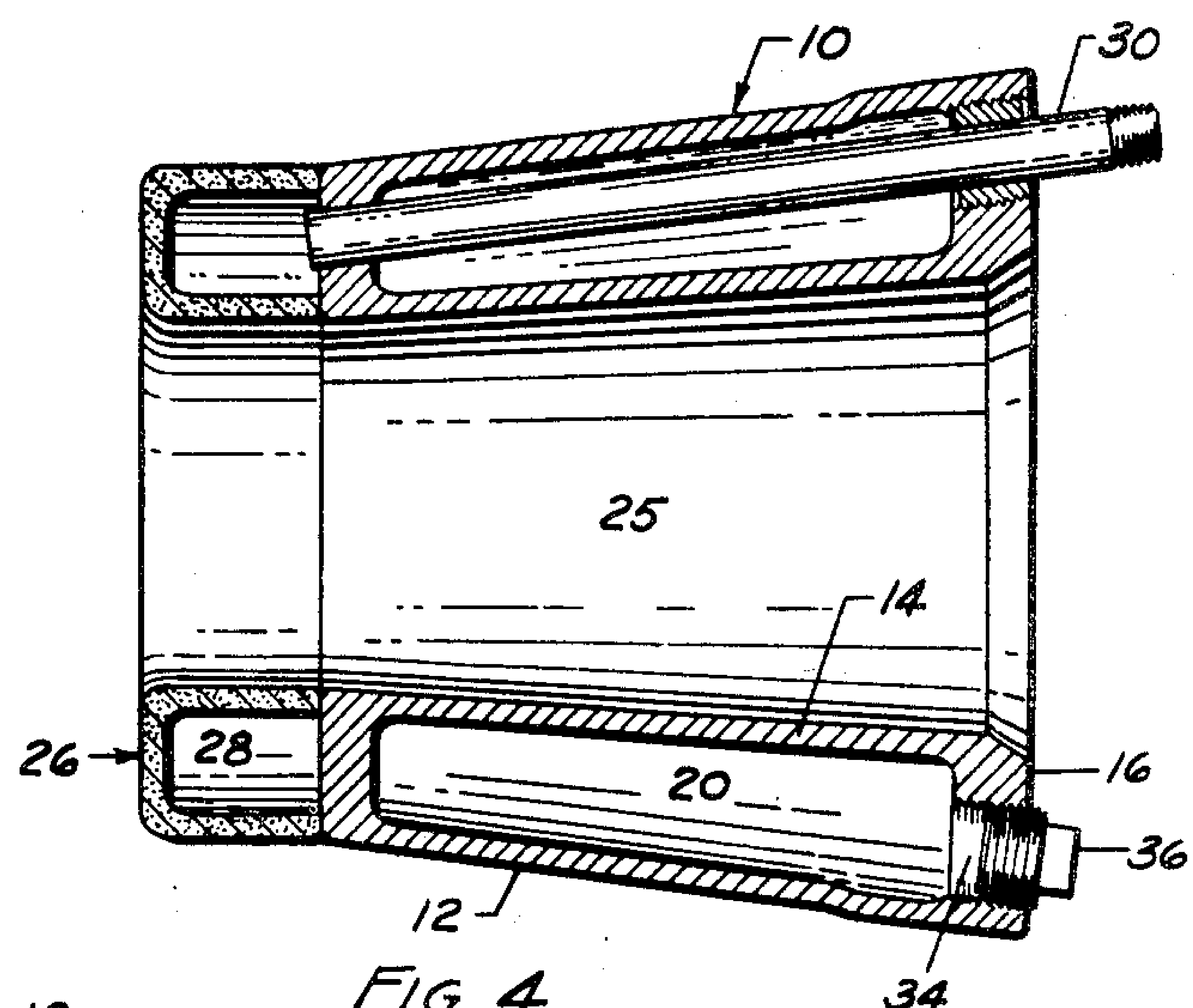

FIG. 4

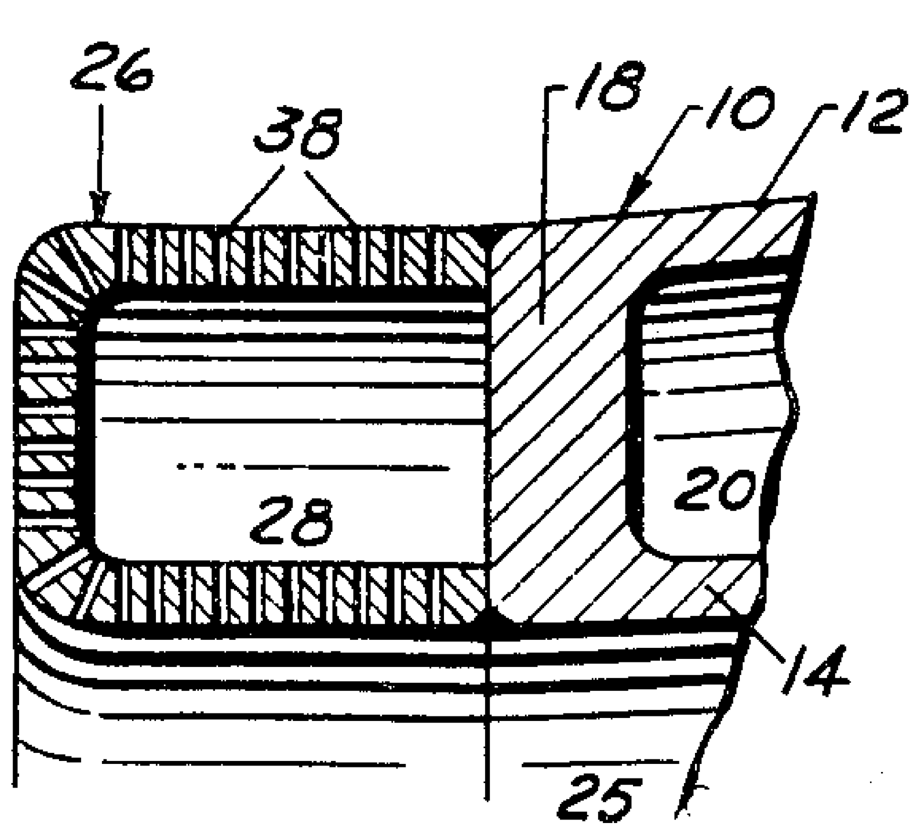

FIG. 5

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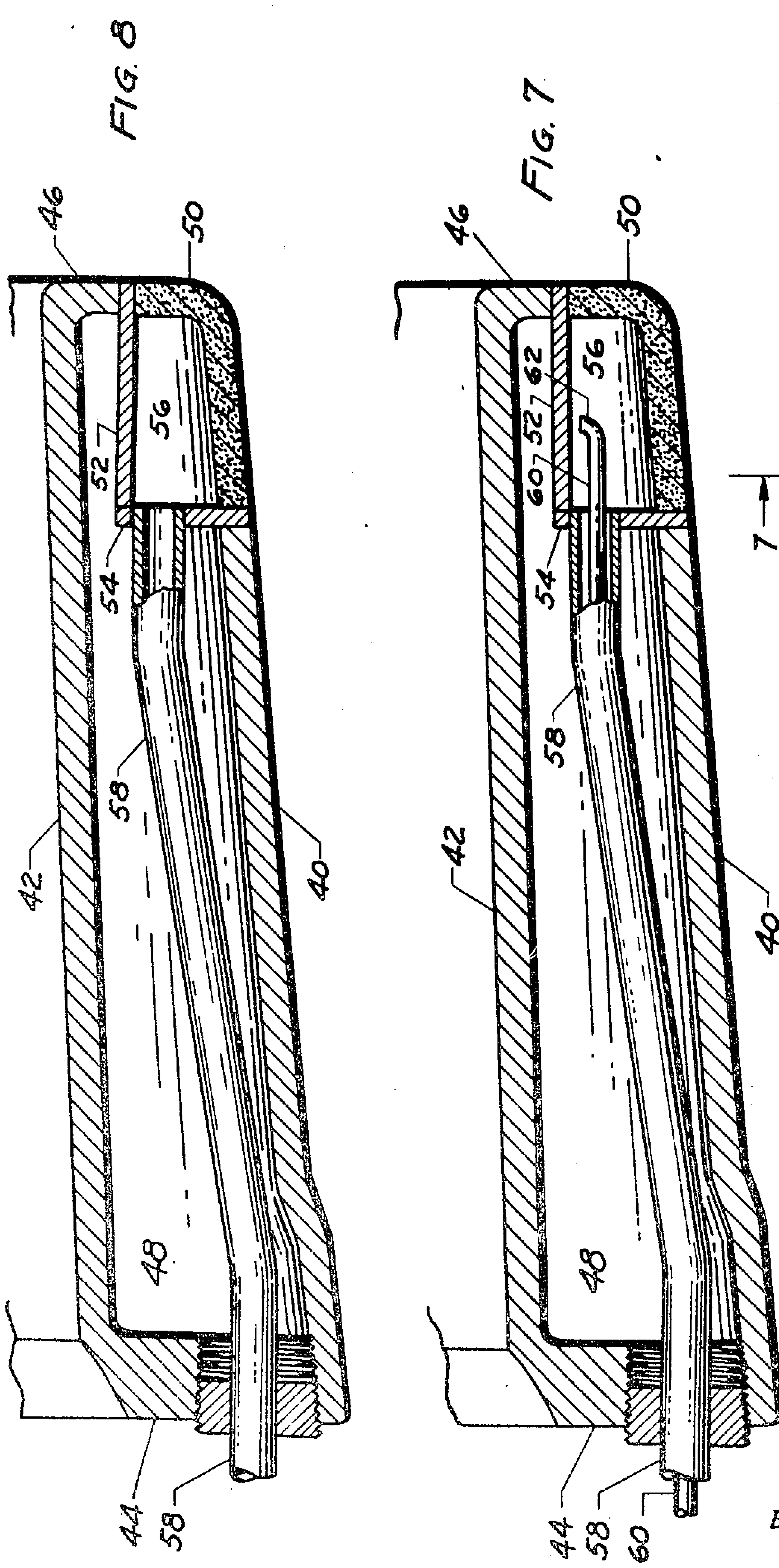

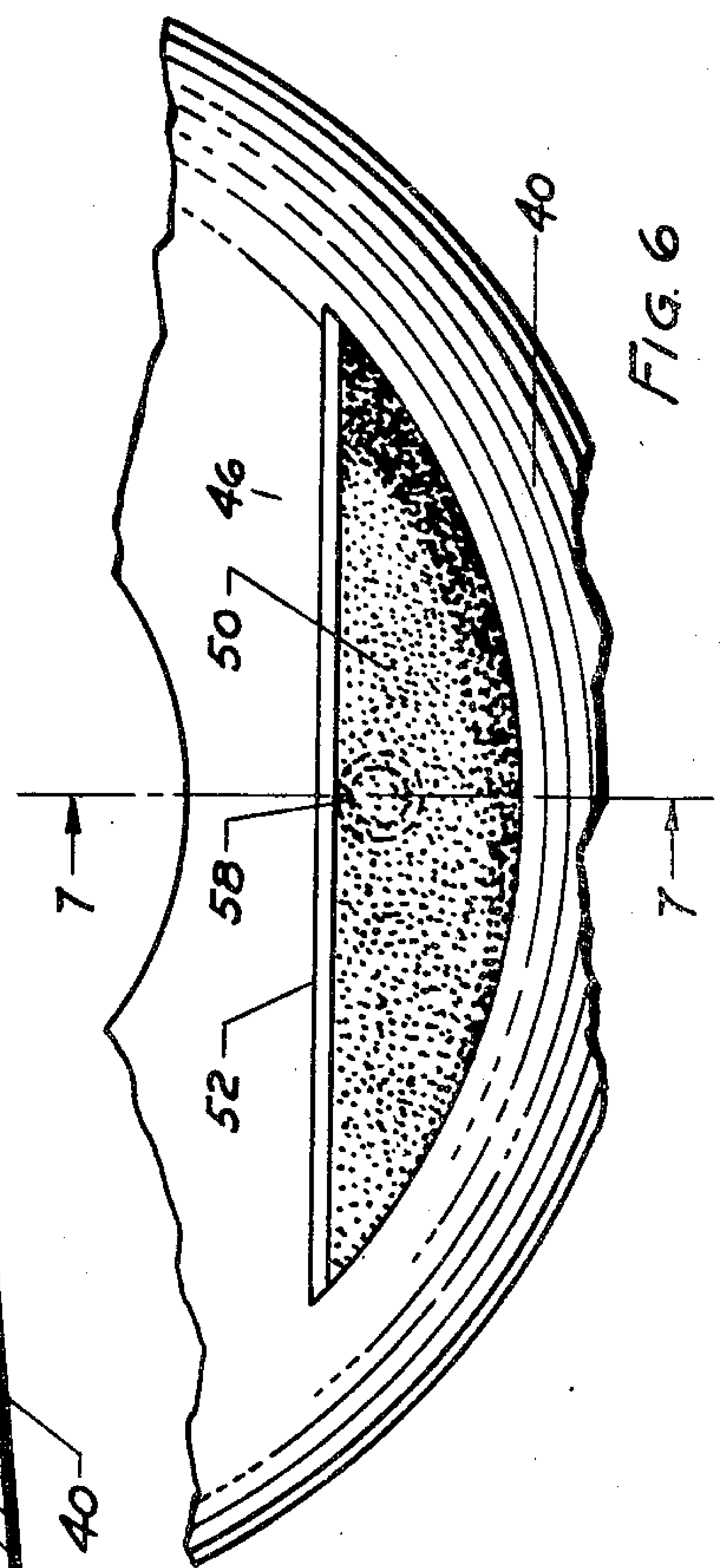

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TUYÈRE

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Application August 24, 1948, Serial No. 45,826

5 Claims. (Cl. 266—41)

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This invention relates to the cooling of tuyères of the type commonly used in delivering the air blast to blast furnaces. In particular, it relates to a novel means of cooling the tuyères.

As is well known, the severe operating conditions to which tuyères are subjected, particularly in the nose areas, cause rapid burning out unless special means for protection are employed. The special means heretofore proposed have taken many forms; the forms now commonly used comprise circulating cooling water between double walls provided in the tuyère body. Nevertheless, and in spite of a number of ingenious systems for increasing the effectiveness of this cooling water with respect to transferring heat away from the tuyère nose, the heat transfer through the wall of the tuyère at its nose is insufficient to prevent fairly frequent burn-outs.

In accordance with the present invention, part or all of that nose area of the tuyère which is exposed to the high temperature of the furnace (i. e. the nose wall and adjacent areas of the concentric side walls of the tuyère) is replaced by a permeable wall area of metal or ceramic, and means are provided for conveying a fluid medium through such permeable wall area from the inside to the outside and toward the interior of the furnace. The term "permeable nose" will be used hereinafter to denote this nose area having permeable walls, whether such permeable walls are located entirely in what is ordinarily termed the nose wall itself, or in the adjoining concentric tuyère walls, or both. The fluid is therefore not only in contact with the interior surface of the permeable nose area, as is conventional, but also with its exterior surface, which so far as we are aware has never been suggested heretofore. As a result, the cooling effect of the cooling fluid extends throughout substantially the entire thickness of the permeable nose, thereby reducing the number of burn-outs to a degree which has not hitherto been believed possible. The permeable nature of the walls of the nose area may be attained in any suitable manner, for example by forming them porous initially, or by perforation of initially impervious walls, as described in more detail below.

The cooling fluid may be a liquid, such as water, or a gas, such as air. Liquids are advantageous in that they absorb considerable heat when vaporizing, as they do at or adjacent the outside surface of the permeable nose, thereby producing added cooling effect. Gases, on the other hand, are advantageous in that, if of substantially the same constitution as the blast delivered

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by the tuyère, they are of no effect upon the reactions taking place within the furnace. With liquids, on the other hand, care should be taken to avoid introducing so much as to unbalance the reactions taking place within the furnace. This, however, may be readily accomplished by limiting the number of the permeable-nosed tuyères of this invention to less than all of those in a given furnace, or by limiting the permeable nose area, or by modifying and adjusting the conditions and controls of the furnace reaction in connection with the supply of fluid through the permeable noses, or by any appropriate combination of these factors.

All of the fluid conveyed into the permeable nose may be passed through the pores or holes in the nose into the furnace, or only part of the fluid may be so passed and the balance returned for removal or recirculation or other disposal. The fluid should be sufficiently free of suspended solids, and also of dissolved solids, if the fluid is a liquid, so that the suspended solids will not plug the pores or holes, and the dissolved solids will not form a crust which would cover or plug the pores or holes at or adjacent the outside surface where the liquid evaporates. It may, however, be advantageous to have a non-plugging deposit formed from the dissolved solids and laid down on the outside surface of the permeable wall. In such cases, the nature of the dissolved solids and the pressure of the liquid passing through the walls should be sufficient to avoid any significant plugging of the pores.

Furthermore the fluid, if a liquid, should be sufficiently low in dissolved gases to obviate any appreciable formation of gas pockets in the hollow nose or its permeable wall. Such pockets, if of appreciable size, may interfere with the flow of the liquid.

It is therefore advantageous to provide a tuyère having its main body of the usual hollow double-wall construction, and to have the permeable nose portion also hollow but compartmentalized by a suitable barrier from the hollow body of the tuyère. A separate water supply means is provided for each of said two hollow parts. Thus it is possible to lead the ordinary cooling water into and through the hollow main body of the tuyère, and to lead the solids-free cooling fluid into the hollow permeable-walled nose portion of the tuyère. Since the said ordinary cooling water will usually constitute the main bulk of cooling fluid furnished to the entire tuyère, it becomes unnecessary to supply purified cooling fluid except to the hollow permeable-walled nose portion. The purified cooling fluid may advantageously be conducted from its source by conduits passing through the hollow space in the main body of the tuyère formed by the inner and outer walls thereof, and thence to the hollow permeable-walled nose portion. Sufficient pressure is applied to said purified cooling fluid to cause it to pass through the pores or holes of said nose portion. On the other hand, when the cooling water supplied to the main body of the tuyère also has properties which render it suitable for supplying to the permeable nose, it may be used for both purposes. In such instances no barrier is necessary between the main body and the nose portion of the tuyère, and no separate means of supply is required for the nose portion. The tuyère then may be of conventional contruction but with a permeable insert in the nose area, or with fine holes drilled or formed in said area, for example.

The permeable wall of the nose portion may be made in any suitable manner, of which several are known, and set into the body of the tuyère by suitable means. The said wall may conveniently be made from a mass of particles suitably sized to ensure proper porosity, which mass is shaped and sintered, or otherwise processed, to produce the final structure of the desired shape and porosity. For example, the said mass may be pressed or jiggled or otherwise formed into the desired shape with or without the aid of a temporary binder, and then sintered to cause the particles to bond and any binder to volatilize, but at a temperature insufficient to cause melting with consequent plugging of the pores. If the said mass is composed of metallic particles, the final shape may be brazed, welded, or otherwise joined to the metallic tuyère body. On the other hand, if the said mass is composed of ceramic particles, it may be attached to the tuyère body by suitable projections, fins, or other engaging parts, or by cementing. Alternatively, the permeable nose portion may be initially made with impermeable walls, and these walls may then be provided with many small holes, as by punching or drilling, at the desired areas.

The tuyères of blast furnaces have a tendency to burn out first around the bottom portion of the nose. It has already been indicated herein that the amount of cooling fluid to be passed through the nose, when this fluid is a liquid, may desirably be limited so as not to unbalance the furnace operation. It follows accordingly that, under some conditions, only that portion of the tuyère nose near the bottom may be made permeable instead of more or all of the nose portion.

This invention will be more fully understood by reference to the accompanying drawings, which are to be considered as illustrative and not limiting, and wherein:

Fig. 1 is a side elevation showing the back wall of a tuyère and illustrating one embodiment of this invention;

Fig. 2 is a sectional view along the plane indicated by the arrows 2—2 of Fig. 1;

Fig. 3 is a sectional view along the plane indicated by the arrows 3—3 of Fig. 1;

Fig. 4 is a sectional view taken similar to that of Fig. 3 but showing a modification thereof;

Fig. 5 is a sectional view of a modified form of the permeable nose portion shown in Figs. 2, 3 and 4;

Fig. 6 is a side elevation showing the lower part of the front wall of a tuyère with a permeable insert therein; according to another embodiment of this invention;

Fig. 7 is a sectional view along the plane indicated by the arrows 7—7 of Fig. 6;

Fig. 8 is a sectional view taken similar to that of Fig. 7 but showing a modification thereof; and

Fig. 9 is a sectional view similar to Fig. 8 but without the barrier walls between the nose portion and the main body of the tuyère.

In the drawings, Figs. 1 to 5 inclusive show an embodiment of this invention wherein the entire nose portion of the tuyère is permeable, and Figs. 6 to 9 inclusive show another embodiment wherein the permeable portion of the nose wall is confined to a small area located along the lower part of the nose.

Referring now to Figs. 1 to 5 inclusive, numeral **10** represents the main body of a tuyère having outer and inner concentric walls **12** and **14**, respectively, back wall **16**, and front or barrier wall **18**, all defining a generally annular chamber **20** for circulation of cooling fluid which is supplied to said chamber in the conventional manner by pipes (not shown) which engage the threaded openings **22**, **24** in the back wall **16** of the tuyère. Numeral **26** represents the permeable nose of the tuyère, here shown as a piece of generally annular form and U-shaped cross section, and attached in fluid-tight relation to front or barrier wall **18** of the main body of the tuyère. There is thereby provided the annular fluid space **28** within said nose **26**. Space **28** is supplied with fluid by pipe **30** which passes through chamber **20**. A smaller return pipe **32** may be provided (see Fig. 3) for return of a portion of the fluid supplied to space **28** by pipe **30**. Alternatively (see Fig. 4) there may be no return pipe if all the fluid supplied through pipe **30** is passed through the pores or holes in nose **26**; hence pipe **32** may be omitted and opening **34** plugged with plug **36**. In any event, pipe **30**, and pipe **32** when used, are arranged to keep out-of-contact with each other the fluids within said pipes, on the one hand, and the fluid within annular chamber **20**, on the other.

The permeable nose may have walls of porous metal or ceramic as shown in Figs. 2, 3 and 4, or may have otherwise impermeable walls which are provided with drilled or punched holes **38**, as shown in Fig. 5.

In the operation of the tuyère shown in Figs. 1 to 5 inclusive, cooling water for the main body **10** of the tuyère is circulated through annular chamber **20** thereof by means of supply pipes (not shown) positioned in openings **22**, **24**, as already stated. Fluid (gaseous or liquid) is led through pipe **30** into annular space **28** of the nose **26**, and passes through the pores or openings in the walls of said nose. A portion of said fluid may be returned through pipe **32**.

The hot air blast for the furnace of course passes through the central opening **25** of the tuyère, from right to left in Figs. 2, 3, and 4, from the blast source into the furnace into which the tuyère nose projects.

When a gas such as air is the cooling fluid supplied to nose **26**, through pipe **30**, a modification of the foregoing procedure may be employed, if desired, to guard against the hazards of back-drafts, which may cause explosions when mixing with the air or gas coming through the porous nose. According to such modification, when a back-draft occurs, pipe **32** is used to supply water or other suitable liquid to space **28**, and the supply of air or gas through pipe **30** is cut off. After the danger of back-draft is over, the water supply through pipe 32 is discontinued and flow of air or gas through pipe 30 is resumed.

In the embodiment shown in Figs. 6, 7 and 8, a tuyère having outer and inner concentric walls 40 and 42, respectively, back wall 44, and nose wall 46, all defining a generally annular chamber 48 for circulating cooling fluid in conventional manner (e. g. as shown in Figs. 1 and 2), is provided with a permeable portion 50 of the nose wall located along the lower part of the tuyère nose. Behind this permeable portion 50 are fluid-tight walls 52, 54, forming fluid space 56. This space 56 is supplied with cooling fluid by pipe 58, and this fluid passes out through the pores or holes in permeable portion 50. If desired, a return pipe 60 may be provided (see Fig. 7), to convey back a portion of the said fluid; this pipe, being ordinarily considerably smaller than pipe 58, may if convenient be placed within pipe 58, as shown. If said fluid is a liquid which is likely to result in some gas formation within space 56, pipe 60 may be bent upwardly at its inner end, as shown at 62, so as more readily to remove such gas from said space. In fact, pipe 60 may be used primarily for gas removal, with relatively little liquid return therethrough.

The embodiment shown in Fig. 9 is suitable for use when the cooling liquid for the main body of the tuyère is of such properties that it can also be used for passing through the permeable nose portion. This embodiment is the same as that of Fig. 8 except that the fluid-tight walls 52, 54 and the pipe 58 are omitted. The cooling liquid for the tuyère may be introduced through a pipe (not shown) which engages the threaded opening 64, and after circulating through the tuyère and in part passing through permeable portion 50, it passes out through a similar opening elsewhere in the back wall 44 of the tuyère, in the usual manner.

Other modifications than those specifically illustrated above will occur to those skilled in this art. However, it is intended to cover all such modifications as fall within the scope of the appended claims.

What is claimed is:

1. In a tuyère, an inner wall defining a passageway through the tuyère, an outer wall spaced from the inner wall, said inner and outer walls being generally annular in cross-section, a nose wall, and a back wall spaced from the nose wall, said nose wall and said back wall cooperating with said inner and outer walls to define a jacket for cooling fluid, said jacket surrounding said passageway, means for supplying cooling fluid to the jacket, and a permeable area at least in part in said nose wall permitting passage of said fluid therethrough.

2. In a tuyère, an inner wall defining a passageway through the tuyère, an outer wall spaced from the inner wall, a nose wall, and a back wall spaced from the nose wall, said walls cooperating to define a jacket for cooling fluid, said jacket surrounding said passageway, a permeable area in said nose wall permitting passage of said fluid therethrough, a barrier wall between said nose wall and said back wall and spaced from each to divide said jacket into two parts, and means for separately supplying cooling fluid to each of said parts.

3. In a tuyère, an inner wall defining a passageway for a gaseous fluid through the tuyère, an outer wall spaced from the inner wall, a nose wall permeable to a cooling fluid, and a back wall spaced from the nose wall, said walls cooperating to define an annular jacket for cooling fluid, said jacket surrounding said passageway, a barrier within said jacket separating said jacket into a first annular space defined in part by said nose wall and a second annular space rearwardly thereof and out of contact with said nose wall, means for supplying cooling fluid to said first space under sufficient pressure to cause it to pass through the pores in said nose, and means for supplying another cooling fluid to said second space.

4. In a tuyère, an inner wall defining a passageway for a gaseous fluid through the tuyère, an outer wall spaced from the inner wall, a nose wall permeable to a cooling fluid, and a back wall spaced from the nose wall, said walls cooperating to define an annular jacket for cooling fluid, said jacket surrounding said passageway, a barrier within said jacket separating said jacket into a first annular space defined in part by said nose wall and a second annular space rearwardly thereof and out of contact with said nose wall, means for supplying a gaseous cooling fluid to said first space under sufficient pressure to cause it to pass through the pores in said nose, means for supplying a liquid cooling fluid to said first space, and means for supplying another cooling fluid to said second space.

5. In a tuyère, an inner wall defining a passageway through the tuyère, an outer wall spaced from the inner wall, said inner and outer walls being generally annular in cross-section, a nose wall and a back wall spaced from said nose wall, said nose wall and said back wall cooperating with said inner and outer walls to define a jacket for cooling fluid, said jacket surrounding said passageway, means for supplying cooling fluid to the jacket and a permeable area disposed at least in part in said nose wall and in part in a portion of one of said inner and outer walls contiguous with the permeable area in said nose wall permitting passage of said fluid therethrough.

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