

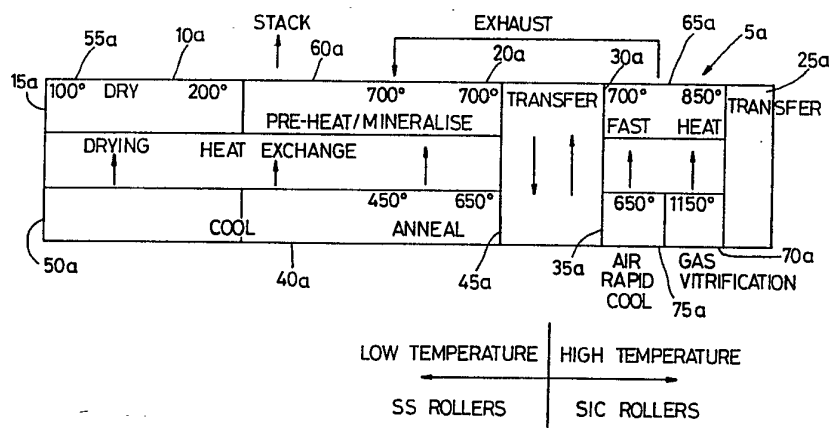


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(54) Title: THERMAL PROCESS WHEREIN THE CHARGE IS ROTATED ALONG INTO LONGITUDINAL AXIS

LAYOUT OF HEAT TREATMENT UNITS



(57) Abstract

There is disclosed a kiln (5a, 5b), particularly but not exclusively, for heat treating clay products such as pipes (85a, 85b) or tiles. Prior art kilns suffer from a number of problems. For example: the length of the kiln makes it impractical for large diameter pipes; limited only to heat treating pipes of a certain diameter; heat exchange is not properly effected between lower and upper zones. The invention, therefore, provides a kiln (5a, 5b) for heat treating pipes (85a, 85b) comprising a drying/preheat zone (10a, 10b), a firing zone (25a, 25b) and a cooling zone (40a, 40b), and conveyor means for transporting one or more support means (80a, 95a, 80b, 95b) each supporting one or more pipes (85a, 85b) through at least one of such zones, in use each pipe (85a, 85b) being supported upon the respective support means (80a, 95a, 80b, 95b) substantially perpendicularly to the direction of transportation, each support means (80a, 95a, 80b, 95b) further having means for rotating (100a, 100b) each pipe (85a, 85b) supported therein along a longitudinal direction of the respective pipe.

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THERMAL PROCESS WHEREIN THE CHARGE IS ROTATED
ALONG INTO A LONGITUDINAL AXIS

Background to the Invention

5 This invention relates to thermal processes, to kilns, and more particularly but not exclusively to kilns for heat treating clay products such as pipes or tiles.

 There is disclosed in GB 2 021 743 (Hepworth) a kiln in which pipes are rotated in a hot zone to maintain
10 roundness and ensure uniform heating. There is disclosed in US 4 628 615 (Verheyden) a kiln having upper and lower levels in which a chain moves pipes of same diameter rotatably along a path including both levels.

 The arrangements disclosed in the above patent
15 specifications suffer from a number of problems. For example, the kiln disclosed in GB 1 021 743 is very long, and therefore impractical for large diameter pipes. The kiln disclosed in US 4 628 615 suffers from the problem that it is only suitable for heat treating pipes of a
20 certain diameter. Also, US 4 628 615 has the problem that the temperature of the vitrification zone is cycled between maximum and minimum temperatures, and that heat exchange is not properly effected between lower and upper zones.

 It is, therefore, an object of the present invention
25 to obviate or mitigate at least some of the aforementioned disadvantages.

Summary of the Invention

30 A first aspect of the present invention provides a kiln for heat treating pipes comprising a drying/preheat zone, a firing zone and a cooling zone, and conveyor means for transporting one or more support means each supporting one or more pipes through at least one of such zones. In
35 use each pipe is supported upon the respective support means substantially perpendicularly to the direction of transportation, each support means further having means for

rotating each pipe supported thereon along a longitudinal direction of the respective pipe.

The support means in at least one zone may comprise a wheeled trolley.

5 The support means in at least one zone may comprise a walking frame or beam.

Advantageously, adjacent zones are spaced apart from one another by a transfer zone having means for transferring pipes from a support means used in one zone to
10 a support means used in a next zone.

Support means for use in the drying/preheat zone and in the cooling zone may be made from mild steel, the means for rotating each pipe possibly being made from stainless steel.

15 Support means for use in the firing zone may be made from mild steel, the means for rotating each pipe possibly being made from silicon carbide.

The support means for use in the firing zone may have insulated plates at either end thereof to reduce heat loss.

20 The firing zone may have lower and upper sections through which the support means pass in opposite directions, so as to provide heat exchange between the lower and upper sections.

The firing zone may comprise an upper fast heat
25 section, and lower vitrification and rapid cooling sections.

Similarly, the drying/preheat zone may be provided above the cooling zone so as to provide heat exchange between the cooling zone and the drying/preheat zone.

30 The drying/preheat zone may comprise a drying section and a preheat/mineralise section.

According to a second aspect of the present invention there is provided a support means for use in a kiln the support means being capable of supporting and transporting
35 one or more pipes through such zones, and further having means for rotating each pipe along a longitudinal direction thereof.

According to a third aspect of the present invention there is provided a method of heat treating pipes comprising placing the pipe(s) on a support means having means for rotating each pipe supported thereon along a longitudinal direction of the respective pipe, and transporting each support means by conveyor means through at least one zone of a kiln comprising a drying/preheat zone, a firing zone and a cooling zone, each pipe being supported on the support means substantially perpendicularly to the direction of transportation.

According to a fourth aspect of the present invention there is provided a kiln for heat treating materials comprising a drying/preheat zone, firing zone, a cooling zone, and conveyor means for transporting one or more materials through each zone, wherein adjacent zones are spaced apart from one another by a transfer zone having means for transferring the materials from one zone to a next zone.

Advantageously, one or more of the materials is supported on a support means, the support means being transportable by the conveyor means.

The firing zone may have lower and upper sections through which the support means pass in opposite directions, so as to provide heat exchange between the lower and upper sections.

The firing zone may comprise an upper fast heat section, and lower vitrification and rapid cooling sections.

Similarly, the drying/preheat zone may be provided above the cooling zone so as to provide heat exchange between the cooling and the drying/preheat zone.

The drying/preheat zone may comprise a drying section and a preheat/mineralise section.

According to a fifth aspect of the present invention there is provided a method of heat treating materials comprising passing the materials through a drying/preheat zone, transferring the materials to a firing zone via a first transfer zone, passing the materials through the

firing zone, and thence transferring the materials to a cooling zone via a second transfer zone.

Description of the Drawings

5

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings which are:

- 10 Fig 1 a simplified heat treatment schedule for
 vitrified clay pipe;
- Fig 2 a schematic side elevation of a first
 embodiment of a kiln according to the
 present invention;
- 15 Fig 3 a side elevation of a kiln according to
 the first embodiment of the present
 invention shown in Fig 2;
- Fig 4 a sectional side elevation of the kiln of
 Fig 3;
- 20 Fig 5 a sectional end elevation to an enlarged
 scale of a low temperature zone of the
 kiln of Fig 3;
- Fig 6 a sectional end elevation to an enlarged
 scale of a transfer zone of the kiln of
25 Fig 3; and
- Fig 7 a sectional end elevation to an enlarged
 scale of a firing zone of the kiln of
 Fig 3.
- Fig 8 a schematic side elevation of a second
30 embodiment of a kiln according to the
 present invention;
- Fig 9 a plan elevation of a kiln according to the
 second embodiment of the present invention
 shown in Fig 8;
- 35 Fig 10 a sectional side elevation of a
 drying/preheat zone and cooling zone of the
 kiln of Fig 9;

- Fig 11 a sectional end elevation to an enlarged scale of the drying/preheat zone and cooling zone of the kiln of Fig 9;
- Fig 12 a sectional side view to an enlarged scale of a firing zone of the kiln of Fig 9;
- Fig 13 a sectional end elevation to an enlarged scale of a firing zone of the kiln of Fig 9;
- Fig 14 an end view of a high temperature walking frame and associated gearing of the kiln of Fig 9; and
- Fig 15 a side view to an enlarged scale of rollers of a walking frame of the firing zone of the kiln of Fig 9 showing different sizes of pipes which can be placed thereupon.

Description of a First Embodiment

Referring to Fig 1, there is shown a simplified heat treatment schedule for vitrified clay pipe. As can be seen from Fig 1, the schedule can be divided into a high temperature process comprising fire, sinter and quench stages, which require high temperature engineering materials, and a low temperature processes comprising drying/preheat and cool stages provided before and after the high temperature process respectively for which more conventional engineering materials can be used.

Referring to Figs 2 - 7 there is provided a first embodiment of a kiln according to the present invention, generally designated 5a, comprising a drying/preheat zone 10a having input and output ends 15a, 20a, a firing zone 25a having input and output ends 30a, 35a and a cooling zone 40a also having input and output ends 45a, 50a.

The drying/preheat zone 10a is divided into a drying section 55a, wherein the temperature is gradated from approximately 100°C to 200°C, and a preheat/mineralise section 60a, wherein the temperature is gradated from approximately 200°C to 750°C.

The cooling zone 40a is positioned below the drying/preheat zone 10a to provide heat exchange therebetween, as is conventional in half-tunnel kilns. In the cooling zone 40a the temperature is gradated from approximately 650°C to 100°C.

The firing zone 25a comprises an upper, fast heat or fire section 65a and lower vitrification (or sinter) and rapid cooling (or quench) sections 70a, 75a. The vitrification and rapid cooling sections 70a, 75a are positioned below the fast heat section 65a to provide heat exchange therebetween.

In the fast heat section 65a the temperature is gradated from approximately 700°C to 850°C, while in the vitrification section the temperature is gradated from approximately 850°C to 1150°C.

In the rapid cooling section the temperature is gradated from approximately 1150°C to 650°C.

Low temperature support means in the form of trolleys 80a are provided, these being capable of containing at least one pipe 85a, and passing the pipe(s) 85a through the drying/preheat zone 10a.

The low temperature trolleys 80a may be made out of mild steel and consist of two external side frames tied by cross beams having, for example, 8 stainless steel pipe rollers 90a (4 pairs - 1 pair for each pipe 85a to be heat treated). Each of the rollers 90a are mounted on the side frames and driven, for example, by an electric motor (not shown).

Note that the size and spacing of the rollers 90a would be suited to the pipe size to be heat treated. Accordingly, different trolleys can be provided for different pipe sizes. This allows the kiln 5a to be adapted for the firing of different sizes of pipes 85a.

High temperature support means in the form of trolleys 95a are also provided, these being capable of containing at least one pipe 85a, and passing the pipe(s) through the firing zone 25a.

In this embodiment, the high temperature trolleys 95a are substantially similar to the low temperature trolleys 80a in design, except that their rollers 100a are made from silicon carbide, and the trolleys 95a may also have insulated end plates 110a at either end thereof to reduce heat loss from the firing zone 25a. The provision of silicon carbide rollers 100a allow the kiln 5a to be operated at higher temperatures than conventional kilns - for example up to a temperature of around 1400°C.

Note again, that the size and spacing of the rollers 100a would be suited to the particular pipe size to be heat treated, thus allowing the kiln 5a to be adapted for the firing of different sizes of pipes 85a.

Provided between the output of the drying/preheat zone 10a and the input to the firing zone 25a, and consequently between the output of the firing zone 25a and the input of the cooling zone 40a there is a transfer zone 115a including first and second pneumatic/hydraulic scissor platforms 120a, 125a. The first platform 120a is movable between a first position where it is substantially level with the output of the drying/preheat zone 10a and a second position where it is substantially level with the input of the cooling zone 40a, while the second platform 125a is moveable between a first position where it is substantially level with the input to the firing zone 25a and a second position where it is substantially level with the output of the firing zone 25a. Further, the first and second positions of the two platforms 120a, 125a are substantially equal in height.

Also provided within the transfer zone 115a are a plurality of transversely aligned lifting arms (not shown), there being at least as many lift arms as pipes 85a in the trolleys 80a, 95a.

A further transfer zone 130a is provided between an output 135a of the upper level of the firing zone 25a and an input 140a of the lower level of the firing zone 25a. In this transfer zone 130a there is provided a third pneumatic/hydraulic scissor platform 145a moveable between

a first position where it is substantially level with the output of the upper level of the firing zone 25a, and a second position where it is substantially level with the input of the lower level of the firing zone 25a.

5 In use, the pipes 85a are extruded onto the lower temperature trolleys 80a and conveyed to the input end 15a of the drying/preheat zone 10a.

The trolleys 80a are then pushed through the kiln 5a by an extendible ram (not shown) on a continuous, 10 intermittent basis, ie a trolley 85a is pushed on one position every set time period.

Simultaneously the rollers 90a will be rotated in order that the pipes 85a can be constantly turned as they dry and so do not dry unevenly or distort.

15 One end of the rollers 90a will have a chain sprocket (not shown) fixed to it and will be driven by either an endless transmission chain or by electric motors on each individual trolley 85a linked to a bus bar system.

Subsequently the lower temperature trolley 80a is 20 pushed out into the transfer section 115a, and onto the first platform 120a which is in its first, raised position. The lifting arms are then pushed into the centre of the pipes 85a, and the platform 120a, and hence the trolley 85a, lowered leaving the pipes 85a on the arms.

25 The arms are then moved across the transfer section 115a until the pipes 85a are above an empty high temperature trolley 95a on the second platform 125a which is in or near to its first raised position. The platform 125a height is then adjusted until the pipes 85a are 30 resting on the rollers 90a, at which time the arms can be retracted and the trolley 95a pushed into the firing zone 25a.

It should be noted that when the trolleys 95a pass out of the drying/preheat zone 10a and into the transfer area 35 115a, the ambient temperature is maintained at a low level. It is important that the pipe 85a temperature is maintained, and so the transfer time should be quick as

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possible. Accordingly, the whole transfer zone 115a is required to be insulated.

Subsequently, the trolley 95a is pushed through the upper section of the firing zone 25a and thence onto the third platform 145a which is in its raised position.

The third platform 145a will then be lowered to its second position, and the trolley 95a pushed into, and passed through, the lower section of the firing zone 25a by another pusher (not shown).

In a similar way as in the drying/preheat section 10a, the rollers 90a may be made to rotate as necessary in order to provide even heating and prevent distortion of the pipes 85a.

After passing through the lower level of the firing zone 25a, the trolley 95a is pushed into the transfer zone 115a and onto the second platform 125a which is at its second lower position. The lifting arms then lift the pipes 85a up and transfer then onto a waiting low temperature trolley 80a on the first platform 120a which is also at its second, lower level. The trolley 80a is then pushed into and through the cooling section 40a.

Description of a Second Embodiment

Referring to Figs 8-15 there is provided a second embodiment of a kiln according to the present invention, generally designated 5b, comprising a drying/preheat zone 10b having input and output ends 15b, 20b, a firing zone 25b having input and output positions 30b, 35b, and a cooling zone 40b also having input and output ends 45b, 50b.

The division of, and temperature gradients within, the drying/preheat zone 10b and the cooling zone 40b may be substantially the same as in the first embodiment.

Similarly the cooling zone 40b is positioned below the drying/preheat zone 10b to provide heat exchange therebetween, as in the first embodiment.

Further, the firing zone 25b may be suitably divided into sections having substantially the same temperature gradients as those of the first embodiment. However, in the second embodiment the firing zone 25b comprises a continuous closed rectangular loop, as can best be seen from Fig 9.

Low temperature support means in the form of trolleys 80b are provided, these being capable of containing at least one pipe 85b, and passing the pipe(s) 85b through the drying/preheat zone 10b.

The low temperature trolleys 80b may be made out of mild steel and consist of two external side frames tied by cross beams having, for example, 8 stainless steel pipe rollers 90b (3 pairs - 1 pair for each pipe 85b to be heat treated). Each of the rollers 90b are mounted on the side frames and driven, for example, by an electric motor (not shown).

Note that the size and spacing of the rollers 90b would be suited to the pipe size to be heat treated. Accordingly, different trolleys can be provided for different pipe sizes. This allows the kiln 5b to be adapted for the firing of different sizes of pipes 85b.

High temperature support means in the form of walking frames (beams) 95b are also provided, these being capable of containing at least one pipe 85b, and passing the pipe(s) through the firing zone 25b. The walking frames 95b are similar in material construction to the high temperature trolleys 95a of the first embodiment. The walking frames 95b are, however, wheel-less.

The walking frames 95b may be pushed along and around paralalled rails 96b, 97b by means of a plurality of hydraulic rams or the like (not shown).

Rotatable rollers 100b of the high temperature walking frames 95b are made from silicon carbide, and the frames 95b may also have insulated end plates (not shown) at either end thereof to reduce heat loss from the firing zone 25b.

Note again, that the size and spacing of the rollers 100b would be suited to the particular pipe size to be heat treated.

5 Provided between the output of the drying/preheat zone 10b and the input position 30b of the firing zone 25b, and between the output position 35b of the firing zone 25b and the input 45b of the cooling zone 40b there is a transfer zone 115b including first and second pneumatic/hydraulic scissor platforms 120b, 125b. The first platform 120b is 10 movable between a first position where it is substantially level with the output of the drying/preheat zone 10b and a second position where it is substantially level with the input of the cooling zone 40b. Similarly, the second platform 125b is moveable between a first position where it 15 is substantially level with the output of the drying/preheat zone 10b and a second position where it is substantially level with the input of the cooling zone 40b. Further, the first and second positions of the two platforms 120b, 125b are substantially equal in height.

20 Also provided within the transfer zone 115b are a plurality of transversely aligned lifting arms (not shown), there being at least as many lift arms as pipes 85b in the trolleys 80b and walking beams 95b.

In use, the pipes 85b are extruded onto the lower 25 temperature trolleys 80b and conveyed to the input end 15b of the drying/preheat zone 10b.

The trolleys 80b are then pushed through the kiln 5b by an extendible ram (not shown) on a continuous, intermittent basis, ie a trolley 85b is pushed on one 30 position every set time period.

Simultaneously the rollers 90b will be rotated in order that the pipes 85b can be constantly turned as they dry and so do not dry unevenly or distort.

One end of the rollers 90b will have a chain sprocket 35 (not shown) fixed to it and will be driven by either an endless transmission chain or by electric motors on each individual trolley 85b linked to a bus bar system.

Subsequently the lower temperature trolley 80b is pushed out into the transfer section 115b, and onto the first platform 120b which is in its first. The lifting arms are then pushed into the centre of the pipes 85b, and the platform 120b, and hence the trolley 85b, lowered leaving the pipes 85b on the arms.

The arms are then moved across the transfer section 115b until the pipes 85b are above an empty high temperature walking frame 95b located on the firing zone 25b. The height of the arms is then adjusted until the pipes 85b are resting on the rollers 90b, at which time the arms can be retracted and the walking frame 95b pushed along within the firing zone 25b.

It should be noted that when the trolleys 80b pass out of the drying/preheat zone 10b and into the transfer area 115b, the ambient temperature is maintained at a low level. It is important that the pipe 85b temperature is maintained, and so the transfer time should be quick as possible. Accordingly, the whole transfer zone 115b is required to be insulated.

Subsequently, each walking frame 95b is pushed through the firing zone 25b by hydraulic rams (not shown).

In a similar way as in the drying/preheat section 10b, the rollers 90b may be made to rotate as necessary in order to provide even heating and prevent distortion of the pipes 85b.

After passing through the firing zone 25b and eventually to the output position 35b, the pipes 85b are lifted from the walking beam 95b onto a trolley 80b onto the second platform 125b which is then lowered to its second lower position. The trolley 80b is pushed (eg. by rams) on to the first platform 120b which is also at its second, lower level. The trolley 80b is then pushed into and through the cooling section 40b.

35 Summary

The embodiments of the invention hereinbefore described are given by way of example only, and are not meant to limit the scope of the invention in any way.

It should be particularly appreciated that the timing of pushing of the trolleys/walking frames 80a, 95a, 80b, 95b and transfer within the transfer zones 115a, 130a, 115b, is critical, but such timing would be apparent to a skilled person when presented with the invention. For that reason such have not been discussed in detail.

Also, the zones 10a, 25a, 40a, 10b, 25b, 40b will be insulated with, and made from, materials known in the art.

Further, the heating/cooling of pipes 85a, 85b within each zone 10a, 25a, 40a, 10b, 25b, 40b may be carried out by techniques and apparatus conventional to kilns.

However, it should be noted that in the vitrifying section 70a, the pipes 85a may be fired by firing of a burner, eg a high velocity gas burner, down the pipe 85a bore when the trolleys 95a are stationary and the pipes 85a rotating. In this way, the trolleys 95a may be moved intermittently, stopping when the pipes 85a are in line with the burners. The pipes 85a are therefore fully supported along their length when passing through the "plastic stage". This is a novel firing technique.

Further, it should be noted that in the rapid cooling section 40a, pipes 85a may be cooled from approximately 1150°C to 650°C in about 10 minutes by blowing cold air down the pipe 85a bores. This imparts an annealing process on the pipes 85a by stressing them and, in turn, raising their strength. This is a novel cooling technique.

Also, within the zones 10a, 25a, 40a, 10b, 25b, 40b and also on the various platforms 120a, 125a, 140a, 120b, 125b, the trolleys/walking frames 80a, 95a, 80b, 85b may advantageously be run on rails.

Finally, baffles or the like may be provided at the inputs to, and the outputs from, the various zones 10a, 25a, 40a, 10b, 25b, 40b in order to aid in insulation and isolate the zones 10a, 25a, 40a, 10b, 25b, 40b from one another.

Claims

1. A kiln for heat treating pipes comprising a drying/preheat zone, a firing zone and a cooling zone, and conveyor means for transporting one or more support means each supporting one or more pipes through at least one of such zones, in use each pipe being supported upon the respective support means substantially perpendicularly to the direction of transportation, each support means further having means for rotating each pipe supported thereon along a longitudinal direction of the respective pipe.

2. A kiln as claimed in claim 1, wherein the support means in at least one zone comprises a wheeled trolley.

3. A kiln as claimed in either of claims 1 or 2, wherein the support means in at least one zone comprises a walking beam.

4. A kiln as claimed in any preceeding claim, wherein adjacent zones are spaced apart from one another by a transfer zone having means for transferring pipes from a support means used in one zone to a support means used in a next zone.

5. A kiln as claimed in any preceeding claim, wherein support means for use in the drying/preheat zone and in the cooling zone are made from mild steel, the means for rotating each pipe being made from stainless steel.

6. A kiln as claimed in any preceeding claim, wherein support means for use in the firing zone are made from mild steel, the means for rotating each pipe being made from silicon carbide.

7. A kiln as claimed in any preceeding claim, wherein the support means for use in the firing zone have insulated plates at either end thereof to reduce heat loss.

8. A kiln as claimed in any preceeding claim, wherein the firing zone has lower and upper sections through which the support means pass in opposite directions, so as to provide heat exchange between the lower and upper sections.

9. A kiln as claimed in any preceeding claim, wherein the firing zone comprises an upper fast heat section, and lower vitrification and rapid cooling sections.

10. A kiln as claimed in any preceeding claim, wherein the drying/preheat zone is provided above the cooling zone so as to provide heat exchange between the cooling zone and the drying/preheat zone.

11. A kiln as claimed in any preceeding claim, wherein the drying/preheat zone comprises a drying section and a preheat/mineralise section.

12. A support means for use in a kiln as claimed in any of claims 1 to 11, the support means being capable of supporting and transporting one or more pipes through at least one of such zones, and further having means for rotating each pipe along a longitudinal direction thereof.

13. A method of heat treating pipes comprising placing the pipe(s) on a support means having means for rotating each pipe supported thereon along a longitudinal direction of the respective pipe, and transporting each support means by conveyor means through at least one zone of a kiln comprising a drying/preheat zone, a firing zone and a cooling zone, each pipe being supported on the support means substantially perpendicularly to the direction of transportation.

14. A kiln for heat treating materials comprising a drying/preheat zone, firing zone, cooling zone, and conveyor means for transporting one or more materials through each zone, wherein adjacent zones are spaced apart from one another by a transfer zone having means for transferring the materials from one zone to a next zone.

15. A kiln as claimed in claim 14, wherein one or more of the materials is supported on a support means, the support means being transportable by the conveyor means.

16. A kiln as claimed in any of claims 14 or 15, wherein the firing zone has lower and upper sections through which the support means pass in opposite

directions, so as to provide heat exchange between the lower and upper sections.

17. A kiln as claimed in any of claims 14 to 16, wherein the firing zone comprises an upper fast heat section, and lower vitrification and rapid cooling sections.

18. A kiln as claimed in any of claims 14 to 17, wherein the drying/preheat zone is provided above the cooling zone so as to provide heat exchange between the cooling and the drying/preheat zones.

19. A kiln as claimed in any of claims 14 or 18, wherein the drying/preheat zone comprises a drying section and a preheat/mineralise section.

20. A method of heat treating materials comprising passing the materials through a drying/preheat zone, transferring the materials to a firing zone via a first transfer zone, passing the materials through the firing zone, and thence transferring the materials to a cooling zone via a second transfer zone.

SIMPLIFIED HEAT TREATMENT SCHEDULE
FOR VITRIFIED CLAY PIPE

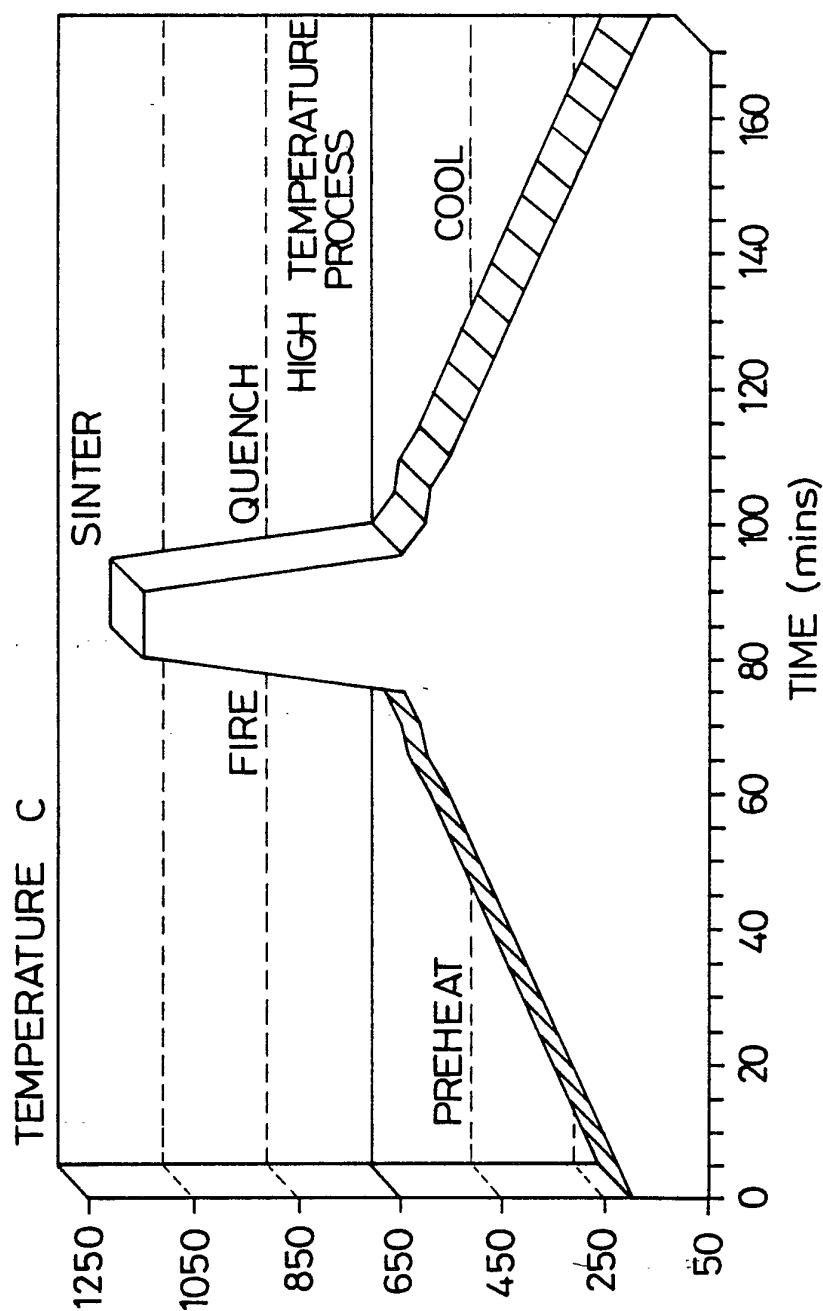


Fig.1

LAYOUT OF HEAT TREATMENT UNITS

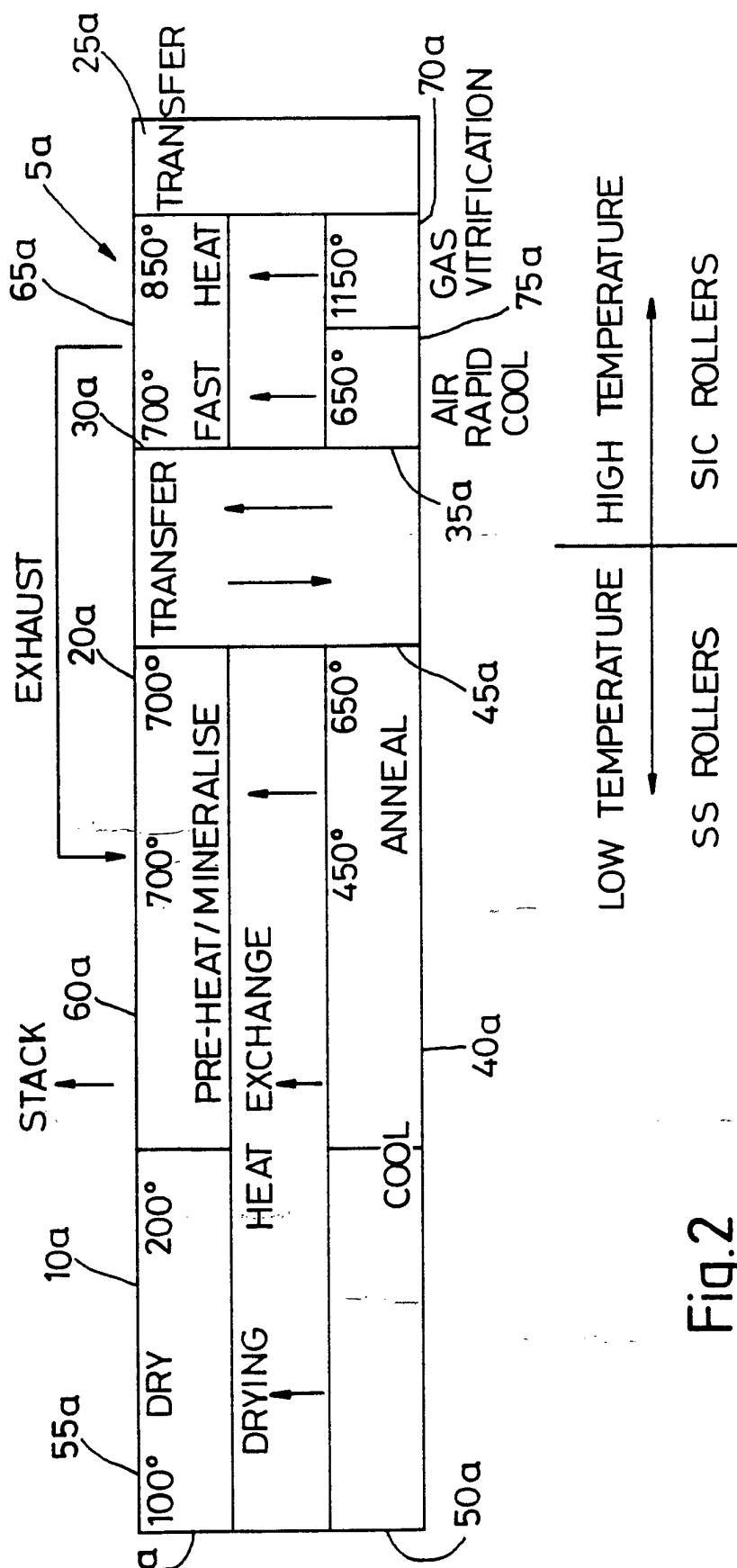


Fig. 2

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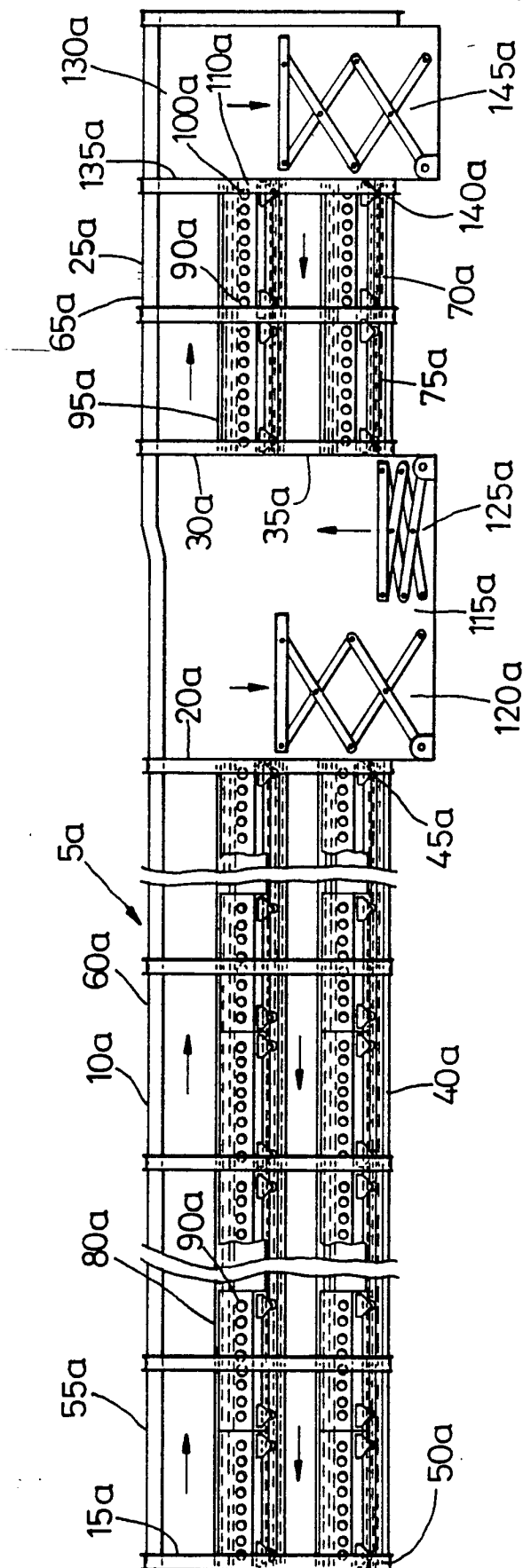
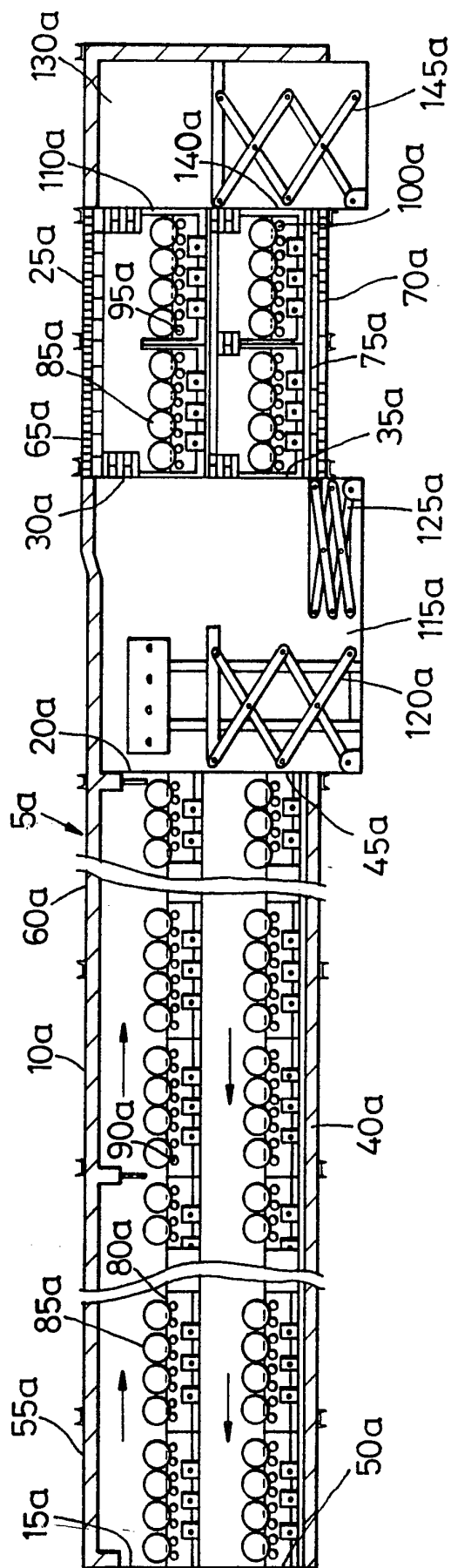


Fig. 3

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SUBSTITUTE SHEET

Fig. 4

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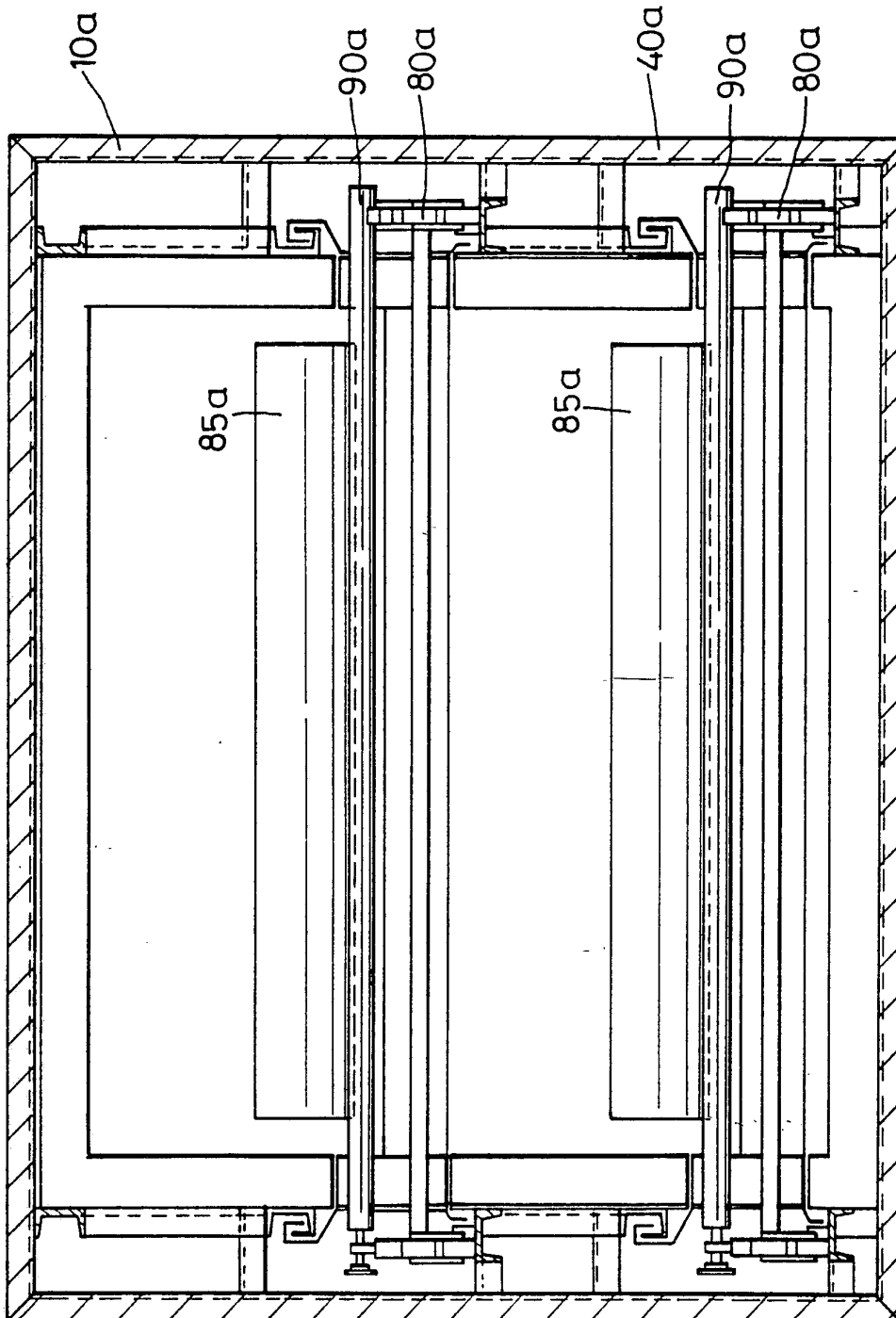


Fig. 5

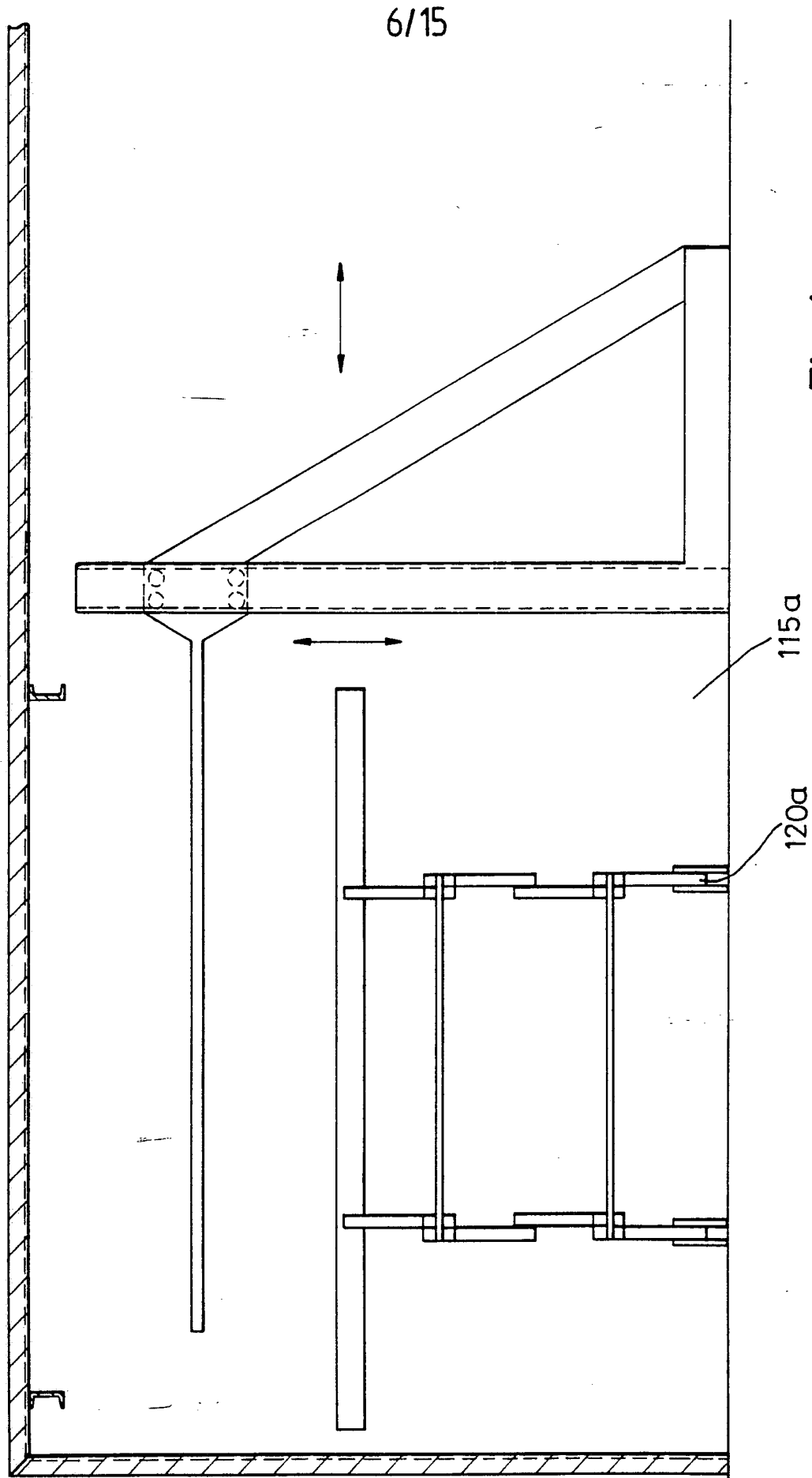


Fig. 6

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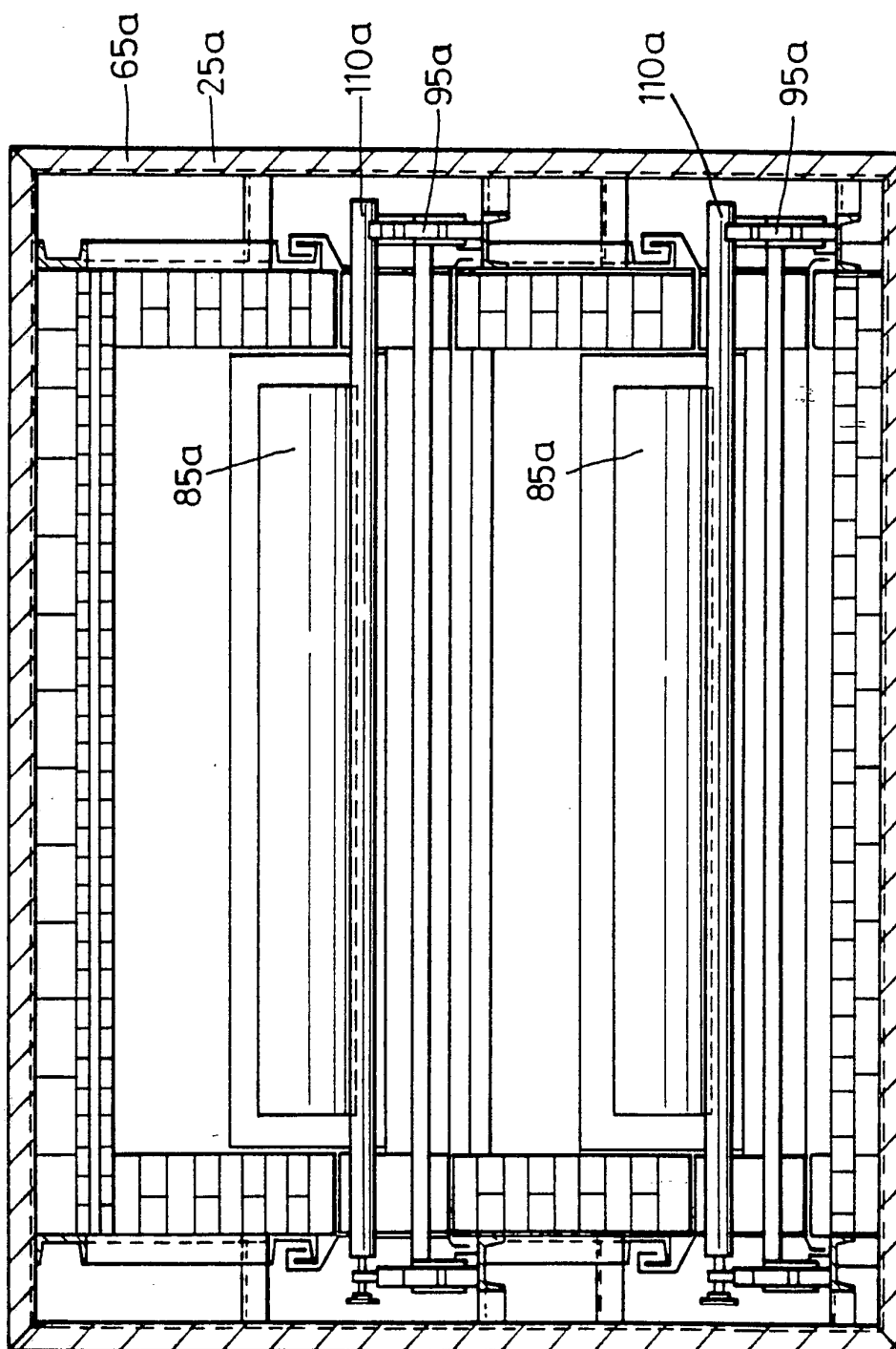


Fig.7

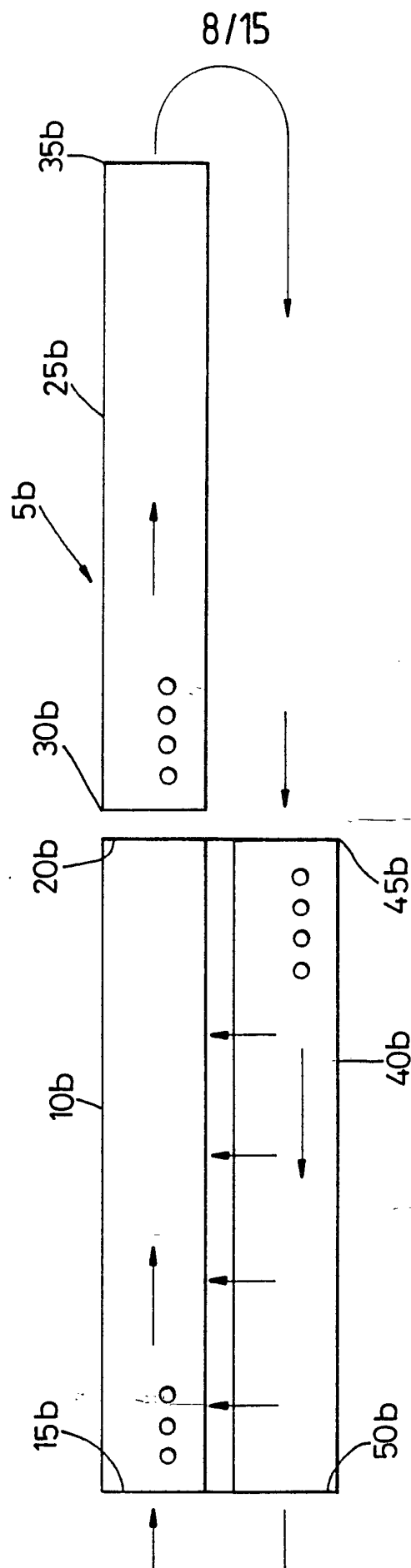


Fig. 8

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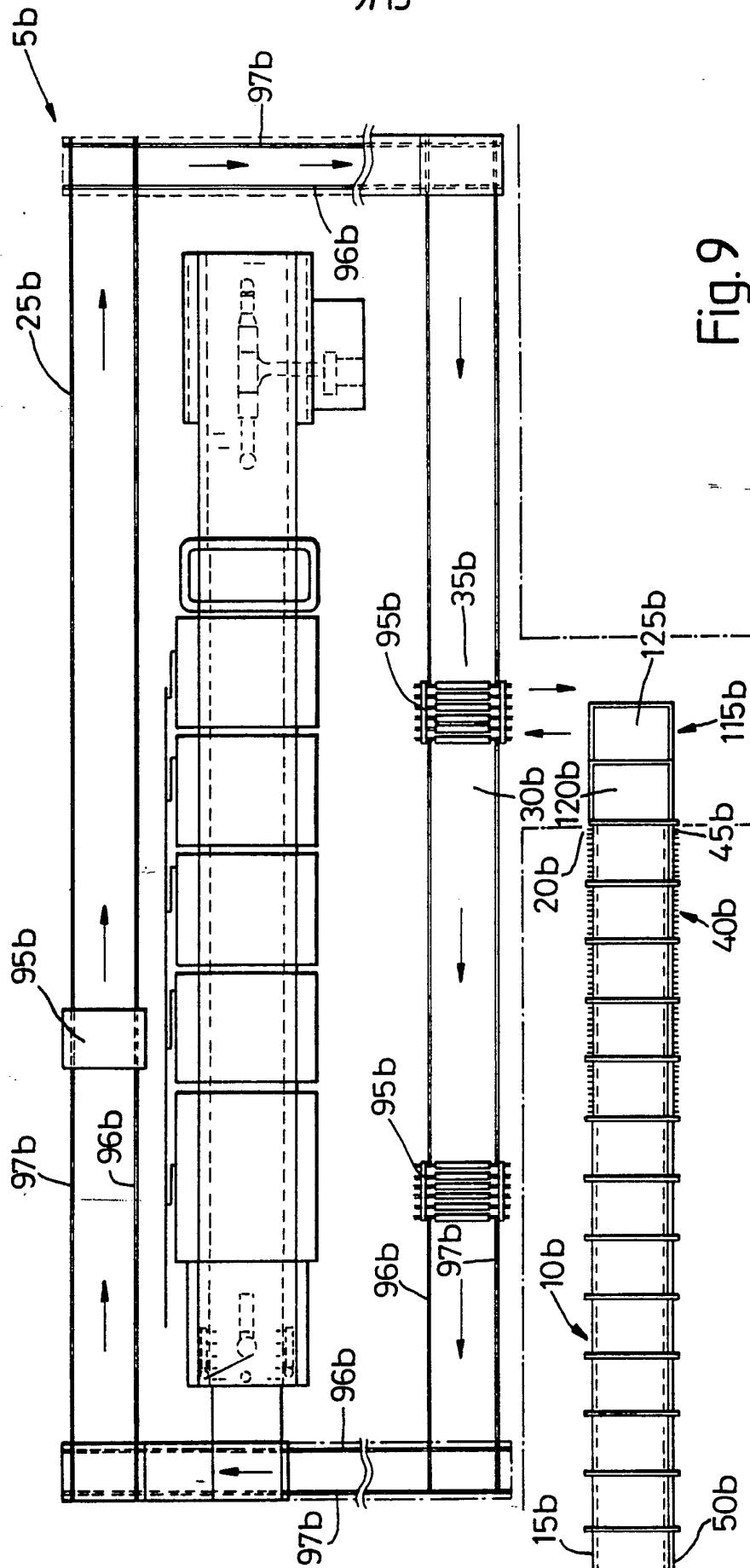


Fig. 9

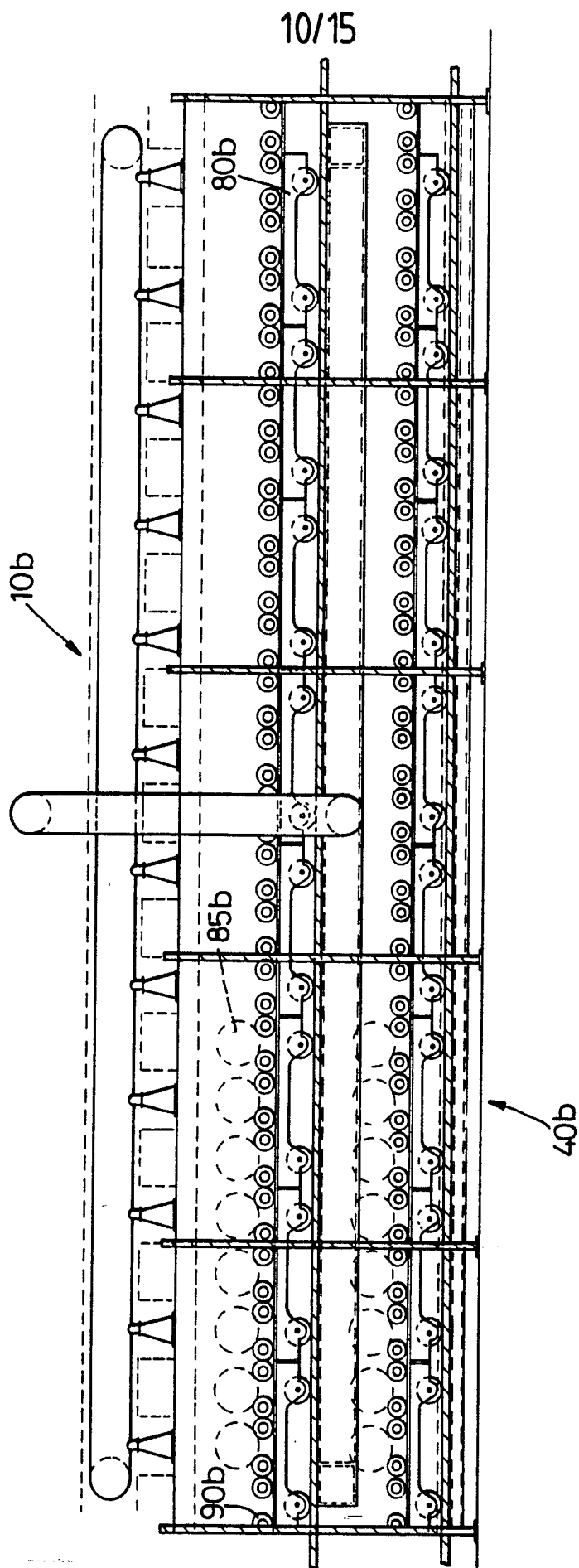
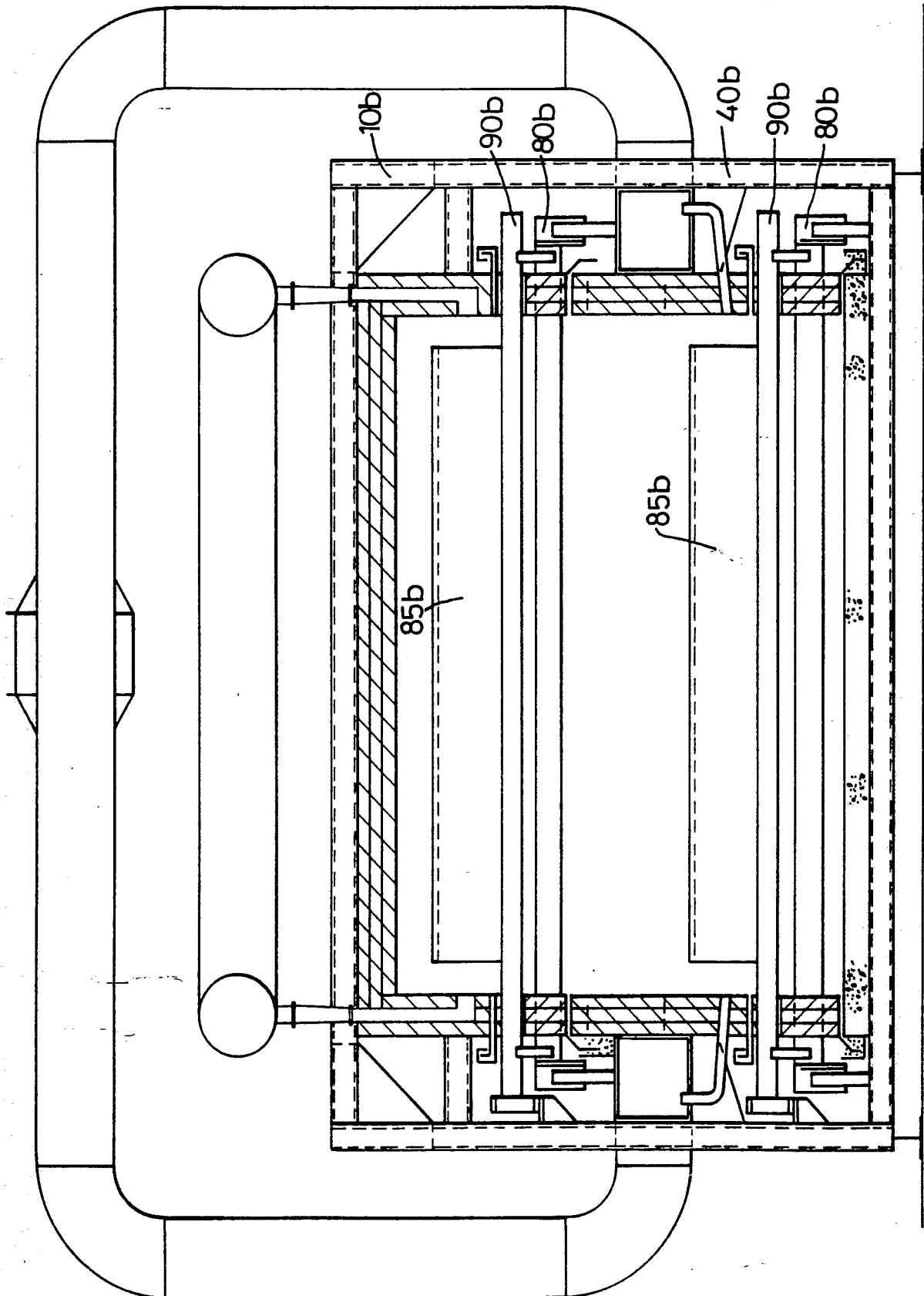


Fig. 10

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Fig.11



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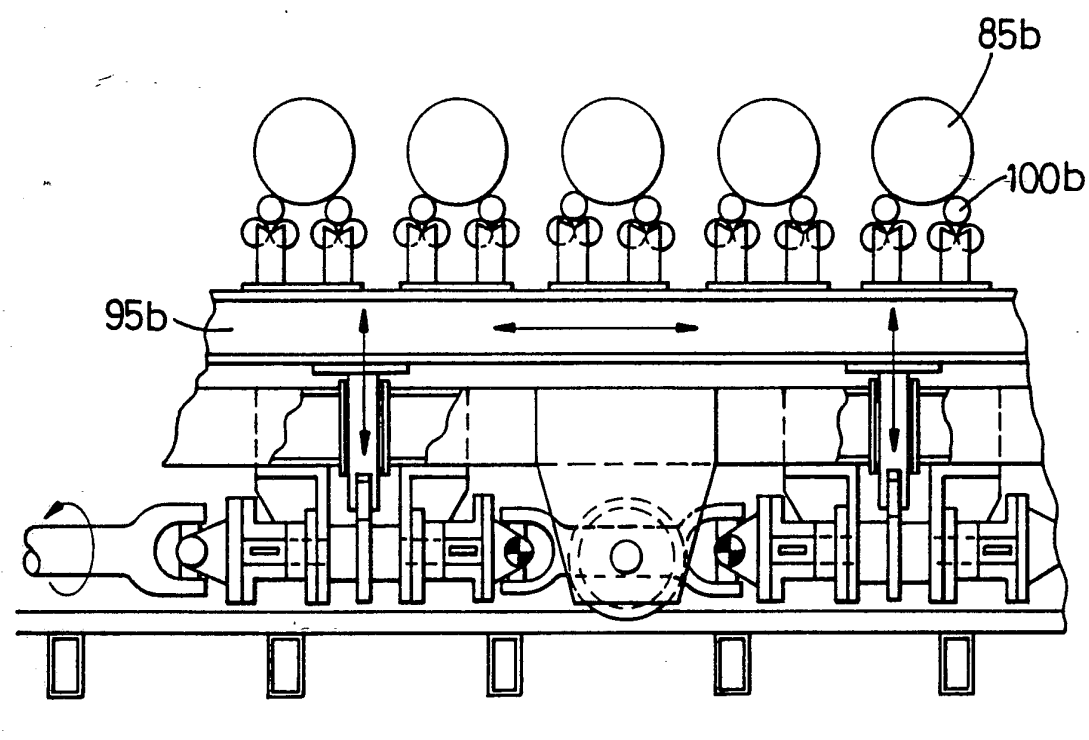


Fig. 12

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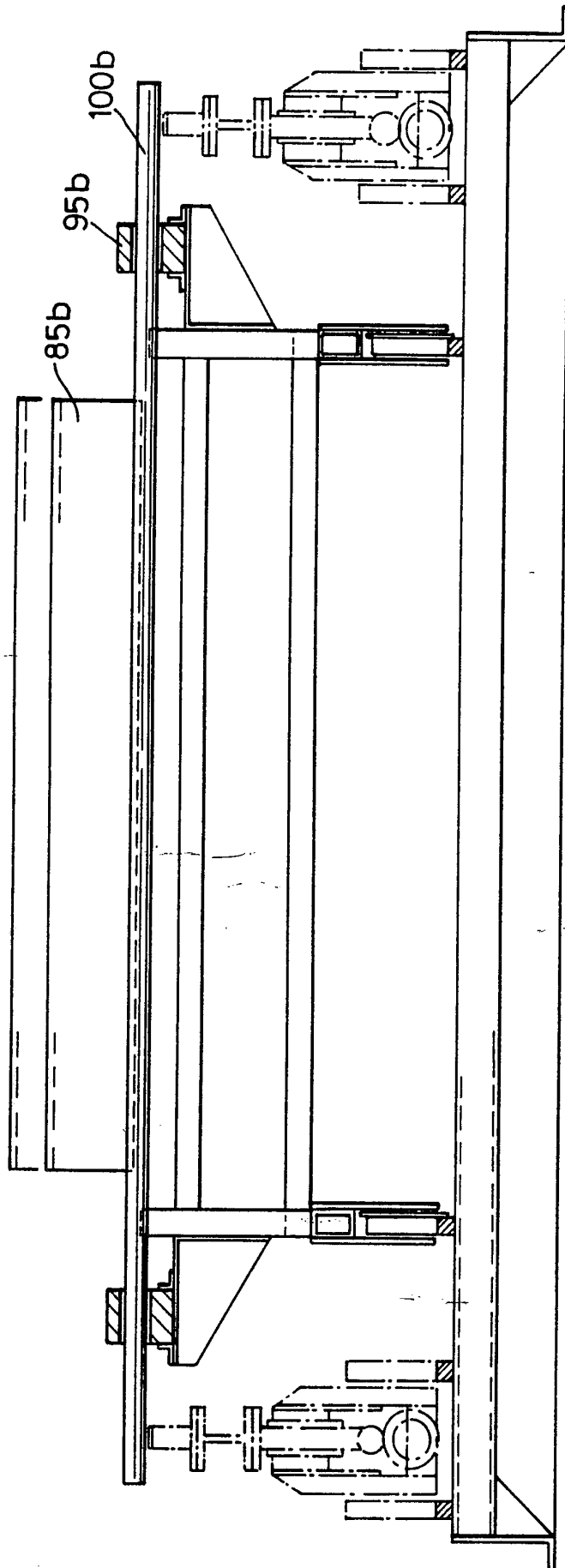


Fig.13

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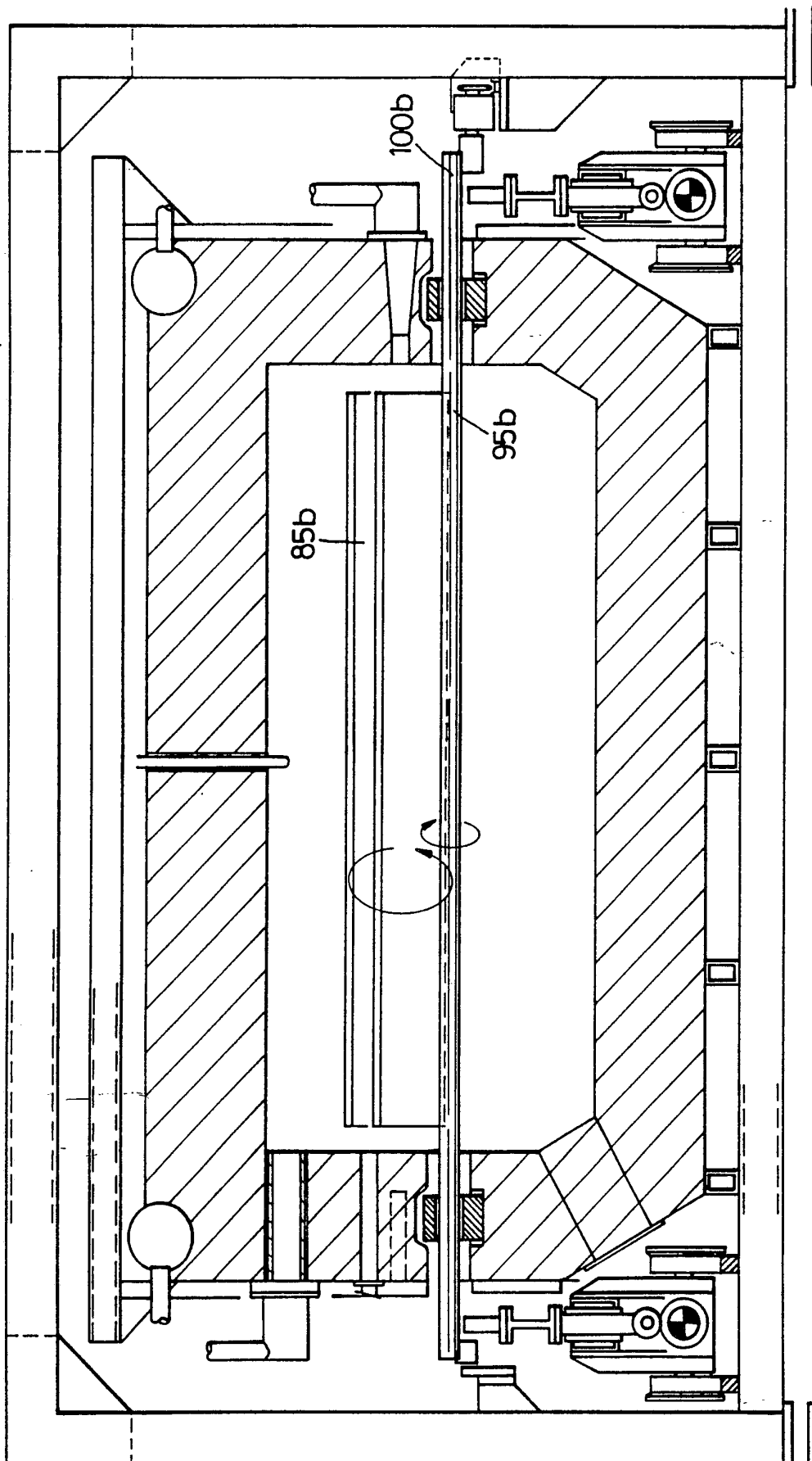


Fig. 14

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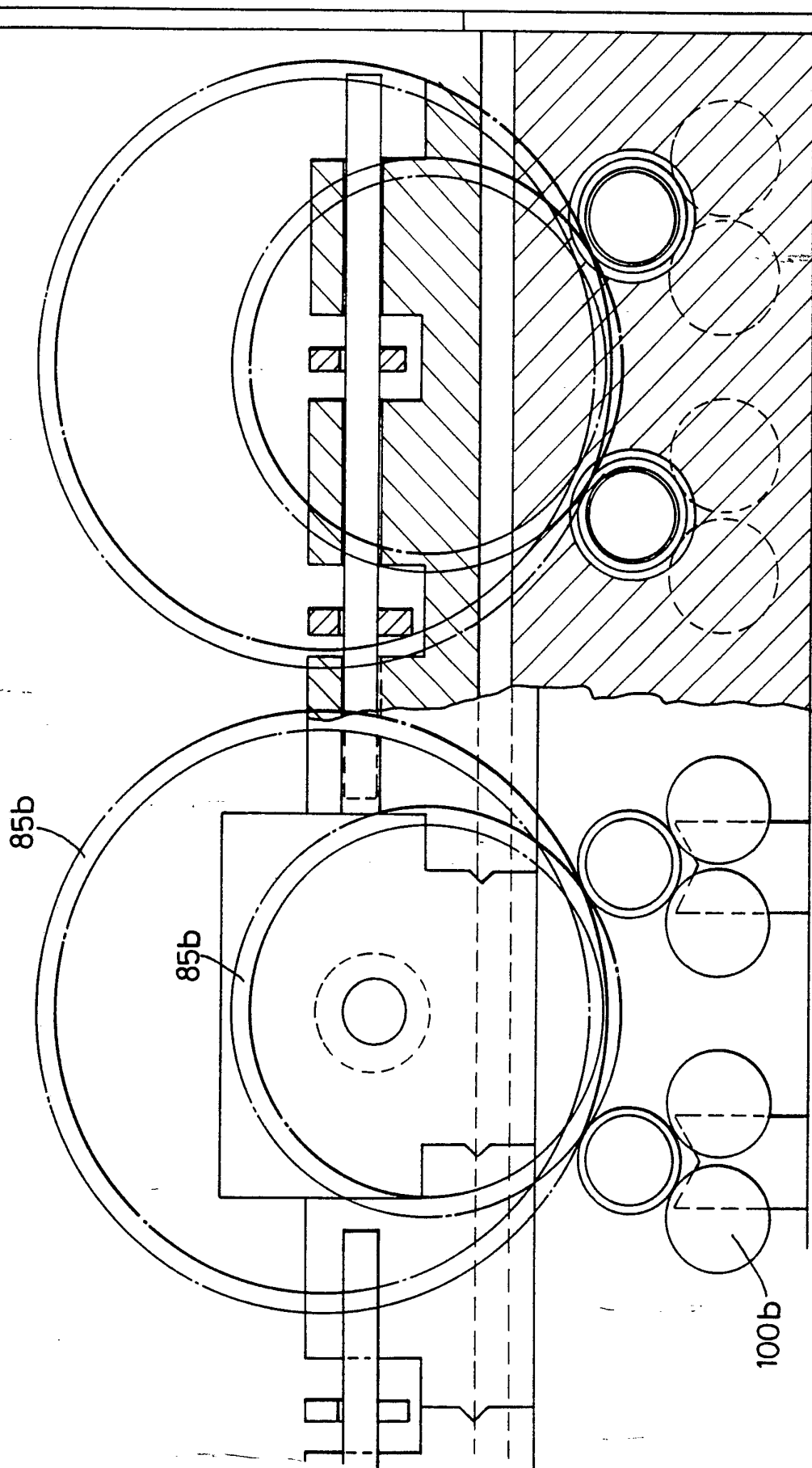


Fig. 15

INTERNATIONAL SEARCH REPORT

PCT/GB 93/00237

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F27B9/24; F27B9/20

II. FIELDS SEARCHEDMinimum Documentation Searched⁷

Classification System

Classification Symbols

Int.Cl. 5

F27B

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched⁸**III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹**

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	DE,A,1 935 921 (OOMS ITTNER) 11 March 1971 see claims 1-14; figures ---	1, 2, 12, 13, 15
X	DE,B,1 055 570 (H.J.BAGGELER) 23 April 1959 see claims 1,2; figures 3-5 ---	1, 2, 12, 13, 15
A	US,A,4 505 670 (J.A.SILVESTRINI) 19 March 1985 see claims; figure 1 ---	1, 3
A	GB,A,2 210 681 (CONSULTANT GAS ENGINEERS) 14 June 1989 see claims 1-9; figures ---	9-11, 14, 16-20
	--- -/--	

¹⁰ Special categories of cited documents:^{"A"} document defining the general state of the art which is not considered to be of particular relevance^{"E"} earlier document but published on or after the international filing date^{"L"} document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)^{"O"} document referring to an oral disclosure, use, exhibition or other means^{"P"} document published prior to the international filing date but later than the priority date claimed^{"T"} later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention^{"X"} document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step^{"Y"} document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.^{"&"} document member of the same patent family**IV. CERTIFICATION**

Date of the Actual Completion of the International Search

23 APRIL 1993

Date of Mailing of this International Search Report

29. 5. 93

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

COULOMB J.C.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
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A	GB,A,2 021 743 (HEPWORTH IRON) 5 December 1979 cited in the application ---	1
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A	EP,A,0 131 955 (APT) 23 January 1985 see claims 1-12; figures & US,A,4 628 615 cited in the application ---	1,4
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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