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GB-A- 663 781
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Description

This invention relates to an improved method of casting and more particularly to a method of casting by which an elongate opening is formed in a workpiece during casting.

At present, if it is required to provide an elongate opening in a workpiece during casting, a sand core is constructed and the sand core placed in a mould into which hot molten metal is subsequently cast. However, such sand cores require supporting along their length, otherwise the core tends to sag intermediate its ends.

Hence, particularly in mass production conditions, providing an elongate opening in a workpiece in this manner is totally unsatisfactory.

Further, the sand core method is unsatisfactory because the wall of the opening formed is rough and further machining is required.

It is a recent requirement due to up-rating of engines, for camshafts to be provided with axial openings and various proposals have been put forward to achieve this.

One proposal is described in the Nippon British Patent Specification No. 1191202 in which a steel rod coated with an insulating material is placed inside a steel tube and the assembly is then placed in the mould. Hot metal is cast into the mould and subsequently, the steel rod is removed. Where the steel tube is thin, this is consumed during casting, or where the wall of the steel tube is thicker, the tube becomes permanently attached to the casting.

The Nippon method is unsatisfactory because of cost constraints, the steel tube being lost in each casting.

Another proposal is disclosed in Lydmet British Patent Specification No. 1596442. In this method a graphite rod is placed in a mould and molten metal is poured into the mould. Once the cast metal has set, the graphite rod has to be removed from the cast workpiece by drilling.

The Lydmet method is unsatisfactory because further operations are required to remove the graphite rod, and graphite rods are lost during casting.

A very old still further proposal is described in GB Patent 386,302. In this proposal, a vented rigid metal rod is used as a core in a casting which is covered prior to casting with an incombustible refractory material. The refractory material is permeable to allow gases produced during casting to escape into the vent of the core rod.

However, this method has disadvantages which makes it inherently unsuitable for mass production of castings, particularly of castings such as cam shafts.

These disadvantages are, firstly, because the covering is not consumed during casting, it is necessary upon removing the core from the casting to perform a machining operation to remove residual refractory material.

Secondly, because the refractory material is necessarily permeable, the cast metal is chilled where it contacts the cool metal core rod, thereby hardening the surface of the elongate opening, making further work operations, for example drilling to provide lubrication passages transverse to the elongate opening, very difficult.

It is an object of the present invention to provide a new or improved method of casting which overcomes these problems.

According to the invention, we provide a method of casting comprising placing in a mould an elongate rigid member which is formed with an opening to facilitate the passage of gases during the casting process, introducing into the mould molten metal, permitting the metal to set to form a casting, removing the casting from the mould and removing the elongate rigid member from the casting, characterised in that prior to casting, the elongate rigid member is surrounded along at least part of its length, with an insulating material which is directly contacted and decomposed by the molten metal during casting.

Thus an elongate opening is provided in the cast workpiece, during casting, and there is no need to subsequently drill or otherwise provide the opening. Because of the insulating material, the metal being cast is not brought immediately into contact with the elongate rigid member. Thus hardening of the resultant casting in the region surrounding the elongate member by a chilling effect as would otherwise occur, is alleviated. Furthermore, because the elongate rigid member is protected by the insulating material from the hot metal as it is cast, the elongate rigid member can be repeatedly re-used.

This method thus provides advantages over the known methods described hereinbefore, because the elongate rigid member is easier to use than a sand core as it is not so fragile, and no steel tube is lost in the casting process as in the Nippon method. Further, there is no need to drill out or otherwise remove a graphite rod as in the Lydmet process or residual material as in the method described in GB 386,302.

These advantages are achieved because the insulating material is entirely decomposed during casting, and this is itself successful because of the opening formed in the elongate rigid member which allows the gases produced during casting, to escape.

In a method in accordance with the present invention, by "rigid" member we mean that the member is substantially self-supporting over its length so that no support intermediate its ends are required in the mould.

The insulating material can conveniently be a ceramic paper, i.e. a paper impregnated with ceramic particles such as that sold under the Trade Name "Triton Kaowool" and may be between 0.5 mm and 6 mm thick.

The paper and impregnated ceramic particles may be wrapped around the rigid member, or it is envisaged that the insulating material may be applied as a coating by dipping the elongate rigid member into a suspension of the paper and ceramic particles or otherwise. In each case, the ceramic paper provides an insulating barrier

between the hot metal as it is cast into the mould, and the relatively much cooler elongate rigid member. Alternatively, any other suitable insulating material could be provided.

The elongate rigid member may comprise a solid rod, and the opening formed therein may comprise a longitudinally extending groove in the surface of the rod. Alternatively, the elongate rigid member may comprise a tube or hollow rod, in which case the formed opening may comprise an aperture extending through the wall into the hollow thereof or more preferably a series of apertures.

The invention is particularly applicable to providing an axial opening for a camshaft, for passage of lubricant along the length of the camshaft in which case the mould may comprise a shell mould, the cam profiles on the camshaft being provided by shall moulding, although the method in accordance with the invention is also applicable to moulding by the green sand, gang method or any other moulding method as required.

In camshafts, radial passages which communicate with the axial elongate opening are also often required, and by providing the opening according to a method in accordance with the invention, the region of metal immediately surrounding the opening is not hardened by chilling due to the presence of the insulating material around the rod, and hence drilling radial passages in the cam shafts thus provided, is considerably facilitated.

If desired, the elongate rigid member need only be coated along part of its length with the insulating material, the remainder of the member being coated with moulding material.

The invention will now be described with the aid of the accompanying drawings, in which:—

FIGURE 1 is a perspective view of an elongate rigid member and insulating material for use in a method in accordance with the invention;

FIGURE 2 is an end view of the elongate rigid member and insulating material of Figure 1;

FIGURE 3 is a diagrammatic illustration of a moulding box for use with the elongate rigid member and insulation material of figures 1 and 2, in a method according to the invention;

FIGURE 4 is an end view of an alternative elongate rigid member for use in the method according to the invention.

FIGURE 5 is a section through a further alternative elongate rigid member and insulating material for use in a method in accordance with the invention, outlining the shape of a camshaft which may be produced.

Referring first to Figures 1 and 2, an elongate rigid member 10 for use in a method according to the invention comprises a solid elongate rigid steel rod 11 having a central axis A. Extending axially in the surface of the rod 11 is an opening comprising a narrow groove 12 for a purpose hereinafter explained, which extends along the entire length of the rod 11.

Insulating material comprising ceramic paper sheet 13 is wrapped about the rod 11 for a major central part of its axial length, a small overlap 14 being provided so that the rod 11 is surrounded, ends 15 of the rod projecting from the ends of the sheet 13.

The paper sheet 13 is of the type sold under the Trade Name "Triton Kaowool" and comprises ceramic particles embedded in the paper during manufacture. Preferably the paper sheet is between 0.5 mm and 6 mm thick, although best results have been obtained with paper sheet 0.5 mm thick. The paper provides an insulating material to reduce the flow of heat to the rod 11 during casting, as hereinafter explained. Of course, any other suitable insulating material could be used, although the ceramic paper described is preferred as this produces a longitudinal opening in the final casting with a smooth wall, obviating the need for further machining once the casting has solidified.

It is envisaged that ceramic paper could be applied to the elongate rigid member 10 by dipping in a suspension of paper and ceramic particles and thereafter permitting the liquid in which the particles are suspended, to dry thus leaving the member 10 coated with the ceramic and paper particles.

Another insulating material may be provided as required, for example, by spraying, brushing, or otherwise.

Referring now to Figure 3, a moulding box 20 for casting a camshaft is shown, in which the elongate rigid member 10 of Figures 1 and 2 is received.

The moulding box 20 has a bottom part 21 with a bed of sand 22 therein, which provides one half of a two-part mould made by a conventional moulding technique as is well known in the art.

The moulding box 20 further comprises an upper part 24 in which the other half of the mould is provided by a further layer 26 of sand.

In the moulding box 20 shown in the drawings, openings 27 and 28 are provided through the mould half 26, to permit of the introduction of molten metal into a cavity 30 formed between the mould halves 22, 26. Opposite engaging edges of the mould box 20 each have a U-shaped recess 32, 33, to receive the rod 11 which thus extends through the cavity 30 so that the rod 11 will extend through the resultant casting.

The sheet of paper and impregnated ceramic particles 13 covers the rod 11 over the entire length thereof between side walls 34, 35 of the moulding box 20 and thus no metal as it is cast, immediately directly contacts the rod 11, but rather contacts the insulating paper sheet 13.

Also received in the cavity 30 moulded into the mould halves 22, 26 are a number of chills 36, 37, 38 each made of metal, with which the hot metal as it is cast, directly contacts The chills 36, 37, 38 are located at the surfaces of where the cams of the camshaft will be formed, and thus chill the hot metal in these regions, resulting in a hardening of the casting in those regions. This is required to provide hard bearing surfaces for connecting rods

of the engine in which the cam shaft will be assembled which, when the resultant camshaft is in use, bear on the cam surfaces.

Figure 3 is only a diagrammatic representation, and in practice, a camshaft may have more than three cams as shown, and other bearing surfaces for bearings in which the camshaft rotates about its axis A. Additional chills may be placed in the cavity 30 where required, for example around the bearing surfaces where provided, or indeed in any region where it is required to harden the surface of the metal.

With the moulding box 20 assembled as shown in Figure 3, hot molten metal which may be alloyed or unalloyd iron, or indeed any other suitable metal, is poured through the openings 27 and 28 into the cavity 30.

Because of the presence of the ceramic paper sheet 13 surrounding the rod 11, the metal is not chilled around the rod. The ceramic paper 13 protects the rod 11 but is itself entirely consumed as the hot metal directly contacts the paper 13. However, the short time delay from when the metal is cast to when the paper 13 is decomposed is adequate to allow the rod 11 to become heated sufficiently to ensure that even after the paper 13 is consumed, the cast metal is not significantly chilled round the rod 11 and hence the metal is not appreciably hardened in this region.

It will be appreciated that as the paper 13 is consumed, gases will be produced which require venting from the cavity 30. Gases may also be produced from any binder of the moulding material in the mould halves 22, 26. These gases may pass from the cavity 30 through auxiliary openings such as shown at 40 and via the groove 12 provided in the rod 11. If desired the rod 11 may have further axial grooves, similar to the groove 12, or may be at least partially hollow and have openings comprising apertures extending through the wall of rod 11 into the hollow, again to facilitate the venting of gases.

When the resulting casting has solidified, the mould box parts 21, 24 are separated and the casting shaken out of the mould. Thereafter, the rod 11 may be pulled axially from the casting to leave a clean elongate opening through the casting. This contrasts with present methods which use a sand core to produce such openings, wherein the openings thus produced require drilling to smooth and clean the internal surface of the opening.

Because the sheet of ceramic paper 13 protects the rod 11 from the effects of the hot metal, the rod 11 may be re-used in subsequent casting operations after a new sheet of paper 13, or other insulating material, has been applied.

It can be seen from Figure 3 that the rod 11 when placed in the moulding box 20 is supported only at its ends, and is self-supporting otherwise. The rod is sufficiently rigid, even if it is hollowed as mentioned above, to obviate the need for any supports intermediate its ends.

Any other member sufficiently rigid to achieve this could be provided in place of rod 11. Furthermore, although the rod 11 has been described as being made of steel, any other suitable rigid material which can withstand the hot casting temperatures could be used.

Of course, moulding materials other than sand could alternatively be used in the moulding process if required.

Referring now to Figure 4, an alternative rigid member 10′ comprises a thin walled tube 11′ having a central hollow H, the tube 11′ having an opening comprising a groove 12′ similar to the groove 12 of the member 10 of Figures 1 to 3, the groove 12′ being formed with radial apertures 50 along its length, into the hollow H.

It has been found that if apertures are provided from the surface 5 of the tube 11′ into the hollow H, that small indents of metal formed in the mouths of the apertures due to the weight of the casting metal bearing on the surrounding insulating material, make withdrawal of the rod 11′ from the casting difficult. By providing the apertures from the groove 12′, withdrawal of the tube 11′ is not inhibited.

If the rigid member 10 of Figures 1 to 3 is hollow, preferably any apertures provided into the hollow would be provided in the groove 12 rather than from the surface of the member.

Referring now to Figure 5, a further alternative arrangement is shown. An elongate rigid member 10″ again comprises a thin walled tube 11″ but without any surface groove. However a plurality of openings 12″ are provided from the exterior of the tube 11″ to an internal hollow H″ thereof. It can be seen that end regions 15″ of the tube 11″ are each covered with a ceramic paper sheet insulating material 13*a*, 13*b* respectively, but a central region C of the tube 11″ does not have a covering of insulating material, but rather, a layer of moulding material i.e. sand S is compacted onto the exterior surface of the tube 11″.

Thus in regions 15″ of the tube 11″, the tube 11″ is protected as hot metal is cast into a mould in which the tube 11″ is received, like the mould 20 of Figure 3, by the insulating ceramic paper 13*a*, 13*b*. In the central region C, the tube 11″ is protected by the sand S.

Gases produced during casting are vented from the mould through openings 12″ and the central hollow H″ of the tube 11″. The resultant casting will have a central axial opening of larger diameter in the centre region C than in the end regions 15″. Thus the weight of the camshaft will be reduced.

In Figure 5, one example of a form of camshaft which may be produced is outlined at 0, although it will be appreciated that any other camshaft configuration could be produced.

The rigid member 10, 10′, or 10″ of all of the embodiments need not be of circular cross-section as described above where this shaped axial opening is not required, but the method is useful to produce an elongate opening of any desired cross-section in a casting, provided that a rigid member of complementary cross-section is used.

Although the methods described with reference

to the drawings are all ordinary sand moulding method known as green sand casting, the invention is equally applicable to shell moulding, or even lost pattern casting to produce camshafts or any other article by casting. In the latter case, the rigid member and insulating means would be received in an opening in the pattern prior to casting.

In the case of camshafts, the opening thus provided is for the passage of lubricant along the camshaft. It is often required for radial passages to be provided from the opening to positions at or adjacent to the cam surfaces or bearing surfaces of the camshaft so as to pass lubricant to these positions.

The above described method facilitates the provision of these radial passages subsequent to casting because the metal of the casting in the region of the axial elongate opening produced is not hardened, due to the presence of the ceramic paper 13, 13*a*, 13*b* or other insulating means.

Although the invention has been described for the provision of a central opening through a camshaft, the method may be used to provide an elongate opening in other castings. If desired, more than a single longitudinal opening or other internal opening, in the casting may be provided, in which case more than one elongate rigid member each provided with an insulating means such as ceramic paper sheet, would need to be provided.

Claims

1. A method of casting comprising placing in a mould an elongate rigid member (10, 10', 10'') which is formed with an opening (12; 12'; 12'') to facilitate the passage of gases during the casting process, introducing into the mould molten metal, permitting the metal to set to form a casting, removing the casting from the mould and removing the elongate rigid member (10; 10'; 10'') from the casting, characterised in that prior to casting, the elongate rigid member (10, 10', 10'') is surrounded along at least part of its length, with an insulating material (13, 13*a*, 13*b*) which is directly contacted and decomposed by the molten metal during casting.

2. A method according to Claim 1 characterised in that the insulating material (13; 13*a*, 13*b*) is a paper impregnated with ceramic particles.

3. A method according to Claim 1 characterised in that the paper (13; 13*a*, 13*b*) is between 0.5 mm and 0.6 mm thick.

4. A method according to Claim 2 or Claim 3 characterised in that the paper and impregnated ceramic particles (13; 13*a*, 13*b*) is wrapped around the elongate rigid member (10; 10'; 10'').

5. A method according to any one of the preceding claims characterised in that the elongate rigid member (10) is a solid metal rod (11) and the opening (12) formed therein comprises a longitudinally extending groove in the surface of the rod (11).

6. A method according to any one of Calims 1 to 4 characterised in that the elongate rigid member (10'; 10'') is hollow and the opening (12'; 12'') comprises an aperture extending through the wall thereof into the hollow thereof.

7. A method according to Claim 1 characterised in that the elongate rigid member is a thin walled tube (10'; 10'').

8. A method according to any one of the preceding claims characterised in moulding material of the mould is formed so that the casting produced is a camshaft (0).

9. A method according to Claim 8 characterised in that the mould comprises a shell mould, the cam profiles on the camshaft being provided by shell moulding.

10. A method according to any one of the preceding claims characterised in that the elongate rigid member (10'') is coated along a part of its length not surrounded or coated with the decomposable insulating material with moulding material (S).

Patentansprüche

1. Gußverfahren unter Einbringen eines länglichen, festen Elements (10, 10', 10''), das mit einer Öffnung (12, 12', 12'') zur Ermöglichung des Durchtritts von Gasen während des Gußvorgangs versehen ist, in eine Gußform, Einbringen von geschmolzenem Metall in die Gußform, Erstarrenlassen des Metalls unter Ausbildung des Gusses, Entnehmen des Gusses aus der Gußform und Entnehmen des länglichen festen Elements (10, 10', 10'') aus der Gußform, dadurch gekennzeichnet, daß das längliche feste Element (10, 10', 10'') vor dem Gießen über wenigstens einen Teil seiner Länge mit einem Isolationsmaterial (13, 13a, 13b) umgeben ist, das während des Gießens mit dem geschmolzenen Material direkt in Berührung steht und von diesem zersetzt wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Isolationsmaterial (13, 13a, 13b) ein mit keramischen Partikeln imprägniertes Papier ist.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Papier (13, 13a, 13b) eine Dicke zwischen 0,5 mm und 0,6 mm aufweist.

4. Verfahren nach Anspruch 2 oder Anspruch 3, dadurch gekennzeichnet, daß das mit den keramischen Partikeln imprägnierte Papier (13, 13a, 13b) um das längliche feste Element (10, 10', 10'') herumgewickelt ist.

5. Verfahren nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß das längliche feste Element (10) eine starke Metallstange (11) ist und die darin ausgebildete Öffnung (12) eine sich längs in der Oberfläche der Stange (11) erstreckende Kerbe ist.

6. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das längliche feste Element (10, 10', 10'') sich durch deren Wande in das Innere von dieser erstreckt.

7. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das längliche feste Element eine dünnwandige Röhre (10', 10'') ist.

8. Verfahren nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß das Material der Gußform so ausgebildet ist, daß der hergestellte Guß eine Nockenwelle (30) ist.

9. Verfahren nach Anspruch 8, dadurch gekennzeichnet, daß die Gußform eine Außenwandung aufweist, wobei die Profilierung der Nocken der Nockenwelle durch die äußere Wandung gebildet wird.

10. Verfahren nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß das längliche feste Element (10'') über einen nicht mit dem zersetzbaren Isolationsmaterial umgebenen oder beschichteten Material mit Gußmaterial (S) beschichtet ist.

Revendications

1. Procédé de coulée comprenant l'étape consistant à mettre en place dans un moule un élément rigide allongé (10; 10'; 10'') qui est muni d'une ouverture (12; 12'; 12'') pour faciliter le passage des gaz pendant le procédé de coulée, à introduire du métal fondu dans le moule, à permettre la prise du métal pour former un corps moulé, à enlever le corps moulé du moule et à enlever l'élément rigide allongé (10; 10'; 10'') du corps moulé, caractérisé en ce que préalablement à la coulée, l'élément rigide allongé (10; 10'; 10'') est entouré sur au moins une partie de sa longueur, d'un matériau isolant (13; 13*a*; 13*b*) qui est directement mis en contact avec le métal en fusion lors de la coulée et qui se décompose sous l'action dudit métal.

2. Procédé selon la revendication 1, caractérisé en ce que le matériau isolant (13; 13*a*; 13*b*) est un papier imprégné de particules céramiques.

3. Procédé selon la revendication 1, caractérisé en ce que le papier (13; 13*a*; 13*b*) présente une épaisseur située entre 0,5 mm et 0,6 mm.

4. Procédé selon la revendication 2 ou la revendication 3, caractérisé en ce que le papier et les particules céramiques imprégnées (13; 13*a*; 13*b*) sont enveloppées autour de l'élément rigide allongé (10; 10'; 10'').

5. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que l'élément rigide allongé (10) est une tige en metal plein (11) et l'ouverture (12) formée dans celle-ci comprend une rainure s'étendant longitudinalement dans la surface de la tige (11).

6. Procédé selon l'une quelconque des revendications 1 à 4, caractérisé en ce que l'élément rigide allongée (10'; 10'') est creux et l'ouverture (12'; 12'') comprend un orifice s'ouvrant, à travers la paroi dudit élément rigide, sur sa partie creuse.

7. Procédé selon la revendication 1, caractérisé en ce que l'élément rigide allongé est un tube à paroi mince (10'; 10'').

8. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le matériau de moulage du moule est formé de telle manière que la pièce coulée produite est un arbre à cames (0).

9. Procédé selon la revendication 8, caractérisé en ce que le moule comprend un moule carapace, les profilés de cames sur l'arbre à cames étant réalisés par moulage en carapace.

10. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que l'élément rigide allongé (10'') est revêtu du matériau de moulage (S) sur une partie de sa longueur non entourée ou revêtue du matériau isolant décomposable.

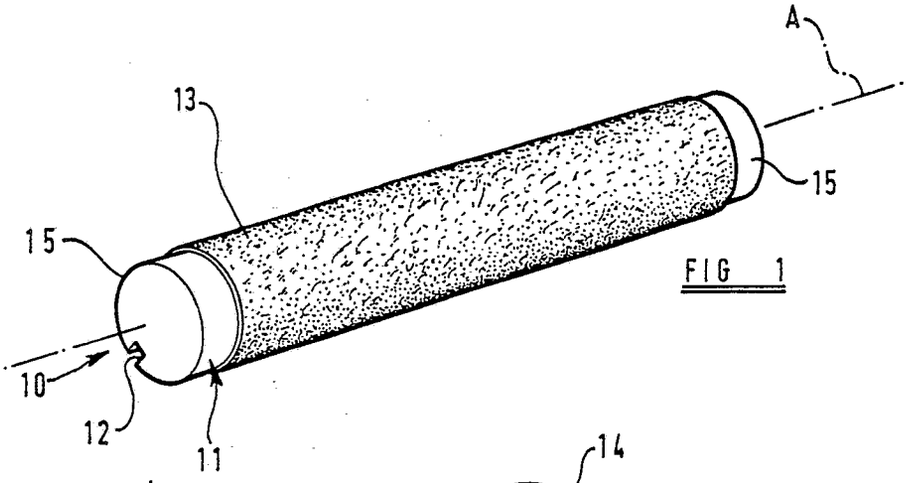

FIG 1

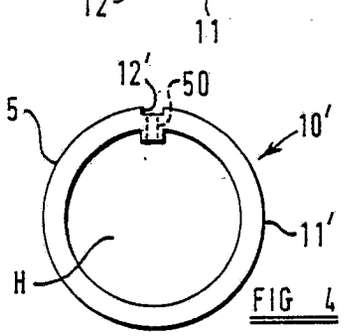

FIG 4

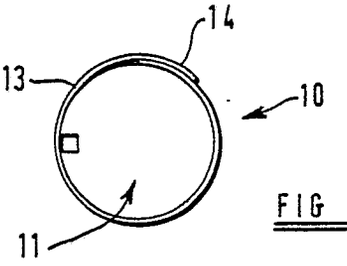

FIG 2

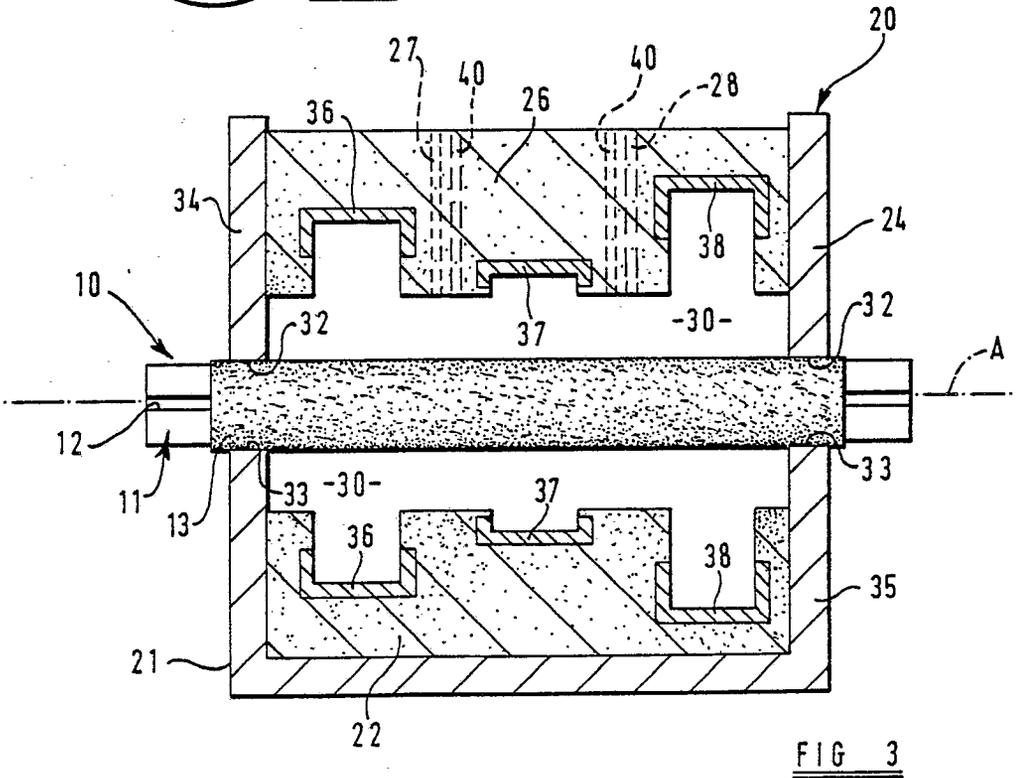

FIG 3

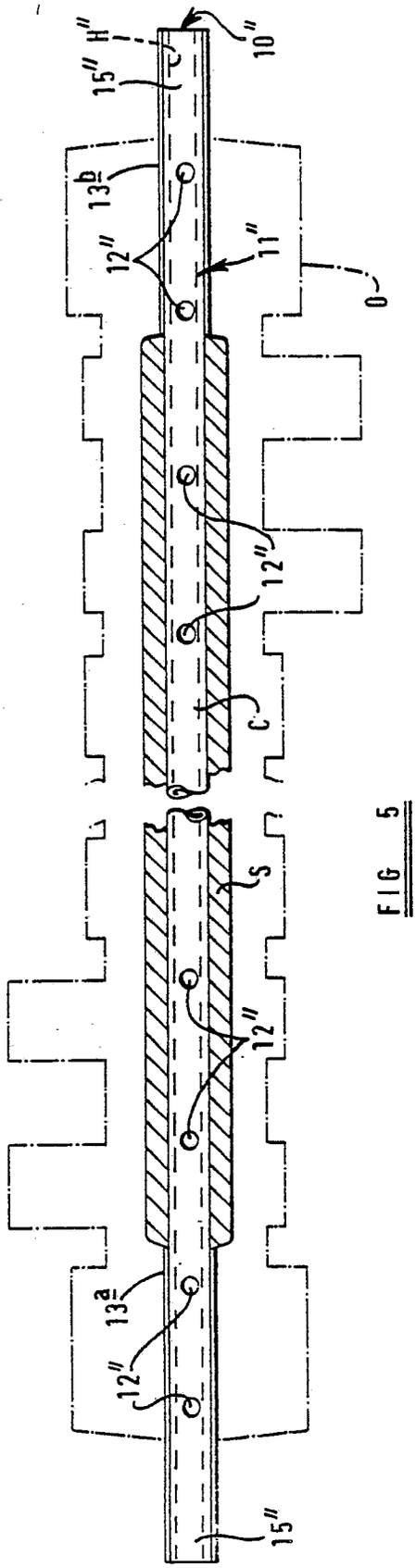

FIG 5