(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 141 511 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 84306131.8

(22) Date of filing: 07.09.84

(51) Int. Cl.⁴: B 21 B 45/02

(30) Priority: 10.09.83 GB 8324292

(43) Date of publication of application: 15.05.85 Bulletin 85/20

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

(71) Applicant: ASHLOW LIMITED
Sheffield Road
Rotherham S60 1EE(GB)

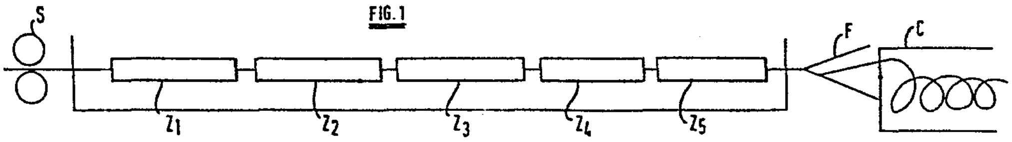
(72) Inventor: Cooper, Arthur Edward
56 Cherry Bank Road
Sheffield S8 8RD(GB)

(74) Representative: Leach, John Nigel et al,
FORRESTER & BOEHMERT Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) Apparatus for and method of cooling elongate stock.

(57) An apparatus for cooling elongate stock such as wire rod after hot rolling in a rolling mill comprises a cooling zone (Z2) having a cooling tube (10), a coolant injector (11) to inject liquid coolant into the cooling tube (10), means (12) downstream of the cooling tube (10) to strip the liquid coolant from the stock wherein a purge injector (15) is provided to inject a gaseous fluid such as air into the cooling tube (10) to displace liquid coolant therefrom.

FIG. 1



Croydon Printing Company Ltd.

Title: "Apparatus for and method of cooling elongate stock"

This invention relates to a method of and apparatus for cooling elongate stock, such as wire rod, after hot rolling in a rolling mill.

Wire rod from a hot rolling mill is conventionally cooled by passage through a series of cooling zones in each of which the rod is passed through a cooling tube into which liquid coolant is injected and, at the downstream end of the cooling tube there is a stripper injector which directs liquid coolant in a direction so as to strip coolant from the wire rod emerging from the cooling tube. Generally, in each zone, there is at least one further cooling tube into which liquid coolant is injected, upstream of said first mentioned cooling tube. Such an arrangement is shown in German specification OS 2151210.

In this, and all similar arrangements, after the tail end of a length of rod has passed through the tube or tubes of a zone, and before the nose end of a next following length of rod can be permitted to enter the tube or tubes, any liquid coolant remaining in the or each tube must have drained out. This is because at high speeds of operation if the nose end of the next following wire rod were to encounter water in a tube, a cobble would occur.

The period of time which must be allowed for any coolant present in the tube or tubes to drain therefrom limits the rate of production.

It is accordingly one object of the present invention to provide a new or improved apparatus for cooling elongate stock, such as wire rod after hot rolling which permits of increase in the rate of production compared with that hitherto obtainable.

According to one aspect of the present invention, we provide an apparatus for cooling elongate stock after hot rolling in a rolling mill comprising a cooling zone having a cooling tube, a coolant injector to inject liquid coolant into the cooling tube, means downstream of the cooling tube to strip the liquid coolant from the stock wherein a purge injector is provided to inject a gaseous fluid into the cooling tube to displace liquid coolant therefrom.

Thus the injection of gaseous fluid causes any liquid coolant remaining in the cooling tube when the injection of coolant has ceased, to be positively purged from the cooling tube rather than merely allowing the liquid to drain therefrom. This allows for the period of time between feeding lengths of stock to be reduced thereby increasing production rates.

The purge injector is preferably provided downstream of the coolant injector, in which case the purge injector for introducing the gaseous fluid into the cooling tube may be adjacent the upstream end thereof.

The gaseous fluid may be injected into the cooling tube in a direction lying in a conical surface, the apex of the cone pointing in the downstream direction although alternative arrangements are no doubt possible.

Alternatively, the purge injector may be provided in combination with the coolant injector, means being provided to permit of substitution of the gaseous fluid supply used for purging with a liquid coolant supply used for cooling.

Alternatively, where the means to strip the liquid coolant from the stock comprises a stripper injector which injects a fluid, such as a liquid, in an upstream direction, the purge injector may be provided in combination with the stripper injector.

The stripper fluid could comprise a gaseous fluid, but where the stripper fluid is a liquid, means are required to permit of substitution of the gaseous fluid supply used for purging with a liquid fluid supply used for stripping.

A guide tube may be provided downstream of said cooling tube but upstream of the stripper means and a second purge injector may be provided to inject a gaseous fluid into the guide tube to displace liquid coolant therefrom.

The second purge injector may be provided at the downstream end of the guide tube and the gaseous fluid may be injected by the second purge injector in a direction lying in a conical surface, the apex of the cone pointing in an upstream direction.

A further guide tube may be provided downstream of said stripper means and a further purge injector may be provided to inject a gaseous fluid into the "stripper" guide tube to displace liquid coolant therefrom.

Gaseous fluid may be introduced into the further guide tube adjacent the upstream end thereof.

Again, the gaseous fluid may be introduced into the further guide tube in a direction lying in a conical surface, the apex of the cone pointing in the downstream direction.

The or each purge injector may comprise a manifold extending around, for example surrounding, or partly surrounding, an associated cooling or guide tube and there may be a plurality of passages extending through the wall of the tube to permit of passage of gaseous fluid from the manifold to the interior the tube, the passages each having a central axis lying on said conical surface.

The cooling zone may include at least one further cooling tube and associated coolant injector and first purge injector, upstream of said first mentioned cooling tube.

In that case, an intermediate guide tube may be positioned downstream of the additional cooling tube, the intermediate guide tube being provided with a purge injector as defined above.

A plurality of cooling zones may be provided in series.

A rolling mill may be positioned upstream of the cooling zone or zones and where the stock is wire, a coil former and a cooling conveyor downstream of the cooling zone or zones.

According to another aspect of the invention, we provide a method of cooling elongate stock after hot rolling in a rolling mill comprising the steps of passing the stock through a cooling tube, injecting liquid coolant into the cooling tube at an upstream end thereof, stripping the coolant from the stock at the downstream end of the cooling tube, terminating the injection of liquid coolant approximately as the tail end of the stock leaves the rolling mill, injecting a gaseous fluid into the cooling tube to displace liquid coolant therefrom.

The fluid may be injected in an upstream direction to strip liquid coolant from the stock, and the injection of liquid coolant may be re-started as the nose end of a new length of stock is subsequently fed through the thus cleared tube at high speed.

Preferably, the injection of liquid coolant is re-started after the nose end of the length of stock leaves the cooling tube.

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

FIGURE 1 is a diagrammatic side elevation of a wire rod cooling line;

FIGURE 2 is a diagrammatic side elevation, to an enlarged scale, of one of the cooling zones of the line of Figure 1;

FIGURE 3 is a cross-sectional view, to an enlarged scale, of part of the zone of Figure 2; and

FIGURE 4 is a cross-sectional view, to an enlarged scale, of another part of the zone of Figure 2.

Referring to the drawings, a rod cooling line comprises a series of five cooling zones Z1-5. If desired, the number of cooling zones may be more or less than five. In the present example, each cooling zone is similar and hence only one cooling zone, i.e. that identified at Z2 in Figure 1, will be described in detail with reference to Figure 2.

The cooling zone shown in Figure 2 has a cooling tube 10 and an associated liquid coolant injector 11 at the upstream end of the cooling tube 10. Downstream of the cooling tube 10 is a guide tube 14, and further downstream of the tube 10 is a stripper injector 12. Still further downstream is a further tube 13.

Upstream of the cooling tube 10 and associated liquid coolant injector 11 is an additional cooling tube 10a and associated liquid coolant injector 11a, as well as a further guide tube 14a between the further cooling tube 10a and coolant injector 11, as well as a still further guide tube 14b upstream of the coolant injector 11a.

Thus in the present example, the cooling zone Z2 shown in Figure 2 has two cooling tubes 10, 10a and associated liquid coolant injectors 11, 11a respectively, together with a single stripper injector 12. If desired, the cooling zone Z2 could contain only the cooling tube 10 and associated injector 11 together with the stripper 12. Alternatively, further additional cooling tubes and associated coolant injectors with, as required, intermediate guide tubes, may be provided upstream of the cooling tube 10a.

Also, if desired, different ones of the cooling zones Z1 to Z5 may have a different number of cooling tubes and associated coolant injectors.

The series of cooling zones Z1-Z5 are provided, in the example described, downstream of the last stand S of a hot rolling finishing mill and upstream of a coil former F and cooling conveyor C on which the coils are laid.

Adjacent the upstream end of the cooling tube 10 there is provided a first air purge injector 15 positioned as close as practicable to the coolant injector 11. A second air purge injector 17 is provided at the downstream end of the guide tube 14 whilst a still further air purge injector 16 is provided at the upstream end of the guide tube 13.

An air purge injector 15a, analogous to the purge injector 15 is provided at the upstream end of the cooling tube 10a and purge injectors 17a, 17b, analogous to the injector 17, are provided at the downstream ends of the guide tubes 14a, 14b respectively.

Each of the cooling tubes 10, 10a, and associated liquid coolant injectors 11, 11a are similar, purge injectors 15, 15a, 16, are similar and purge injectors 17, 17a, 17b are similar, and hence only cooling tube 10 and purge injectors 15 and 17 will hereinafter be described with reference to Figures 3 and 4.

In the present example, cooling tube 10, in addition to guide tube 13 and 14 each have an internal diameter of 19mm and the wire rod to be cooled may have a diameter lying anywhere in the range 5mm to 16mm. If desired, the cooling and guide tubes may have an internal diameter lying the range 12mm to 25mm.

The liquid coolant injector 11 provided at the upstream end of the tube 10 comprises a cylindrical body 20 within which is defined a generally annular in cross-section manifold 21 to which liquid coolant, in the present example water, is fed via an inlet 22. A sleeve 23 is removably and adjustably mounted at the upstream end of the body 20 by means of a screw-threaded connection 23a and has an internal passage 24 of 20mm diameter. The diameter of the passage 24 can be varied to suit varying rod sizes. Typically, the following relationship between rod diameter and the diameter of passage 24 is arranged:-

Rod Diameter	Passage Diameter
5.0mm - 8.5mm	15mm
8.5mm - 12.5mm	20mm
12.5mm - 16mm	25mm

The above mentioned typical figures ensure that there is a minimum difference of 6mm in total between the diameter of rod and the sleeve.

The external surface of the sleeve 23 at the downstream thereof is frusto-conical as indicated at 25 and co-operates with a frusto-conical recess 26 of a further sleeve 27 which is received in the body 20 by means of a further screw threaded connection as indicated at 28. As a result, a conical passage 29 is provided between the surfaces 25 and 26, the width of which can be adjusted by axial movement of the sleeve 23 by virtue of the threaded connection 23a and typically the width of the passageway lies in the range 0.5mm to 6mm. The apex angle of the conical passage 29 is 10° but may lie in the range 5° to 40°. The sleeve 27 has a cylindrical inlet passage 29a of a diameter related to the wire rod diameter in the same way as the internal passage 24 as mentioned above. Of course, any alternative form of coolant injector could be provided in place of either or both of the injectors 11, 11a if required.

Downstream of the coolant injector 11, and as close as practicable thereto, is provided the purge injector 15 which comprises a generally cylindrical body 31 having end walls 32 apertured to receive the pipe 10 and providing an annular in cross-section reservoir 33 to which gaseous fluid under pressure is fed via an inlet 34. Thus the purge injector 15 extends completely around the tube 10, but may only partly surround the tube 10 where a different construction is used.

The cooling tube itself 10 is provided within the reservoir 33, with a plurality of circumferentially disposed inlet passages 35 each of which has a central axis 36 which lies on a conical surface, the apex of which points downstream, and has an apex angle of 45^{o}, and may lie in the range 20^{o} to 60^{o}.

The stripper injector 12, as shown in Figure 4, is similar to the liquid coolant injector 11 except that the parts thereof are orientated in the reverse direction so that the conical space 29' converges in an upstream direction and thus as liquid is injected, this has the effect of stripping liquid coolant from the wire rod in the region indicated at 40 between the stripper injector 12 and the tail end of the upstream guide tube 14. Thus when, in use, liquid coolant, leaves the frusto-conical space 29', it moves in a direction having a component extending upstream of the cooling line and thus serves to strip liquid coolant surrounding the wire rod as it emerges from the upstream guide tube 14.

At the downstream end of the guide tube 14, a purge injector 17 is provided which is similar to the purge injectors 15, 15a and 16 described hereinbefore but in this case, the guide tube 14 is formed with cylindrical passages 35a having central axes 36a lying on a conical surface, the apex of which points upstream and again having an apex angle of 45^{o} but which may lie in the range of 20^{o} to 60^{o}.

The guide tubes 14a, 14b are identical to the cooling guide tube 14.

In use of the apparatus, wire rod leaves the last stand S of a hot rolling finishing mill at a temperature of approximately $1000^{o}C$ and emerges from the downstream end of the cooling line, i.e. cooling zone Z5, at approximately $750^{o}C$. The wire rod as it leaves the finishing mill, may attain a speed of 100 metres per second or may even exceed this speed and the time interval between rolling billets in the rolling mill is approximately five seconds. In this five second interval, as the tail end of a wire rod leaves the last stand S, the passage of the tail end is detected, by conventional means, to provide a signal to cause the liquid coolant supply to the coolant injectors 11, 11a and stripper injector 12 to be interrupted. If desired, means may be provided to detect the egress of the tail end from each cooling tube 10, 10a and for the liquid coolant to be cut off progressively downstream but the above described procedure of interrupting all the coolant of all the zones as the tail end of the wire rod leaves the last stand S is conventional practice.

In a conventional arrangement, coolant remaining within the cooling tubes 10, 10a and guide tubes 14, 14a, 14b must drain from the tubes, for example through the gaps shown at G and 40 between adjacent tubes, before the nose end of the next following wire rod can be introduced into the cooling line, and thus a relatively long time delay of five seconds must be allowed.

In accordance with the present invention, the signal provided by the leaving of the tail end of the wire rod from the stand S not only causes interruption of the coolant supply to injectors 11, 11a but also initiates the supply of gaseous fluid, i.e. air under pressure, into the purge injectors 15, 15a, 16, 17 17a, 17b to drive coolant from within the tubes 10, 10a, 13, 14, 14a, 14b. In the present example the air pressure is 90 p.s.i, but may lie in the range 30 p.s.i. to 100 p.s.i.

As a result of the present invention, the time interval between the rolling of billets can be reduced to the order of three seconds and this results in increase in the production rate by approximately 5%, which is a significant improvement. In addition, any risk of cobbles due to coolant being accidentally present in the cooling tubes 10, 10a or guide tubes 14, 14a, 14b, 13 as a result of a leak is reduced.

Besides positively driving coolant from the tubes, the purge injectors also ensure that any debris, such as scale, is driven from the tubes.

As the nose end of a new length of wire rod leaves the most upstream cooling tube 10a of the first zone Z1, it provides a signal to re-start the coolant supply to the injector 11a and this is repeated progressively as the nose end progresses down the cooling line, so that the coolant supply is only initiated as the nose end enters the next downstream cooling tube thereby ensuring that the nose end has passed completely through a cooling tube before any coolant is supplied.

Of course, if desired, some other means for re-starting coolant supply may be adopted, for example a signal may be provided to supply the coolant to all the coolant injectors at the zone simultaneously as the nose end leaves the downstream end of the cooling zone but this would result in a longer nose portion requiring to be scrapped.

In the present example, the coolant has been described as water and the purge fluid as air. If desired other coolant liquid than water may be used, such as a mixture of water and lubricant, or cooling oil alone, and a gaseous fluid other than air may be used, such as nitrogen, for purging.

Although in the present example separate purge injectors have been described, it is envisaged that one or more of the separate purge injectors may be provided combined with a coolant injector, or the stripper injector. In each case means would be required whereby the supply of liquid for cooling or stripping may be substituted by gaseous purge fluid, when appropriate.

However, it is also envisaged that a gaseous fluid could be used for stripping, rather than a liquid fluid, in which case, such substitution means may not be required.

Any alternative means for stripping liquid coolant from the wire rod could be provided instead of the liquid or gaseous fluid stripping means described.

Although the invention has been described in relation to cooling wire rod, the invention may be used for cooling other elongate stock, as required.

CLAIMS:

1. Apparatus for cooling elongate stock after hot rolling in a rolling mill comprising a cooling zone (Z2) having a cooling tube (10), a coolant injector (11) to inject liquid coolant into the cooling tube (10), means (12) downstream of the cooling tube (10), to strip liquid coolant from the stock characterised in that a purge injector (15) is provided to inject a gaseous fluid into the cooling tube (10) to displace liquid coolant therefrom.

2. Apparatus according to Claim 1 wherein the purge injector (15) is provided downstream of the coolant injector (11).

3. Apparatus according to Claim 1 or Claim 2 characterised in that the purge injector for introducing the gaseous fluid into the cooling tube (10) is adjacent the upstream end thereof.

4. Apparatus according to Claim 3 characterised in that the gaseous fluid is injected into the cooling tube (10) in a direction lying in a conical surface, the apex of the cone pointing in the downstream direction.

5. Apparatus according to any one of the preceding claims characterised in that said means (12) to strip liquid coolant from the stock comprises a stripper injector which injects a stripper fluid in an upstream direction.

6. Apparatus according to any one of the preceding claims characterised in that a guide tube (14) is provided downstream of said cooling tube (10) but upstream of the stripper means (12), a second purge injector (17) being provided to inject a gaseous fluid into the guide tube (14) to displace liquid coolant therefrom.

7. Apparatus according to Claim 6 characterised in that the gaseous fluid is introduced into the guide tube adjacent the downstream end thereof and in a direction lying in a conical surface, the apex of the cone pointing in the downstream direction.

8. Apparatus according to any one of Claims 6 or 7 characterised in that a further guide tube (13) is provided downstream of said stripper means (12) and

a further purge injector (16) is provided to inject a gaseous fluid into the further guide tube (13) to displace liquid coolant therefrom, the fluid being introduced into the further guide tube (13) adjacent the upstream end thereof.

9. Apparatus according to Claim 8 characterised in that the gaseous fluid is introduced in a direction lying in a conical surface, the apex of the cone pointing in the downstream direction, each purge injector (15,16,17) comprising a manifold (21) extending around an associated cooling tube (10) or guide tube (14) and there being a plurality of passages (35, 35a) extending through the wall of the cooling tube (10) or guide tube (14) to permit of passage of gaseous fluid from the manifold (21) to the interior of the tube, the passages (35,35a) having a central axis (36,36a) lying on a conical surface.

10. Apparatus according to any one of the preceding claims characterised in that the zone (Z2) includes at least one further cooling tube (10a) and associated coolant injector (11a) and first purge injector (15a) upstream of said first mentioned cooling tube (10).

11. Apparatus according to Claim 10 characterised in that an intermediate guide tube (14a) is positioned downstream of the additional cooling tube (10a), the intermediate guide tube (14a) having a purge injector (17a).

12. A method of cooling elongate stock after hot rolling in a rolling mill comprising the steps of passing the stock through a cooling tube (10), injecting liquid coolant into the cooling tube (10) at an upstream end thereof, stripping the coolant from the stock at the downstream end of the cooling tube (10), terminating the injection of liquid coolant approximately as the tail end of the stock leaves the rolling mill(s), injecting a gaseous fluid into the cooling tube (10) to displace liquid coolant therefrom.

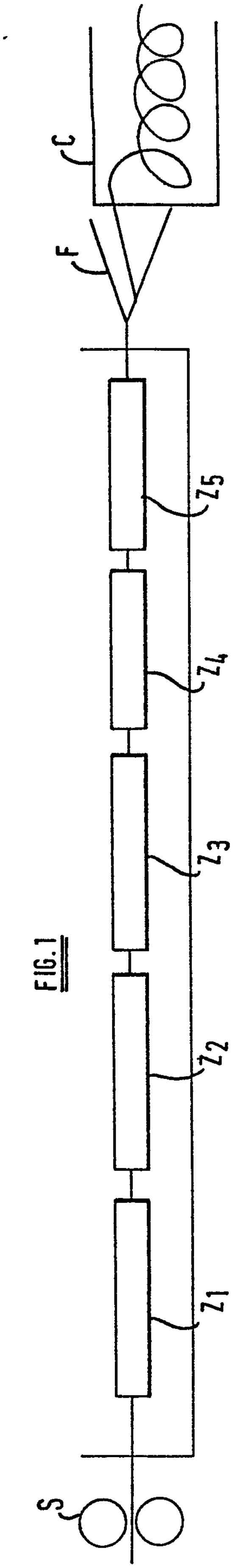

C
F
Z5
Z4
Z3
Z2
Z1
S

FIG.1

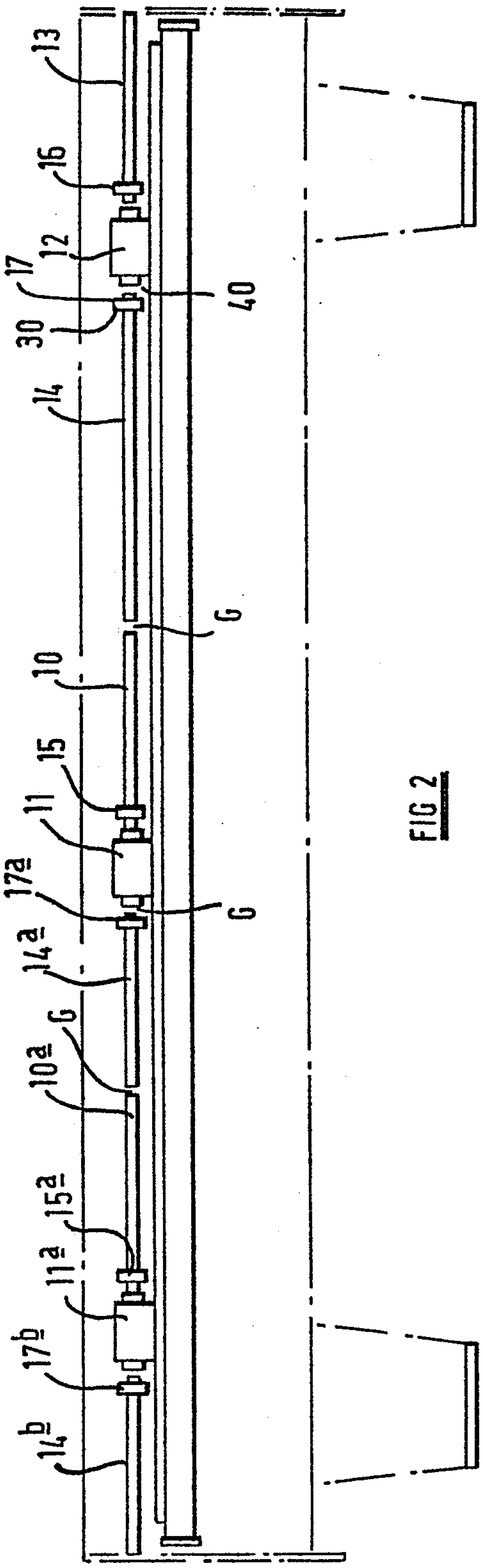

13
16
12
17
30
40
14
G
10
15
11
17a
G
14a
G
10a
15a
11a
17b
14b

FIG 2

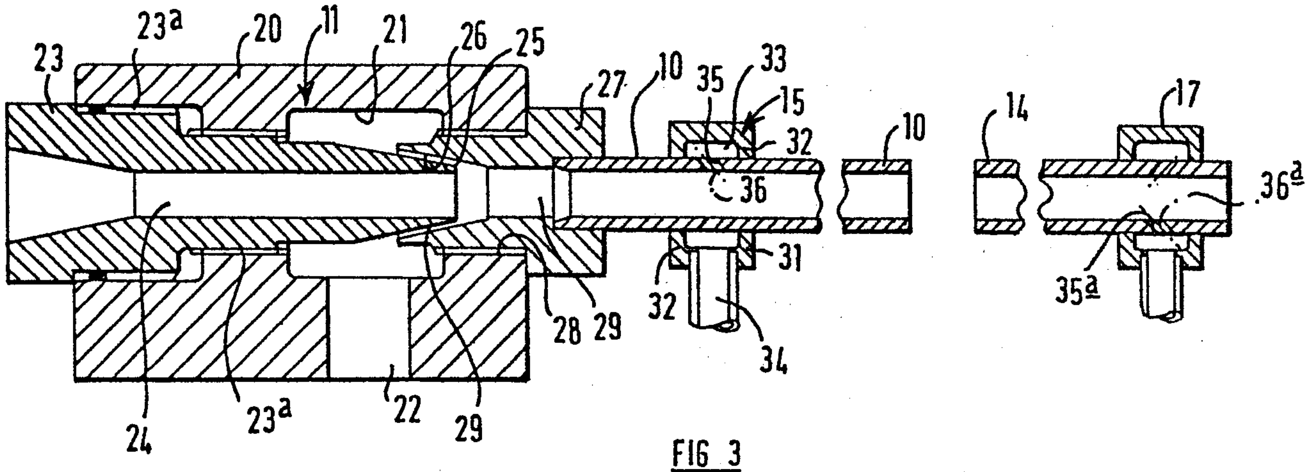

23
23a
20
11
21
26
25
27
10
35
33
15
32
10
14
17
36
36a
31
32
34
35a
28
29
24
23a
22
29

FIG 3

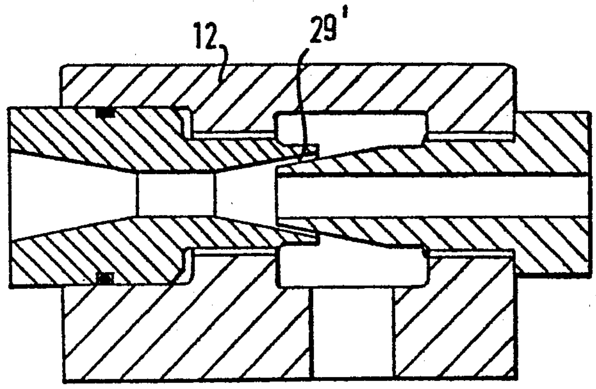

12
29'

FIG 4

European Patent Office

EUROPEAN SEARCH REPORT

0141511

Application number

EP 84 30 6131

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)
X	FR-A-2 253 578 (SCHLOEMANN-SIEMAG AG) * page 1, lines 19-37; page 2, lines 1-7; claim 1 *	1,12, 17	B 21 B 45/02

D,A	DE-A-2 151 210 (SCHLOEMANN AG) * figure 1; page 4, paragraphs 6-8; page 5, paragraphs 1-2 *	1	

			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 21 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-12-1984	NOESEN R.F.

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