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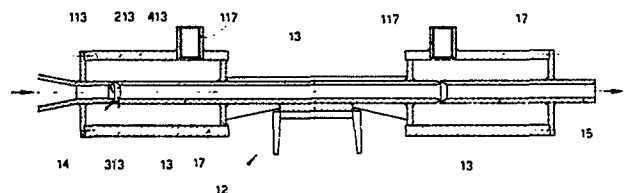
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54 **High-efficiency device to cool rolled bars.**

57 Device (10) to cool bars which is located at the outlet of the finishing stand in hot-rolling mills and comprises an outer container (11) in which there is positioned lengthwise a plurality of cooling units (12) separated from each other through which the bars to be cooled pass, said device being characterized by the fact that each cooling unit (12) consists of a plurality of conduits (13) placed in line, whereby the mating ends (213-413) of the conduits forming each cooling unit (12) are conformed so as to create between themselves an annular nozzle (14) which narrows in the direction of the feed of the bars, and whereby a chamber (17) for diffusing cooling liquid under pressure is located inside said outer container (11) and around each annular nozzle (14) and is connected to means (19) which feed cooling liquid under pressure and which are positioned outside said outer container (11).



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1 Description of the invention entitled:

2 "HIGH-EFFICIENCY DEVICE TO COOL ROLLED BARS"

3 in the name of DANIELI & C. OFFICINE MECCANICHE SpA at Buttrio
4 (Udine Province)

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6 This invention concerns a high-efficiency device to cool
7 rolled steel bars leaving the rolling stand, said device being
8 able to obtain a desired, even temperature along the bars.

9 To be more exact, this invention concerns a device for the
10 controlled cooling of hot-rolled bars moving at a high speed
11 by means of a cooling liquid such as water or water containing
12 mineral salts and/or surface-active agents, whereby said de-
13 vice is located downstream from the hot-rolling stand and has
14 the purpose of bringing the temperature of the rolled products
15 passing through down to a desired temperature quickly.

16 It is known in the art that the steel bars leave the hot-
17 rolling stand with a temperature of about 1000-1100°C and are
18 made to pass through cooling devices which have the task of
19 bringing this temperature down to a minimum within a given
20 time, whereby said time and minimum temperature depend on the
21 mechanical properties required of the bars, such as the brea-
22 king point, fatigue strength, ductility and weldability.

23 To be more exact, the cooling time and minimum temperature
24 of the bars are selected to suit the destination and end use
25 conditions of the bars, for this cooling determines the mic-

Gilberto Faraz

1 rostructure of the material, and the microstructure in its
2 turn determines and governs the aforesaid mechanical proper-
3 ties of the bars.

4 Moreover, the carbon and manganese content of the bars has
5 to be reduced to improve their weldability and ductility; but
6 this lessens the tensile strength of the bars.

7 It was proposed a short time ago, among other things, that
8 immediately after leaving the finishing stand of a rolling
9 mill for bars said bars should undergo surface quenching with
10 a suitable cooling liquid and that the conditions of said
11 cooling should be regulated in such a way that, on leaving the
12 cooling zone provided by the liquid, the core of the bar
13 should have a temperature of about 850°C while the bar stayed
14 in the cooling device; this condition permits, on the one
15 hand, a tempering of the hardened surface layer consisting of
16 martensite and bainite and, on the other hand, an assurance
17 that the austenite in the central part of the bar is converted
18 into ferrite and pearlite.

19 Said quenching has to take place in a very short time of
20 the order of fractions of a second.

21 Said cooling also has to permit the aforesaid mechanical
22 properties to be as even as possible along the rolled bar.

23 Moreover, it is known that such evenness is linked to the
24 uniformity of the cooling process itself.

25 Devices employing a cooling liquid are known into which the
26 rolled bars to be cooled are introduced while the latter are
27 travelling at a high speed in a liquid environment, normally
28 water, which is either running or static.

29 Patent BE 826.199, for instance, proposes a device to cool
30 rolled steel bars which consists of a cylindrical conduit
31 within which the bars pass, whereby the upstream end of the
32 conduit is provided with an annular funnel which narrows in
33 the direction of the feed of the bars and which serves to

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1 guide the bars, whereas the downstream end of the conduit is
2 equipped with a guide ring.

3 According to this solution the conduit is fed with a con-
4 tinual flow of cooling water under pressure, said water being
5 introduced through an opening provided in the middle of the
6 wall of the cooling conduit so as to create substantially a
7 cooling bath in which the bar to be cooled is momentarily im-
8 mersed.

9 So as to slow down the cooling water leaving from both ends
10 of the conduit, a jet of water directed towards the inner part
11 of the conduit is introduced into said conduit through each of
12 said funnels.

13 Furthermore, so as to complete the cooling according to
14 this solution, the bar has to pass through a series of cooling
15 conduits located separately, so that said cooling operation is
16 performed with alternate phases of cooling with water in the
17 conduit, then with static air between one conduit and the
18 next, and then with water in the next conduit, and so on.

19 This lay-out is of necessity hard to regulate and requires
20 the employment of many cooling conduits arranged very near to
21 each other, so that each conduit makes its own contribution
22 with a rather limited lowering of the temperature.

23 Moreover, this reduces the cooling efficiency and unhelp-
24 fully makes more difficult the formation of martensite on the
25 surface and, in the case of thin bars, also reduces the speed
26 of the passage of the bar itself.

27 The solution of patent BE 826.199 is further improved by
28 patent BE 844.183. The improvement in the latter only concerns
29 the annular narrowing funnel located at the upstream end of
30 the cooling conduit, whereby said funnel is now equipped cir-
31 cumferentially with a series of holes which are sloped in the
32 direction of the feed of the rolled bars and which act as
33 nozzles to direct towards said bars the water under pressure

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1 coming from the supply conduit opening into the annular space
2 created between the narrowing part of the funnel and the inner
3 wall of the cooling conduit.

4 Even though this latter solution makes the cooling more
5 regular within the cooling conduit, the aforesaid problems are
6 still not overcome satisfactorily.

7 The invention described in FR-A-2.394.337 proposes in its
8 turn the use of a plurality of cooling pipes positioned in
9 series underwater in a container provided with holes for the
10 passage of rolled products.

11 According to this lay-out each cooling pipe has a constant
12 inner diameter and a diameter-to-length ratio of between 1:5
13 and 1:15 and is equipped at its end with a circumferential
14 series of holes to feed cooling water under pressure, said
15 holes being sloped in a direction opposite to that of the feed
16 of the rolled products.

17 So as to complete the cooling cycle in this device, it is
18 necessary to position a consecutive series of cooling con-
19 tainers separated from each other.

20 This solution has the drawback of being very costly to
21 construct because of its size and therefore entails a great
22 deal of space and a heavy consumption of water under pressure.

23 The fact that the ratio between the inner diameter and the
24 length of the pipe is between 1:5 and 1:15 means that, if this
25 cooling plant is to work well, it will have to have a great
26 number of small cooling pipes and therefore a great number of
27 cooling containers.

28 A further drawback of the invention is found when the bar
29 to be cooled is thin, for the bar undergoes, as we said, a
30 braking action owing to the jet of water flowing in the op-
31 posite direction to that of the movement of the bar.

32 In the field of production of metallic wires the patent US
33 2,756,169 proposes a device to cool the rod before it is

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1 drawn, said device being able to cool the rod quickly from
2 982°C down to 482-704°C in 0.75-1.5 seconds.

3 Said device, however, consists of an inner pipe perforated
4 peripherally and located inside another outer pipe, which is
5 closed at its end and fed with cooling water that passes
6 through the peripheral perforations into the said inner pipe,
7 within which the rod to be cooled passes. The cooling water
8 leaves from the ends of the inner pipe.

9 Said device also requires a group of water traps and a
10 device to cool the rod by means of air as it passes along.

11 Besides the fact that this device is designed to carry out
12 a heat-treatment of the rod which eliminates the need to per-
13 form heat-treatment of said rod before the drawing process,
14 said device involves substantially the same problems as those
15 described with regard to the aforesaid FR-A-2.394.337.

16 There exists another device for cooling bars which is de-
17 scribed in GB-A-2,021,998; this device is substantially like
18 that of US 2,756,169 except that the cooling water introduced
19 into the inner pipe also leaves through diverging radial con-
20 duits opening outside the outer pipe.

21 Amongst other things, said device entails the drawback that
22 the bubbles of steam forming on the surface of the bar being
23 cooled adhere to the bar and form a boiling film which causes
24 a considerable exchange of heat between the bar and the cool-
25 ing liquid, thereby lessening the overall efficiency of the
26 cooling device.

27 Standard Search Report No. RS 65507 IT, as drawn up by the
28 European Patents Office after submission of our application
29 for a patent in Italy and on the basis of said application,
30 has brought forward other patents regarding the subject.

31 FR-A-2.231.440 (Hoogovens) shows a cooling device consist-
32 ing of nozzles which are wholly immersed in water held in a
33 tank. The cooling pipes are formed with two walls, of which

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1 the inner wall comprises a plurality of radial holes through
2 which the cooling fluid flows.

3 This lay-out does not allow the cooling value to be regul-
4 ated as wished unless a great number of tanks are employed,
5 but in this latter case the device becomes very costly and
6 complicated. Moreover, the quantities of water cannot be var-
7 ied in the lay-out of this patent.

8 In FR-A-2.453.689 (British Steel) the device described is
9 very complex and consists of various stages of which each is
10 composed of a set of nozzles spaced apart; between said noz-
11 zles there are inserted some auxiliary nozzles which spray
12 water onto the bar in the opposite direction to that of the
13 feed of the bar. But said solution is wholly different from
14 that set forth in our application.

15 US-A-3,044,098 (Stalson) deals with a pickling device whic
16 has nothing to do with a cooling device such as that of our
17 invention.

18 The article taken from "La Metallurgie" examines the pro-
19 blem of pickling, which has nothing to do with the cooling
20 device proposed by our invention, nor anything to do with the
21 problems linked thereto.

22 Our invention has the purpose of eliminating the aforesaid
23 drawbacks. A further purpose of our invention is to interrupt
24 continuously the growth of bubbles of steam and also the for-
25 mation of the boiling film on the surface of the bar and to
26 carry out forced removal, towards the outlet of the device, o
27 the bubbles of steam generated by contact between the cooling
28 liquid and the bar passing through.

29 Another advantage of our invention is to be able to regul-
30 ate at will the speed and intensity of the cooling.

31 Yet another advantage of our invention is that it obviates
32 further heat-treatments aimed at the improvement of the mic-
33 rostructure and therefore of the mechanical properties of the

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1 bars, especially their weldability, ductility and strength.

2 A further advantage is the development of an even and uni-
3 form microstructure throughout the length of the bar, thereby
4 obtaining bars with constant and uniform mechanical proper-
5 ties.

6 Our invention is therefore embodied with a device for
7 cooling bars which is located at the outlet of the finishing
8 stand in hot-rolling mills and which comprises an outer con-
9 tainer within which a plurality of cooling units is arranged
10 lengthwise and separated one from another, the bars to be
11 cooled passing along inside said units, whereby the device is
12 characterized by the facts that each cooling unit consists of
13 a plurality of conduits positioned in line, and that the mated
14 ends of the conduits forming each cooling unit are conformed
15 so as to create between them an annular nozzle which narrows
16 in the direction of the feed of the bars, and that within said
17 outer container and around each annular nozzle a chamber is
18 located for diffusing cooling liquid under pressure and is
19 connected to adjustable means which feed cooling liquid under
20 pressure and which are positioned outside said outer contain-
21 er.

22 We shall describe hereinafter a preferred embodiment of the
23 invention as a non-restrictive example and shall refer to the
24 attached tables, wherein:-

25 Fig.1 shows a diagram of a cooling device according to the
26 invention;

27 Fig.2 shows a lengthwise section of a cooling unit according
28 to the invention;

29 Fig.3 shows a crosswise section of the cooling device of
30 Fig.1;

31 Fig.4 shows a diagram of a cooling device according to the
32 invention together with the feeding means.

33 In the figures the same parts or parts having the same

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1 functions bear the same reference numbers.

2 In the figures the device 10 to cool bars according to th
3 invention consists of an outer container 11 and a plurality
4 cooling units 12 within which the bars to be cooled pass, sa
5 units 12 being positioned lengthwise within said outer con-
6 tainer 11 having a round, square or rectangular section (the
7 figures show it as being rectangular).

8 Said outer container 11 is equipped with an outlet pipe 1
9 for discharging, if necessary, the cooling liquid leaving th
10 cooling units 12, which are positioned separated from each
11 other, as shown in Fig.1.

12 Said cooling liquid may consist of water or of water with
13 suitable additives containing mineral salts and/or surface-
14 active agents.

15 Each cooling unit 12 consists of at least two lengthwise
16 conduits 13 positioned in line, and the bars to be cooled pas
17 through said conduits 13 (the bars are not shown).

18 The mating ends of the conduits 13 are conformed so as to
19 constitute between them an annular nozzle 14 which is sloped
20 and faces in the direction of the feed of the bars.

21 Said annular nozzle 14 is formed by bevelling the outer
22 edge 113 of the outlet 213 of one conduit 13 and bevelling th
23 inner edge 313 of the inlet 413 of the next conduit 13.

24 This enables the cooling liquid under pressure to be dir-
25 ected against the bars passing along in their direction of
26 forward movement so as to discharge, preferably towards the
27 outlet 15 of the cooling unit, any steam generated by the
28 contact between the hot bars and the cooling liquid, for it i
29 known that the presence of steam inside the cooling unit les-
30 sens the efficiency and overall yield of the cooling device.

31 According to the invention a chamber 17 for diffusing
32 cooling liquid through the nozzle 14 into the conduits 13 is
33 located within the outer container 11 and around each annular

1 nozzle 14.

2 Said diffusion chamber 17 has a circular section in our
3 example, but could have another section, and comprises a nip-
4 ple 117 connected by a conduit 18 to means 19 feeding cooling
5 liquid at an adjustable pressure to each annular nozzle 14.

6 In the example shown said means 19 feeding cooling liquid
7 under pressure comprise a main conduit 119 connected, at one
8 end, to the source of cooling liquid under pressure and, at
9 its other end, to a distribution manifold 219, to which the
10 conduits 18 conveying cooling liquid into the respective dif-
11 fusion chambers 17 are connected by individual means 118 which
12 regulate the flow.

13 The main conduit 119 is equipped with servo-controlled
14 means 20 governing the rate of flow.

15 To be more exact, said servo-controlled means 20 regulating
16 the flow comprise a servo-controlled valve 120 located between
17 said main conduit 119 and the distribution manifold 219, and
18 also comprise another servo-controlled valve 220 positioned
19 between said main conduit 119 and a discharge outlet 320.

20 The main conduit 119 is equipped with a flow indicator 191,
21 a thermometer 291, a pressure gauge 391 with an appropriate
22 tap and also a main gate valve 491.

23 The preferred lay-out of the cooling device of the invent-
24 ion is shown in Fig.4, wherein the means 19 feeding the cool-
25 ing liquid serve more than one cooling unit positioned in
26 line.

27 The device 10 of the invention is able to cool the bars
28 passing through from a temperature between 1100° and 1000°C
29 down to even 80-100°C within a period of 0.5-1.5 seconds.

30 This is brought about by introducing the cooling liquid
31 into the chambers at a pressure between 12 and 16 atmospheres.

32 Said liquid is thrust at high speed into the respective
33 cooling conduits 13 through the plurality of annular nozzles

1 14, which spray it evenly over the surface of the bars passing
2 through and break up continuously the film formed by the bub-
3 bles of steam and drive said bubbles of steam towards the
4 outlet 15 of each cooling unit.

5 According to the invention the cooling of the bars can be
6 regulated and differentiated during their passage through the
7 cooling device by operating by hand or automatically on the
8 adjustable means 19 feeding the cooling liquid.

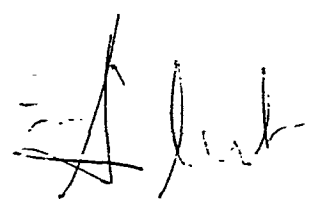
9 It is also possible to position several cooling units 12 or
10 several cooling devices 10 in series on the path of the bars.

11 Moreover, it is possible to locate in the end part of the
12 outer container 11 one or more cooling units 12 in which the
13 nozzles 14 are reversed, that is, turned in the direction op-
14 posite to that of the feed of the bars to be cooled; the pur-
15 pose of this is to halt the jet of cooling water at the outlet
16 of the device and to restrict its flow out of the cooling de-
17 vice.

18 It is also possible to put an air drier at the outlet of
19 the device so as to eliminate any residual water on the cooled
20 bars.

21 We have described here a preferred embodiment of the in-
22 vention, but variants are possible.

23 The shapes, sizes and proportions can be changed and it is
24 possible to use the device of the invention to carry out
25 cooling cycles and heat-treatments other than those described
26 herein without departing thereby from the scope of this
27 invention.

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CLAIMS

- 1 - Device (10) to cool bars which is located at the outlet of the finishing stand in hot-rolling mills and comprises an outer container (11) in which there is positioned lengthwise a plurality of cooling units (12) separated from each other through which the bars to be cooled pass, said device being characterized by the fact that each cooling unit (12) consists of a plurality of conduits (13) placed in line, whereby the mating ends (213-413) of the conduits forming each cooling unit (12) are conformed so as to create between themselves an annular nozzle (14) which narrows in the direction of the feed of the bars, and whereby a chamber (17) for diffusing cooling liquid under pressure is located inside said outer container (11) and around each annular nozzle (14) and is connected to means (19) which feed cooling liquid under pressure and which are positioned outside said outer container (11).
- 2 - Device (10) to cool bars as in Claim 1, characterized by the fact that each annular nozzle (14) is obtained by bevelling the outer edge (113) of the outlet (213) of one conduit (13) and by bevelling the inner edge (313) of the inlet (413) of the next conduit (13).
- 3 - Device (10) to cool bars as in Claims 1 and/or 2, characterized by comprising in the end part of the outer container (11) at least one cooling unit (12) positioned back-to-front with its annular nozzles (14) turned in the opposite direction to that of the feed of the bars to be cooled.
- 4 - Device (10) to cool bars as in Claim 1 and in one or the other of the Claims thereafter, characterized by the fact that the means (19) feeding liquid under pressure can be regulated for each annular nozzle (14).
- 5 - Device (10) to cool bars as in Claim 1 and in one or another of the Claims thereafter, characterized by the fact that said means (19) feeding liquid under pressure comprise a main

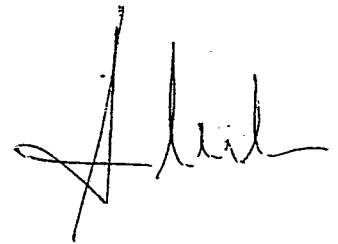
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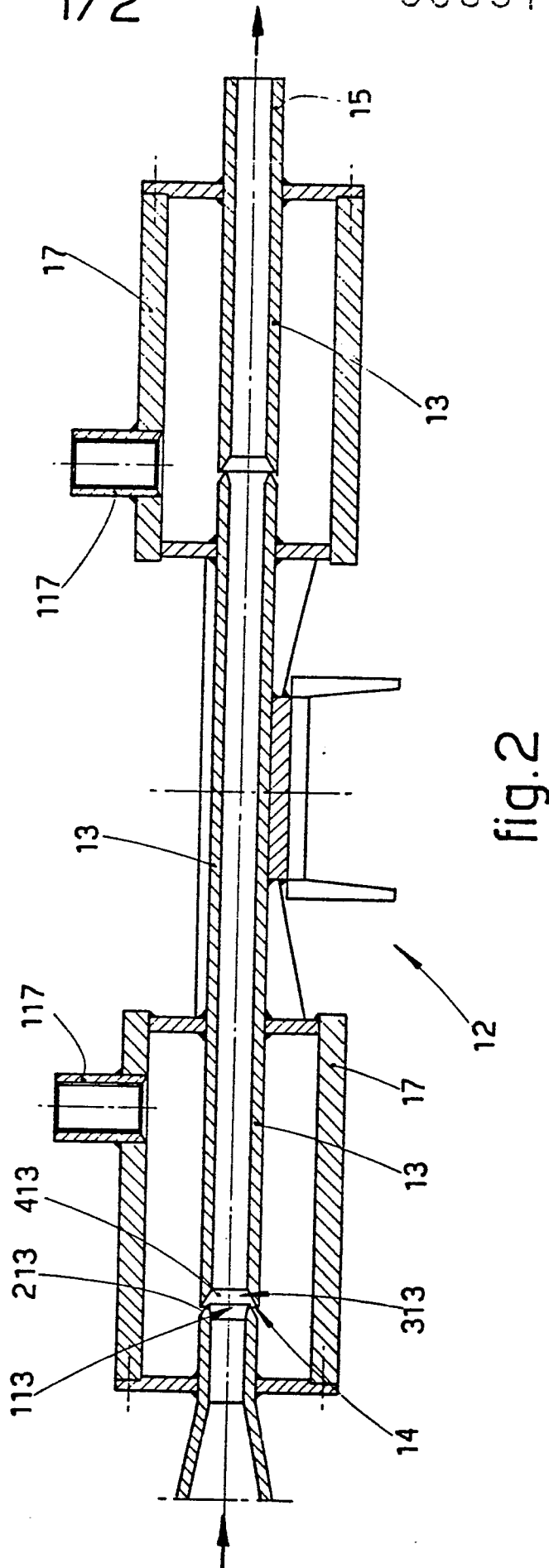
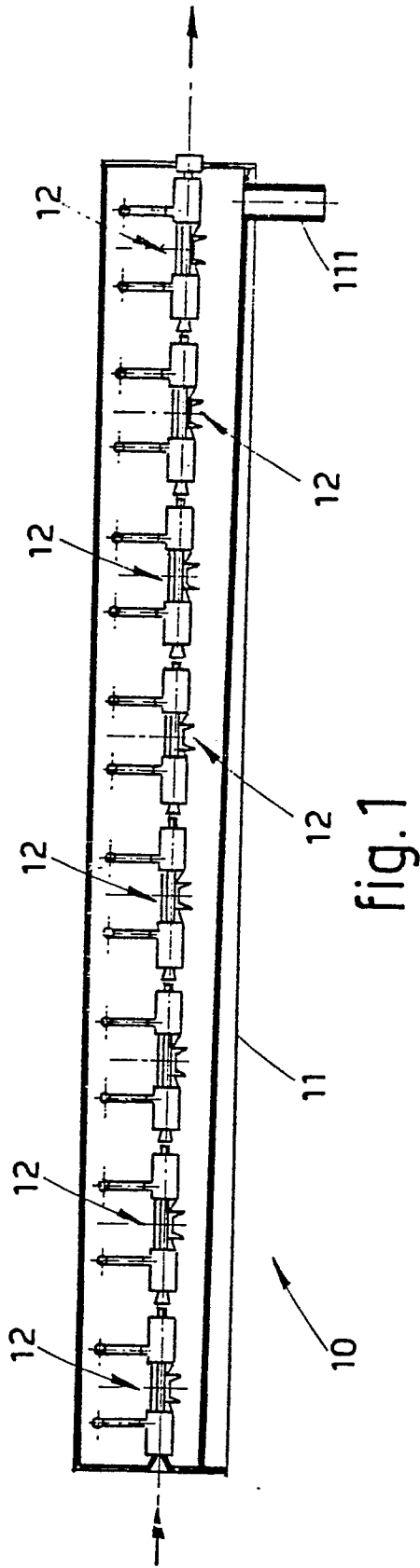
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1 conduit (119) connected, at one end, to the source of cooling
2 liquid under pressure and, at its other end, to a distribution
3 manifold (219) to which the conduits (18) conveying cooling
4 liquid into the respective diffusion chambers (17) are con-
5 nected by individual means (118) which regulate the flow.

6 6 - Device (10) to cool bars as in Claim 1 and in one or an-
7 other of the Claims thereafter, characterized by the fact that
8 said main conduit (119) is equipped with servo-controlled
9 means (20) to regulate the flow.

10 7 - Device (10) to cool bars as in Claim 1 and in one or an-
11 other of the Claims thereafter, characterized by the fact that
12 said servo-controlled means (20) to regulate the flow comprise
13 a servo-controlled valve (120) located between said main con-
14 duit (119) and said distribution manifold (219), and also
15 comprise another servo-controlled valve (220) placed between
16 said main conduit (119) and a discharge outlet (320).

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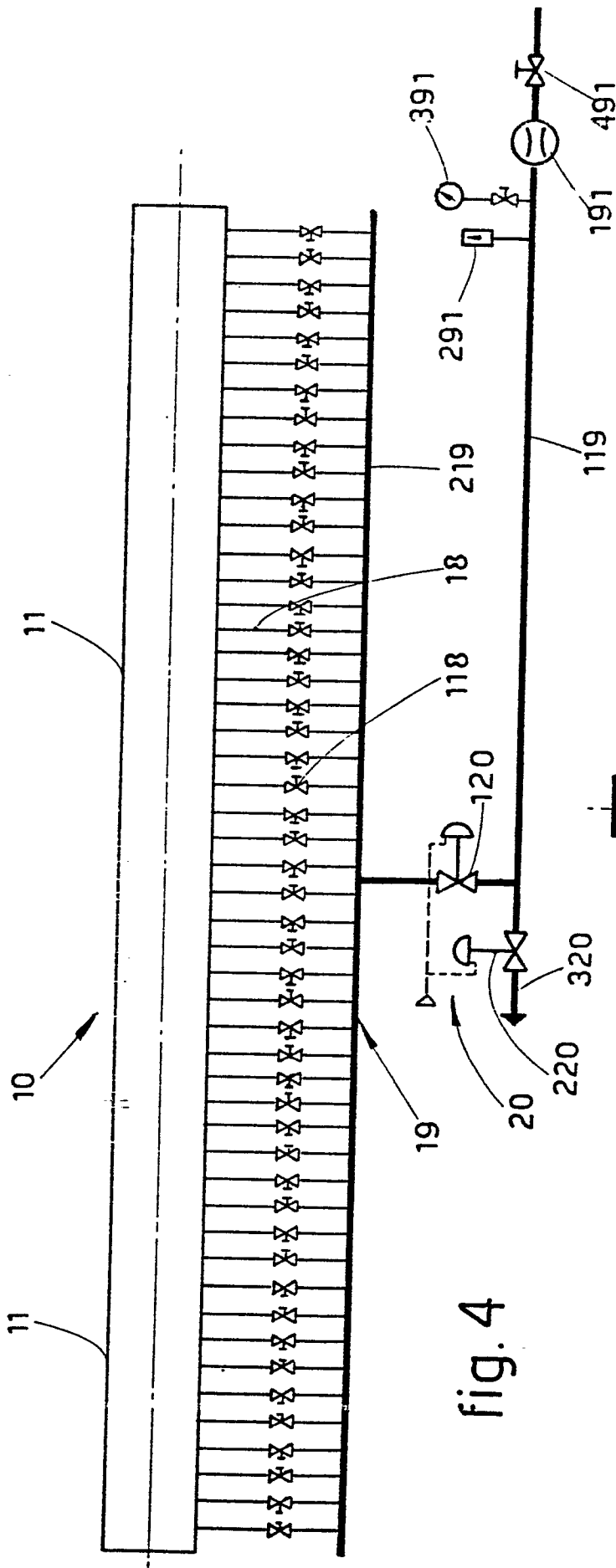


fig. 4

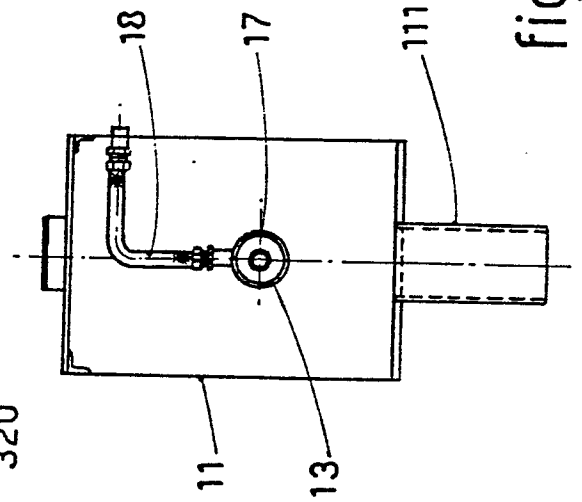


fig. 3

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European Patent
Office

EUROPEAN SEARCH REPORT

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Application number

EP 83 83 0023

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. ³)
A, D	FR-A-2 394 337 (SCHLOEMANN) *The whole document*	1, 2	B 21 B 45/02
A	FR-A-2 231 440 (HOOGOSENS)	1	
A	US-A-3 044 098 (STALSON)	3	
A	FR-A-2 453 689 (BRITISH STEEL)	4, 5	
A	LA METALLURGIE, vol. 102, no. 7, July - August 1970, pages 389-397, Paris (FR) "Methode de dimensionnement d'une installation de decalaminage"		
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			B 21 B C 21 D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30-03-1983	Examiner SEMBRITZKI K.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	