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## (54) Drag head for a trailing suction hopper dredger and process for dredging by means of this drag head

(57) This invention concerns a drag head for a trailing suction hopper dredger which essentially consists of a structure connected to a suction pipe, with a visor (2) rotating around an horizontal axis (6), in which a series of teeth (10) are applied for breaking up the sand, which are arranged along a line which extends perpendicularly with respect to the direction of motion of the drag head, and a first series of jet pipes (9) for injecting water under high pressure, which are arranged along a line parallel to the line and in front of said teeth, wherein at least one second series of jet pipes (12,12') is provided along a line parallel to and behind the line of said teeth
Figure 1.

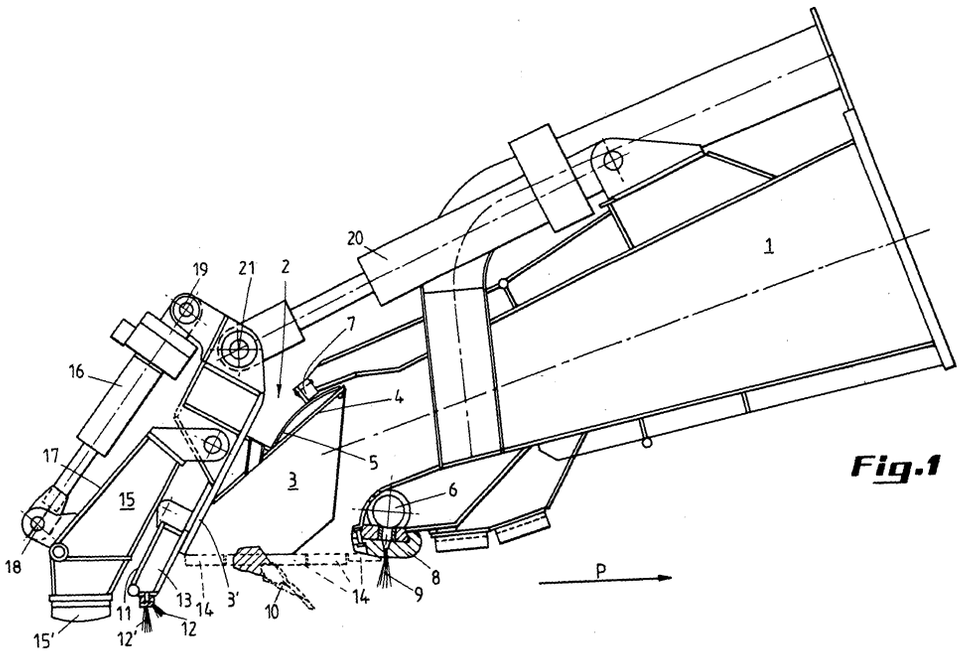


Fig.1

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## Description

**[0001]** The invention relates to a drag head for a trailing suction hopper dredger which essentially consists of a structure connected to a suction pipe, with a visor rotating around an horizontal axis, in which a series of teeth are applied for breaking up the sand, which are fitted on a toothed beam extending perpendicularly with reference to the direction of motion of the drag head, and a series of jet pipes for injecting water under high pressure, extending parallel to said toothed beam and in front of these teeth, always when considering the direction of motion of the drag head.

**[0002]** Such a drag head is known from GB-A-1.312.032. In GB-A-1.312.032 a hopper suction dredge is described which solves the problem of providing the means which allow carrying along a greater part of the coherent ground scraped off by the scraper of the hopper suction dredge in the suction current. This is done by increasing the suction pressure available for lifting the water/ground mixture by means of a hopper suction dredge comprising a suction mouth with a wall defining a chamber with an opening for connection to a suction pipe. The suction mouth comprises a pivoted visor shaped flap to which a scraper blade lying outside the chamber is secured. Within the suction mouth at least one nozzle is arranged for directing at least one water jet on material lying adjacent a second portion of the scraper blade inside the chamber, the flow direction of the jet being substantially parallel to the suction direction. In that way scraped off ground is crumbled by the water jets and sucked into the suction mouth.

**[0003]** A trailing suction hopper dredger consists of a structure connected to a suction pipe, which is open at the bottom side and is dragged over the ground during dredging.

**[0004]** The drag head itself consists of two parts: a cap which is directly connected to the suction pipe of the ship, and a visor which is hingingly connected to the cap by means of an horizontal axis. In the visor a series of teeth 4 are applied on an horizontal beam in order to break up the ground. Such a beam is known as a toothed beam.

**[0005]** At the bottom side of the cap, at the height of the connection with the visor, a series of wear heel pieces are applied. These form the heel plate. In these wear heel pieces a number of nozzles are provided.

**[0006]** During dredging, the head is moved over the ground. In this way, the cap is resting by the heel plate onto the bottom. Because the visor can move independently from the cap, the latter is resting with the side and/or back wall on the bottom. Depending on the hardness of the bottom, these walls will more or less penetrate the bottom. By the suction action of the dredging pump at the suction pipe end, an underpressure will finally be built up in the drag head, which among others depends on the extent of sealing of this head. Through this, together with the water from the outside which has to be fed inevitably, an amount of sand will be sucked up. In this way, sand is dredged by means of the erosion action of the water.

**[0007]** The sand production is up to now increased by two additional elements:

a) Teeth: owing to the teeth present in the visor, a layer is peeled off the bottom at the passage of the head. In this way, the broken up earth may then be sucked up.
b) Jets: in the wear heel pieces one or more nozzles are to be found. Through these, at present, water is pumped with a pressure of approximately 10 bar. These allow to suck up extra sand, since:

**[0008]** The sand to be dredged consists of piled up grains. By their own weight, these are pressed onto each other. This pressure is transferred between the grains by the mutual points of support, being the points of contact between the grains.

**[0009]** It is this pressure which ensures that the grains remain at rest in a certain way: the grains remain packed in a certain state of equilibrium.

**[0010]** If it is desired to suck up this sand, this equilibrium has to be disturbed. This may be achieved by using the jets: by feeding water under high pressure, the mutual pressure between the grains may be removed. By this, the force which keeps the grains on each other is removed, causing the grains to start moving. These grains try to reach another state of equilibrium, and this is called the fluidization of the sand. Now, only this sand has yet to be sucked up, which may be achieved by the underpressure built up in the drag head.

**[0011]** In general it may thus be said that the jets serve to loosen up the sand and that the suction force of the dredging pump serves for the transport of the loosened up sand.

**[0012]** Trailing hoppers which correspond to the above given description are known.

**[0013]** It is the aim of the invention to design a drag head which, thanks to a number of modifications and improvements, shows an increased efficiency, thanks to among others an increased concentration of sand in the pumped up mixture, whereto preferably means are provided to adjust the water gap independently from the cutting thickness.

**[0014]** In order to allow this in accordance with the invention, behind the above said teeth, always with reference to the direction of motion of the drag head, at least one second series of jet pipes is provided.

**[0015]** As mentioned above, the sand to be dredged consists of piled up grains which are pressed onto each other by their own weight. The passage of the first series of jet pipes makes the grains up to a first depth come loose from each other and fluidizes the soil up to this first depth. The passage of the teeth disturbs the soil up to the first depth, causing it to be sucked up. Furthermore, the passage of the teeth breaks up the sand, i.e.

makes the grains up to a second, increased depth come loose from each other, creating cavities and causing an underpressure in the soil up to this second depth. By providing the second series of jet pipes, the cavities which are created between the grains of sand are immediately filled with water and the underpressure is minimized, which can ensure that the grains up to the second depth remain loose from each other and are sucked up with the suction current.

**[0016]** It should be mentioned that from JP60055133 a ditch excavation device is known, which employs a plurality of water jet nozzles mounted on a plurality of plow blades. The plow of JP60055133 is used to make an underwater ditch for receiving cables, pipelines, and the like, and therefore simply pushes underwater ground material to the sides, i.e. away from the blades. JP60055133 does not relate to a dredging drag head which, on the contrary, aims at collecting and sucking away underwater ground material through the suction pipe. JP60055133 only teaches that excavation efficiency may be improved by employing water jets, however it does not teach that the use of a plurality of water jets actually improves the efficiency of sucking away ground material.

**[0017]** Always according to the invention, the above said second series of jet pipes is preferably subdivided in jet pipes directed at the inside of the visor, more particularly at above said teeth, and in jet pipes which are directed vertically or substantially vertically downwards.

**[0018]** Other details and advantages of the invention will appear from the following description of a drag head according to the invention. This description is exclusively given as an example and does not limit the invention. The reference numbers refer to the attached figures.

Figure 1 is a schematic side view of the dredge head according to the invention.

Figure 2 is, at a bigger scale, a perspective representation of the dredge head according to the invention.

Figure 3 schematically illustrates the operational depth of a drag head of the known type.

Figure 4 in the same way illustrates the possible operational depth of a drag head according to the invention.

**[0019]** The drag head for a trailing suction hopper dredger according to the invention is moved over the bottom in the direction of arrow P which is shown in figure 1. The drag head according to the invention is found at the end of a suction pipe 1 which is equipped with a visor 2 consisting a.o. of side walls 3, a back wall 3', a top plate 4 with an arc-shaped section 5, which upon rotation of the visor 2 around its axis 6 remains in close contact with the sealing strip 7 belonging to the fixed parts which are fitted to the suction pipe. During dredging, indeed an underpressure is maintained within the visor, and it is actually a clear objective of the invention to increase the sand fraction of the dredged slurry. Through the heel plates 8 a number of jet pipes 9 pass, which inject water under high pressure. The heel plate 8 with jet pipes 9 applied at the front are currently used up to now. During the dragging of the drag head over the bottom, the injected jets will first loosen up the sand, which will subsequently be sucked up immediately. Simultaneously, the teeth 10, which are found behind the jet pipes 9, will break up the sand. (In this text, the terms "in front of" and "behind" shall be understood with reference to the direction of motion of the drag head). Also these teeth are found in the drag heads existing up to now.

**[0020]** Behind these teeth 10, at the height of the water valve 11 closing down the visor at the back side, a second series of jet pipes is now provided. These jet pipes are subdivided into a first series of jet pipes 12 which are directed towards the teeth 10, and a second series of jet pipes 12' which are directed vertically or substantially vertically downwards. The jets injected through jet pipes 12 are directed towards the inside of the visor. The jet pipes 12' are aimed at fluidizing the bottom better, i.e. deeper at the height of the back wall 3'.

**[0021]** The presence of the jet pipes 12 and 12' has the following advantages:

a) The sand loosened up by the teeth 10 and the jet pipes 9 which was not yet sucked up is extra fluidized and may thus be sucked up better;

b) The breaking up in several stages by jet pipes 9 on the one hand, and jet pipes 12 and 12' on the other hand, increases the depth at which the sand is agitated and sucked up. This may be clearly ascertained by comparing the operational depth according to figure 3 with the operational depth according to figure 4.

c) An increase of the efficiency through the water gap. Whereas before, a mixture of sand/water only passed through the water gap by erosion, now the concentration of the mixture is increased by erosion and by the presence of fluidized sand as a result of the action of the jet pipes immediately in front of the water gap.

**[0022]** The advantages explained here are the immediate result of the switching on of the jet pipes 12, 12' immediately behind the teeth 10.

**[0023]** The different jet pipes 12, 12' immediately link up with a water valve 11 which may be moved, and this according to a translation which occurs in a plane that runs parallel to the back wall 3' of the visor. This water valve 11 is designed in the shape of a water chamber 13. In case of hydraulic operation, this is carried out from the bridge of the trailing suction hopper dredger. The fitting of the water valve which is adjustable in the height direction, increases the efficiency of the new drag head further, because the water gap may be optimally adjust-

ed as a function of the soil conditions and totally independent from the penetration of the bottom by the visor.

**[0024]** The efficiency of the trailing suction hopper dredger is further increased by applying at the bottom of the side walls 3 of the visor, one or a series of several lateral knife-shaped wear strips 14. These wear strips are sufficiently thin to penetrate into the sand in order to realize the desired sealing, so that the ratio sand/water of the sucked off mixture is further optimized.

**[0025]** In order to prevent feed water from being fed along the relatively unproductive sides of the visor, the drag head has to be well sealed at these sites. The side walls of the visor should well penetrate into the bottom.

**[0026]** By the presence of thinly walled wear strips 14, the visor is laterally perfectly sealed, so that the required transport water is integrally sucked up at the back through the water gap and the agitated soil. This new layout forms a second important feature of the invention.

**[0027]** A further improvement of the drag head should be seen in the presence at the back side of the drag head of the feet 15 hinging with respect to the visor, the useful surface of which, i.e. the base 15', is sufficiently great to guarantee a fixed support on the bottom. By regulating the depth of the feet 15, which are mutually connected by a plate 17 (figure 2), the penetration of the visor and thus of the teeth into the soil is regulated. This allows to regulate the cutting thickness of the teeth and this independently from the water gap. In a possible embodiment, feet 15, with their widened bases 15', are rotatably fitted around hinge point 18. The rotation is effectuated by the action of the hydraulic cylinder 16, with hinge point 18 with respect to the feet 15 and hinge point 19 with respect to the visor. The visor itself is lifted or lowered by the action of hydraulic cylinder 20. The cylinder 20 is rigidly fastened with respect to the suction pipe 1 and is in 21 hingingly connected to fixed parts belonging to the structure of the visor, in order to lift or lower the back wall 3' thereof.

**[0028]** In figure 2, one of the hydraulic cylinders, 22, which controls the water valve 11, is shown.

**[0029]** By increasing the operational pressure of the water jets from 10 bars to 20 bars, a clearly better penetration of these water jets may be expected. This forms a further feature of the invention.

**[0030]** By the combination of the different improvements to a drag head of the known type, as explained above, a surprising increase of the efficiency of the new drag head may be expected.

**[0031]** The invention is not limited to the embodiment described herein, and modifications thereof might be applied in as much as they fall within the scope of the attached claims.

## Claims

1. A drag head for a trailing suction hopper dredger which essentially consists of a structure connected to a suction pipe, with a visor (2) rotating around an horizontal axis (6), in which a series of teeth (10) are applied for breaking up the sand, which are arranged along a line which extends perpendicularly with respect to the direction of motion of the drag head, and a first series of jet pipes (9) for injecting water under high pressure, which are arranged along a line parallel to and in front of the line of said teeth, **characterized in that** at least one second series of jet pipes (12,12') is provided along a line parallel to and behind the line of said teeth.

2. A drag head as claimed in claim 1, **characterized in that** said second series of jet pipes is fitted on a water valve (11) in the shape of a water chamber (13), which is hydraulically moveable in a plane extending tangently or substantially tangently to the back wall (3') of the visor.

3. A drag head as claimed in claim 1 or claim 2, **characterized in that** the second series of jet pipes (12) is subdivided into jet pipes (12) directed at the inside of the visor and jet pipes (12') which are directed vertically or substantially vertically downwards.

4. A drag head as claimed in claim 3, **characterized in that** the jet pipes (12) directed at the inside of the visor are directed to above the teeth (10).

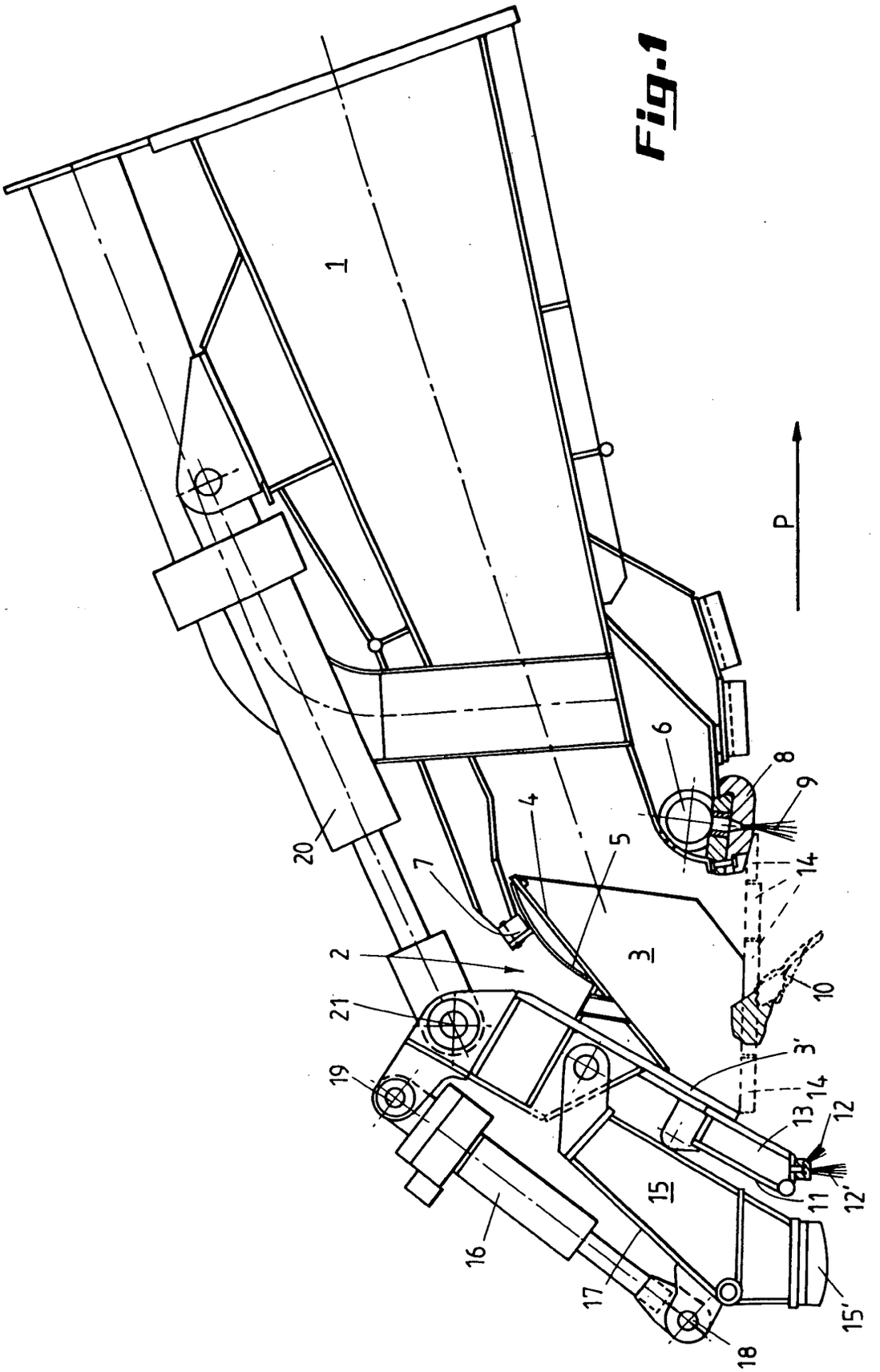
5. A drag head as claimed in any of claims 1-4, **characterized in that** above said visor (2), together with above said suction pipe (1) is equipped with adjustable feet (15), the useful surface (15') of which is sufficiently great to get support on the bottom, whereto the visor, at the bottom of the side walls 3' is equipped with knife-shaped wear strips (14), which are sufficiently thin so as to penetrate into the bottom and to ensure the desired lateral sealing.

6. A drag head as claimed in any of claims 1-5, **characterized in that** the second series of jet pipes (12, 12') is mounted at the height of the back wall (3') of the visor.

7. A drag head as claimed in any of claims 1-6, **characterized in that** the second series of jet pipes (12, 12') is mounted immediately behind the teeth (10).

8. A process for dredging with a trailing suction hopper dredger equipped with a drag head according to any one of claims 1-7, **characterised in that** the pressure in the jet pipes is increased to 20 bars.

Fig.1



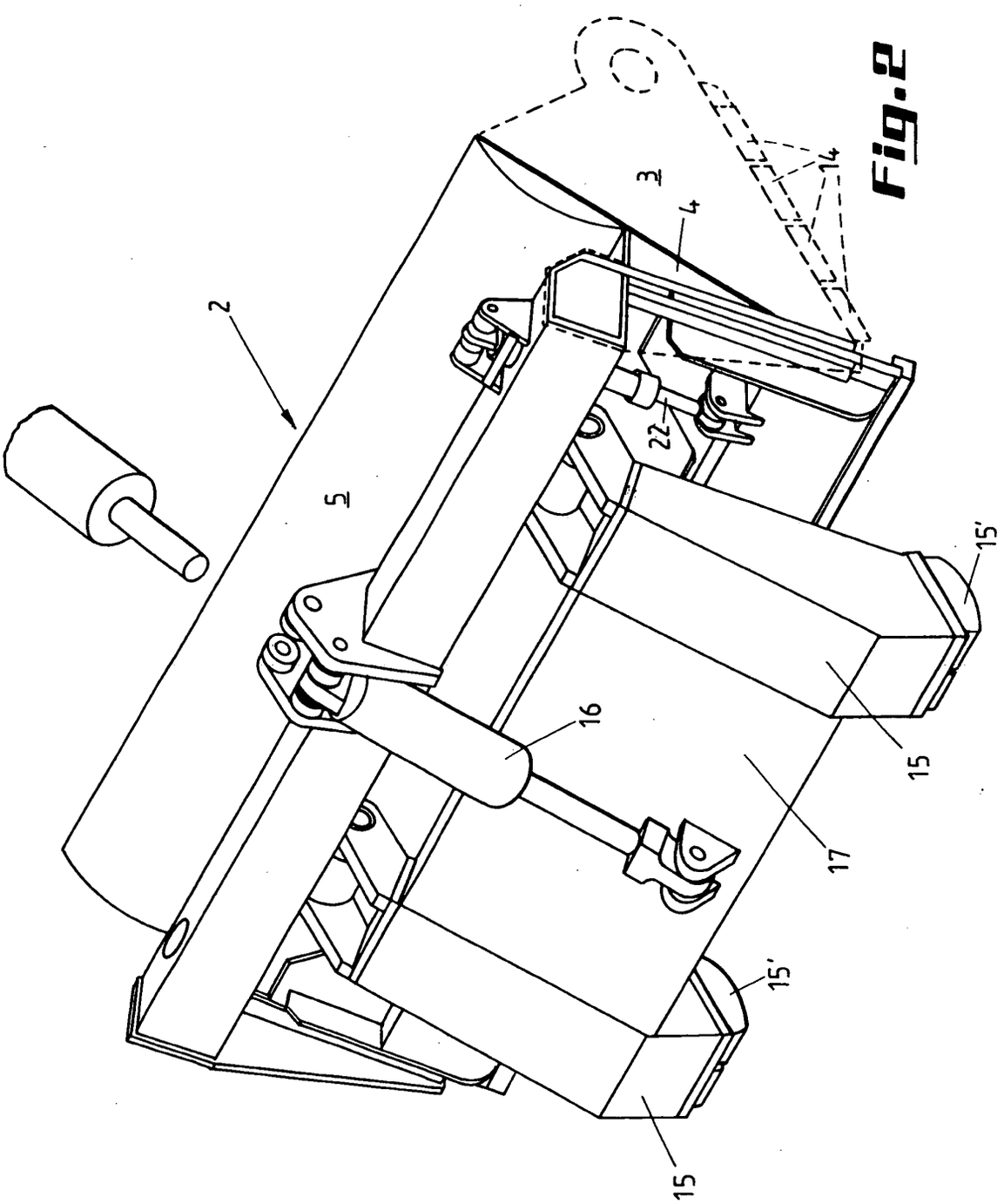



Fig.2

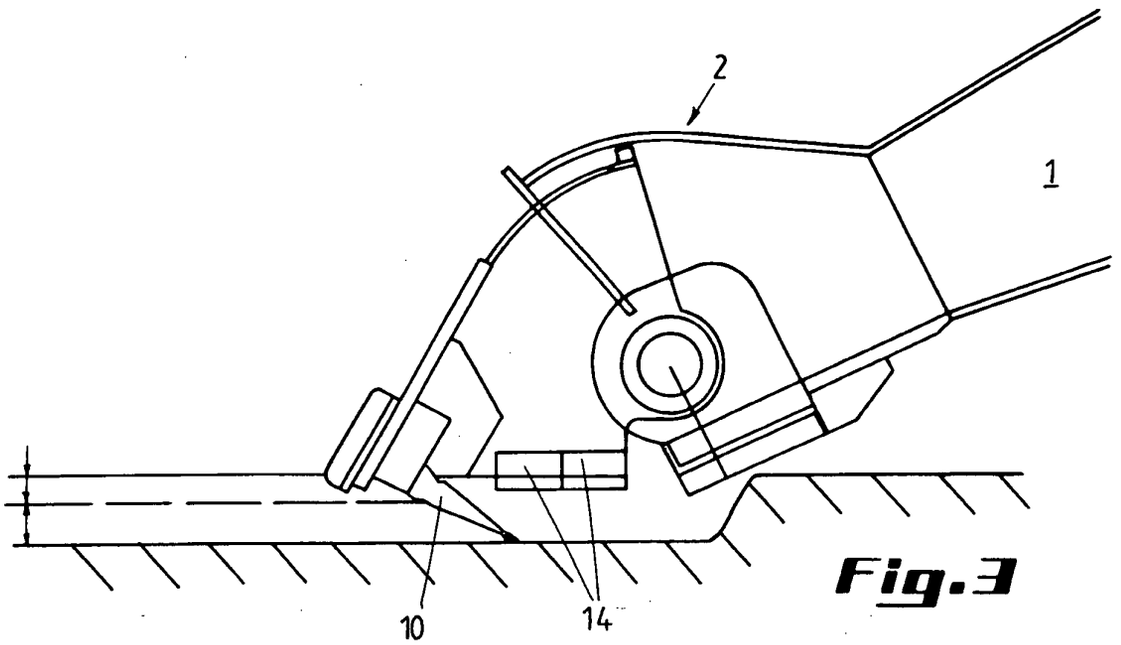



Fig.3

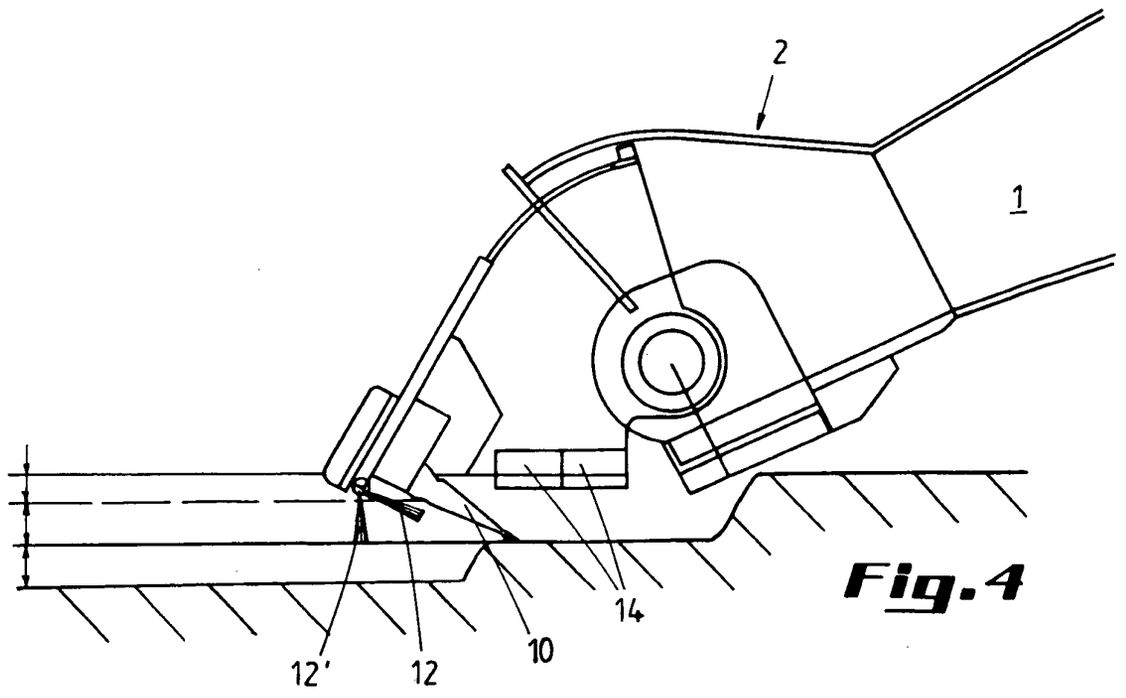



Fig.4