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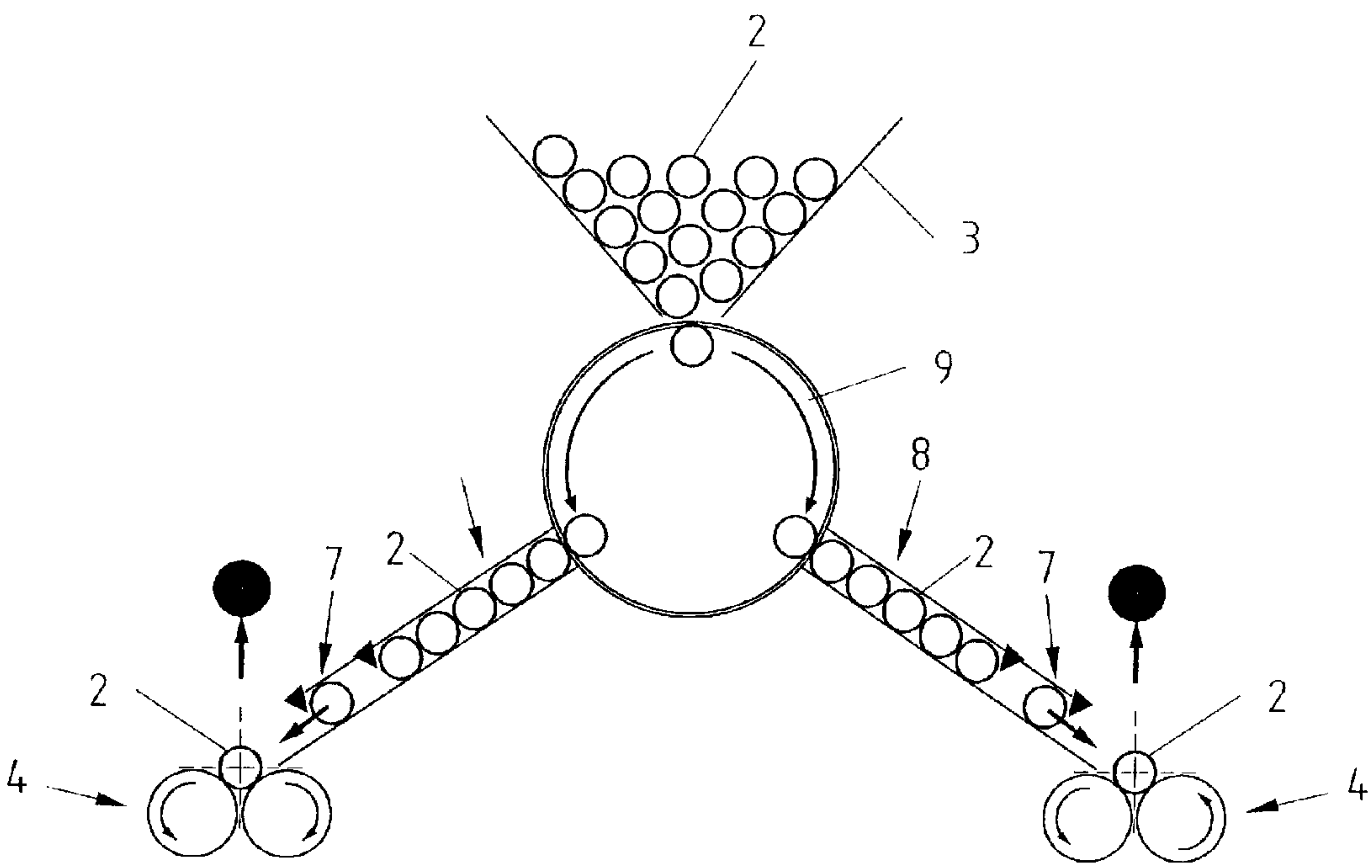
(54) Titre : PROCEDE ET DISPOSITIF DE FABRICATION DE TRONCONS CYLINDRIQUES A PARTIR DE TUBES, DE PREFERENCE EN VERRE

(54) Title: PROCESS FOR MANUFACTURING CYLINDRICAL SECTIONS FROM TUBES, PREFERABLY OF GLASS, AND A DEVICE FOR PERFORMING THE PROCESS



(57) Abrégé/Abstract:
The process to which this invention relates is used to manufacture cylindrical sections from tubes, preferably of glass, for use in particular as syringe cylinders. The tubes are first withdrawn from the supply station and are then transferred individually to the processing station . There the tubes are held in such a manner that they can be moved axially forward and rotated about their axis, so that cylindrical sections can be sequentially cut from them by means of a laser. After each section is cut off, it is moved axially forward away from the tube. The opposing end surfaces of the tube and the section are simultaneously or serially melted to form a bulge or lip. Finally, the sections are conducted by means of guiding devices to the transportation unit, which is equipped with receptacles that have low heat-conducting properties, so as to avoid the occurrence of any mechanical stress in the sections as they cool, while the tube is moved forward for removal of the next section.

Abstract

The process to which this invention relates is used to manufacture cylindrical sections from tubes, preferably of glass, for use in particular as syringe cylinders. The tubes are first withdrawn from the supply station and are then transferred individually to the processing station . There the tubes are held in such a manner that they can be moved axially forward and rotated about their axis, so that cylindrical sections can be sequentially cut from them by means of a laser. After each section is cut off, it is moved axially forward away from the tube. The opposing end surfaces of the tube and the section are simultaneously or serially melted to form a bulge or lip. Finally, the sections are conducted by means of guiding devices to the transportation unit, which is equipped with receptacles that have low heat-conducting properties, so as to avoid the occurrence of any mechanical stress in the sections as they cool, while the tube is moved forward for removal of the next section.

Process for manufacturing cylindrical sections from tubes, preferably of glass, and a device for performing the process.

The invention concerns a process for manufacturing cylindrical sections from tubes, preferably of glass, for use in particular as syringe cylinders, with a supply station for the tubes, a processing station, a transportation unit for removal of the finished sections and a laser head, arranged in the processing station, for cutting the sections from the tube. The invention also concerns a device for performing the process.

There are several known variants for processing materials of various kinds through the use of one or more lasers. For making products in large numbers, however, it is important to be able to use fully automated processing stations that will work reliably and, as in the case of making syringe cylinders for medical use, will meet high quality standards.

An object of the invention is to develop a process of the kind referred to at the outset that will allow tubes of different diameters to be processed into cylindrical sections of desired length, through a fully automated procedure that, when completed, leaves the device ready to conduct further processing.

Summary of the Invention

In a first aspect the invention provides an apparatus for cutting a plurality of tube sections from an elongated glass tube, the apparatus comprising: a supply holding a plurality of the tubes; means for feeding the tubes one at a time from the supply to a station; means for rotating each of the tubes in the station about a longitudinal axis of the tube in the station; an axially fixed stop in the station; pusher means in the station for pressing the tube axially against the fixed stop; cutting means in the station for directing a laser beam at the rotating tube in the station at a location along the tube offset from the stop to melt the tube at the location and cut from the tube a section lying between the location and the stop; means for aspirating vapors produced by the cutting operation from the location; a conveyor adjacent the station; and unloading means for transversely displacing the tube section after cutting from the tube onto the conveyor and transporting the tube section from the station by means of the conveyor.

In a second aspect the invention provides an apparatus for cutting a plurality of tube sections from an elongated glass tube, the apparatus comprising: a supply holding a plurality of the tubes; means for feeding the tubes one at a time from the supply to a station; means for rotating each of the tubes in the station about a longitudinal axis of the tube in the station; an axially fixed stop roller in the station aligned axially with the tube in the station; pusher means in the station for pressing the tube axially against the fixed stop; cutting means in the station for directing a laser beam at the rotating tube in the station at a location along the tube offset from the stop to melt the tube at the location and cut from the tube a section lying between the location and the stop; a conveyor adjacent the station; and unloading means for transversely displacing the tube section after cutting from the tube onto the conveyor and transporting the tube section from the station by means of the conveyor.

Detailed Description of Preferred Embodiments

The advance represented by the invention consists essentially of the fact that cylindrical sections of high quality can be made in a fully automated process, and the sections so produced will be largely stress-free. The manufactured output is therefore optimal. In this way an intelligent, self-controlled system can offer a fully automated production process. This makes it possible, for example, to be very flexible in selecting the length and diameter of the tubes to be processed. The entire system can be controlled by the usual computers, but also through a memory-stored program.

Since the ends of the tubes to be processed may be closed, and are in any case unsuitable for processing, it is recommended, in line with the invention, that after a new tube is placed in the processing station an end-piece should first be cut off and removed from the process through a swinging flap or trapdoor. Similarly, once the tube has been fully cut to length, the remaining portion is also removed from further processing by the same means.

In order to take account during the production process of the many parameters, such as diameter, type of glass, etc., the invention provides for adjusting the rotational speed of the tubes to the various processing steps involved in cutting, melting and moving the tube forward.

With a supply station for supplying the tubes, a processing station and a transportation unit for removal of the finished sections, the purpose of the invention is further fulfilled in that the supply station is located above the processing station and has a stock separator, arranged so that between the supply station and the separator there is a storage unit. This arrangement ensures a continuous feed of tubes into the device for processing.

From the viewpoint of achieving greater throughput, it is advantageous if the supply station is directly connected to a distributor drum that can supply at least two processing stations with tubes.

The invention also provides for the supply station to be shaped as a funnel that can be moved into servicing position for filling with tubes. This not only makes it easier to stock it with new raw materials but, thanks to the storage unit, re-loading can be performed without interrupting the other processing steps.

In one particularly advantageous and hence preferred embodiment of the invention the processing station consists of a rotation and propulsion unit for the tubes and a reception and removal unit for the cylindrical sections.

The rotation and propulsion unit accordingly has two supporting rollers for the tubes, arranged axially parallel and at a slight distance to each other, and rotating in the same direction. Above these are arranged pressure rollers for the tubes that can be swung out of the way. This makes it possible to ensure proper guidance and centering of the tube for processing.

It is advantageous if these pressure rollers are applied against the tube by means of pneumatic cylinders, where the pneumatic cylinders are arranged together with a swinging arm that can be adjusted at right angles to the axis of the supporting rollers. This makes it possible to lift and withdraw those pressure rollers that are no longer needed, as the tube is gradually reduced in length during the course of processing. It also facilitates the axial motion of the tube. Through the overall arrangement of the cylinder on the swinging arm it is also readily possible to raise the pressure roller slightly for moving the tube forward.

In order to improve the guiding and centering of the tube yet further, the pressure of the pneumatic cylinders is preferably controlled by a pressure regulator.

In order to ensure slippage-free operation and to exclude the risk of damage, the surface of the supporting rollers is such as to exert sufficient friction against glass.

In order to be able to move the tube forward promptly after a section has been cut off, the rotation and propulsion unit has a sliding carriage for moving the tube axially forward, one that preferably engages the end of the tube.

The reception and removal unit has a pinching device consisting of two supporting rollers. The two supporting rollers run axially parallel and at a slight distance to each other. These rollers rotate in the same direction as the supporting rollers of the rotation and propulsion unit and are synchronized with them. This arrangement provides for uniform propulsion of the tube and of the sections as they are cut off, and ensures that the cut is cleanly made.

It has been found to be advantageous if each of the two supporting rollers in the reception and removal unit is arranged at one end of a single-arm positioning lever, and if the other ends of the positioning levers are fastened co-axially and pivotally to a cogwheel that drives the rollers. This makes it possible, by swivelling the positioning levers, to separate the rollers and allow the cut cylindrical sections to drop through and be removed.

The reception and removal unit has a stopper roller that serves as a stop both for the forward movement of the tube and for the processing itself. The stop has a diameter that is adjustable to the cylinder section, and it is axially aligned with the section. In order to avoid inducing thermal-mechanical stress from the stopper roller to the glass, which particularly in the bulge or lip is still hot from the melting process, it is advisable to pre-heat the stopper roller (e.g. by induction).

In the corresponding embodiment of the invention, the reception and removal unit also has at least one pressure roller that can be applied against the tube by means of a pneumatic cylinder. This pneumatic cylinder is likewise arranged on the adjustable swinging arm.

In order to promote the proper axial movement of the tube and the positioning of the section to be cut, the invention allows for one or more of the pressure rollers to be aligned at an angle to the supporting rollers.

It is also recommended that a suction device be installed in the transition zone between the rotation and propulsion unit and the reception and removal unit to absorb any glass sublimate.

In order to control the gap between the tube and the cylindrical section during processing, and in particular during melting of the edges after cutting, an optical sensor for measuring this gap is provided in the transition zone between the rotation and propulsion unit and the reception and removal unit. The signal from this sensor can be used to regulate parameters within the entire system.

If it is found necessary to do so, a shaping roller can be arranged in the transition zone between the rotation and propulsion unit and the reception and removal unit, to influence mechanically the bulge or lip formed by the melting process.

So that the cylindrical sections can be retrieved with a minimum of mechanical stress from the reception and removal unit, that unit is equipped with metallic springs located beneath the pincher roller, to guide the cut sections to the transportation unit.

Finally, to avoid the appearance of mechanical stress in the incompletely cooled cylindrical sections, the transportation unit is equipped with prismatic receptacles for the sections, which will allow them to cool safely.

The invention is further explained below, in the embodiment shown in the illustrations. These show:

Figure 1 a schematic representation of the supply station and the processing station of the device according to the invention,

Figure 2a the processing station, seen from the side,

Figure 2b the processing station, seen from the front,

Figure 3 the object from figure 2 seen from above,

Figure 4 the transportation unit of the device,

Figure 5a and 5b a detailed view of the object from figure 2, showing how the process proceeds,

Figure 6 a detailed view of the reception and removal unit, seen from the side,

Figure 7 the object from figure 5, seen from the front, showing the processing situation (figure 7a) and the removal process (figure 7b).

The device shown in the illustrations is used to manufacture cylindrical sections 1 from glass tubes 2, for use in particular as syringe cylinders. The device includes a supply station 3 for the tubes 2, which can be seen in the upper portion of figure 1. There is also a processing station 4, as portrayed particularly in figures 2 and 3. The device includes, as well, a transport unit 5 for removal of the finished cylindrical sections 1, through which the sections 1 are conducted for further processing. In the area of the processing station 4 there is a laser head 6, whereby the laser can either be applied directly to the processing station 4, or the laser beam can be guided to the processing station 4 by means of mirrors.

The device also has a stock separator 7, which ensures that only one tube 2 at a time is conducted to the processing station 4. Between the supply station 3 and the separator 7 there is also a storage facility 8, consisting essentially of a sloping ramp, along which the tubes 2 slide towards the separator 7.

As shown in figure 1, the supply station 3 can be equipped with a distributor drum 9, by means of which at least two processing stations 4 can be supplied with tubes 2 at the same time. It is of course possible to supply further processing stations 4 from a single distributor drum 9.

The supply station 3 is designed essentially as a funnel that can be moved into a servicing position, not shown in the illustration, for loading with tubes 2. The storage device 8 allows sufficient time to re-load the supply station 3 without interrupting the production process.

The processing station 4 consists essentially of a rotation and propulsion unit 10 for the tubes and a reception and removal facility 11 for the cylindrical sections, as shown in figures 2a, 2b and 3. The rotation and propulsion unit 10 has two supporting rollers 12 for the tubes 2, arranged axially parallel and at a slight distance to each other, and rotatable in the same direction. Above these are arranged pressure rollers 13 for the tube 2. These pressure rollers 13 are applied against the tube 2 by means of a pneumatic cylinder 14 and they are affixed to a swinging arm 15 that can be adjusted at right angles to the axis of the supporting rollers 12. This makes it possible to lift the pressure roller 13 slightly from the tube 2, by means of the swinging arm 15, when it is time to move the tube 2 forward to the reception and removal unit 11.

The pneumatic cylinder 14 is controlled by a pressure regulator so that the proper pressure can be selected and applied. The supporting rollers 12 are equipped with a surface that exerts sufficient friction against the glass so that, on one hand, the tubes 2 can be securely rotated, and on the other hand their surface will not be damaged.

The rotation and propulsion unit is equipped with a carriage 16 for moving the tubes 2 axially forward, and as the carriage 16 moves toward the reception and removal unit 11, the pressure roller 13 is lifted by means of the pneumatic cylinder 14, so that the carriage 16 can pass beneath it freely.

The reception and removal unit 11 has a pinching device consisting of two supporting rollers 17, as shown clearly in figure 7. These two supporting rollers 17 are arranged axially parallel to each other and, in processing position, at a slight distance from each other. These supporting rollers rotate in the same direction as the supporting rollers 12, and are synchronized with them.

Each of the two supporting rollers 17 is arranged at one end of a single-arm positioning lever 18. At their other end the positioning levers 18 are fastened co-axially and pivotally to a cogwheel 19 that drives the supporting rollers 17.

The reception and removal unit 11 has a stopper roller 20, as shown in Figures 2a, 2b and 3, the diameter of which fits the cylindrical section 1 and is axially aligned with it. A uniform length for the cylindrical sections is thereby assured.

The reception and removal unit 11 also has a pressure roller 13 that can be applied against the tube 2 or the cylindrical section 1 by means of a pneumatic cylinder. This pneumatic cylinder is likewise arranged on the adjustable swinging arm 15, so that as the tube 2 is pushed forward this pressure roller 13 moves to the raised position.

As can be seen in Figure 3, one or more of the pressure rollers 13 can be adjusted at an angle to the supporting rollers 12. Such an arrangement provides additional force to the forward motion of the tube 2 or the cylindrical section 1.

During the laser procedure, i.e. the cutting and melting steps, a radiation trap or sink 24 located under the laser head 6 protects the removal unit 11 from the laser rays. Just before removal (see Figure 5a) of the cylindrical section 1, with bulges at each end, the radiation trap is pneumatically drawn back (see Figure 5b) so that the cylindrical section 1 can be transferred freely via the metallic springs to the transport unit 5.

In the transition zone between the rotation and propulsion unit 10 and the reception and removal unit 11 a suction device (not shown in the illustrations) can be installed to absorb any glass sublimate. In the same zone an optical sensor (not shown) can be installed to measure the gap between the tube 2 and the cylindrical section 1. The measurement of the gap can be important in setting the processing parameters for melting the tubular ends.

Finally, in the transition zone between the rotation and propulsion unit 10 and the reception and removal unit 11 a shaping roller 21 can be arranged, as shown schematically in figure 3, to influence mechanically the bulge formed by melting at the end surfaces.

In order to transfer the cylindrical sections 1 to the transport unit 5 after cutting, without mechanical stress, the reception and removal unit 11 is equipped with metallic springs 22 located beneath the pincher roller, as shown in figure 4. These springs 22 guide the cylindrical sections 1, as they are cut off, into the prismatic receptacles 23 of the transport unit 5, a procedure that also ensures against any excessive heat loss from the still-hot sections 1. This avoids the risk of inducing additional mechanical stress in the sections 1.

During processing the tubes 2 are first separated from the supply station 3 and then individually transferred to the processing station 4, where the tubes 2 are held in such a manner that they can be axially moved forward and rotated about their axis, so that cylindrical sections 1 can be serially cut from them.

The actual cutting of the cylindrical sections 1 is done by means of a laser 6, which is merely indicated in the illustrations.

After it is cut the section 1 is axially distanced from the tube 2. The opposing end surfaces of the tube 2 and the section 1 are simultaneously or serially melted to form a bulge or lip, the geometric form of which is shaped by rotation, geared to the diameter of the piece (tube 2 and section 1), and the resulting centrifugal force. The end surfaces of the tube 2 and the section 1 can be processed either simultaneously or serially.

Finally, the cylindrical sections 1 are transferred via the guides to the transport unit 5, whereby the receptacles 23 have a low heat conductivity to prevent mechanical stress through cooling. The tube 2 is then moved axially forward to the reception and removal unit 11 for cutting of the next section.

After a new tube 2 is placed in the processing station 4, a first section must be cut off and removed through a swinging flap or trapdoor, since the end surfaces are frequently untreated, or alternatively they may be fused shut. Similarly, once the tube 2 has been fully cut to length, the remaining portion is also removed from further processing by the same means.

It is also possible to vary the speed of rotation of the tube 2 and adjust it to the various processing steps of cutting or melting and moving forward.

For the sake of processing efficiency and capacity use, as shown in figure 1, the processing stations can be operated in pairs, with the two processing stations supplied from the same supply station. Moreover, a greater number of processing stations can be used, preferably in pairs, employing the laser process alternately among the stations, so that the cylindrical sections 1 can be removed and the glass tubes 2 pushed forward in one station while the laser is operating at the other.

Claims:

1. An apparatus for cutting a plurality of tube sections from an elongated glass tube, the apparatus comprising:

a supply holding a plurality of the tubes;

means for feeding the tubes one at a time from the supply to a station;

means for rotating each of the tubes in the station about a longitudinal axis of the tube in the station;

an axially fixed stop in the station;

pusher means in the station for pressing the tube axially against the fixed stop;

cutting means in the station for directing a laser beam at the rotating tube in the station at a location along the tube offset from the stop to melt the tube at the location and cut from the tube a section lying between the location and the stop;

means for aspirating vapors produced by the cutting operation from the location;

a conveyor adjacent the station; and

unloading means for transversely displacing the tube section after cutting from the tube onto the conveyor and transporting the tube section from the station by means of the conveyor.

2. The tube-cutting apparatus defined in claim 1 wherein the feeding means includes structure for forming a single-file row of the tubes leading to the station.

3. The tube-cutting apparatus defined in claim 2 wherein the feeding means includes a selector wheel for taking the tubes one at a time from the supply and feeding them to the structure.

4. The tube-cutting apparatus defined in claim 1 wherein the supply is a downwardly tapering hopper.

5. The tube-cutting apparatus defined in claim 1 wherein the rotating means includes:

a pair of lower cradle-forming support rollers extending along and rotatable about parallel axes parallel to the tube and adapted to hold and support the tube in the station;

at least one upper hold-down roller engageable with the tube on the support rollers; and

means for rotating at least one of the rollers and thereby rotating the tube about its axis.

6. The tube-cutting apparatus defined in claim 5 wherein each roller has an upstream portion to one axial side of the location and a downstream portion to an opposite axial side of the station.

7. The tube-cutting apparatus defined in claim 6, further comprising:

means for urging the hold-down-roller portions downward against the tube on the support rollers with a predetermined force.

8. The tube-cutting apparatus defined in claim 7 wherein each of the rollers has a surface with a substantially higher coefficient of friction than glass.

9. The tube-cutting apparatus defined in claim 8 wherein the upper roller has two portions axially flanking the location and canted oppositely to urge the tube away from the location, whereby when the tube is cut through the piece and tube are urged apart at the location.

10. The tube-cutting apparatus defined in claim 6 wherein the conveyor is underneath the station and the unloading means includes means for spreading the downstream portions of the lower roller and thereby dropping the tube section onto the conveyor.

11. The tube-cutting apparatus defined in claim 10 wherein the unloading means further includes guides extending downward from the lower-roller downstream portions to the conveyor.

12. The tube-cutting apparatus defined in claim 10 wherein the spreading means includes respective arms pivoted about an axis parallel to the tube and underneath the

station, each arm having an outer end carrying a respective one of the lower-roller downstream portions.

13. The tube-cutting apparatus defined in claim 1 wherein the conveyor has seats adapted to receive the tube sections and of very low heat capacity.

14. The tube-cutting apparatus defined in claim 1 further comprising:

a smoothing roller and means for pressing the smoothing roller against the tube at the location and thereby rounding ends created in the tube by the laser beam.

15. The tube-cutting apparatus defined in claim 1 wherein the pusher means includes:

a pusher element axially engageable with an end of the tube in the station; and

means for axially displacing the pusher element and thereby axially displacing the tube through the location toward the stop.

16. An apparatus for cutting a plurality of tube sections from an elongated glass tube, the apparatus comprising:

a supply holding a plurality of the tubes;

means for feeding the tubes one at a time from the supply to a station;

means for rotating each of the tubes in the station about a longitudinal axis of the tube in the station;

an axially fixed stop roller in the station aligned axially with the tube in the station;

pusher means in the station for pressing the tube axially against the fixed stop;

cutting means in the station for directing a laser beam at the rotating tube in the station at a location along the tube offset from the stop to melt the tube at the location and cut from the tube a section lying between the location and the stop;

a conveyor adjacent the station; and

unloading means for transversely displacing the tube section after cutting from the tube onto the conveyor and transporting the tube section from the station by means of the conveyor.

17. The tube-cutting apparatus defined in claim 16 wherein the feeding means includes structure for forming a single-file row of the tubes leading to the station.

18. The tube-cutting apparatus defined in claim 17 wherein the feeding means includes a selector wheel for taking the tubes one at a time from the supply and feeding them to the structure.

19. The tube-cutting apparatus defined in claim 16 wherein the supply is a downwardly tapering hopper.

20. The tube-cutting apparatus defined in claim 16 wherein the rotating means includes:

a pair of lower cradle-forming support rollers extending along and rotatable about parallel axes parallel to the tube and adapted to hold and support the tube in the station;

at least one upper hold-down roller engageable with the tube on the support rollers; and

means for rotating at least one of the rollers and thereby rotating the tube about its axis.

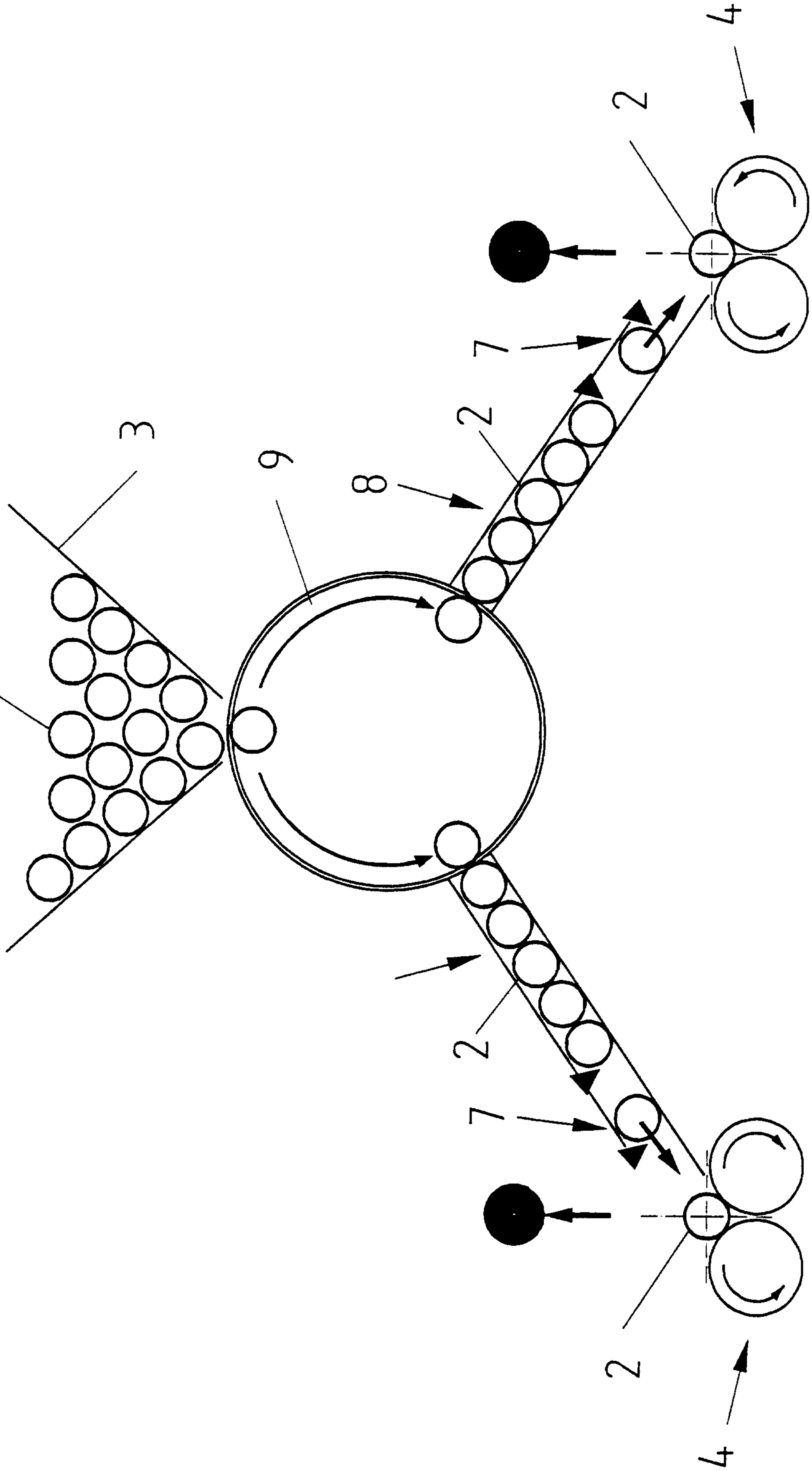


Fig. 1

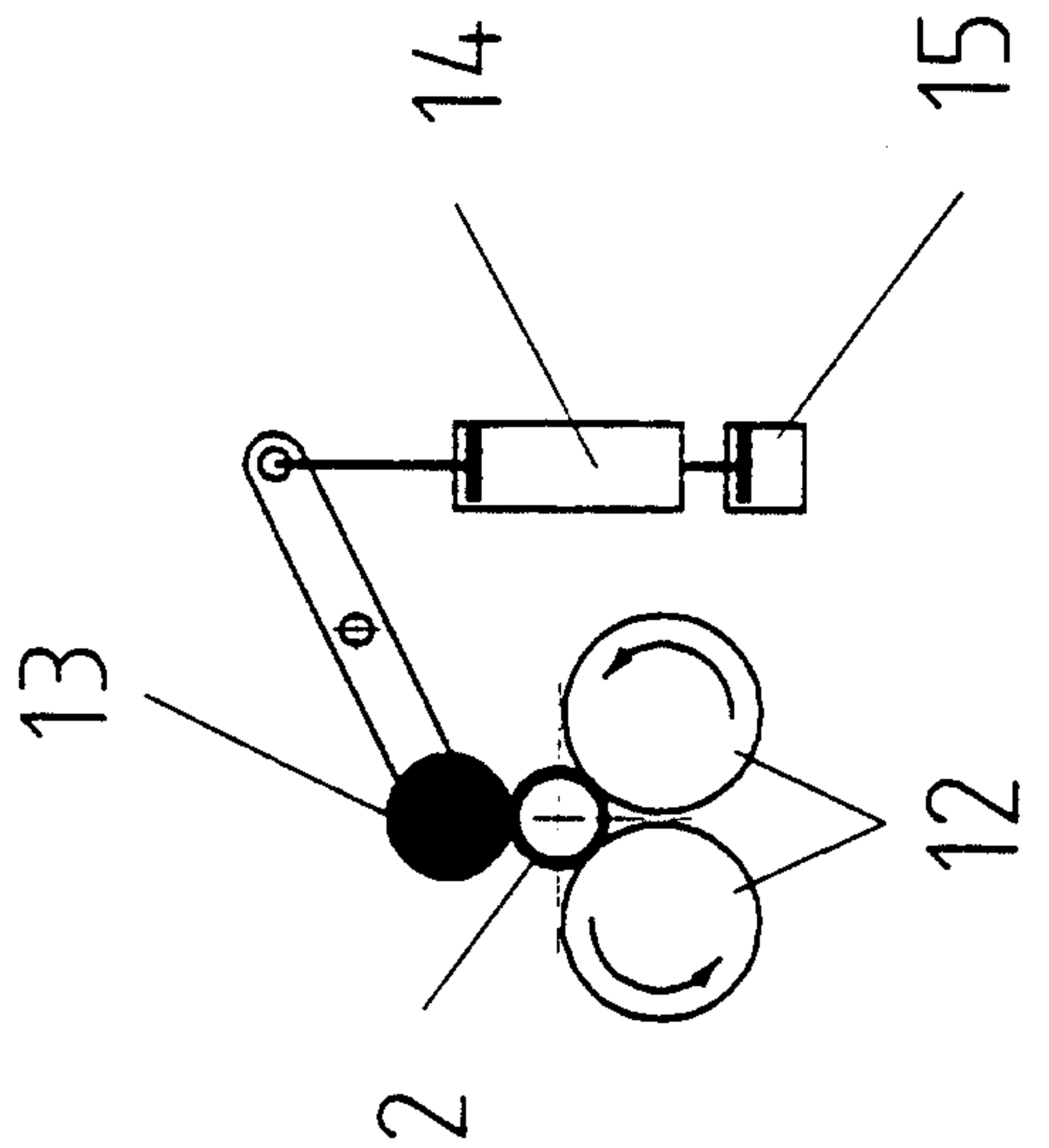


Fig. 2b

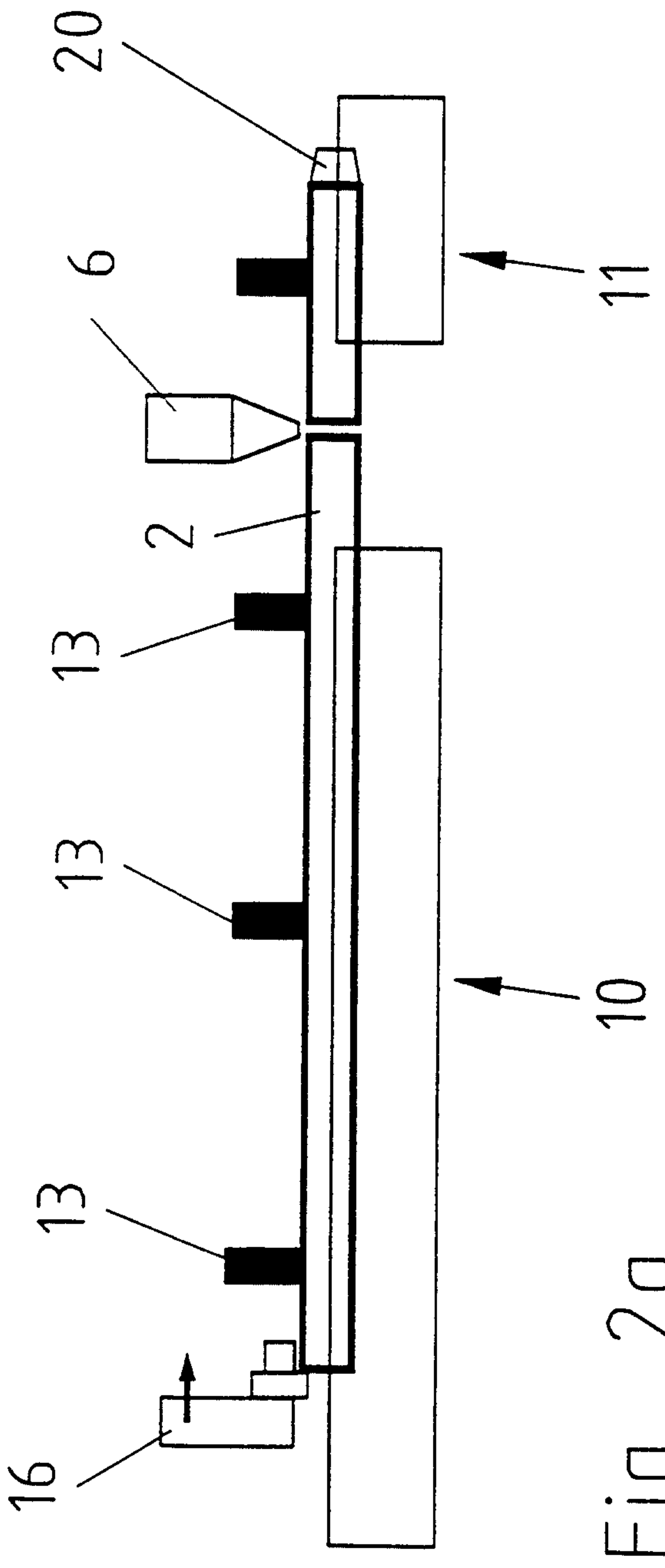


Fig. 2a

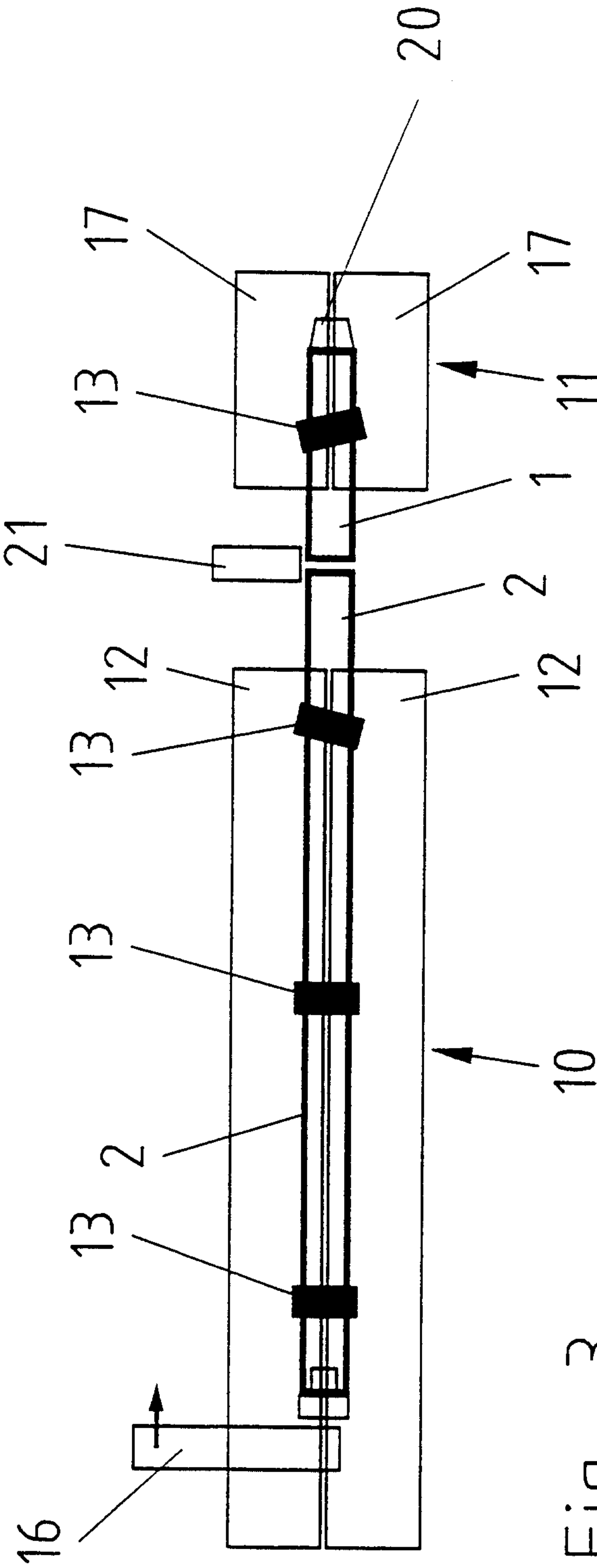


Fig. 3

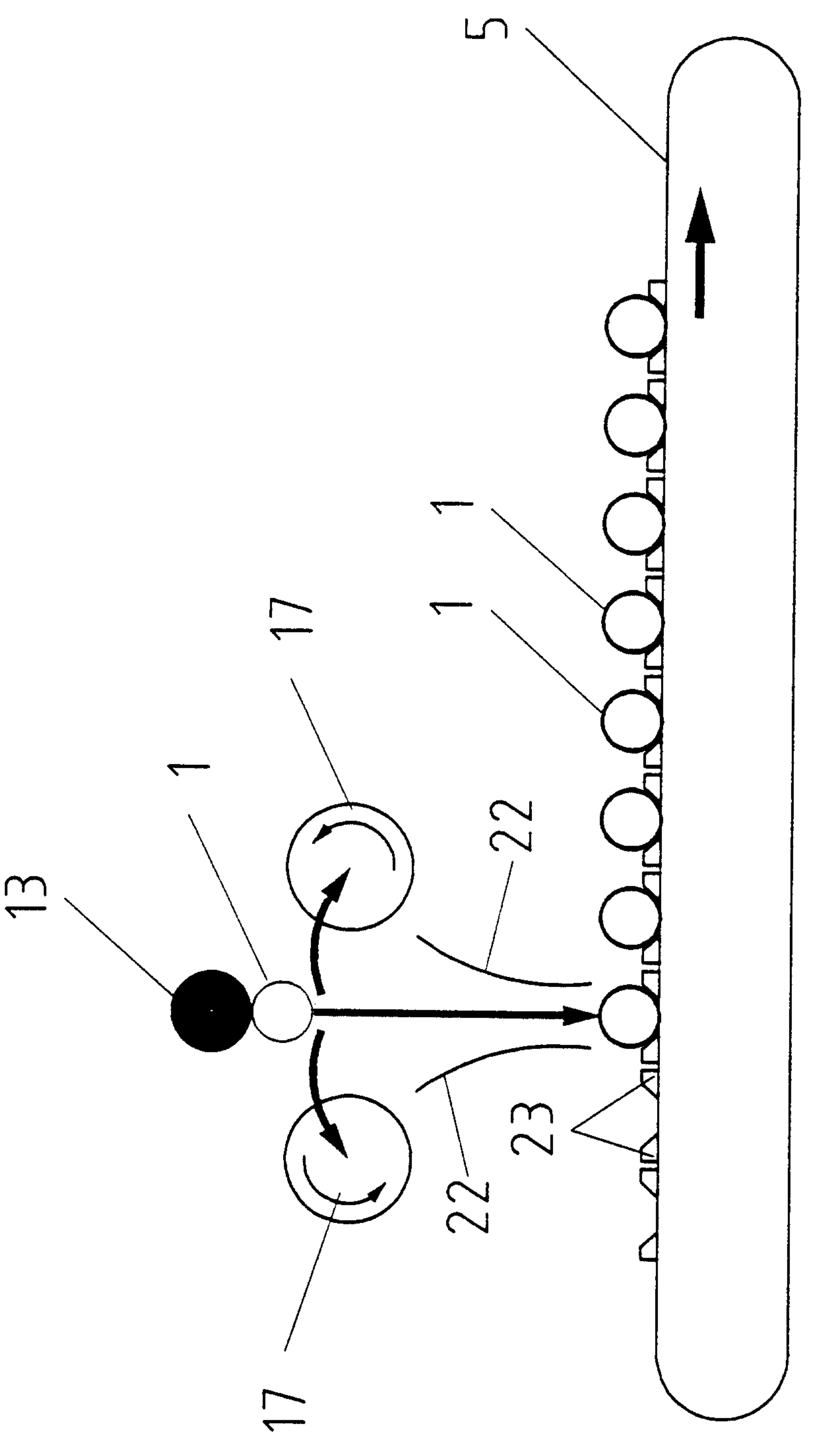


Fig. 4

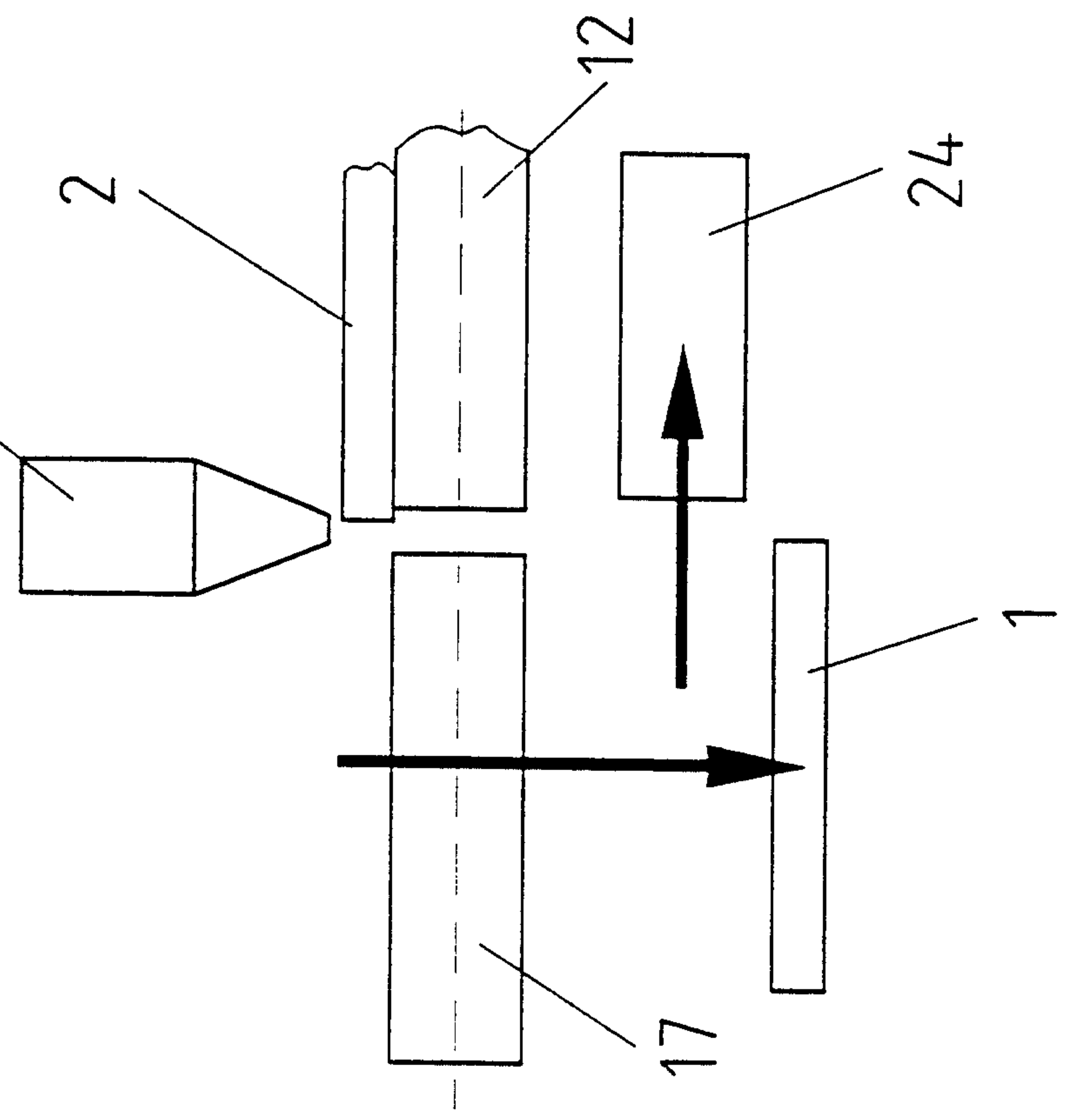


Fig. 5b

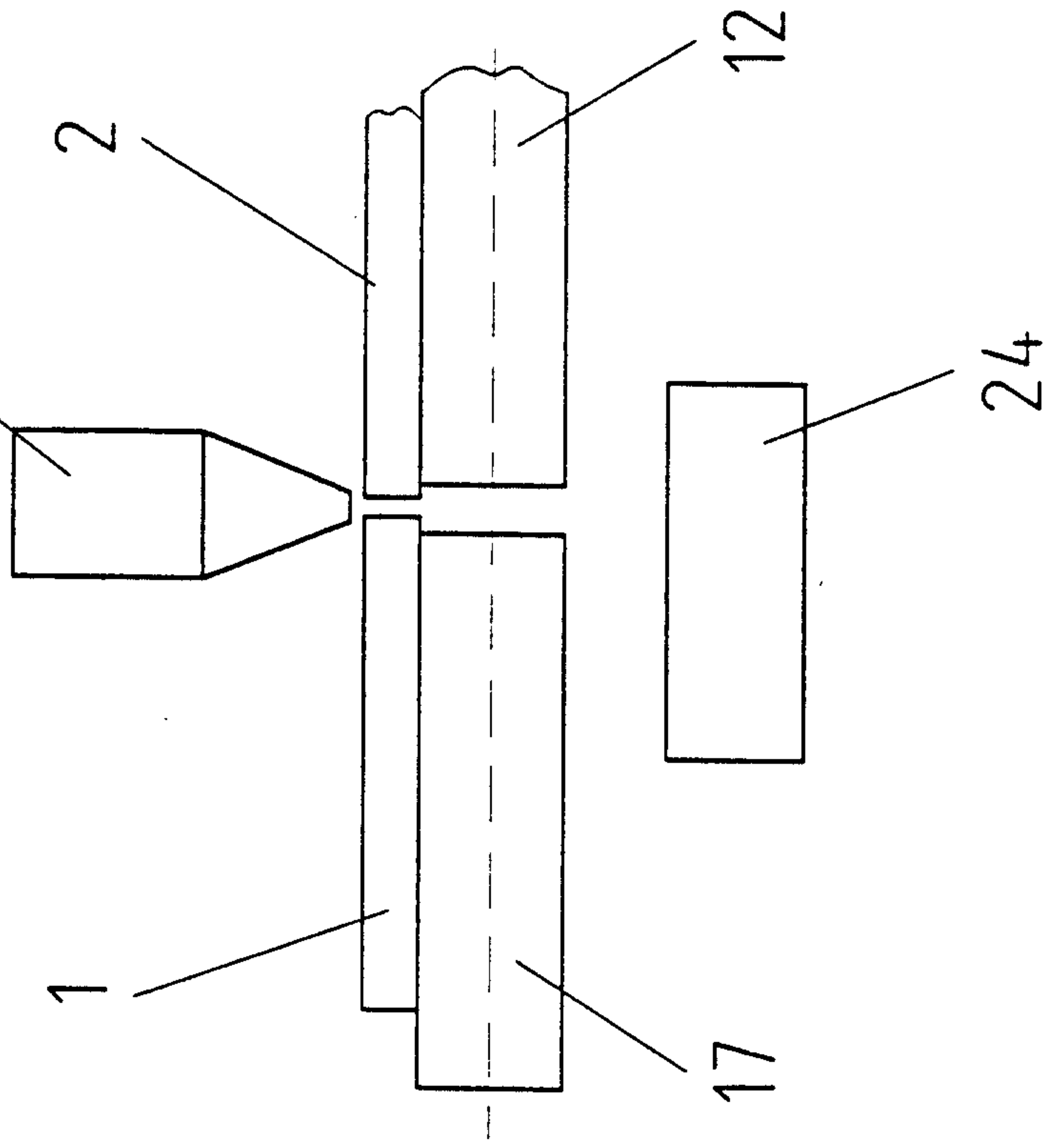


Fig. 5a

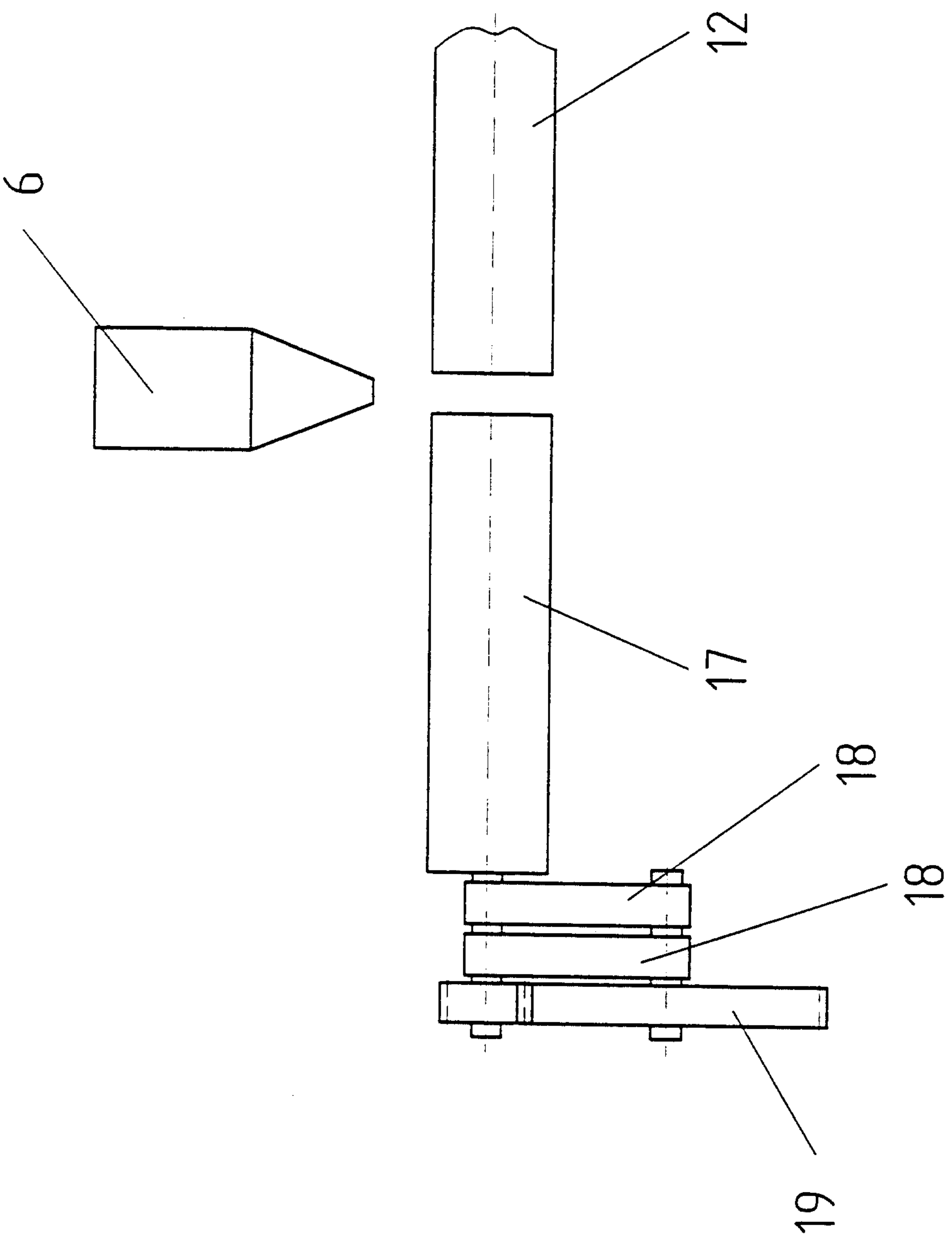


Fig. 6

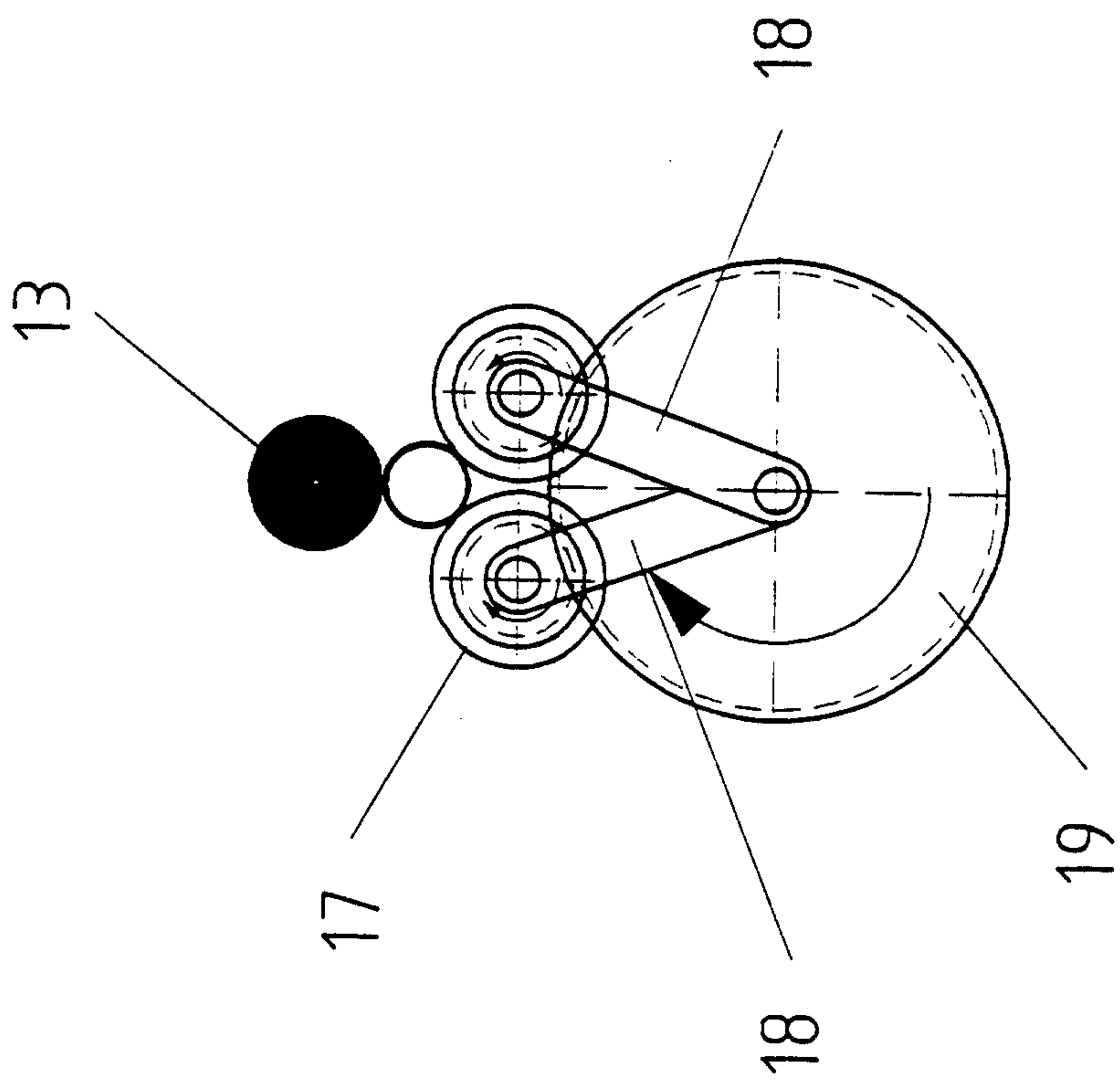


Fig. 7a

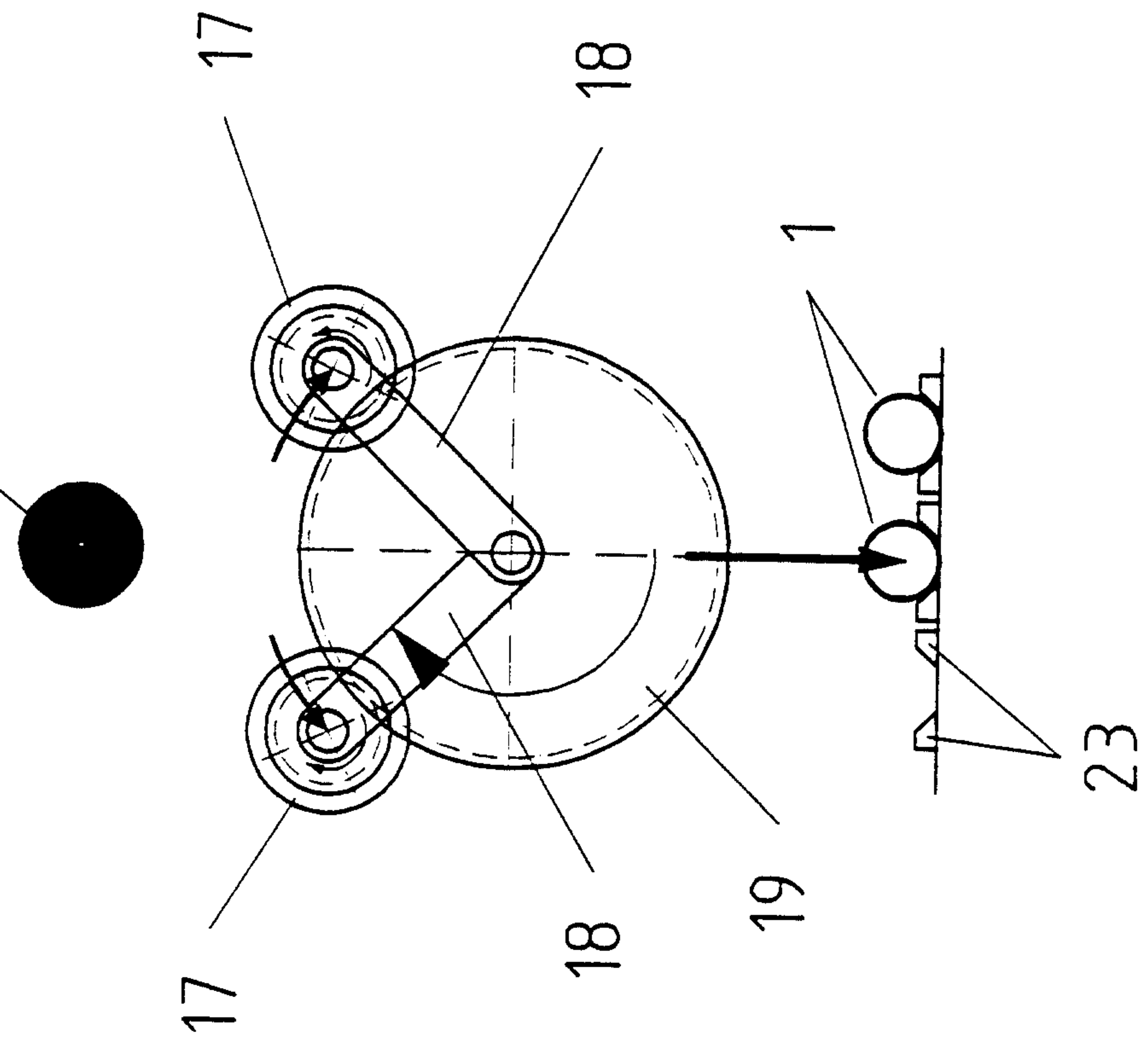
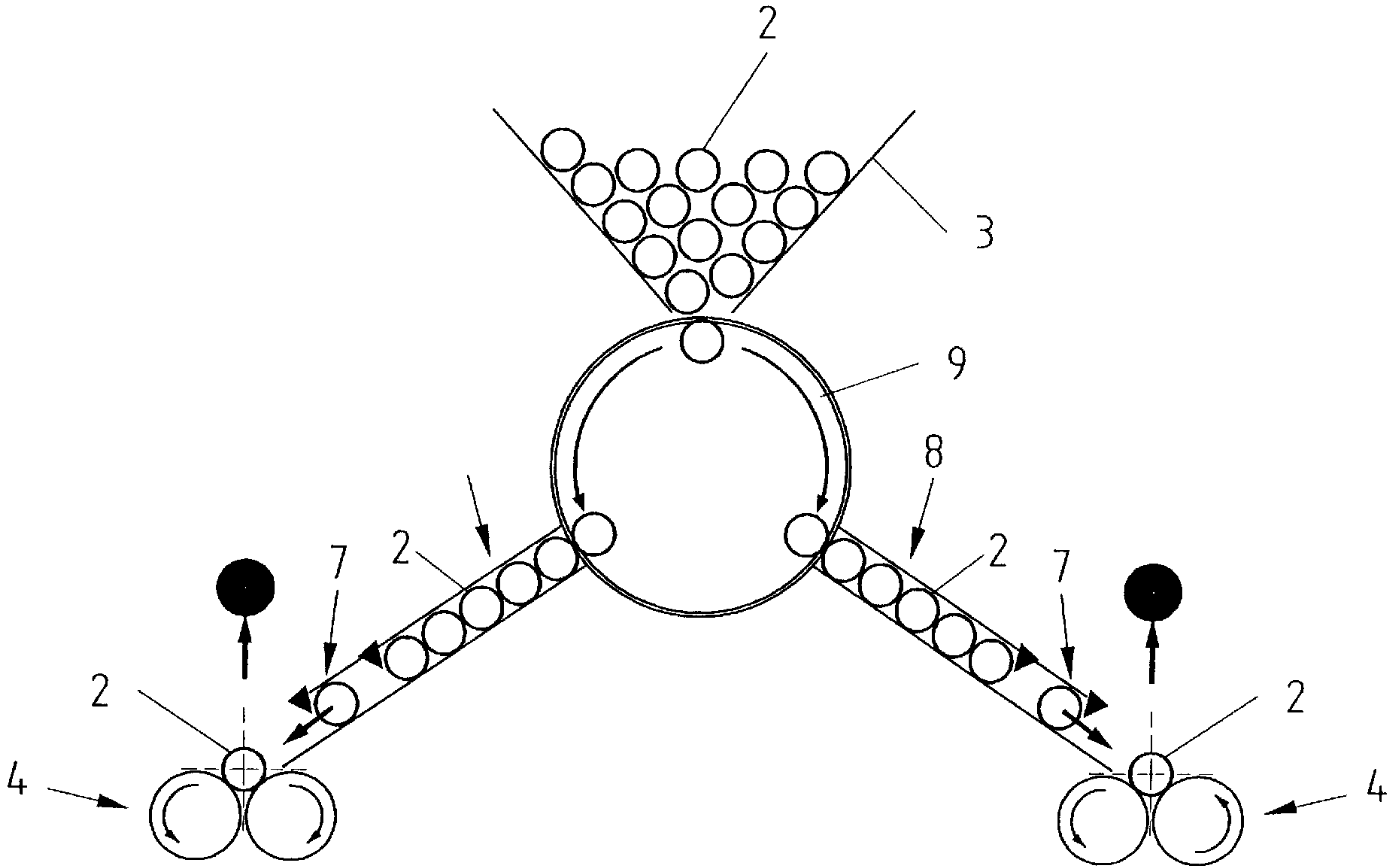


Fig. 7b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