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54 **Wire processing machine.**

57 Wire processing machine consisting of:

a) a feeder mechanism, providing simultaneously:

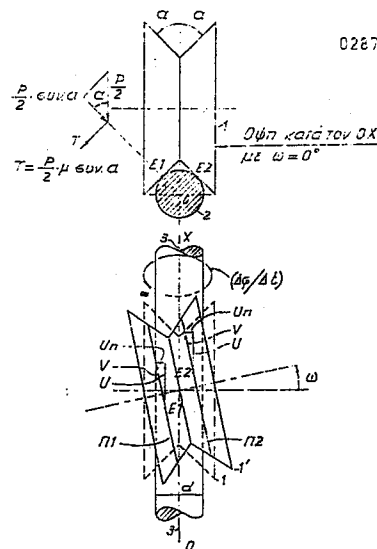
1. pulling or feeding of wire.
2. straightening of wire
3. torsion to any direction or counter torsion of the wire.

b) a wire bending system, of adjustable curvature radius, two direction bending with moving cutting system mounted on the bending system.

The advantages of this bending system, in comparison to the existing ones are the following:

1. The curvature radius of the processed metal rod may be changed fast and easily.
2. Two different curvature radii for left and right bends may be used.
3. We can cut metal rod, leaning after bent any straight portion, even even of zero length, because we can cut directly at the point where the bent ends, ie in any angle position of the bending system.
4. The shape cutted is launched, normal to the table where the formed plane shape rests.
5. We can set the moving cutter stroke from a distant position.

Fig.1



Description

Wire processing machine

The invention refers to a machine which process circular section wire, including straightening, two directional bending and cutting. The machine consists of:

- a system forcing torsion , pulling and straightening.
- a bending system capable of bending the wire in two directions with adjustable curvature radius and mounted cutter, which follows wire while bending and may cut the wire in any position.

Existing machines for wire straightening, bending and cutting distinguish themselves from the a.m. machine in following:

- Wire pulling is achieved through two roller pairs, placed exactly across the wire, which press wire inbetween forcing it to pass through straightening rollers, located ahead pulling rollers. This results to a radial deformation of the wire. To prevent deformation, different rollers with respective grooves should be used for each wire diameter.

This should cost a lot of money and time during adjustment to new wire diameters.

Existing machines use for two directional bending three pins. Two of them position wire and are fixed and the third one is the bending pin, which bends wire around the one or the other pin for left or right bends respectively. This is a disadvantage as when bending pin is on the right, and a left bend is required, the pin has to pass under the wire to go left. This makes existing machines complicated. Cutting is made by a cutter located either ahead bending head, causing the wire to move backwards to be cut this making the machine slow and complicated, or after bending head, where a flying cutter has to approach for cutting. In this case time and higher costs are required.

In my machine there is no need for the two roller pairs of the wire. Pulling is supplied by the lower mechanically driven straightening rollers.

This way, pulling is distributed to several rollers avoiding thus surface deformation of the wire, and straightening becomes easier. Moreover wire feeding is easier, as straightening rollers pull wire as soon as it is put in contact to them.

The upper straightening rollers are not driven directly and they force a slight wire torsion, as it is explained analytically in the following.

The advantage of the bending system is that only two pins are used for two direction bending. In each bending one acts as the pin around which wire is bent and the other one as the bending pin. For counter bends functions of both pins alternate.

The on the bender fixed cutter, enables cutting of wire while bender is rotated or directly after bent, without leaving a straight portion if desirable.

The above mentioned function is explained analytically using figs 1,2,3.

Figure 1.-Nomenclature.

1. Roller
2. Metal circular section rod.
3. Theoretical axis of straightened rod (OX).

Function

We consider any roller(1) of a rod straightening system using rollers, with the straightened rod(2) exactly below it. The resulting picture is given in Fig.1, where the roller is presented dotted.

This is the case in all static systems for metal, circular section, rod straightening up to now and as torsion is examined on the rod.

If the roller plane is rotated by an angle(w), around an axis vertical to OX and passing through the roller centerpoint, torsion of the straightened and pulled rod is achieved as it is proved theoretically and practically. The rotation of the roller plane, thus deviating from the up to now used through OX passing plane and the important result achieved through this rotation on the controlled rod torsion build the substance of the here described invention.

This controlled torsion enables forming of perfect 2 - D shapes and complicated 3-D shapes on automatic rod bending machines.

Analysis of rod torsion.

Consider that roller (1) is rotated by an angle (w), counterclockwise in Fig (1), taking position (1') and contacting rods on points (E1) and (E2).

Points (E1) and (E2) move both on the with a velocity ($\bar{u}$) pulled rod (2) and on the with the rotational speed ($\bar{V}$) rotating roller.

Direction of ($\bar{V}$) is constant and tangential to the circles ($\Pi 1$) and ($\Pi 2$) of the roller. If there is no slip between the contacting surfaces, points (E1) and (E2) as belonging to the rod, follow ($\bar{V}$). This is possible only if there is a rod torsion, giving a rotational speed of the rod contact points, as indicated in Fig. 1.

Following vector equation is valid :

$$\bar{V} = \bar{u} + \bar{u}_\pi \quad (a)$$

For small values of angle w we have:

$$V = u / \cos w = u \quad (b)$$

$$U_{\pi} = u \tan w = u \cdot w(\text{RAD}) = \frac{\pi}{180} u \cdot w(^{\circ}) \quad (c)$$

Rod centerpoint O is approximately fixed. With $(\Delta\Phi/\Delta t)$ the torsion angle of the rod is one second and (d) the rod diameter, we derive :

$$U_{\pi} = (\Delta\Phi/\Delta t) \cdot \frac{d}{2} = \frac{\pi}{180} u \cdot w(^{\circ}) \quad \text{or}$$

$$(\Delta\Phi/\Delta t) (^{\circ}/\text{sec}) = 34,9 \frac{u(\text{m/s} \cdot w(^{\circ}))}{d(\text{mm})} \quad (d)$$

This means that counterclockwise (w) results to a counterclockwise torsion of the pulled rod (direction O----X) and inversely.

The resulting torsion torque (M_t) by each rotating roller is:

$$M_t = (\text{Friction}) d/2 = T \cdot d = 0,5P \cdot \cos a \cdot d$$

Where

P: The roller pressing force.

T: Friction force

a: half roller angle

μ : friction factor.

For (n) rollers, the total torsion torque is:

$$M_{to} = 0,5 \cdot n \cdot P \cdot \mu \cdot \cos a \cdot d \quad (e)$$

The required power N for the torsion is

$$N = M_{to} \cdot (\Delta\Phi/\Delta t) (\text{kpm} \cdot \text{rad/sec}) = \Delta\Phi / (75 \cdot \Delta t) (\text{HP})$$

Figure 2 - Nomendature

1. Not adjustable roller with one or more grooves
2. Adjustable roller with one or more grooves
3. Motor
4. Adjustable roller support
5. Adjustable roller housing
6. Lever
7. Common transmission bar
8. Piston
9. Disk with adjustable pins
10. Disk shaft
11. Disk shaft housing
12. Disk shaft piston
13. Disk shaft positioner
14. Metal wire
15. Adjustable pin
16. Wire pulling direction
17. Rotation direction of non adjustable roller
18. Axis of rotation of roller support (4).

Function

1. Pulling or forwarding of wire

Wire transportation from pay-off station to the machine is usually described using one of the two words above. The number of the non adjustable rollers (1) as well as of the adjustable ones(2) may be anyone. The numbers of non adjustable and adjustable rollers may be equal to each other or differ by one. The distances between the non adjustable rollers and the distances between the adjustable ones may be equal to each other or differ from each other. Non adjustable and adjustable rollers may have or may not have grooves. First, metal wire(14) is put between rollers(1)and (2). Trapping of metal wire (14) between non adjustable(1)and adjustable rollers(2) is acheived by moving the lateres to the formers. Moveme-is acheived by pistons(12), which stretch out pressing through housing (11) shaft(10), bearing the disks with adjustable pins(9).

The number of disks(9) is equal to the number of the adjustable rollers(2).Each disk(9) bears some adjustable pins(15), placed if possible on the corners of a regular polygon.The length of each pin (15) may be adjusted through a bolt. The pins (15) are grouped. Each group has a pin number, equal to the disks(9) and the pins of every group, belonging one to each disk, lay on the same, through shaft (10) passing level. The disks (9) are actually normal to the shaft (10), but for visualization purposes are drawn , turned by 90° on the drawing level. The disk shaft positioner (13) defines the pin group, which will press the adjustable roller supports(4)

through rotation of shaft(10).

Further the pin (15) group, being above the adjustable roller supports(4) presses them forcing them into the spaces between the non adjustable roller(1). Wire (14) is trapped this way and is forced to form a curved line between the adjustable and non adjustable rollers.

As non adjustable rollers (1) are driven by motor (3) in rotation direction (17) , wire moves towards pulling direction(16). Any type of motor may be used , but the hydraulic one gives best performance. Roller driving may be also supplied by more than one motors , each motor driving one group of rollers(1). In Fig.2 , only one motor (3) is presented schematically through a chain of all the non adjustable rollers(1). If the rotation direction (17) of motor (3) is reversed wire pulling direction(16) changes.

For each rod diameter , eg 6.8.10.12.14.16.mm, a group of pins (15) is preset, having preset the lengths of the pins to give best pulling and straightening, as it is described later on. By rotating simultaneously all disks (9) through positioner(13), setting of the feeder is achieved very quickly and precisely for the wire diameter to be feeded. The end of the approach between rollers is determined by the pistons.(12).

2.Wire straightening.

The final position of adjustable rollers (2) in respect to the non adjustable rollers(1) guarantees a plastic deformation of the wire on the contact points between wire and rollers. This deformation differs from roller to roller depending on the setting of the respective pin(15) The elastic comeback of the wire after its plastic deformation is exactly sufficient to give it the wire a straight form on the level, which is normal to the paper level of the drawing. For full straightening of the wire , a second mechanism is required, similar to the one described above. Its rollers should lay in a level normal to the drawing level, and it should be located directly after the first one in a distance not causing plastic deformation to the processed wire.

3. Torsion and counter torsion.

The adjustable rollers supports(4) may be rotated round the axis of rotation(18), using levers(6) and the common transmission bar(7), driven by the double direction piston (8) to left or to right. The roller support(4) rotates in its housing (5) around axis (18) by a small angle to the right or to the left in respect to the drawing level. Due to friction , rotation of rollers(2) around axis (18) results to torsional movement of the pulled rod. This achievement is documented in my patent Nr87.0596/t.8 76/s.-191 of April 14th 1987, 00.30am.

Without power to the piston (8), the adjustable rollers (2) are put, due to the grooves , on the drawing level.

Figure 3.- Nomenclature

1. Rotating body
2. Interchangeable upper part.
3. Interchangeable lower part.
4. Lower left pin.
5. Lower right pin
6. Upper left pin
7. Upper right pin
8. Fixed cutter.
9. Moving cutter.
10. Housing
11. Fixed wire guide
12. Motion system of housing(10) along Ψ and X directions. (but not Z)
13. Interchangeable plate with 2 centers of rotation.
14. Cutter transmission piston.
15. Piston front sealing ring
16. Piston back sealing ring
17. Position marker of transmission piston.
18. Flexible hydraulic pipe between transmission piston (14) and cutter piston.
19. Flexible hydraulic pipe between transmission piston (14) and oil pump.
20. Cylinder of transmission piston.
21. Metal rod.
22. Housing(10). draw-back spring.
23. Chain gear.
24. Chain.
25. Left semicircular housing of plate (13)
26. Right semicircular housing of plate(13).
27. Trapped oil between transmission piston(14) and oil piston.
28. Trapped oil between transmission piston(14) and oil pump.
29. Draw back spring of transmission piston.
30. Motion direction of metal rod.
31. Direction of chain(24) first motion.
32. Direction of chain (24) second motion.

Function

Housing (10) remain always , parallel to itself, on level O^uX.

Inside housing (10), the rotating body (1) of the bender may rotate freely , driven by a motor, fixed on body(1), through the chain gear(23) and the chain(24). Certainly, chain motion may have two directions: (31) and (32). Mounted on the rotating body(1), is the piston which drives the moving cutter(9). The rotating body(1) ends up at the interchangeable upper part(2) and down at the interchangeable lower part(3). 5

Parts (2) and (3) are fastened to body(1) by means of belts

The interchangeable upper parts(2) bears: a square opening through which passes the moving cutter (9), the upper left(6) and upper right (7) pins of the cutter (8).

Pins (6) and (7) locate the fixed cutter (8) at a certain distance from the upper level of (2) and on the other hand, they provide bending of the rod(21) passing between them. The interchangeable lower part (3) bears only the - lower left pin (5) and the lower right pin. (4) 10

The draw-back spring (22) keeps housing (10) in such a position that at least of pins (4) or (5) is placed inside the grooves (25) or (26) of plate (13) respectively.

The distance between the centerpoints of the semicircular grooves(25) and (26), the distance between the centerpoints of the upper pins (6) and (7) are equal to each other Pins (4) and (5), as well as pins (6) and (7) may bear outer rings, to prevent their wear. The outer diameter of pins(4) and (5) is equal to the diameter of grooves (25) and (26) respectively. The outer diameter of pins (6) and (7) is equal to the inner diameter of the circles we want to form on the processed rod. 15

Metal rod (21) goes through pins (6) and (7) after passing through the fixed wire guide(11). 20

If the motor moves chain (24) to direction (31) , then following will happen:

- 1.Pin (4) will rotate inside groove(25).
- 2.Pin (5) will move away from groove (26).
- 3.Body(1) will rotate inside housing (10).
- 4.Housing (10) will move respectively inside level OYX.
- 5.Pin (6) rotates around the same axis as pin(4) does.
- 6.Pin (7) will move pressing the rod(21) and bending it as it is shown in in Fig 3.

Similar things happen, when chain moves in direction (32) The upper part (2) along with (6) , (7) and (8), and the lower part (3) along with (4) and (5) and plate (13) with its grooves (25) and (26), build a series of interchangeable parts, allowing bending of certain sizes of metal rods with certain curvature radii. We mark the possibility of forming different diameters with pins (6) and (7). Cutting is achieved by pushing moving cutter (9) to approach fixed cutter (8), as it is usual in all cutters cutting through shearing of metalrod. When metal rod is cut, by the upwards moved moving cutter (9), it is launched away from table's surface, where it rests. Moving cutter is driven by a hydraulic piston, located in the rotating body. (1). These are one direction pistons . They are pushed by high pressure oil and they are drawn back by a strong spring. Position of moving cutter(9) is of great importance for a) decreasing the moving cutter stroke in small diameter rods and b) for giving next command to the bending head, directly after cutting. 30 35

As cutter moves along with the bending head, I have found out following movement transmission system from a fixed point to the moving cutter.

In the flexible high pressure oil pipe(19), from the hydraulic pump to the cutter piston, the cylinder of transmission piston (20) is inserted. This is a cylinder inside of which piston (14) retrogrades freely, supported against the input of the higher pressure oil by a coil(29). There are two sealings for piston (14), (15) and (16). 40

The position marker (17) supplies outside information about the position of transmission piston (14).Both resulting spaces of the flexible pipe, (27) and (28), are filled with oil after removing air.

This way oil pressure from space (28) is transmitted through piston (14) to the oil of space (27). The transmission piston (14) movement, may now be followed by the position marker (17). Given that oil is not compressible and piping (18) is melastic , transmission piston movement is related directly to moving cutter piston movement, allowing thus full monitoring of the later. 45 50

Claims

The machine for processing of circular section wire, consisting of straightening system (Fig 2), pulling rollers(Fig 2),upper rollers (Fig 2) rotating systemfor upper rollers(Fig2),bending head for two direction bending bending(Fig 3),flying cutter (Fig 3,9), motor, chain (Fig3,24),plate(Fig.3,13) and pins (Fig.3,4 and 5) and having following features: 55

1.Amelioration of static roller mechanisms for straightening of metal circular section rods, through supplying of rotation driving for the rollers, around an axis normal to OX, thus enabling fully controlled torsion of the, through feeding and pulling , straightened rod (torsional speed and and torsional direction). This additional feature of the static roller mechanisms for wire straightening, is of great importance, when this straightening mechanisms are used in automatic bending machines , for forming of plane shapes using metal circular section rods. 60

In this case, during the successive bendings, a continuous torsion on the rod is required to achieve 65

continuous contact between the formed plane shape and the machine table.
Otherwise almost always, shapes remain open and not plane.

2. Feeder of metal wire processing machines, ensuring simultaneously:

Feeding - torsion of countertorsion on request and straightening with fast adjustment to any processed wire diameter.

3. System of disks (9) with pins (15) on shaft (10) with disk shaft positioner (13), enabling fast adjustment of adjustable rollers (2) mounted on supports (4) and housing (5), where driving is supplied by pistons (12) (Fig 2)

4. Supports (4) rotating system, with housings (5), levers (6) through common transmission bar and double direction piston (8), enabling a small rotation of adjustable rollers (2) around axis (18), clockwise, or counterclockwise (Fig 2).

5. Compound straightening and pulling system through insertion of adjustable rollers (2) in the spaces between the non adjustable rollers (1), where driven are only the non adjustable rollers (1). (Fig 2).

6. System of housing (10) moving on the OXY level, with the rotating body (1) inside, driven by a motor mounted on it, through chain (24) and chain gear (23), where the rotation centerpoint is defined only by the centerpoints of plate (13) and the pins (4) and (5) (Fig 3).

7. Moving cutter system with rotating body (1), consisting of a moving cutter (9), driven by a hydraulic piston mounted on body (1), and fixed cutter (8) mounted on body (1) through pins (6) and (7) and part (2). With this cutting system, wire cutting is possible in any position of the bending system. (Fig 3).

8. Series of 3 interchangeable parts A, B, C consisting of following parts:

A) (2) + (6) + (7) + (8)

B) (3) + (4) + (5)

C) (13)

through which a fast and easy adjusting of bending system on the desired wire diameter and curvature radius of the bends is achieved (Fig 3)

9. Transmission piston system, of moving cutter (9) from the rotating body (1) to the steady part of the machine consisting of cylinder (20), free piston (14) with two sealing rings (15) and (16) as well as the draw-back piston (29) and the position marker (17). (fig. 3).

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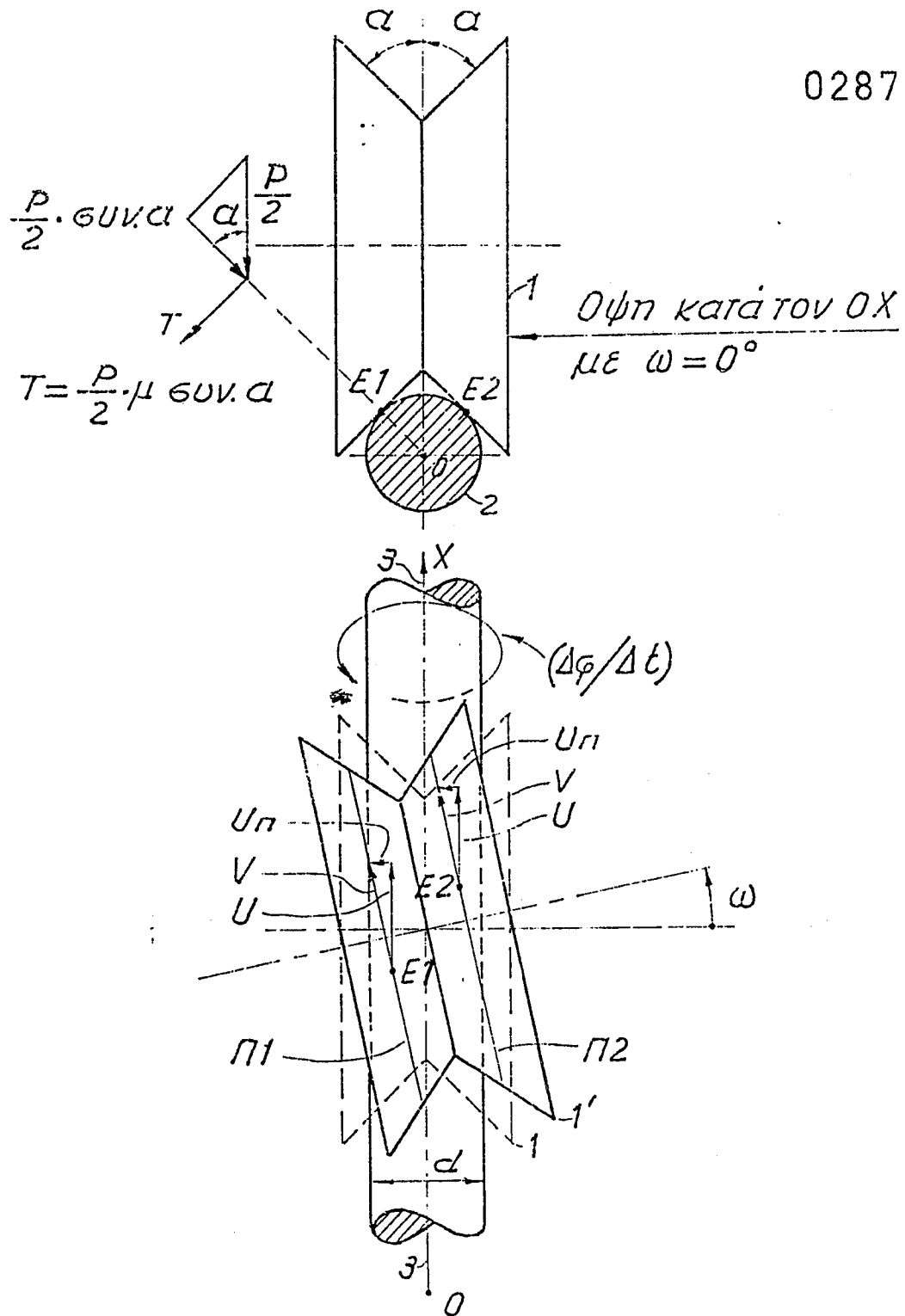


Fig.1

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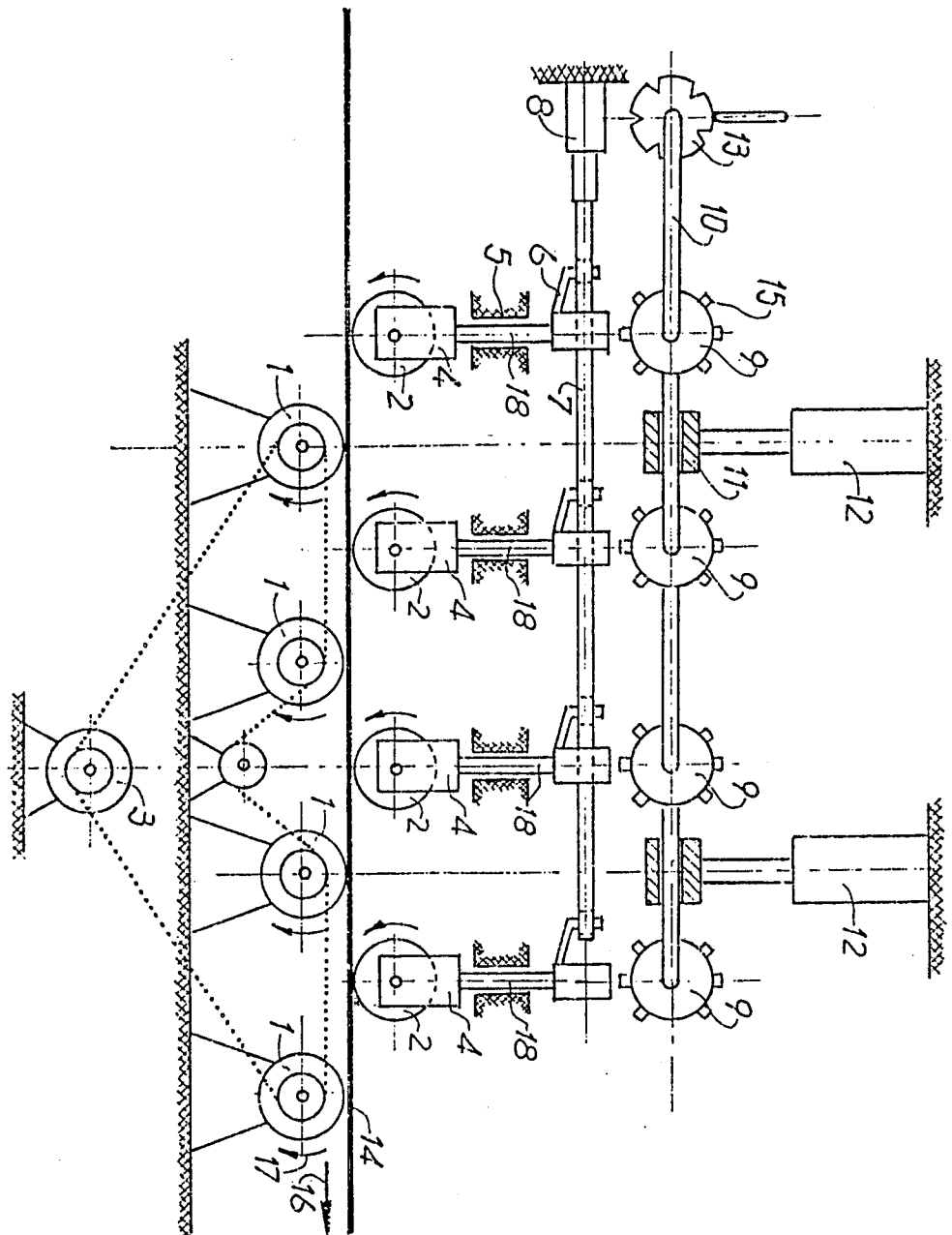


Fig. 2

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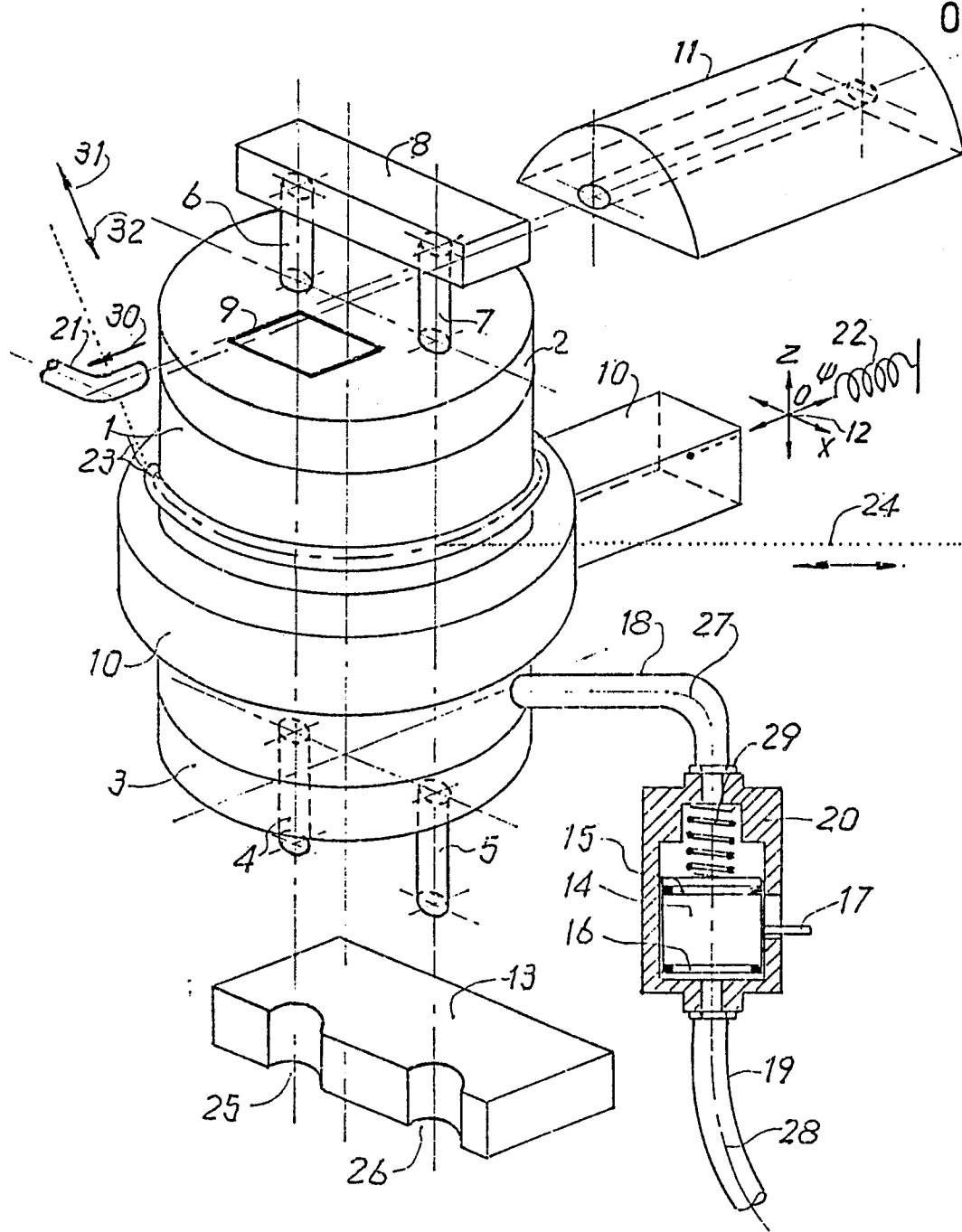


Fig. 3