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

(11) EP 1 589 154 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.10.2005 Bulletin 2005/43

(51) Int Cl.[7]: **E03C 1/04**

(21) Application number: **05008837.6**

(22) Date of filing: **22.04.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **23.04.2004 IT MI20040800**

(71) Applicant: **Archedes S.r.l.**
20123 Milano (IT)

(72) Inventor: **Sargiani, Franco**
20123 Milano (IT)

(74) Representative: **Simino, Massimo et al**
Perani Mezzanotte & Partners
Piazza S. Babila, 5
20122 Milano (IT)

(54) Multifunction unit for sanitary fittings

(57) A multifunction unit for sanitary fittings comprises hydraulic means (9, 10) suitable to be connected to sanitary water mains for controlling water delivery to at least one water delivery outlet; said unit having an internal structure suitable to define a housing for such hydraulic means (9, 10) and to be secured to a support structure, and a covering structure externally associated to said internal structure to act as an external finish, said covering structure allowing the use of actuator means for control and adjustment of said hydraulic means (9, 10) and being equipped with hydraulic connection means for allowing fluid communication between said hydraulic means (9, 10) and said at least one water delivery outlet.

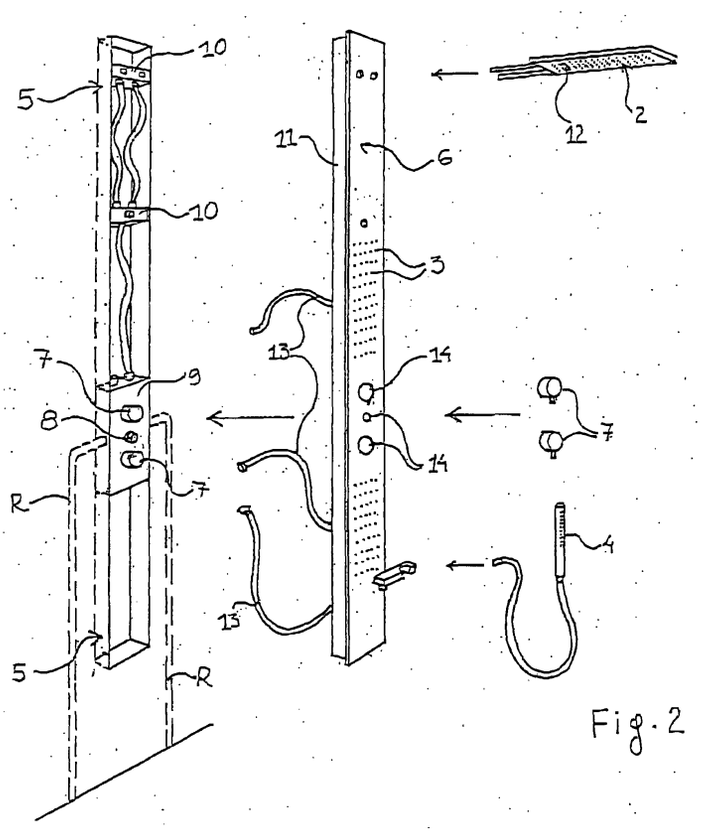


Fig. 2

EP 1 589 154 A2

Description

[0001] The present invention relates to a multifunction unit for sanitary fittings according to the preamble of claim 1.

[0002] The term sanitary fittings, as used herein, includes those fittings that are required for proper operation of a shower, a sink, a washbasin and the like.

[0003] Such multifunction units, e.g. a shower column having a plurality of shower heads and/or water delivery outlets and spot-lights are currently well known and widely used. They are mainly wall-mounted and connected to the water mains and when appropriate to the power mains for water and power supply.

[0004] These multifunction units comprise a plurality of hydraulic means, such as mixers/diverters and thermostatic units, which are wall-embedded and are suitably connected to the water mains and to water delivery outlets by connecting pipes.

[0005] In this respect, it should be noted that wall mounting of these hydraulic means is somewhat troublesome, in that it requires both compliance with the distances and tolerances of the various parts and combined and substantially simultaneous work by a plumber and a mason. Installation of hydraulic means requires the steps of forming special receptacles in the wall, positioning and connecting together the components and finally resurfacing the wall.

[0006] It shall be further considered that, for self-evident reasons, these multifunction units shall be wall-mounted when the wall surface is still in the raw state, e.g. before lining it with tiles or otherwise finishing it. As a result, during masonry works for finishing and/or lining the wall, damages may somewhat frequently occur to the multifunction unit due to accidental impacts with tools and masonry debris or to contact with the wall finishing raw materials.

[0007] The above clearly shows that a need exists for a multifunction unit which allows easier and faster installation and more accurate positioning, and avoids the risk of damages to such unit during wall finishing masonry works.

[0008] The problem on which the present invention is based is that of providing a multifunction unit for sanitary fittings which has such structural and functional features such as to fulfil the above need, while obviating the above prior art drawbacks.

[0009] This problem is solved by a multifunction unit for sanitary fittings according to the features of claim 1.

[0010] Further features and advantages of the multifunction unit of the present invention will be apparent from the following description of a few preferred embodiments thereof provided by way of indicative and non-limiting example, with reference to the attached figures, in which:

- Figure 1 is a diagrammatic perspective view of a wall-mounted multifunction unit for sanitary fittings according to the invention;
- Figure 2 is an exploded perspective view of the multifunction unit of Figure 1;
- Figure 3 is an exploded perspective view of the multifunction unit of Figure 2;
- Figure 4 is a front view of the multifunction unit of Figure 1;
- Figure 5 is a cross section of the multifunction unit of Figure 1;
- Figure 6 is a diagrammatic perspective view of a second embodiment of a multifunction unit for sanitary fittings according to the invention;
- Figure 7 is an exploded perspective view of the multifunction unit of Figure 6;
- Figure 8 is a sectional side view of the multifunction unit of Figure 7;
- Figure 9 is a cross section of the multifunction unit of Figure 6;
- Figure 10 is a diagrammatic perspective view of a multifunction unit for sanitary fittings according to a third embodiment of the invention;
- Figure 11 is an exploded perspective view of the multifunction unit of Figure 10;
- Figure 12 is an sectional side view of the multifunction unit of Figure 11;
- Figure 13 is a cross section of the multifunction unit of Figure 10;
- Figure 14 is a perspective view of a detail of the multifunction unit of Figure 10 and
- Figure 15 is a side plan view of the detail of Figure 14.

[0011] Referring to Figures 1 to 5, numeral 1 generally designates a multifunction unit for sanitary fittings according to the invention which, in this specific embodiment, is implemented as a multifunction unit for a shower.

[0012] The multifunction unit 1 comprises hydraulic means which are suitable to be connected to sanitary water main for controlling water delivery to at least one water delivery outlet the latter comprising, in this embodiment: a fixed shower head 2, a plurality of stationary front nozzles 3 and a hand shower 4.

[0013] The multifunction unit 1 advantageously comprises:

- an internal structure 5 which is suitable to be mounted to a wall P of a support structure, e. g. a bathroom wall, and to define a receptacle for said hydraulic means, and
- a covering structure 6, which is externally associated to the internal structure 5 to form an external finish thereof.

[0014] The covering structure 6 allows the provision of actuator means associated thereto, for control and adjustment of the hydraulic means received in the internal structure. In this embodiment, the actuator means

comprise control knobs and levers, designated by numeral 7, as well as selectors S, which act on water flow diverters, for instance to divert water flow from shower head 2 to the hand shower 4.

[0015] In the example of the multifunction unit 1, the internal structure 5 is embodied by a substantially box-like enclosure, suitable to be embedded in the wall P to receive and support the above mentioned hydraulic means.

[0016] In this embodiment, the hydraulic means comprise a mixer and/or delivery unit, designated by numeral 9, a flow diverter designated by numeral 10 and hydraulic pipe fittings. The structure and functions of the hydraulic means will not be described in detail, because they are known per se and have standard sizes.

[0017] It should be noted that the box-like enclosure 5 can receive any currently available hydraulic means, although there may be provided box-like enclosures having different sizes depending on the volume of the specific hydraulic means to be accommodated therein.

[0018] In order that the hydraulic means may be conveniently accommodated in the box-like enclosure 5, the latter has an open front side and has such a position relative to the wall P that this open front side is substantially flush with the outer surface of the wall P. As a result, once the box-like enclosure 5 has been embedded in the wall, the hydraulic means may still be introduced therein or removed therefrom. The box-like enclosure has support means of traditional construction, which are useful for securing the hydraulic means thereto.

[0019] Apertures and/or holes are made in the box-like enclosure to allow insertion of pipes for connection to water mains, e.g. hot water and cold water delivery pipes, as well as any cables for connection to power supply mains (not shown) or for transmission of electric signals, e.g. for voice transmission to a loudspeaker in the multifunction unit.

[0020] Otherwise, the structure of the box-like enclosure may be perforated during installation for later introduction of pipes, cables and else.

[0021] The box-like enclosure 5 is further equipped with stop and positioning means, which allow the box-like enclosure to be appropriately embedded in the wall P at the proper depth.

[0022] Advantageously, the covering structure has such a shape as to form a cover to be associated to the above mentioned front opening of the box-like enclosure 5 in closing relationship therewith.

[0023] Preferably, the cover has a form fit with the front opening of the box-like enclosure 5 with gasket means, not shown, interposed therebetween, which safely seal the front opening of the box-like enclosure. Such form fit is achieved by providing the cover 6, at its inner side, i.e. the side turned toward the box-like enclosure 5, with a rim 11 that defines a peripheral frame, which may be inserted by a slight force fit in the front opening of the box-like enclosure 5.

[0024] Advantageously, the cover 6, i.e. the covering structure has such a size as to lie over and beyond said peripheral rim 11, to hide the box-like enclosure 5 while wholly covering it.

[0025] The outer side of the cover 6, i.e. that opposite to the inner side turned toward the box-like enclosure 5, is designed to be exposed when the multifunction unit 1 is installed and has the desired surface finish. Hence, for example, if the cover 6 is made of metal, the surface of the outer side of the cover may be chromium plated, satin finished, anodized, painted or otherwise processed and/or coated. The surface of the outer side of the cover is suitable to be coated with any material having the shape of a flat plate, e.g. glass, marble, ceramics, plastics and others.

[0026] Special holes and/or apertures 14 are made in the covering structure, in the same position as the actuator means 7, 8 for control and adjustment of the hydraulic means and of any other electric means possibly contained in the multifunction unit.

[0027] In addition to its finishing function, the covering structure 6, i.e. the cover, may advantageously have, as shown in the figures, the function of supporting the water delivery means, in the specific embodiment that comprises a fixed shower head 2, a plurality of fixed front nozzles 3 and a support for the hand shower 4. Possibly, the cover 6 may further support light means, such as LEDs and lamps and/or sound diffusion means, such as a loudspeaker. Advantageously, the covering structure 6 is equipped with hydraulic connection means 13 for allowing fluid communication between the hydraulic means, i.e. of the mixer and/or distribution unit 9 and flow diverter 10, and the water delivery means 2, 3 and 4.

[0028] These hydraulic connection means include pipes, preferably of the flexible type, as well as their respective screwed fittings.

[0029] Essentially, the covering structure 6 supports both the water delivery means and the hydraulic connection means required to assure proper connection thereof with said hydraulic means.

[0030] Similarly, the covering structure 6 may be designed for fast wiring of electric means.

[0031] This will be highly advantageous and appreciated during installation of the multifunction unit 1. One must simply embed the box-like enclosure 5 in the wall P, and assure that the latter is perfectly level and positioned at the proper depth from the outer surface of the wall P. This is facilitated by the stop and positioning means, whose position is related to the unfinished wall, i.e. a wall that has not been finished with tiles, marble, plaster or else.

[0032] After positioning and fixation of the box-like enclosure 5, the hydraulic means for the specific application may be introduced therein, and connected to the sanitary water mains, and any electric means, such as lights, an alarm and/or sound diffusion means may be connected to the power supply mains.

[0033] Once the above fastening, connection and

possible wiring steps have been completed, the wall P may be resurfaced and finished with the desired outer finish. It shall be noted that these steps involve no risk of damaging the exposed part of the multifunction unit, the sanitary water delivery means, the actuator means or any , as the latter have not been positioned yet. Only when the masonry and surface finishing works on the wall P have been completed, the box-like enclosure may be associated to the covering structure 6, and to the various components wherewith the latter is equipped.

[0034] It will be appreciated that this step is very fast and simple, as it only requires:

- connection of flexible pipe fittings,
- connection of electric wires, if any, e.g. for power supply to lights, an alarm and/or sound diffusion means,
- mounting of the cover 6, so that the peripheral rim 11 is introduced within the front opening of the box-like enclosure 5, and
- mounting of actuator means, i.e. the knobs 7 and the diverter 10 to the hydraulic means.

[0035] The cover 6 is tightly secured to the box-like enclosure thanks to the sealing effect exerted thereon by the actuator means, once the latter have been associated to the hydraulic means. As an alternative, the cover may be mounted to the box-like enclosure by an interference fit, a snap fit or any connection using traditional fastener means, such as clips, screws, putties and the like.

[0036] The multifunction unit of the invention may be also equipped with lighting means, such as LEDs 12, lamps and others, which are directly supported by the covering structure 6 and connected by electric wires to respective connector blocks that are accommodated in the box-like enclosure 5 and in turn connected to the mains.

[0037] Similarly, the multifunction unit may be equipped with sound diffusion means, such as loudspeakers of a radio unit or a wire radio system.

[0038] Referring to Figures 6 to 9 and 10 to 15 a multifunction unit 101 and a multifunction unit 201 will be described hereafter, corresponding to a second and a third embodiment of the above multifunction unit 1 respectively.

[0039] It shall be noted that the multifunction units 101 and 201 are only two of the possible variant embodiments. The parts of the multifunction units 101 and 201 that are structurally and/or functionally equivalent to those of the multifunction unit 1 described hereinbefore will be designated by the same numerals and will not be further described.

[0040] Referring to the multifunction unit 101, the main difference of the latter from the multifunction unit 1 is that the internal structure 105, i.e. the box-like enclosure, is suitable to be only partly embedded in the wall P. This arrangement is particularly advantageous when the thickness of the wall P does not allow full-depth embedding of the box-like enclosure 105. This occurs, for instance, when the wall P is a partition having a thickness of 8-10 centimetres only. It shall be noted in this respect that the depth of hydraulic means is typically of 6-8 centimetres, particularly when these means are mixer and/or diverter units that can selectively serve multiple water delivery outlets.

[0041] In the multifunction unit 101, the covering structure 106 comprises a cover 106a as well as a plurality of sections or wire covers 106b, suitable to be fixedly or preferably removably associated to the side portions of the box-like enclosure 105 projecting from the wall P.

[0042] As clearly shown in Figure 9, in this embodiment the multifunction unit 102 has separate lower and upper side wire covers 106b, which are suitable to cooperate with the cover 106a for frontally and fully cover the portion of the box-like enclosure 105 projecting from the wall P.

[0043] As an alternative to the above description, the covering structure may be designed in such a manner that the cover to be associated to the box-like enclosure already has integral tabs for covering the portions of the box-like enclosure walls projecting from the wall P.

[0044] The installation of the multifunction unit 101 is essentially coincident with the installation described for the multifunction unit 1, except that the wire covers 106b shall be also secured upon mounting of the cover 106a.

[0045] Considering now the multifunction unit 201, this is shown as a column-like unit, to be installed in such a manner that a predominant portion thereof projects vertically from a support structure such as a slab or a ceiling or horizontally from a wall.

[0046] In the case of Figure 10, the multifunction unit 10 is secured to a slab S, i.e. a floor, and has an internal structure 205 with a covering structure 206 associated thereto.

[0047] Preferably, the internal structure 205 is divided into two parts, and comprises a support 205a, which is suitable to be at least partly embedded in the slab S and a box-like enclosure 205b, which is suitable to be coupled to the support 205a to be supported thereby.

[0048] The support 205a is shaped in such a manner as to define a tubular member with a flange 214 for firmer fixation thereof to the slab.

[0049] The tubular member, which is shown to have a rectangular section, provides a form fit with the box-like enclosure 205b. Essentially, the box-like enclosure 205b has a rectangular section which is suitable to be slideably inserted in the tubular member of the support 205a, thereby providing a precision male/female coupling.

[0050] Provision may be made for fastener means, which are known per se and not shown, to secure the box-like member 205b to the support 205a.

[0051] As an alternative to the above and according to a simplified embodiment, the internal support struc-

ture may be formed by a single box-like enclosure suitable to be partly embedded in the slab, as described above, by an end portion thereof, whereat a flange is provided.

[0052] The box-like enclosure 205b is open at a front wall to allow introduction of appropriate hydraulic means therein.

[0053] The covering structure 206 is secured to the portion of the internal structure 205 which projects out of the slab S and includes a cover 206a to be mounted to the open front portion of the box-like enclosure 205b, and a plurality of sections or wire covers 206b, which are designed to cooperate with the cover 206a for fully covering the internal structure 205.

[0054] The cover 206a has a form fit with the box-like enclosure 205b with gasket means, not shown, interposed therebetween, which safely seal the front opening of the box-like enclosure 205b. Such form fit is achieved by providing the cover 206b, at its inner side, i.e. the side turned toward the box-like enclosure 205b, with a peripheral rim 211 that defines a frame, which may be inserted by a slight force fit in the front opening of the box-like enclosure 205b.

[0055] Advantageously, the cover 206b of the covering structure has such a size as to lie over and beyond said peripheral rim 211, to hide the front side of the internal structure 205.

[0056] The wire covers 206b are suitable to be fixedly or preferably removably associated to the upper and lower side portions of the internal structure 205 which projects out of the slab S, as shown in the exploded view of Figure 11.

[0057] Like in the above multifunction units 1 and 101, the covering structure 206 of the multifunction unit 201, and particularly the cover 206a allows to use actuator means 7, 8 for control and adjustment of said hydraulic means and acts as a support for water delivery means, in this case the fixed shower head 2, the plurality of fixed front nozzles 3 and the hand shower 4. Advantageously, the cover 206b is equipped with hydraulic connection means 213 for allowing fluid communication between the hydraulic means 9 and 10 in the box-like enclosure 205b and said water delivery means.

[0058] These hydraulic connection means 213 include pipes, preferably flexible connection pipes, as well as their respective screwed fittings.

[0059] The installation of the multifunction unit 201 is substantially coincident with the above described installation of the multifunction unit 1. The main difference consists in that a prior step is provided to fix the support 205a to the slab S so that the lower part thereof, comprising the flange 214 is only embedded in the slab. This step is facilitated by the stop and positioning means of the support, whose position is related to the unfinished and unpaved slab S.

[0060] Then, the box-like enclosure 205b may be coupled to the support 205a, thereby providing a male/female coupling. The piping for connection to the sanitary water mains, as well as any cables for connection to the power supply mains extend within the box-like enclosure 205b from the support 205a and the slab S.

[0061] Once the internal structure 205 has been positioned and fastened to the slab S, the appropriate hydraulic means may be introduced therein and connected to the sanitary water mains.

[0062] Finally, once the slab S has been resurfaced and paved, the covering structure 206, i.e. the wire covers 206b and the cover 206a will be mounted, with all water delivery and connection means 213 fitted thereon.

[0063] The multifunction unit 201 is highly versatile and functional as it can be advantageously installed both on floors and on ceilings, in such a manner as to extend from the ceiling to the floor along a predetermined length, or even on walls.

[0064] It shall be noted that the structure of the multifunction unit may be suitably modified, e.g. to allow installation of a sink where no wall is provided. Here, the multifunctional unit shall be simply equipped with suitable hydraulic means for ensuring proper operation of a sink, i.e. the hot and cold water supply pipes and a drainage pipe, with its respective pipe fitting, and the structure of the multifunction unit may be also used as a support for the sink. In this case, the multifunction unit shall be obviously put in fluid communication not only with the sanitary water mains but also with a sewer. Thus, the multifunction unit shall also have pipe fittings and connection pipes between the sink drainage and the sewer.

[0065] Furthermore, a multifunction unit may be provided which has two or more separate covers, possibly on opposed or adjacent sides, which are respectively equipped with water delivery means, such as a shower head or a hand shower, and with the water supply and drainage fittings for a sink.

[0066] As clearly shown in the above description, the multifunction unit for sanitary fittings according to the present invention fulfils the above mentioned need and also obviates prior art drawbacks as set out in the introduction of this disclosure. Installation is simple and fast and may be carried out in two successive steps, with surface finishing of the support structure, i.e. the wall, slab or ceiling whereto the multifunction unit is secured, being performed in between. It will be particularly appreciated that no risk of damaging the external parts of the multifunction unit exists during surface finishing of the support structure.

[0067] An additional advantage of the multifunction unit for sanitary fittings according to this invention consists in the possibility of introducing any hydraulic means therein, therefore the decision about the hydraulic means to be used, e.g. a mixer unit from a particular manufacturer or having particular features may be also made when the masonry works have been completed, that is upon mounting of the cover to the box-like enclosure.

[0068] A further advantage of the multifunction unit for sanitary fittings according to this invention is the possi-

bility of preparing the internal structure, namely the box-like enclosure, for reception and fast connection of the various available hydraulic means.

[0069] Yet another advantage of the multifunction unit for sanitary fittings according to this invention is that it obviates the problem of properly positioning the hydraulic means relative to the wall.

[0070] Those skilled in the art will obviously appreciate that a number of changes and variants may be made to the multifunction unit for sanitary fittings as described hereinbefore, without departure from the scope of the invention, as defined in the following claims.

[0071] For example, as an alternative to the above, the internal structure, i.e. the box-like enclosure may be fitted with the hydraulic means, which are accommodated and secured therein, before installation. Therefore, installation will simply consist in securing such assembly to the support structure, e.g. the wall, as described hereinbefore, and in connecting the pipes and electric cables, if any, to the water and power supply mains respectively. By this arrangement, the internal structure may be previously fitted with the appropriate hydraulic means required for any specific installation at the factory, and still assure the highest mounting precision and dramatically reduce the time required for on-site installation of the multifunction unit.

Claims

1. A multifunction unit for sanitary fittings, comprising hydraulic means (9, 10) suitable to be connected to sanitary water mains for controlling water delivery to at least one water delivery outlet (2, 3, 4) **characterized in that** it comprises:

   - an internal structure (5; 105; 205) suitable to define a housing for such hydraulic means (9, 10) and to be secured to a support structure (P; S), and
   - a covering structure (6;106;206) externally associated to said internal structure (5;105;205), said covering structure (6;106;206) allowing the use of actuator means (7, 8) associated thereto for control and adjustment of said hydraulic means (9, 10).

2. A multifunction unit according to claim 1, wherein said covering structure (6;106;206) is equipped with hydraulic connection means (13;213) for allowing fluid communication between said hydraulic means (9, 10) and said at least one water delivery outlet (2, 3, 4).

3. A multifunction unit according to claim 1 or 2, wherein electric means are associated to said covering structure (6;106;206), said covering structure being equipped with wiring means to allow connection of said electric means to the electric mains associated to said support structure.

4. A multifunction unit according to any one of claims 1 to 3, wherein said internal structure (5) comprises an essentially box-like enclosure suitable to be secured to said support structure (P) and support said hydraulic means (9, 10).

5. A multifunction unit according to claim 4, wherein said internal structure (5) is suitable to be embedded in said support structure.

6. A multifunction unit according to claim 4, wherein said internal structure (105) is partly embedded in said support structure (P) and said covering structure (106) has a plurality of finishing sections (106b), which are mounted to the portion of said internal structure (105) which projects out of the support structure (P).

7. A multifunction unit according to claim 4, 5 or 6, wherein said substantially box-like enclosure (5; 105) has a front side that may be accessed from the outside of the support structure and said covering structure (6;106) comprises a cover (6;106a) to be mounted to said front side of the box-like enclosure (5; 105) .

8. A multifunction unit according to claim 7, wherein said cover (6;106a) has a form fit with said box-like enclosure (5;105).

9. A multifunction unit according to claim 7 or 8, wherein said box-like enclosure (5;105) has an opening at said front wall and said cover (6;106a) has gasket means for safely sealing said opening.

10. A multifunction unit according to claim 5, wherein said internal structure (205) has a first end portion (205a) which is suitable to be embedded in said support structure (S) and a remaining portion (205b), which is suitable to project out of said support structure (S) and be covered by said covering structure (206).

11. A multifunction unit according to claim 10, wherein said first end (205a) of the internal structure (205) has a fastening flange (214).

12. A multifunction unit according to claim 10 or 11, wherein said remaining portion (205b) of the internal structure (205) comprises a substantially box-like enclosure, which is integrally coupled to said first end (205a) of the internal structure (205).

13. A multifunction unit according to claim 12, wherein said support (205a) and said box-like enclosure

(205b) have a form fit engagement.

14. A multifunction unit according to claim 13, wherein said support (205a) and said box-like enclosure (205b) have a slideable male/female form fit engagement.

15. A multifunction unit according to claim 12, 13 or 14, wherein said covering structure (206) comprises a cover (206a) to be mounted to a front wall of said substantially box-like enclosure (205b).

16. A multifunction unit according to claim 15, wherein said cover (206a) has a form fit with said box-like enclosure (205b).

17. A multifunction unit according to claim 15 or 16, wherein said box-like enclosure (205b) has an opening at said front wall and said cover (206a) has gasket means for safely sealing said opening.

18. A multifunction unit according to any one of claims 2 to 17, wherein the hydraulic connection means (13;213) include flexible connection pipes.

19. A multifunction unit according to any one of claims 1 to 18, wherein said at least one water delivery outlet (2, 3, 4) is associated to said covering structure (6;106a;206a).

20. A multifunction unit according to any one of claims 1 to 19, wherein said hydraulic means (9, 10) include mixer / diverter units, which are suitable to supply sanitary water to a plurality of delivery outlets (2, 3, 4) associated to said covering structure (6; 106a;206a).

21. A multifunction unit according to any one of claims 1 to 20, comprising a drainage canalization extending through the covering structure and said internal structure to allow fluid communication between the drainage of a sanitary fitting lying against said multifunction unit with a sewer system associated to said support structure.

22. A multifunction unit according to any one of claims 1 to 21, wherein said internal structure (5;105;205) comprises a plurality of stop elements for proper positioning it relative to said support structure (P;S).

23. A multifunction unit according to any one of claims 1 to 18, wherein said support structure is a wall (P), a slab (S) or a ceiling.

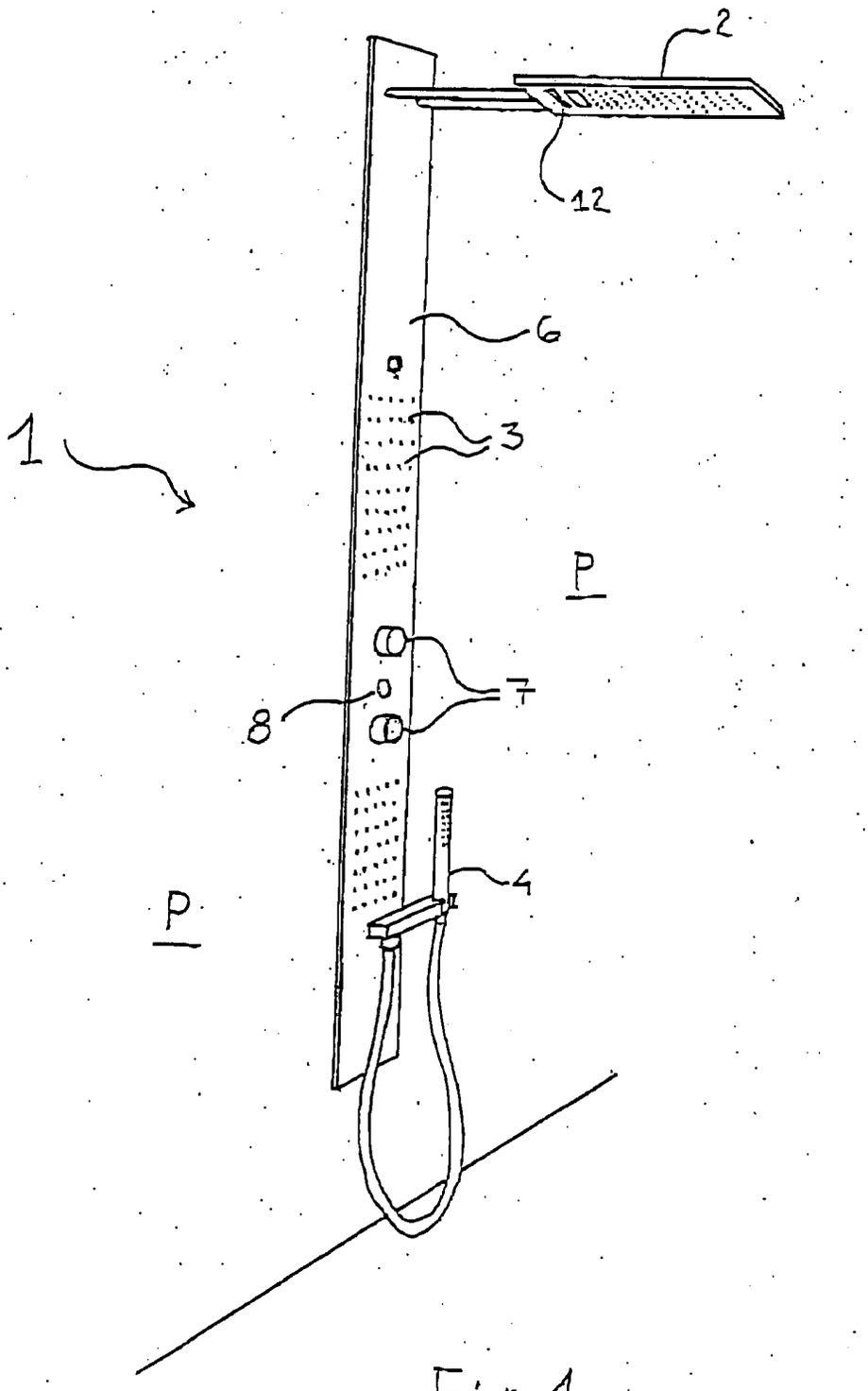


Fig 1

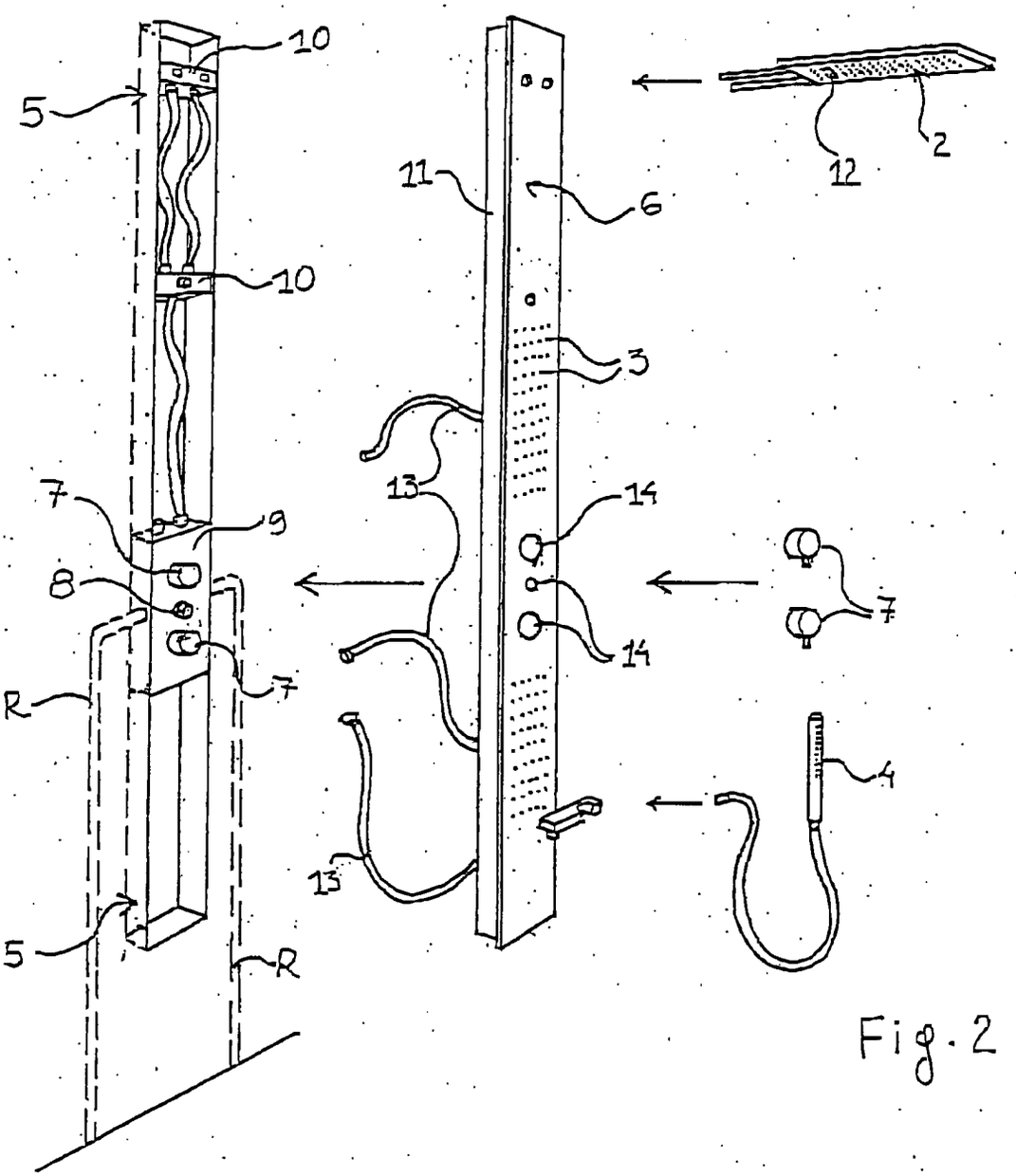


Fig. 2

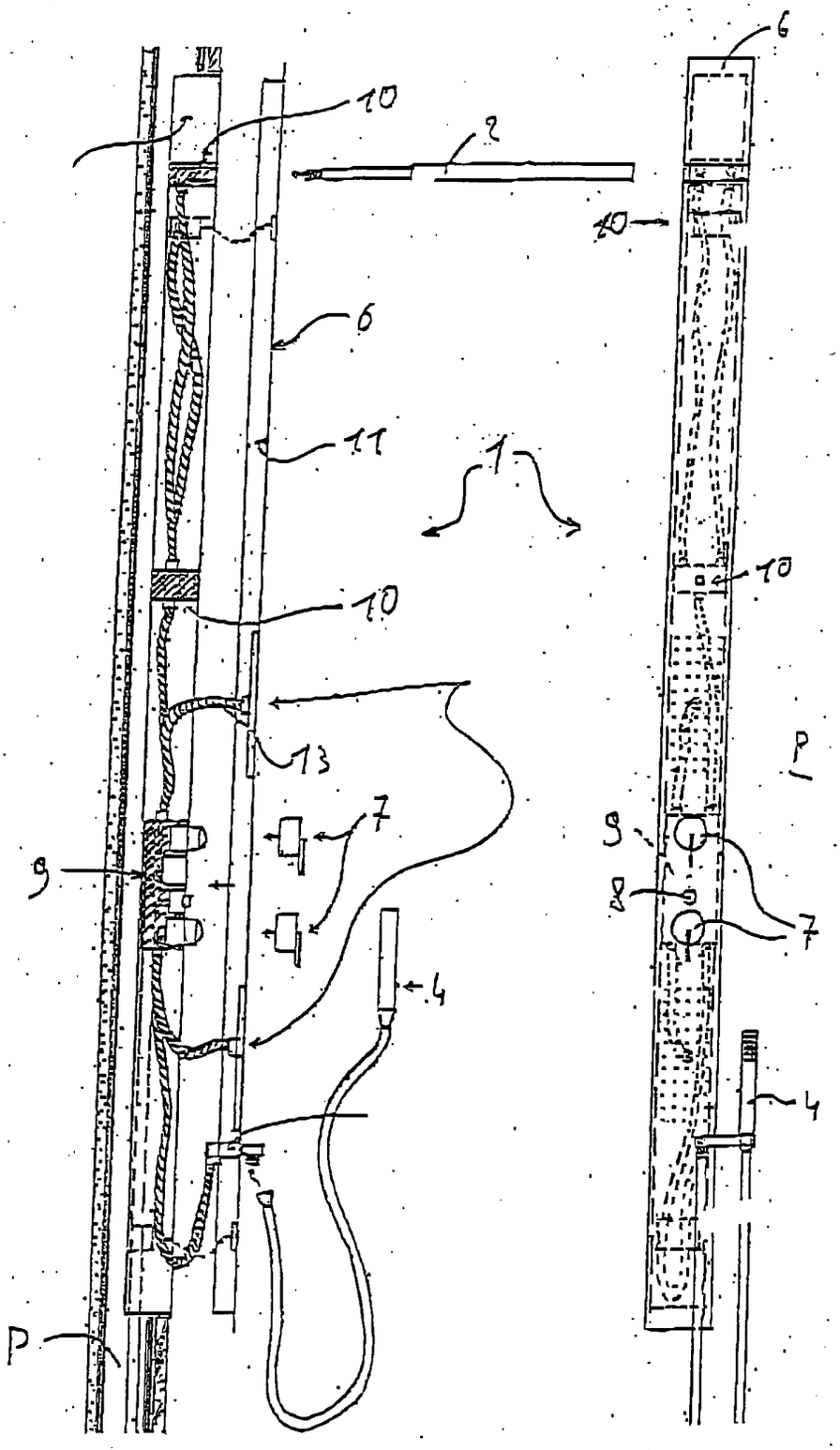


Fig. 3

Fig. 4

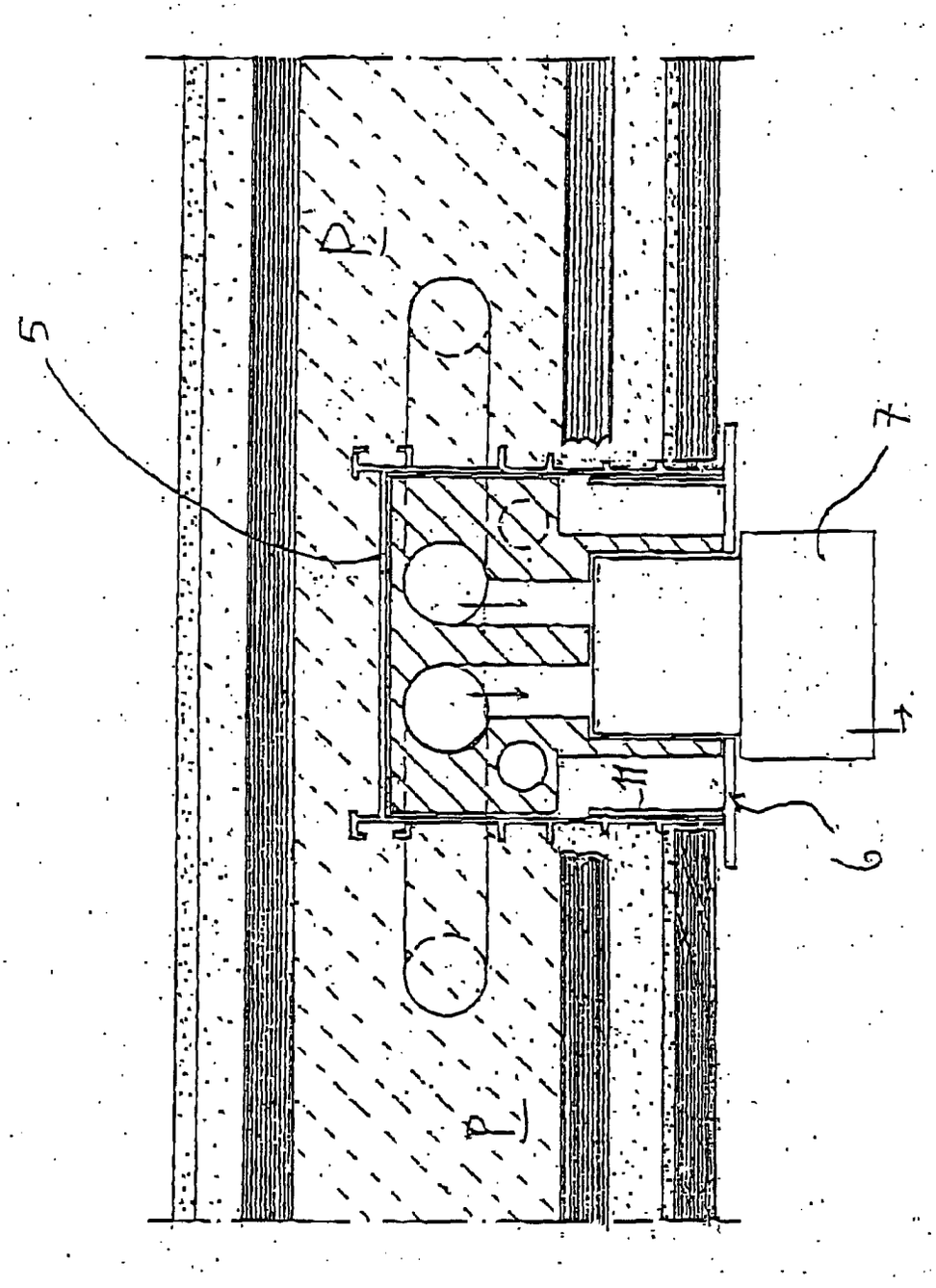


Fig. 5

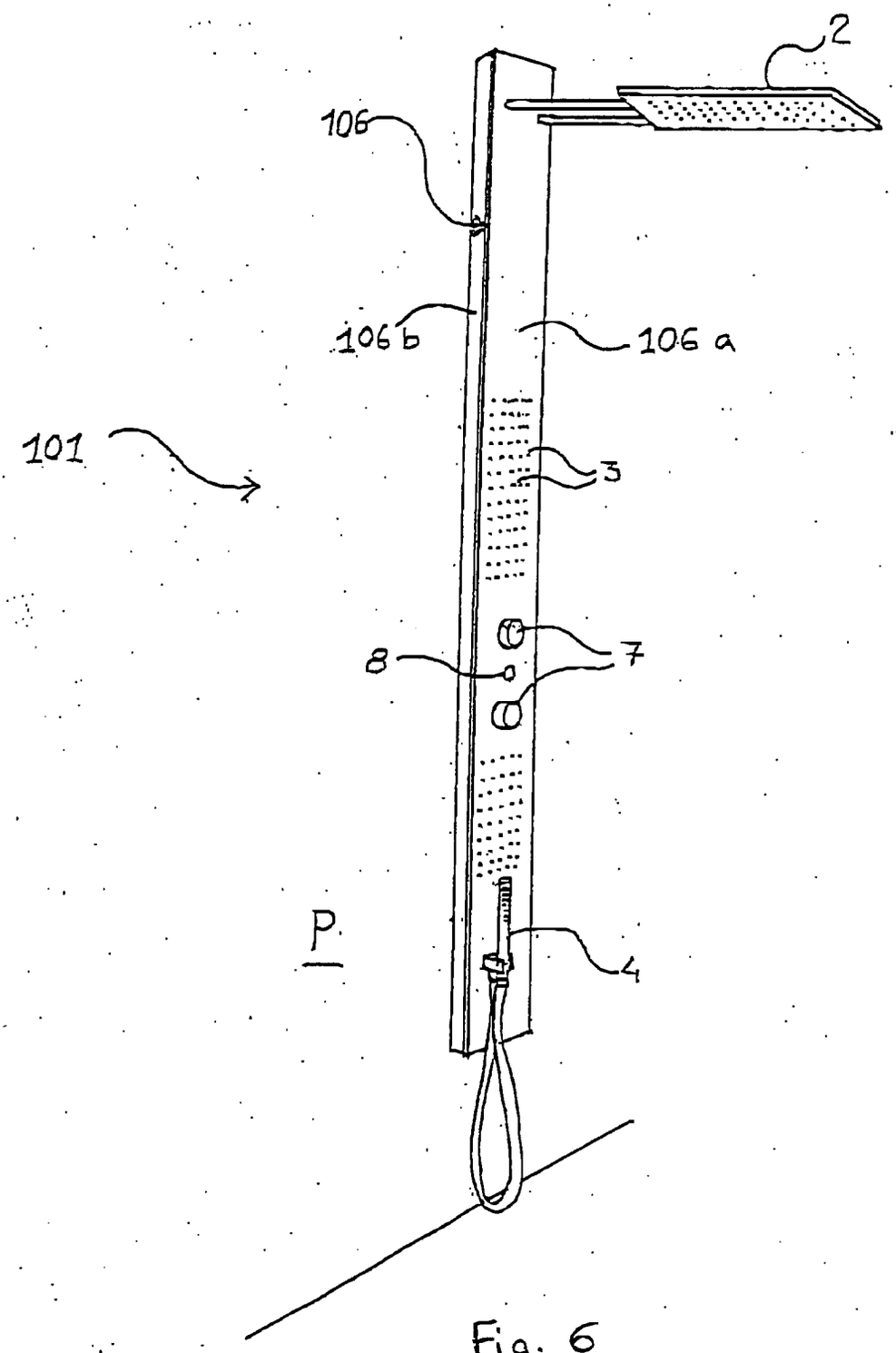


Fig. 6

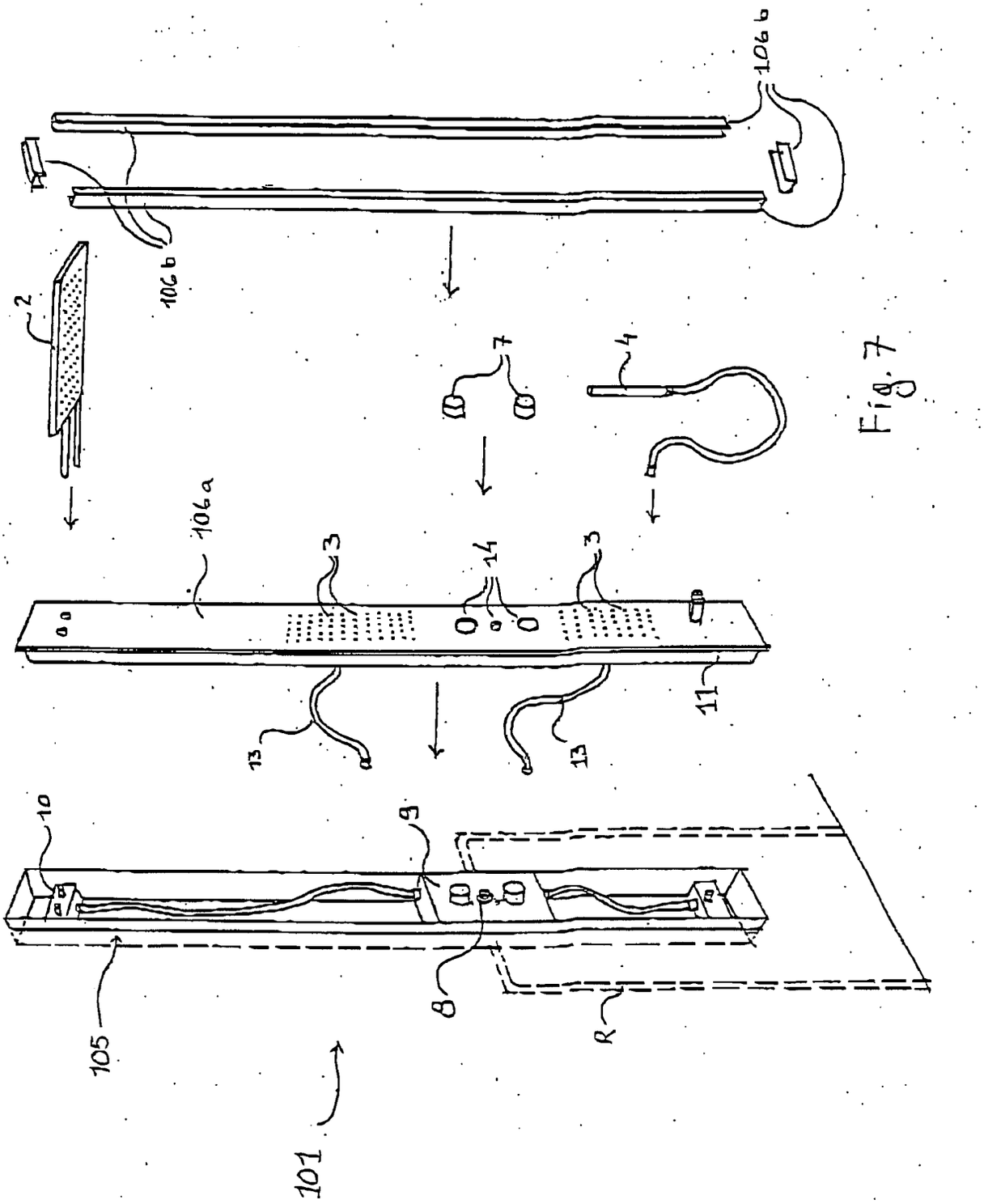


Fig. 7

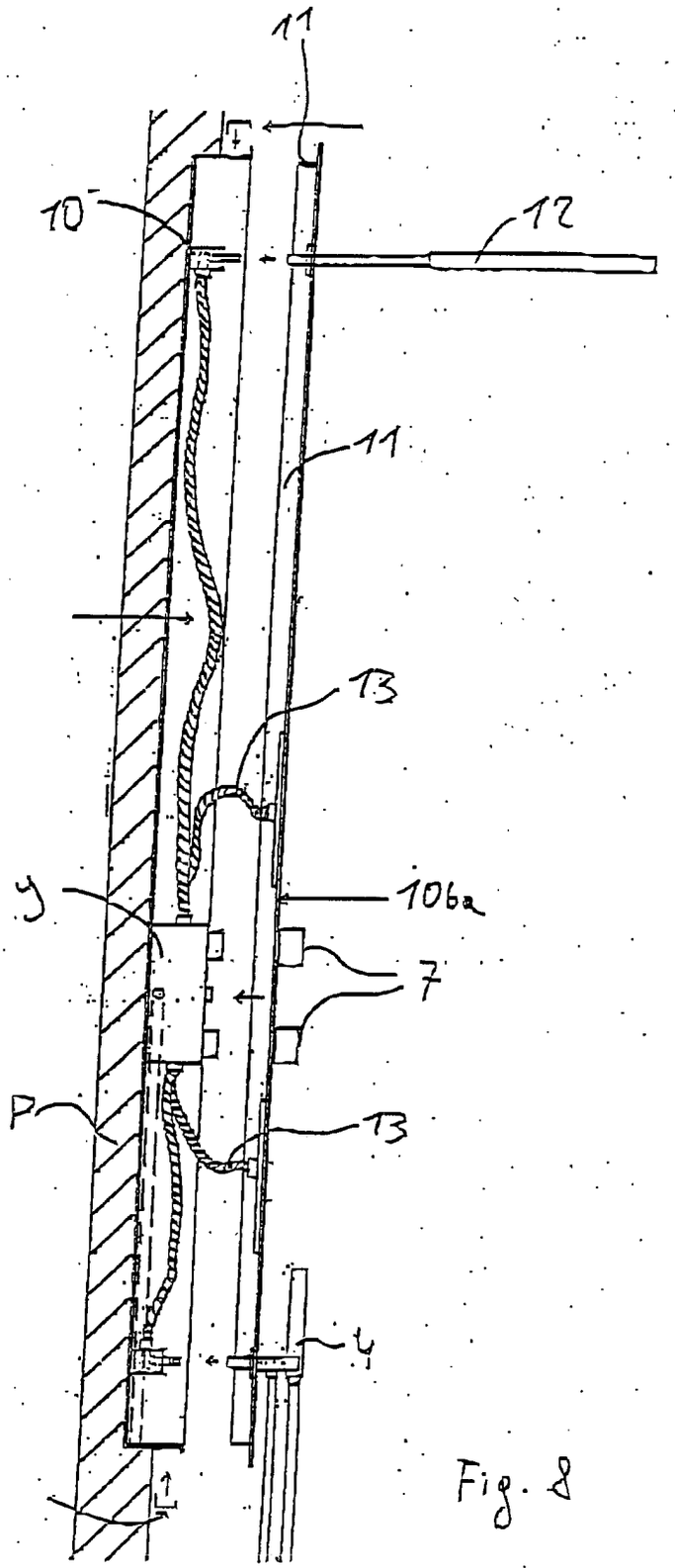


Fig. 8

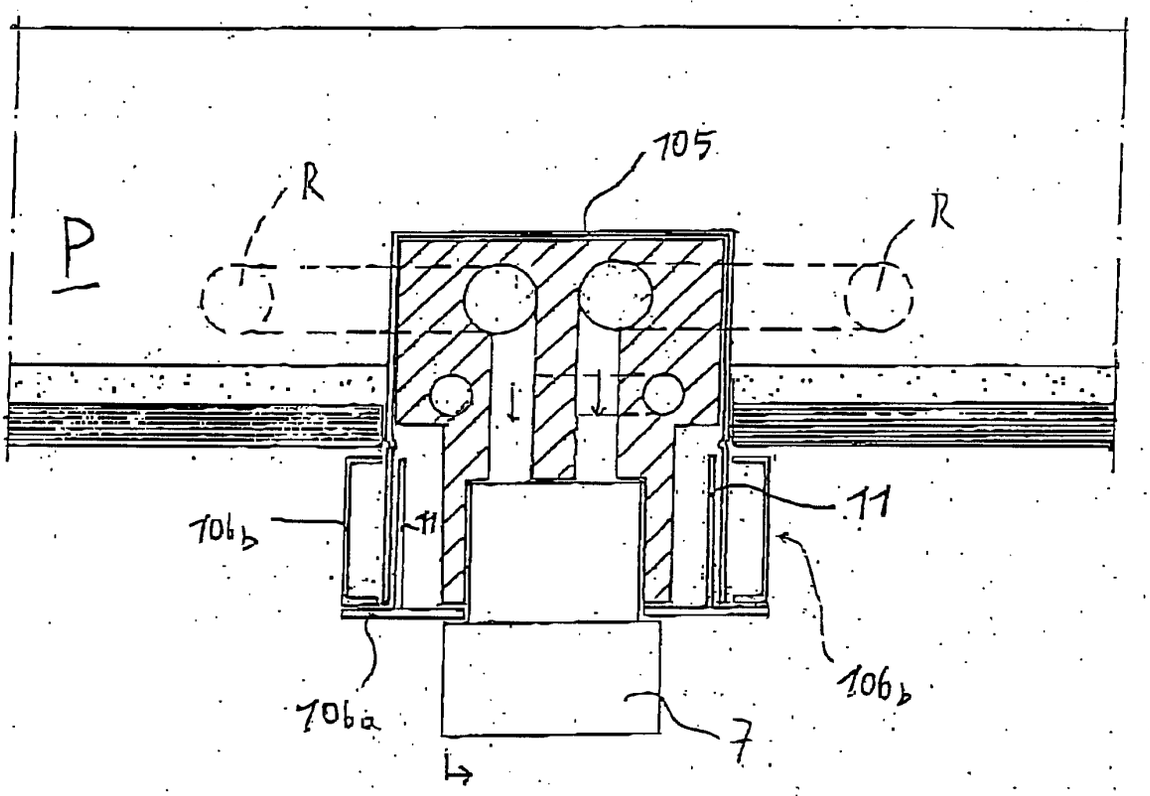
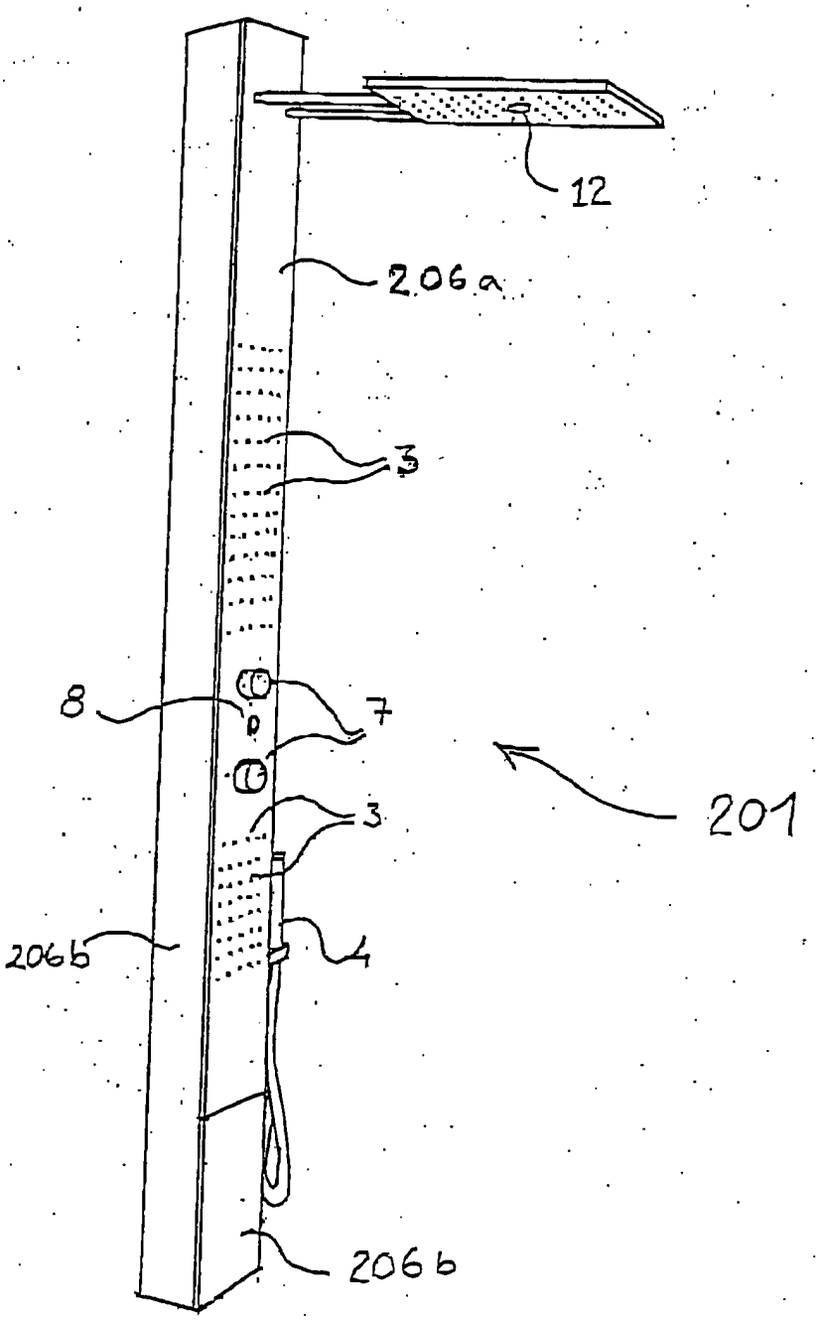


Fig. 9



S Fig. 10

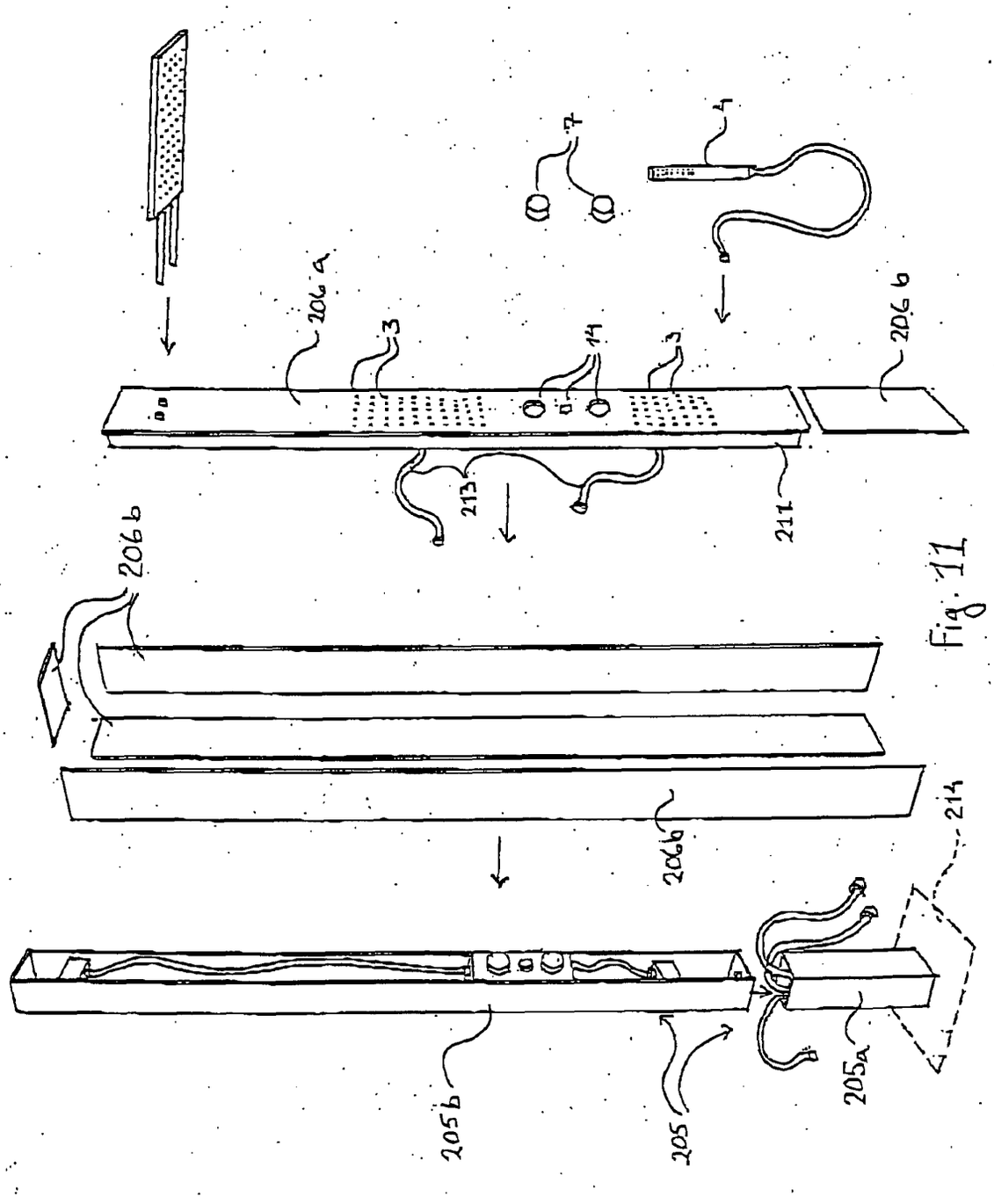


Fig. 11

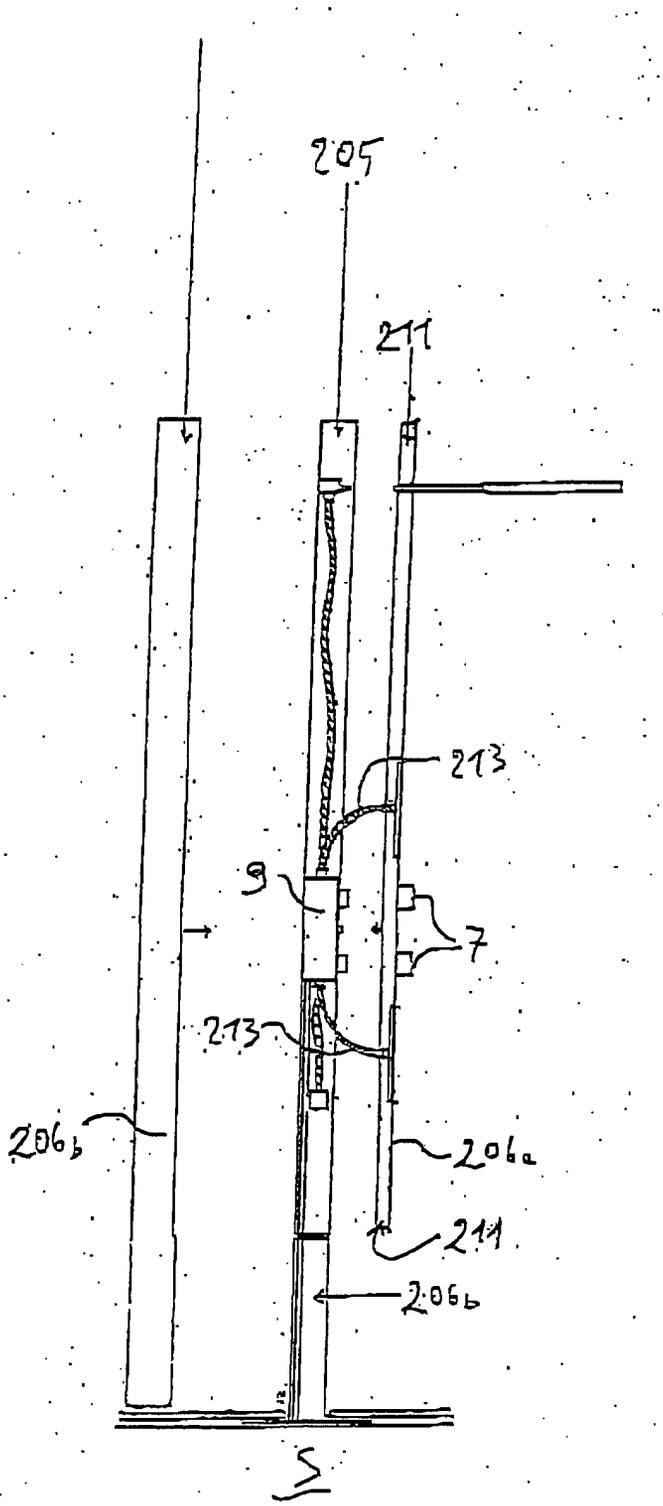


Fig. 12

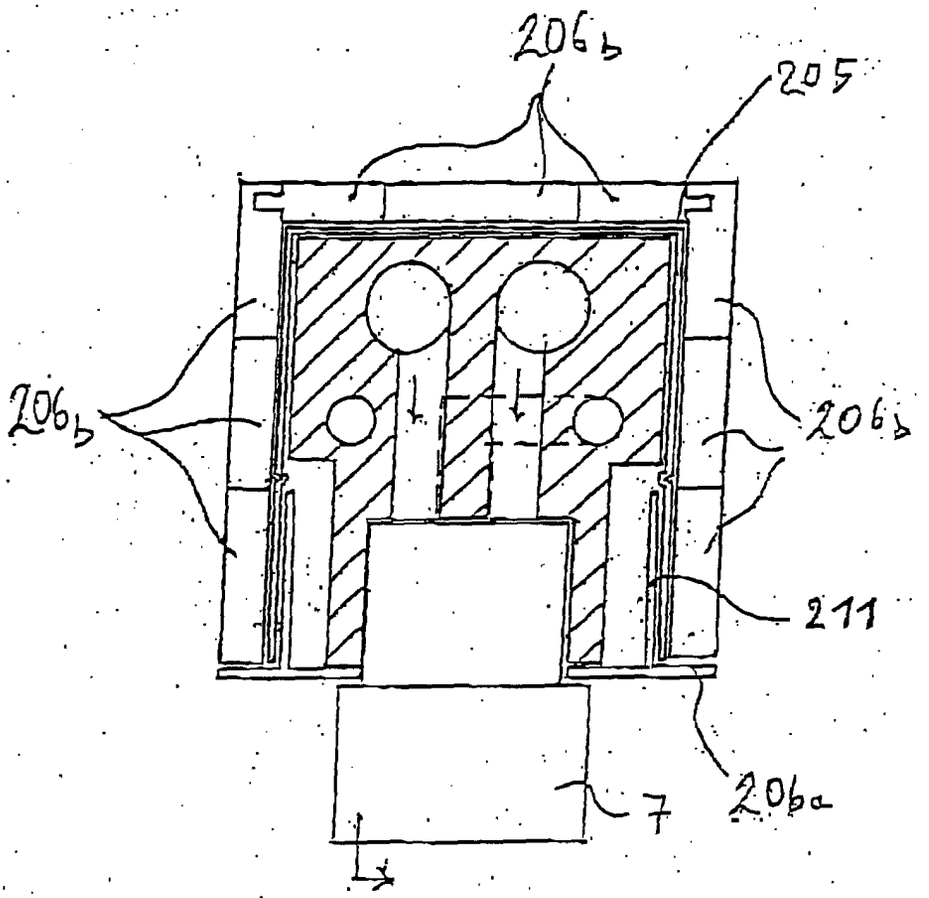


Fig. 13

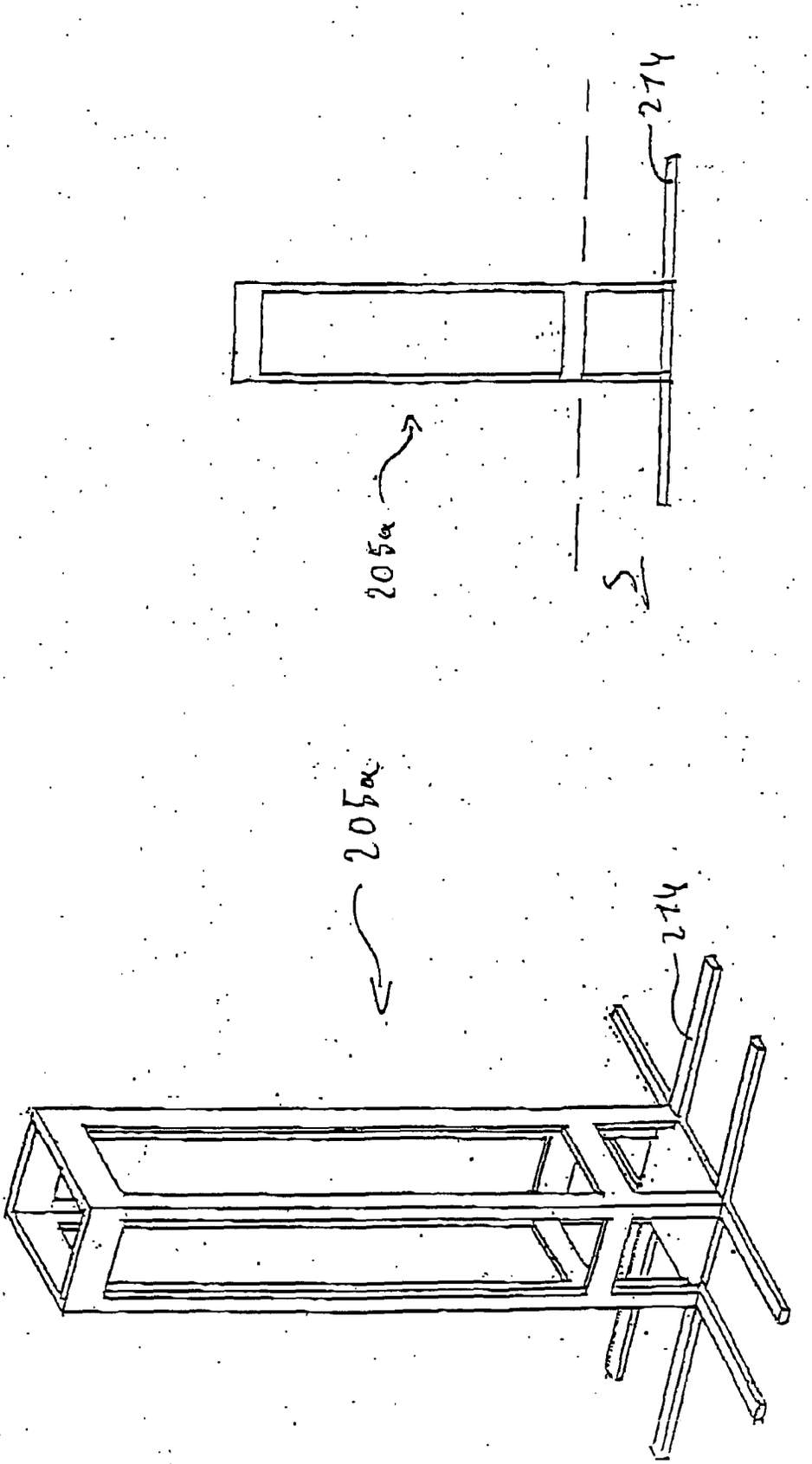


Fig. 14

Fig. 15