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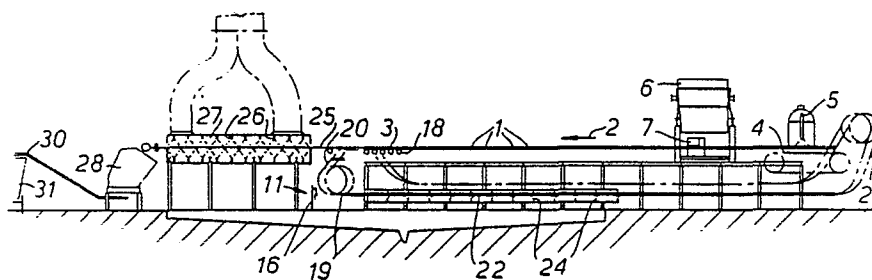
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(54) Continuous casting of metal.

(57) Apparatus for continuously casting metal strip includes a plurality of individual mould segments (1) movable about an endless path having an upper flight and a vertically displaced lower flight.

Liquid metal is cast from a tundish (7) onto the mould segments and a starter bar (11) is positioned within one or more mould segment and to inhibit the flow of liquid metal in a

direction counter to the intended direction of travel of the mould segments. The solidified cast strip is removed from the mould segments and, positioned downstream of the point of removal of the cast strip, is a device (16) which is adapted to engage with and remove the starter bar from the mould segments.



CONTINUOUS CASTING OF METAL

This invention relates to the continuous casting of metal and more especially but not exclusively, to casting molten metal from a melting or smelting furnace into a strip form which can readily either be rolled and/or processed to
5 form a semi-finished or finished strip product or be fragmented for subsequent use as a feedstock, deoxidant, or alloying addition in, for example, a steel-making vessel.

Various proposals have been made previously for continuously casting metal strip. For example, in USA Patent
10 3703204, there is disclosed the concept of casting molten metal into a horizontally moving channel-shaped mould of so-called ablative material, such as papier mache, which is charred or burned onto the molten metal to form a mould surface during its solidification therein. It is also known
15 to continuously cast molten metal into channel-shaped moulds lined with a non-sacrificial ceramic material.

In our Copending British Patent Application No. 80 24389 there is described apparatus for producing a ferrous feedstock for subsequent use in a melting or smelting furnace.
20 The apparatus comprises a channel-shaped iron substrate movable in a generally horizontal direction continuously past a casting station, means at said casting station operable to cast molten ferrous material continuously onto said substrate to produce a solidified metal strip means for
25 separating the strip from the substrate and means for frag-

menting the solidified strip into segments of a size suitable for use as a ferrous feedstock.

The present invention is directed to a device for use with said and similar apparatus which enables the required
5 strip thickness to be achieved by use of a starter bar which is subsequently automatically removed from the mould substrate.

According to the present invention, there is provided apparatus for continuously casting metal strip including
10 a channel-shaped substrate comprising a plurality of individual mould segments movable about an endless path having a generally horizontal upper flight and a vertically displaced lower flight, casting means operable to cast liquid metal onto the substrate, a starter bar adapted to be posi-
15 tioned within one or more mould segments and to inhibit the flow of liquid metal beyond said one or more mould segments, means for removing the solidified cast strip from the substrate and means positioned downstream of the point of removal of the cast strip from the substrate and adapted
20 to engage with and remove the starter bar from said one or more mould segments.

The starter bar may comprise a base which seats within a mould segment and one or more upstanding and forwardly protruding arms which engage catch plates forming part of
25 said starter bar removal means.

The metal cast continuously on to the substrate may comprise molten iron from an iron making vessel(eg.a blast furnace)or molten steel from a steel-making vessel or molten ferro alloy from a melting unit (eg a blast furnace or smelting vessel). The cast product may be of a substantially uniform thickness (for example 25mm)and may subsequently be grooved to facilitate subsequent fragmentation.

Alternatively, grooves may be cast into the strip product by virtue of the configuration of the substrate or may be formed into the upper surface of the strip as it solidifies by means of a roller having an indented surface rotatable in contact with the strip surface. Thus,the substrate may be formed with laterally and/or longitudinally extending grooves.

Coolant, eg a water spray, may be directed onto the surface of the cast strip to assist solidification of the same.

In one application of the invention,the furnace comprises a blast furnace or an electrical smelting or melting furnace.The ferrous material may comprise molten iron,steel or ferro alloy, eg.ferro manganese,ferro chrome, ferro silicon,ferro vanadium, ferro molybdenum, ferro boron or ferro titanium.

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

Figures 1 & 2 are respectively,side elevational and plan view of apparatus in accordance with the invention ;

Figure 3 is a cross-section to an enlarged scale taken along line III-III of Figure 2;

Figure 4 is a side elevational view taken in the direction of arrow A of Figure 3;

5 Figure 5 is a side elevational view to an enlarged scale of a detail of Figure 1; and

Figure 6 is a view taken in the direction of arrow B of Figure 5.

The apparatus illustrated comprises a substrate consisting of a plurality of channel shaped mould segments 1 movable by a system of belts, rollers and chains continuously around an endless path. The shape and configuration of the individual mould segments can be seen more clearly from Figures 3 and 4 and their direction of movement is indicated by arrow 2
15 in Figures 1 and 2.

From Figures 1 and 2 it will be seen that the upper flight of the endless path travelled by the mould segments comprises a generally horizontal roller table 3. Positioned at the entry end of the roller table is a steel bushed roller chain conveyor 4 operable beneath the mould segments and between the adjacent rollers of the roller table to drive the mould segments along the table at a substantially constant speed. For this purpose the chain conveyor 4 is formed with pusher attachments (not shown) which co-operate with lugs or
20 indentations formed in the mould segments. Thus, over the
25

entire length of the upper flight of the endless path adjacent mould segments abut to present a continuous substrate surface with no spacings between individual mould segments.

A spraying apparatus 5 for depositing a coating material e.g. graphite on to the upper surfaces of the mould segments is positioned above and to one side of the roller table at its entry end.

As the coated mould segments travel along the roller table 3 liquid metal from a casting ladle 6 is poured via a tundish 7 continuously on to the abutting mould segments to form a continuous metal strand. In order to inhibit movement of liquid metal along the mould substrate surface in a direction counter to the direction of travel of the mould segments, a graphite end bar 8 is positioned just upstream of the casting station. This end bar is illustrated in greater detail in Figure 3 and comprises a graphite block 9 which is supported above and in contact with the mould segment upper surface to completely fill the same and to prevent the flow of liquid metal in the aforesaid direction.

During the initial casting of liquid metal onto the mould substrate, it is necessary to restrict movement of the metal in the intended direction of travel of the substrate until the liquid metal height reaches a level consistent with the required cast strip thickness. For this purpose, a starter bar 11 is located within the stationary substrate

mould prior to initial casting at a location just downstream of the casting station. As will be seen from Figures 5 and 6, the starter bar comprises a plate-like base 12 which seats within and completely fills the widthwise dimension of one
5 mould segment and has two upstanding and forwardly protruding arms 13 each of which carries a lug 14. The lugs 14 are adapted to engage recessed catch plates 15 supported on stands 16 positioned so as to remove the starter bar from the respective mould segments as it moves downwardly from
10 the horizontal roller table 3.

The cast liquid metal rapidly cools and solidifies within the mould segments, the segments being relatively massive so as to extract heat from the cast metal. At a location along the roller table sufficiently remote from
15 the casting station to enable solidification to have taken place the solidified cast strip is stripped from the mould segments by means of a stripping conveyor 18. This conveyor comprises two strands of steel bushed roller conveying chains arranged on a Paternoster principle each strand having
20 carrier attachments (not shown) at a constant pitch. The stripping conveyor 18 collects each individual mould segment 1 by engagement of the carrier attachments with the mould segment lugs or indentations, conveys the segment off from the roller table 3, lowers the segment and transfers it down
25 a shallow incline past the catch plates 15 for subsequent

transfer to a return conveyor 19. At its upper end the stripping conveyor 18 is arranged to operate beneath the mould segments within the segment width and between the adjacent rollers of the roller table 3.

5 The return conveyor 19 operates to return the mould segments from the stripping conveyor to the end of the roller table adjacent the spraying apparatus 5. The conveyor 19 again comprises two strands of steel bushed roller conveying chains arranged on a Paternoster principle and between which
10 the mould segments are supported. The chain strands are equipped with extending bearing pins or similar attachments (not shown) for location in the indented sides of the mould segments.

 The return conveyor 19 has inclined sections 20, 21
15 respectively for transfer of the mould segments off from the stripping conveyor 18 and for reintroduction of the mould segments on to the roller support table 3.

 As each mould segment travels along the lower flight of its endless path, it is additionally supported on a gravity
20 roller track 22. As the mould segments travel along the roller track 22 their upper and lower surfaces are cooled by water sprays 24.

 The conveyors 4 18 and 19 are driven from one main motor drive and reduction gear unit (not shown) via constant
25 speed layshaft and final chain drives of the required ratios

to the respective conveyor driving wheels. The drive for the stripping conveyor 18 is derived from the tail wheel shafts of the return conveyor 19 by the inclusion of 1:1 ratio final chain drives.

5 On initial casting, the mould substrate remains stationary until the the liquid metal confined by the starter bar 11 reaches the required level. Once this has been achieved, the mould segments are moved by the bushed roller chain conveyor 4
10 along the roller table 3. As the mould segment carrying the starter bar is moved downwardly by the stripping conveyor 18, the lugs 14 of the starter bar engage the recessed catch plates 15 thereby causing the starter bar to slide from its seating within the mould segment and be supported wholly by the catch plates 15.

15 Following stripping of the mould segments 1 from the solid cast strip by the conveyor 18, the cast strip 25 continues its generally horizontal travel along the roller table 3 and is further cooled by coolant sprays 26 within a spray chamber 27. The fully solidified strip is then
20 broken- up into segments of the required size and shape by a rotary hammer 28 and crushing rolls, the segments then being transferred via a conveyor 30 into a container 31.

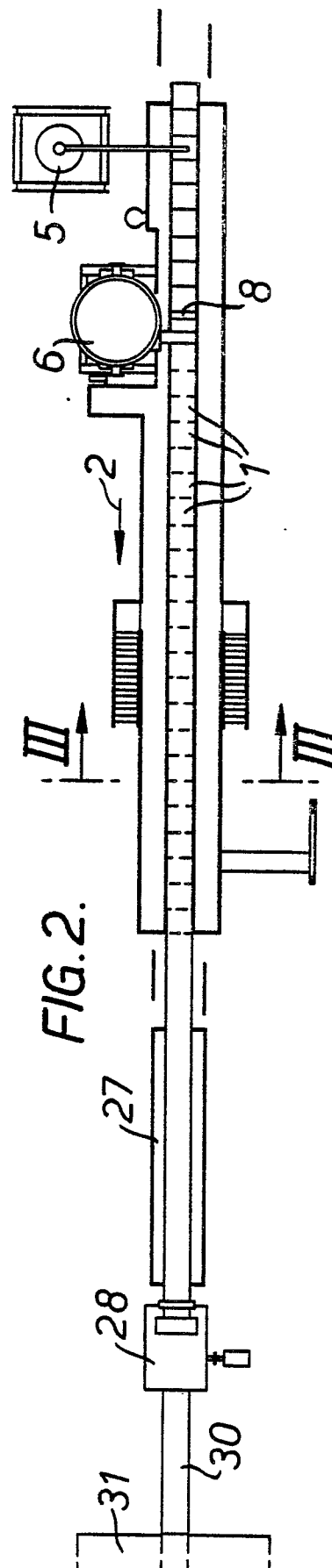
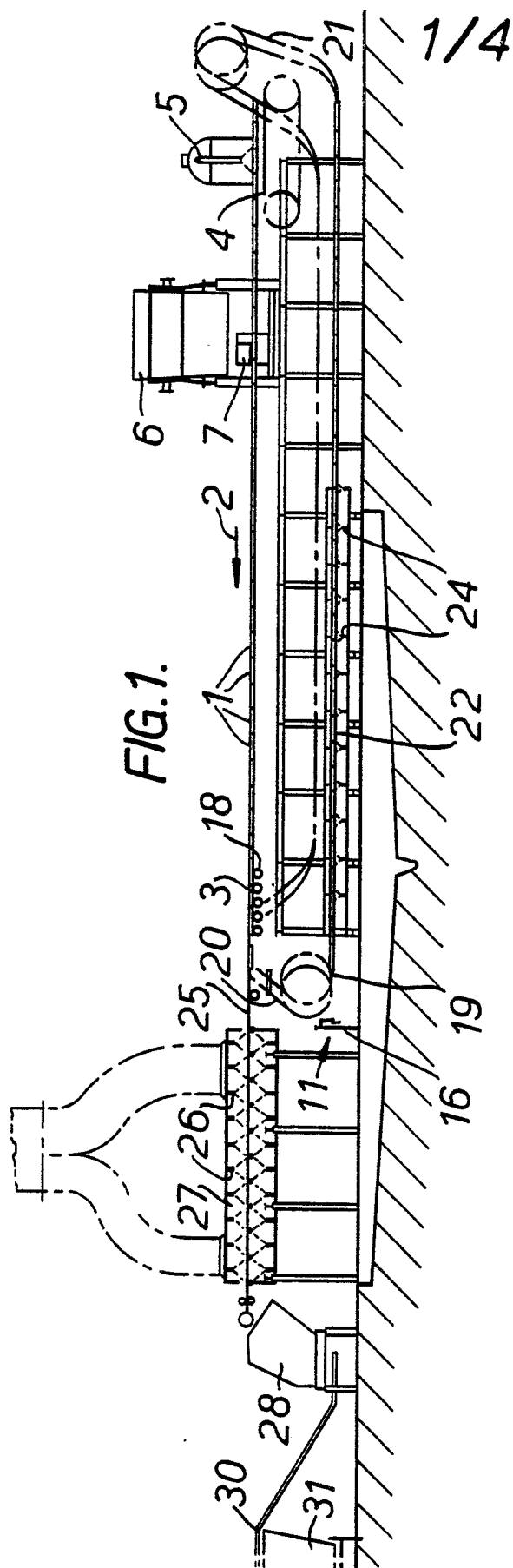
 Burners may be provided to preheat the starter bar and individual mould segments before liquid metal is first cast
25 onto the mould surfaces. Conveniently, the burners for

preheating the mould segments are positioned to preheat the individual mould segments as they approach the entry end of the roller table 3. i

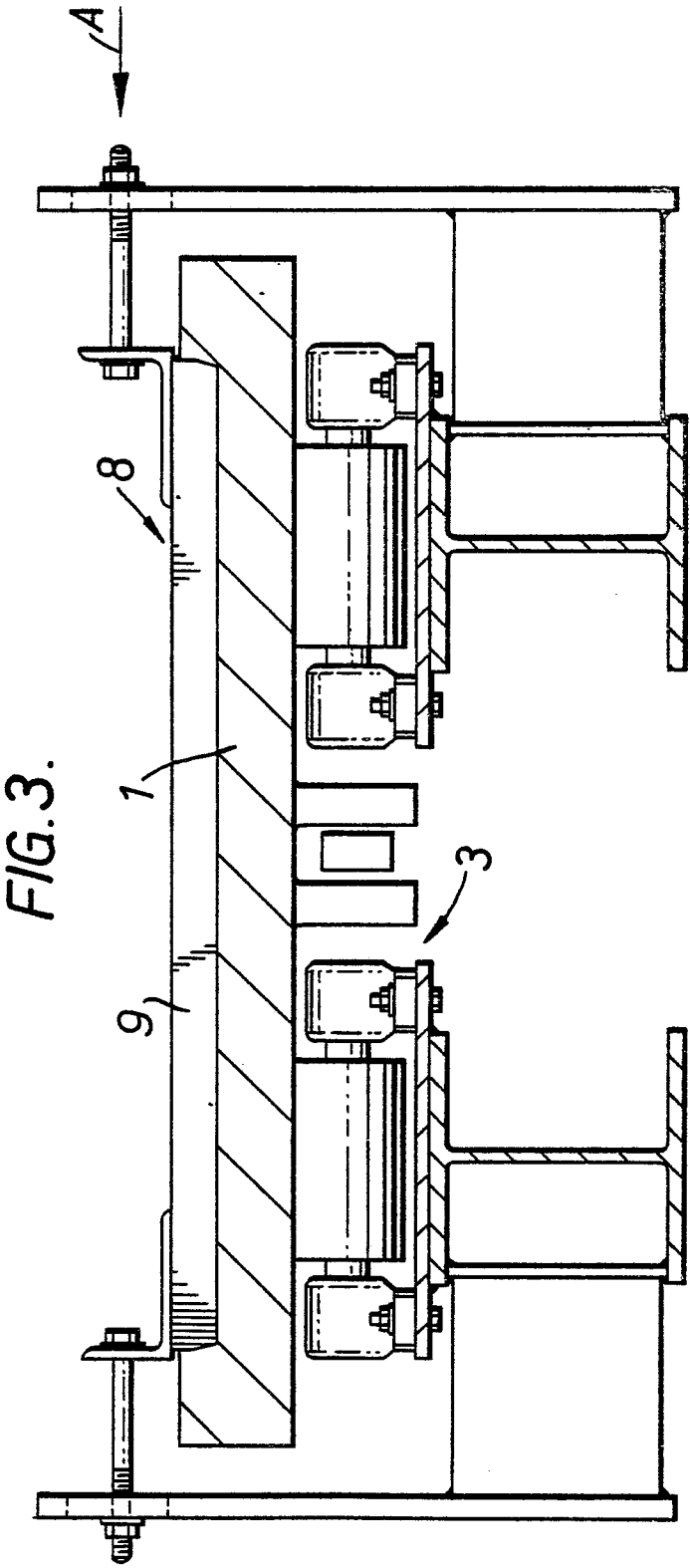
Claims :

- 1) Apparatus for continuously casting metal strip characterised by a channel-shaped substrate comprising a plurality of individual mould segments (1) movable about an endless path having a generally horizontal upper flight and a vertically displaced lower flight, casting means (7) operable to cast liquid metal onto the substrate, a starter bar (11) adapted to be positioned within one or more mould segments and to inhibit the flow of liquid metal beyond said one or more mould segments, means (18) for removing the solidified cast strip from the substrate and means (15,16) positioned downstream of the point of removal of the cast strip from the substrate and adapted to engage with and remove the starter bar from said one or more mould segments.
- 2) Apparatus as claimed in Claim 1 wherein the starter bar comprises a base (12) which seats within a mould segment and one or more upstanding and forwardly protruding arms (13) which engage catch plates (15) forming part of said starter bar removal means.
- 3) Apparatus as claimed in Claim 1 or Claim 2 wherein the starter bar removal means is positioned to engage the starter bar (11) as the mould segments which carry the starter bar pass between the upper and lower flights of the aforementioned endless paths.

- 4) Apparatus for continuously casting metal strip substantially as herein described with reference to the accompanying drawings.



2/4



3/4

FIG. 4.

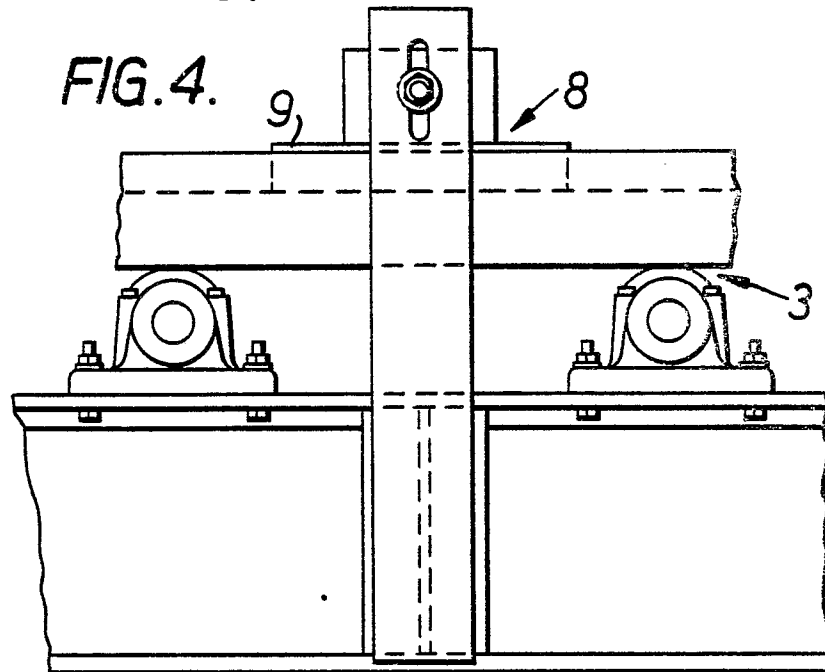


FIG. 5.

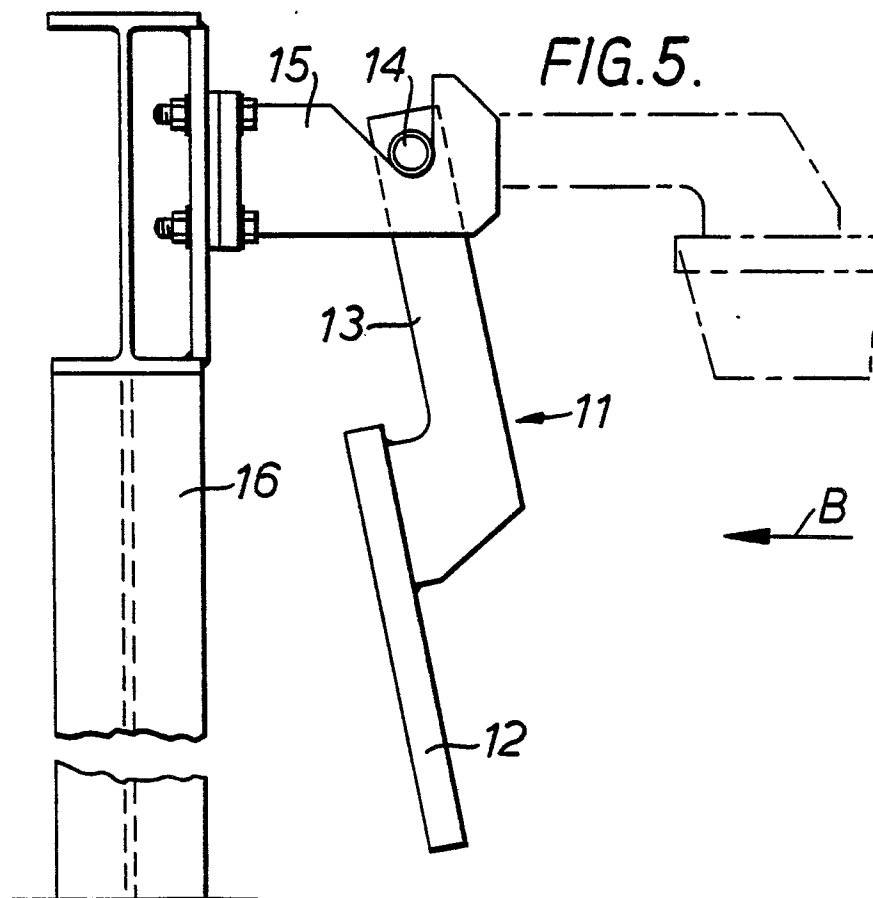
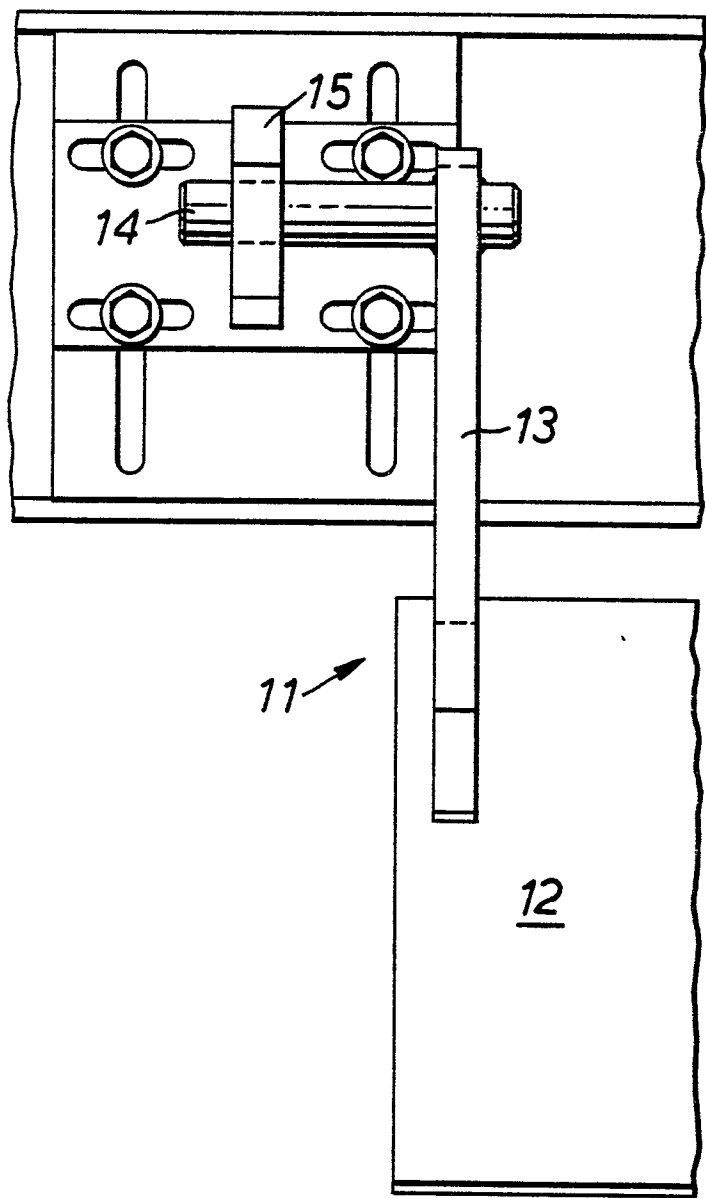


FIG. 6.





European Patent
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EUROPEAN SEARCH REPORT

0060661
Application number

EP 82 30 1138.2

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	US - A - 3 645 321 (C.G. ROBINSON) * claims 1 to 6 * --	1	B 22 D 5/04 B 22 D 11/00 B 22 D 11/06
A	DE - B2 - 2 462 136 (MITSUI MINING & SMELTING CO., LTD.) * claim *	1	
A	DE - U - 6 914 066 (NIPPON LIGHT METAL CO. LTD.) * fig. 1 *	1	
A	US - A - 3 502 136 (W.H. PARMELEE et al.) * fig. 1 *	1	
D,A	US - A - 3 703 204 (D.W. BROWNSTEIN) * claims 1 to 5 * ----	1,2	B 22 D 5/00 B 22 D 11/00
			TECHNICAL FIELDS SEARCHED (Int.Cl.3)
			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
X The present search report has been drawn up for all claims			
Place of search Berlin		Date of completion of the search 04-05-1982	Examiner GOLDSCHMIDT