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(71) Applicant: ALFORM ALLOYS LIMITED
Unit 6, Holton Heath Trading Park
Holton Heath Poole DorsetBH16 6LF(GB)

(72) Inventor: Maddock, Brian
"West Ridge" Corfe Lodge Road
Broadstone Dorset(GB)

(74) Representative: Kirk, Geoffrey Thomas et al,
BATCHELLOR, KIRK & EYLES 2 Pear Tree Court
Farringdon Road
London EC1R 0DS(GB)

(54) Extrusion of metals.

(57) An apparatus and method are described for the extrusion of metal using an apparatus of the "Conform" type. A furnace (1) is used to heat metal to a molten state, and an electromagnetic pump (4) transfers molten metal from below the level of the surface of the molten metal in the furnace. A transfer tube (3, 6) from the electromagnetic pump (4) extends to adjacent an inlet (3a) to the apparatus (3) of the "Conform" type, and a tube (7) of restricted diameter extends from the transfer tube (5, 6) to the inlet (3a), to supply the molten metal from the transfer tube (5, 6) to the inlet (3a).

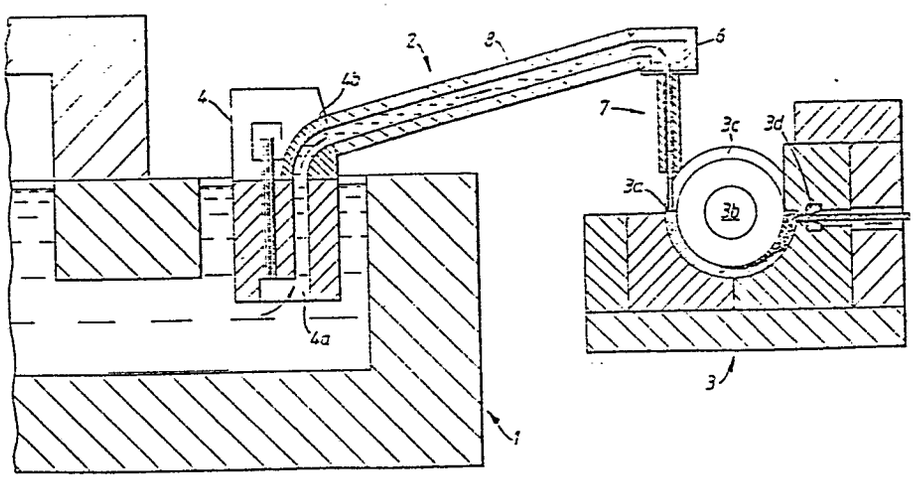

FIG. 1.

EP 0 244 254 A1

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EXTRUSION OF METALS

TECHNICAL FIELD

The present invention relates to the extrusion of metals.

BACKGROUND ART

In British Patent Specification No. 1370894, there is described a method of, and apparatus for, continuously extruding metal. The apparatus comprises a rotatable wheel having an endless groove extending around its periphery, a fixed structure covering the groove along part of its length to define a passageway therewith, a blocking member projecting into the groove to close off one end of the passageway and a die orifice leading from the closed off passageway adjacent said blocking member. In use, the wheel is rotated relative to the fixed structure and metal rod to be extruded is fed into the end of the passageway away from the blocking member and the metal is carried along in the groove by frictional drag in the direction towards the blocking member and is forced through the die orifice to produce the metal product. Such an apparatus will be referred to as an apparatus of the type described, and is known commonly as a "Conform" apparatus and the method is similarly named.

A Conform apparatus is usually supplied with solid metal, but it is known to provide molten metal for extrusion, but it is necessary to ensure that the metal fed into the input side of the Conform apparatus is clean and free from oxides and dissolved gases.

Known melting technlology can provide a supply of clean molten metal, but there still remains the problem of transferring the metal from a furnace to the Conform apparatus without inducing oxides and gases in the molten metal. Generally, where a continuous supply of molten metal is required, the metal is allowed to flow in launders without breaking the oxide skin which forms on the surface of the metal. The oxide skin forms a protective skin for the molten, oxide and gas free metal within. This method has been used satisfactorily down to flow rates of about 1 tonne/hour

but the Conform apparatus typically requires only 200 kg/hour and at such low flow rates the cross section of metal in the launders becomes so small that due to heat losses the metal tends to freeze. Consequently it has not been possible to use this method of metal transfer, taking advantage of the naturally formed oxide layer on the surface. The molten metal has to be taken, therefore, from below the surface of the metal in the furnace to avoid mixing in the oxides at the surface. This can be achieved by tapping the furnace through a hole in the side of the furnace below the level of the surface of the molten metal from the furnace. A stopper can be used to control the flow rate of the tapped-off, molten metal but such stoppers have a limited life and do not acurately control the flow of the metal at low flow rates.

DISCLOSURE OF THE INVENTION

According to one aspect the present invention provides a method of extruding metal using an apparatus of the type described, comprising the steps of:

(a) heating metal to be extruded in a furnace so that the metal becomes molten,

(b) pumping molten metal from below the surface of the molten metal up by means of an electromagnetic pump to an inlet side of an apparatus of the type described, and

(c) providing a restricted flow of the molten metal into the inlet of the apparatus of the type described.

The method of the present invention provides a useful way of providing the molten metal to the inlet of the Conform apparatus in an oxide and gas free condition.

Preferably the electromagnetic pump transfers the molten metal up from below the surface of the molten metal through that surface and transfers the molten metal to adjacent and above the apparatus of the type described, and while the molten metal is being transferred the molten metal is heated. Still more preferably as the molten metal is supplied downwardly into the inlet of the apparatus of the type described the molten metal is also heated.

According to another aspect the invention provides an apparatus for the extrusion of metal using an apparatus of the type described, comprising: a furnace for heating metal to a molten state, an electromagnetic pump for transferring molten metal from below the level of the surface of the molten metal in the furnace, a transfer tube from the electromagnetic pump extending to adjacent and above an inlet to the apparatus of the type described, and a tube of restricted diameter extending from the transfer tube to immediately adjacent the inlet to the apparatus of the type described for supplying the molten metal from the transfer tube to the inlet to the apparatus of the type described.

Preferably the transfer tube is adapted to be heated to maintain the metal in the molten state. The transfer tube may terminate in a top box for temporarily holding the molten metal, and from the underside of which the down tube extends. Preferably the top box is adapted to be heated.

The restricted diameter tube is preferably heated to heat the flowing metal. Advantageously this can be done by induction heating. In an embodiment the heating is provided by an outer cover tube made of metal arranged about an inner, metal carrying tube. The ends of the outer tube are connected to a current supply at low voltage to heat the outer tube and thereby the inner tube.

In a preferred embodiment the down tube is made from titanium and the transfer tubes and top box are made from silicon carbide refractory.

Preferred embodiments of the invention will now be described by way of example and with reference to the accompanying drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic representation of an apparatus according to a preferred embodiment in conjunction with a Conform apparatus of the type described;

Figure 2 is a cross-sectional view through a down pipe of the apparatus of the preferred embodiment of the invention; and

Figures 3, 4, and 5 are variations in the arrangement of

the input side of a Conform apparatus of the type described used in conjunction with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1 of the drawings an extrusion apparatus generally comprises a furnace 1 for heating metal, a transfer mechanism 2 for transferring molten metal from the furnace 1 to a Conform apparatus 3, of the type described. The furnace 1 is of conventional design, for example an Elmouth resistance heated furnace. The Conform apparatus is of conventional form, with an inlet 3a to a wheel 3b having a groove 3c, and an extrusion orifice 3d. The transfer mechanism 2 comprises an electromagnetic pump 4 with an inlet 4a arranged to be below the level of the molten metal in the furnace 1. An output 4b of the electromagnetic pump 4 is connected to a transfer tube 5 which terminates at a top box 6. A down tube 7 extends from within the bottom half of the top box 6 to adjacent an inlet 3a of the Conform apparatus 3. Electromagnetic pumps per se are known and produced by Novatome of France.

The transfer mechanism 2 will now be described in more detail. The electromagnetic pump 4 is itself conventional and will not be described in detail. The transfer tube 5 and top box 6 are made from silicon carbide refractory and are wound about with resistance wire to which electric current can be supplied to heat the transfer tube 5 and the top box 6. The down tube 7 comprises a central titanium tube 8 of restricted diameter which is surrounded over most of its length by a hollow bodied cover tube 9. The hollow bodied cover tube 9 is made up of an inner cylindrical wall 10 and an outer cylindrical wall 11 which are held together by annular end members 12 and 13. The outer tube 11 is divided into two parts 11a and 11b which are electrically isolated. The outer tube is made of stainless steel so as to provide a suitable current path e.g. tube 11a, end ring 12, tube 10, end ring 13 and outer tube 11b. The two halves of the outer tube 11a, 11b have respective terminals 14, 15. The hollow body of the outer, cover tube 9 is filled with high temperature insulation material. The down tube 7 is mounted to project downwards from the heated top box

6 with one end 7a within top box 6. That end 7a of the down tube 7 has an annular titanium flange 16 and ceramic gaskets 17 on the annular end member 12 of the outer cover tube 9 to protect the cover tube.

In use the resistance wires about the transfer tubes 5 and top box 6 are connected to a mains power supply while the outer cover tube 9 of the down tube 7 has its terminals 14, 15 connected to a low voltage high current power supply typically two volts, 200 amps.

In use, the electromagnetic pump takes molten metal from below the melt surface and transfers the metal through transfer tube 5 to top box 6, both of which are of course heated. The molten metal then passes from the top box 6 down the restricted diameter titanium tube 8 into the inlet 3a of the molten Conform machine 3. It is to be appreciated that the metal is kept heated throughout the transfer from the furnace to the Conform machine in a substantially oxide and gas free condition. In particular the heating of the down pipe 7 is important to maintain the metal molten as the diameter of the down tube is small. The heating arrangement of the down tube 7 is designed to allow the necessary, periodic replacement of the titanium tube 8, and as a low voltage arrangement is relatively safe. The construction of the downpipe 7 is advantageously rugged to cope with the harsh environment at the input to the Conform machine.

Figures 3 and 4 show adaptations of Conform apparatus to take advantage of the described apparatus for transferring molten metal to the Conform apparatus. Referring first to Figure 3 in the Conform apparatus 3 the inlet or molten metal shoe 31 extends about substantially the whole of the left-hand half of the Conform wheel 3b and the heated down tube 7 is positioned adjacent to the "12 O'clock" position of the wheel 3b. A nosepiece 32 extends into the groove 3c of the wheel 3b from the inlet tube and next to the end of the down tube 7. With this arrangement the molten metal is fed to the groove 3c of the Conform wheel 3b at the top of the wheel 3b. The metal flow to the wheel is not restricted and the whole

groove is filled.

Turning now to Figure 4 in another adaptation of the Conform apparatus the down pipe 7 again terminates adjacent the "12 O'clock" position of the Conform wheel 3b. In this adaptation the inlet shoe 41 of the Conform apparatus has an internal pocket 42 adjacent to the groove 3c in the wheel 3b, and into which can be supplied water for cooling the shoe and thereby the molten metal in the groove 3c. Also, a water spray 43 is provided adjacent the lower left-hand part of the wheel 3b for spraying water directly onto the metal in the groove 3c.

In the Figure 5 arrangement the down pipe 7 again terminates near the "12 O'clock" position of the conform wheel 3b. In this arrangement, the wheel rotates clockwise so that the molten (solidifying) metal is only transported through 90° before being forced through the extrusion outlet. Therefore heat flows in the wheel over 90° and out over 360°, so that the wheel forms an effective heat sink. A gas rich flame (51) is applied to the molten metal to reduce oxidation of the meniscus.

Other variations may be possible, e.g. the down tube may not necessarily be vertical, in fact, for low flows of metal it could be positioned almost horizontally in order to keep the tube full of metal.

CLAIMS:

1. A method of extruding metal using an apparatus of the type described, comprising the steps of:

(a) heating metal to be extruded in a furnace so that the metal becomes molten,

(b) pumping molten metal from below the surface of the molten metal up by means of an electromagnetic pump to an inlet side of an apparatus of the type described, and

(c) providing a restricted flow of the molten metal into the inlet of the apparatus of the type described.

2. A method as claimed in claim 1, wherein the electromagnetic pump transfers the molten metal up from below the surface of the molten metal through that surface and transfers the molten metal to adjacent and above the apparatus of the type described, and while the molten metal is being transferred the molten metal is heated to maintain the metal in a molten state.

3. A method as claimed in claim 2, wherein as the molten metal is supplied downwardly into the inlet of the apparatus of the type described the molten metal is also heated to maintain the metal molten.

4. An apparatus for the extrusion of metal using an apparatus of the type described, comprising: a furnace (1) for heating metal to a molten state, an electromagnetic pump (4) for transferring molten metal from below the level of the surface of the molten metal in the furnace, a transfer tube (3, 6) from the electromagnetic pump (4) extending to adjacent an inlet (3a) to the apparatus (3) of the type described, and a tube (7) of restricted diameter extending from the transfer tube (5, 6) to the inlet (3a) to the apparatus of the type described for supplying the molten metal from the transfer tube (5, 6) to the inlet (3a) to the apparatus of the type described.

5. An apparatus as claimed in claim 4, wherein the transfer tube (5) has heating means for maintaining the metal in a molten state.

6. An apparatus as claimed in claim 4 or claim 5, wherein the transfer tube (5) terminates in a top box (6) for temporarily holding the molten metal, and from the underside of which the down tube (7) extends.

7. An apparatus as claimed in claim 6, wherein the top box (6) has heating means.

8. An apparatus as claimed in claims 4, 5, 6 or 7, wherein the tube (7) of restricted diameter has heating means to heat the metal flowing within.

9. An apparatus as claimed in claim 8, wherein the heating means is an electrical induction heating means.

10. An apparatus as claimed in claim 8 or claim 9, wherein the heating means for the down tube (7) has an outer electrical conductive tube (10, 11) positioned about an inner, fluid metal carrying tube (8), the outer tube (10, 11) is, in use, connected to an electrical supply, and the flow of current in the outer tube includes eddy current heating in the inner, fluid metal tube (8).

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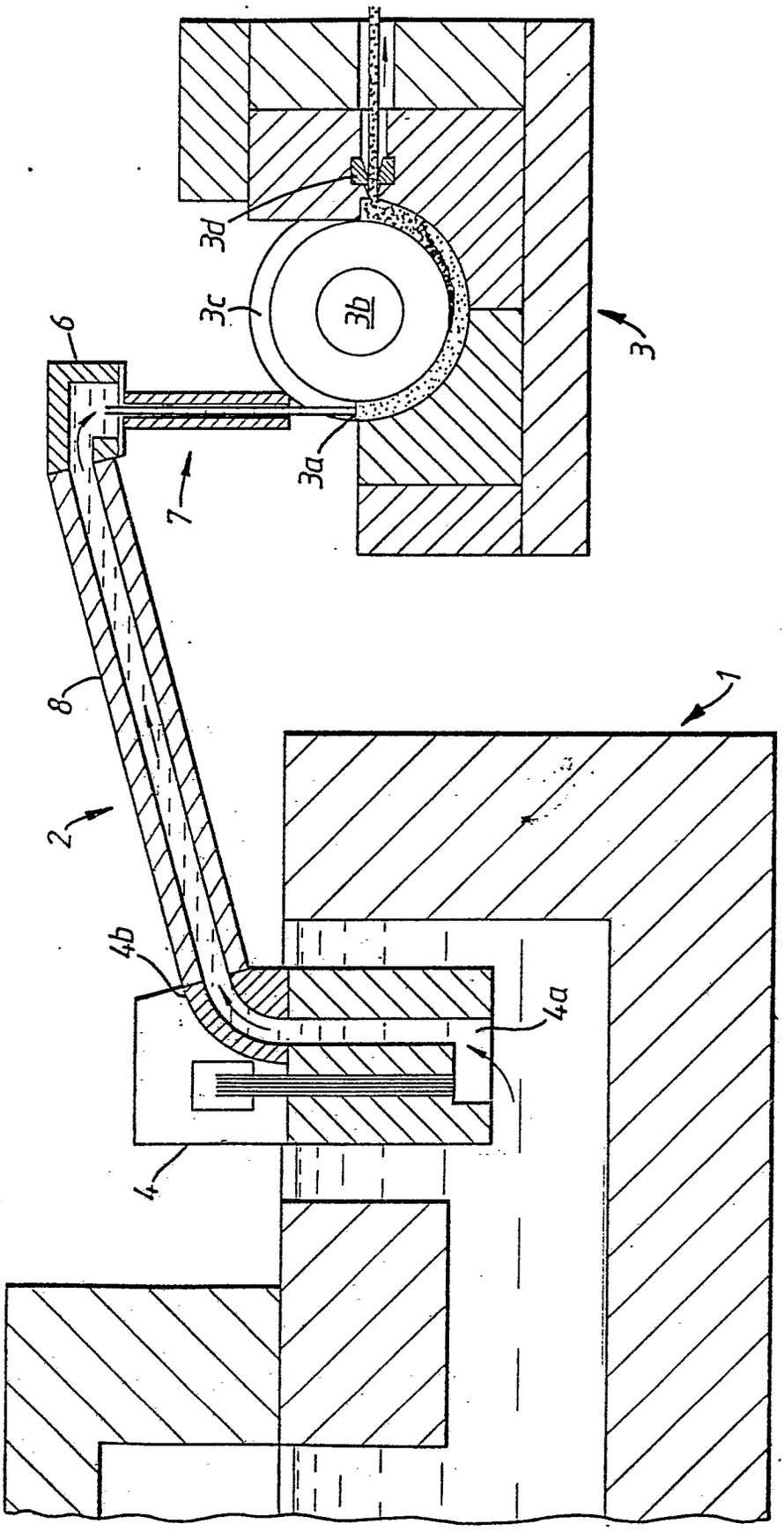

FIG. 1.

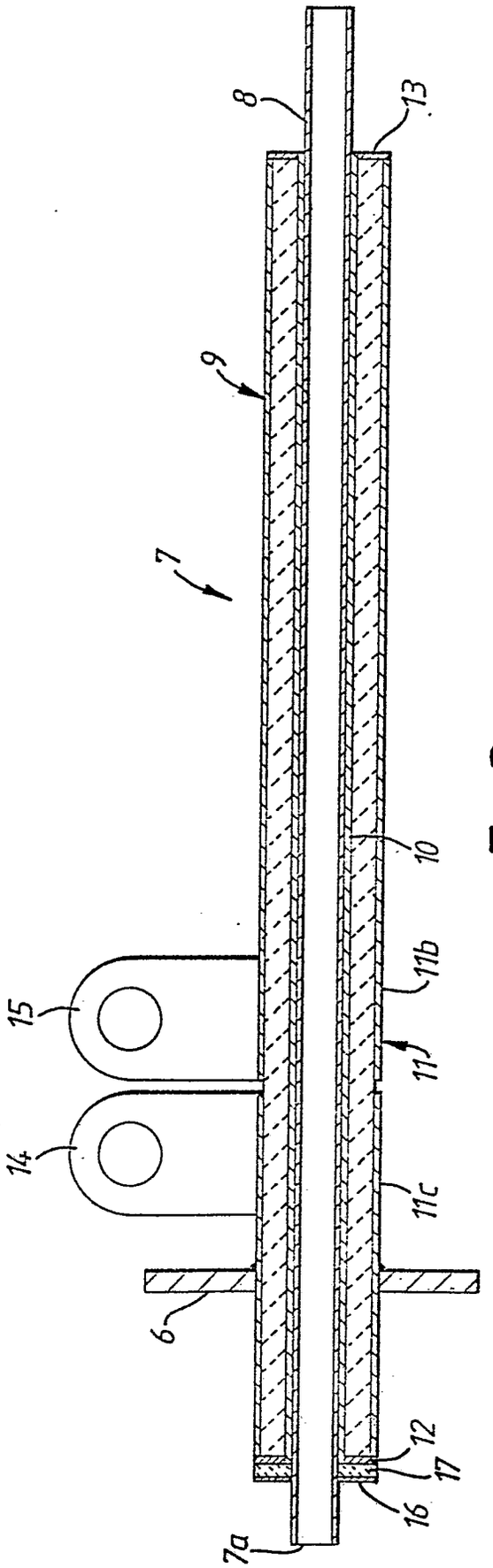

FIG.2.

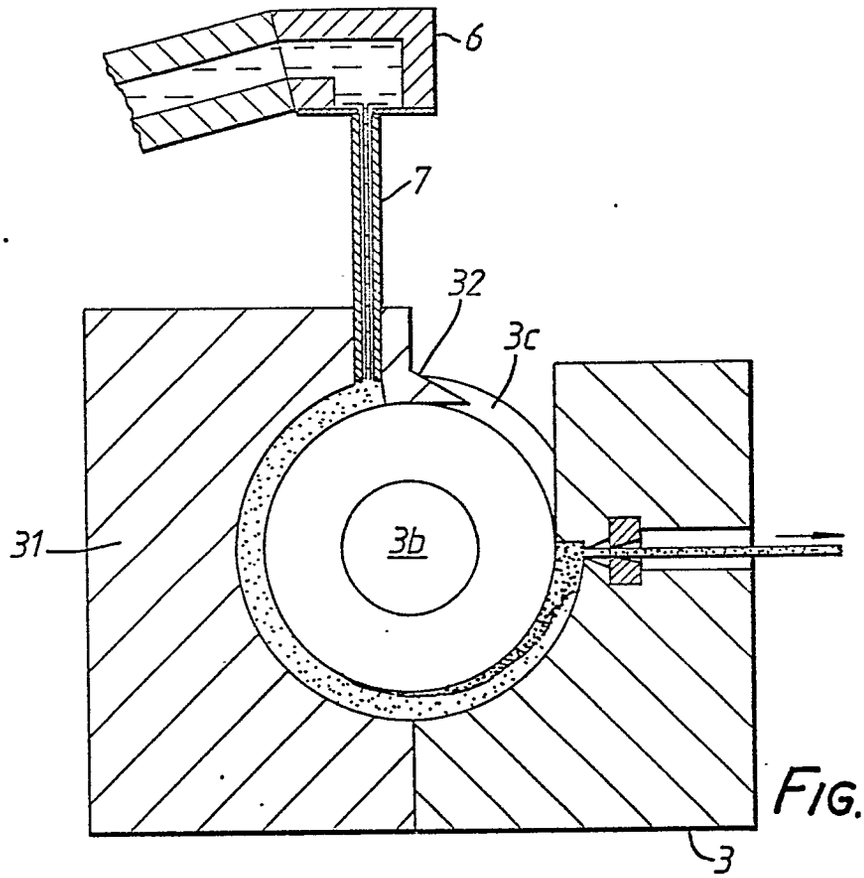

FIG. 3.

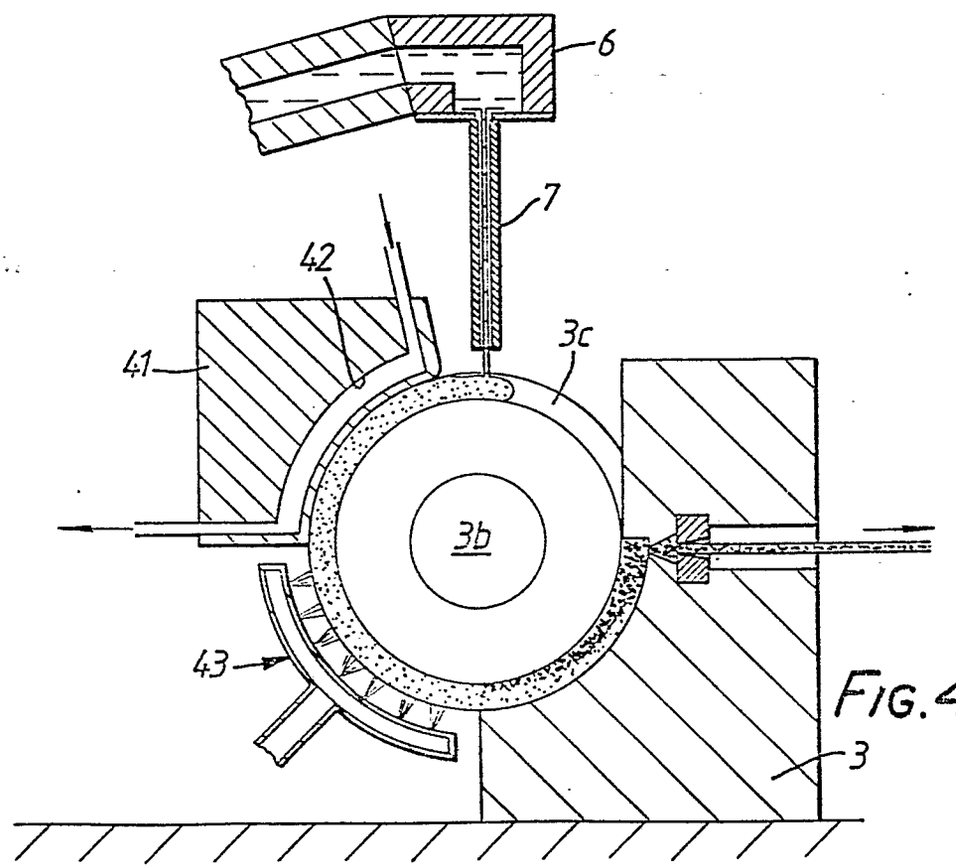

FIG. 4.

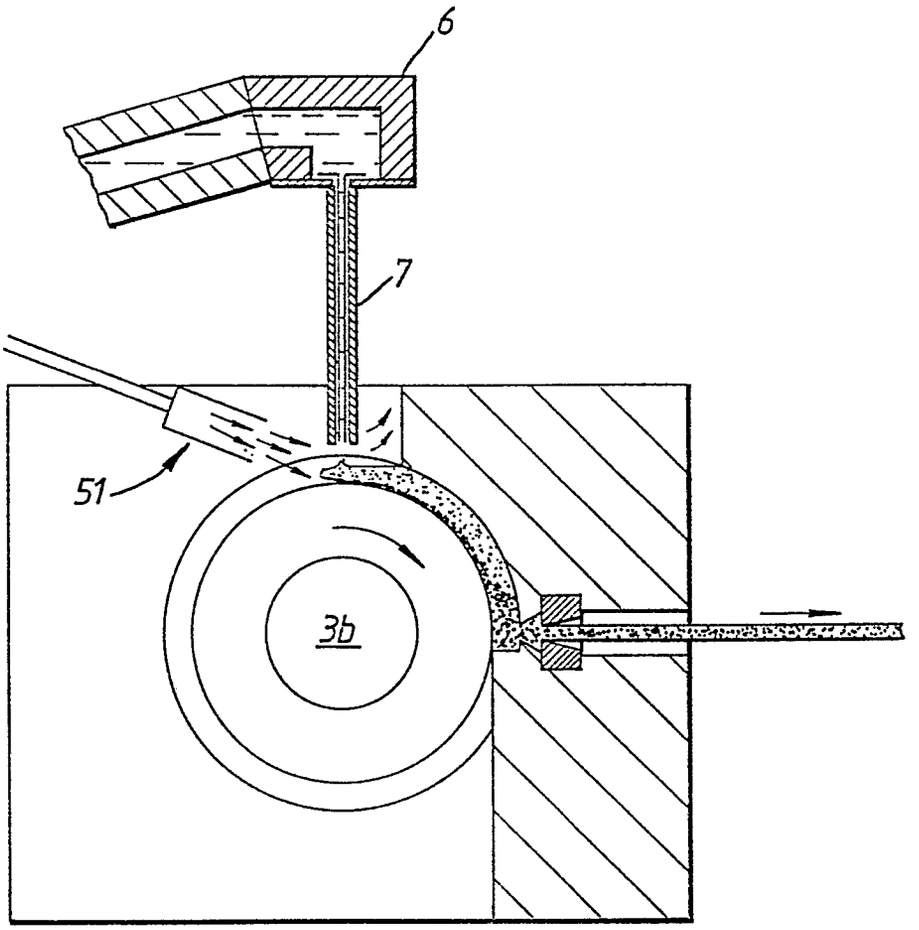

FIG. 5.

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EUROPEAN SEARCH REPORT

0244254
Application number

EP 87 30 3901

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	DE-B-1 195 062 (OFFICINE A. TRIULZI) * Whole document *	1,2,4, 6	B 21 C 33/02 B 21 C 23/00 B 22 D 11/06
A	FR-A- 882 973 (HERMES) * Whole document *	1,2,4, 5	
A	US-A-3 384 150 (NEWSOME) * Whole document *	1,2,4-7	
A	GB-A- 899 318 (PIRELLI) * Page 2, lines 26-66; figure 1 *	8,9,10	
P,A	US-A-4 590 988 (FUKUOKA)	1,4	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	EP-A-0 110 653 (ALFORM)	1,4	B 21 C B 22 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30-06-1987	THE K.H.

CATEGORY OF CITED DOCUMENTS

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