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⑳ **Spherical surface grinding device.**

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Description

The present invention relates to a spherical surface grinding device for manufacturing such optical parts as an optical lens, mirror, etc., which enable realization of a well furnished surface at high efficiency.

In the conventional spherical grinding device, with structure particularly as shown in Fig. 1, a lens 3 held by a collet chuck 1, which is mounted on a rotary spindle 2, to be turned thereby at a low speed, is subject of spherical grinding by means of a diamond grinding stone 7 turned at a high speed, mounted on a high speed rotary spindle 6 which is inclined at a specific slope angle by a sloping slide shaft 4 and, further, which is placed in a specific position by a parallel slide shaft 5. In doing this work, the glass stock is brought to the collet chuck 1 by a worker's hand or by an auto loader, to be held thereby, and is taken out by the same means. The diamond grinding stone generally used is METAL BOND of the order of #100~#400, which produces a finished surface roughness of 2~6 Rmax. In after-processing, smoothing is performed with diamond METAL BOND pellet and RESINOID BOND pellet and in further later processing, polishing is performed, using an abrasive such as CeO₂, etc.

In the device as above-described, however, the lens 3 held by the collet chuck 1 can be ground only by one diamond grinding stone 7. When it is further to be finished, it is necessary to replace the stone or transfer the lens 3 to another spherical surface grinding device. For again holding the lens 3 by another collet chuck 1, the lens holding posture will be altered and, therefore, a larger margin of error must be provided for precision grinding. Accordingly, rough grinding and precision grinding can not be performed at high efficiency. Since the forced cutting-in method in rough grinding and the constant pressure cutting-in method in precision grinding, respectively, cannot be readily adopted, a well finished surface can not be obtained. Thus, this device was unable to be put to use for production.

A grinding machine for grinding lenses or other objects of glass is disclosed in US Patent 1,432,093. The machine incorporates a rotat turret which carries at three equidistant points in its face work spindles 3, 3a and 3b which are similar in construction and can be rotated by suitable means. The axes of the spindles 3, 3a, 3b are parallel to and at equal distances from that of the turret. The spindles carry in their outer ends, in chucks 3L, discs of glass 24 to be ground. Abrasive wheel 4 performs rough grinding of the disc so as to make it roughly concave or convex in shape. Precision grinding is performed by adjustably mounted wheel 5, which is of cup form and provided with an annular grinding edge. While grinding wheels 4 and 5 operate on discs held on spindles 3b and 3, respectively, a finished disc held on spindle 3a is in a position where it may be removed by an operator and replaced by a new disc. There is provided a means of rotating the

turret in steps of one third of a turn to advance a disc to its next position.

The present invention provides a device for grinding a spherical surface of a lens, comprising:

- 5 a machine base;
- an index table having a periphery and being rotatable on the machine base;
- a plurality of chuck units spaced equidistantly around and attached to the periphery of the index table;
- 10 a rough grinding station fixedly positioned on the machine base in communication with the periphery of the index table;
- a precision grinding station fixedly positioned but spaced from the rough grinding station on the machine base, said precision grinding station also being in communication with the periphery of the index table;
- 15 first rotary spindle means arranged in the machine base under the rough grinding station and the precision grinding station;
- first motor means, arranged in the machine base, for driving the first rotary spindle means;
- 20 diamond stones arranged at the rough grinding station and at the precision grinding station;
- second rotary spindle means arranged on the machine base at the rough grinding station and the precision grinding station, for rotating the diamond stones thereat in to and out of grinding engagement with the lens to be ground; and
- 25 second motor means, arranged on the machine base, for driving the second rotary spindle means;
- characterised by the device comprising:
- 30 lens holding means, gripped by each of the plurality of chuck units, for holding the lens to be ground;
- conveyor means, spaced from the machine base, for moving the lens;
- 40 an auto-hand, positioned between the machine base and the conveyor means, for transferring the lens from the conveyor means to the lens holding means; and
- characterised in that the first rotary spindle means move into and out of engagement with the lens holding means at the rough grinding station and the precision grinding station and in that the second rotary spindle for rough grinding is provided with a mechanism for moving the lens to the grinding stones by the predetermined amount and the second rotary spindle for precision grinding is provided with a mechanism for moving the lens to the grinding stones at the predetermined constant pressure.
- 45 In a further aspect, the invention provides a spherical surface grinding device having a holder capable of holding the work, characterised by a chuck unit for gripping this holder and comprising a transferring device capable of moving between the position for rough grinding of the work and the position for precision grindings, two work shafts each of which receives the holder transferred from the aforementioned chuck unit, is rotatable and moves up and down, one being adapted for rough grinding of the work, and the
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other for precision grinding, and two grinding tools placed respectively facing the two work shafts, which are in concert capable of grinding the work to the desired spherical shape and each of which is located at a specified angle and position relative to the work surface.

In a further aspect, the invention provides a spherical surface grinding device having a holder capable of holding the work characterised by a chuck unit for gripping this holder, and comprising a transferring device capable of moving between the position for rough grinding of the work and the position for precision grinding, two shafts each of which receives the holder transferred from the aforementioned chuck unit and holds it, and which are rotatable and move up and down, one of them being adaptable for rough grinding of the work and the other for precision grinding, and two grinding tools placed respectively facing these two work shafts, which in concert are capable of grinding the work held by the holder to the desired spherical shape, and each of which is located at a specified angle and position relative to the work surface, the work shaft for rough grinding being so arranged as to feed in the work the prescribed distance against the grinding tool, and the work shaft for precision grinding to feed in the work at a prescribed pressure.

The device according to the invention is quite advantageous in maintenance and control of precision and reduction of cost.

Fig. 1 is a plan view showing a particular structure of a conventional spherical surface grinding device;

Fig. 2 is a conceptual diagram showing the scheme for transferring the work in an embodiment of this invention;

Fig. 3 is a plan view showing this spherical surface grinding device; and

Fig. 4 is a front elevation of the same.

The Most Preferable Mode in Exercising the Invention

In the following discussion, an embodiment of this invention is described with reference to the accompanying drawings.

Fig. 2 is a conceptual diagram showing the scheme for transferring the work. Lens 9 on conveyor 8 is transferred in the direction of a by auto-hand 10 and is taken in by a holder 12 supported on a chuck unit 11, to be held thereby. The chuck unit 11 is on an index table 13, turned by 120° in the direction of b, to conduct the rough grinding, then, further turned by 120° in the direction of c, to conduct the precision grinding and again turned by 120° in the direction of d to the former position, where the lens 9 is detached from the holder 12, taken out in the direction of e and put on a conveyor 14. The aforementioned operations are continuously run one after another at the same time.

Fig. 3 presents a particular embodiment, giving a plan view of a spherical surface grinding device and Fig. 4 is its front elevation. In Fig. 4, a

diamond stone 15 is provided for rough grinding and is METAL BOND of the order of #100~#400. Diamond grinding stone 16 is provided for precision grinding and is METAL BOND of the order of #800~#1500. The respective rotary spindles 17 and 18 are provided for the aforementioned grinding stones 15 and 16 with respective driving motors 19 and 20. The sliding drive motors 21 and 22 are provided for transferring the aforementioned grinding stones 15 and 16 to their specified positions. Further, by drive motors, not shown in the figures, the stones are inclined at specified slope angles pivoting around grinding stations 23 and 24. On each of the rotary spindles 25 and 26, the holder 28 (Fig. 3 only) holding the lens stock 27 to be ground is mounted. The rotary spindles 25 and 26 shown in Fig. 4 turn at about 5~50 rpm and have drive motors 29 and 30, respectively. The rotary spindle 25, being for rough grinding, is forcibly fed in for a specified distance against the diamond grinding stone 15, realizing the grinding in the forced cutting-in way. The rotary spindle 26, being for precision grinding, is fed in against the diamond grinding stone 16 at a specified constant pressure, realizing the grinding in the constant pressure cutting in way.

As shown in Fig. 3 an auto-hand 31 is provided for taking the lens stock 27 into this spherical surface grinding device, which performs the operation of getting the work to be held by or taken out of the holder 28. The chuck unit 32 supports the holder 28 and is mounted on a rotary index 33. The machine base 34 is shown in Fig. 4 only.

In the following discussion, the operation of the spherical surface grinding device is described.

First, as seen in Fig. 3, the auto-hand 31 takes in the lens stock 27 from outside and sets it on the holder 28, to be held thereby. The holder 28, being held by the chuck unit 32, is turned by 120° in the direction of f by the rotary index 33, to be set in position, and is secured by the rotary spindle 25 upon the chuck unit 32 releasing it. The diamond grinding stone 15 is so arranged as to grind the lens stock 27 to the desired radius of curvature and is running at as high a speed as 800~1,200 rpm. Against this stone, the lens stock 27 fixed on the aforementioned rotary spindle 25 shown in Fig. 4 is forcibly subjected to a constant dimension cutting-in, while turning at 50 rpm for performing the rough grinding. After this grinding, the holder 28 is released from the rotary spindle 25, again supported by the chuck unit 32 and, then, turned further by 120° in the direction of f, to be set in position. Then the lens stock 27 is secured on the rotary spindle 26 similarly as above-described and is subjected to a cutting-in at a constant pressure, while turning at 5~50 rpm, for performing the precision grinding. After this grinding, the lens stock 27 is again supported similarly by the chuck unit 32 and again turned by 120° in the direction of f, to be returned to its former position. Thereafter, the lens 27 is finished by the precision grinding as above-described and is taken out from the spherical surface grinding device by means of the auto-hand 31. A series of

operations as above mentioned are continuously carried out each at the same time.

According to the embodiment above-described, Rmax of the order of 0.2 m can be readily achieved after finishing by precision grinding within a time of about 20~50 sec and this process is automatable.

The composition and operation of the spherical surface grinding device are described below.

In Fig. 2, the auto-hand 10 has, for example, an attraction head to attract the lens 9 by vacuum suction attached to its end, and the lens 9, being transferred by the conveyor 8, is attracted by the attraction head of the auto-hand 10. In this state, when the auto-hand 10 is rotated in the direction of arrow a, the lens 9 is transferred onto the holder 12 which is chucked to the chuck unit 11 of the index table 13. The holder 12 is intended to hold the lens 9 by tightening its outer circumference by means of, for example, a chuck ring, and this chuck ring always acts in the direction to tighten to outer circumference of the lens 9 by means of compression spring or the like built in the holder 12. When dismounting the lens 9 from the holder 12, the tightening force of the chuck ring by the compression spring are cancelled by other means.

On the other hand, three chuck units 11 are provided on the index table 13, and the chuck units 11 it to be opened and closed, for example, by a hydraulically driven piston (unnumbered) as shown in Fig. 3. Each chuck unit chucks the holder 12 which holds the lens 9. By rotating the index table 13, the holder 12 may be transferred up to the rough grinding position and then to the precision grinding position.

As shown in Figs. 3 and 4, a work turning spindle 25, which is free to move vertically, is installed beneath the rough grinding position. When the chuck unit 32 opens to release the chuck of the holder 28 is held simultaneously by, for example, the collet chuck provided at the upper end of the work turning spindle 25. Meanwhile, since the upper plane of the collet chuck and the lower plane of the holder 28 are machined at a constant dimensional precision, the holder 28 is always held in the same state by the work turning spindle 25. This relationship holds true also between the work turning spindle 26 and the holder 28 as mentioned below.

Above the rough grinding position, incidentally, the diamond grinding stone 15 for rough grinding is at the end of the rotary spindle 17. The rotary spindle 17 can rotate around the shaft 23 which is vertical to the paper surface, and which is moved reciprocally in a specified angular range by a motor (not shown). When grinding the lens 27 held by the holder 28, the work turning spindle 25 is raised until the lens 27 contracts the grinding stone 15. After the slide drive motor 21 is rotated to move the grinding stone 15 in the horizontal direction to keep a specified positional relationship with the lens 27, then the rotary spindle 17 is rotated about the shaft 23 by the motor 19. By feeding upwards at a specified dimension in

cooperation with the reciprocal motion of the rotary spindle 17 while rotating the work turning spindle 25 (forced cutting-in), the lens 27 held on the holder 28 is subjected to rough grinding by the grinding stone 15 which rotates at high speed.

After the grinding, the holders 28 is released from the collet chuck of the work turning spindle 25, is chucked again by the chuck unit 32, and then is transferred to the precision grinding position as the index table 33 rotates 120 degrees in the direction of arrow f.

Similar to the configuration of the rough grinding position, a work turning spindle 26 is disposed beneath the precision grinding position, and a diamond grinding stone 16 is disposed at the end of the turning spindle 18 in a fixed state. The operation of precision grinding is almost the same as that of rough grinding, its explanation is omitted, but one difference from the rough grinding operation is that the precision grinding operation uses constant pressure cutting-in. Accordingly, the work turning spindle 26 is designed to move upward by, for example, a constant high pressure air.

As mentioned above, the positional precision of the holder 28 and the work turning spindle 26 in the state where the holder 28 is held by the work turning spindle 26 is the same as that of the holder 28 and work turning spindle 25 at the rough grinding position. Since the lens 27 is fixed firmly by the holder 28, the lens holding state does not change at all in both grinding processes. Therefore, grinding of high precision is realized.

Returning to Fig. 2, after the precision grinding, the holder 12 is chucked again by the chuck unit 11. When the index table 13 rotates 120 degrees in the direction of arrow d to return to the initial position, the lens 9, after the grinding process, is attracted by the attraction head of the auto-hand 10, is released from the holder 12, and then is transferred in the direction of the arrow e by the auto-hand 10 to be mounted on the conveyor 14.

Industrial Applicability

According to this invention, the holder 28 holding the lens stock 27 is transferred to the chuck unit 32 for rough grinding and then to the chuck unit for precision grinding. Further, the chuck unit for rough grinding is provided with the mechanism for forced cutting-in against the grinding tool, while the chuck unit for precision grinding is provided with the mechanism for cutting-in at a specified pressure, respectively. For this reason, a well finished surface is realizable in a short time at high efficiency and such post-processing operations as smoothing and polishing may be eliminated. Besides, automation of the processes is feasible and maintenance of quality and cost reduction are easy.

Claims

1. A device for grinding a spherical surface of a lens, comprising:
a machine base (34);

an index table (13, 33) having a periphery and being rotatable on the machine base (34);

a plurality of chuck units (11, 32) spaced equidistantly around and attached to the periphery of the index table (13, 33);

a rough grinding station (23) fixedly positioned on the machine base (34) in communication with the periphery of the index table (13, 33);

a precision grinding station (24) fixedly positioned but spaced from the rough grinding station (23) on the machine base (34), said precision grinding station (24) also being in communication with the periphery of the index table (13, 33);

first rotary spindle means (25, 26), arranged in the machine base (34) under the rough grinding station and (23) the precision grinding station (24);

first motor means (29, 30), arranged in the machine base (34), for driving the first rotary spindle means (25, 26);

diamond stones (15, 16) arranged at the rough grinding station (23) and at the precision grinding station (24);

second rotary spindle means (17, 18) arranged on the machine base (34) at the rough grinding station (23) and the precision grinding station (24), for rotating the diamond stones (15, 16) thereat in to and out of grinding engagement with the lens (9, 27) to be ground; and

second motor means (19, 20), arranged on the machine base (34), for driving the second rotary spindle means (17, 18);

characterised by the device comprising:

lens holding means (12, 28), gripped by each of the plurality of chuck units (11, 32), for holding the lens to be ground;

conveyor means (8, 14), spaced from the machine base (34), for moving the lens (9, 27);

an auto-hand (10, 31), positioned between the machine base (34) and the conveyor means (8, 14), for transferring the lens (9, 27) from the conveyor means (8, 14) to the lens holding means (12, 28); and

characterised in that the first rotary spindle means (25, 26) move into and out of engagement with the lens holding means (12, 28) at the rough grinding station (23) and the precision grinding station (24), and in that the second rotary spindle (25) for rough grinding is provided with a mechanism for moving the lens (27) to the diamond stones (15) by the predetermined amount and the second rotary spindle (26) for precision grinding is provided with a mechanism for moving the lens (27) to the diamond stones (16) at the predetermined constant pressure.

2. A device according to claim 1, wherein:

said plurality of chuck units (11, 32) spaced equidistantly around the periphery of the index table (13, 33) numbers three.

3. A device according to claim 1, wherein:

said rough grinding station (23) and said precision grinding station (24) are fixedly positioned on the machine base (34), at approximately 120 degrees from each other around the periphery of the index table (13, 33).

Patentansprüche

1. Vorrichtung zum Schleifen einer sphärischen Fläche einer Linse

mit einem Maschinenbett (34),
mit einer eine Peripherie besitzenden Indexplatte (13, 33), die auf dem Maschinenbett (34) drehbar ist,

mit mehreren Einspanneinheiten (11, 32), die in gleichen Abständen rund um die Peripherie der Indexplatte (13, 33) befestigt sind,

mit einer Grobschleifstation (23), die fest an dem Maschinenbett (34) in Verbindung mit der Peripherie der Indexplatte (13, 33) angeordnet ist,

mit einer Präzisions-Schleifstation (24), die fest, aber in einem Abstand von der Grobschleifstation (23) an dem Maschinenbett (34) in Verbindung mit der Peripherie der Indexplatte (13, 33) angeordnet ist,

mit einer ersten Drehspindel-Vorrichtung (25, 26), die am Maschinenbett (34) unterhalb der Grobschleifstation (23) und der Präzisions-Schleifstation (24) angeordnet ist,

mit einem ersten am Maschinenbett (34) angeordneten Motor (29, 30) zum Antrieb der ersten Drehspindel-Vorrichtung (25, 26),

mit Diamantkristallen (15, 16), die an der Grobschleifstation (23) und an der Präzisions-Schleifstation (24) angeordnet sind,

mit einer zweiten Drehspindel-Vorrichtung (17, 18), die an der Grobschleifstation (23) und der Präzisions-Schleifstation (24) auf dem Maschinenbett (34) zur Drehung der Diamantkristalle (15, 16) in die und aus der Schleifposition an der zu schleifenden Linse (9, 27) angeordnet ist,

mit einem zweiten am Maschinenbett (34) angeordneten Motor (19, 20) zum Antrieb der zweiten Drehspindel-Vorrichtung (17, 18),

gekennzeichnet
durch eine Linsenhalterung (12, 28), die zum Halten der zu schleifenden Linse von jeder Einspanneinheit (11, 32) ergriffen wird,

durch ein von dem Maschinenbett (34) mit Abstand angeordnetes Fördermittel (8, 14) zur Bewegung der Linse (9, 27),

durch einen selbsttätigen Greifer (10, 31), der zwischen dem Maschinenbett (34) und dem Fördermittel (8, 14) zur Beförderung der Linse (9, 27) von dem Fördermittel (8, 14) zu der Linsenhalterung (12, 28) vorgesehen ist,

und dadurch, daß sich die erste Drehspindel-Vorrichtung (25, 26) an der Grobschleifstation (23) und an der Präzisions-Schleifstation (24) in und außer Eingriff mit der Linsenhalterung (12, 28) bewegt,

und dadurch, daß die zweite Drehspindel-Vorrichtung zum Grobschliff (25) mit einem Mechanismus für eine Bewegung der Linse (27) um einen vorherbestimmten Betrag zu den Diamantkristallen (15) hin und zum Präzisionsschliff (26) mit einem Mechanismus für eine Bewegung der Linse (27) bei einem vorherbestimmten, konstanten Druck zu den Diamantkristallen (16) hin versehen ist.

2. Vorrichtung gemäß Anspruch 1, bei der die Einspanneinheiten (11, 32) zu dritt in gleichen Abständen rund um die Peripherie der Indexplatte (13, 33) angeordnet sind.

3. Vorrichtung gemäß Anspruch 1, bei der auf dem Maschinenbett (34) die Grobschleifstation (23) und die Präzisions-Schleifstation (24) fest in Winkeln von etwa 120° voneinander rund um die Peripherie der Indexplatte (13, 33) angeordnet sind.

Revendications

1. Dispositif pour roder une surface sphérique d'une lentille, comprenant:

une plaque de base de machine (34);

une table à transfert circulaire (13, 33) ayant une périphérie et pouvant tourner sur la plaque de base de machine (34);

une pluralité d'unités de mandrins de serrage (11, 32) disposées à égale distance et fixées sur la périphérie de la table à transfert circulaire (13, 33);

un poste de rodage grossier (23) disposé de façon fixe sur la plaque de base de machine (34) en communication avec la périphérie de la table à transfert circulaire (13, 33);

un poste de rodage de précision (24) disposé de façon fixe sur la plaque de base de machine (34) mais à distance du poste de rodage grossier (23), ledit poste de rodage de précision (24) étant également en communication avec la périphérie de la table à transfert circulaire (13, 33);

des premiers axes rotatifs (25, 26) disposés dans la plaque de base de machine (34) sous le poste de rodage grossier (23) et le poste de rodage de précision (24);

des premiers moteurs (29, 30) disposés dans la plaque de base de machine (34) pour entraîner les premiers axes rotatifs (25, 26);

des diamants (15, 16) disposés sur le poste de rodage grossier (23) et sur le poste de rodage de précision (24);

des seconds axes rotatifs (17, 18) disposés sur la plaque de base de machine (34) au niveau du

poste de rodage grossier (23) et du poste de rodage de précision (24), pour entraîner en rotation les diamants (15, 16) de ceux-ci en contact de rodage et hors de contact de rodage avec la lentille (9, 27) qui doit être rodée; et

des seconds moteurs (19, 20) disposés sur la plaque de base de machine (34) pour entraîner les seconds axes rotatifs (17, 18);

caractérisé en ce que le dispositif comprend:

des moyens de support de lentille (12, 28) serrés par chacune des unités de mandrins de serrage (11, 32) pour maintenir la lentille qui doit être rodée;

des moyens de transport (8, 14) distants de la plaque de base de machine (34) pour déplacer la lentille (9, 27);

un bras automatique (10, 31) placé entre la plaque de base de machine (34) et les moyens de transport (8, 14), pour transférer la lentille (9, 27) des moyens de transport (9, 14) aux moyens de support de lentille (12, 28); et

caractérisé en ce que les premiers axes rotatifs (25, 26) viennent en contact avec les moyens de support de lentille (12, 28) et se séparent de ceux-ci au niveau du poste de rodage grossier (23) et du poste de rodage de précision (24), et en ce que le second axe rotatif (25) pour le rodage grossier est muni d'un mécanisme pour déplacer la lentille (27) vers les diamants (15) de la quantité prédéterminée et en ce que le second axe rotatif (26) pour le rodage de précision est muni d'un mécanisme pour déplacer la lentille (27) vers les diamants (16) sous la pression constante prédéterminée.

2. Dispositif selon la revendication 1, dans lequel ladite pluralité d'unités de mandrins de serrage (11, 32) disposées à égale distance sur la périphérie de la table à transfert circulaire (13, 33) est égale à 3.

3. Dispositif selon la revendication 1, dans lequel ledit poste de rodage grossier (23) et ledit poste de rodage de précision (24) sont disposés de façon fixe sur la plaque de base de machine (34) à approximativement 120° l'un de l'autre sur la périphérie de la table à transfert circulaire (13, 33).

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Fig. 1

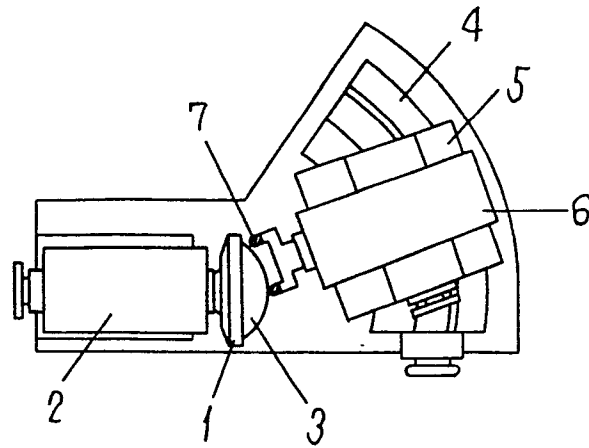


Fig. 2

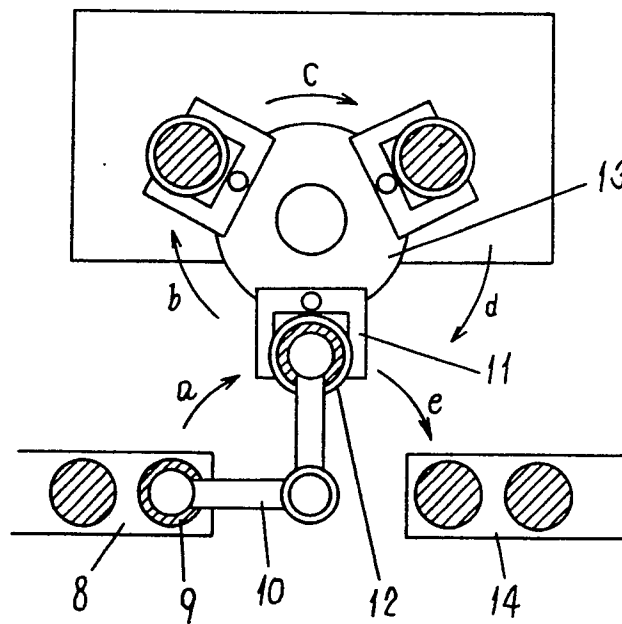


Fig.3

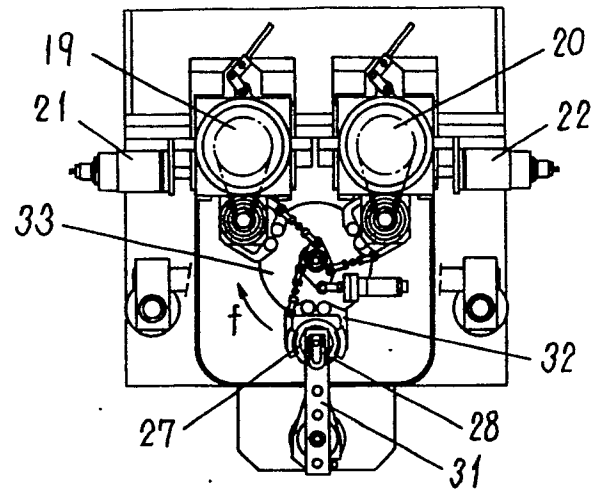


Fig.4

