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(54) Submerged pouring.

(57) Metal teeming apparatus comprises a molten metal supply vessel or ladle (10) a receiving vessel or tundish (18) and a submerged pouring tube (16) fitted to an outlet (14) of a gate valve (12). The pouring tube (16) has a venting duct (25) for exhausting entrapped air from the tube when the valve (12) is first opened to commence a teem. The duct (25) is generally U-shaped. It has one limb (26) extending out of the discharge end (20) of the tube (16) and another limb (27) extending alongside the tube to a position above the metal (M) in vessel (18). A downturned part of the limb (27) has an air outlet while the limb (26) has air inlets (36) in its wall. Anchors (40) which secure the limb (26) in the pouring tube (16) protect the inlets (36) from ingress of molten metal at the onset of teeming.

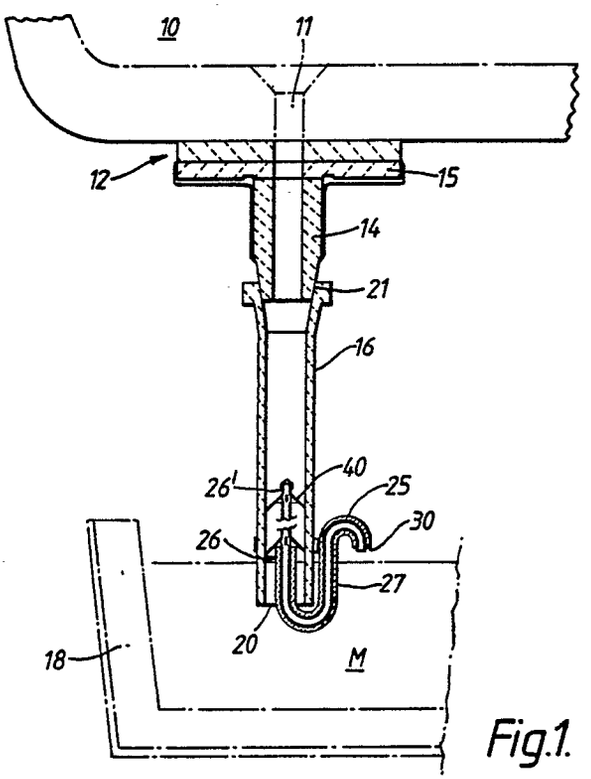

Fig.1.

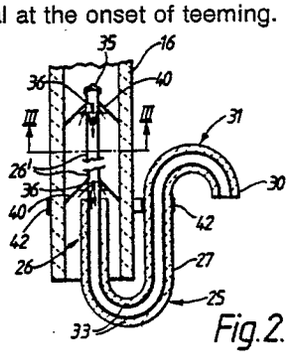

Fig.2.

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SUBMERGED POURING

The present invention relates to improvements in submerged pouring of molten metals.

When molten metal is teemed from a bottom pour vessel into a receiving vessel, it is often desirable to adopt the submerged pouring technique. By this technique, the stream of molten metal is protected from the atmosphere and problems of flaring or spraying are avoided. In the submerged pouring technique, a submerged pouring nozzle has its discharge end dipped beneath the surface of molten metal already present in the receiving vessel.

Submerged pouring techniques to which this invention applies are used, by way of example, in the iron and steel industry. The metal may be poured via a submerged pouring tube from a supply vessel such as a ladle into a mould, tundish or degassing vessel, or from either of the latter into a mould. The latter may be a continuous caster mould.

A typical continuous casting plant has the mould fed with molten metal from a tundish which continuously contains molten metal. The molten metal in the tundish is supplied by submerged pouring from a ladle and when the ladle has been emptied a fresh ladle, containing molten metal is brought to the tun dish to maintain the supply of molten metal thereto.

When a ladle of molten metal is brought to the tundish, air is inevitably trapped in the submerged pouring tube when the end of the latter is submerged in the metal inside the tundish. Teeming from the ladle is commenced at a chosen time by opening the pour opening by operation of a stopper rod closure or a sliding gate closure. When the teeming is initiated, the molten metal entering the submerged pouring tube has to displace the entrapped air. It is not uncommon for this air to expand and blow back or burst through joints e.g. between the submerged pouring tube and a nozzle depending from the ladle or a sliding gate valve collector nozzle (where such is fitted). When this happens, molten metal may be entrained in the escaping air. This can be hazardous or at least damaging to the installation, e.g. the sliding gate valve.

An object of this invention is to overcome the foregoing problems, and the object is met by safely venting the submerged pouring tube.

According to the present invention, there is provided a pouring tube for use in the submerged pouring of molten metal from one vessel to another, wherein the tube incorporates a venting duct having air inlet and outlet ports respectively inside and outside the tube, the outlet being so located that, when the tube in use has its discharge end submerged in molten metal, the outlet port is above the said metal, the vent duct being operable to discharge air displaced from the tube when teeming of metal therethrough is commenced.

Submerged pouring tubes according to the invention can be fitted to vessels having bottom pour openings controlled by stopper rod or sliding gate valve systems.

The venting duct is at least partly destroyed by the molten metal in the course of teeming from the vessel. The submerged pouring tube, however, may be fit for reuse. Its service life may span several filling and teeming cycles. The invention comprehends venting ducts per se which can be installed quickly and easily in a submerged pouring tube; the said ducts are dispensible one-use items, therefore.

Accordingly, the present invention also provides a dispensible venting duct for fitting to the discharge end of a submerged pouring tube, the duct comprising a generally U-shaped pipe having at least one inlet port and an outlet port in the respective two limbs of the U-shaped pipe, and anchoring means are fitted to one limb for resiliently engaging the inside of a submerged pouring tube to mount the duct therein.

The invention will now be described in more detail by way of example only with reference to the accompanying drawings in which:

Fig. 1 schematically illustrates metal teeming equipment including a ladle, a tundish and a submerged pouring tube according to the invention;

Fig. 2 is an enlarged longitudinal sectional view of a discharge end portion of the submerged pouring tube according to the invention;

Fig. 3 is a cross-section through the submerged pouring tube taken on the line III-III of Fig. 2; and

Figs. 4 and 5 are side elevation and cross-sectional views through a second embodiment of the invention, Fig. 5 being taken on the line V-V of Fig. 4.

As aforesaid, this invention concerns submerged pouring of molten metal from one vessel to another. The flowing metal is conveyed down a conduit or submerged pouring tube, from the supply to the receiving vessel and the pouring tube has its bottom, outlet end dipped beneath the surface of metal within the receiving vessel. The incoming metal is therefore delivered at a sub-surface location and is kept from contact with the surrounding air as it flows between the two vessels.

Typically, the supply vessel is a ladle and the

receiving vessel is a tundish but, as indicated hereinbefore, the invention is not limited to submerged pouring between these particular kinds of vessels.

Fig. 1 schematically illustrates a typical ladle/tundish arrangement. The charging vessel or ladle 10 has a bottom pour opening 11, and in this instance teeming of metal from the ladle 10 will be controlled by a sliding gate valve indicated generally at 12. The valve shown in Fig. 1 is a conventional two-plate valve, but it could be a three-plate valve or a shove-through valve. Such valves are known in the art and thus need not be described in detail herein. Alternatively, teeming can be controlled by a stopper rod system such as is known in the art.

The valve 12 has a collector nozzle 14 depending from its downstream or sliding plate 15 and a submerged pouring tube 16 is secured to the lower end of the collector nozzle 14. Although as drawn the valve 12 is in its open or teeming position, initially it will be closed with the orifices in its plates out of registry, i.e. the plate 14 will be in a displaced position relative to that drawn.

The ladle 10 is positioned above a tundish 18 with the lower or discharge end 20 of the submerged pouring tube 16 submerged in the molten metal M in the tundish.

Inevitably, air will be present in the orifice of plate 15, in the collector nozzle 14 and in submerged pouring tube 16 when the filled ladle is brought into its operative position with respect to the tundish 18 as shown. This air is trapped when the pour tube 16 has its end 20 submerged in the metal M. Upon opening the valve 12 to commence teeming from the ladle into the tundish, this air has to be displaced by the molten metal which enters the pouring path including the collector nozzle 14 and pouring tube 16.

The displacement of this air has given rise to problems in the past. For example, the air can burst through the joint 21 between the collector nozzle 14 and the submerged pouring tube 16.

Molten metal may be entrained in the air and if escapes therewith could represent a hazard to personnel or to the equipment including the valve 12.

In order to overcome the foregoing problems, the present invention provides a venting duct 25 for the submerged pouring tube 16.

The venting duct 25 is located in the lower end part of the submerged pouring tube 16. The duct 25 protrudes from the lower or discharge end 20 of the pouring tube 16 and has first and second parts 26 and 27. First limb or part 26 of the duct 25 is located inside the pouring tube 16. The second limb or part 27 extends upwardly alongside the pouring tube. The second part 27 of the duct extends far enough to ensure that its free end 30 will be well clear of the surface of metal M in the tundish 20 when the ladle is in its operative position.

As will be apparent from Figs. 1 and 2, the venting duct 25 is generally U-shaped. The second part 27 of the duct has a terminal portion turned downwardly towards the surface of melt in the tundish 18. As shown, the terminal portion 31 has a semicircular form but this form is not essential to the practice of this invention. The reason that the terminal portion 31 is down-turned is to deliver any molten metal that may enter the duct 25 safely into the metal M in the tundish 18.

As will be seen from Figs. 1 and 2, the venting duct 25 has a generally S-shaped outline.

The duct 25 is made of seamless metal tubing, e.g. of stainless steel.

Portions of the venting duct 25 which will come into contact with the metal in the tundish 18 are provided with a protective refractory coating or sheath 33. In the illustrated example, the coating 33 completely encases the second part 27 of the duct but extends only part way along the first part 26. The coating 33 could, however, encase the whole of the duct.

If desired, the duct 25 could be made entirely of refractory tubing.

The duct 25 is so designed that when teeming is initiated, the initial flow of metal does not immediately enter the first part 26 of the duct. To this end, the top end of the first part 26 is closed by a refractory plug 35. Air can, however, enter the first part of the duct 25 thanks to ports 36 provided in its wall. These ports can comprise slots, or more conveniently circular apertures, in the side wall of the uncoated portion 26′ of the first part 26 of the duct. There may be e.g. three ports on each of e.g. two or three levels or locations along the uncoated portion 26′.

The duct 25 is secured to the end of the submerged pouring tube 16 by means of anchors 40 which engage the inside of the tube 16 and a strap 42 which encompasses the tube 16 and the second part 27 of the duct 25. The strap is, however, optional.

A plurality of anchors 40 are fastened to the uncoated portion 26′ of the first part 26 of the duct. Each anchor is resilient and has a plurality of legs 43 which are sprung outwardly but are displaceable inwardly when they are forced into the pouring tube 16 upon installing the duct 25. The legs 43 of the anchors 40 serve to centralise the first part 26 of the venting duct 25 in the pouring tube 16. Each anchor 40 can have any convenient number of legs 43, four being shown in the illustrated embodiment. As will be noted from Figs. 1, 2, 4 and 5, the legs 43 point downwardly and, due to their outward bias, they will jam more tightly against the inner

wall of the pouring tube 16 if the duct 25 were displaced downwardly, e.g. by molten metal impacting thereon. If desired, the pouring tube could have ledges in its inner wall against which the ends of the legs 43 could abut for positively locating the duct 25.

The anchors 40 serve to deflect the initial onrushing melt away from the ports 36. As shown, each anchor has a downwardly-flaring conical skirt portion 45 from which the legs 43 extend. The anchors are so located relative to the ports 36 that the skirt portions enshroud the ports. The anchors therefore serve the dual functions of locating the duct as well as protecting it from immediately filling with molten metal via the ports 26, which are thus kept open for exhausting air from the inside of the pouring tube 18.

As illustrated, the duct 25 exits the pouring tube 18 via its submerged end 20. A beneficial consequence of this is that during the teem, there is no way air can be aspirated into the stream of teeming melt through the duct.

Equipment embodying this invention can be adapted so as to perform a second function, namely that of disrupting or dispersing a well-filler skull such as may sometimes form and obstruct the bottom opening 11 of the ladle 10. The present equipment can, therefore, incorporate apparatus the subject of our British Patent Application No. 8811937 filed 20th May, 1988, the contents of which earlier application are incorporated herein by this reference.

Suffice to say, in Figs. 4 and 5 the venting duct 25′ according to this invention includes a barrel and a tubular projectile 51 constructed and functional as disclosed in the aforementioned application. The duct 25′ also includes an inner, heat-resistant air hose H connectible to a supply of pressurised gas, for firing the projectile at a well-filler skull.

The barrel 50 is appropriately centred within the duct 25′ which has a sealing cap C at its end past which the projectile can force its way. The projectile 51 when fired could pierce the cap C or dislodge it from the duct 25′. Means 52 by which the barrel 50 is located at its top end in the duct 25′ will be constructed so as to effectively block entry of melt into the space within the duct 25′ surrounding the barrel 50.

Another optional feature of the invention is disclosed in Figs. 4 and 5 wherein it will be seen that the duct 25 is in two separable parts connectible together by way of a twist-lock connector 54. One portion A has the anchors 40′ fitted thereto and the other portion B is the refractory-clad part which projects out of the lower end of the pouring tube 16.

Such a two-part construction could be adopted for the embodiment of Figs. 1 to 3, although the simpler one-part form may be preferred.

The bore size of the venting duct 25, 25′ should be sufficient to enable the air in the pouring tube 16 to be exhausted quickly enough to cope with the rate at which molten metal may enter the pouring tube at the onset of teeming. By way of example, in a steel ladle having a ferrostatic head of 6. 1 m (20 feet), this steel flow rate may be of the order of 3.7×10^{-2} cu.m/h (1.3 cubic feet per second). Merely by way of example, the venting duct 25, 25′ could have a bore of 2.54 cm (1 inch) where the pouring tube has a diameter of some 100 mm and a length of 1 metre to 1.5 metres. This venting duct can have three sets of ports, three in each set, with each bore being of 12.7 mm (0.5 inch) diameter. For a smaller pouring tube of 70 mm diameter such as may be fitted to a tundish, the venting duct 25, 25′ may have a 19 mm (3/4 inch) bore with ports 9.5 mm (3/8 inch) in diameter.

It should be understood that the dimensions given in the last preceding paragraph are given merely for illustration, and it is expected that the dimensions will be varied to suit individual metal pouring plants.

The venting duct could have different forms. For example, the air admittance ports 36 in the wall could be omitted. Thus, the end of part 26 of duct 25 shown as closed by plug 35 could be open for exhausting air from the submerged pouring tube if the end were fitted with a protective cover or cowl to prevent the initial onrush of molten metal from entering the duct. Such a cover or cowl could be avoided if the end portion of duct part 26 were downturned such that its open end faces away from the onrushing molten metal.

Although the anchors 40, 40′ are shown centralising the venting duct in the pouring tube 16, the duct and tube need not be coaxial and in some cases it may be preferred to have duct part 26 off-centre within the pouring tube.

The height to which duct part 26 extends within the pouring tube 16, and the position of the air-admittance opening(s), will be dictated by experience.

Industrial Applicability

The invention is applicable to the pouring of molten metals from one vessel to another, where the metals are to be poured into the receiving vessel via a duct submerged in molten metal in the latter vessel, to keep the flowing metal out of contact with the air. The vessels can include ladles, tundishes, degassing vessels and moulds. The invention is primarily, but not exclusively, intended

for use in the iron and steel industry, and has particular application in continuous caster operations.

Claims

1. A pouring tube for use in the submerged pouring of molten metal from one vessel (10) to another (18), wherein the tube (16) incorporates a venting duct (25, 25′) having air inlet and outlet ports (36, 30) respectively inside and outside the tube (16), the outlet being so located that, when the tube (25, 25′) in use has its discharge end (20) submerged in molten metal (M), the outlet port is above the said metal, the vent duct (25, 25′) being operable to discharge air displaced from the tube (16) when teeming of metal therethrough is commenced.

2. A pouring tube according to claim 1, wherein the venting duct (25, 25′) is generally U-shaped and has a first part (26) extending downwardly from inside the tube (16) and through its discharge end (20), and a second part (27) which extends upwardly alongside the tube (16).

3. A pouring tube according to claim 2, wherein the second part (27) has a downturned end portion (31) containing the outlet port (30).

4. A pouring tube according to claim 1, 2 or 3, wherein at least portions of the venting duct (25, 25′) have a protective refractory coating (33) to protect the duct from molten metal when immersed therein.

5. A pouring tube according to any of claims to 4, wherein the venting duct (25, 25′) has a first part (26) located within the pouring tube (16), the first part having a closed end (at 35) and the wall thereof has at least one opening therein serving as an air inlet port (36).

6. A pouring tube according to claim 5, wherein a shroud means (45) is provided adjacent the or each inlet port (36) to guard against ingress of molten metal upon commencing teeming through the tube (16).

7. A pouring tube according to any of claims 1 to 6, wherein at least one anchor (40, 40′) fitted to the venting duct (25, 25′) for locating and securing same in the pouring tube (16), the anchor including a plurality of outwardly-projecting, resilient legs (43) which engage, e.g. frictionally, the inside of the said tube.

8. A pouring tube according to claim 7, wherein the or each anchor (40) has an inner skirt portion (45) from which the legs (43) extend, the skirt portion (45) serving as a melt-deflector for one or more inlet ports (36) in the wall of the venting duct (25, 25′), the anchor being so located that its skirt portion (45) enshrouds the said one or more ports.

9. A pouring tube according to any of claims 1 to 8, wherein the venting duct (25′) includes therein a device for breaking-up or dispersing a well filler blockage or skull in the metal teeming path upstream of the tube, the said device comprising a barrel (50) and a close fitting tubular projectile (51) pneumatically ejectable from the barrel to impact upon a blockage or skull.

10. A bottom-pour vessel fitted with a submerged pouring tube according to any of claims 1 to 9.

11. Metal teeming equipment including a bottom pour supply vessel such as a ladle (10) for molten metal, a receiving vessel such as a tundish (18) for molten metal, and a submerged pouring tube (16) extending from the former, the pouring tube being in accordance with any of claims 1 to 9.

12. Equipment according to claim 11, wherein the supply vessel (10) is furnished with a teeming control means upstream of the pouring tube (16), the control means being selected from a stopper rod system and a sliding gate valve system (12).

13. A dispensible venting duct for fitting to the discharge end of a submerged pouring tube (16), the duct (25, 25′) comprising a generally U-shaped pipe having at least one inlet port (36) and an outlet port (30) in the respective two limbs (26, 27) of the U-shaped pipe, and anchoring means (40) are fitted to one limb (26) for resiliently engaging the inside of a submerged pouring tube (16) to mount the duct therein.

14. A duct according to claim 13, wherein the outlet port (30) is provided in a downturned end portion (31) of the second limb (27) of the pipe.

15. A duct according to claim 13 or claim 14, wherein the said one limb (26) has a downturned end portion terminating in an air inlet port (36).

16. A duct according to claim 13 or claim 14, wherein the said one limb (26) has a closed end and at least one air inlet port (36) provided in a side wall thereof.

17. A duct according to claim 16, wherein the anchoring means (40) are located adjacent the air inlet port(s) (36) and are operative to shield the latter from ingress of molten metal.

18. A duct according to claim 17, wherein the anchoring means have an inner conical, downwardly- flaring skirt portion (45) located to enshroud air inlet port(s) (36) in the said side wall and outwardly-extending resilient legs (43) for engaging the inside of a submerged pouring tube (16).

19. A duct according to any of claims 13 to 18, comprising a metal pipe and at least lower portions of its limbs (26, 27) and a portion interconnecting them are encased in refractory material (33).

20. A duct according to any of claims 13 to 19, which has a device for breaking-up or dispersing a well filler blockage or skull, the said device comprising a barrel (50) and a close-fitting tubular projectile (51) pneumatically ejectable from the barrel to impact upon a skull.

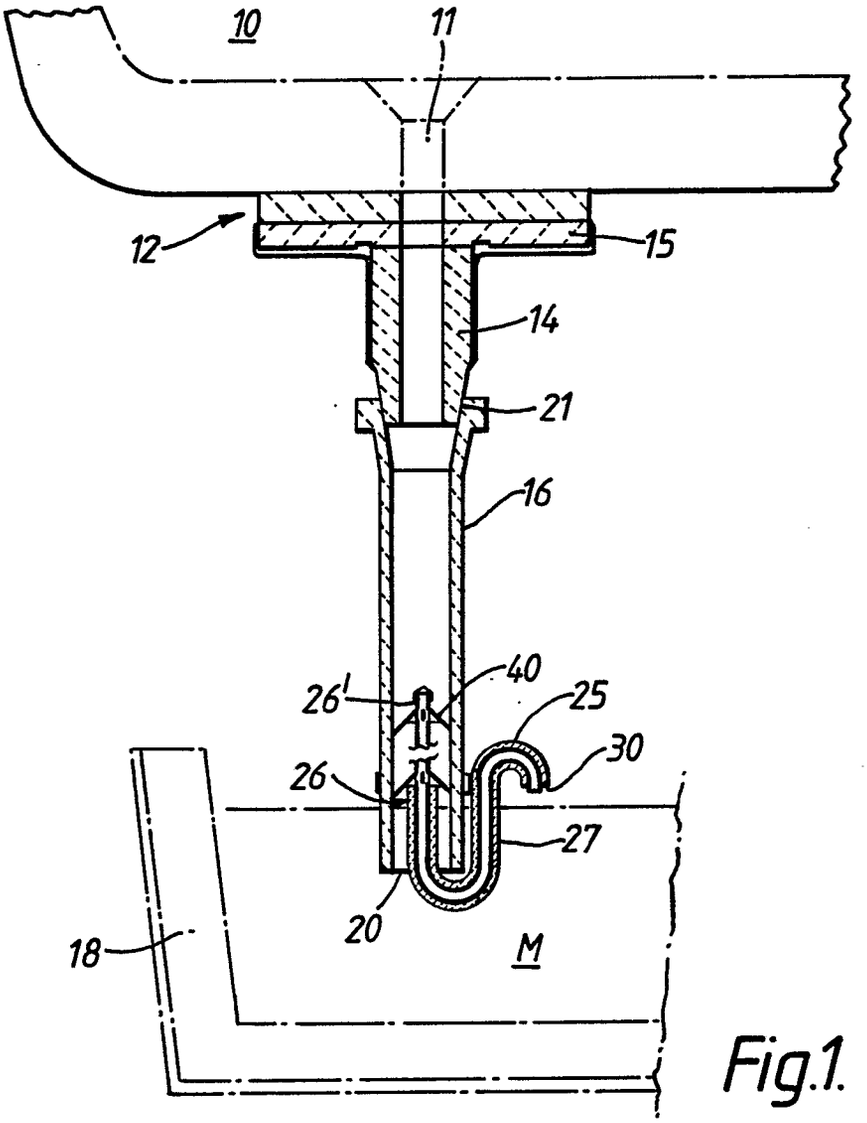

Fig.1.

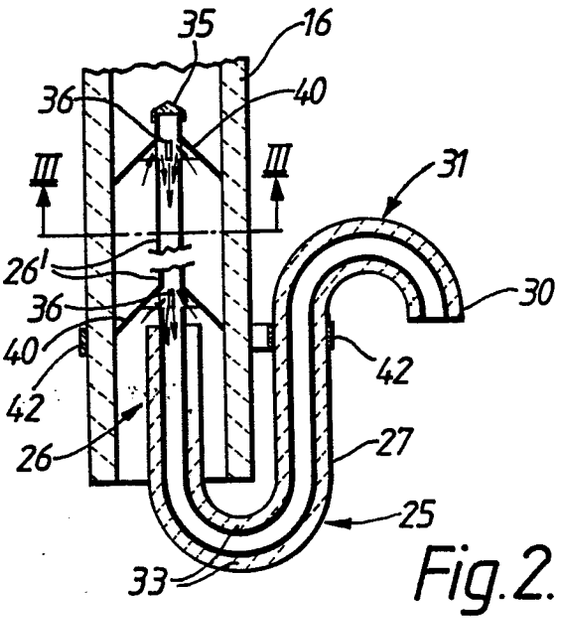

Fig.2.

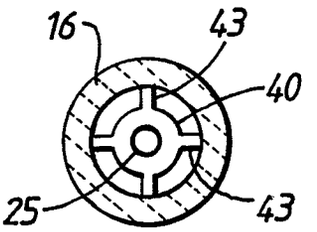

Fig.3.

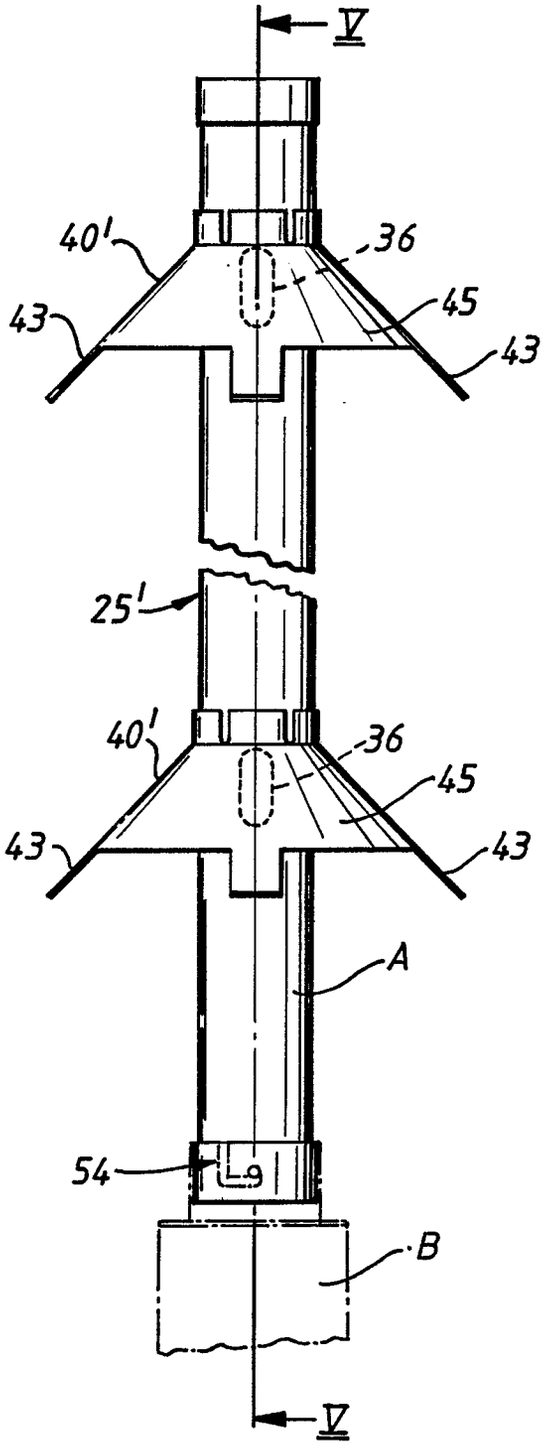
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Fig.4.

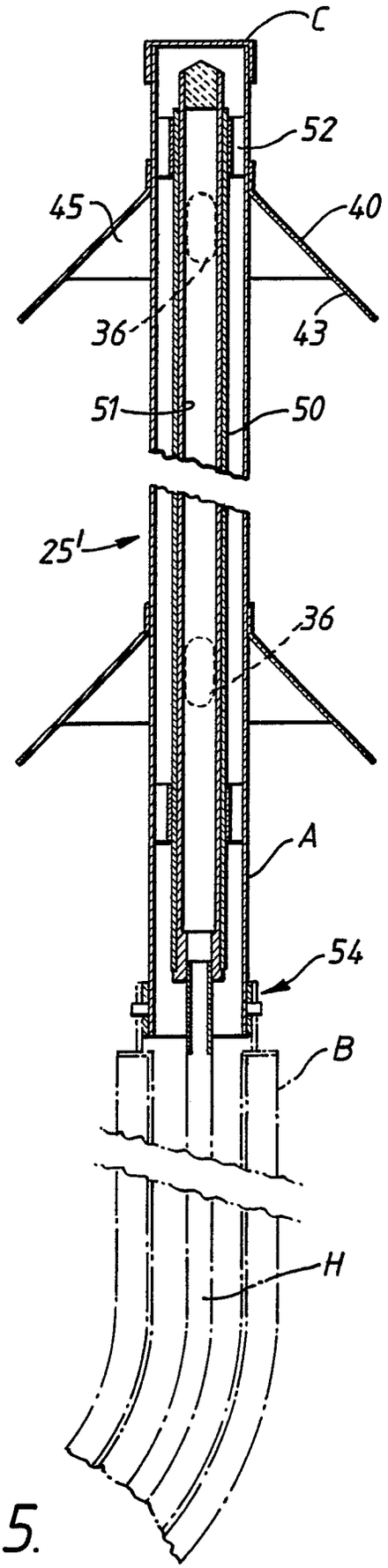
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Fig.5.

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EUROPEAN SEARCH REPORT

Application Number

EP 89 30 6123

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	FR-A- 485 095 (D. PALYITCH) * Figures 1-4; abstract *	1	B 22 D 41/08
A	US-A-4 708 326 (BROCKMEYER et al.) * Abstract; figures 1-5 *	1	
A	US-A-4 546 812 (R.G. TIEGEL) * Abstract; figures 1-4 *	1	
A	GB-A- 100 044 (G. MELLEN) * Figures 2-8; page 1, line 32 - page 3, line 11 *	1	
A	GB-A- 551 372 (V. WILLIAMS) * Figures 1,2; page 4, lines 27-90 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

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	03-10-1989	MAILLIARD A.M.

CATEGORY OF CITED DOCUMENTS

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