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(54) **A vibrating device comprising two pairs of two eccentric weights**

(57) The invention relates to a vibrating device comprising a housing in which two pairs of two eccentric weights arranged beside each other are accommodated for rotation about axes of rotation. Each pair of eccentric weights has its own driving unit for rotating the eccentric weights in such a manner that the two eccentric weights of each pair rotate in opposite directions during operation.

The device comprises an electric/electronic control unit for controlling the two driving units of the two pairs of eccentric weights in such a manner that it is possible to effect synchronous rotation of the two driving units by means of the control unit on the one hand and to adjust the rotational position of one pair of weights relative to the rotational position of the other pair of weights by influencing at least one driving unit on the other hand.

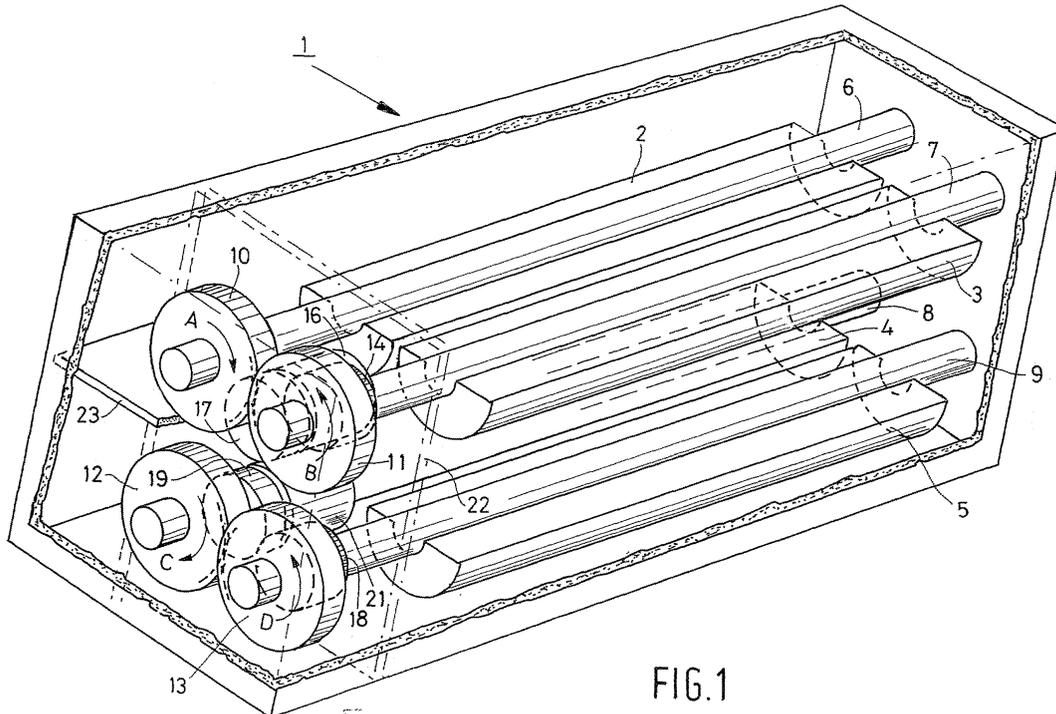


FIG. 1

Description

[0001] The invention relates to a vibrating device comprising a housing in which two pairs of two eccentric weights arranged beside each other are accommodated for rotation about axes of rotation, each pair of eccentric weights having its own driving unit for rotating the eccentric weights in such a manner that the two eccentric weights of each pair rotate in opposite directions during operation, the device being constructed so that the rotational position of one pair of weights is adjustable relative to the rotational position of the other pair of weights.

[0002] Such a vibrating device is known from European patent No. 1 038 068. In this known device, each pair of eccentric plates is driven via a gear mounted on an outgoing shaft of a driving unit, which gear meshes with a gear connected to one of the eccentric weights. Said gear connected to an eccentric weight meshes with a further gear mounted to the other eccentric weight of the pair. The gears of the two pairs of eccentric weights, which do not mesh with the gears mounted on the outgoing shafts of the driving units, are interconnected via a complicated, heavy gear mechanism which takes up a great deal of space in the housing, by means of which gear mechanism the rotational position of one pair of weights relative to the rotational position of the other pair of weights can be adjusted. In practice it has become apparent that such a construction is very vulnerable, since damage to one of the many gears during operation, for example a piece breaking off a gear, may result in damage being caused to at least several of the gears and the like, such that a complete exchange of all the gears will be necessary.

[0003] Another drawback of said known device is the fact that the great amount of space taken up by the driving units and the gear mechanism disposed on either side of the two pairs of counterweights makes it necessary, in order to keep the dimensions of the housing within acceptable bounds, to mount the counterweights in such a manner that the axes of rotation of the counterweights extend perpendicularly to the long sides of the housing. Accordingly, the counterweights may only have a short length, considering the admissible dimensions of the housing, which imposes limitations as regards the weight of said counterweights.

[0004] From US-A-6,504,278 a vibrating device of the above kind is known in which two hydraulic motors, each coupled with a pair of eccentric weights arranged beside each other, are connected in series for adjusting the phase angles of the pairs of eccentric weights, using valves and the like fitted between the hydraulic motors and a pump that feeds the motors.

[0005] Furthermore, mechanical stop means are provided for defining the end positions of the pairs of eccentric weights. All this leads to a complicated construction.

[0006] According to the invention, the device compris-

es an electric/electronic control unit for controlling the two driving units of the two pairs of eccentric weights in such a manner that it is possible to effect synchronous rotation of the two driving units by means of the control unit on the one hand and to adjust the rotational position of one pair of weights relative to the rotational position of the other pair of weights by influencing at least one driving unit on the other hand.

[0007] By directly influencing the driving units by means of a suitable control unit comprising computer-controlled electronic means or the like, for example, it is possible on the one hand to effect the desired synchronous rotation of the driving units and thus of the counterweights during normal operation for the purpose of generating a vibrating force, whilst on the other hand it is possible, if desired, to adjust the rotational position of one pair of weights relative to the rotational position of the other pair of weights during operation by influencing one driving unit, or both.

[0008] The use of the construction according to the invention makes it possible to leave out the complicated gear mechanism that is used in the prior art construction for changing the rotational position of one pair of counterweights relative to the rotational position of the other pair of counterweights, which makes the vibrating device less vulnerable and which provides greater possibilities for achieving an efficient construction of the vibrating device.

[0009] Preferably, hydraulic motors are used as the driving units, and the supply of fluid to the hydraulic motors is controlled by means of the control unit.

[0010] A compact arrangement of gears used for driving a pair of eccentric weights and the driving unit used for driving the gears in question can be obtained if the driving unit associated with a pair of eccentric weights is disposed between the axes of rotation of said pair of eccentric weights, seen in a direction perpendicular to a plane through said axes of rotation.

[0011] Advantageously, the axes of rotation of two driving units disposed one above another in the housing lie closer together than the two planes extending through respective axes of rotation of a pair of eccentric weights, as a result of which a very compact construction of the vibrating device can be obtained.

[0012] Since the gears used for driving the eccentric weights are all disposed near one end of the housing, the gears can be accommodated in a housing part that is separated from the housing part in which the eccentric weights are accommodated, so that any damage to the gears will not lead to damage being caused to the counterweights and the bearings supporting said counterweights.

[0013] Preferably, said housing part comprises two parts separated from each other, one part accommodating the gears associated with a first pair of eccentric weights and the other part accommodating the gears associated with the other pair of eccentric weights.

[0014] According to the invention, the eccentric

weights furthermore extend in the longitudinal direction of the housing, making it possible to use weights of comparatively great length, so that either heavier weights than is possible with the known device or counterweights having a smaller external radius may be used.

[0015] The invention will be explained in more detail hereinafter with reference to the accompanying figures.

[0016] Fig. 1 is a schematic perspective view of a vibrating device according to the invention, certain parts of which have been left out so as to show parts disposed therebehind.

[0017] Fig. 2 is a side elevation of the device that is shown in Fig. 1, a wall of the housing of which has been left out.

[0018] Fig. 3 shows a diagram for controlling the driving units.

[0019] Figs. 4 and 5 show two different relative positions that the eccentric weights may take up with respect to each other.

[0020] Fig. 6 is a sectional view of a second embodiment of a vibrating device according to the invention.

[0021] The vibrating device that is shown in Fig. 1 comprises a housing 1, in which four eccentric weights 2-5 are accommodated. The weights 2, 3, 4, 5 are mounted on shafts 6, 7, 8 and 9, respectively, which extend parallel to each other and which are mounted in bearings (not shown) in such a manner that the shafts 6-9 are rotatable about their central axes, which form axes of rotation for the eccentric weights.

[0022] The two eccentric weights 2 and 3 form a first pair of cooperating eccentric weights, which weights 2 and 3 are coupled by means of meshing gears 10 and 11 mounted on the shafts 6, 7. The eccentric weights 4 and 5 are coupled in a similar manner by means of meshing gears 12 and 13 mounted on the shafts 8 and 9.

[0023] A further gear 14 mounted on the shaft 7 of the eccentric weight 3 meshes with a gear 17 mounted on the outgoing shaft 15 of a hydraulic motor 16. Similarly, a gear 18 is mounted on the shaft 9 of the eccentric weight 5, which gear meshes with a gear 19 mounted on the outgoing shaft 20 of a hydraulic motor 21.

[0024] During operation, the eccentric weights 2 and 3 will be driven by means of the hydraulic motor 16, in such a manner that they will rotate in the direction indicated by the arrows A and B. Furthermore, the eccentric weights 4 and 5 will be driven by means of the hydraulic motor 21 during operation, in such a manner that they will rotate in the direction indicated by the arrows C and D.

[0025] Since all the gears used for driving the eccentric weights are disposed near one end of the housing, the space in which the gears are accommodated may be separated from the remaining part of the housing 1 by means of a partition 22 (schematically indicated). Said space may furthermore be divided into two parts by a further partition 23, so that the gears used for driving one pair of eccentric weights 2 and 3 are disposed in a space or housing part that is separated from the

space or the housing part in which the gears for driving the other are disposed. This achieves that any damage to gears driving a pair of eccentric weights 2, 3 or 4, 5 will not affect the gears driving the other pair of eccentric weights.

[0026] As will furthermore be apparent from Fig. 1, the hydraulic motor 16 that drives the pair of eccentric weights 2 and 3 is positioned between the axes of rotation of the eccentric weights 2 and 3, seen in a direction perpendicular to the plane through the axes of rotation of said eccentric weights 2 and 3. The same applies to the hydraulic motor 21 that drives the pair of eccentric weights 4, 5. The central axes or axes of rotation of the two hydraulic motors 16 and 21 are furthermore spaced apart by a distance smaller than the distance between the plane through the axes of rotation of the pair of eccentric weights 2, 3 and the plane through the axes of rotation of the pair of eccentric weights 4 and 5. This arrangement enables a compact construction of the vibrating device, whilst said arrangement furthermore makes it possible to have the eccentric weights extend in the longitudinal direction of the housing 1 without this leading to undesirable dimensions of the housing. It is possible, therefore, to use eccentric weights of comparatively great length, which enables the use of heavy counterweights without the outer circumference of the path described by the counterweights during operation becoming too large.

[0027] As is schematically shown in Fig. 3, fluid will be supplied to the two hydraulic motors 16 and 21 by means of a pump 24 via a valve mechanism 25. As is furthermore indicated in Fig. 2, the hydraulic motors 16 and 21 and the valve block 25 are connected to a control unit 27, which measures the rotational speed of the two motors 16 and 21 during operation and which is capable of influencing said rotational speed of the two motors 16 and 21 by controlling the supply of fluid to the motors 16 and 21 via the valve mechanism. The control unit 27 may comprise a computer, which receives signals from the motors by electric/electronic means and which controls valves by electric/electronic means for the purpose of regulating the fluid flow to the motors.

[0028] During normal operation, the eccentric weights 2 and 3 of one pair and the eccentric weights 4 and 5 of the other pair will take up the relative position that is indicated in Fig. 1 with respect to each other so as to effect a vibrating force in the direction indicated by the arrow E. The control unit 27 will effect a supply of fluid to the hydraulic motors 16 and 21 such that the eccentric weights will all rotate at the same rotational speed.

[0029] Preferably, the eccentric weights are preferably moved to the relative position that is shown in Fig. 4 with respect to each other, so as to eliminate the vibrating force, before the vibrating device is turned off. To that end the valve mechanism 25 is influenced by means of the control unit 27 in such a manner that one hydraulic motor is briefly supplied with more fluid or less fluid than the other hydraulic motor, so that the eccentric weights

of one pair will briefly rotate slightly more quickly or more slowly than the eccentric weights of the other pair for the purpose of changing the relative position of the eccentric weights of the two groups with respect to each other. Subsequently, the rotational speed of the two pairs of eccentric weights can be simultaneously reduced to zero and the vibrating machine can be stopped.

[0030] During standstill of the machine, the eccentric weights of the two pairs will generally return to the relative position that is shown in Fig. 5 with respect to each other under the influence of the force of gravity and leakage of oil from the hydraulic motors 16 and 21. When the machine is started, it is therefore arranged by means of the control unit 27 that one hydraulic motor is briefly supplied with more fluid or less fluid than the other hydraulic motor so as to achieve the relative position of the eccentric weights that is shown in Fig. 4 with respect to each other, so that no vibrating force will be exerted while the rotational speed of the eccentric weights is being increased to the operating speed. Following that, the rotational speed of the eccentric weights will be increased to the intended operating speed used for vibrating, after which one of the two hydraulic motors will briefly receive more fluid or less fluid so as to restore the relative position for normal operation of the eccentric weights of the two pairs as shown in Fig. 5 with respect to each other. It will be apparent that also other relative positions of the eccentric weights with respect to each other can be effected by means of the control unit 27, if desired.

[0031] The use of the control unit 27, which monitors and controls the rotational speeds of the hydraulic motors and the supply of fluid to the hydraulic motors, makes it possible to adjust the relative position of the two pairs of eccentric weights with respect to each other in a simple manner without using complicated mechanical means, which makes the construction of the vibrating device simpler and less vulnerable than that of the known devices. The direction in which the vibrating force acts can be changed by reversing the direction of rotation of the eccentric weights.

[0032] Fig. 6 shows a second embodiment of the vibrating device according to the invention. In said figure, those parts that correspond to parts shown in the preceding figures and described above are indicated by the same numerals as used in Figs. 1-5.

[0033] As will be apparent from Fig. 6, the gears connected to the eccentric weights 2 and 3 and the motor 16 that drives said eccentric weights are disposed near one end of the housing 1 in this embodiment, whilst the gears connected to the eccentric weights 4 and 5 and the motor 21 that drives said eccentric weights are disposed near the other end of the housing 1. The gear 17 that is mounted on the outgoing shaft of the motor 16 directly meshes with one of the gears connected to the eccentric weights 2 and 3, whilst the gear 19 mounted on the outgoing shaft of the motor 21 directly meshes with one of the gears connected to the eccentric weights

4 and 5.

[0034] The ends of the shafts supporting the eccentric weights are mounted in bearings 28, which are disposed in covers 29 that close the housing 1 at the end thereof.

[0035] Two partitions 30 extending parallel to the covers are disposed in the housing at some distance from the two covers 29, in such a manner that the gears are disposed in a space separated from the space that accommodates the eccentric weights at the two ends of the housing 1. Division plates 31 are furthermore provided between the covers 29 and the partitions 30 halfway the height of the space, so that the space accommodating the gears associated with one pair of eccentric weights is separated from the ends of the shafts of the other pair of eccentric weights present at the corresponding end of the housing 1. It will be apparent that in this way damage to gears associated with one pair of counterweights will not lead to damage being caused to other parts of the vibrating device. Furthermore, the various parts are readily accessible for maintenance and the like, whilst at the same time a good weight distribution is obtained as a result of the even distribution of the various parts.

[0036] Fig. 6 furthermore shows a clamping device 32, by means of which the vibrating device can be clamped down to a sheet pile or the like, for example.

[0037] It will be understood that additions and/or alterations to the embodiments as described above and illustrated in the figures are possible within the spirit and scope of the invention. Thus it is for example conceivable to use electric motors rather than hydraulic motors for driving the eccentric weights, in which case the rotational speeds of the electric motors may be influenced by means of a control unit again.

[0038] The vibrating device is in particular intended for being used for driving piles or the like into the ground or removing piles and the like from the ground, but it will be apparent that the vibrating device may also be used for other purposes.

Claims

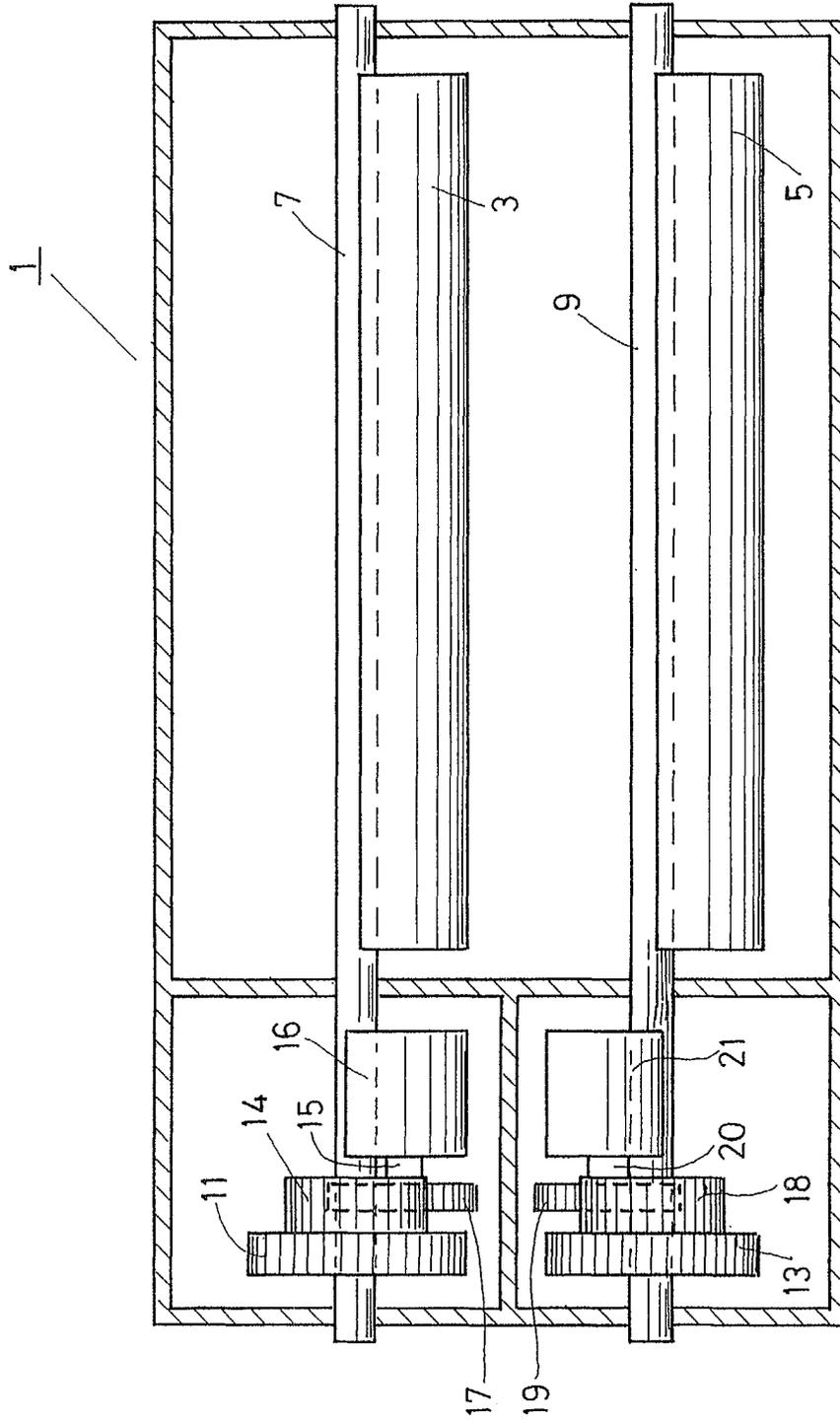
1. A vibrating device comprising a housing in which two pairs of two eccentric weights arranged beside each other are accommodated for rotation about axes of rotation, each pair of eccentric weights having its own driving unit for rotating the eccentric weights in such a manner that the two eccentric weights of each pair rotate in opposite directions during operation, the device being constructed so that the rotational position of one pair of weights is adjustable relative to the rotational position of the other pair of weights, **characterized in that** the device comprises an electric/electronic control unit for controlling the two driving units of the two pairs of eccentric weights in such a manner that it is possible to effect synchronous rotation of the two driving

units by means of the control unit on the one hand and to adjust the rotational position of one pair of weights relative to the rotational position of the other pair of weights by influencing at least one driving unit on the other hand.

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2. A vibrating device according to claim 1, **characterized in that** hydraulic motors are used as the driving units, and **in that** the supply of fluid to the hydraulic motors is controlled by means of the control unit. 10
3. A vibrating device according to claim 1 or 2, **characterized in that** the driving unit associated with a pair of eccentric weights is disposed between the axes of rotation of said pair of eccentric weights, seen in a direction perpendicular to a plane through said axes of rotation. 15
4. A vibrating device according to any one of the preceding claims, **characterized in that** the axes of rotation of two driving units disposed one above another in the housing lie closer together than the two planes extending through respective axes of rotation of a pair of eccentric weights. 20
25
5. A vibrating device according to any one of the preceding claims, **characterized in that** gears associated with one pair of eccentric weights are disposed near one end of the housing and the gears associated with the other pair of eccentric weights are disposed near the other end of the housing. 30
6. A vibrating device according to any one of the preceding claims, **characterized in that** the gears for driving the eccentric weights are accommodated in a housing part that is separated from the housing part that accommodates the eccentric weights. 35
7. A vibrating device according to claim 6, **characterized in that** the housing part that accommodates the gears comprises two parts separated from each other, one part accommodating the gears associated with a first pair of eccentric weights and the other part accommodating the gears associated with the other pair of eccentric weights. 40
45
8. A vibrating device according to claim 6, **characterized in that** the gears disposed near the two ends of the housing are accommodated in housing parts separated from the housing part that accommodates the eccentric weights, whilst the gears associated with one pair of eccentric weights, which are accommodated in one housing part, are separated from the ends of the shafts of the other pair of eccentric weights that are disposed in the housing part in question. 50
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9. A vibrating device according to any one of the pre-

ceding claims, **characterized in that** the eccentric weights extend in the longitudinal direction of the housing.



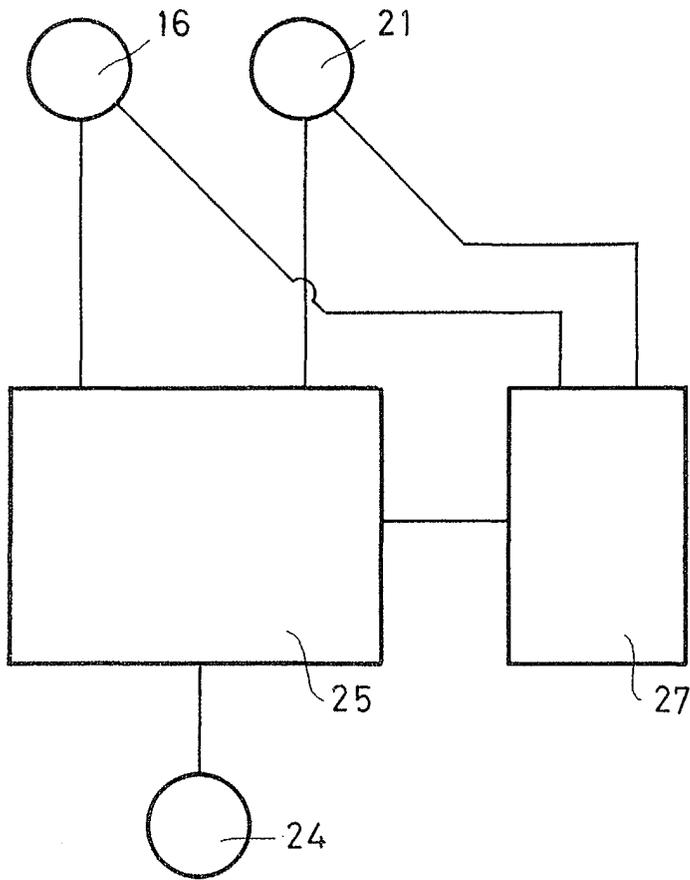


FIG. 3

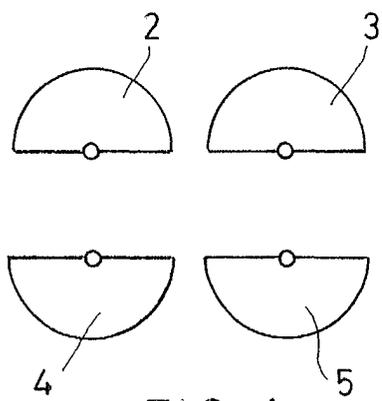


FIG. 4

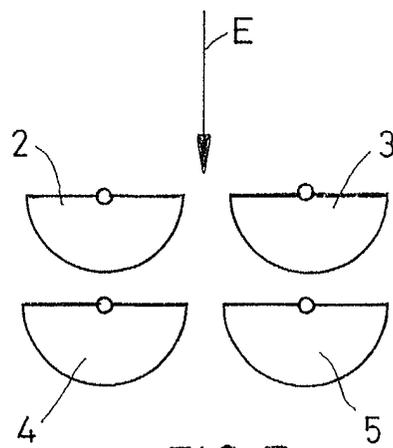


FIG. 5

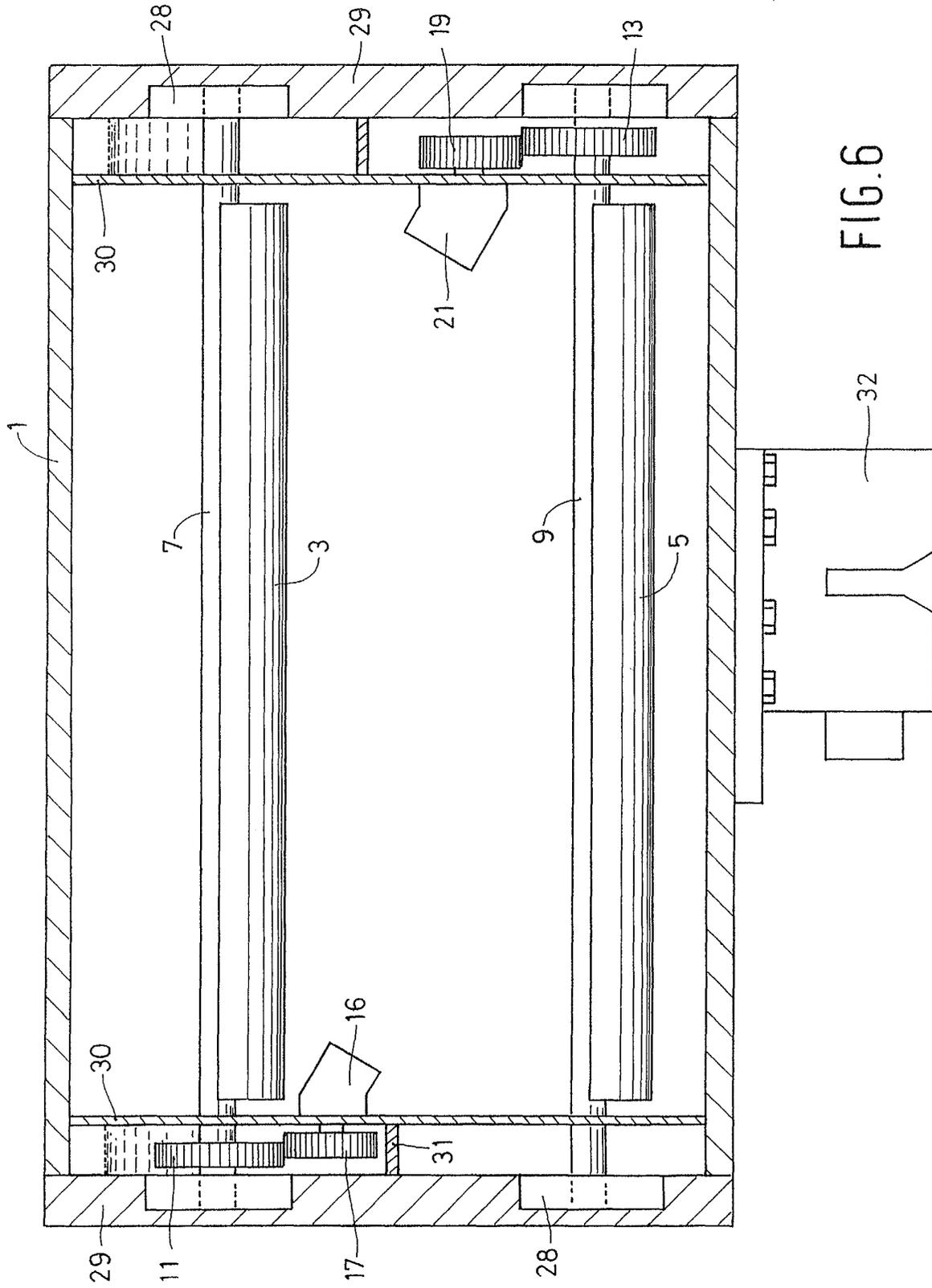


FIG. 6



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Application Number
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