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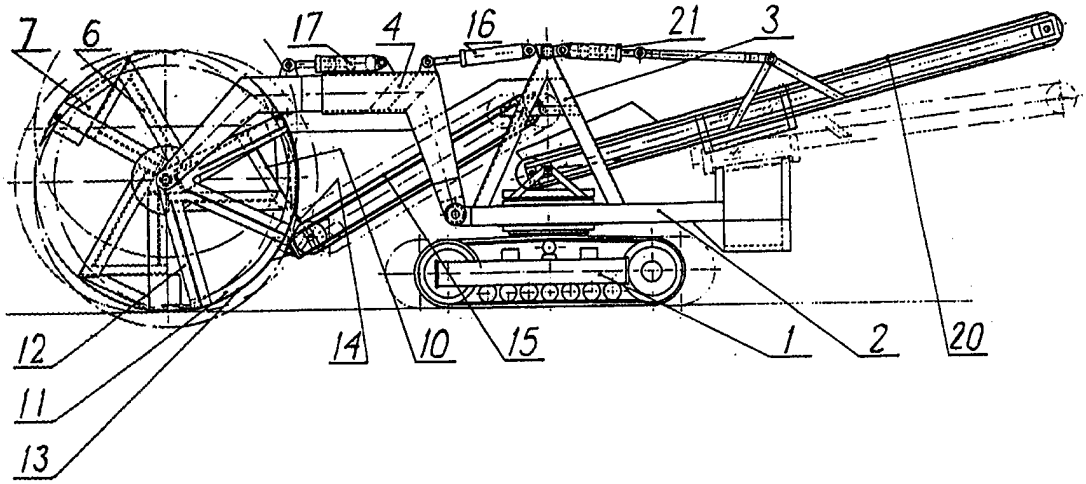

(57) Abstract

The invention enables separation of earth from subsoil at many times lower cutting resistance and at higher speed. The applied continuous output loading onto means of transport substantially increases additionally the productivity of the arrangement in relation to other excavators with thus mechanism. The arrangement/excavator consists of undercarriage (1) and rotary platform (2) on which are mounted an extension arm (4) with bucket wheel (6), provided preferably with three buckets (7) cutting earth downward and then moving the output along slip plate (11) to a chute (14), wherefrom such output is transferred to continuous duty conveyor I (15), mounted also on this rotary platform (2). Then the output is transferred to continuous duty conveyor II (20), mounted independently and rotationally on undercarriage (1), which conveyor loads the output on independent means of transport. The invention may find an application in loading an unloading equipment for crushed materials.

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Method and an Arrangement for Earth Separation and Loading

The method of earth separation and loading and the arrangement for application of this method may be utilised in various types of excavators and loaders, picking up crushed material, store in dumps and transferring it to means of transport of various types.

Known face-shovel excavators separate the output from the subsoil with an upward motion of the bucket and therefore lumps of soil, separated with bucket blades or teeth, drop inside the bucket. Emptying the bucket is accomplished in various ways. In single bucket excavators, the bucket, after filling, is lifted upwards and then the superstructure of the machine, together with the bucket, rotates in order to place the bucket above the designated means of transport. After opening the bottom flap of the bucket, the output is discharged, usually into an open body of a road vehicle. After another rotation of the excavator superstructure and lowering the bucket, the latter begins to move upwards, separating another portion of soil. In multi-bucket excavators buckets are mounted on the bucket wheel or circular chain and, after separation of appropriate amount of

soil, lift the output to a considerable height and due to that, the output pours off onto continuous duty belt conveyor situated nearby, which subsequently transfers the output to the means of transport or to a dump. Single-bucket undershot excavators are mainly used to dig soil below the level, on which the excavator moves. In such case they also cut soil in an upward direction. These excavators are also used for cutting soil above the level, on which the excavator moves. Contrary to the previous cases the cutting is performed with an downward motion, whilst in the last part of the cycle, the bucket performs a scraping turn whereby it is filled with output. After lifting the bucket and rotating the excavator superstructure, the output is discharged onto the means of transport, due to another rotation of the bucket in relation to the extension arm.

The said single-bucket excavators feature two major flaws:

- high cut resistance /face-shovel excavators/,
- low productivity in relation to weight, due to cycle operation instead of continuous operation.

Multi-bucket excavators have the following flaws:

- high cut resistance,
- high bucket wheel weight /or extension arm frame with chain/ resulting in excessive weight of the entire excavator.

The valid cutting theory has it that cut resistance depends, by large, on the soil category. In fact, as proved by research conducted by the author, this resistance depends, to a much larger extent, on the separation method, whereas the internal friction of the material being separated is decisive.

The internal friction depends to a large extent, on the density of the material and the pressure, to which the separated layer is subjected. And therefore upward cut takes place under a high pressure of material, situated above the layer being cut, what results in excessive energy consumption. Rational soil separation should be accomplished at a minimum load of the layer being cut. This can only be accomplished with a downward motion of the bucket. It is generally known that when digging trenches, side walls must be protected with formwork and struts, resisting horizontal outward pressure of soil, caused by internal pressure. Without these protections soil creep takes place, i.e. self separation of soil. In the case of downward cutting of soil of low cohesion /e.g. dry sand/, internal friction may be reduced so much that the material will become fluid. In such case it is enough to scrape fluid material onto suitable conveyor. Another disadvantage of upward cutting is imparting on the output an acceleration in a direction opposite to gravity what results in excessive energy consumption and practically restricts higher cutting speeds. One more disadvantage of this type of arrangements is reduced stability of the excavator. The overturning moment of the extension arm weight, bucket and output is increased by an overturning moment caused by the reaction of the soil being cut. More favourable cutting conditions exist in the case of single-bucket backhoe excavator digging soil above the level on which it is moving. But also in this case the excavator operates in cycles. Cutting is only a part of the cycle, followed by a break in cutting, necessary for rotation, subsequently in both directions, of the superstructure weight,

exceeding several times the output weight and a break for loading the output on a means of transport.

The purpose of the invention is to develop a method of soil cutting at a substantially lower energy consumption and different operating technique. The cutting method allows also to increase the cutting speed, what additionally results in increased productivity. The method of soil separation consists in separating the soil by means of several, preferably three buckets, mounted on a bucket wheel, whilst the separation of earth from subsoil is accomplished by downward motion and the buckets move consecutively separated portions of the output along the slip plate to a height, allowing - due to gravity and centrifugal force - to pour subsequent portions onto an inclined first continuous duty conveyor, mounted with the bucket wheel on the rotary part of the excavator, whilst the output is transferred from the first conveyor to the second continuous duty conveyor, mounted independently and rotationally on the undercarriage, and subsequently this second conveyor conveys the output to any means of road or rail transport or to other continuous duty conveyors, independent from the excavator or to a dump.

The arrangement for the application of the method consists of an undercarriage with a running gear and a rotary platform on this undercarriage, on which an extension arm with a bucket wheel and slip plate are mounted on an articulated joint and an inclined continuous duty conveyor and, additionally, an independent rotary second continuous duty conveyor is mounted, whilst each bucket on the bucket wheel is provided with cutting blades, two side walls and a plate, appropria-

tely situated on the bucket wheel side, enabling the output to be slid along it to the first conveyor after moving this output along the slip plate to an appropriate height. Moreover the extension arm, to which the bucket wheel is mounted, has a variable extension due to a hydraulic cylinder moving the front part of the arm with bucket wheel in relation to the rear part of the arm mounted with a universal joint to the rotary platform. A variation of the arrangement is fitted with buckets, each of which is provided with cutting blades, two side walls, internal plate situated at the centre of the bucket wheel and a swinging outer wall, opened with a cam or a buffer, allowing the discharge of the output onto a conveyor after the bucket reaches an appropriate height. The variation of the arrangement for cutting earth below the level on which the arrangement is moving, is provided with a bucket wheel with several, preferably three buckets, located on an arm while the soil is cut with a downward motion of the buckets and the output is slip upwards along the slip to the discharge height and then conveyed by means of conveyors to means of transport or dump.

The method of separation and loading earth onto means of transport and the arrangement for the application of this method - an excavator are shown on an example application in the figures, where in fig.1 a side view of the excavator is shown, in fig.2 - top view of the excavator, in fig.3 platform turning gear and loading conveyor turning gear are shown and in fig.4 - the top view of both said turning gears. The excavator consists of an undercarriage 1 e.g. on crawlers with a running gear and a turning gear and a rotary platform

2 with supporting structure 3. An extension arm 4 is mounted with an articulated joint to the front of the rotary platform, bearings 5 of bucket wheel 6 with a number, preferably three buckets 7 are located at the front of them with cutting blades 8, two side walls 9 and plate 10 situated at the centre of the bucket wheel. The bucket has no wall on the outside. Slip plate 11 is rotationally mounted to the bucket wheel shaft, by means of arms 12. The slip plate is secured against rotation by means of a screw joint with the extension arm. The slip plate consists of slip 13 located on the circumference of the bucket wheel and two side plates. The inside diameter of the slip is marginally larger than the outside diameter of the bucket wheel. The slip has a constant cross section, from the bottom to a chute 14, whereas above the chute, it has a hole, slightly wider than buckets. Below the chute belt conveyor I begins with ribbed belt 15. The bottom end of the supporting structure of the conveyor is mounted with an articulated joint to the slip plate and its top end mounted slidingly on rollers to supporting structure 3. Extension arm 4 is inclined by means of hydraulic cylinder 16 allowing lifting and lowering the bucket wheel. Apart from that this extension arm has its front part sliding in the rear part what allows for the movement of the bucket wheel, within definite limits, forwards and backwards. This movement is generated by hydraulic cylinder 17, mounted with an articulated joint to the front and rear part of extension arm 4. As already mentioned rotary platform 2 is mounted to undercarriage frame 1 by means of roller bearing 18, situated under the platform. Above the platform there is another roller

bearing 19 allowing the rotation of loading conveyor II 20 in relation to the undercarriage. This conveyor is designed to load the output onto any means of transport. Conveyor 20 in its lower part is mounted with an articulated joint to the rotary frame of this conveyor and in its central part, by means of a link and hydraulic cylinder 21,to the rotary bearing on the top of supporting structure 3. Hydraulic cylinder 21 allows inclination of the loading conveyor in the vertical plane, according to the height of any means of transport, independent from the excavator. Turning gear of the excavator is shown in fig.3 and 4. This gear consists of hydraulic cylinder 22, vertical inner sleeve 23, linking the undercarriage supporting structure with the rotary structure of the loading conveyor above rotary bearing 19 and of appropriate articulated joints. Hydraulic cylinder 22 is connected with one joint to the undercarriage supporting structure and with the other end to the articulated joint of inner sleeve 23. The movement of hydraulic cylinder piston rod causes the rotary structure of loading conveyor to turn in one or other direction, within determined limits. Similarly, as shown in fig.3 and fig.4, hydraulic cylinder 24 is joined at one end, by means of an articulated joint, with the undercarriage supporting structure 1 and at the other end, also by means of an articulated joint, with rotary platform 2 what allows platform 2 to rotate, within definite limits in relation to undercarriage 1. At the end of the rotary platform an internal combustion engine is installed,driving all excavator mechanisms by means of an oil pump. This engine performs also the role of an additional counterweight for extension arm 4 and bucket

wheel 6. Controls are located in cab 25, omitted for clarity sake from fig.1. The excavator is operated by two people. One operator controls the bucket wheel and conveyor I with ribbed belt; the other one controls the loading of independent means of transport.

The functioning of the excavator, where the method of earth separation and loading on means of transport has been applied, is as follows. After the excavator has arrived at the slope to be dug and after a means of transport has been arranged for loading, the operator of loading devices sets the outlet of loading conveyor 20 horizontally, above the open body of a vehicle, by means of hydraulic cylinder 22, and the outlet height by means of hydraulic cylinder 21, and then starts the loading conveyor. Then the other operator starts the turning gear of bucket wheel 6 and, as necessary, the thrust gear by means of hydraulic cylinder 17. The separation of earth commences and a subsequent bucket is filled by the earth moving downwards. The cut begins according to the slope height, approximately in the position, where in fig.1 is the top left bucket. In the position, where in the figure is the bottom bucket, the slip plate 11 begins to close the outside surface of the bucket, whilst the inner plate 10 pushes before it the output contained in the bucket. During the upward motion of the bottom bucket, the output in the bucket slides on the slip 13 to the height of chute 14. The discharge of the loosened output from the bucket commences from the position, where the top right bucket is in fig.1. In such situation, due to appropriate inclination of inner plate 10 and due to cenrtifugal force, the output slides

along the chute and above it onto belt conveyor I with ribbet belt, which subsequently feeds it to loading conveyor 20 and the letter discharges the output onto any means of transport. Earth separation is accomplished as platform 2 rotates from one extreme position to another, by means of hydraulic cylinder 24. The operator has here at his disposal a thrust mechachanism, which controls the thickness of the layer cut. The excavator, without the use of the running gear, cut subsequent layers until the total movement of the thrust mechanism is exhausted, where the bucket wheel is reversed by means of hydraulic cylinder 17 and the excavator moves forward by means of the running gear of the undercarriage.

The method of earth separation and loading onto means of transport, according to the invention, has a number of outstanding advantages in relation to methods commonly used. First of all cutting earth takes place with a cut layer maximally relieved and thereby with very low friction of earth cut and with the utilisation of horizontal pressure, repelling extreme layers in the vertical zone of the slope. In some cases, with dry and loose soil, serious loss of internal friction may occur. Then so called fluidisation of crushed material occurs. This material flows down the slope /known self creep of trench walls/ and it is enough, without moving the excavator, to pump the material, like pumping liquids, at an extremely low energy consumption. Another advantage of the method according to the invention is the maximum utilisation of engine power for cutting soil. When one bucket completes the cutting process, the second bucket begins this process and the next one discharges, at the same time, a por-

tion of separated soil onto conveyor. There is no loss of energy for accelerating a portion from rest to operating velocity, as the material accelerates due to gravity. This allows to increase twofold the cutting speed and thereby to increase the productivity of the excavator. With this method it is also avoided to generate rotational motion of large mass of the rotary platform, extension arm, bucket and output contained therein. Elimination of cycle operation of such excavators, combined with additional advantages, mentioned above, allows to mount, on the same undercarriage an excavator of eight times higher productivity. The stability of the excavator is thereby improved, as the overturning moment from the extension arm, buckets and output is balanced, by large, by the loading conveyor located on the other side of the undercarriage. Additionally, a substantial moment from the cutting reaction is replaced by a substantially smaller, and at the same time, stabilising moment from cutting reaction /due to opposite direction of the reaction/. In relation to multi-bucket excavators, the cutting system according to the invention, allows reduction in energy consumption for soil separation, substantial reduction in bucket wheel weight and in consequence counterweight and supporting structure weights. An additional advantage of soil separation method, according to the invention, is the use of thrust mechanism, allowing excavator operation when cutting non-homogeneous soil, containing considerable amount of rock what practically prevents the use of multi-bucket excavators. Elimination of full rotation of excavators simplifies to a large extent the turning gear. In such case, a multi-step mechanical gear, driven by a simple

hydrulic motor or a slow speed hydraulic motor, becomes superfluous. It is enough to use a simple hydraulc cylider in lieu of such devices. Complex rotary columns, feeding oil under prssure to the running gear of both crawlers of the undercarriage are avoided, whilst each crawler must have the capability to run in both directions.

Claims

1. A method of earth separation and loading, comprising:
the separation of earth by means of a number, of preferably, three buckets mounted on bucket wheel, whilst soil separation from subsoil is accomplished by a downward motion of buckets,
thereafter a movement by the buckets of the subsequently separated portions of the output along the slip plate to a height allowing - due to gravity and centrifugal force - to pour subsequent portions onto an inclined first continuous duty conveyor, mounted with the bucket wheel on the rotary part of the excavator,
thereafter a transfer of the output by first conveyor to the second continuous duty conveyor mounted on the excavator undercarriage with possibility of independent rotation,
and a conveying of the output by the second conveyor to any means of road, rail, or other means of transport or other continuous duty conveyors or to a dump.

2. An arrangement for application of the method, as claimed in claim 1, comprising:
an undercarriage with running gear and a rotary platform

on this undercarriage,

an arm connected with the rotary platform and having a bucked wheel, a slip plate, a chute and an inclined first continuous duty conveyor,

each bucket on said bucket wheel having cutting blades, two side walls and an inner plate, enabling the discharge of the output onto the first conveyor after movement of the output along slip plate on appropriate height,

and besides a second continuous duty conveyor mounted on the excavator undercarriage with possibility of independent rotation.

3. An arrangement according to claim 2. comprising:

an extension arm onto which bucket wheel is mounted, having a variable reach due to hydraulic cylinder moving the front part of the extension arm with bucket wheel in relation to the rear part of the extension arm linked by an articulated joint with rotary platform.

4. An arrangement according to claim 2, in which the slip plate is omitted, but each of buckets has cutting blades, two side walls, an inner plate and a swinging outer wall, opened by means of a cam or buffer, when the bucket, in its upward motion reaches the level of chute to discharge the output onto the first continuous conveyor.

5. An arrangement for application of the method, as claimed in claim 1, designated for separation of earth below the the level on which it moves and for loading of this earth onto means of transport, comprising:

an undercarriage with a running gear, an arm provided with a bucket wheel with several, preferably three buckets, whilst cutting the soil is performed by an downward motion of buckets and then the output is moved along slip plate upward to the chute height and then is transported by means of conveyors onto means of transport or onto a dump.

Fig.1

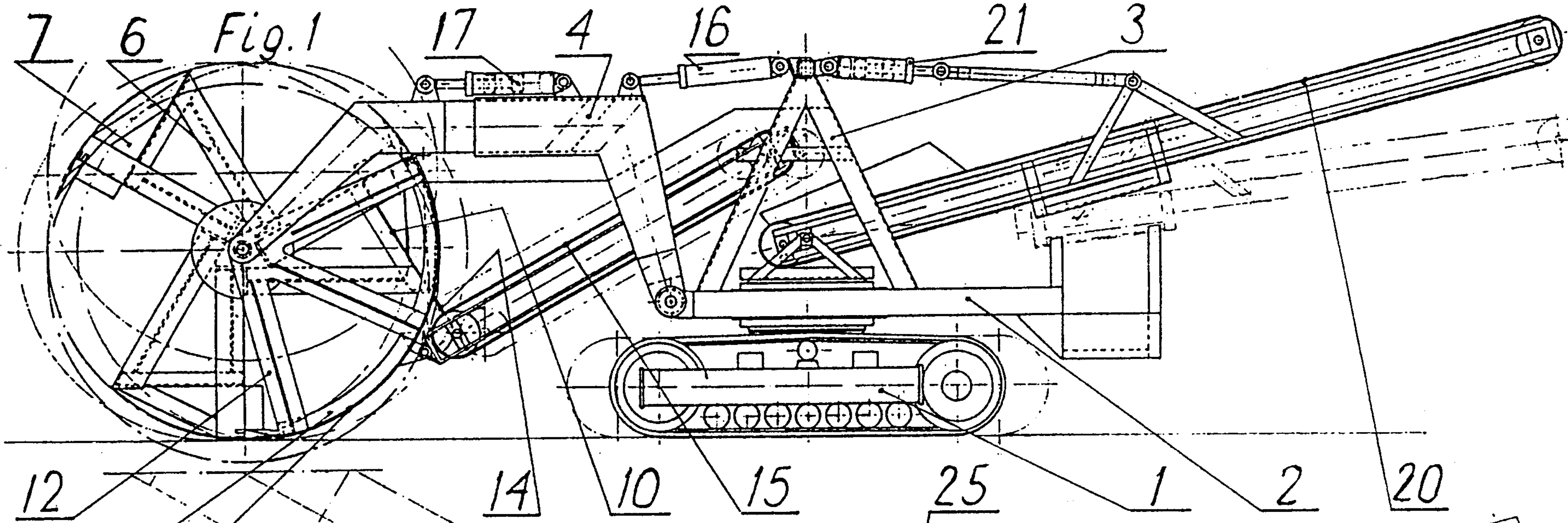
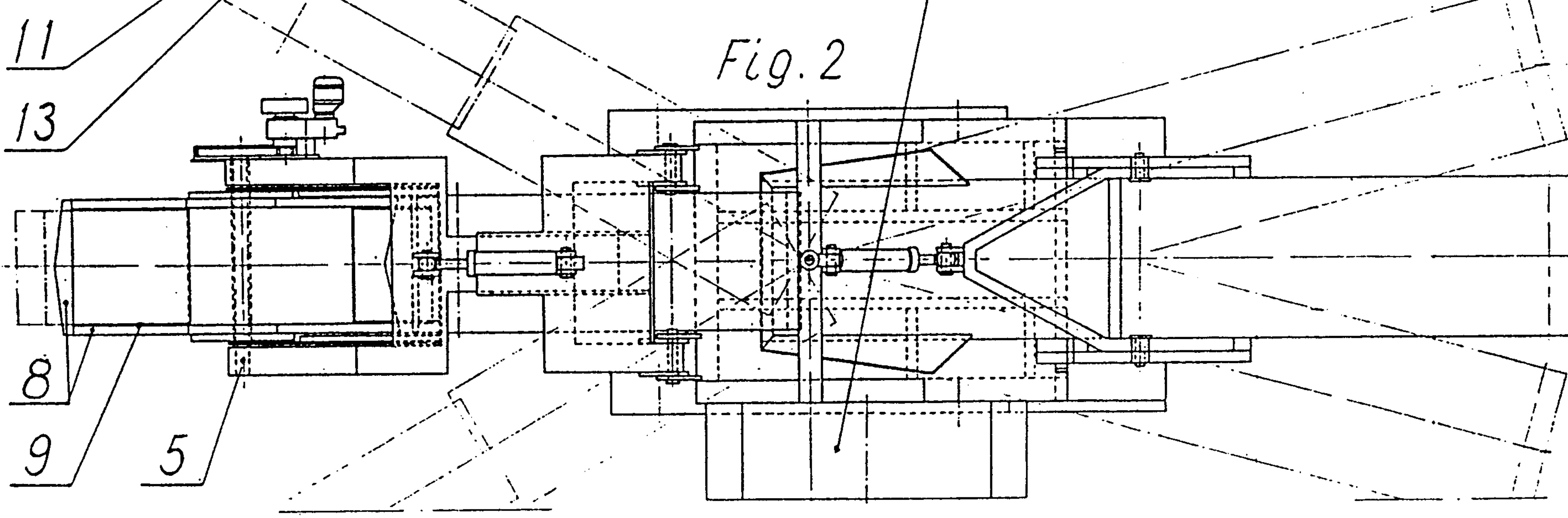


Fig.2



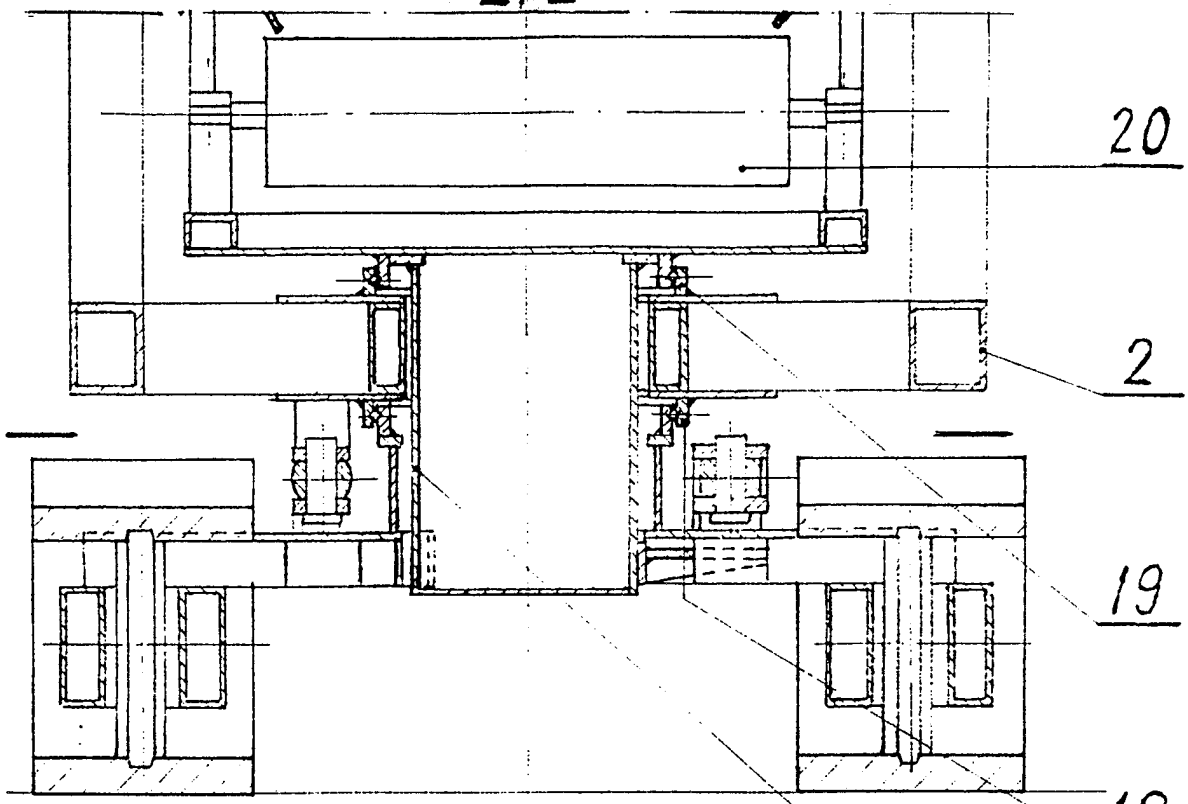


Fig.3

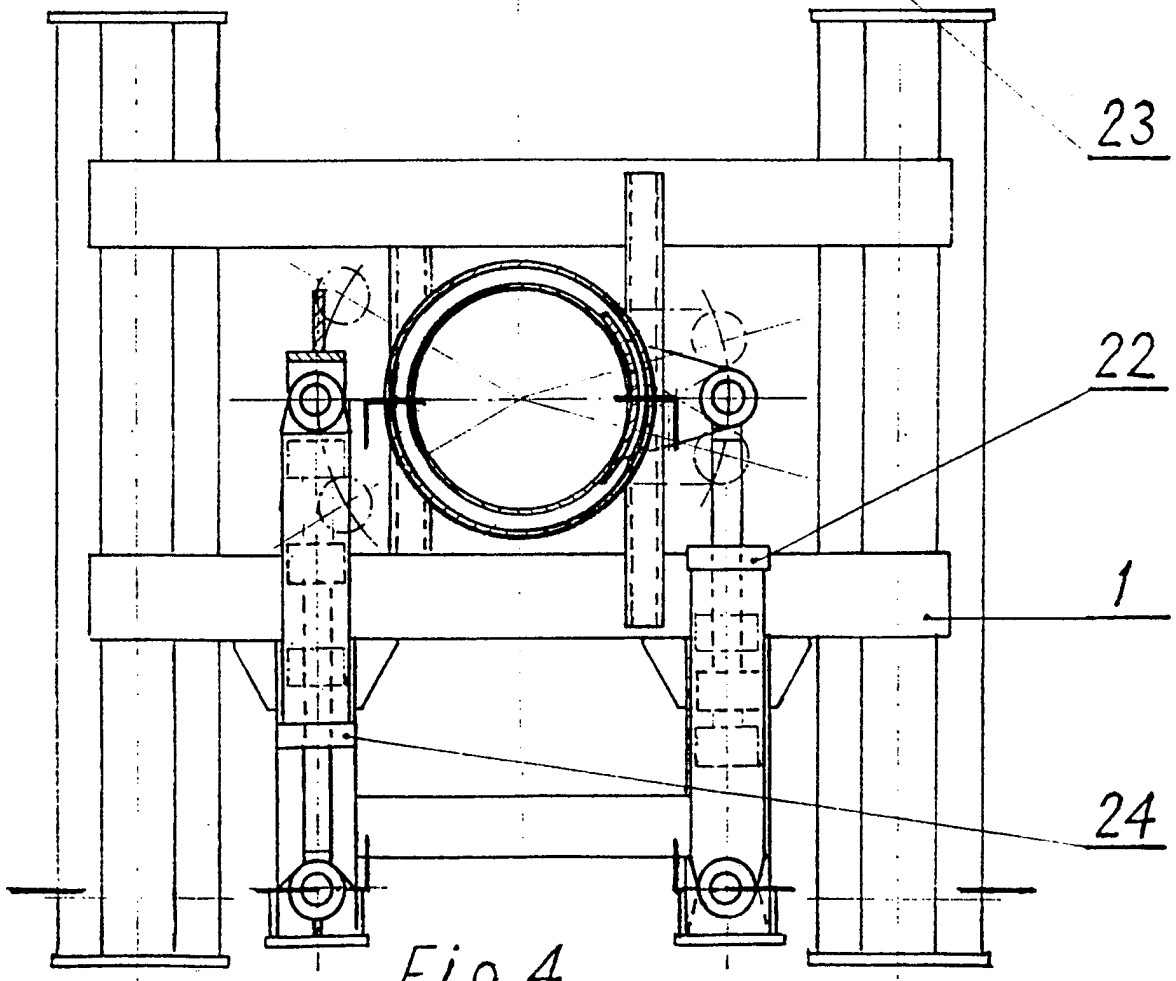


Fig.4

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E02F3/18 E02F3/24

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Minimum documentation searched (classification system followed by classification symbols)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 180 927 A (SATTERWHITE) 1 January 1980 see column 9, line 28-53 see column 11, line 49-56 see column 12, line 30-42; figures 6-12,14,15,26	1,2
X		5
A		4

Y	AU 427 389 B (HITACHI) 14 September 1972 see figures 1,2	1,2

A	CH 464 094 A (BADE&CO) 29 November 1968 see column 2, line 11-18; figure 2	3

A	US 1 386 987 A (BROWN) 9 August 1921 see figures 1-5	4

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1

Date of the actual completion of the international search	Date of mailing of the international search report
1 August 1997	22. 08. 97

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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1

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Information on patent family members

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