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(71) Demandeur/Applicant:
WOBBEN, ALOYS, DE

(72) Inventeur/Inventor:
WOBBEN, ALOYS, DE

(74) Agent: OYEN WIGGS GREEN & MUTALA

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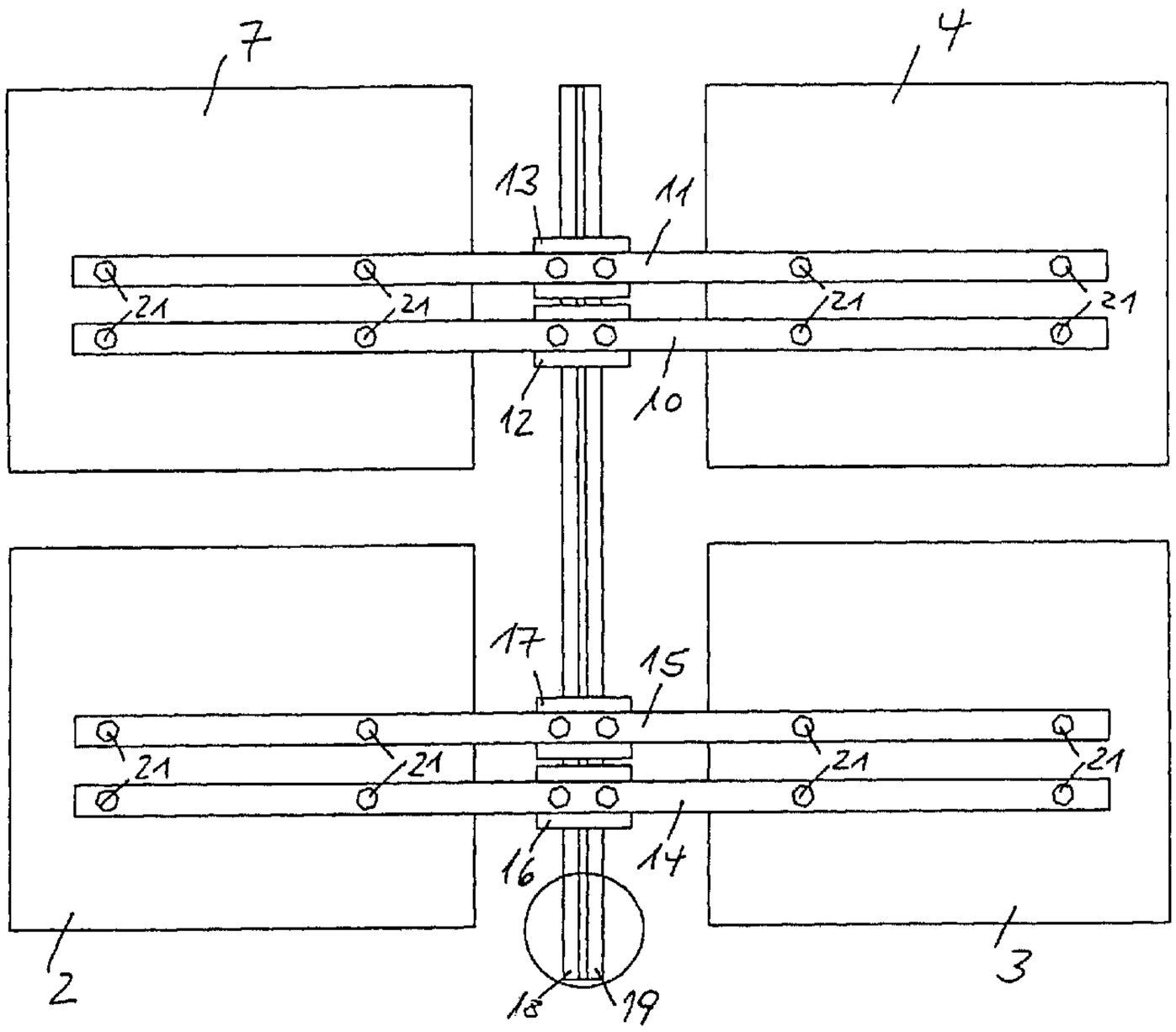

(57) Abrégé/Abstract:
The invention relates to a power inverter for converting a direct current into an alternating current. The aim of the invention is to provide a power inverter which can be repaired in its place of use in a faster and more reliable manner. To this end, the inventive power inverter has an at least partially modular structure consisting of detachably integrated modules and connection lines which are detachably applied to said modules.

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Abstract

The present invention concerns an inverter for converting a direct current into an alternating current. In order to provide an inverter which can be repaired more quickly and more reliably at the location of use, it is of an at least partially modular structure, with releasably installed modules and connecting lines releasably mounted to the modules.

POWER INVERTER

The present invention concerns an inverter (dc-ac converter) for converting a direct current into an alternating current. Such inverters have long been known and are used in many different situations, inter alia in wind power installations. In that respect modern inverters use semiconductor switching elements such as IGBTs which are suitably actuated to produce the alternating current. Those semiconductor switching elements are admittedly overall relatively reliable, but failure thereof is not out of the question.

In the case of inverters of a conventional structure, upon failure of such a semiconductor switching element it is replaced on site. In that situation, unintended and unwanted fouling and/or damage and/or fitting errors can occur, which remain unnoticed and which in a short time result in (renewed) destruction of the semiconductor switching element. The repair procedure which is thus required once again involves expenditure which would have been avoidable.

Therefore the object of the present invention is to provide an inverter which reduces or avoids those disadvantages.

In an inverter of the kind set forth in the opening part of this specification, that object is attained by an at least partly modular structure, with releasably installed modules and connecting lines releasably mounted to the modules. In that respect the invention is based on the realisation that repair on site is naturally more susceptible to error than repair in a workshop which is specifically set up for that purpose. Therefore repair on site is limited to identifying the defective module, removing it, and replacing it by a faultless module. Besides the reduced level of susceptibility to error of the repair operation in itself, replacement is to be effected, if the modules are of a suitable design configuration, more quickly than repair, so that the inverter can be more rapidly brought back into operation again.

In a preferred embodiment of the invention modularisation is directed to the function of a module so that, upon the occurrence of a fault, it is already possible to infer from the fault a specific module and at least a small number of modules which are then still to be checked.

In a particularly preferred development of the invention the inverter further includes an intermediate storage means which is formed from a plurality of capacitors and to which at least some of the modules are connected. If those modules which are connected to the intermediate storage means are the semiconductor switching element modules, the intermediate storage means is in a position to compensate for fluctuations as a consequence of the switching procedures of the semiconductor switching elements, and thus to permit stable operation of the semiconductor switching elements.

In a particularly advantageous development of the invention the connection between the intermediate storage means and at least some of the modules is capacitive. That capacitive configuration of the connection provides that it is possible for the influences of parasitic inductances which are inevitable in connecting lines to be reduced to a minimum. In that way it is also possible to avoid operational faults and disturbances which are to be attributed to the effect of such inductances.

In order to eliminate inductive influences to the greatest possible extent, the capacitive connection in an inverter according to the invention particularly preferably includes at least one plate capacitor and the modules are mechanically connected to the plates of that plate capacitor.

In a preferred development of the invention the plates of a plate capacitor form a mechanical and electrical connection between the intermediate storage means formed from a plurality of capacitors, and the connected modules. It is possible in that way to reduce the influence of inductances to the greatest possible extent.

In a particularly advantageous development of the invention the spacing of the output terminals of the semiconductor switching elements of a module does not exceed a predetermined magnitude. In that way the lines connected thereto are also at a corresponding spacing. In that fashion

those adjacent lines can pass through a common measuring transducer and thus the complication and expenditure involved for detecting the current flowing in the lines is limited.

Advantageous developments of the invention are recited in the appendant claims.

An embodiment of the invention is described in greater detail hereinafter with reference to the Figures in which:

Figure 1 shows a simplified view of an inverter according to the invention,

Figure 2 shows a selection of modules from Figure 1,

Figure 3 shows a detail on an enlarged scale from Figure 2,

Figure 4 shows a simplified view of a semiconductor module,

Figure 5 shows a side view of a capacitor plate,

Figure 6 shows a view on to a further capacitor plate,

Figure 7 shows a detail of the capacitor plate, and

Figure 8 shows an alternative embodiment to Figure 2.

Figure 1 shows a simplified view of an inverter according to the invention. This Figure does not show components such as chokes, relays, safety devices and the like but also cables, in order to improve the clarity of the drawing. The inverter is disposed in a cabinet 1 and has a plurality of modules. Those modules perform different functions. Thus, the modules 2, 3 and 4 are semiconductor modules which produce an alternating current from a direct current. In that respect, provided for each phase is a specific module at 2, 3 and 4. A further module 5 is provided for controlling all modules of the inverter according to the invention. A module 6 is a voltage balancing device. Further modules 7 can also be provided. They can perform the function of a chopper, a step-up booster device or the like.

Those modules 2, 3, 4, 5, 6, 7 are installed in a cabinet 1 which is already prepared in a particular manner for the installation of modules. Extending between the modules 2, 3, 4, 5, 6, 7 are cable connections (not shown) which preferably connect the individual modules together by way of plug connections. The modules 2, 3, 4, 5, 6, 7 themselves are fixed releasably in the cabinet 1, for example with screws.

Therefore, to exchange a module 2, 3, 4, 5, 6 or 7, it is only necessary to withdraw the cable at that module and to release the screw connections of the module. Then, each individual one of the modules 2, 3, 4, 5, 6, 7 can be separately replaced in that way. In the case of a fault therefore the service engineer only has to fit a suitable replacement module in place of the module which has been recognised as being defective, and the inverter can be brought back into operation again after a short repair time.

Figure 2 shows in particular the connection of the modules 2, 3, 4 and 7 to the dc circuit of the inverter. It has already been explained with reference to Figure 1 that the modules 2, 3 and 4 are semiconductor modules which produce for a respective phase an alternating current from a direct current. The switching elements used can be for example thyristors or IGTBs or other semiconductors. In order to feed direct current to those modules 2, 3, 4, 7, the arrangement has connecting plates 12, 13, 16, 17 to which the modules 2, 3, 4, 7 are connected. That connection is made by way of bars 10, 11, 14, 15 which are mounted on the one hand to the connecting plates 12, 13, 16, 17 and on the other hand to the modules 2, 3, 4, 7 by screws 21. The bars 10, 11, 14, 15, like the connecting plates 12, 13, 16, 17, are separated in accordance with potentials. In the present embodiment for example plates 12 and 16 can be anodes and thus involve a positive potential and the plates 13 and 17 can be cathodes and accordingly involve a negative potential or also ground potential. It will be appreciated that in that case the bars 12 and 14 are correspondingly at positive potential and the bars 11 and 15 are at negative or ground potential.

The use of bars 10, 11, 14, 15 for feeding electrical power to the modules 2, 3, 4, 7 means that correspondingly high currents can flow as the cross-section of the bars can be correspondingly large. To improve handleability, the bars 10, 11, 14, 15 can be divided so that a respective separate bar 10, 11, 14, 15 extends from a connecting plate to a module 2, 3, 4, 7.

As can be seen from Figure 2 disposed behind the connecting plates 12, 13, 16, 17 are further plates 18, 19 in mutually parallel relationship. The arrangement and the mode of operation of those plates 18, 19 will be described in greater detail with reference to Figure 3. In that respect Figure 3 is a view on an enlarged scale of the portion enclosed by a circle in Figure 2.

Figure 3 shows a 3-layer structure. That 3-layer structure is formed from two capacitor plates 18, 19 and a dielectric 20. Accordingly that structure forms a plate capacitor. In this case the plates 18, 19 of the capacitor can be produced for example from aluminium and may be of a thickness of several millimetres. The dielectric 20 can be formed by a plastic film or sheet and can be of a thickness of some tenths of a millimetre. With this structure, one of the plates 18, 19 is necessarily the anode plate and the other plate is then inevitably the cathode plate. The plates 18, 19 of the capacitor are used to feed direct current to the modules 2, 3, 4, 7. By virtue of the fact that the feed means is in the form of a plate capacitor, that feed is purely capacitive and the influence of unwanted inductances is avoided. If the capacitor plate 18 is the cathode plate, the connecting plates 13 and 17 are connected to that capacitor plate 18. In a corresponding manner the connecting plates 12 and 16 are connected to the capacitor plate 19 acting as an anode plate.

Figure 4 shows a simplified view of a semiconductor module 2, 3, 4, more specifically with the semiconductor switching elements 22. Those semiconductor switching elements 22 for which for example IGTBs are used are actuated in a suitable manner known from the state of the art in order to produce a desired alternating current which is taken off by way of cables 25. The mode of operation of such a semiconductor module can be found for example from patent specification DE 197 48 479 C1.

In order to limit the spacing between cables 25 provided with the cable terminal lugs 24 and therewith naturally also between the cables 25 to a predetermined dimension, semiconductor switching elements 22 can be provided with suitably arranged connecting terminals. Alternatively, bars 23 are provided from the output terminals of the semiconductor modules

22 to the cable connecting lugs 24, the bars 23 passing the output current of the semiconductor element 22 to a corresponding cable 25. The bars 23 are fixed to the output terminal of the semiconductor module 22 by screws 26 which are shown here in the form of screws with a hexagonal recess in the head, and the cables 25 are in turn fixed to the bars 23 by means of cable connecting lugs 24 and screws 26 which are illustrated in the form of cross-headed screws. That arrangement makes it possible for the two cables 25 to be passed for example jointly through a measurement value pick-up device such as a ferrite ring of a current transformer in order to monitor the flow of current in the cables 25.

In accordance with the with the invention the inverter has an intermediate storage means formed from a plurality of capacitors. The purpose of that intermediate storage means is inter alia to smooth the dc voltage applied to the semiconductor modules and to compensate for voltage fluctuations as a consequence of the switching procedures of the semiconductor switching elements 22. For that purpose that intermediate storage means (not shown) is connected by way of the plate capacitor 18, 19, 20 to the modules. The plates 18, 19 of the plate capacitor are shown in Figures 5 and 6. In that respect Figure 5 shows the anode plate and Figure 6 shows the cathode plate. Those plates 18, 19 have bores 28 and recesses 29 extending around those bores. That is shown in detail in a cross-sectional view by way of the example of a bore/recess in Figure 7.

By virtue of that arrangement, it is possible on the one hand to connect the capacitors (not shown) forming the intermediate storage means to the plates 18, 19 by screw means so that, if required, individual capacitors can also be replaced, and, by virtue of the sunk arrangement of the screw head in the recess 29, to arrange the plates in mutually juxtaposed relationship separated from each other only by the spacing of the dielectric (reference 20 in Figure 3). A comparison of the plates shown in Figures 5 and 6 already shows that the connecting plates 12, 13, 16, 17 for the connecting bars are in displaced relationship with each other in respect of height, thus affording the staggered arrangement already shown in Figure 2.

Figure 8 shows an alternative arrangement to the connecting bars 10, 11, 14, 15 shown in Figure 2. For that purpose the bars are broadened in such a way that they cover over both connecting plates 12, 13. These bars which are also shown in plate form in this Figure are identified here by references 31 and 32. In order to make it clear that they are in mutually superposed relationship, they are illustrated as being displaced relative to each other. In situ they are disposed in substantially aligned relationship one above the other.

In this case, one of the plates is connected to the anode 12 and the other to the cathode 13. These plates 31, 32 also form a capacitor, by virtue of a dielectric which is inserted between the plates 31, 32 but which is not shown in the Figure. In accordance with the view in this Figure, the plate 32 is the anode plate and the plate 31 is the cathode plate. It will be appreciated that these plates are once again suitably connected to the semiconductor modules which are also not shown in this Figure, in order to feed them with the required direct current. As therefore the connecting plates 12, 13 are also connected to the semiconductor modules by way of a plate capacitor, inductive influence is also prevented on this portion of the electrical connection.

This therefore involves a capacitive connection from the intermediate storage means to the input terminals of the semiconductor modules.

CLAIMS

1. An inverter characterised by at least a partially modular structure with releasably installed modules (2, 3, 4) and connecting lines releasably mounted to the modules (2, 3, 4), wherein a module is a respective semiconductor module which for a respective phase produces an alternating current from a direct current.

2. An inverter according to claim 1 characterised by modularisation which is oriented to the function of a module (2, 3, 4, 5, 6, 7).

3. An inverter according to one of the preceding claims characterised by an intermediate storage means formed from a plurality of capacitors.

4. An inverter according to claim 3 characterised in that at least some of the modules (2, 3, 4, 5, 6, 7) are connected to the intermediate storage means.

5. An inverter according to claim 4 characterised in that the connection between the intermediate storage means and the modules (2, 3, 4, 5, 6, 7) is capacitive.

6. An inverter according to claim 5 characterised in that the capacitive connection includes at least one plate capacitor (18, 19, 20, 31, 32) and that the modules (2, 3, 4, 5, 6, 7) are mechanically and electrically connected to the plates of the plate capacitors (18, 19; 31, 32).

7. An inverter according to one of the preceding claims characterised in that the plates (18, 19; 31, 32) of at least one plate capacitor form a mechanical and electrical connection between the intermediate storage means and the modules (2, 3, 4, 5, 6, 7) connected thereto.

8. An inverter according to claim 7 characterised by an intermediate storage means formed from a plurality of capacitors and by capacitors releasably connected to the capacitor plates (18, 19; 31, 32).

9. An inverter according to one of the preceding claims characterised in that the spacing of the output terminals of the semiconductor switching elements (22) of a module (2, 3, 4, 5, 6, 7) does not exceed a predetermined magnitude.

10. A wind power installation characterised by at least one inverter according to one of the preceding claims.

Fig. 1

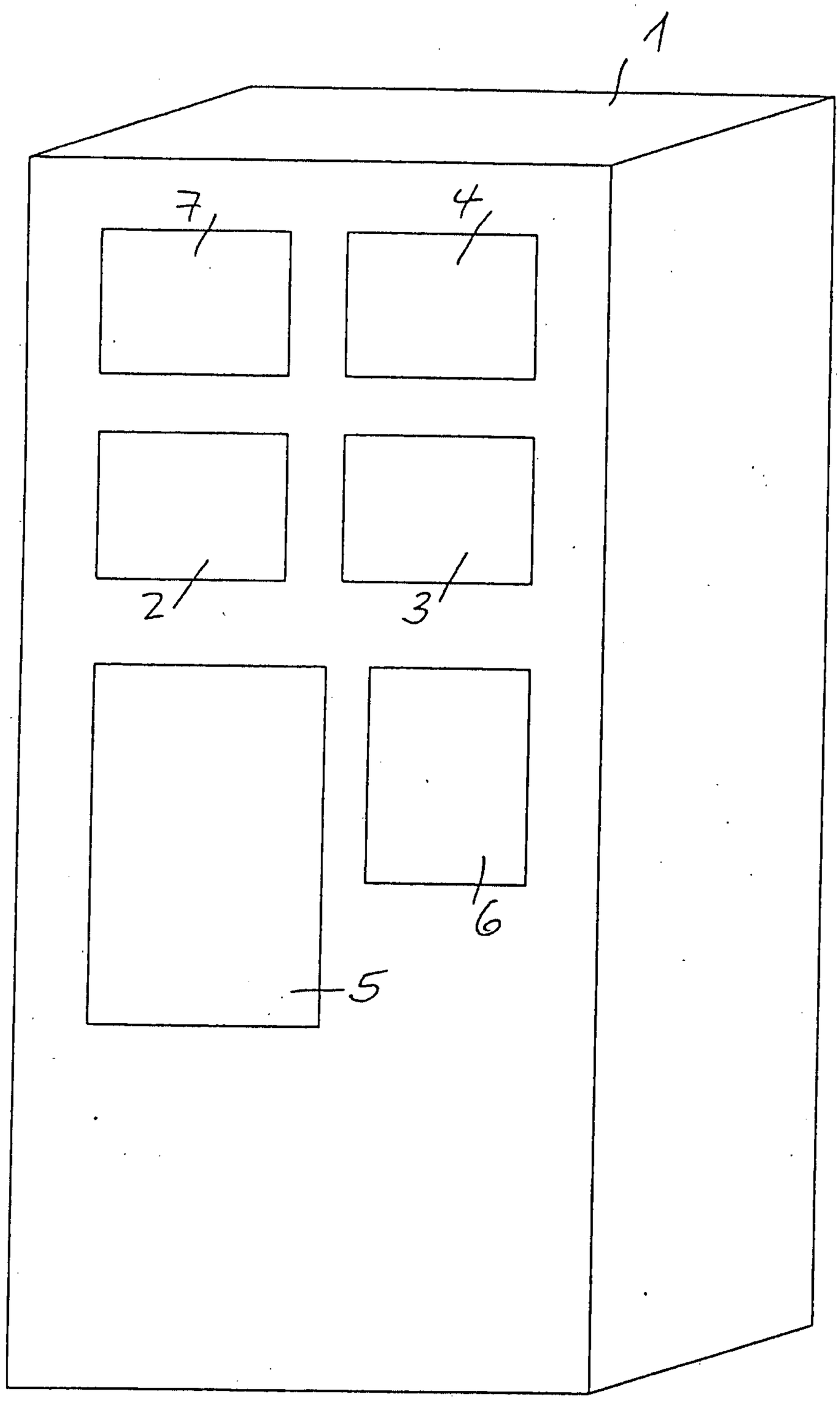
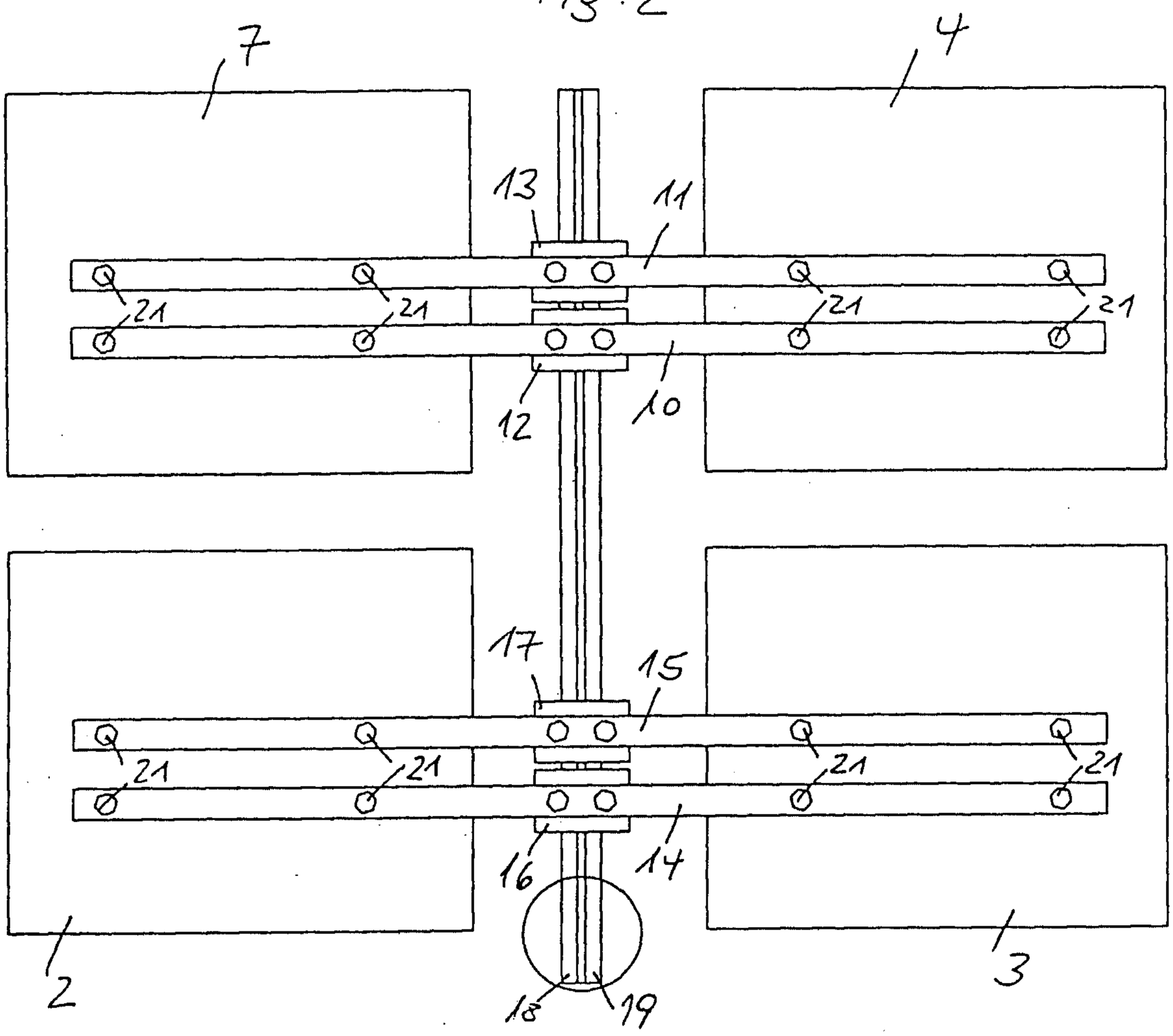


Fig. 2



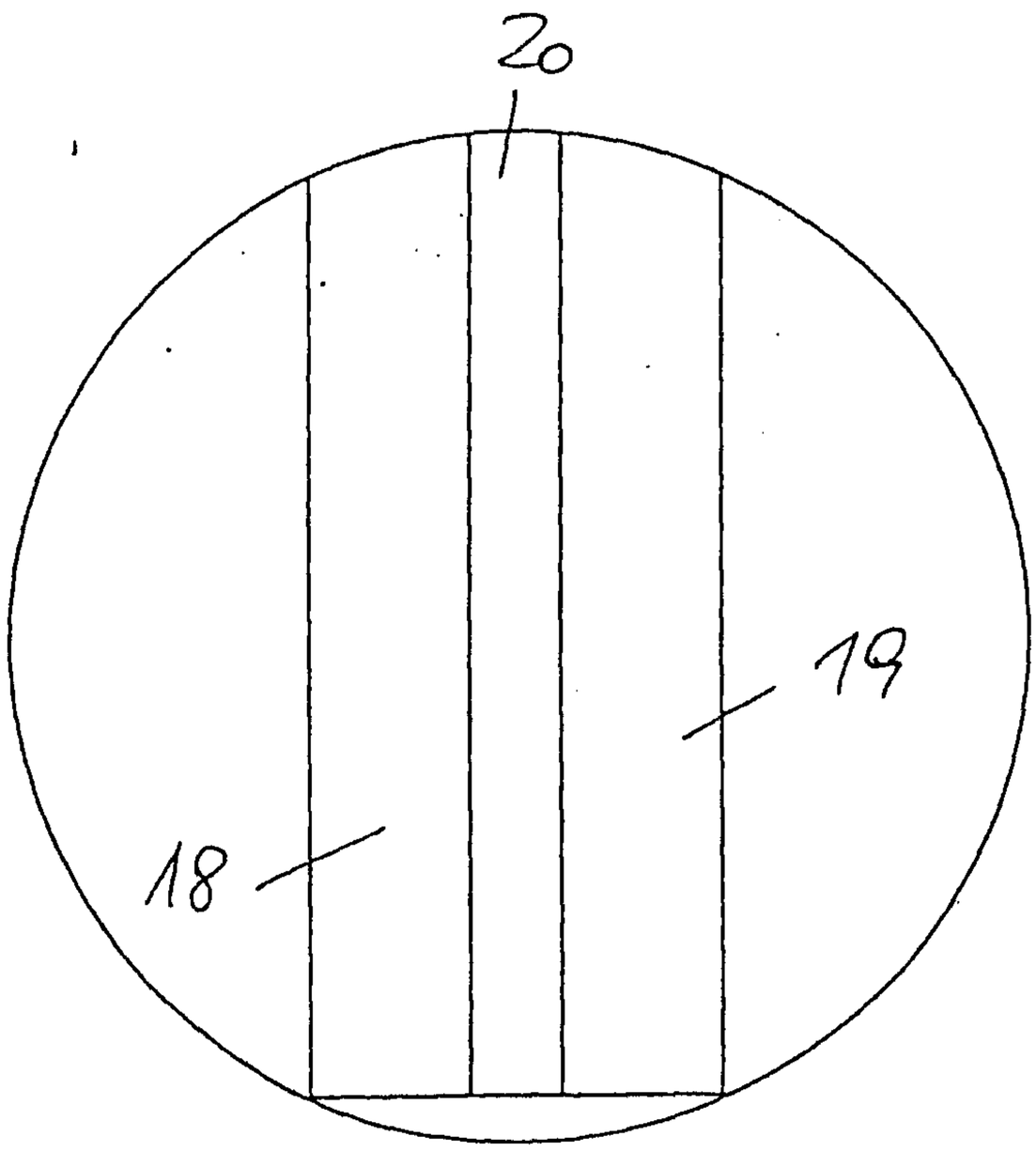


Fig. 3

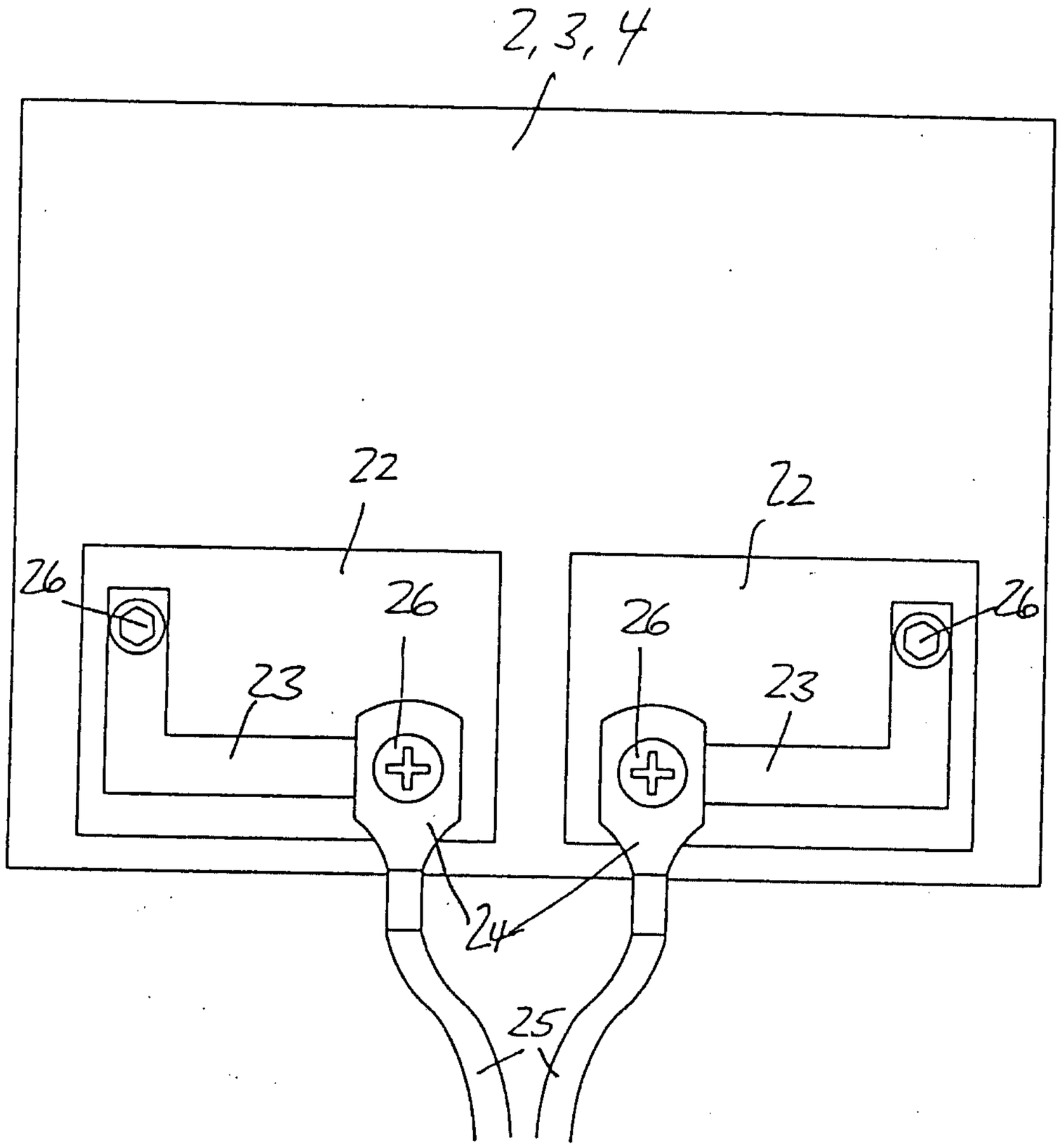


Fig. 4

Fig.5

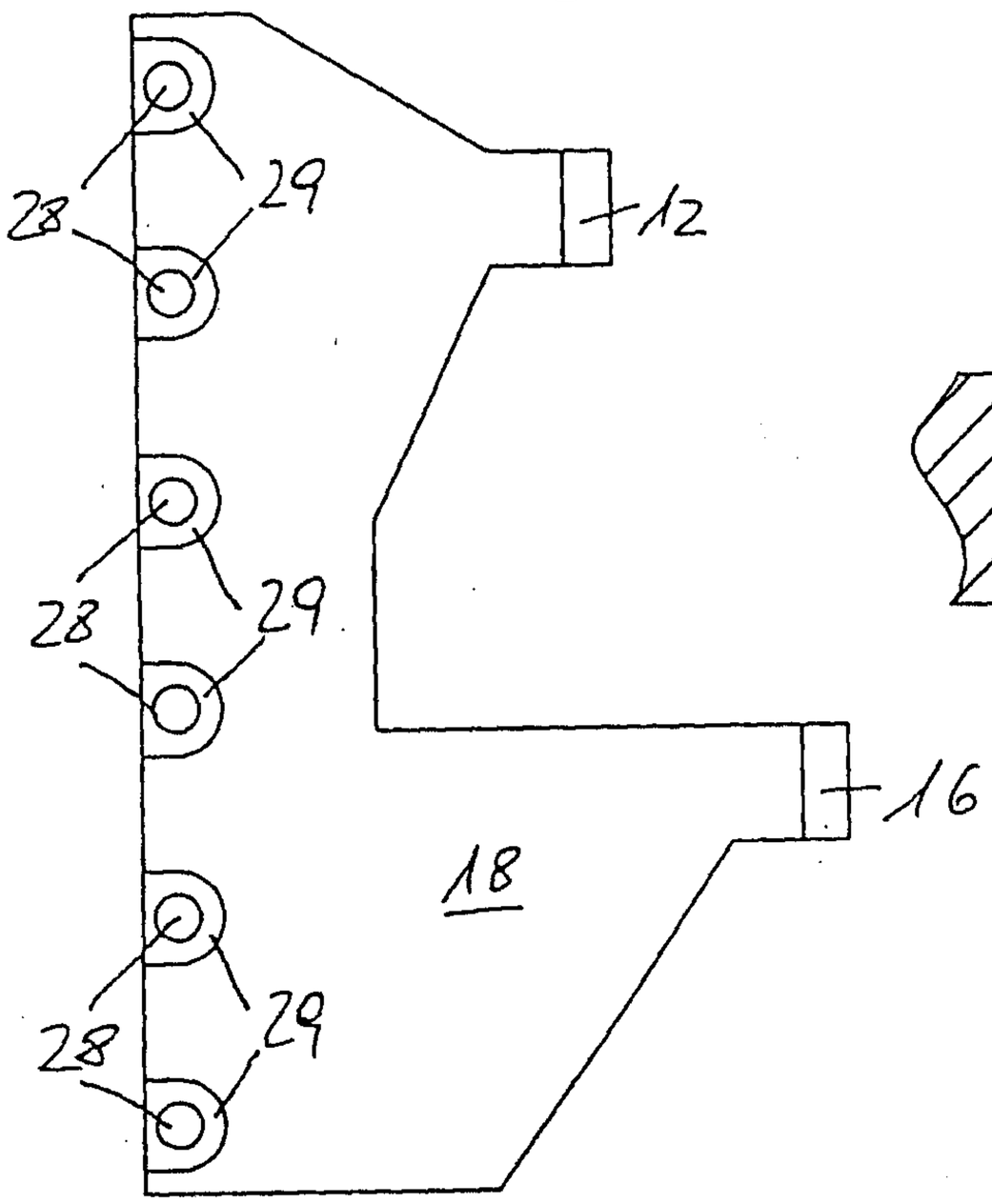
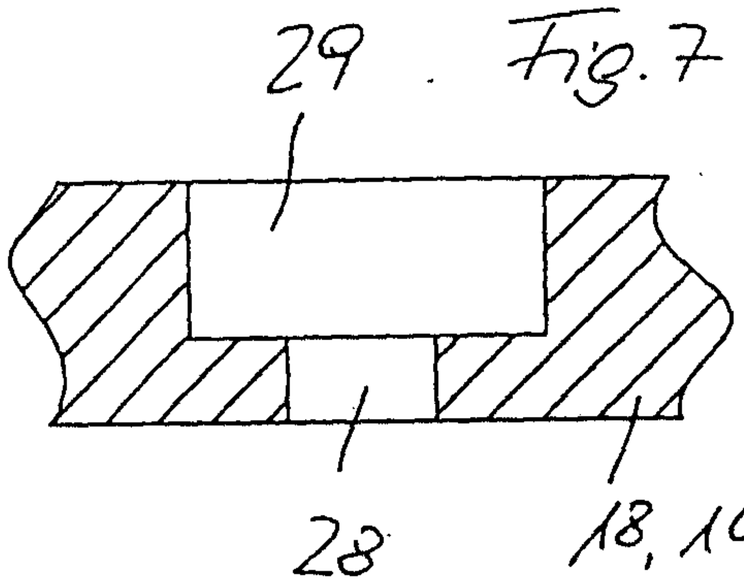


Fig.7



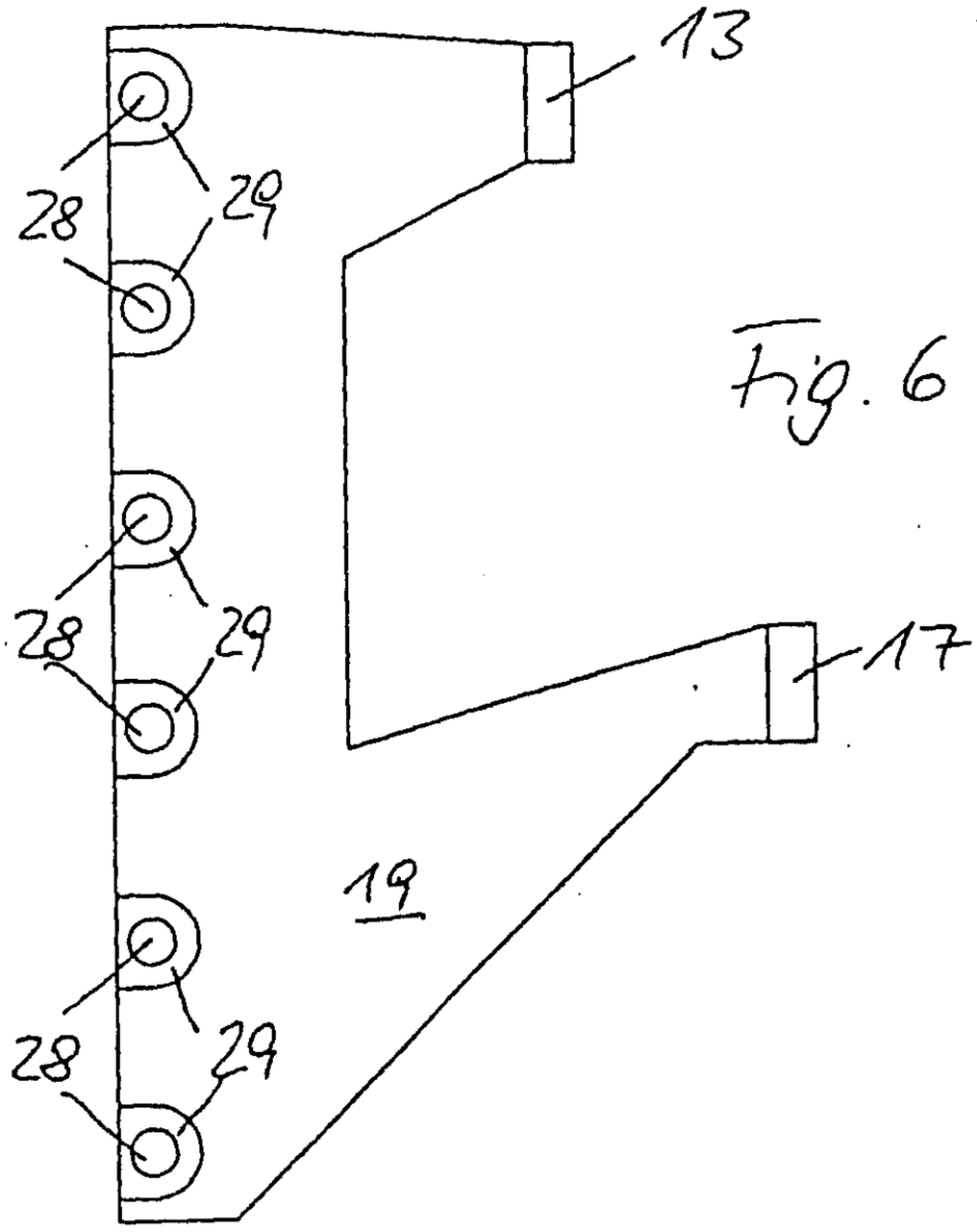
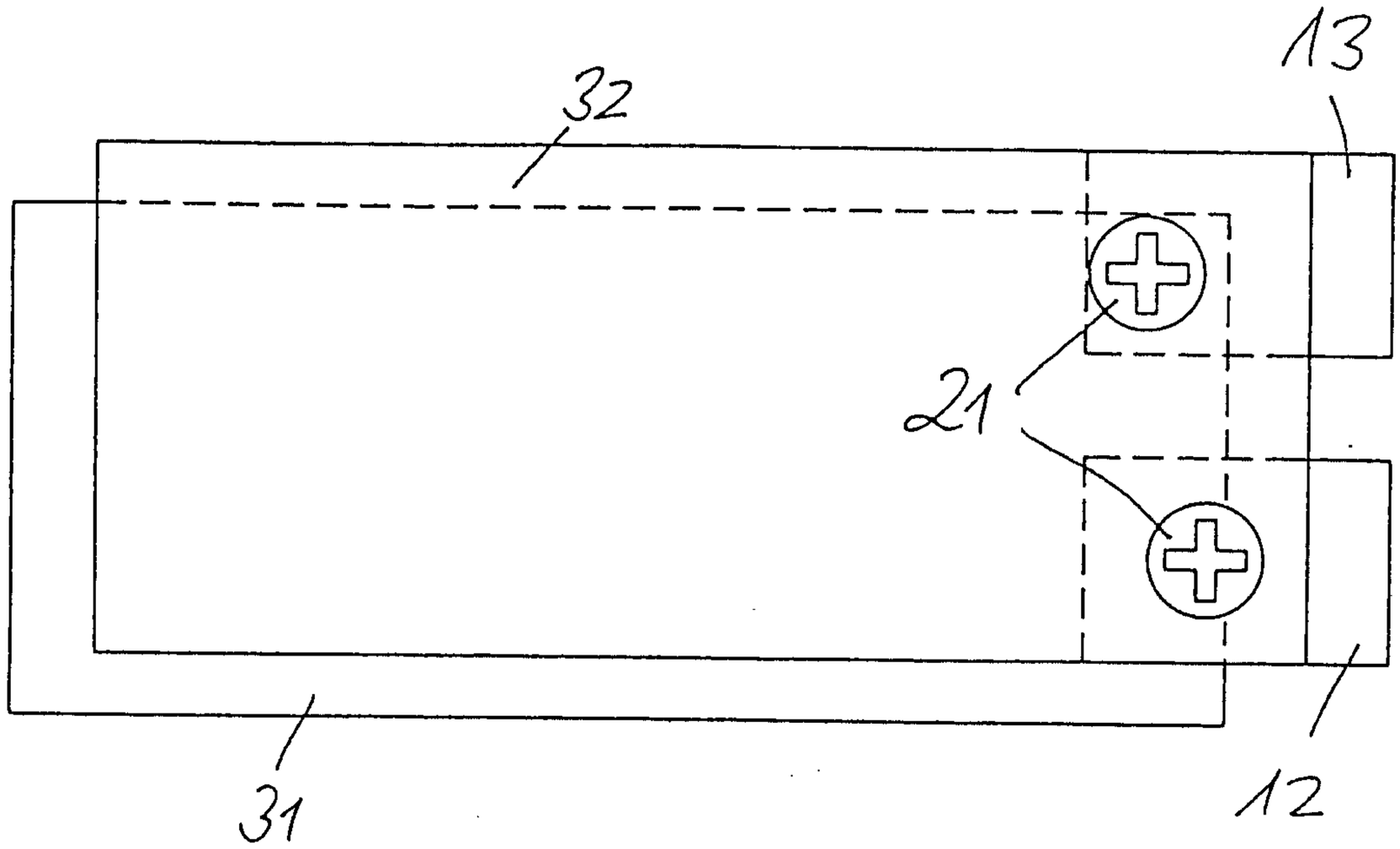
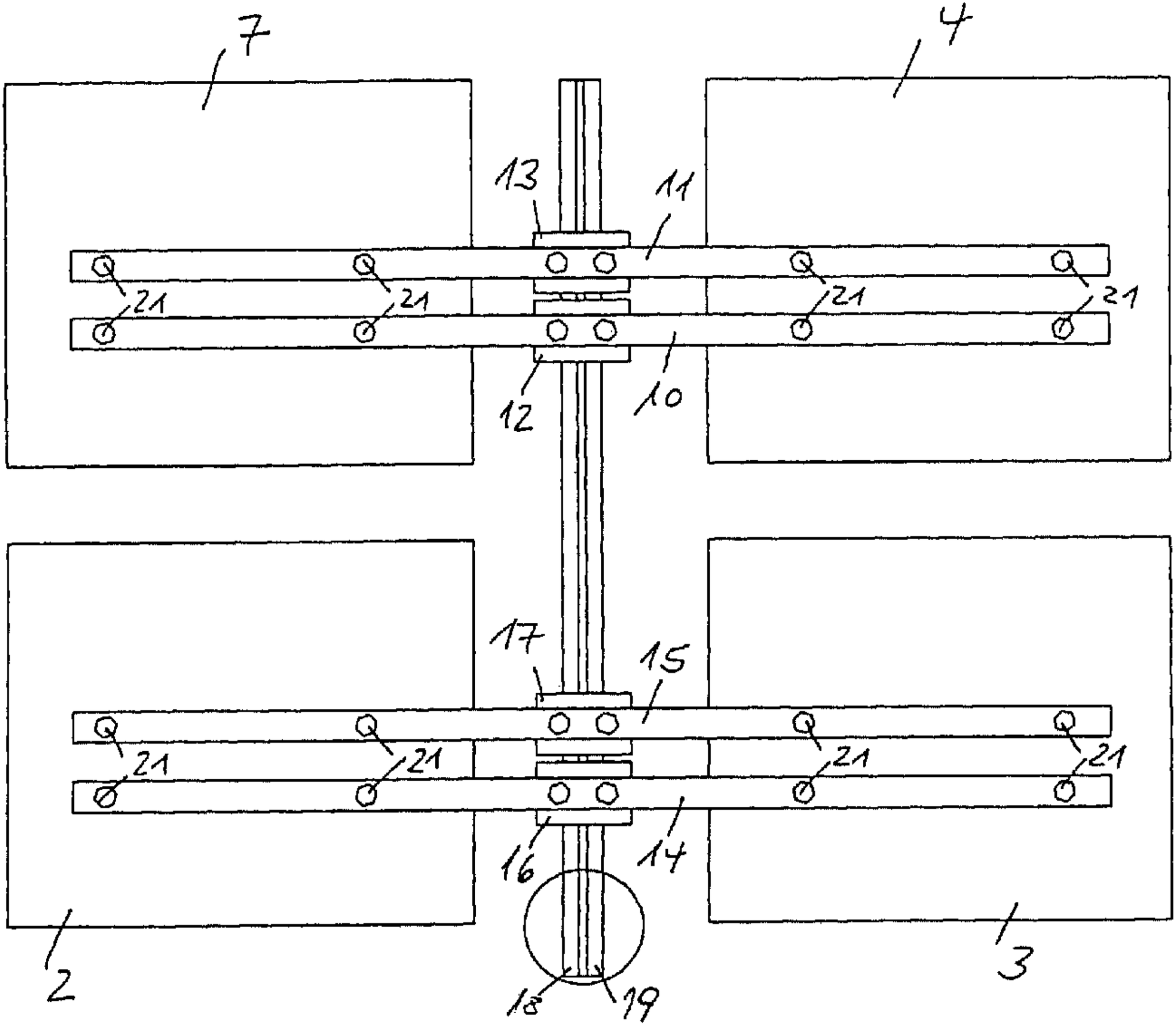


Fig.6

Fig. 8

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