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(54) Horizontal continuous casting moulds.

(57) A horizontal continuous casting mould comprises a housing structure which defines a horizontal opening through it. A mould tube defining a mould passage is removably secured in the structure such that it extends through the opening with the axis of the mould passage horizontal and the structure provides means by which cooling water is applied to the outside of the mould tube.

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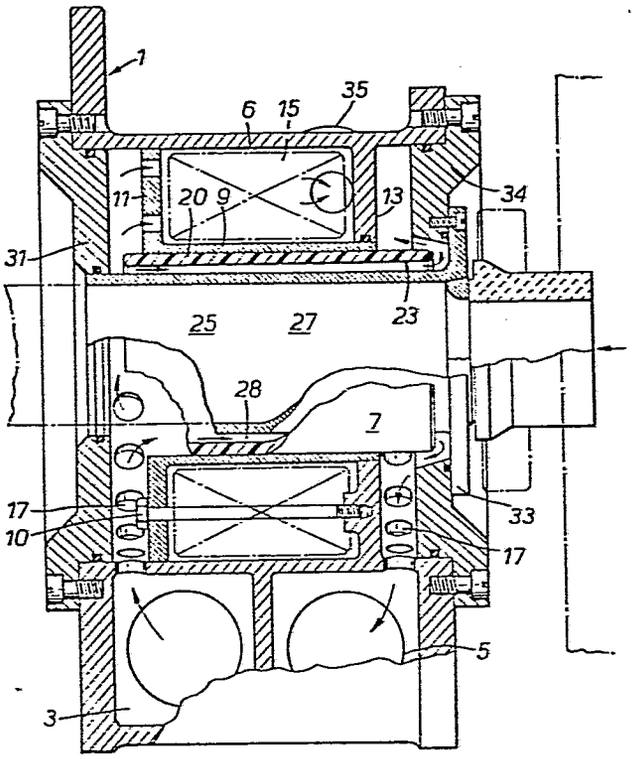

FIG.2.

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HORIZONTAL CONTINUOUS CASTING MOULDS

It is well known for a horizontal continuous casting mould to consist of a mould tube, which defines the mould passage, mounted in a housing structure. The housing structure provides liquid cooling for molten metal passed along the mould passage so that the molten metal begins to solidify in the mould passage and for the cross-section of the casting to be determined by the cross-section of the mould passage.

Clearly, if the cross-section of the desired casting is to be changed, then a different mould tube has to be provided and this means that the entire continuous casting mould which has previously been used has to be removed and replaced with a different continuous casting mould having the required mould passage.

If different casting sizes are to be cast, then the operator must carry an inventory of different moulds resulting in increased investment costs and inventory control.

According to a first aspect of the present invention, a horizontal continuous casting mould comprises a housing structure, a mould tube defining a mould passage, and means by which liquid coolant is applied to the outside of the mould tube, characterised

in that the housing structure defines an opening therethrough, the opening being arranged with its longitudinal axis substantially horizontal; and the mould tube is removably secured to the structure such that it extends through the opening with the longitudinal axis of the mould passage substantially horizontal.

In this way, it is only necessary to remove the mould tube from the housing structure when a different casting size is required or to replace a mould which is worn or damaged. A replacement mould tube having the appropriate mould passage is then repositioned in the structure. Thus, castings of different cross-section can readily be made by fitting the appropriate mould tube into the housing structure. The operator must carry a number of mould tubes but these are much less of a capital investment than complete continuous casting moulds.

Conveniently, an annular spacer is movably mounted in the structure to surround the mould tube and provide an annular duct between the spacer and the outer surface of the mould tube, the structure providing means by which liquid coolant is caused to flow along the duct.

The housing structure is arranged such that liquid coolant is brought into contact with the outer

surface of whichever mould tube is in use. It is most desirable that a predetermined flow of liquid coolant along the duct takes place whatever the size of the mould tube. To this end, it is desirable to replace the annular spacer each time the size of the mould tube is changed to keep the cross-section of the annular duct between the spacer and the mould tube at a predetermined value.

It is desirable that the longitudinal axis of the mould passage is always in a fixed relation with the longitudinal axis of the opening in the housing structure. In a preferred arrangement, the longitudinal axis of the mould passage is coincident with the longitudinal axis of the opening. In this way, the pass-line of the casting produced in the mould is always the same regardless of the cross-section of the casting.

In order that the invention may be more readily understood, it will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a front view, partly in section, of a continuous casting mould in accordance with the present invention;

Figure 2 is a section on the line 2-2 of Figure 1; and

Figure 3 is an alternative section on the line 2-2 of Figure 1.

A horizontal continuous casting mould has a housing structure 1 which is located in the casting position between the supply tundish for the molten metal and a run-out table for the casting, neither of which are shown.

The housing structure is mainly of fabricated metal plates and it defines a pair of chambers 3, 5 located close to the base of the housing structure. The chambers are defined in part by a cylindrical tube 6 which also defines an opening 7 through the structure, the longitudinal axis of the opening being arranged substantially horizontal. A tube 9 having an outwardly extending flange at one end is mounted within the opening 7. A number of bolts 10 secure the tube 9 to an inwardly extending rib 13 on the tube 6 and thus form an annular enclosure 15. At each end of the structure, a group of holes 17 are provided in the tube 6 and the group of holes at each end are in communication with the respective chambers 3, 5.

An annular spacer in the form of a tube 20 is removably mounted in the opening 7 and defines an opening 23 of reduced cross-section as compared with that of the opening 7. The spacer is conveniently a push fit into the inside of the tube 9. A mould tube

25, conveniently of copper alloy, defines a mould passage 27 of the cross-section of the required casting. One end of the mould tube is sealed into an aperture in an end plate 31 which is removably bolted to one end of the housing structure. The other end of the mould tube has an outwardly extending flange 33 which is bolted to an end plate which, in turn, is removably bolted to the other end of the housing structure.

In the correct position of the mould tube, the longitudinal axis of the mould passage is coincident with the longitudinal axis of the opening 7.

The outer surface of the mould tube is spaced apart from the spacer 20 which surrounds it to form a duct 28 between them.

The housing structure provides cooling for the molten metal passed through the mould tube. To this end, liquid coolant, usually water, is supplied to the chamber 3 from where it flows out through the openings 17 at the adjacent end of the structure into contact with the outer surface of the mould tube and the spacer. Some of the water passes along the duct 28, along the length of the outside of the mould tube and through further openings 17 at the opposite end of the structure into the chamber 5, from where it flows to drain. There is, therefore, a continuous flow of

cooling water in contact with the outer surface of the mould tube. In addition, some of the cooling water which is supplied to the chamber 3 passes through openings in the flange 11 and into the enclosure 15 and out from the enclosure through a further outlet port 35.

It is most desirable that a predetermined flow of liquid coolant along the duct 28 takes place whatever the size of the mould tube. To this end, therefore, it is desirable to keep the cross-section of the duct 28 at a predetermined value. For each mould tube, therefore, an appropriately sized annular spacer is always provided so that the two together define a duct of the predetermined cross-section.

Figure 3 shows an alternative form of the continuous casting mould in which a casting of a much smaller cross-section than that shown in Figures 1 and 2 is required. To this end, the annular spacer and the mould tube shown in Figures 1 and 2 are removed with the end plates 31, 34. A new spacer 41 is pushed into the tube 9 and a second mould tube 43 is located in the opening through the housing structure and held in position by new end plates 45, 47. The longitudinal axis of the mould tube is still coincident with the longitudinal axis of the opening provided by the housing structure. The cooling means provided in the

housing remain and a large part of the water from the chamber 3 flows along the duct 28 and into the chamber 5. It will be noticed that the cross-section of the duct in the arrangement of Figure 3 is substantially as the cross-section of the duct in the arrangements of Figures 1 and 2.

It is important that the lowest part of all the castings produced in the mould remains level with the upper surfaces of the rolls of the roller table and, to this end, the mould can be raised or lowered with respect to the roller table.

The horizontal continuous casting mould of this invention may incorporate electro-magnetic stirring of the molten metal passed through the mould tube. In horizontal continuous casting, the solidifying casting is withdrawn from the mould tube using a push-pull cycle withdrawal pattern and this may bring about a surface defect on the produced casting, known as a cold shut crack, a witness mark or a ghost line. By causing the molten metal in the mould tube to be stirred as part of it is solidified, the surface defects referred to above can be reduced. To this end, electric coils, indicated by the broken line in Figure 2, can be positioned in the enclosure 15. The spacer 20 is of magnetically transparent material. When these coils are energised with alternating current, the

material can be caused to give either linear or rotational stirring of the liquid core in the mould tube. Alternatively, differential stirring intensity can be applied along the length of the horizontal mould in order to effect the solidification rate of the skin at any point.

Claims:

1. A horizontal continuous casting mould comprising a housing structure (1), a mould tube (25) defining a mould passage (27), and means (28) by which liquid coolant is applied to the outside of the mould tube, characterised in that the housing structure defines an opening (7) therethrough, the opening being arranged with its longitudinal axis substantially horizontal; and the mould tube (25) is removably secured to the structure such that it extends through the opening (7) with the longitudinal axis of the mould passage (27) substantially horizontal.

2. A horizontal continuous casting mould as claimed in claim 1, characterised in that the mould tube is supported by a pair of end plates (31, 34) removably secured to the housing structure (1).

3. A horizontal continuous casting mould as claimed in claim 2, characterised in that the end plates (31, 34) are arranged such that the longitudinal axis of the mould passage is coincident with the longitudinal axis of the opening.

4. A horizontal continuous casting mould as claimed in claim 1, 2 or 3, characterised in that an annular spacer (20) is movably mounted in the structure to surround the mould tube and provide an annular duct (28) between the spacer and the outer surface of the mould tube (25); and said structure providing means by which liquid coolant is caused to flow along said duct (28).

5. A horizontal continuous casting mould as claimed in claim 4, characterised in that the size of the annular spacer and the size of the mould tube are arranged to define an annular duct of predetermined cross-section.

6. A horizontal continuous casting mould as claimed in claim 4 or 5, characterised in that the housing structure defines a pair of chambers (35) which are in communication with respective ends of the duct (28) and liquid coolant is forced from one chamber along the duct to the other chamber.

7. A horizontal continuous casting mould as claimed in claim 4, 5 or 6, characterised in that the housing structure defines an annular enclosure (15) outside of and surrounding the annular spacer, said enclosure containing a coil for electro-magnetic stirring of molten metal passed along the mould passage.

8. A horizontal continuous casting mould as claimed in claim 7, characterised in that provision is made for passing liquid coolant through said enclosure (15).

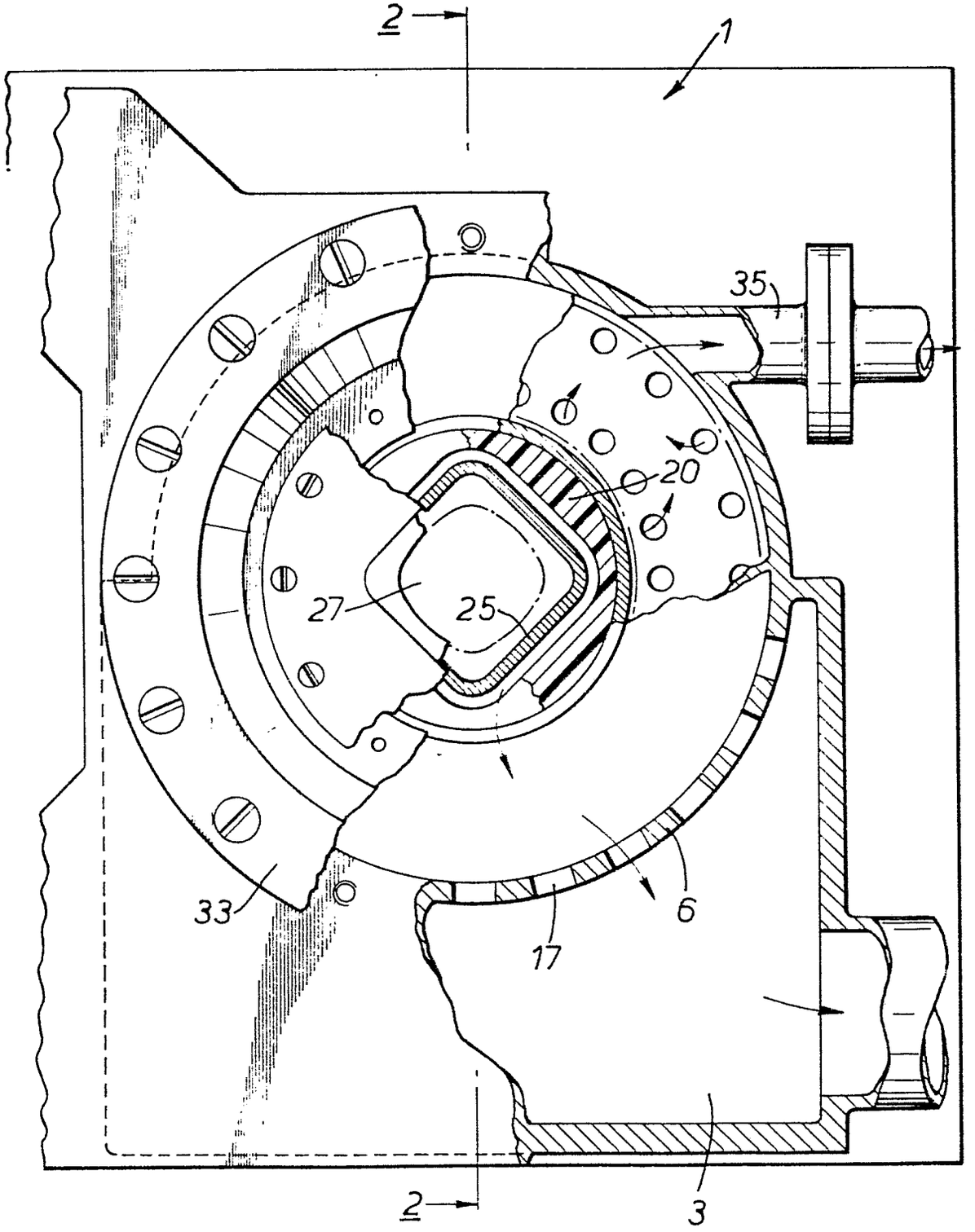

FIG. 1.

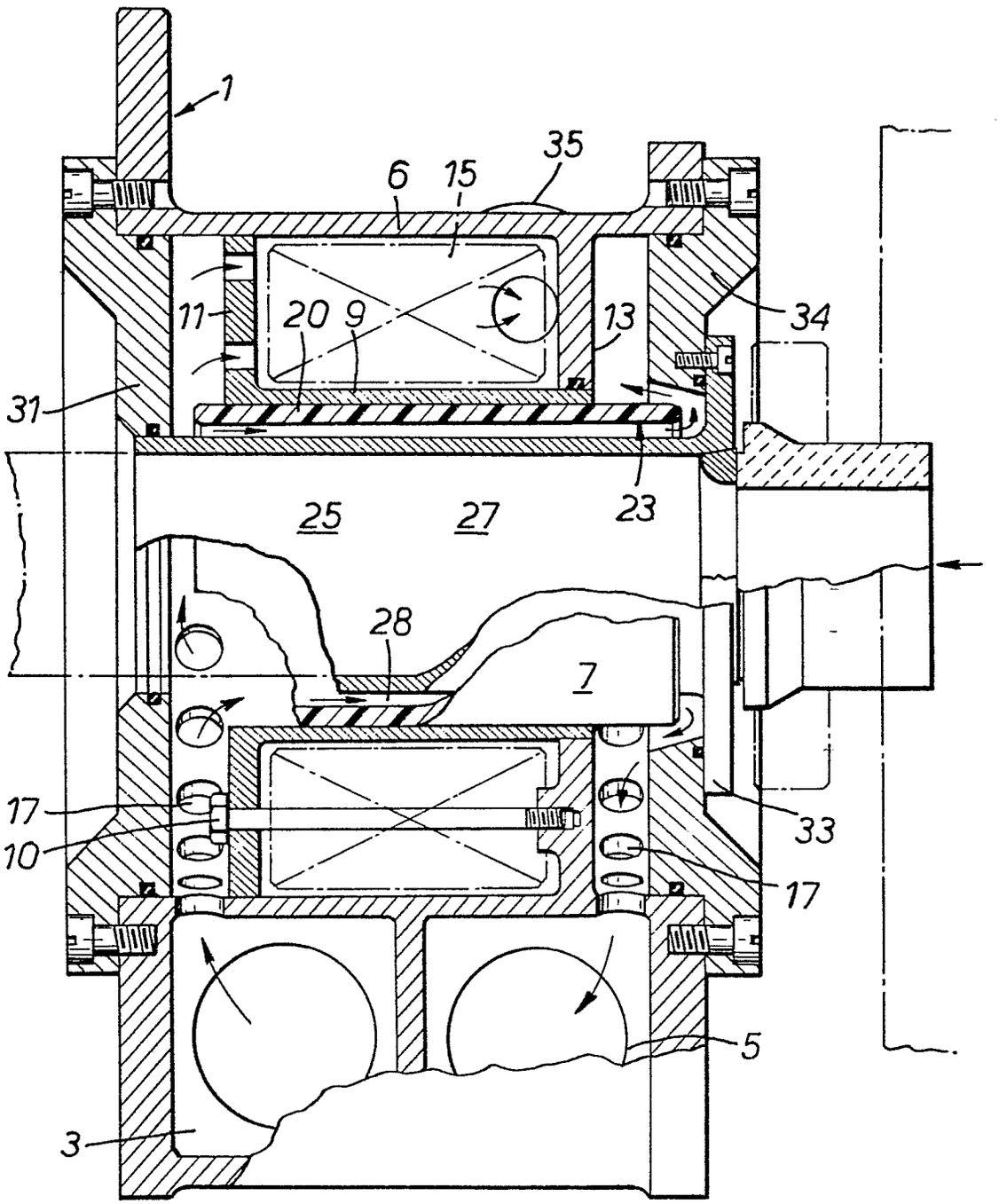

FIG.2.

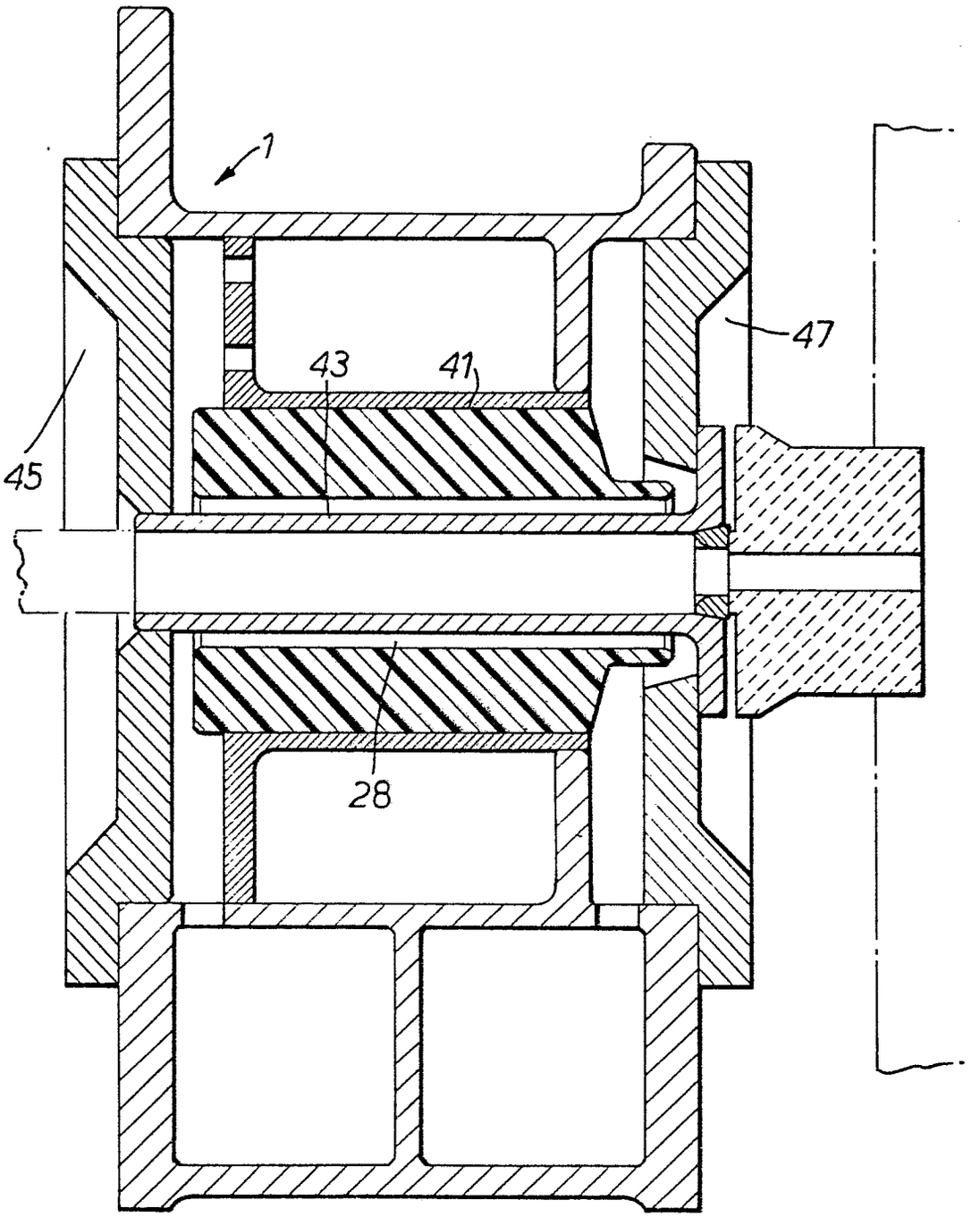

FIG. 3.