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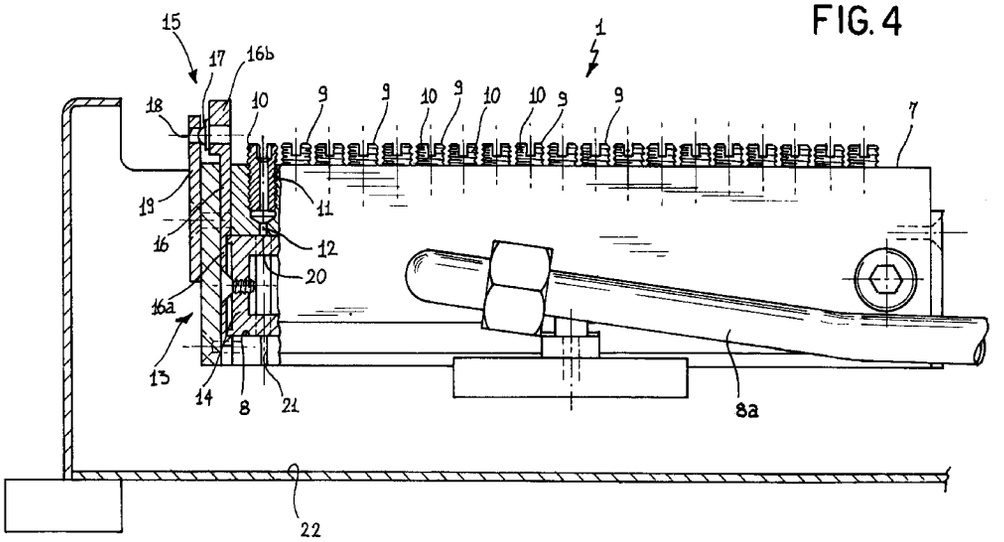
(54) Device and process for applying insulating material, in particular insulating enamel to a wire material

(57) The invention relates to a device and a process for applying insulating enamel to a wire material. In particular, the applying device (1) comprises a holding body (7) internally defining a main chamber (8) into which the enamel to be applied flows. The holding body (7) carries a plurality of delivery members (9) transferring enamel to respective portions of the wire material (50). A closure member (14) operates within the main chamber (8) and said member is movable between a plurality of operating positions in each of which it is arranged to selectively enable or inhibit a fluid communication between a corresponding number of delivery members (9) and the main chamber (8). More particularly, the delivery members can be activated by successive groups each consisting of two or more delivery members, by angular rotation of the closure member.

FIG. 4



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Description

The present invention relates to a device and a process for applying insulating material, in particular insulating enamel, to a wire material. It is particularly employed in plants adapted to apply insulating enamels to wires of electrically insulating material such as copper or aluminium wires to be utilized in manufacturing motor windings, transformers or coils for various uses.

It is known that conductor wires coated with insulating enamels for the above mentioned uses are produced in enamelling plants comprising several different stations operating downstream of the drawing apparatus manufacturing the metal wires to be coated. More particularly, conventional enamelling plants comprise one station in which one or more applying devices carry out coating of the conductor wire with several successive layers of insulating enamels, a second station substantially consisting of an oven adapted to perform solvent evaporation and enamel polymerization or cross-linking operations, and a third station at which the wire emerging from the oven is cooled before being rewound onto appropriate spools.

That being stated from a general point of view, the structure of the insulating-enamel applying devices to which the present invention refers is hereinafter described in more detail.

Devices currently used for applying insulating enamel comprise a holding body internally defining a main chamber into which the insulating enamel to be applied to the wires flows from a supply line. The holding body has a plurality of delivery nozzles receiving the insulating enamel from the main chamber and applying it to corresponding portions of the wire material to be coated.

In greater detail, as shown in Figs. 1 and 2, the wire to be coated, coming from the drawing machine, moves across the first delivery nozzle from which it receives an excess amount of enamel and then reaches a drawplate carrying out adjustment of thickness of the enamel applied by the nozzle. Subsequently, the wire comes to an enamelling oven and is then sent back by a return system to the applying device. At this point the wire moves across the second nozzle to receive another enamel layer the thickness of which is adjusted by a second drawplate. Afterwards the wire enters the oven again and then comes back to the applying device so as to repeat the hitherto described cycle moving across part or all of the delivery nozzles and thereby receiving a corresponding number of enamel layers. As can be easily imagined, since the section of the wire material increases in proportion as the enamel layers are applied, the different drawplates have a passage port the area of which must necessarily become increasingly bigger from the first to the last drawplate in order to conform to the sizes achieved by the wire material section.

The holding body is also provided with an exhaust line that, during the applying device operation, makes the excess enamel recirculate towards a collection tank thereby ensuring that the enamel will be always fresh and will always have substantially constant physico-chemical features. At the enamel supply line a cock is also provided which will enable the enamel flow to the main chamber to be stopped during the inoperative periods of the applying device.

While the applying devices of the above type are widely used, they however show several operating inconveniences in particular in a starting transient of the applying device, each time the enamelling plant is stopped.

It should be noted in fact that, due to different reasons such as sudden breakages or when a change in the type of wire material is required, the necessity frequenty arises to stop the plant and reposition the wire material to be enamel led along the plant itself. During this step the cock mounted in the enamel supply line is closed. At this point, the wire material is previously positioned along its operating path of travel so that it may cross all the delivery nozzles. Subsequently, the wire material is set in motion and by opening said cock all the delivery nozzles interlocked to the cock itself are simultaneously activated. As a result, the wire material portions disposed at the last nozzles will receive a great amount of enamel the thickness of which necessarily will not be adjusted in that, as said, the size of the passage port in the drawplates is set depending on the diameter of the wire material in a steady-state condition. Practically, the wire material portions located close to the nozzles following the third-fourth ones are coated with an enamel layer of a quite uneven thickness when they reach the polymerization oven. When said wire portions come to the subsequent drawplate, they disadvantageously give rise to resistances which are often inacceptable and inevitably involve the wire breakage.

This drawback brings about the necessity to carry out the wire positioning again, stopping the enamel supply once more and substantially repeating the whole procedure described above, which involves inconveniences in terms of time and waste material.

It should be also noted that, since the opening/closing cock is placed along the supply line, each time it is necessary to stop the enamel flow coming out of the nozzles, a predetermined amount of enamel settles in the main chamber of the holding body without being recirculated towards the collection tank. Since the insulating enamel cannot recirculate, it undergoes important changes in its physico-chemical features, in particular in terms of temperature and viscosity. These changes cause problems when the enamel is to be applied and, as a result, in this case too there are risks of breakages in the wire material.

Under this situation, the present invention aims at substantially solving all the drawbacks of the known art.

In particular, it is a main object of the present invention to provide a device for applying insulating enamel to a wire material which is capable of ensuring an efficient recirculation of the enamel even when said enamel is not being delivered by the nozzles and at the same time

enables the nozzles to be supplied in such a manner that breakage of the wire material are avoided, in particular with reference to the transient following a new positioning of the wire material.

The foregoing and further objects that will become more apparent in the course of the following description are substantially achieved by a device for applying insulating material , in particular insulating enamel, to a wire material comprising: a holding body internally defining at least one main chamber into which the enamel to be applied flows; delivery members operatively associated with said holding body and disposed into fluid communication with said main chamber to receive the enamel to be applied, each of said delivery members acting on at least one corresponding portion of the wire material to be enamelled, characterized in that selective means is provided which operatively acts in said main chamber and is capable of selectively enabling or inhibiting a fluid communication between each of said delivery members and said main chamber.

The above objects are also achieved by a process for applying insulating material, in particular insulating enamel to a wire material, said process contemplating the use of an enamel-applying device provided with a plurality of delivery members each acting on at least one corresponding portion of the wire material to be enamelled for transferring predetermined amounts of enamel thereonto, said process being characterized in that it comprises the following steps: positioning the wire material along a predetermined operating path so that each delivery member is crossed by one respective portion of the wire material: activating a first group of said delivery members to cause coating of respective portions of wire material with a first layer of enamel: moving the wire material until the portions coated with the first layer of enamel are brought to a second group of said delivery members net to said first group; activating the second group of said delivery members to cause coating of the portions of wire material provided with said first layer, with a second layer of enamel; repeating the two preceding steps until all the delivery members have been activated.

Further features and advantages will be more fully understood from the detailed description of a preferred embodiment of a device and a process for applying insulating enamel to a wire material according to the present invention.

This description will be given hereinafter, by way of non-limiting example, with reference to the accompanying drawings, in which:

- Fig. 1 is a diagrammatic plan view of an enamelling plant of a traditional type, to which the applying device in accordance with the invention can be fitted;
- Fig. 2 is an enlarged view of a detail of fig. 1 relative to the delivery nozzles and drawplates for adjusting the insulating enamel thickness;
- Fig. 3 is a fragmentary perspective and partly exploded view of the applying device according to the invention;
- fig. 4 is a partly sectional front view of the applying device in reference;
- fig. 5 is a side view of the applying device shown in fig. 4;
- Fig. 6 is a fragmentary plan view of the applying device shown in Fig. 4;
- Fig. 7 is a sectional view taken along line VII-VII in Fig. 6;
- Fig. 8 is a perspective view of a closure member being part of the applying device in reference.

Referring to the drawings, a device to apply enamel, in particular insulating enamel, to a wire material in accordance with the present invention has been generally identified by reference numeral 1.

The applying device 1 can be fitted to a conventional enamelling plant 2 (generally depicted in Fig. 1) which comprises a drawplate set denoted by 3 and located downstream of the applying device 1, as well as an enamelling oven 4 and intermediate rollers 5 and 6.

In a conventional manner, the applying device 1 comprises a holding body 7 internally defining at least one main work chamber 8 into which the enamel to be applied flows, via a supply line 8a for example.

Operatively associated with the holding body 7 is a series of delivery members 9 brought into fluid communication with the main chamber 8 so as to receive the enamel to be applied to the wire material 50 therefrom. Each of the delivery members 9 is constantly active on at least one corresponding portion of the wire material 50 to be enamelled, as diagrammatically depicted in Figs. 1 and 2. In the embodiment shown, the delivery members 9 preferably consist of a tubular body 10 detachably engaged, by a threaded coupling for example, into a respective cylindrical seating 11 formed in the holding body 7 and put into fluid communication with the main chamber 8 by a channel 12.

Advantageously and in accordance with the present invention the device 1 comprises selective means 13 operatively active in said main chamber 8 and capable of selectively enabling or inhibiting a fluid communication between each of the delivery members 9 and the main chamber 8 itself.

In more detail, the selective means 13 preferably comprises a closure member 14 rotatably housed in the main chamber 8 and angularly movable between a plurality of operative positions in succession, upon command of actuation means 15 operatively connected to the closure member 14. In this case the means 15 consists of a lever 16 one end 16a of which is integral with the closure member 14 and a second end 16b of which is accessible from the outside and operable by an operator. Associated with the second end 16b of the control lever 16 is a stop element 17 adapted to be fitted into housings 18 formed in a fixed flange 19 integral with the holding body 7 and facing the lever 16. More particularly, housings 18 are angularly spaced apart the same

distance from each other and each correspond to one of said operating positions that the closure member 14 can take. In other words, the stop element 17 by its fitting into one housing 18 gives rise to a well precise operating position of the closure member 14.

On examining the structure of said closure member 14 in more detail, one can see that it has a tubular conformation and is provided with a plurality of through openings 20 disposed at a side wall 14a thereof. The through openings 20 extend parallelly to one another according to an arc of a given width, as clearly viewed from the perspective view in Fig. 8. In particular, the through openings 20 are in the form of an arc of a circumference and are axially spaced apart from each other the same distance, along said side wall 14a. It should be also noted that openings 20 are divided into a plurality of groups in each of which the openings have the same positioning and extension in the side wall 14a of the closure member 14. In addition, each group may comprise one, two (as in the example herein shown), three or more openings depending on requirements. By way of example only, three of such groups have been denoted by "A", "B" and "C" in Fig. 8. Still referring to Fig. 8, one can see that the openings in each group are angularly offset by an arc of a predetermined amplitude with respect to the openings belonging to the adjacent groups.

Obviously, this arc corresponds to the arc subtended by the control lever 16 and the stop element 17 on passing from one housing 18 to the adjacent housings 18.

Therefore, (as shown in Fig. 3), by rotating the lever 16 it is possible to rotate the closure member 14 and therefore bring zero, two, four or more delivery members 9 into fluid communication with the main chamber 8, as described in more detail in the following, when discussing operation of the applying device according to the invention.

The applying device 1 at the holding body 7 also has a series of exhaust passages 21 which are arranged to evacuate the excess enamel present in the main chamber, to a collection body 22 disposed under the device 1, for example.

Preferably and in accordance with another aspect of the invention, the exhaust passages 21 are each disposed at a respective one of said delivery members 9. More particularly, in each section of the holding body 7 in which a delivery member 9 is provided a corresponding exhaust passage 21 is also provided, which passage is angularly spaced apart from the respective delivery member 9. In this case (see Fig. 7), each exhaust passage 21 is at an opposite position relative to the corresponding delivery member 9.

Advantageously, the above described closure member 14 at each of its operating positions is also active on said exhaust passages 21 so as to selectively enable or inhibit a fluid communication between each exhaust passage 21 and the main chamber 8 depending on whether the fluid communication between the corresponding delivery member 9 and the main chamber 8 is respectively inhibited or enabled.

In this manner, as soon as, due to rotation of the closure member 14, opening of one or more delivery members 9 occurs, the simultaneous closure of the corresponding exhaust passage also takes place. This ensures that the enamel flow within the main chamber 8 is always constant because, by adding the number N1 of the delivery members 9 that are open at a given instant to the number N2 of the exhaust passages 21 that are open at the same instant, a constant value is always reached at any operating position of the closure member 14.

Operation of the applying device 1 according to the invention described above mainly as regards structure is as follows.

It is necessary to point out that, in order to explain operation of the device in reference, first the starting transient of the device and of the whole plant is to be analyzed, passing then to describe operation in a steady-state condition.

Therefore, assuming that one starts from a rest condition of the whole plant, the first operation to accomplish is that of positioning the wire material 50 to be coated along its characteristic path of travel shown in Fig. 1.

Once the wire material 50 has been correctly positioned, each delivery member 9 will be crossed by a corresponding portion of the wire material to be coated.

During this step, the closure member 14 is such positioned as to inhibit the fluid communication between the main chamber 8 and said delivery members 9, so that all enamel is recirculated through the exhaust passages.

At this point, when starting of the enamelling process is desired, movement of the wire material 50 is caused and this wire material moves forward along its operative path of travel. Simultaneously with, or after setting of the wire material in motion, the closure member 14 is rotated, the control lever being acted upon, so as to open a first group of delivery members 9 and close the corresponding exhaust passages 21.

In this particular case, following a rotation through about 4° of the closure member, the two first delivery members 9 are opened and the corresponding two first exhaust passages 21 are closed. Following this operation, the wire portions moving across the two first delivery members 9 are coated with a first layer of insulating enamel and move forward through the thickness-adjusting drawplates 3. After a predetermined amount of time has elapsed, the wire that has received the first enamel layer comes to a second group of delivery members 9 subsequent to said first group. At this point, as soon as the wire material coated with the first layer of insulating enamel has gone past the delivery members, the closure member 14 is rotated towards its subsequent operating position so that the second group of delivery members 9 is put into fluid communication with the main chamber 8 and is therefore activated. Following this

operation, the corresponding closure of the exhaust passages corresponding to the delivery members that have been opened occurs. In this manner, the wire material portion that has already been coated with the first layer of insulating material is gradually coated with a second layer of enamel. The above described steps repeat in the same manner until the closure member 14 reaches its last operating position in which all the delivery members 9 are in fluid communication with the main chamber 8 and all the exhaust passages 21 are instead cut off from the main chamber itself.

At this point, the wire material portion which was the first to be coated with the insulating material has reached the last one of the delivery members to receive the nth layer of insulating enamel. From this moment on, the closure member is no longer moved in that the steady-state condition has been reached in which all the delivery members 9 apply enamel to the respective wire material portions 50 and in which all the exhaust passages 21 are cut off from the main chamber 9.

The invention achieves important advantages.

It will be recognized in fact that, by virtue of the present invention, all drawbacks typical of the known art are overcome. In particular, the applying device 1 and the process in reference enable the occurrence of tiresome breakages in the wire material during the plant starting step to be avoided, which breakages are typical of the known art plants. This is due to the fact that all delivery members 9 are not activated simultaneously but by successive groups. It is to note that, depending on requirements, i.e. the type of enamel used or other parameters, one can decide on operation of the delivery members one by one, two by two, three by three, or by groups including a greater number of them.

It is also important to note that, under any operating condition of the closure member 14, inclusive of the condition in which all the delivery members 9 are cut off from the main chamber 8, there is always a constant recirculation of the insulating enamel through the exhaust passages 21. This fact ensures that the enamel will maintain its features substantially unchanged, in terms of temperature and viscosity.

In particular, due to the special conformation of the closure member 14, the enamel flow within the main chamber 8 is substantially constant under any operating condition.

Obviously, many modifications and variations may be made to the present invention without departing from the inventive idea characterizing it.

It should be also pointed out that the present invention, with reference both to the device and the process, can apply to coating of wires with fluid-state materials of different kinds such as paints, enamels and the like.

Claims

1. A device for applying enamel material, in particular insulating enamel, to a wire material comprising:
   - a holding body (7) internally defining at least one main chamber (8) into which the enamel to be applied flows;
   - delivery members (9) operatively associated with said holding body (7) and disposed into fluid communication with said main chamber (8) to receive the enamel to be applied, each of said delivery members acting on at least one corresponding portion of the wire material (50) to be enamelled, characterized in that selective means (13) is provided which operatively acts in said main chamber (8) and is capable of selectively enabling or inhibiting a fluid communication between each of said delivery members and said main chamber.

2. A device according to claim 1, characterized in that said selective means (13) comprises a closure member (14) rotatably housed in the main chamber (8) and angularly movable between a plurality of operative positions in succession, at each of said operative positions this closure member being arranged to selectively enable or inhibit a fluid communication between a corresponding number of said delivery members (9) and the main chamber (8).

3. A device according to claim 2, characterized in that said closure member (14) has a tubular conformation and is provided with a plurality of through openings (20) formed in one side wall (14a) thereof.

4. A device according to claim 3, characterized in that said through openings (20) extend parallel to each other according to an arc of predetermined amplitude.

5. A device according to claim 1, characterized in that said holding body (7) has a series of exhaust passages (21) arranged to evacuate the excess enamel present in said main chamber.

6. A device according to claim 5, characterized in that said holding body has an exhaust passage (21) in register with each of said delivery members (9), said exhaust passage (21) being angularly spaced apart from the respective delivery member (9).

7. A device according to claim 6, characterized in that each exhaust passage (21) is at an opposite position with respect to the corresponding delivery member.

8. A device according to claims 2 and 6, characterized in that said closure member (14), at each of its operating positions, is also active on said exhaust passages (21) to selectively enable or inhibit a fluid communication between each exhaust passage (21) and the main chamber (8) depending on

whether a fluid communication between the corresponding delivery member (9) (and the main chamber is respectively inhibited or enabled.

9. A device according to claim 2, characterized in that it further comprises actuation means (15) operatively connected to said closure member (14) to angularly move said member to each of said plurality of operative positions.

10. A device according to claim 9, characterized in that said actuation means (15) comprises:

- at least one lever (16) having one end (16a) integral with said closure member (14) and a second end (16b) operable by an operator;
- a fixed flange (19), integral with said holding body (7) and facing said lever (16), said fixed flange having a plurality of housings (18) angularly spaced apart the same distance from each other and corresponding to said plurality of operative positions of the closure member (14);
- a stop element (17) associated with the second end of said control lever and arranged to be fitted, at each operative position, into the corresponding housing (18).

11. A process for applying enamel material, in particular insulating enamel, to a wire material, said process contemplating the use of an enamel-applying device (1) provided with a plurality of delivery members (9) each acting on at least one corresponding portion of the wire material (50) to be enamelled for transferring predetermined amounts of enamel thereonto, said process being characterized in that it comprises the following steps:

- positioning the wire material (50) along a predetermined operating path so that each delivery member (9) is crossed by a respective one of the portions of the wire material;
- activating a first group of said delivery members to cause coating of respective portions of wire material (50) with a first layer of enamel;
- moving the wire material (50) until the portions coated with the first layer of enamel are brought to a second group of said delivery members (9) next to said first group;
- activating the second group of said delivery members (9) to cause coating of the portions of wire material provided with said first layer, with a second layer of enamel;
- repeating the two preceding steps until all the delivery members have been activated.

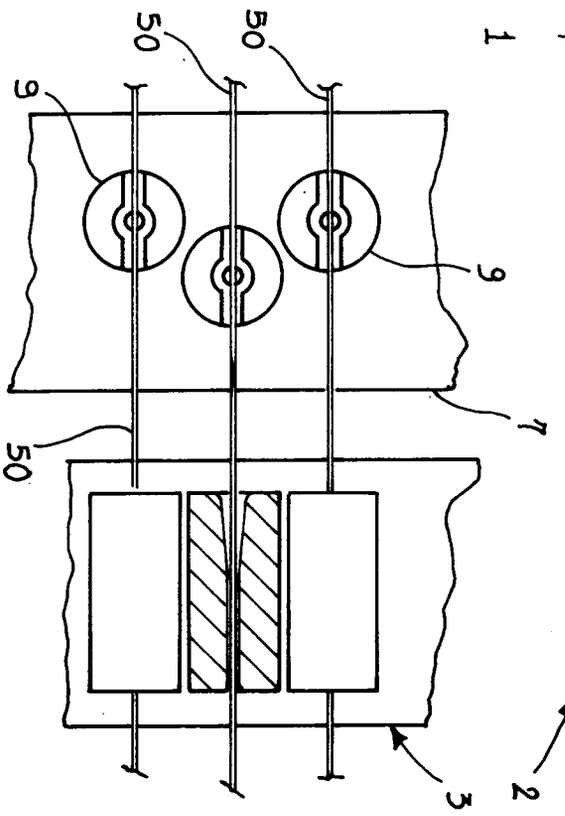


FIG. 2

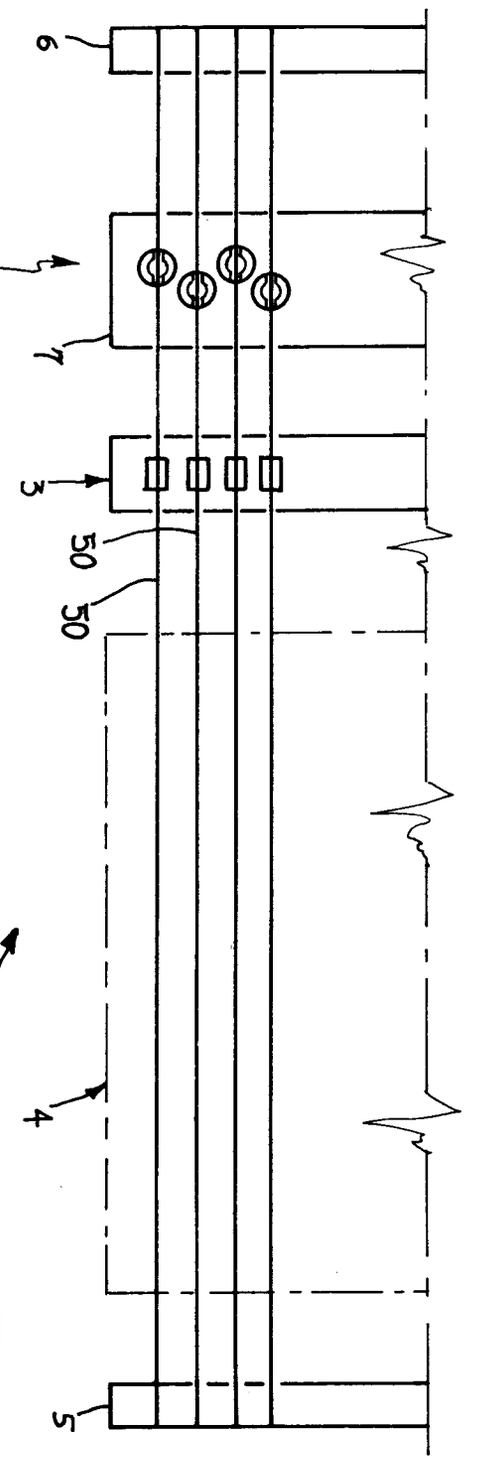
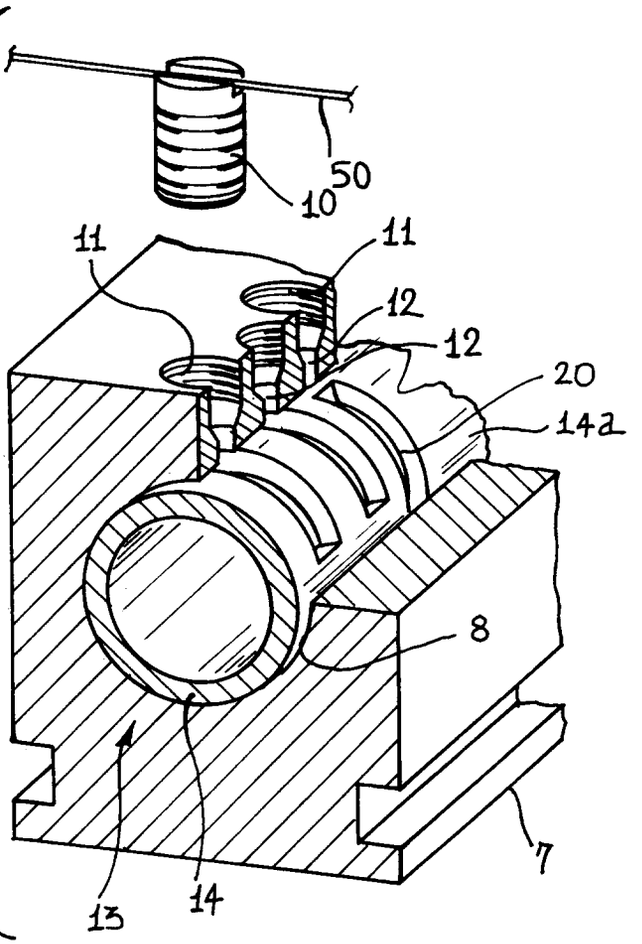


FIG. 1

FIG. 3



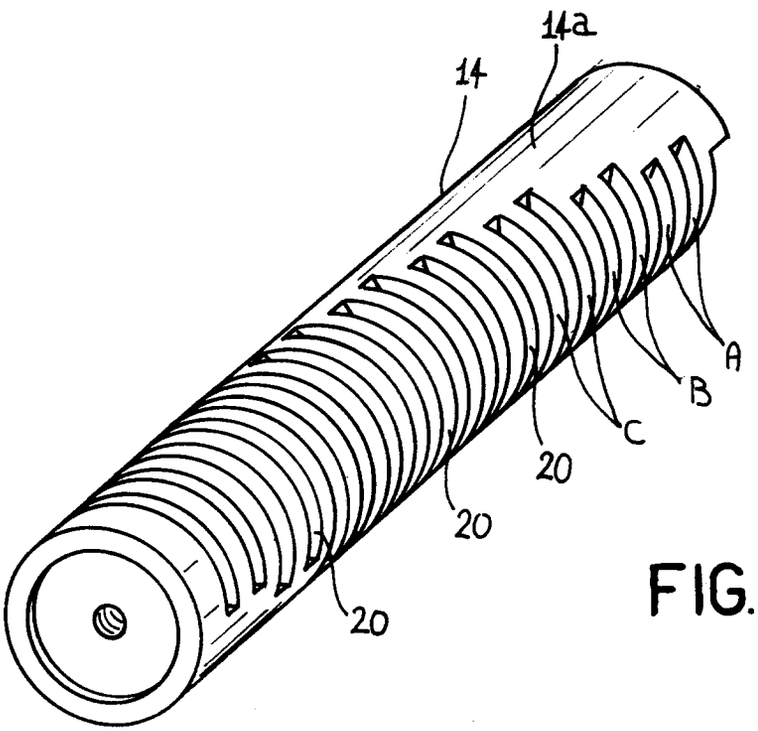


FIG. 8

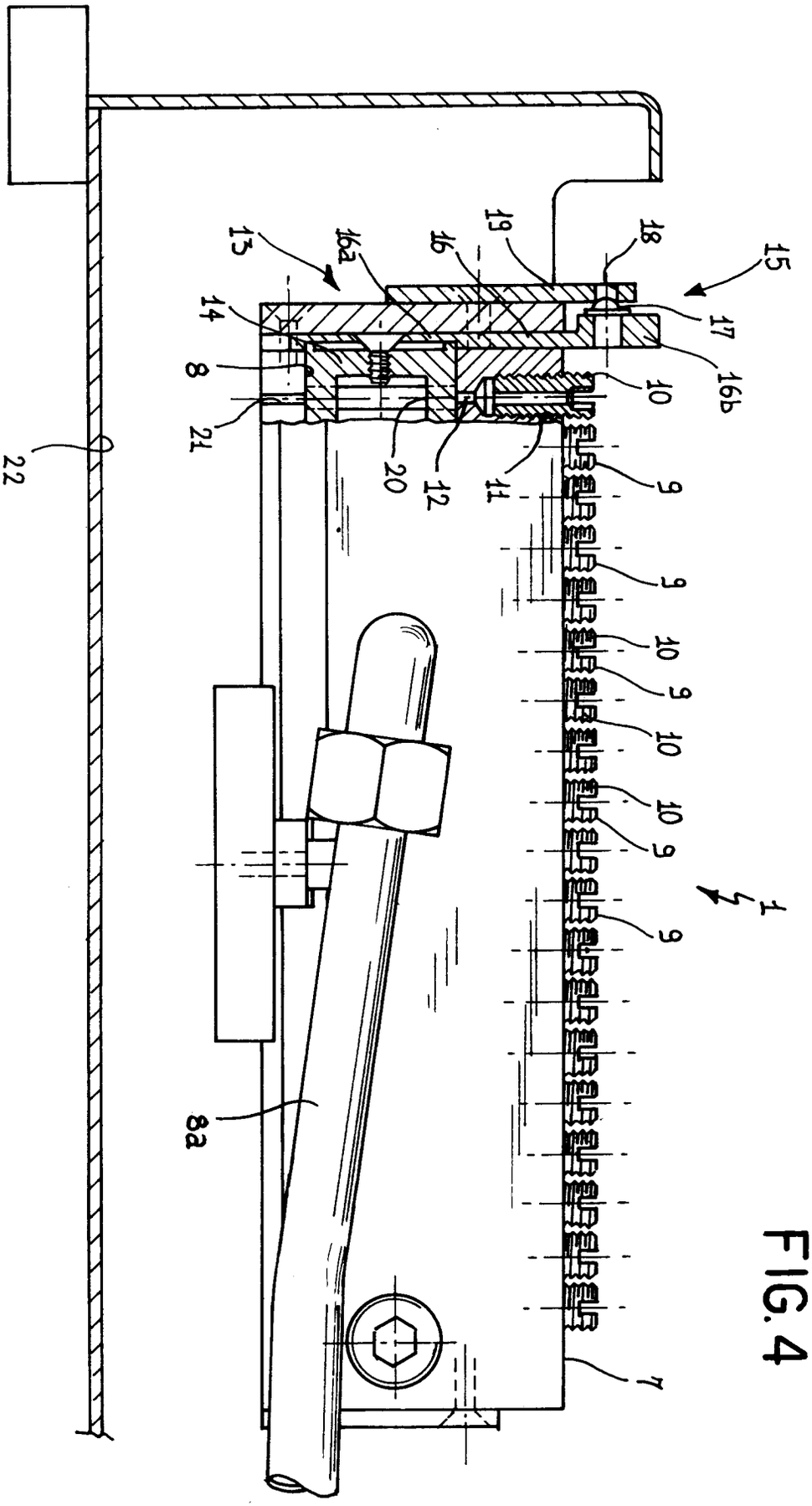


FIG.4

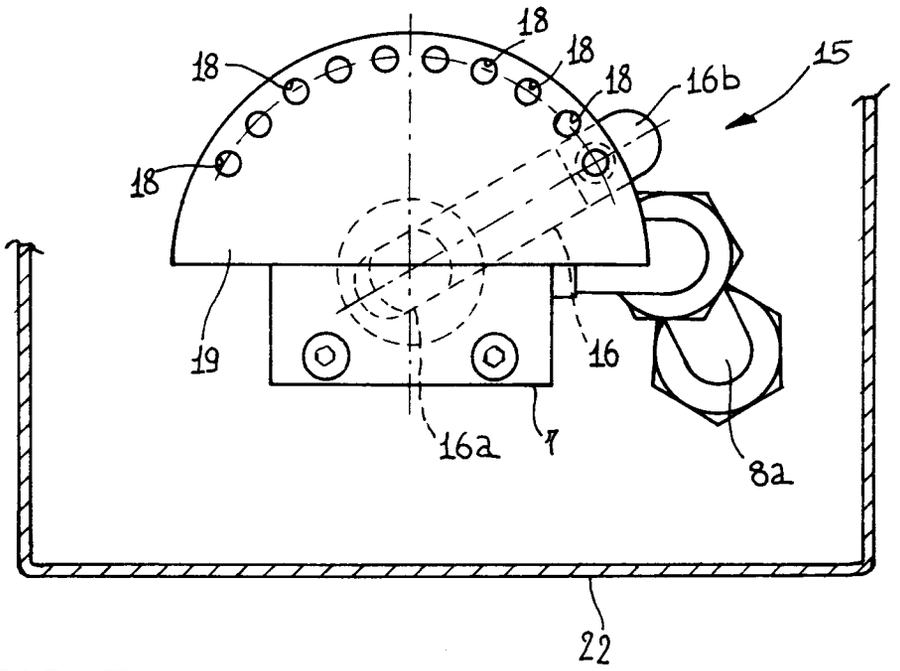
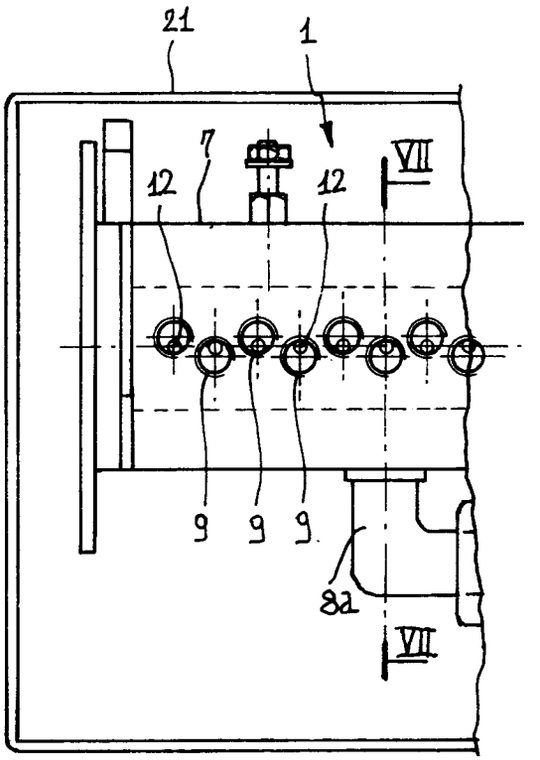


FIG. 5

FIG. 6



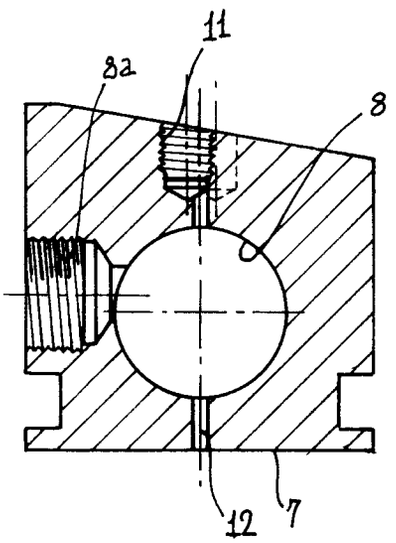


FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 83 0411

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.6)
A	EP-A-0 448 999 (MAG) * the whole document * ---	1,11	H01B13/06 B05C3/12
A	GB-A-2 068 261 (FELTEN & GUILLEAUME CARLSWERK) * the whole document * ---	1,11	
A	US-A-4 869 199 (M.F.ZAMAN) * the whole document * ---	1,11	
A	US-A-4 601 918 (M.F.ZAMAN) * the whole document * ---	1,11	
A	US-A-4 258 646 (H.A.KLOCZEWSKI & AL) * the whole document * -----	1,11	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01B
B05C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 February 1996	Drouot, M-C

CATEGORY OF CITED DOCUMENTS

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