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(54) Strip casting machine.

(57) A strip casting machine including means for feeding molten material from a pool of material through a gap determining the thickness of the strip.

So that the chilling of the material can be closely controlled, the machine includes a pair of contra-rotating rolls (10,10) with means for cooling said rolls and for controlling their rotational speed.

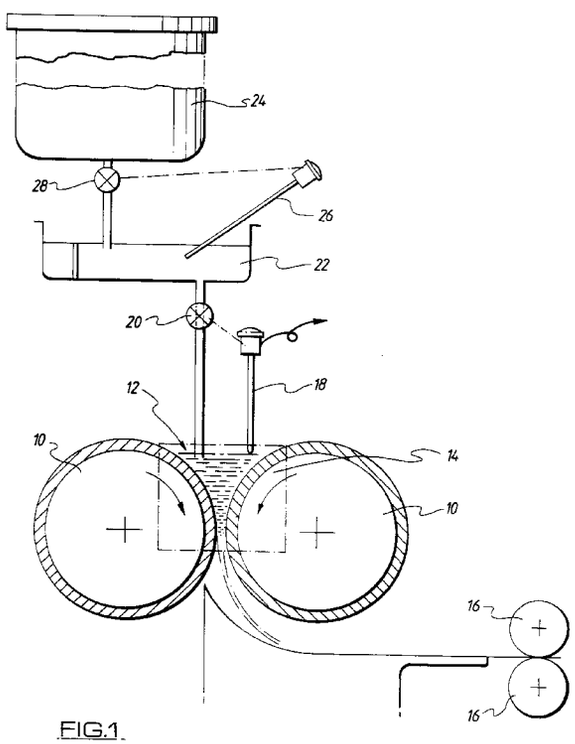

FIG.1

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The invention relates to a strip casting machine primarily intended for the casting of lead strip although it will be understood that other metals, metal alloys, mixtures of metals and non-metallic fillers, and also such materials as polycarbonates and acrylics, may be able to be cast in the form of strip by a machine embodying the invention.

Various designs of continuous casting machines are known but these have static chills and are suitable only for the casting of metal billets. Such known machines are not suitable for the casting of strip.

The invention as claimed is intended to provide a remedy. It solves the problem of how to design a machine for the production of strip.

The advantages offered by the invention are mainly that the rate of solidification of the material forming the strip, and the location at which solidification takes place, can be closely controlled.

One way of carrying out the invention is described in detail below with reference to drawings which illustrate only one specific embodiment, in which:-

Figure 1 is a semi-diagrammatic view of a metal strip casting machine embodying the invention,

Figure 2 is a diagrammatic view illustrating a control means for the machine,

Figure 3 is a circuit diagram,

Figure 4 is a view similar to Figure 1 and illustrating a possible modification, and

Figure 5 is a view of a further possible modification.

Referring now to Figure 1 of the drawings, the metal strip casting machine there illustrated includes a pair of water cooled rolls 10,10 spaced apart side by side, as shown, and capable of being driven, by means not shown, in contra-rotation as indicated by the arrows. A space, generally indicated 12, which is to contain molten metal above and between the rolls is enclosed at its opposite ends by respective graphite plates 14 which are acted upon by spring means (not shown) to urge them into sliding engagement with the end surfaces of the rolls.

The arrangement is such that the molten metal contacting the water cooled rolls is chilled and as the rolls rotate as indicated by the arrows, a metal strip is formed in the "nip" between the two rolls and is carried downwards as shown by the chain-dotted lines.

The spacing of the two rolls, that is to say the width of the gap between them, is adjustable (by means not shown) between zero and some desired maximum, for example up to 2.5 mm. In this way the thickness of the metal strip being carried downwards by the two rolls is adjustable. The metal strip being carried downwards by the rolls is guided towards a pair of rollers 16,16 which in turn guide the strip towards a slitting head (not shown).

Means are provided for maintaining the level of the pool of molten metal between the two rolls 10,10. As shown, these means are constituted by a dip-probe 18 and a solenoid operated valve 20 which can be opened to allow the gravity flow of molten metal from a holding tank 22. The holding tank is itself replenished from time to time from a melting pot 24. A dip-probe 26 and a solenoid operated valve 28 are provided to monitor the level of molten metal in the holding tank and to control the flow of molten metal from the melting pot, respectively.

The cooling flow through the rolls 10,10 takes place through rotatable connectors (not shown) mounted on the roll spindles. Means are provided for controlling the rate of flow of water through the rolls to suit the temperature of the molten metal in the space 12 above and between the rolls and the thickness and the rate of travel of metal strip being carried downwards between the rolls.

Referring now to Figure 2, this illustrates the way in which, during the operation of the machine, the molten metal carried into the gap between the rolls is chilled by contact with the rolls. Ideally, as shown in full lines, the molten metal will have solidified throughout the thickness of the strip being produced as it reaches the plane containing the axes of the two rolls.

If the molten metal has solidified at some distance above the plane containing the axes of the two rolls, for example in the region indicated by the chain-dotted lines in Figure 2, the rolls will require to act in the manner of the rolls of a rolling mill and the power consumption of the electric motor (not shown in Figures 1 and 2) driving said rolls will increase. There are therefore provided means for monitoring the force tending to separate the two rolls and for increasing the driven speed of the rolls in response to a significant increase of said force. The means for monitoring the force tending to separate the two rolls are constituted by a strain gauge 11. In Figure 3 there is illustrated the means whereby the driven speed of the rolls is automatically increased in response to a significant increase of the force tending to separate the two rolls. The motor unit 13 for driving the rolls is provided with a tacho-generator 15 the output from which is fed to a comparator circuit 17 in opposition to a signal from the strain gauge 11. The difference, or error, between the two signals controls the output stage of a triac 19 which is provided for automatically adjusting the coil excitation level of the unit connecting the motor and roll drive.

In operation of the machine, a significant increase of the force tending to separate the two rolls results in an increased speed demand reference signal from the strain gauge. This immediately results in an error signal being produced so that the motor speed is correspondingly increased. The solidification point is thus brought down towards the position shown in full lines in Figure 2, the signal from the strain gauge is automatically reduced, and the rotational speed of the rolls is thus allowed to fall. By fine tuning of the speed of response of the system, the sol-

idification of the strip being produced is automatically maintained substantially at the position shown in full lines in Figure 2.

Referring now to Figure 4, in a modification of the machine just described, the melting pot 24 is located at a lower level than the holding tank, and indeed lower than the space 12 above and between the rolls. A pump 30 is provided for feeding the molten metal from the melting pot 24 to the holding tank 22 through pipe 32.

Means which in this case are provided for maintaining the depth of molten material in the holding tank are constituted by an overflow pipe 34 opening from the side of said tank and leading back to the melting pot. Means which are provided for maintaining the depth of the pool of molten material in the space 12 above and between the rolls are constituted by an overflow or weir 36 formed in one of the graphite plates 14, excess material being returned to the melting pot through a down pipe 38 with which said overflow or weir communicates.

Referring now to Figure 5, this view illustrates a further possible modification in which the pool of molten metal is not held in a space defined by the surfaces of the two rolls but in a chamber generally indicated 40 mounted above the rolls. The chamber has an overflow aperture 42 in an end wall which determines the static head of molten metal. In this case the molten metal is fed to the gap between the rolls through an elongate feed channel 44 extending the full length of the rolls. A wear resistant skirt 46 extends below the lower end of the feed channel and bears against the surfaces of the two rolls. (The graphite end plates 14 of Figures 1 and 4 are not shown in Figure 5. They may or may not be required).

Various other modifications may be made. For example, the respective plates which in the Figure 1 and Figure 4 constructions enclose the containing space for holding the molten material above and between the rolls need not necessarily be acted upon, or directly acted upon, by spring means. A system of levers could be arranged to apply the required forces to said plates, said levers being acted on either by respective springs or by weights acting through respective bell crank levers to apply the required lateral forces.

Other means may be provided for automatically maintaining the solidification of the strip substantially at the position shown in full lines in Figure 2. For example, there could be provided means for monitoring the power consumption of the roll drive motor and means for increasing the driven speed of the rolls in response to a significant increase of electric power consumption.

Provision may be made for 'after cooling' of the strip, that is to say for the cooling of the strip by a water or other fluid bath or by spray after the strip has exited from the rolls.

The rolls could conceivably be cooled by a liquid other than water, or even by vapour, pumped through the hollow interior of each roll.

Although the machine has been described as being for the production of metal strip, it will be understood that with suitable adjustments of the temperature controls and drive controls it could be used for the production of thermoplastics strip, for example polycarbonates and acrylics.

Claims

1. A strip casting machine including means for feeding molten material through a gap between chilling means determining the thickness of the strip, characterised in that said chilling means comprise a pair of contra-rotating rolls (10,10), means being provided for cooling said rolls and for controlling their rotational speed.

2. A strip casting machine according to claim 1, in which the means for cooling the pair of rolls (10,10) are interior spaces within said rolls for the circulation of a cooling fluid.

3. A strip casting machine according to either one of the preceding claims, in which the means for driving the rolls (10,10) includes means for monitoring the power consumption of a drive motor (13) and means for increasing the driven speed of the rolls in response to an increase of power consumption.

4. A strip casting machine according to either one of claims 1 and 2, in which means are provided for sensing the force tending to separate the rolls (10,10) during the operation of the machine, and for increasing the driven speed of the rolls in response to an increase in the force tending to separate said rolls.

5. A strip casting machine according to any one of the preceding claims, including a containing space for holding the molten material above and between the rolls (10,10), said space being enclosed at opposite ends by respective plates (14) urged into sliding engagement with end surfaces of said rolls.

6. A strip casting machine according to claim 5, in which the plates (14) at the opposite ends of the rolls are urged into sliding engagement with the end surfaces of the rolls by spring means acting directly against said plates or by levers acted upon either by spring means or by weights.

7. A strip casting machine according to any one of the preceding claims, in which adjustment means

are provided whereby the distance between the two rolls (10,10) is adjustable.

8. A strip casting machine according to any one of the preceding claims, in which means are provided for maintaining a pool of molten material above and between the two rolls at a substantially constant level.

9. A strip casting machine according to claim 8, in which the means for maintaining the level of said pool of molten material comprise a dip-probe (18) and a solenoid operated valve (20) actuated by said probe.

10. A strip casting machine according to claim 8, in which the means for maintaining the level of said pool of molten material comprise means for feeding the molten material to the pool at a rate greater than that at which the material is fed between the rolls (10,10), and overflow means (36) for returning excess material from the pool.

11. A strip casting machine according to claim 10, in which a holding tank (22) is provided for feeding the molten material to the pool of material, there being means for maintaining the depth of molten material in said holding tank comprising means (30) for feeding the material to said tank at a rate greater than that at which the material is fed between the rolls (10,10), and overflow means (34) in said tank for returning excess material therefrom.

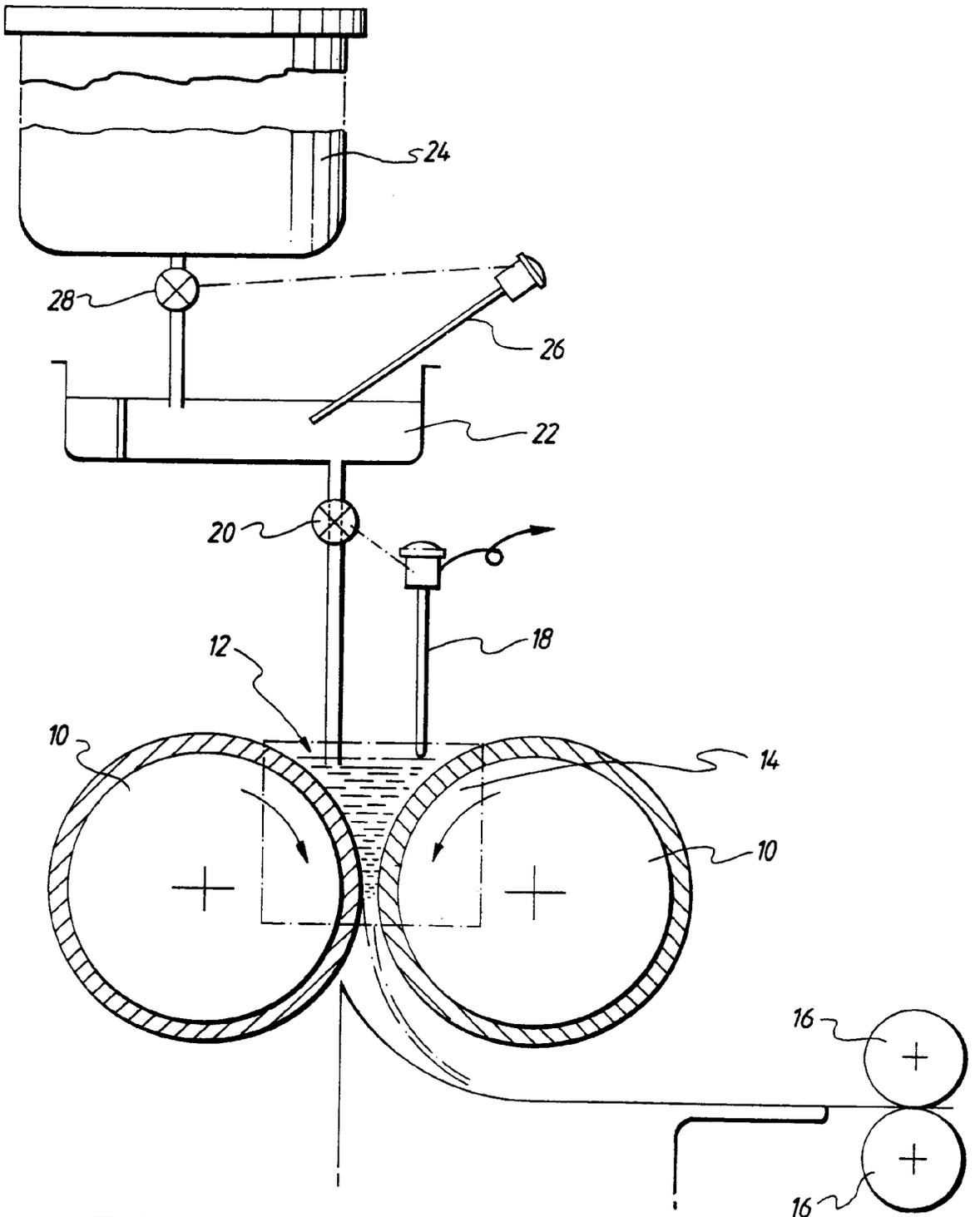

FIG.1

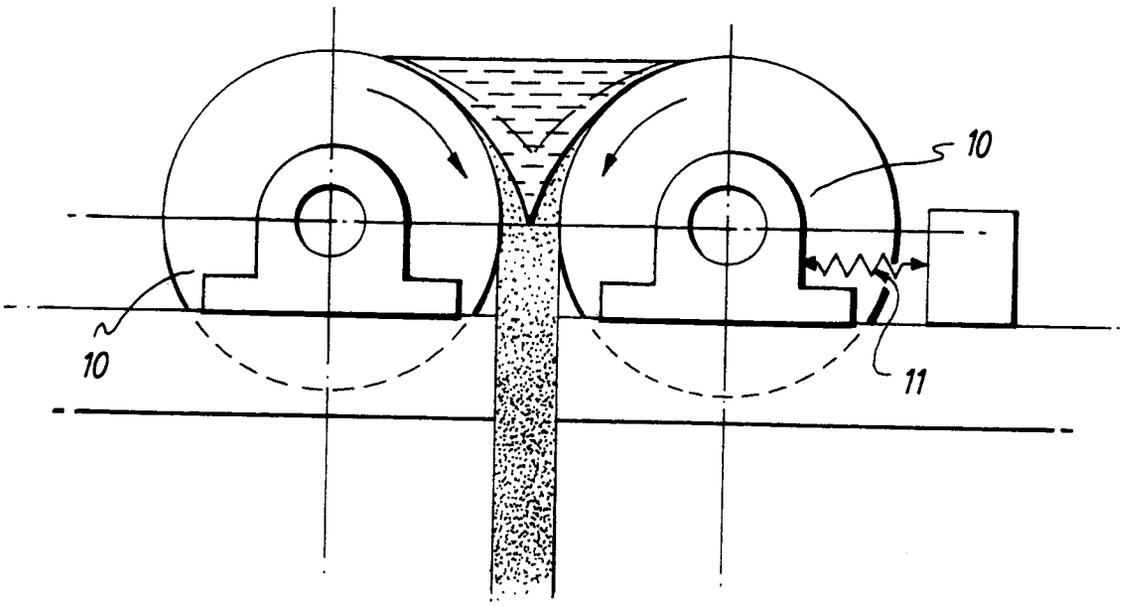

FIG.2

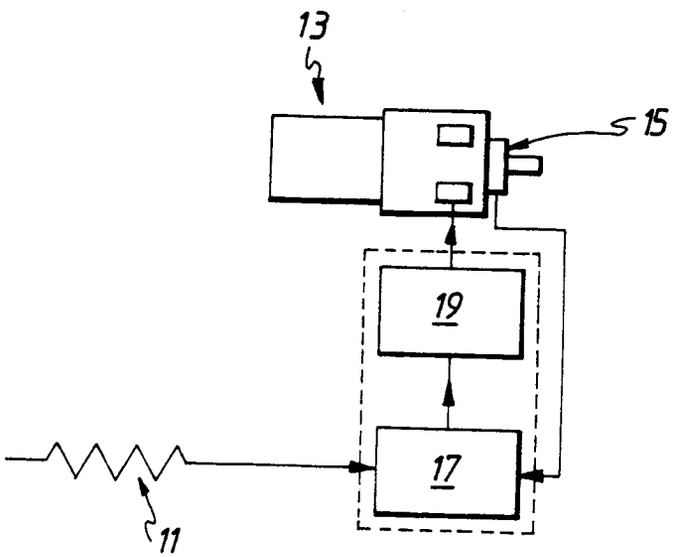

FIG.3

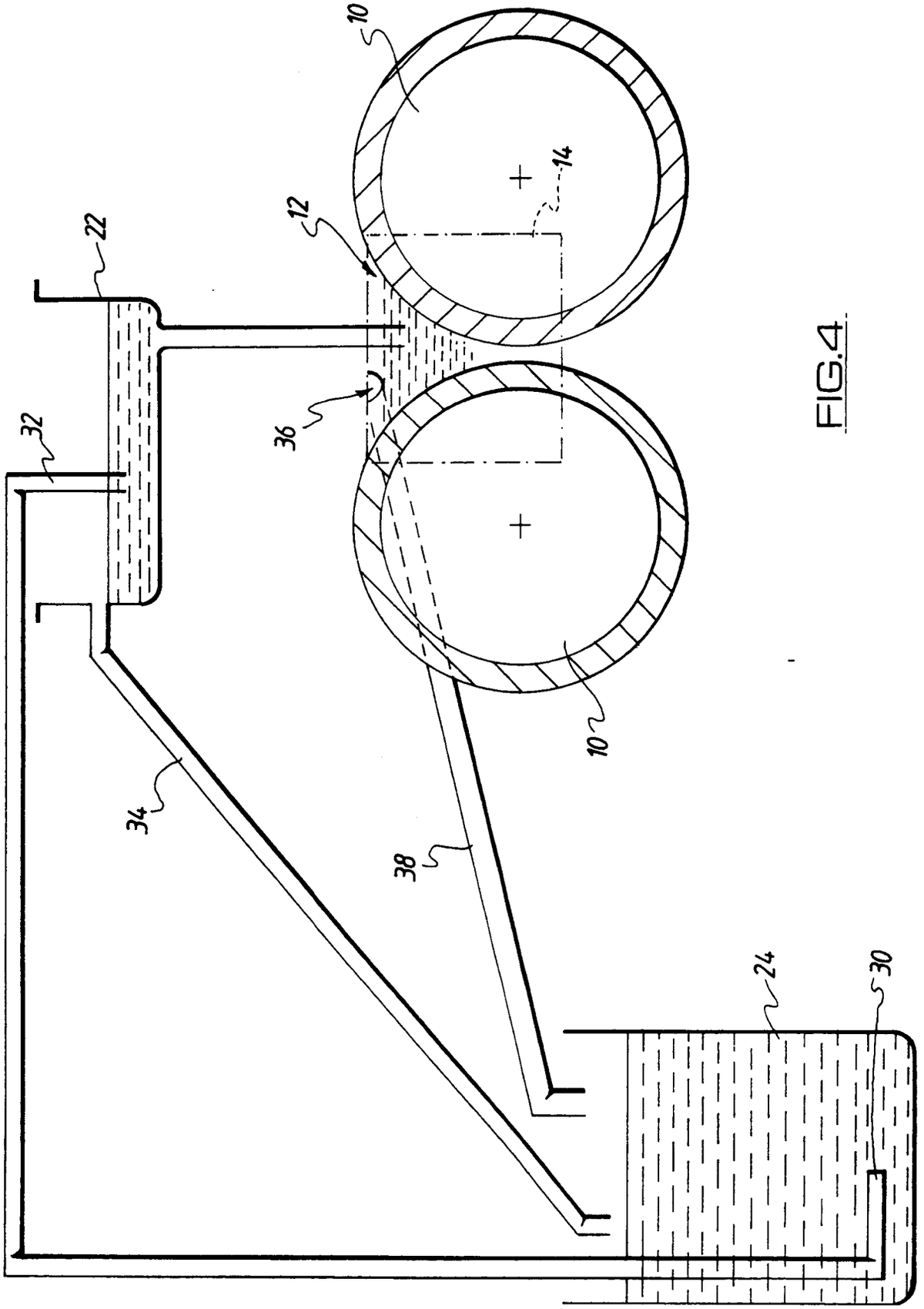

FIG.4

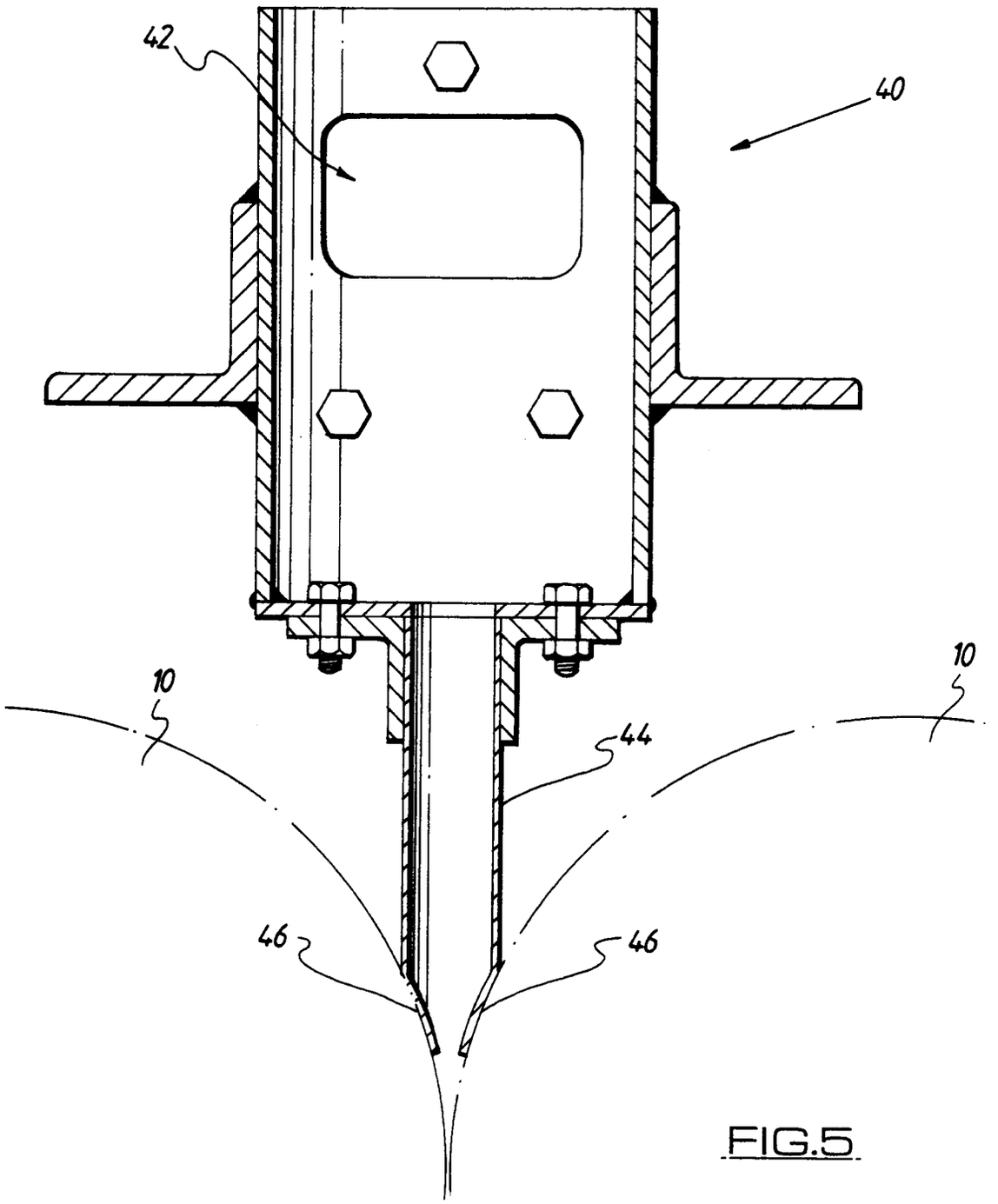

FIG.5

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EUROPEAN SEARCH REPORT

Application Number EP 92306892.8

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.5)
X	EP - A - 0 411 962 (NIPPON STEEL) * Fig. 1,3; claims 1,2,4, 6,7 *	1-5,7	B 22 D 11/06 B 22 D 11/16
A	* Claim 3 *	8,9	
	FR - A - 2 656 550 (INSTITUT DE RECHERCHES DE SIDERURGIE FRANCAISE) * Fig. 1 *	1,6	
A	DE - A - 3 323 749 (NORDDEUTSCHE AFFINERIE AG) * Abstract; claim 1; fig. 2 *	1,8	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 22 D 11/00 B 22 D 21/00 B 21 B 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	23-09-1992	RIEDER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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