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(54) Apparatus and method for use in fluidized powder filling of multiple core unit cables.

(57) For powder filling of cables, in a fluidized powder bed, it has been proposed to pass the cable core through a bed in a substantially closed condition. There is a limit to the number of conductors a core can have for effective filling. In the present invention the cable core is opened up into a number of core units by passing through an opening member (50). The opening member is freely ridable on the cable core and has a hole (55, 55A) for each unit. The opener is held against a support member (40) and an air bearing formed between the two members. Air is also usually fed to the holes (55, 55A) in the opener member through which the core units pass to prevent flow of powder out from the bed. The opening member can be positioned in the fluidized bed or outside immediately prior to passage of the cable core through the bed. The units are each in a substantially closed condition in the bed and the units close to a single core also in the bed.

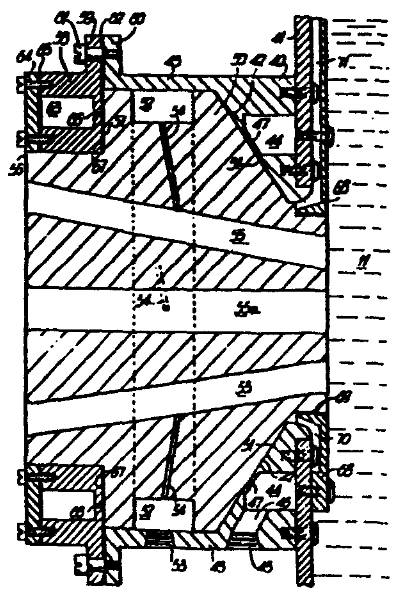

Fig-6-

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This invention relates to apparatus for use in fluidized powder filling of multiple core unit cables, and is particularly concerned with opening means for opening a cable into the individual core units for filling.

In copending Canadian application no. 306,402, filed June 28, 1978, in the name of the present assignee there is described the fluidized powder filling of a cable core by passing the cable core through a fluidized bed in a substantially closed condition. There appears to be a limit to the size of cable core which can effectively be filled, and in the case of a telecommunications cable having a core composed of a multiplicity of pairs of conductors, a convenient maximum unit size is fifty pairs of conductors.

For cables having more than this number of conductors, the cable core is "opened" to form a number of core units, each unit being in a substantially closed condition as it passes through the fluidized bed. The cable core can be opened before or after entering the fluidized bed, and closes back again in the bed.

In its broadest aspect, the invention is concerned with an opening device for opening a cable core into a plurality of core units, with the individual units being powder filled in a substantially closed condition. The opening device can be positioned in the fluidized bed or outside the bed prior to passage of the cable core through the bed. The device comprises an opening member freely riding on the cable core and supported against a support member through an air bearing arrangement.

The invention will be readily understood by the following description of certain embodiments, by way of example, in conjunction with the accompanying drawings, in which:-

Figure 1 is a diagrammatic longitudinal cross-section through a filling bed with an opening device in the bed;

Figure 2 is a diagrammatic perspective view of the two basic parts of the device, shown spaced apart for clarity;

Figure 3 is a cross-section on the line III-III of Figure 2, with the device as in use;

Figure 4 is a diagrammatic longitudinal cross-section through a filling bed with an opening device outside the bed, before entry of the cable core;

Figure 5 is a front view of the opening device in Figure 4, as it would be seen in the direction of the arrow A in Figure 4;

Figure 6 is a cross-section on the line VI-VI of Figure 5, illustrating the opening device in more detail;

Figure 7 is a perspective view on the inner face of the inlet wall of the bed, showing an air collector;

Figure 8 is a cross-section through an alternative form of cable opening device, on the line VIII-VIII of Figure 9;

Figure 9 is a face view in the direction of arrow A in Figure 8, with certain hidden details shown in dotted outline;

Figure 10 is a partial cross-section, on the line X-X of Figure 8, illustrating the structure at the periphery of the rotating member.

As illustrated in Figure 1, a fluidized powder filling bed is indicated generally at 10, the powder being in the main portion 11 having a perforated base member 12, an air box 13 under the member 12, with an air supply at 14. The main portion is covered by a lid 15 and dust extraction is provided at 16. The bed can be supplied with powder either by removing the lid or by providing an inlet. A typical form of bed is illustrated in the above mentioned application.

A cable core 17 enters via an inlet die 18 and then the core is opened by the core units passing through an opening device 19. After passage through the opening device the core units close together, as indicated at 20, and then exit through an exit die 21. After passing through the exit die the core can be wrapped, for example by a tape wrapping device 22 and tape 23. The opening device can be supported in the bed by a support plate 24 extending across the main portion 11.

The opening device 19 is illustrated in more detail in Figures 2 and 3. The device comprises a support member 25 attached to the support plate 24, and an opening member 26 which rides on the cable core 17, the core opens up into a plurality of core units 27. Support member 25 is annular in form and has an annular passage 28 formed from the back surface. The back surface of the support member is held tight against the support plate 22, as by screws at 29, and pressurized air is fed to the passage 28 via an inlet 30. Formed in the front face of the support member 25 are a number of small orifices 31 communicating with the passage 28. In operation, with the opening member 26 riding on the cable core, the drag on the opening member holds it against the support member 25, and the opening member is also maintained in alignment with the support member. High pressure air feeds through the orifices 31 and supports the opening member 26 a short distance away from the support member, allowing virtually friction free relative movement. The air also prevents fluidized powder penetrating between the two members. Holes 32 are formed through the opening member 26 for passage of core units therethrough.

To start the operation, the cable core is divided into the required number of core units after passage through the inlet die 18. While seven are shown in Figures 2 and 3, a smaller number can occur, or a large number. For large cable cores more than one row of holes 32 can be provided in the opening member. The individual core units are then put through the holes 32, then through the centre of the support member 25 and then out through the exit die 21. Usually a pulling member is attached to the end of the cable core to lead it through any successive stages and on to the take-up spool. The bed is then closed, air admitted to the air box 13 and the powder fluidized. The cable core is pulled through the bed, the core opening to pass through the opening member 26 and then closing again. The powder fills the interstices between the conductors in each core unit prior to the cable core closing together. There is some twist in the core units, about the longitudinal axis of the core, and the opening member 26 can rotate relative to the support member 25 quite easily.

Figure 4 illustrates diagrammatically an alternative arrangement in which the opening device 19 is mounted on the outside of the bed 10 at the inlet to the filling portion 11. Where applicable the same reference numerals are used in Figure 4, and in Figures 5 and 6, for the same items as in Figures 1 to 3. The cable core is opened into units before entering the fluidized bed, closing again in the bed at 20.

Figures 5 and 6 illustrate in more detail the opening device 19 of Figure 4. In this example a support member 40 is attached to the inlet end wall 41 of the main portion 11 of the bed. The support member 40 is tubular and has a conical support surface 42 and an annular wall 43 extending from the outer periphery of the conical surface forming a chamber. An annular channel 44 is formed in the back of the support member and pressurized air is supplied to this channel via an inlet 45 connecting passage 46. Small orifices 47 extend from the support surface 42 through to the channel 44.

Positioned within the support member 40 is an opening member 50. The opening member has a forward, conical surface 51 which is in opposition to surface 42. The periphery of the opening member is also a freely moveable fit inside the wall 43. An annular chamber 52 is formed in the periphery of the opening member and pressurized air is fed to this chamber via an inlet 53. From the chamber 52 air is fed via small diameter bores 54 to holes 55 and 55a extending through the opening member and through which pass the core units. The feature of the air supply bores 54 will be described later.

The rearward surface 56 of the opening member 50 is recessed around the periphery to provide a rearward bearing surface 57, and a retaining member 58 is positioned in the recess. The retaining member has a radially extending flange 59 which mates with a radially extending flange 60 on the support member 40 and screws 61 connect the two flanges together. A gasket 62 can be positioned between the flanges. The retaining member has an annular cavity 63, closed by a cover plate 64 with a gasket 65. Small orifices 66 connect the cavity 63 with the front surface 67 of the retaining member. Pressurized air is fed to the cavity 63 via an inlet, not shown.

In operation, once the cable core has been initially opened and the core units passed through the holes 55, and 55a through the bed 10, out through the unit die 21 and on to the take up spool, air is supplied to the air box 13 to fluidize the powder and also to the channel 44, chamber 52 and cavity 63.

The pressurized air fed to the channel 44 and cavity 63 flows through the orifices 47 and 66 and forms an air bearing between the support member and the opening member. There is thus virtually no friction between support member and opening member. Air will also flow between the outer periphery of the opening member and the inner surface of the wall 43.

Although the core units are passing through the holes 55 and 55a at a fairly high speed, say over 100 ft. per minute, powder tends to escape from the bed out through the holes. By feeding air in via inlet 53, chamber 52 and bores 54, a small net flow of air into the bed can be achieved, preventing outflow of powder. The flow of this air can be control so that powder leakage is just prevented. The air flowing from the orifice 47 between concial surfaces 42 and 51 flows out from between these surfaces at the mounting position on the end wall 41. This flow could interfere with the fluidized bed and a collection system can be provided. As seen in Figures 6 and 7, collector member 68 is attached to the inside of the wall 41, the inner periphery of the member 68 situated in a recess 69 in the forward end of the opening member. The inner portion of the member 68 is recessed on the side facing the support member 40 and opening member 50 and forms an annular conduit 70 into which the air flows from between surfaces 42 and 51. The annular conduit 70 connects via a passage 71 to an outlet 72 opening into the space above the bed at 11. The bed exhaust is slightly below atmosphere pressure. Similarly, an air supply can be provided to feed air to the holes 32 in the opening member of Figures 1, 2 and 3.

Thus the opening member 50 rides freely on the cable core and can rotate freely within the support member as the cable core passes through the bed. The number of holes 55 can vary depending upon core size and number of core units. More than one row of holes 55 can be provided, as necessary. It is also possible to provide an opening member with a large number of holes 55, with means for blocking those holes not used.

The arrangement illustrated in Figure 8 is for a large cable, the arrangement opening the cable into 18 units. The arrangement comprises an opening member or rotor 80 having eighteen axially extending holes 81 extending therethrough. The rotor is supported in a support member or housing, indicated generally at 82, and has a central portion 83 of larger diameter than end portions 84 and 85. The housing 82 has a central portion 86 and end portions 87 and 88, the inner bores of the portions 86, 87 and 88 being such that the rotor is a close rotating fit therein.

Inset into the central portion 86 of the housing 82 are a plurality of nozzle units 89 and a plurality of exhaust outlets 90. In the particular example illustrated there are four nozzle units 89 spaced 90° apart round the central portion 86, and four exhaust outlets 90 also spaced 90° apart and being midway between the nozzle units. Air is supplied to the nozzle units 89 via pipes, not shown, connected to threaded inlets 91, and exhaust air is exhausted through pipes, not shown, connected to threaded outlets 99. The four nozzle units 89 and four exhaust outlets 90 are shown in dotted outline in Figure 9.

Positioned in each nozzle unit 89 is a nozzle member 92, illustrated in cross-section in Figure 10. The periphery of the central portion 83 of the rotor 80 has a plurality of semi-circular grooves 93 in alignment with the nozzle members 92. A circumferential groove 94 extends on either side of the grooves 93. The grooves 93, with the nozzle members 92, form an air turbine structure. Air admitted to a nozzle unit 89 is ejected by the nozzle member to impinge on the grooves 93 to produce a rotational effort on the rotor 80. The nozzle units 89 are mounted in circular housings 95 welded to the housing 82. The nozzle units can be inserted in the housings in one of two directions, either as illustrated in Figure 10, or rotated through 180°. Thus the nozzle member can be positioned to eject air in one direction or another, 180° apart, and provides for both rotational and braking effort as required.

The central portion 86 of the housing on either side of the central section is formed by spaced members 96 to provide an annular air chamber 97. Small bores 98 extend through the inner members 96, and air passes through the bores 98 to form an air bearing between the periphery of the central portion of the rotor and the inner surfaces of inner members 96.

Similarly end members 100 and 101 form annular air chambers 102 and 103, with small bores 104 extending through the inner walls 105 of the chambers 102 and 103. Air flowing through the bores 104 forms air bearings between the end surfaces 120 of the central portion 83 of the rotor 80 and the end members 100 and 101.

Air, under pressure, is fed to chambers 102 and 103 via inlets 107 and 108 respectively and to chambers 97 via one or more inlets 109. Air escaping by flowing down between the end of the central portion 83 of the rotor and inner wall 105 of end member 100, at the left side of Figure 8, can flow between the circumference of the reduced diameter portion 84 and the end member into chamber 110 and exhaust via outlet 111.

Depending upon the size of cable, and the number of units the cable needs to be divided into, so the rotor can have differing numbers of holes 81. For example rotors with 2 to 12 holes can be provided. Conveniently the dimensions of the rotor are standard, apart from the number, and possibly diameter, of the holes 81. Rotors can be replaced by removing the end portions 88 of the housing 82. The rotor 80 can then be slid out and another replaced. The end portion 88 is located and held in place by dowels 112 and cam action studs 113.

In the example illustrated in Figures 8, 9 and 10, the cable moves through the rotor in a direction indicated by the arrow X in Figure 8. The device is mounted on the end wall of the inlet end of the fluidized bed housing, the wall indicated at 114 in Figure 8. Thus Figure 8 is in the opposite sense to the arrangement illustrated in Figure 6. While the twist of the cable units themselves will tend to rotate the rotor as the cable passes through the fluidized bed, with large cables the size of the rotor can be such as to create significant rotational drag. The use of the "turbine"effect of the nozzle members 92 and grooves 93 can be used to overcome this rotational drag. However, under some circumstances, the rotor can tend to rotate faster than is desired due to the rotation imposed on the motor by the cable. In such circumstances, by reversing the inlet members, as described above, a braking effort can be applied to the rotor. The "turbine" effect can be controlled by controlling the air supply to the nozzle units 89. The number of nozzle units used can be varied, and the number provided can also vary. The end loading imposed on the rotor, or opening member, 80 by passage of the cable is supported by the end member 100 which corresponds to the support member 25 in Figures 2 and 3 and support member 40 in Figure 6. In the example illustrated in Figure 8 the rotor or opening member 80 projects into a hole in the end wall 114. However, the arrangement of Figures 8, 9 and 10 can be mounted on a plate which in turn mounts on the end wall of the fluidized bed.

As a typical example, the bed 10 can be 4 ft. long. The cable core units close down at a position which can vary from about 6" to about 18" from the inlet wall. The larger the cable the greater the distance the closing down from the inlet. The bed can be made shorter, but the size given will accommodate various cable sizes. It is believed that the length of bed beyond the closing down of the core units evens out the filling, but the majority of the filling occurs at the beginning before the core units close down. A typical air supply pressure is about 80 psi although this can vary and lower pressures have been used. The air flows are quite small. The size of the holes 32 and 55 will depend upon the size of the cable core units passing therethrough. As an example, for the arrangement as illustrated in Figures 5 and 6, the following table gives typical dimensions for a telecommunications cable, in which the cable core has been divided up so that core units of alternately twelve and thirteen pairs pass through holes 55, and a twenty-five pair unit passes through holes 55a. Other numbers of pairs per unit can be provided with corresponding adjustment to the hole diameters.

Wire Gauge	Holes 55	Hole 55a
24	.358" dia.	.468" dia.
22	.397" dia.	.515" dia.

Wire Gauge	Holes 55	Hole 55a
26	.316" dia.	.406" dia.
19	.531" dia.	.703" dia.

1. Apparatus for use in fluidized powder filling of multiple core unit cables, comprising an opening member for opening a cable into a plurality of core units, characterized by: a support member (25,40,82); a rotatable opening member (19,50,80) positioned against the support member (25,40,82) and including a plurality of holes (32,55,55a, 81) extending in an axial direction through the opening member, each hole adapted for passage of a core unit therethrough; and means (28,30,31,44,47, 102,103,104) for supply pressurized air between the opening member and the support member to form at least one air bearing therebetween; the opening member freely ridable on the cable core.

2. Apparatus as claimed in claim 1, characterized by the opening member (19,50,80) positioned adjacent to an end surface on the support member.

3. Apparatus as claimed in claim 1 or 2, characterized by the support member (25) and the opening member (19) mounted in a fluidized powder filling bed (10).

4. Apparatus as claimed in claim 1 or 2, characterized by the support member (25,40) and the opening member (19,50,80) mounted at an inlet end of a fluidized powder filling bed (10).

5. Apparatus as claimed in any one of claims 1 to 4, characterized by means (52,54) for supplying pressurized air to the holes (55,55a) extending through the opening member at a position intermediate the ends of the holes.

6. Apparatus as claimed in claim 3, characterized by an inlet die (18) at an inlet end of the bed (10) and an exit die (21) at an exit end of the bed, the inlet and exit dies each adapted to maintain

the cable core in a closed condition.

7. Apparatus as claimed in any one of the preceding claims, characterized by means (22) for wrapping the core after the core issues from the bed.

8. Apparatus as claimed in claim 4, including a wall at the inlet end of the bed, characterized by the opening member (19,50) being mounted on an outer side of the wall (41) and attached to the wall, and a hole extending through the inlet wall in alignment with the opening member.

9. Apparatus as claimed in claim 8, characterized by a tubular support member (40) having a back surface positioned against the wall, and an annular wall (43) extending from the back surface and defining a chamber within which the opening member is positioned.

10. Apparatus as claimed in claim 9, characterized by the chamber having a conical support surface (42) at an inner end, the opening member (50) including a forward, conical, surface (51) in cooperative opposition to the conical support surface (42).

11. Apparatus as claimed in claim 10, characterized by the annular channel (44) formed in the back surface of the tubular support member (40),means (46) for feeding pressurized air to the annular channel, and orifices (47) extending from the annular channel to the conical support surface for supplying the pressurized air between the support member(40)and the opening member (50).

12. Apparatus as claimed in claim 9, characterized by the opening member (50) including a cylindrical portion freely rotatable within the annular wall, an annular chamber (52) extending around the outer periphery of

the cylindrical portion, means (53) for feeding pressurized air through the annular wall to the annular chamber (52), and bores (54) extending from the annular chamber (52) to the holes (55,55a) extending through the opening member (50) for supplying pressurized air to the holes (55,55a).

13. Apparatus as claimed in claim 9, characterized by annular retaining member (58) attached to an outer end of the annular wall (43) and extending radially inward thereof; a front surface on the retaining member; a rearward bearing surface on the opening member (50) in opposition to the front surface on the retaining member; an annular cavity (63) in the retaining member; means for feeding pressurized air to the annular cavity and orifices (66) extending from the cavity to the front surface of the retaining member to feed pressurized air between the front surface and the rearward bearing surface for formation of an air bearing therebetween.

14. Apparatus as claimed in claim 8, characterized by a collector member (68) mounted on an inner side of the wall (41) at the inlet end, for collection of air flowing from between the support member (46) and the opening member (50), and an outlet (72) connected to the collector member.

15. Apparatus as claimed in claim 14, characterized by the outlet (72) connected to an air space above the fluidized bed at a pressure slightly below atmosphere.

16. Apparatus as claimed in any one of the preceding claims, characterized by the opening member (19,50) including a central hole (32,55a) on the central axis of the opening member, and at least one circle of holes (32,55) around the central hole.

17. Apparatus as claimed in claim 16, characterized by each of the holes forming a circle of holes being inclined inwardly towards the central axis, from an inlet surface to an outlet surface on the opening member.

18. Apparatus as claimed in claim 16, characterized by the hole (55a) being larger than the holes forming a circle of holes.

19. Apparatus as claimed in claim 8, characterized by the support member (82) comprising a tubular housing having a cylindrical central portion (86) and cylindrical end portions (87,88), on either side of the central portion, the end portions having an internal diameter smaller than the internal diameter of the central portion, one of the end portions forming an end surface, the opening member (80) comprising a rotor rotatably mounted in the housing and having a centre portion (83) and end portions (84, 85), on either side of the centre portion, the diameters of the end portions and centre portion of the rotor being a close rotating fit in the end portions and central portion respectively of the housing; axially extending grooves (93) in the periphery of the central portion of the rotor and at least one nozzle member(92) in the central portion of the housing, and air supply means (91) to the nozzle member, whereby pressurized air ejecting from the nozzle member acts on the grooves to provide a rotational force on the rotor; the end portions of the housing including surfaces in opposition to end walls on the central portion of the rotor, and means (102,103,104), for supplying pressurized air between the end walls and the surfaces; and means (97,98) for supplying pressurized air between the periphery of the central portion of the rotor and the inner surface of the central portion of the housing to form at least one air bearing therebetween.

20. Apparatus as claimed in claim 19, characterized by the axially extending grooves (93) being of hemispherical cross-section, the nozzle member having an outlet inclined relative to the axes of the grooves.

21. Apparatus as claimed in claim 19 or 20, characterized by each nozzle member (92) being mounted in a nozzle unit (89), and including means for attaching the nozzle unit to the housing to permit attachment of the nozzle unit in either of two positions, of 180° rotation apart.

22. Apparatus as claimed in claim 16, characterized by the opening member (80) including a plurality of circles of holes (81) around the central hole, the axes of all of the holes parallel to each other.

23. A method of fluidized powder filling a multiple core unit cable, characterized by opening the cable (17) into multiple core units, each core unit containing a multiplicity of conductors, feeding the individual core units in a substantially closed condition through a fluidized powder bed, (10), and closing said core units into a cable in the fluidized powder bed.

24. A method as claimed in claim 23, characterized by opening the cable(17) by passing the core units through holes (35,55,55a,81) in an opening member (19,50,80) freely ridable on the cable.

25. A method as claimed in claim 24, characterized by feeding pressurized air to the holes (55,55a,) in the opening member (40), to prevent escape of powder from the bed through the holes.

26. A method as claimed in claim 24 or 25 characterized by feeding pressurized air between the opening member and a support member on the fluidized bed for formation of at least one air bearing between the support member and the opening member.

27. A method as claimed in claim 24 or 25,or 26 characterized by ejecting pressurized air from a housing (82) surrounding the opening member (80), the air impinging on formations (93) on the periphery of the opening member to produce a rotational force on the opening member.

28. A method as claimed in claim 27, characterized by the rotational force being in a direction to rotate the opening member in the same direction as rotation resulting from the passage of the cable core units.

29. A method as claimed in claim 27, characterized by the rotational force being in a direction to oppose the rotation of the opening member resulting from the passage of the cable core units.

30. A method as claimed in any one of claims 23 to 29 characterized by wrapping a tape (23) round the close cable core after exiting from the fluidized powder bed.

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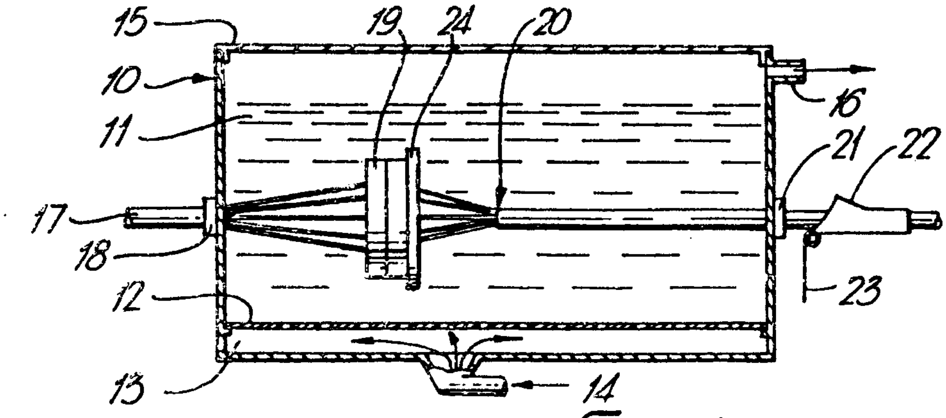

~Fig~1~

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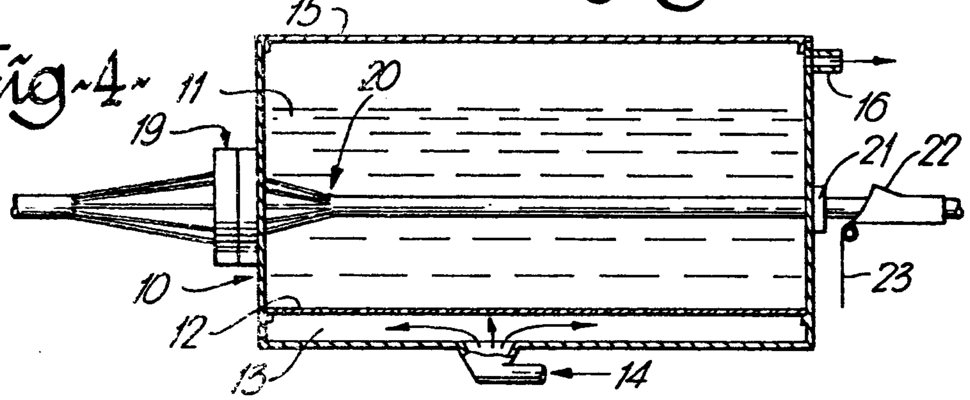

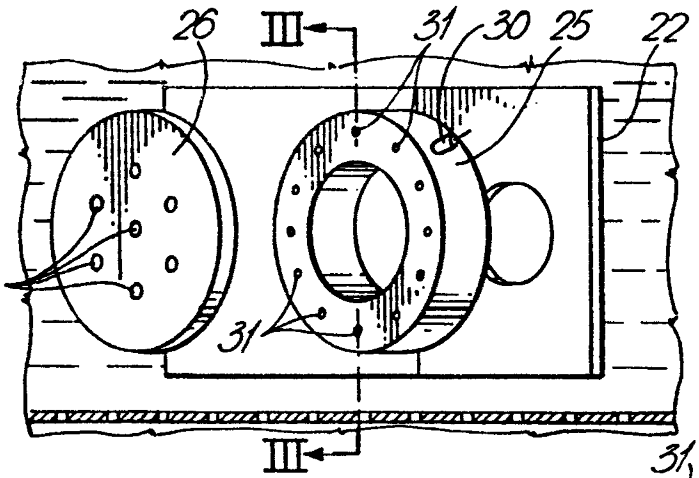

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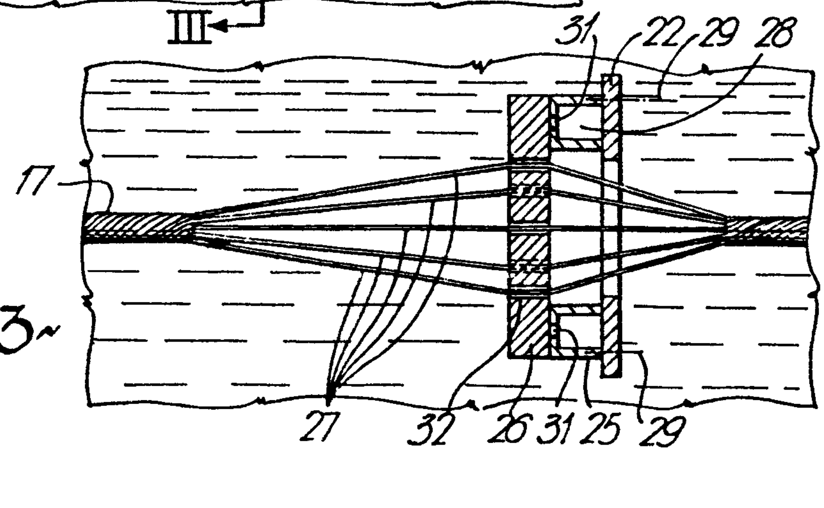

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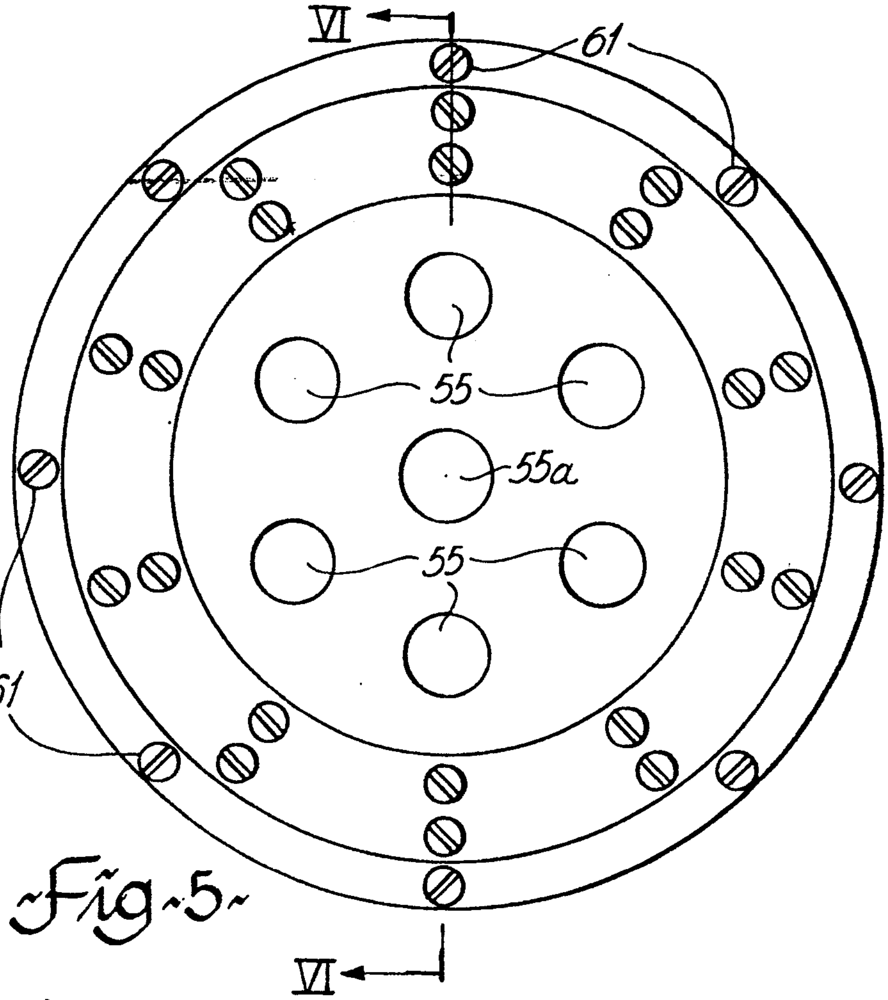

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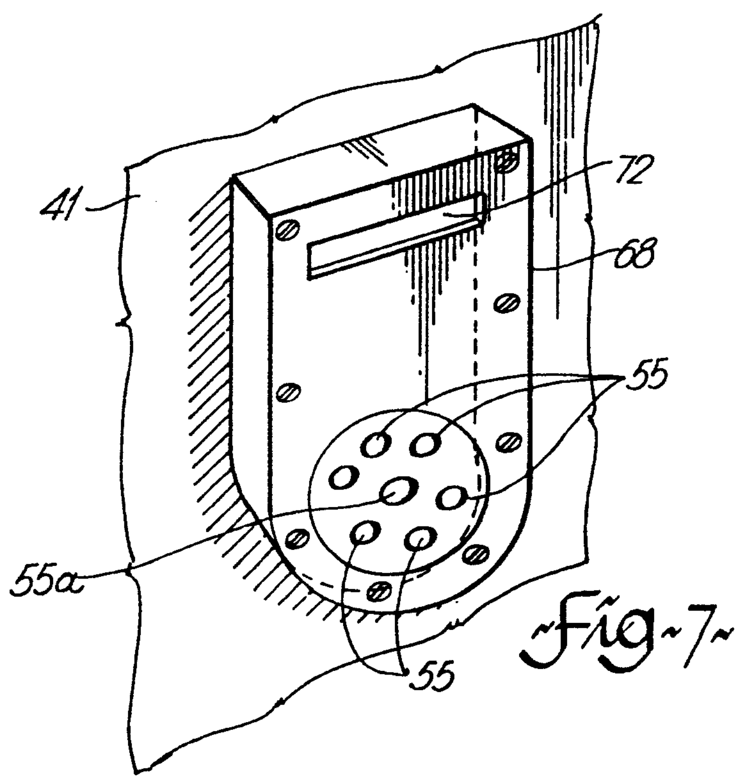

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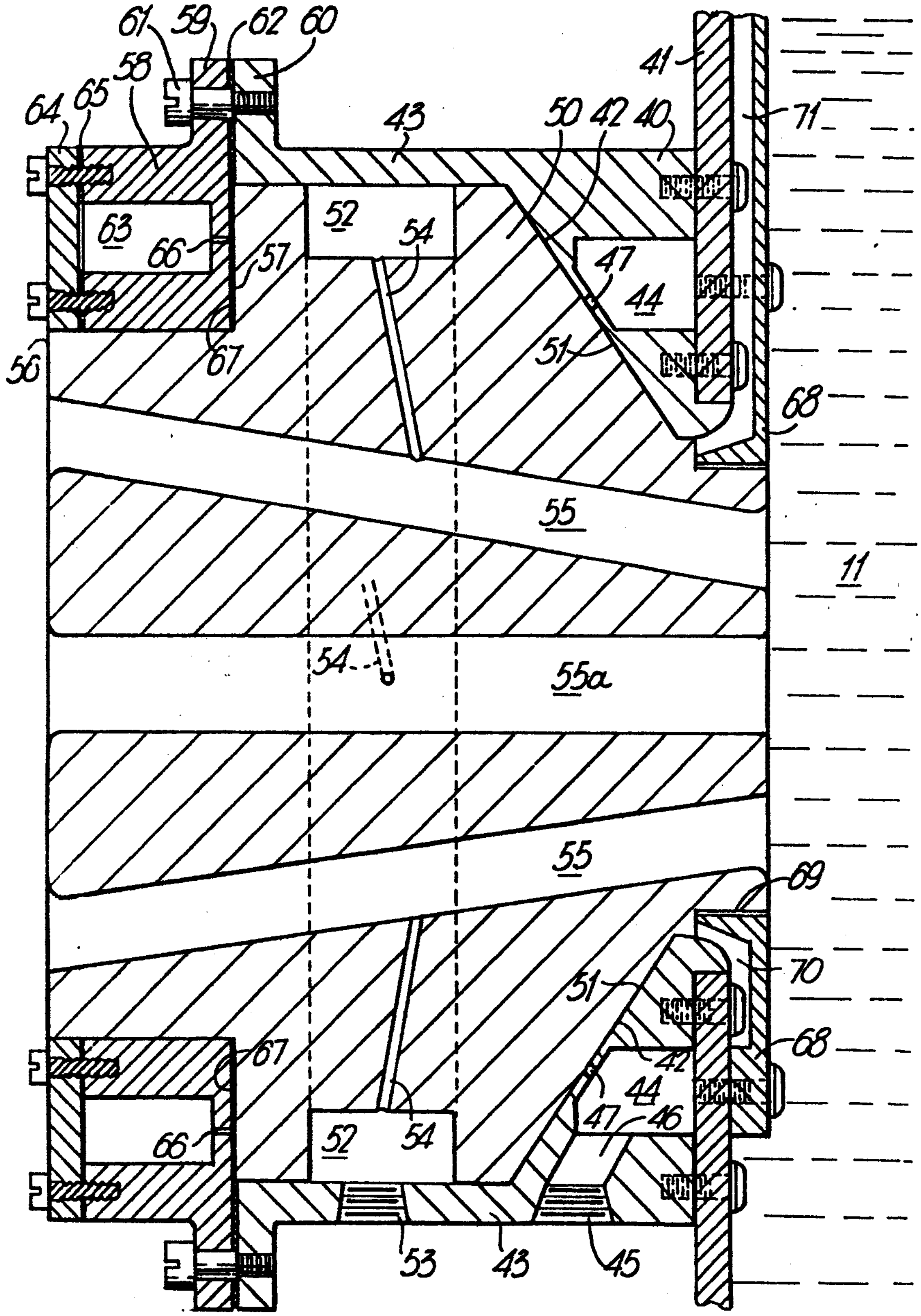
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~Fig~6~

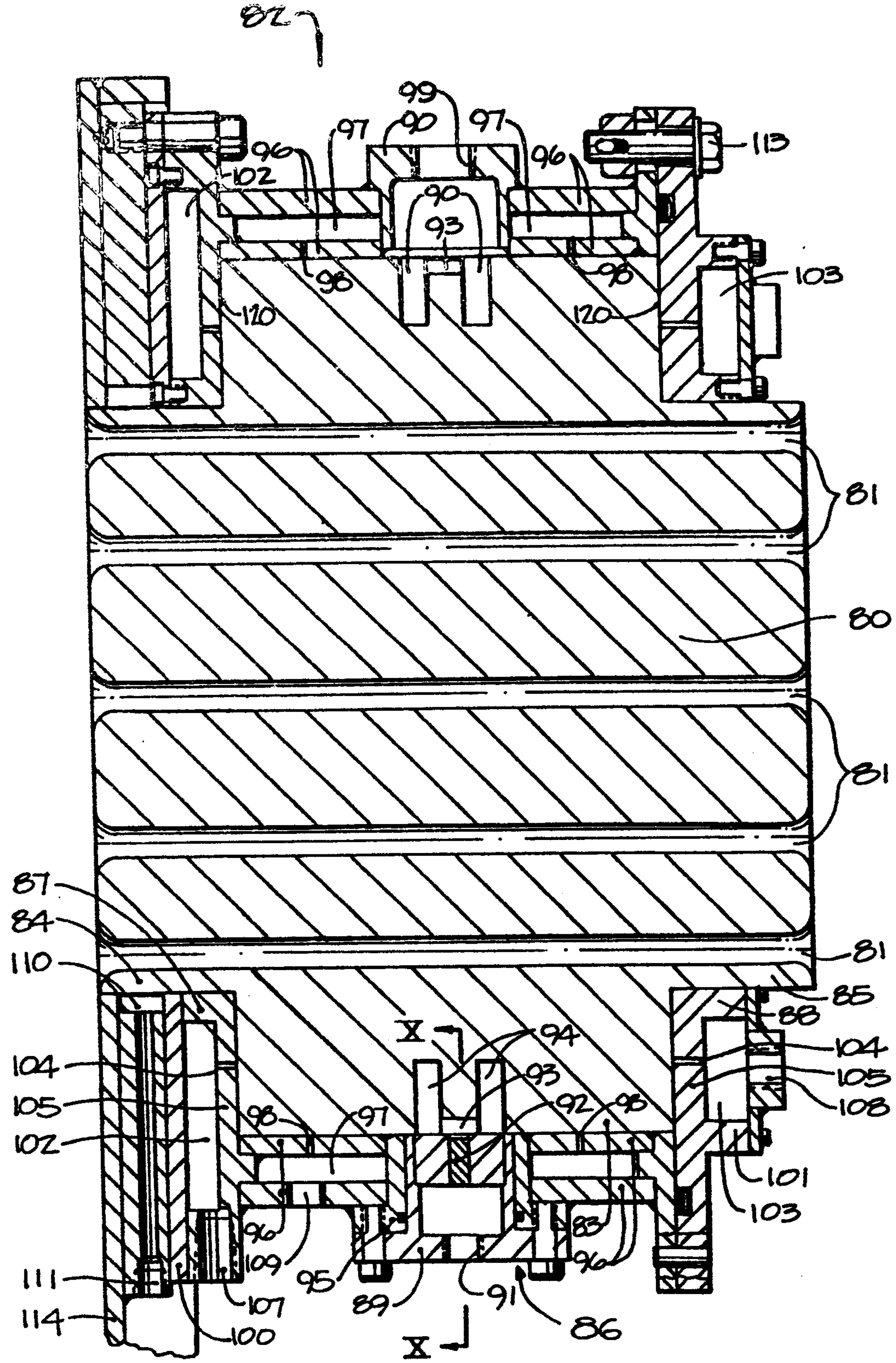
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Fig 8

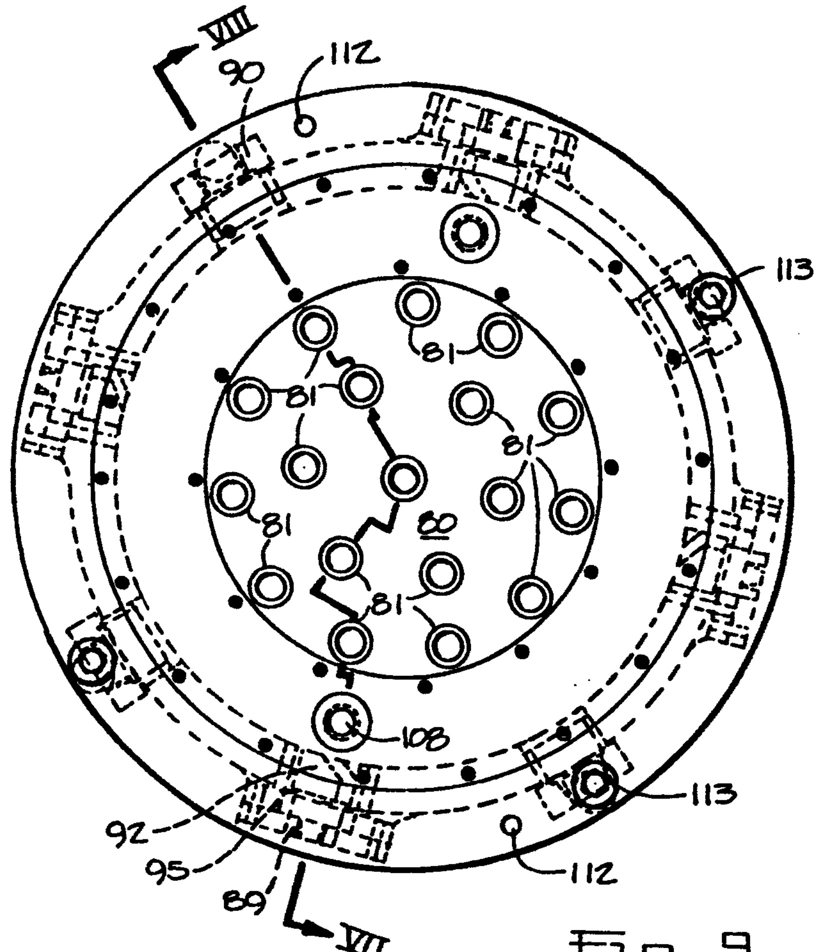
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Fig 9

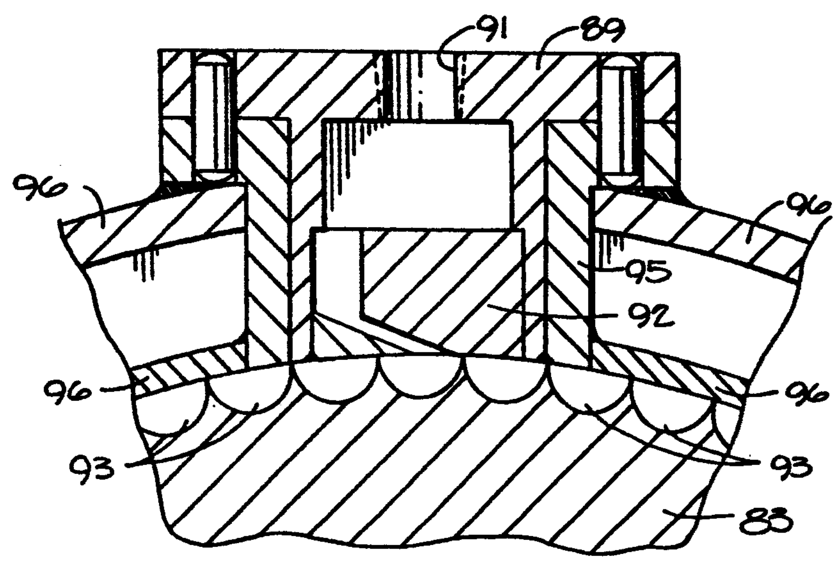
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Fig 10

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European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 79 10 2665

Category	DOCUMENTS CONSIDERED TO BE RELEVANT Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
	FR - A - 1 128 721 (TREF. ET LAM. DU HAVRE) * Page 1, column 2, paragraph 8 to page 2, column 2, paragraph 2; figures 1 to 8 * --	1,2,8, 9,12, 23,24	H 01 B 13/22
	GB - A - 1 464 747 (NORDISKE KABEL- TRAADFABRIKER) * Page 2, lines 22-91; figures 1 and 2 * --	1,6,16, 23,24	TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
	CA - A - 1 019 933 (NORTHERN ELECTRIC) * Page 2, line 14 to page 3, line 19; figure 1 * --	1,7, 23,24, 30	H 01 B 13/22 7/28 13/30
	US - A - 3 566 833 (BEEBE) * Column 2, line 65 to column 3, line 22; figure 2 * ----	1	

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	06-11-1979	DEMOLDER