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(71) Applicant: **S.D.I. Rentals B.V.**
**7844 TG Veenoord (NL)**

(72) Inventor: **Dekker, Jan**
**9606 PG Kropswolde (NL)**

(74) Representative:
**Ottevangers, Sietse Ulbe et al**
**Vereenigde Octrooibureaux**
**Nieuwe Parklaan 97**
**2587 BN 's-Gravenhage (NL)**

## (54) Vibrating screen

(57) A vibrating screen apparatus for the separation of substances comprises a frame built up of several frame parts, while in each of these frame parts a vibrating screen is resiliently suspended and each of these vibrating screens comprises at least one vibrating motor and at least one screening mat. The frame parts are displaceable in a horizontal plane relative to each other. The resilient suspension of the vibrating screens in the separate frame parts is adjustable in height direction. Moreover, a vibrating screen may be tiltably arranged in a relevant frame part.

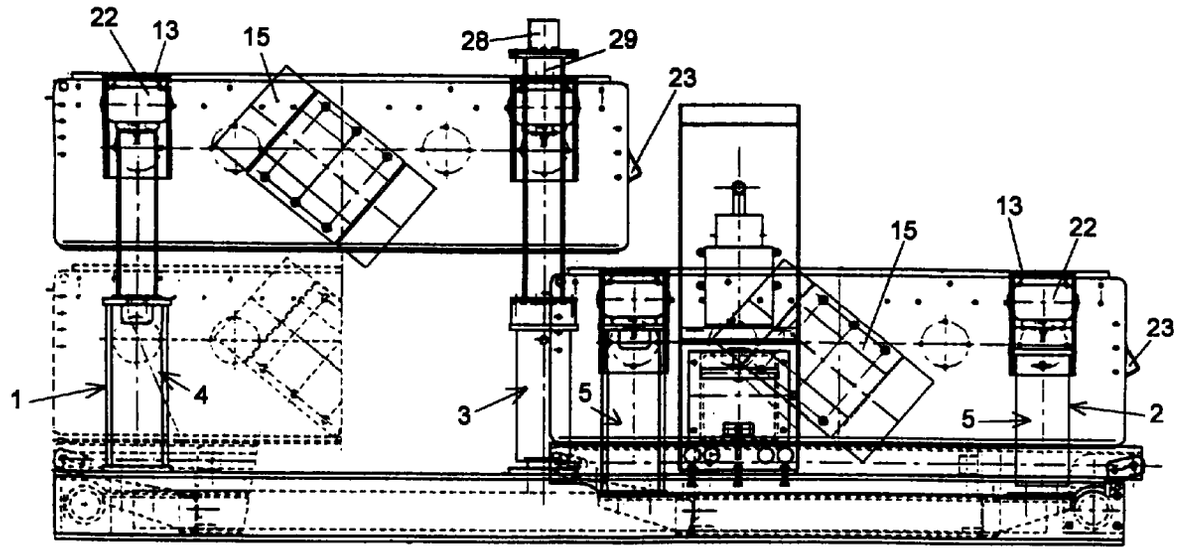


Fig. 3

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## Description

**[0001]** The present invention relates to a vibrating screen apparatus for the separation of substances, comprising a frame in which a vibrating screen is resiliently suspended, which vibrating screen comprises at least one vibrating motor and at least one screening mat.

**[0002]** Such a vibrating screen apparatus is known from Dutch patent application 84.03518 and can be used in the petroleum industry for separating drilling fluid and the solid particles contained therein from each other. Another use concerns the screening of blasting grit in order to clear it of dirt, in particular of paint rests, and to remove smaller pellets that are formed during the blasting operation through pulverization, to enable reuse of the blasting grit. Of course, many other uses are possible.

**[0003]** In the apparatus described in the above-mentioned patent application, the frame is suitable for resiliently supporting a vibrating screen having several screening mats fixedly arranged one above the other between two side elements. These screening mats are driven by the same vibrating motor or by the same pair of vibrating motors. To obtain the desired vibrating movement of the vibrating screen, a vibrating motor is arranged at the center of each of these side elements, at an angle of about 30°. The construction of the vibrating screen apparatus involved is such that material deposited on the vibrating screen, i.e. on the screening mat or the screening mats thereof, is discharged from the screening mat in a substantially linear, upward direction and falls down onto the vibrating screen again, the arrangement being such that the material is, as it were, moved in saw tooth fashion over the screening mat or screening mats in the longitudinal direction of the vibrating screen apparatus.

**[0004]** When an increase of capacity is desired, the mere provision of a larger vibrating screen in the known apparatus is not sufficient, because in that case, the vibrating motors are no longer disposed in the desired position relative to the screening deck or the screening decks, while, further, the frequency of the vibrating screen changes. Moreover, it should be taken into account that an increase of capacity must not be such that the noise production is unduly increased thereby.

**[0005]** Hence, the object of the invention is to provide a vibrating screen apparatus whose capacity can be set as desired and wherein the noise production is kept within limits.

**[0006]** To that end, in accordance with the invention, the vibrating screen apparatus as described in the preamble is characterized in that the frame comprises several frame parts that are movable relative to each other, while in each of these frame parts, a vibrating screen is resiliently suspended and each of these vibrating screens comprises at least one vibrating motor and at least one screening mat.

**[0007]** To cause the vibrating screens to operate separately one below the other, as well as in a cascade arrangement, in which material is transferred from one vibrating screen onto the other, the frame parts are displaceable relative to each other in a horizontal plane.

**[0008]** To cause the vibrating screens to operate at the same level or at a defined height difference, in particular in the cascade arrangement, the spring suspension of each of the vibrating screens in the separate frame parts is adjustable in height direction independently of the spring suspension of another vibrating screen.

**[0009]** To enable setting the speed of advance of the material on a vibrating screen, while the vibrating screens can also be caused to operate in an interconnected manner, a vibrating screen is further tiltably arranged in a relevant frame part. In this last case, a vibrating screen is in particular resiliently supported in four places in the relevant frame part and the spring support is height-adjustable in two places such that the vibrating screen can be tilted about an axis transverse to the longitudinal direction of the vibrating screen apparatus, the longitudinal direction being determined by the direction in which material deposited on the vibrating screen is displaced. Although the support may be height-adjustable in four places, it may under conditions suffice to render only two supports height-adjustable. As the supply height of the material to be screened is usually given, in the first vibrating screen on which the material ends up, only the supports that are foremost in the longitudinal direction of the vibrating screen apparatus will, in practice, need to be height-adjustable.

**[0010]** In a preferred embodiment, the frame comprises two frame parts which are arranged for displacement in the longitudinal direction relative to each other, such that the vibrating screen suspended in one frame part operates either entirely next to the vibrating screen suspended in the other frame part, or in a position in which it is entirely or partially slid under that vibrating screen. The vibrating screens suspended in the separate frame parts may be displaced in such a manner that a screening mat in one vibrating screen is virtually in line with a screening mat in the other vibrating screen.

**[0011]** In a further preferred embodiment, one (first) frame part is fixedly arranged and the other (second) frame part is arranged for sliding hereunder. In this connection, the first frame part is preferably fixedly arranged on parallel rails wherebetween a support construction is displaceable, on which support construction the second frame part is fixedly arranged. Although a roller construction is possible, the support construction is preferably displaceable between and along said rails by means of slide plates. This displaceability can be realized by means of a motor; however, a displaceability of the support construction relative to the first frame part by means of an operating cylinder has been opted for, which operating cylinder may operate hydraulically, pneumatically or electromechanically.

**[0012]** Both for production-technical and for opera-

tional reasons, it is favorable when the vibrating screen in one of the frame parts can also be placed in another frame part or in other frame parts. This also enables an easy exchangeability of the vibrating screens, to replace them when breaking down or to replace a screening mat having gauze openings of a particular size by a screening mat having gauze openings of a different size.

**[0013]** The invention will now be specified with reference to an exemplary embodiment shown in the accompanying drawings. In these drawings:

Fig. 1 is a top plan view of a vibrating screen apparatus according to the invention, having two vibrating screens displaced relative to each other in the longitudinal direction;
Fig. 2 is a front view of the vibrating screen apparatus shown in Fig. 1;
Fig. 3 is a side elevation of this vibrating screen apparatus;
Fig. 4 is a top plan view of the displacement mechanism of one frame part relative to the other frame part; and
Fig. 5 shows a cross section of an alternative manner of fitting a screening mat.

**[0014]** The vibrating screen apparatus comprises a frame having a first frame part 1 and a second frame part 2. Each of these frame parts comprises four supports; the frame part 1 has two front column-shaped supports 3 and two rear column-shaped supports 4, while the frame part 2 has four column-shaped supports 5. Hence, the frame part 1 has two different types of column-shaped supports 3 and 4, which will be further discussed hereinbelow. The terms 'front' and 'rear' relate to the displacement direction of the material in the vibrating screen apparatus; the unscreened material is supplied at the rear end and discharged, in screened condition, at the front end.

**[0015]** In the frame part 1, a vibrating screen 6 is supported, while in the frame part 2, a vibrating screen 7 is supported. Since both vibrating screens are here of identical design, only one of them will be described in more detail; this description will in fact be kept concise, as such a vibrating screen has already been described extensively in the above-mentioned Dutch patent application 84.03518, with the understanding that in the vibrating screen of said Dutch patent application, two screening mats are provided, whereas in the vibrating screen of the exemplary embodiment depicted in the drawing of the present application, only one screening mat is provided. This does not alter the fact that also in the vibrating screen apparatus according to the invention, two ore even more screening mats can be provided in the same vibrating screen.

**[0016]** A vibrating screen comprises two parallel, spaced apart side elements 8 and 9. The side elements each consist of a metal plate having an inwardly bent upper edge 10 and an outwardly bent lower edge 11. The side elements are interconnected by tubular girders 12, fixed at either end thereof to the side elements by welding or by means of bolts passed through flanges provided at the ends of the tubular girders. The side elements each comprise two outwardly directed projections 13 which, in the exemplary embodiment shown, are manufactured from a section whereby each of the vibrating screens rests on said column-shaped supports 3, 4 and 5 respectively.

**[0017]** Mounted between the side elements is a screening mat 14, which may for instance be manufactured from stainless steel.

**[0018]** Mounted on both sides on the outside of the side elements of a relevant vibrating screen is a vibrating motor 15, mounted virtually at the center and at an angle of about 30°. The vibrating motors and the manner in which they are mounted and function are described in detail in the above-mentioned Dutch patent application 84.03518.

**[0019]** Provided in each of the vibrating screens is a screening mat 14. Between the side elements, a screening mat is supported at regular distances by metal strips 16 extending parallel to the side elements, which strips are fixedly welded on the tubular girders 12 and have their free upper edges provided with a plastic or rubber section 17 to prevent damage to the screening mat.

**[0020]** By means of tensioners to be described in more detail hereinbelow, the screening mats are tensioned across the strips 16. To enable a proper tension of the screening mats, the height of the strips 16 gradually decreases from the center of the apparatus in the direction of the two side elements. Hence, in the tensioned condition, each screening mat has a convex shape, as shown in Fig. 2.

**[0021]** For tensioning the screening mats, lever plates 18 are used, pivotally mounted at a suitable height on the inside of the side elements. The lever plates consist of elongated plates extending preferably over the entire length of the side elements substantially parallel to these elements and being fitted about half-way their height with a number of lugs 19 directed towards the side elements, which lugs 19 are pivotally mounted on the corresponding, inwardly extending supports 20 provided on the side elements. The lower edge of each lever plate is bent in the direction of the associated side element, as indicated at 21. At their longitudinal edges, the screening mats comprise fastening strips which are bent inwards and which can be hooked around the outwardly bent lower edges 21 of the lever plates 18. Preferably, these fastening strips extend throughout the length of the screening mat, so that the tension is uniformly distributed over the entire screening mat, which promotes a long lifetime of the screening mat.

**[0022]** In order to tension the screening mat, after the fastening strips have been hooked to the lever plates, it is only necessary to move the portion of the lever plates located above the pivot axis inwards and to fix it in the

desired position. As described in the above-cited Dutch patent application 84.03518, to that end, an inflatable hose (not shown in the Figure) is provided between the upper portion of each lever plate 18 and the associated side element, by means of which hose the upper portion of the lever plate is moved inwards when air is fed to the hose via a pressure line, causing the bent lower edge 23 to pivot outwards and the screening mat to be tensioned. In this manner, the tension of the screening mat can even during operation be adjusted to the composition of the material to be treated. For instance, in general, a higher screening tension will generally be set when coarser material is being processed, to prevent the screening mat from 'flapping' and being damaged thereby. The apparatus can be of such design that when it is put out of operation, the tension in the screening mats is automatically removed through closure of the compressed air supply, and that when the apparatus is put into operation, the screening mats are automatically brought to the proper tension again through the release of the compressed air supply. Of course, the vibrating screens in the two frames may also be put into and out of operation separately, or be automatically put out of operation after the passage of a set period, so that the process of putting one or both vibrating screens into operation and the screening time can in each case be adjusted to the amount of material to be screened. Further, there may occur the situation in which the gauze of the screening mat has silted up; by removing the tension in the screening mat, the openings of the gauze of the screening mat will be cleared again through the operation of the vibrating motors, after which the screening mat can be brought to the proper tension again. For releasing the openings of the screening mat in this manner, the vibrating process does not have to be interrupted. The tension interruption in the screening mat in consequence of the clogging of the openings in the gauze may take place automatically when sensors are present which signal this clogging of the gauze or which do so each case after a predetermined period. Of course, this may also be done visually by a person operating the apparatus. The duration of the tension interruption may be fixedly set, depending or not depending on the medium passing through the openings, or be controlled manually. When during a tension interruption, the material present on the screening mat is advanced too quickly, due to the great vibrating movements of the screening mat, the screening mat can be tilted slightly downwards at the rear, or, of course, tilted slightly upwards at the front.

**[0023]** In the exemplary embodiment shown, a hollow ball or bellows 22 of flexible material, for instance rubber, is located between each projection 13 and the top side of the associated column-shaped supports 3, 4 and 5, for resiliently supporting the vibrating screens. These flexible balls contribute to a low-noise operation of the apparatus. Preferably, the pressure prevailing in these flexible balls can be set, which enables influencing the vibrating behavior and effecting small variations in the position of the screening mats relative to the column-shaped supports 3, 4 and 5. The flexible balls moreover have a damping effect on the vibrations caused by the vibrating motor(s).

**[0024]** The supports 3, 4 and 5 may all be of height-adjustable design. However, it may also suffice to have only the column-shaped supports 3 and 5 of height-adjustable design. If it is assumed that the material to be screened is supplied at a height corresponding to that of the rear side of the vibrating screen 6, it is sufficient to render the column-shaped supports 3 adjustable in height direction for enabling a tilted position of the vibrating screen 6. With respect to the vibrating screen 7, it is desirable that it can connect in a cascade arrangement to the vibrating screen 6; for this reason, all four column-shaped supports 5 of the vibrating screen 7 are height-adjustable. Hence, this vibrating screen can be moved up in parallel or be tilted. The height-adjustability of the column-shaped supports 3 and 5 and possibly that of the column-shaped supports 4 may be realized by utilizing, for instance, hydraulic, pneumatic or electromechanical operating cylinders, which, as a matter of fact, are not shown in the Figures. A manner in which the above-mentioned height-adjustability is realized, is described in the above-mentioned Dutch patent application 84.03518.

**[0025]** Further, Fig. 3 shows a guide plate 23 for material falling at the end of a vibrating screen. This guide plate enables preventing the apparatus from being fouled unnecessarily and the material falling through the screening mat from dripping along the last girder 12 and ending up in the apparatus again. A lateral discharge may be connected to the guide plate 23.

**[0026]** The column-shaped supports 3 and 4 of the frame part 1 supporting the vibrating screen 6 are fixed on two mutually parallel rails 24 and 25. Between these rails, a support construction 26 for the column-shaped supports 5 of the frame part 2 which support the vibrating screen 7 is displaceable in the longitudinal direction of the apparatus. The column-shaped supports 5 are fixedly arranged on the support construction 26. Such displaceability can be realized by motor-driven displacing or rolling means. In the embodiment shown, however, the support construction 26 moves between and along the rails by means of slide plates and a hydraulic, pneumatic or electromechanical operating cylinder 27. This enables moving the frame part 2 underneath the frame part 1, so that the vibrating screen 7 can be placed either under, or before the vibrating screen 6 in a more or less slid-out position. Hence, the vibrating screens 6 and 7 can be used both in a double-deck arrangement, as is the case in the above-cited Dutch patent application 84.03518, and in a cascade arrangement, as shown in Fig. 3.

**[0027]** The vibrating screens 6 and 7 may be of mutually identical design; they may be fitted on the column-shaped supports 3, 4 as well as on the column-shaped

supports 5. To this end, the column-shaped supports 3, 4 are of inwardly bent design such that the bent end of these supports 3, 4 lie in the same lateral planes of the vibrating screen support as the column-shaped supports 5. Accordingly, the flexible balls whereby the vibrating screen 6 rests on the column-shaped supports 3, 4 lie in the same lateral planes as the flexible balls whereby the vibrating screen 7 rests on the column-shaped supports 5. In this manner, it becomes possible to place the vibrating screen of one frame part into the other frame part.

**[0028]** Finally, it is mentioned that the apparatus comprises a girder 28, extending above the upper vibrating screen and fixedly connected to the column-shaped supports 3, for mounting an anti-sputtering cover (not shown), yet in particular for preventing the height-adjustable column-shaped supports for the vibrating screen 6 from slanting. For that reason, the column-shaped supports 3, unlike the column-shaped supports 4, have an upwardly projecting portion 29.

**[0029]** In the foregoing, with reference to Figs. 1-4, a vibrating screen apparatus having an upper and a lower vibrating screen is described, each vibrating screen mounting one screening mat only. In the introduction to the specification, it is made clear that the vibrating screen apparatus could also contain more vibrating screens and that in each vibrating screen, several screening mats could be provided.

**[0030]** In an embodiment employed in practice, the non-pretensioned screening mat present in the lower vibrating screen is replaced by a number of pretensioned screening mats. The non-pretensioned screening mat in the upper vibrating screen is tensioned over the strips 16 by means of the lever plates 18. On the other hand, the screening mats in the lower vibrating screen are pretensioned in a screening frame. The screening panel thus formed is composed from, for instance, an aluminum frame having glued thereon one or two support gauzes and the actual screening gauze. Fig. 5 shows in a cross section how such a pretensioned screening mat can be fitted in the frame of the lower vibrating screen. In this Figure, the clamping elements 30 and 31 are indicated, by means of which a screening mat pretensioned in a screening frame 32 can be provided. Two clamping elements 30 and two clamping elements 31 are present. The clamping elements 30 extend at the center in the longitudinal direction of the apparatus. The clamping elements 31 extend on either side thereof and are secured on the side elements 8 and 9. Only the central clamping elements and the clamping element provided on the side element 9 are shown in Fig. 5. The clamping elements 30 are provided on either side of a central section 33 secured on the tubular girders 12. The clamping elements 30, 31 are further secured on the front and rear plates of the frame of the lower vibrating screen. Each clamping element consists of a section 34 which is open at its lower side. Located in this section, at the top thereof, is a hose-shaped air bellows 35, wherebelow a plastic press-on pin 36 is located, partially projecting from the section. Through inflation and deflation of the air bellows 35, the press-on pin can travel a distance in vertical direction to the order of, for instance, 1 cm. In the frame of the lower vibrating screen, support strips 37 are provided. When the air bellows 35 is free of air, the frame 32 of the screening mat can be slid onto the strips 37, after which, through the introduction of air into the bellows 35, the press-on pin is pressed down and the frame 32 is clamped. Due to the presence of the plastic press-on pins 36, the frame 32 of the screening mat is not clamped directly by the air bellows 35, but indirectly via the press-on pins. Because of the play in the vertical movability, screening mat frames of different thicknesses can be clamped.

**[0031]** The invention is not limited to the exemplary embodiments shown here with reference to the drawings, but comprises all kinds of modifications hereto, of course in so far as they fall within the protective scope of the following claims. For instance, it is pointed out that also in the embodiment of Fig. 5, several screening mats, for instance four, may be present, which may both be mounted at different heights to the tubular girders 12 by the central sections 33, and mounted directly to the side elements 8 and 9 and the front and rear plate of the frame of the vibrating screen. Further, it is observed that the gauzes of the screening mats may be manufactured from stainless steel as well as from a synthetic material or a combination of the two.

## Claims

1. A vibrating screen apparatus for the separation of substances, comprising a frame in which a vibrating screen is resiliently suspended, said vibrating screen comprising at least one vibrating motor and at least one screening mat, **characterized in that** the frame comprises several frame parts, which are movable relative to each other, while in each of said frame parts, a vibrating screen is resiliently suspended and each of said vibrating screens comprises at least one vibrating motor and at least one screening mat.

2. A vibrating screen apparatus according to claim 1, characterized in that the frame parts are displaceable in a horizontal plane relative to each other.

3. A vibrating screen apparatus according to claim 1 or 2, characterized in that the resilient suspension of each of the vibrating screens in the separate frame parts is adjustable in height direction independently of the resilient suspension of another vibrating screen.

4. A vibrating screen apparatus according to any one of the preceding claims, characterized in that a

vibrating screen is tiltably arranged in a relevant frame part.

5. A vibrating screen apparatus according to claim 4, characterized in that a vibrating screen is resiliently supported in the relevant frame part in four places and that the resilient support is height-adjustable in two places such that the vibrating screen can be tilted about an axis transverse to the longitudinal direction of the vibrating screen apparatus, the longitudinal direction being determined by the direction in which material deposited on the vibrating screen is displaced.

6. A vibrating screen apparatus according to any one of the preceding claims, characterized in that the frame comprises two frame parts, arranged for displacement relative to each other in the longitudinal direction such that the vibrating screen suspended in one frame part operates either entirely next to the vibrating screen suspended in the other frame part, or in a position in which it is entirely or partially slid thereunder.

7. A vibrating screen apparatus according to claim 6, characterized in that the vibrating screens suspended in the separate frame parts can be displaced such that a screening mat in one vibrating screen is virtually in line with a screening mat in the other vibrating screen.

8. A vibrating screen apparatus according to claim 6 or 7, characterized in that one (first) frame part is fixedly arranged and the other (second) frame part is arranged for sliding under it.

9. A vibrating screen apparatus according to claim 8, characterized in that the first frame part is fixedly provided on parallel rails wherebetween a support construction is displaceable, on which support construction the second frame part is fixedly provided.

10. A vibrating screen apparatus according to claim 9, characterized in that the support construction is displaceable between and along said rails by means of slide plates.

11. A vibrating screen apparatus according to claim 9 or 10, characterized in that the support construction is displaceable relative to the first frame part by means of an operating cylinder.

12. A vibrating screen apparatus according to any one of the preceding claims, characterized in that the vibrating screen in one of the frame parts can be placed in another frame part or in other frame parts.

13. A vibrating screen apparatus according to any one of the preceding claims, characterized in that at least one of the vibrating screens comprises at least one pretensioned screening mat whose frame can be secured in the frame of the vibrating screen by clamping means.

14. A vibrating screen apparatus according to claim 13, characterized in that the clamping means comprise a number of sections capable of being secured in the frame of the vibrating screen, and, provided in each of the sections, a hose-shaped air bellows and a plastic press-on pin which partially projects from the section and which, through variation of the pressure in the air bellows, is movable in vertical direction to enable clamping the frame of the vibrating screen in the frame of the vibrating screen.

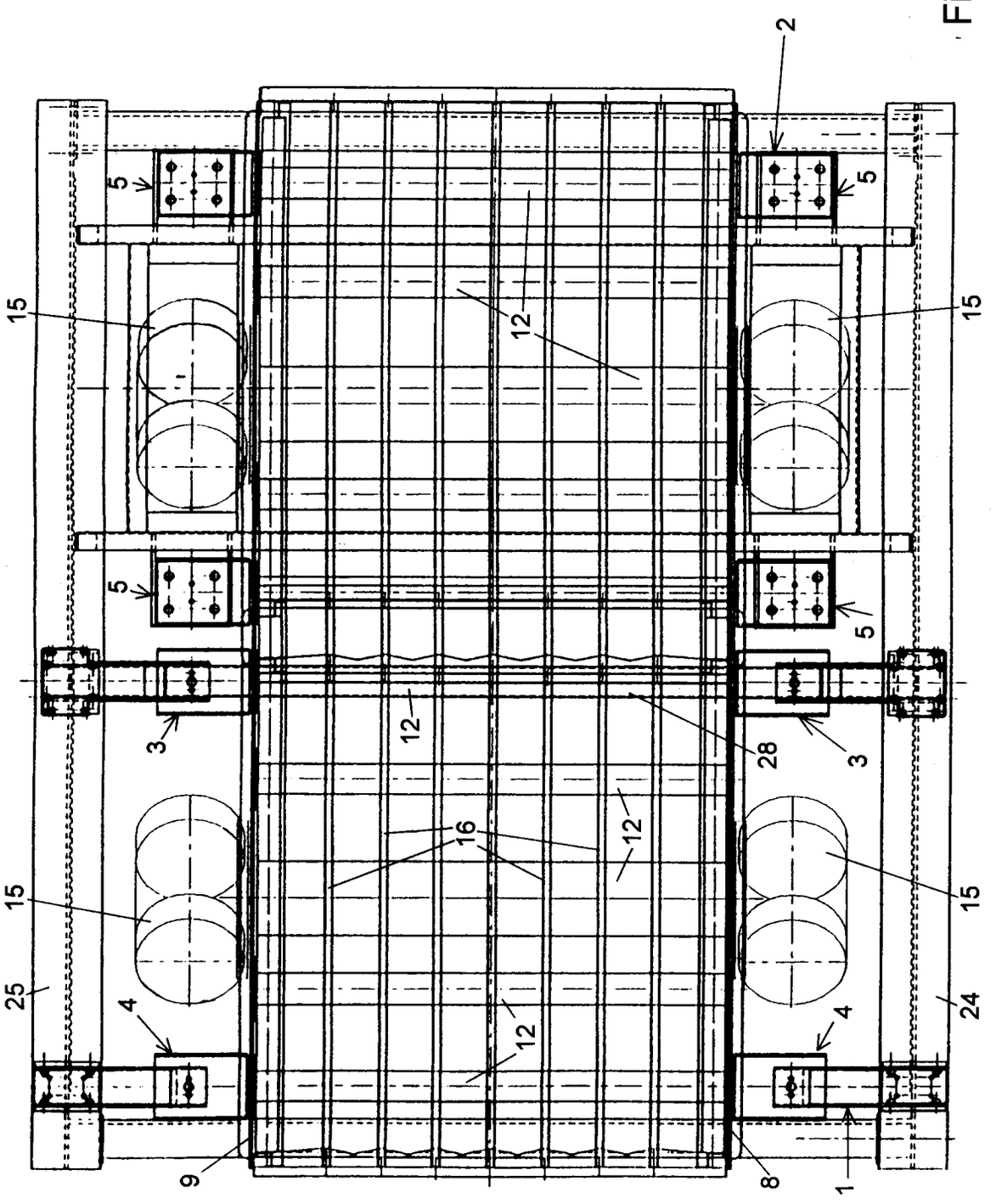


Fig. 1

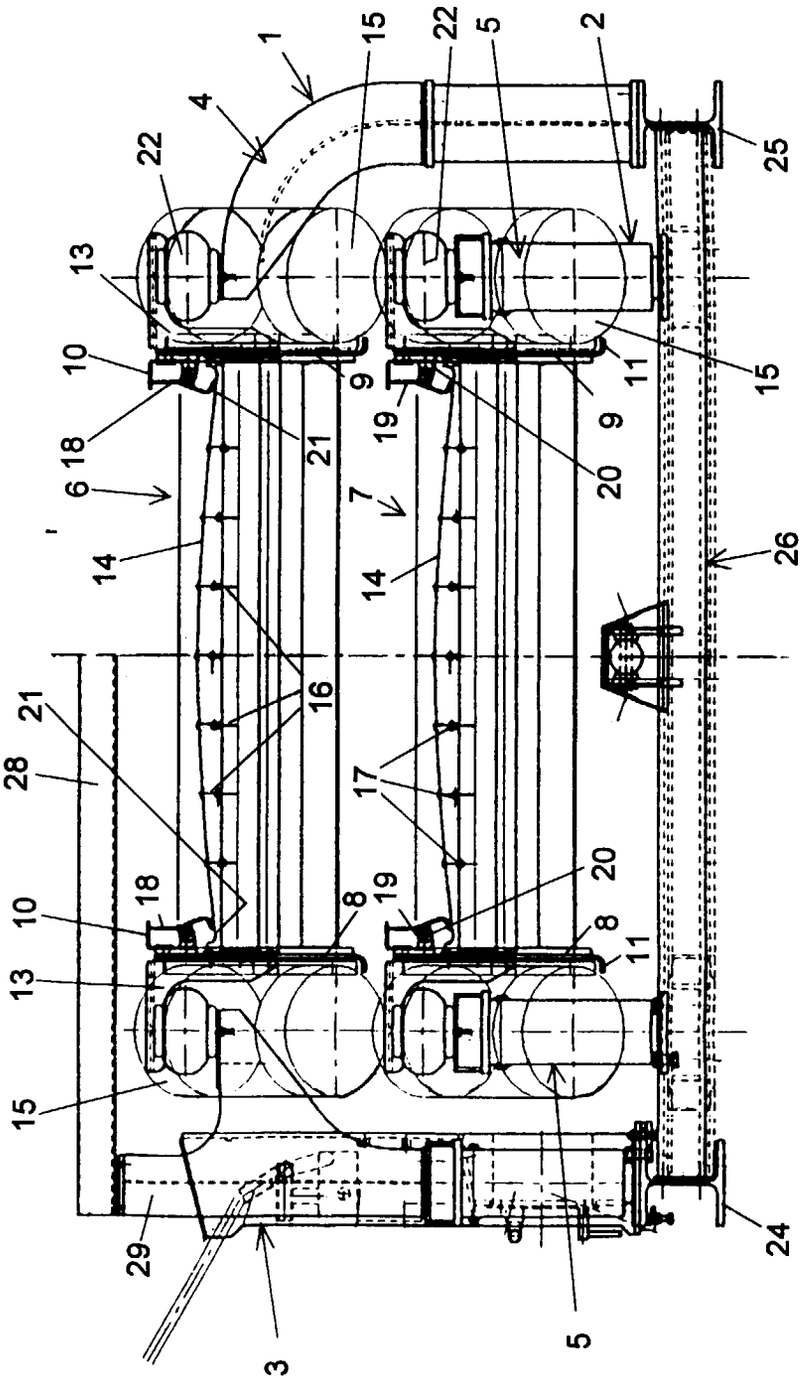
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Fig. 2

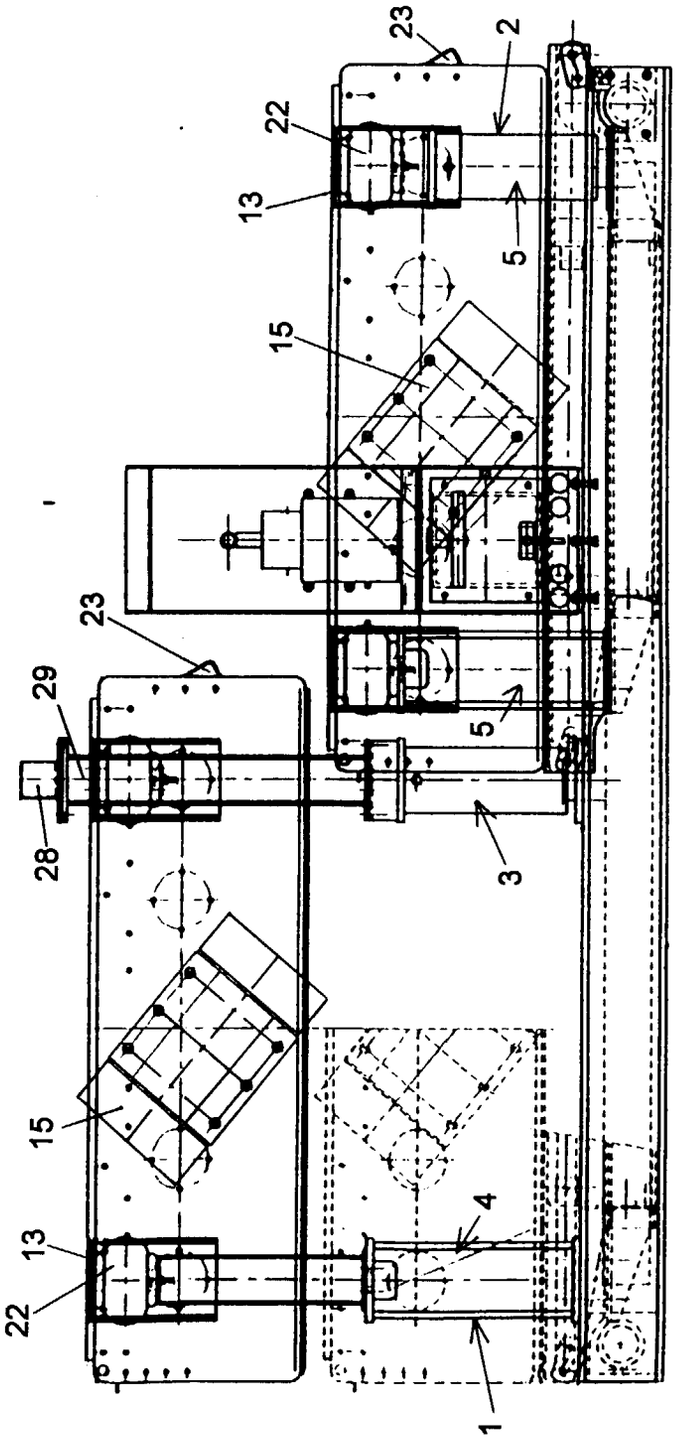


Fig. 3

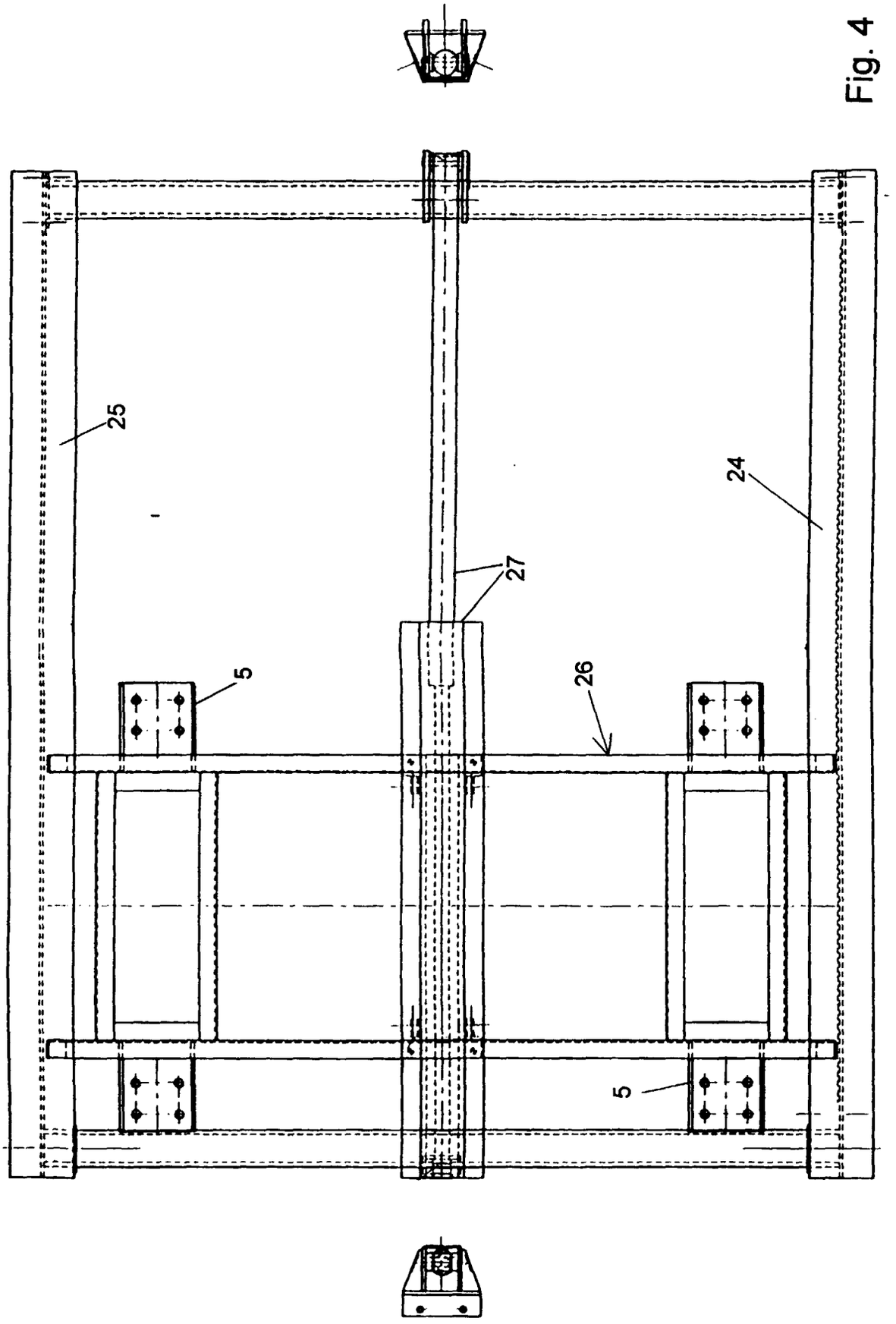


Fig. 4

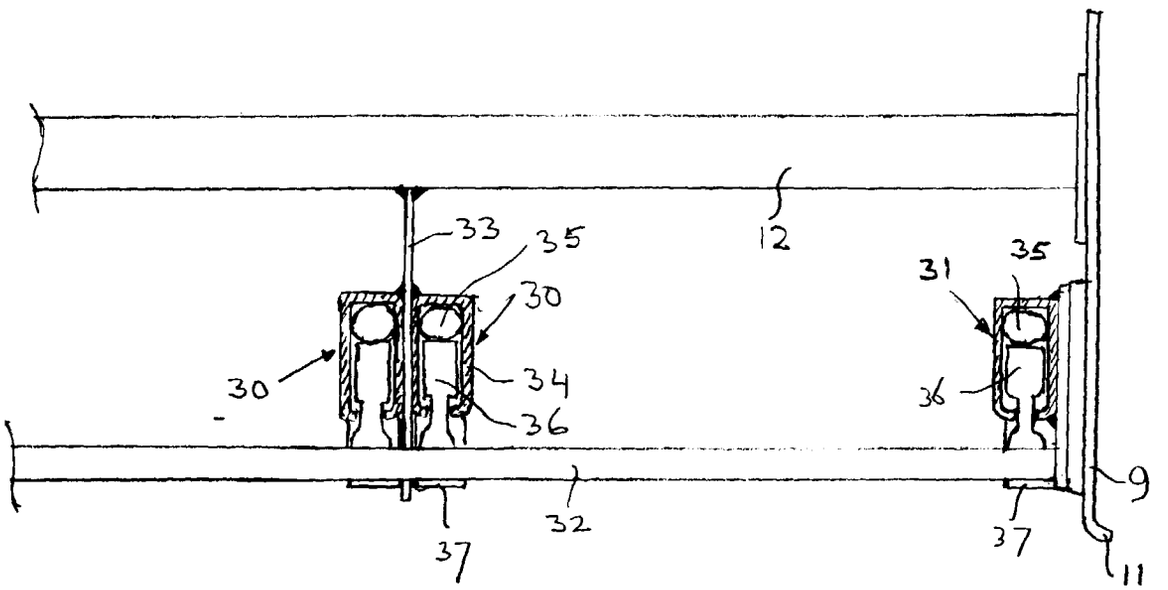


FIG. 5