

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **84109841.1**

(51) Int. Cl.⁴: **B 22 D 11/04**
B 22 D 11/06, B 22 D 35/00

(22) Date of filing: **17.08.84**

(30) Priority: **26.08.83 NO 833086**

(43) Date of publication of application:
08.05.85 Bulletin 85/19

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI NL SE

(71) Applicant: **NORSK HYDRO A/S**
Bygdoy Allé 2
N-Oslo 2(NO)

(72) Inventor: **Rasmussen, Trygve**
Ostrem
N-4250 Kopervik(NO)

(72) Inventor: **Vik, Per Kare**
Sorhaland
N-4280 Skudeneshavn(NO)

(74) Representative: **WILHELMS & KILIAN Patentanwälte**
Eduard-Schmid-Strasse 2
D-8000 München 90(DE)

(54) **Device for feeding molten metal to a strip casting machine.**

(57) A device for feeding molten metal to a continuous strip casting machine is disclosed. A nozzle including two exterior walls (71, 72) is provided with deflector plates (74-77) which form an integral part of the exterior walls. The deflector plates are shaped as oblong bodies essentially grouped in parallel, and the two outermost deflector plates (74, 74') also conform to the contour of the side plates (73, 73').

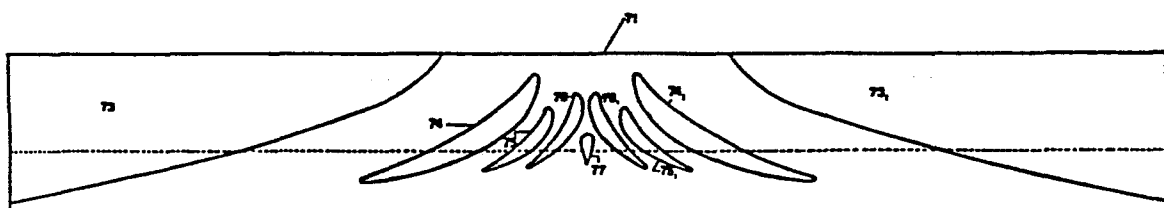


Fig. 3

NORSK HYDRO a.s.
Oslo / Norway

DR. ROLF E. WILHELMS
DR. HELMUT KILIAN

Device for feeding molten metal to a strip
casting machine

EDUARD-SCHMID-STRASSE 2
8000 MÜNCHEN 90

Priority: Aug. 26, 1983 - Norway - No. 833086

TELEFON (089) 65 20 91
TELEX 523467 (wlp-d)
TELEGRAMME PATRANS MUNCHEN
TELECOPIER gr. 2 (089) 222 066

The present invention concerns a device for feeding molten metal to a strip casting machine, especially of the type used for continuous casting between two rotating cylinders, e.g. as disclosed in U.S. Patent No. 3.405.757.

Today the casting of wide strips of different aluminium alloys on such casting machines is limited due to the difficulties of achieving appropriate product quality - surface and internal structure.

Several factors influence the strip quality. The most important ones include uniform, controlled feed of metal to the cylinders, casting temperature control, material and pressure distribution across the casting nozzles and nozzle quality. The final result depends on optimization and interaction at all stages of the total casting system, but nozzle design and quality seem to be crucial.

As regards nozzle materials, there are a number of requirements that must be fulfilled. They must be thermostable, homogeneous and free from stress after machining, heat insulating (low thermal conductivity), hard-wearing and at the same time machinable to exact dimensional tolerances, inert to the cast metal, they must not contain any components that are dangerous to health, they must be reasonably priced, they must have low weight and low hygroscopicity, etc.

A well-known and hitherto widely used fireproof, ceramics-like material sold under the name Marinite, in the form of compressed sheets with a hard surface, has now been abandoned for many applications because of its asbestos content and its relatively high hygroscopicity.

A common feature of the new replacement materials that have gradually appeared is their relatively poor mechanical strength. This results in heavy wear and, consequently, short nozzle life, and further problems of maintaining a uniform strip quality.

As regards graphite nozzles, it is customary to finish the nozzles by applying one or more layers on top of the graphite. U.S. Patent No. 4.175.611 describes several alternative materials and methods that may be used for this purpose. Such treatments make the nozzles more expensive - and their price level is scarcely competitive in the first place - and furthermore the graphite nozzles, despite their protection, are not well suited to casting aluminium and aluminium alloys.

Another material that is gaining more and more popularity within casting technology is based on alumino-silicates (45-50% Al_2O_3 and 45-55% SiO_2) and marketed under various names, e.g. under the name Triton Kaowool from the firm Morganite Ceramic Fibres Ltd. Here, too, the drawback is poorer mechanical strength than Marinite, which results in the above problems regarding quality and short nozzle life.

Besides the choice of material, uniform temperature and pressure distribution across the width of the nozzle are essential to the quality of strip cast aluminium and aluminium alloys. There are several designs, for which patents have been taken out, in which variations have been made as regards rate of insulation and shape and number of nozzles/nozzle outlets (U.S. Patent No. 2.790.216), inclination of nozzle orifice (U.S. Patent No. 3.405.757). Common to most known equipments is a high degree of complexity, heavy, complicated designs requiring a lot of time in connection with replacement of nozzles and starting up the strip casting process. In strip casting the economy of the process depends on a minimum of downtime periods and quick achievement of uniform product quality after starting up the process.

0139966

Consequently, the object of this invention is to provide a simple device for feeding molten metal that considerably improves the feeding and distribution of the metal in mould cavities between rotating cylinders.

It is further the object of the invented device to considerably reduce or eliminate surface defects and to improve the internal structure of the cast strips.

One further object of the invention is to provide a flexible, reasonable and light device that reduces the time required for disassembling and replacing casting system components to the absolute minimum.

These and other objects and advantages are achieved by means of a device according to the invention, the new and unique features of which will be described in more detail in the following specification and patent claims.

The invention will now be described in detail by means of drawings, Figs. 1 to 4, where

Fig. 1 shows a perspective view of a horizontal strip casting machine with auxiliary equipment for feeding molten metal,

Fig. 2 shows in more detail the nozzle, the rotating cylinders and the mould cavity formed between them in a vertical cross-section taken along the line I-I in Fig. 1,

Fig. 3 is a horizontal cross-section of the nozzle taken along the line I-I in Fig. 2, and

Fig. 4 is a schematic sketch of a horizontal cross-section of the nozzle with velocity profile of the cast material after leaving the nozzle.

The continuous casting unit, as shown in Fig. 1, includes a transfer gutter (1) between a holding furnace (not shown in the figure) and a buffer crucible (2), a fireproof, lined gutter (3) that leads the molten metal to a metal levelling box (4), and further a distributor box (5) and feed channel (6) connected to the nozzle (7) that discharges into the cavity formed between the two rotating cylinders (8). Solidified metal is shown behind the cylinders as a (pre)rolled strip.

After a retention in the holding furnace the metal, e.g. aluminium or its alloys, is fed through a fireproof, lined gutter (1) to the crucible (2), shown in the cross-section in the figure as resistance heated, two-chamber crucible, that represents a metal buffer in the casting system. This function is often combined with refining/purification and/or degassing of the metal at this stage. The crucible is further fitted with a temperature regulator (not shown in the figure) which is coupled to a heating device in order to ensure exact cast metal temperature control. A combination of fine temperature adjustment at this stage and extra-insulated metal gutters results in a low-energy casting process.

The treated metal is supplied in desired volume and at adjusted temperature to the levelling box (4) where the fine adjustment of the further metal flow takes place (adjustment equipment not shown in the figure). The casting equipment itself includes the distributor box (5), the feed channel (6) and the nozzle (7) which is designed and dimensioned to achieve utmost uniformity in filling of the mould cavity between the cylinders (8) with uniform pressure and temperature distribution across the full width of the nozzle.

The nozzle (7), as shown in Figs. 2 and 3, has two symmetrical exterior walls (71,72) with conical/inclined contour towards the cylinders (8) conforming to the contour of the cylinder.

The walls have been precast with all essential details from "Triton Kaowool" and with the surfaces of the inclined sections finely machined to exact tolerances.

In all essential aspects except for mechanical strength the material employed is superior to the Marinite hitherto used. "Triton Kaowool" is first and foremost less hygroscopic than Marinite, which eliminates special nozzle drying and storage in cabinet drier prior to installation and all special measures that had previously to be taken during start-up of the casting process. Furthermore, this material has better insulating characteristics, i.e. reduces thermal loss, and this further adds to the low-energy profile of the casting process. In addition, "Triton Kaowool" contains absolutely no asbestos fibre, and consequently it satisfies the heavy demands for occupational hygiene.

Furthermore, the nozzle design has been simplified by pre-casting the exterior walls with integrated spacer and deflector plates (73,74,75,76,77). The nozzle walls are finished in a mould, using a special vacuum casting process. The material, originally a mixture of mineral fibres, binder and water, is dried and heat-treated after casting to required form stability - tolerances and surface conditions. This is a special feature according to the present invention which reduces considerably the nozzle assembly and the replacement rate because, in order to achieve optimum flow configuration, the critical deflector plate spacings and inter-relations have been taken care of automatically as far back as the nozzle component production stage.

Fig. 3 shows the above mentioned deflector plates in more detail in a horizontal cross-section of the nozzle (7). The exterior wall (71) is fitted with a wedge-shaped deflector plate/spacer (73,73') on each side which defines or delimits the inlet section (cavity) of the nozzle. These spacer side plates (73,73') serve a dual purpose in the nozzle - uniform

distribution of the molten metal across the full width of the nozzle, and as spacer and bracing against the other symmetrically arranged and interacting exterior wall.

Furthermore, this wedge-shaped form of the side plates also results in the desired temperature profile across the full width of the nozzle, with maximum thermal insulation outermost on the sides with reduced metal flow. The uniform distribution of the metal flow, pressure and temperature is further ensured by means of the deflector plates (74,75,76,77,74',75',76') integrated in the exterior wall. This solution is simpler, safer and even cheaper than the nozzle systems hitherto used, with several feed channels, deflector plates placed in special distributor boxes in front of the nozzle, etc.

Their design, size and positioning in relation to one another is based on a systematic development effort with many model experiments. According to the present invention the result of this effort is deflector plates shaped as oblong bodies grouped essentially in parallel that split up the main inlet section or cavity (79) of the nozzle into a number of discrete distributor channels. These channels ensure a uniform, laminar flow pattern without "dead" or turbulent zones which have an adverse effect on the cast strip quality - gas content, occlusions and surface quality.

The invention is illustrated in more detail through the following examples with results from the model experiments.

Examples

The model experiments were carried out with a full-size nozzle made of transparent Plexiglass. The flow velocity in the nozzle with different arrangements of the deflector plates was measured by measuring the time taken by the liquid to flow a defined distance. This was facilitated by adding dye to the liquid.

The following parameters were changed during the experiments in order to achieve optimum nozzle geometry:

- a) deflector plate size and positioning in relation to one another
- b) deflector plate shape/design
- c) plate inclination in relation to the vertical axis of the nozzle, and
- d) number of deflector plates

Table 1 shows a selection of the most representative experiments.

Table 1 Results from the model experiments with nozzle geometry

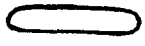
Experiment No.	Number of plates	Shape of plates	Inclination	Deviation of velocity %	Dead zones/ turbulence
1	4		80-90°	150-200	yes/yes
2	12		60°	120-150	yes/yes
3	8		60°	200	yes/yes
4	3		0-30°	50	no/partly
5	7		0-60°	20	no/no

Fig. 4 shows the nozzle (7) schematically in a horizontal cross-section, the inserted velocity profile at the nozzle orifice being based on optimum configuration of the deflector plates - experiment No. 5 in Table 1.

The velocity profile has been plotted in accordance with tabulated values as deviation from the minimum velocity measured, expressed in percentages.

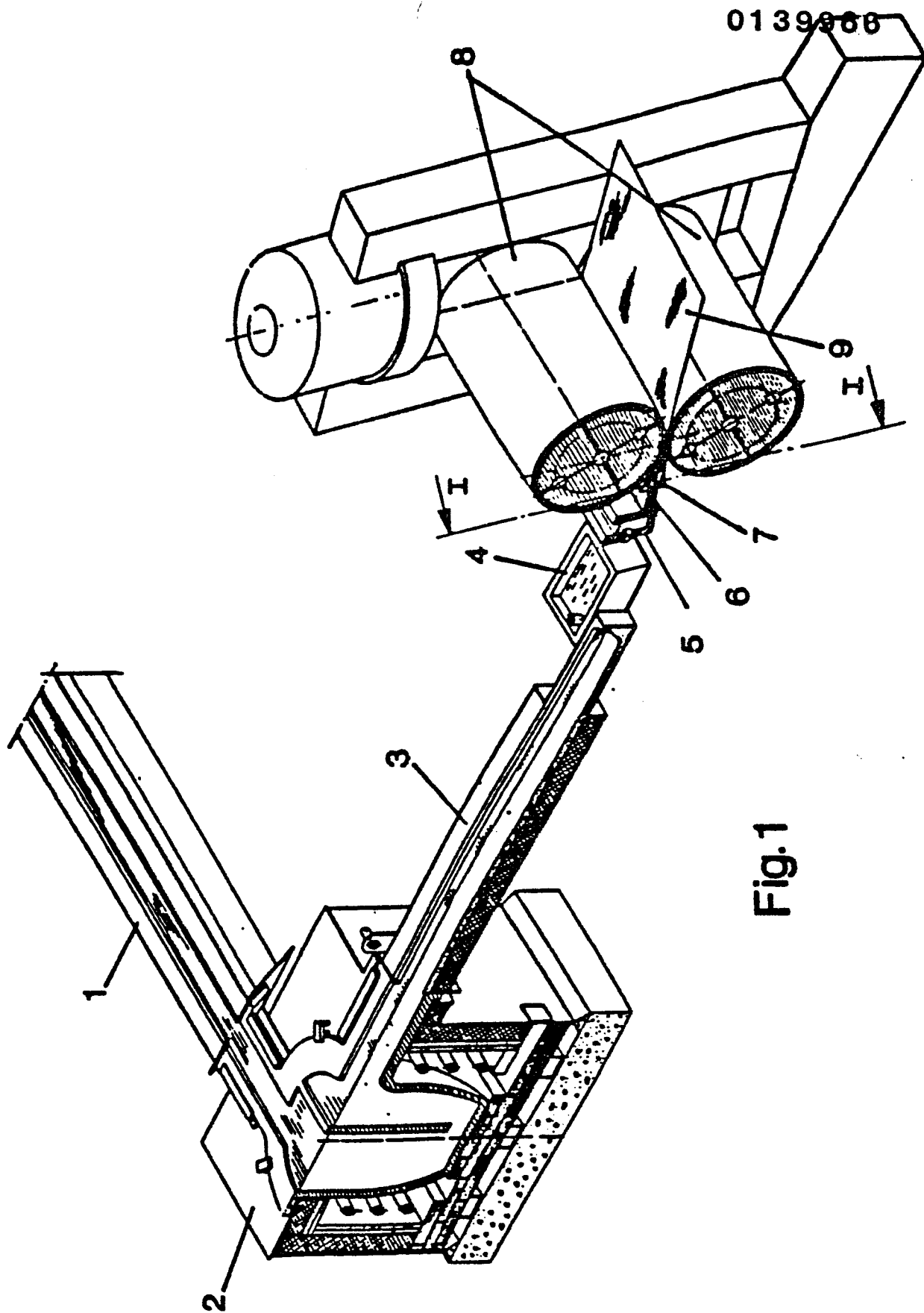
The invention, as specified above and illustrated by means of the attached drawings, is not limited to the nozzle designs shown/mentioned. The deflector plates may be integrated (as shown in the figures) with the lower exterior wall, but also with the upper exterior wall, possibly distributed between the two of them. The number of plates and the spacing between them may vary with the nozzle size (width), and also with the plate inclination, but all these variations of nozzle geometry/plate configuration will fall within the scope of this invention.

Claims

1. A device for feeding molten metal to the mould cavity formed between two continuously moving parallel walls, for instance two rotating cylinders (8) in a strip casting machine, comprising a nozzle (7) with conical or inclining exterior walls (71,72) which conform to the contour of the cylinder surfaces and are provided with spacer side plates (73,73') and deflector or distributor plates (74-77),
c h a r a c t e r i z e d i n t h a t
at least one of the exterior walls (71,72) is provided with deflector plates (74-77) which constitute an integral part of the exterior wall and which are shaped as oblong bodies grouped essentially in parallel.
2. Device according to claim 1,
c h a r a c t e r i z e d i n t h a t
the exterior deflector plates (74,74') conform to the contour of the side plates (73,73') which are also integrated in the exterior walls.
3. Device according to claim 1 or 2,
c h a r a c t e r i z e d i n t h a t
the outermost deflector plate (74) is situated in relation to the side plate (73) in such a way that the channel formed between these two plates has a width of at least half, and preferably two thirds of the cavity width available at the inlet section of the nozzle.

0139966

4. Device according to one or several of the above claims,
c h a r a c t e r i z e d i n t h a t
the number of deflector plates is at least one, and
preferably three deflector plates placed on each side
of a central plate (77) in the cavity of the nozzle.



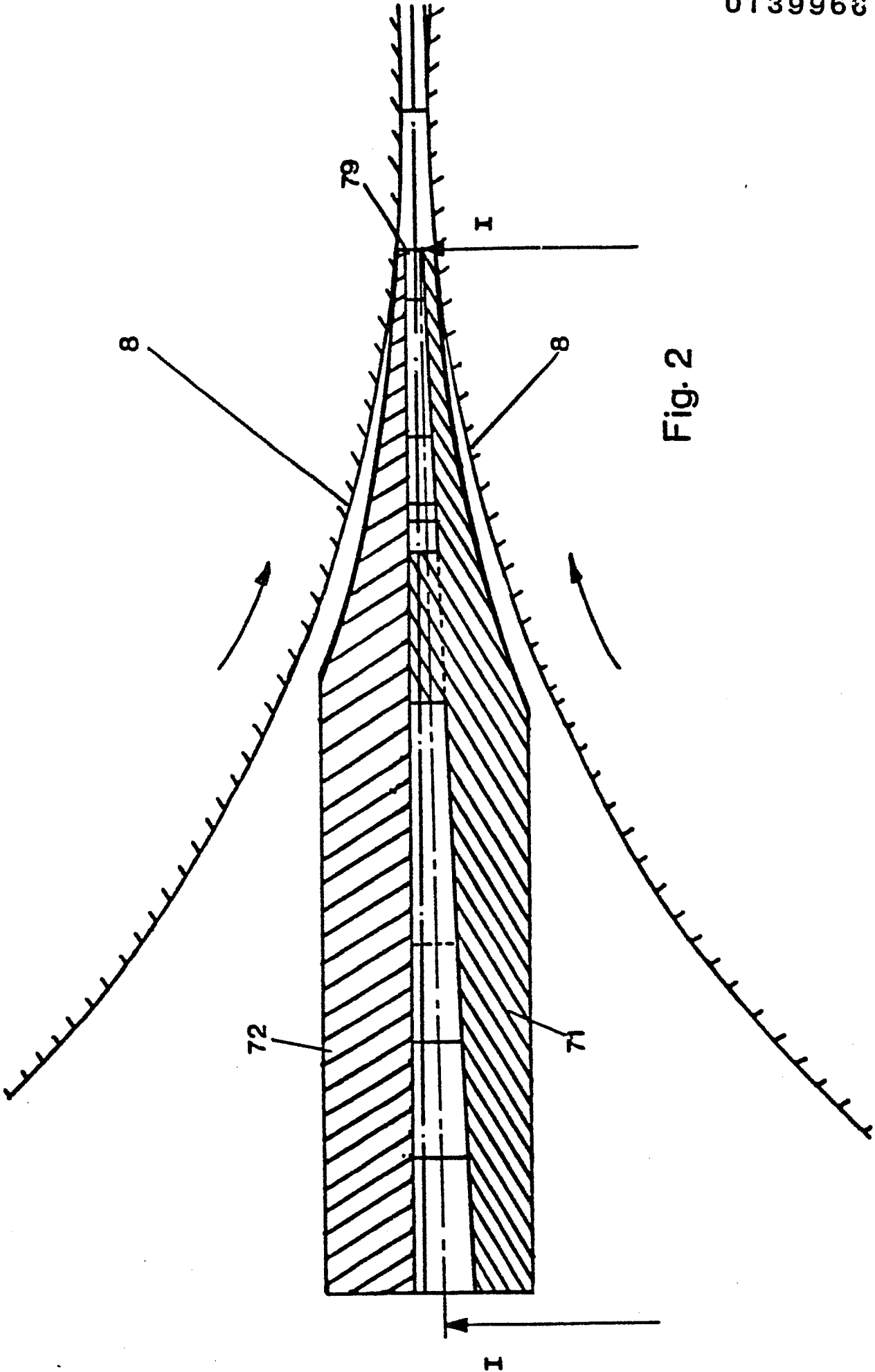


Fig. 2

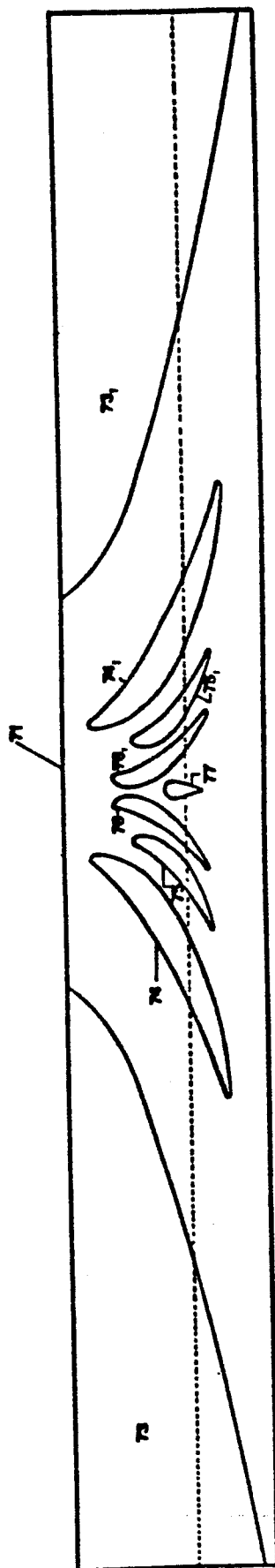


Fig. 3

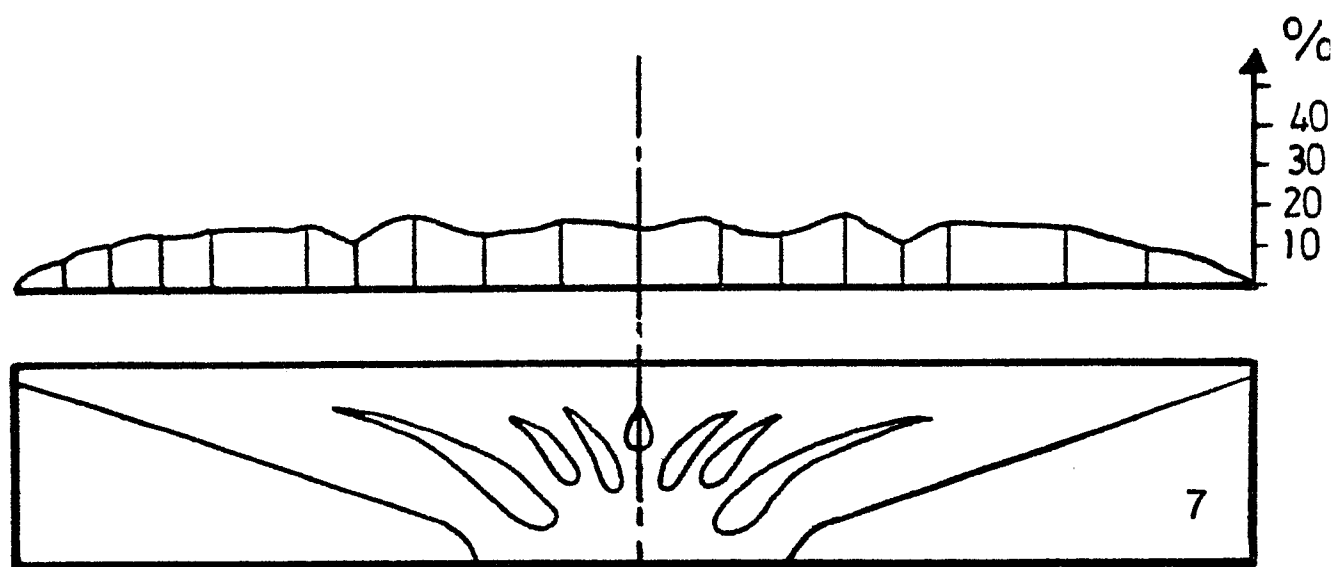


Fig. 4



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,P	PATENT ABSTRACTS OF JAPAN vol. 8, Nr. 73, 5th April 1984, (M-287) (1510); & JP-A-58-218353 (KAWASAKISEITETSU K.K.) 19-12-1983 (Cat. P)	1	B 22 D 11/04 B 22 D 11/06 B 22 D 35/00
A,P	--- PATENT ABSTRACTS OF JAPAN vol. 7, Nr. 269, 30th November 1983, (M-259) (1414); & JP-A-58-148056 (SHIN NIPPON SEITETSU K.K.) 03-09-1983 (Cat. P)	1	
D,A	--- US-A-3 405 757 (L.M. HARVEY et al.)		
D,A	--- US-A-4 175 611 (FLETCHER)		
D,A	--- US-A-2 790 216 (J.L. HUNTER)		

The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 22 D 11/00 B 22 D 35/00
Place of search BERLIN		Date of completion of the search 15-11-1984	Examiner GOLDSCHMIDT G
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 P : intermediate document T : theory or principle underlying the invention 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			