United States Patent [19]

Berger

[11] **3,714,862**

[45] **Feb. 6, 1973**

[54] **BRAIDING MACHINE FOR BRAIDING KNOTLESS NETTING**

[75] Inventor: **Heinz Berger,** Oldenburg, Germany

[73] Assignee: **August Herzog Machinenfabrik,** Oldenburg, Germany

[22] Filed: **Oct. 2, 1970**

[21] Appl. No.: **77,509**

[30] **Foreign Application Priority Data**

Oct. 3, 1969 Germany.....P 19 49 893.2

[52] **U.S. Cl.** **87/8,** 87/33, 87/53

[51] **Int. Cl.**.....**D04c 1/00,** D04c 3/00, D04c 3/02

[58] **Field of Search**.....87/5–8, 28–30, 87/33, 37, 38, 53

[56] **References Cited**

UNITED STATES PATENTS

1,997,210	4/1935	Ford et al.	87/6
2,096,592	10/1937	Petersen	87/30
949,245	2/1910	Orthmann	87/30

Primary Examiner—John Petrakes
Attorney—Nolte and Nolte

[57] **ABSTRACT**

Lace braiding machine for braiding knotless netting. A mechanized braiding assembly is circularly arranged, in horizontal orientation, wherein two rows of wing wheels are provided, with means for carrying and interchanging net lacing needles, provision being made for tracks and track switches for the guidance of these needles. Braid elements formed in this assembly are transported to the upper central region of the machine, where braid lifter means, synchronized with the mechanism of the braiding assembly, complete the loops of the netting and provide for progressive transfer thereof to an overlying take-off unit.

19 Claims, 46 Drawing Figures

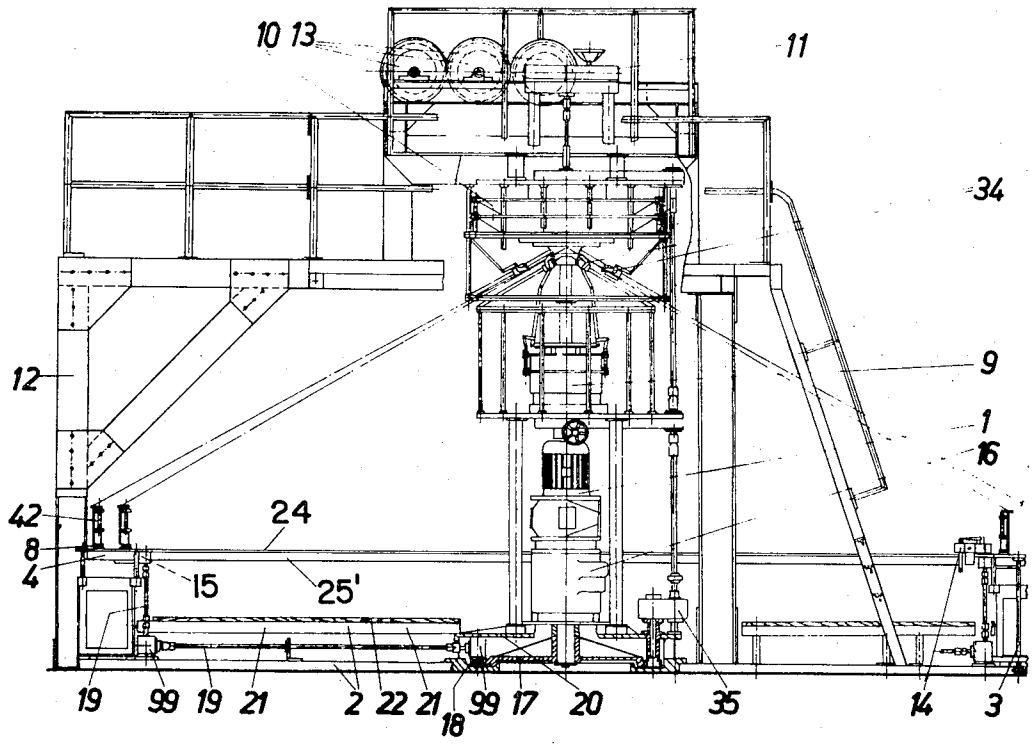

Fig. 1

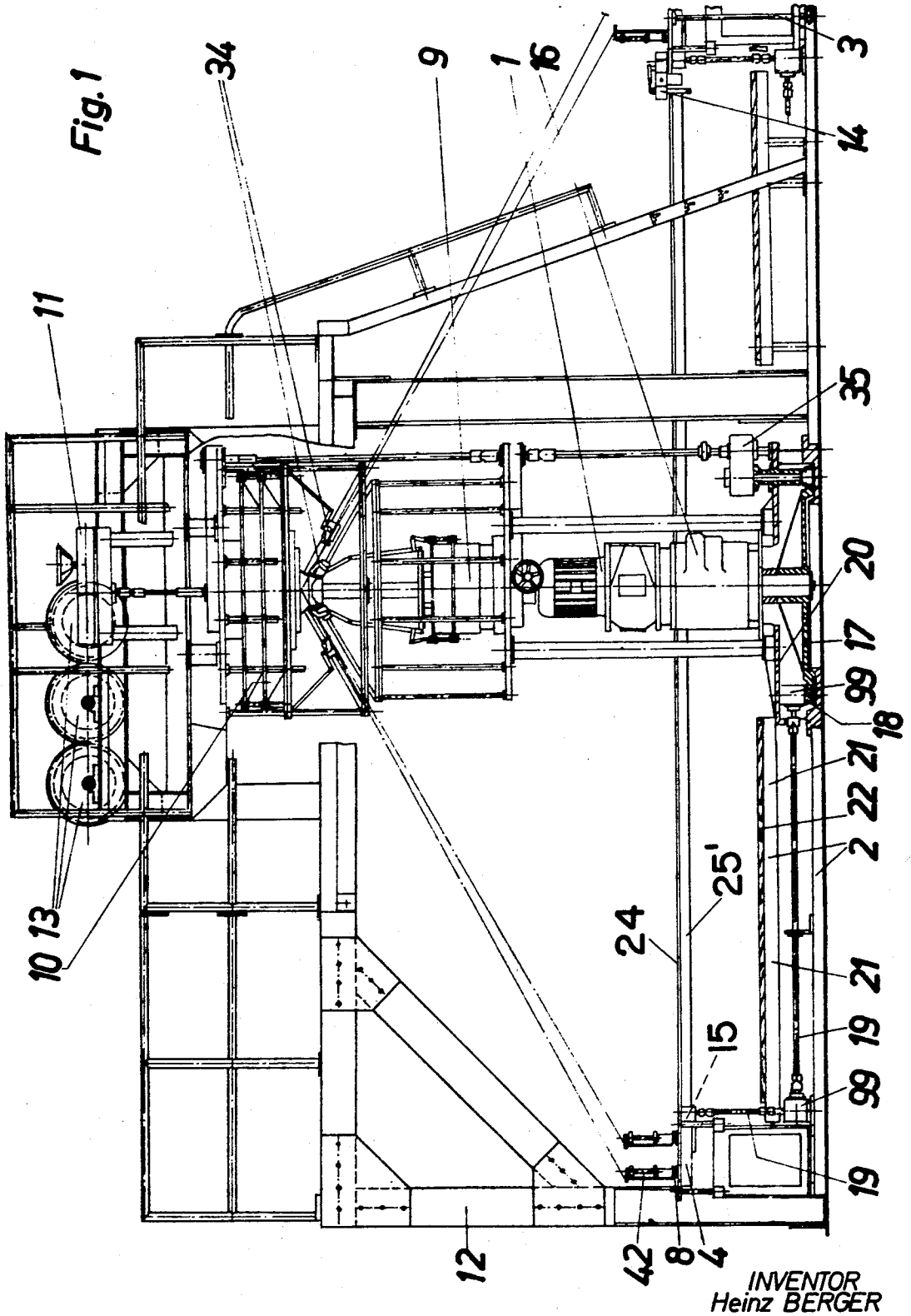

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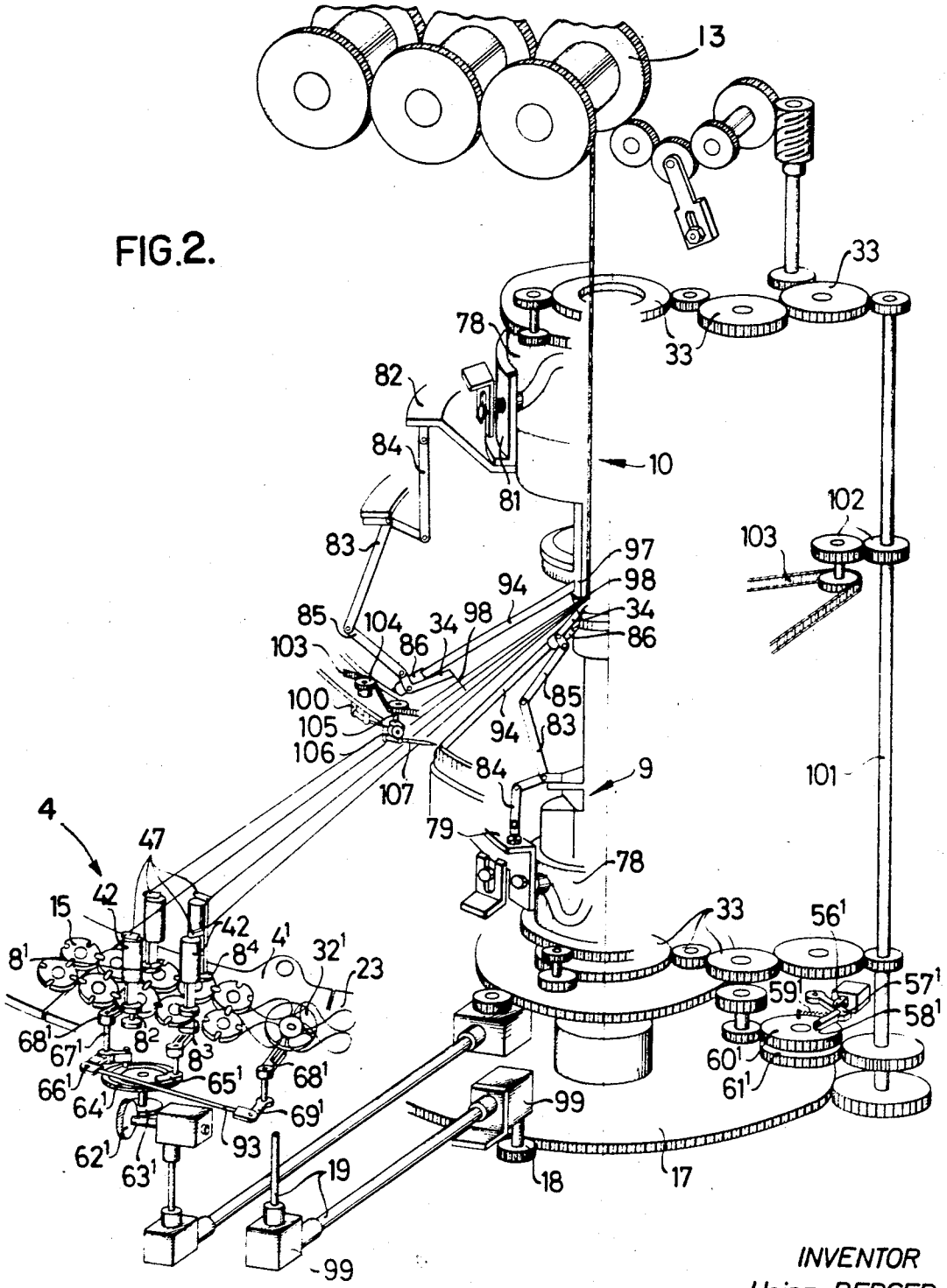
FIG.2.



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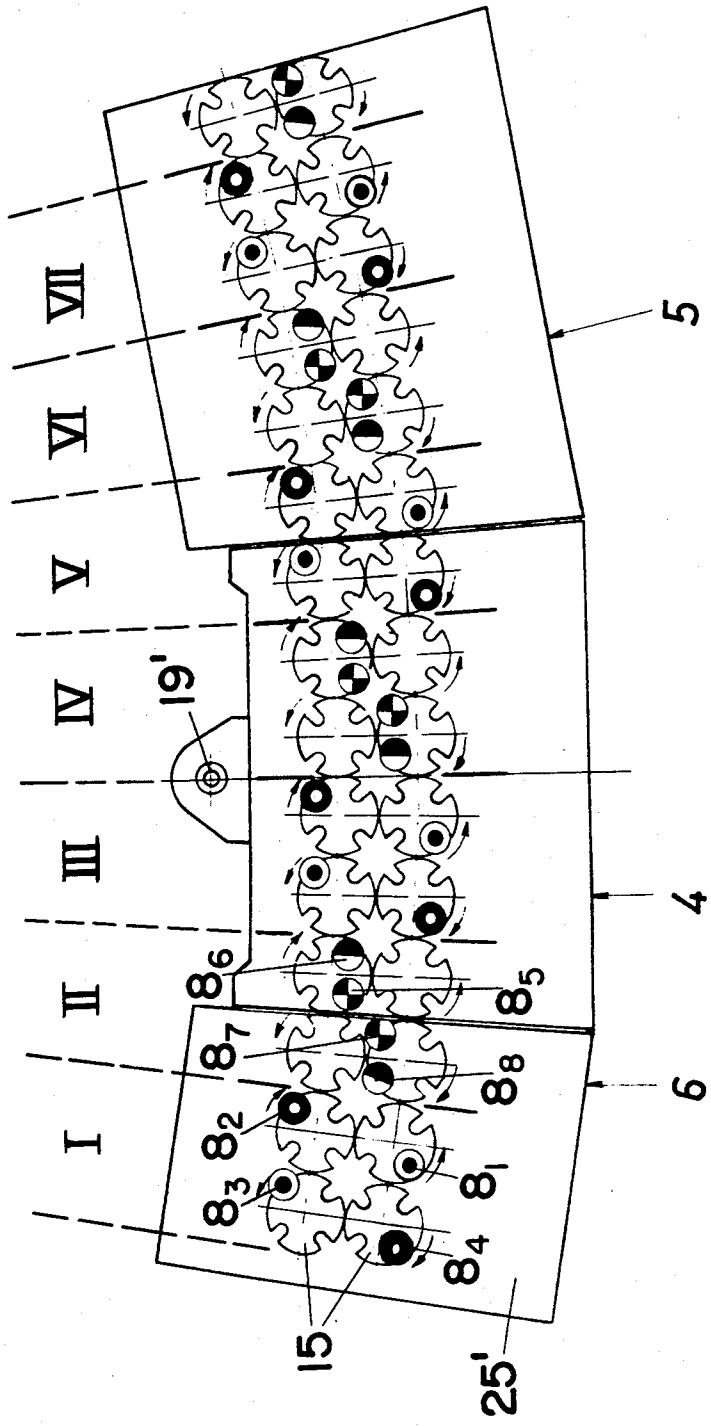

Fig.3

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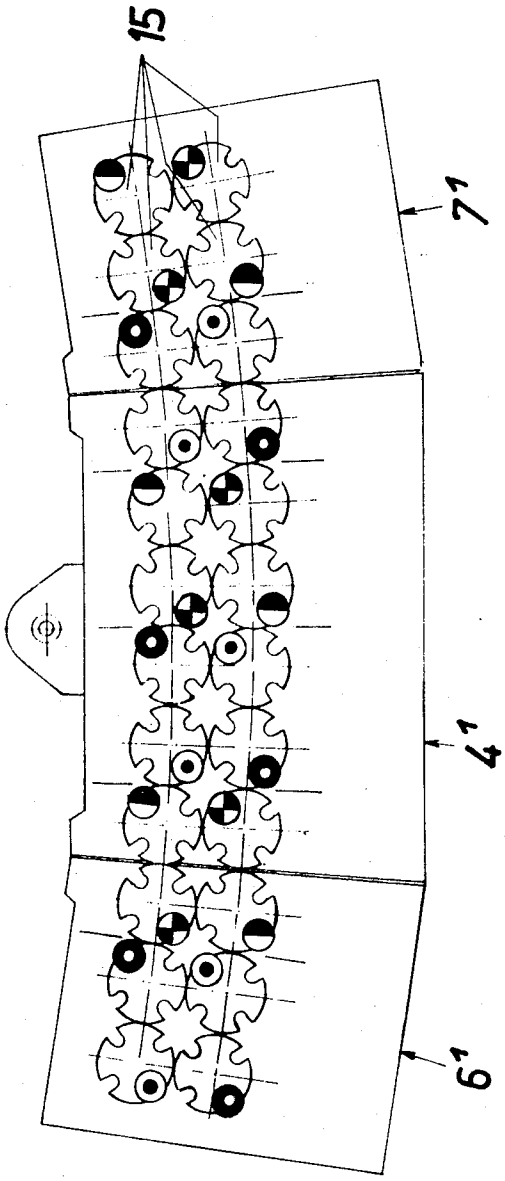

Fig. 3'

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FIG.3²

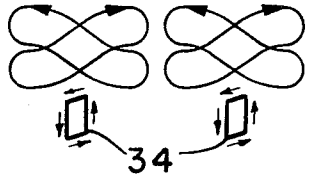


FIG.3²A.

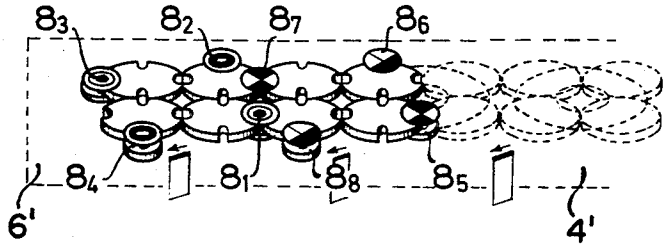


FIG.3²B.

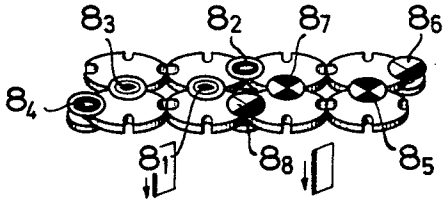
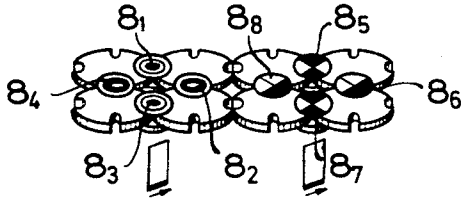


FIG.3²C.



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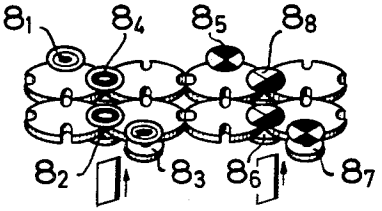

FIG.3²E.

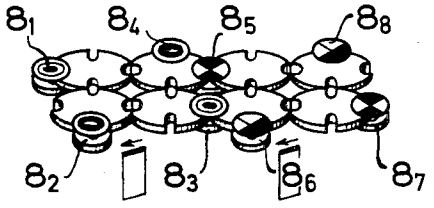

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FIG. 3^3.

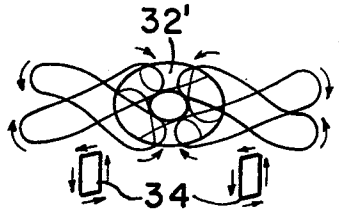


FIG. 3^3D.

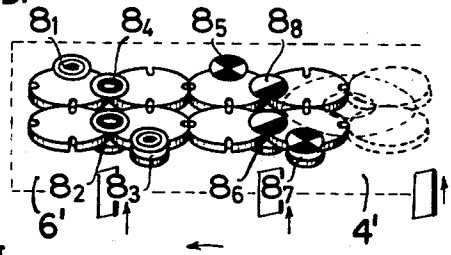


FIG. 3^3I.

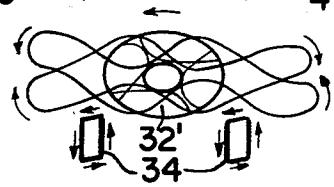
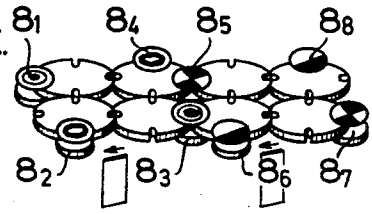


FIG. 3^3E.



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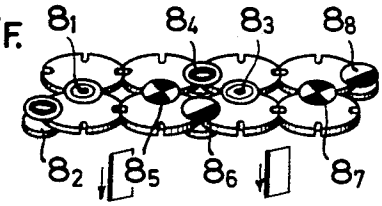
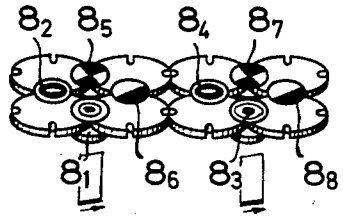


FIG. 3^3G.



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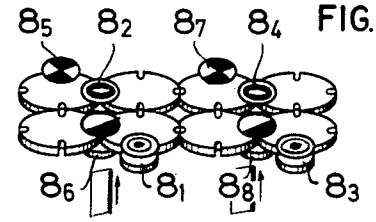

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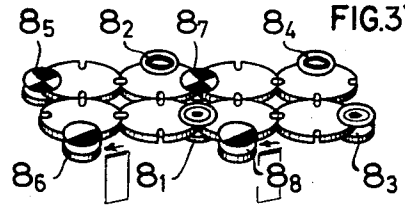


FIG. 3^3K.

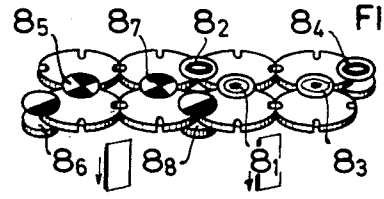


FIG. 3^3L.

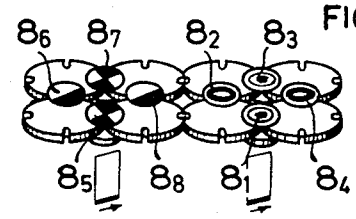
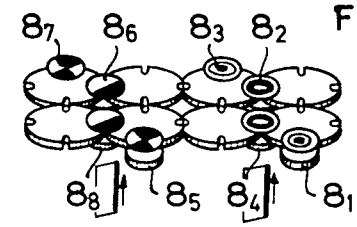


FIG. 3^3M.



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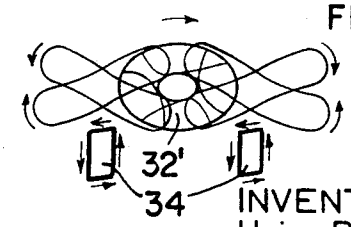

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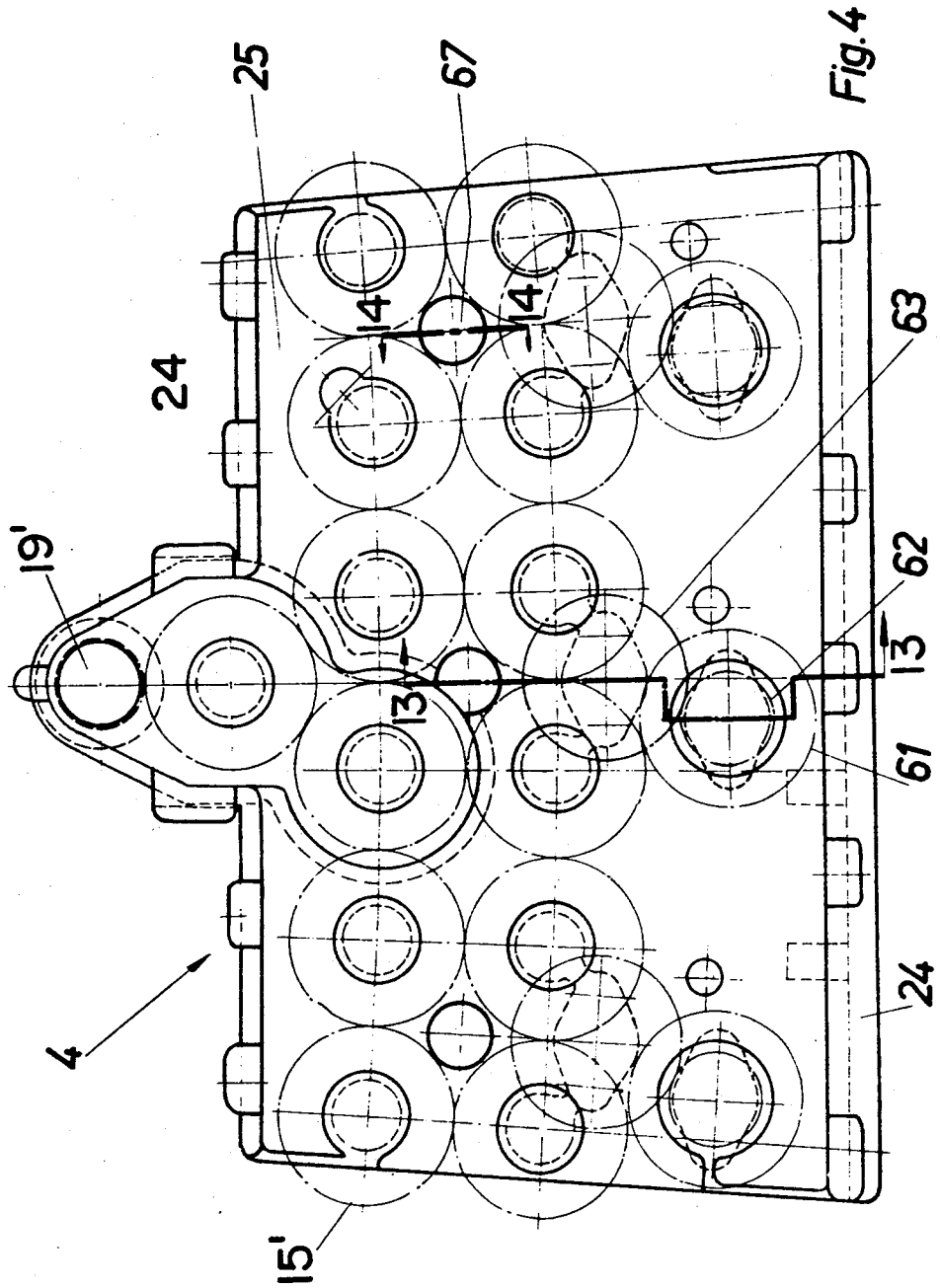

Fig.4

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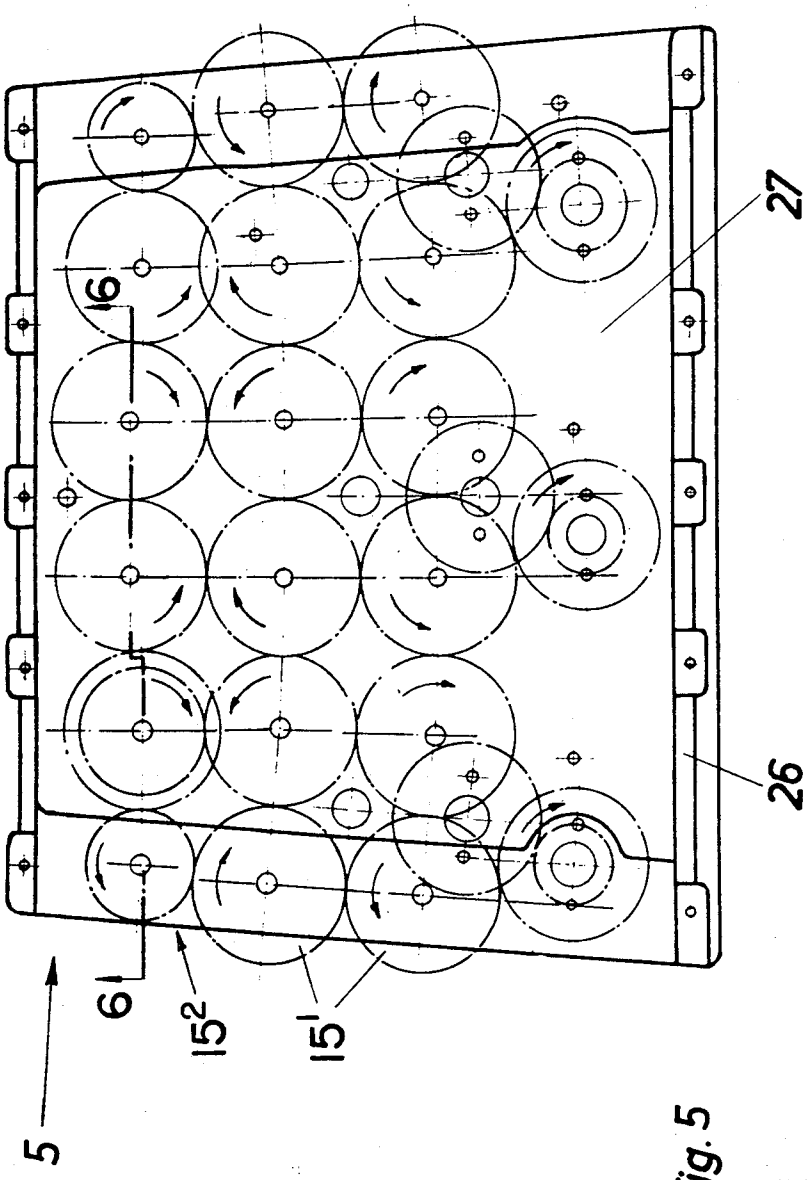

Fig. 5

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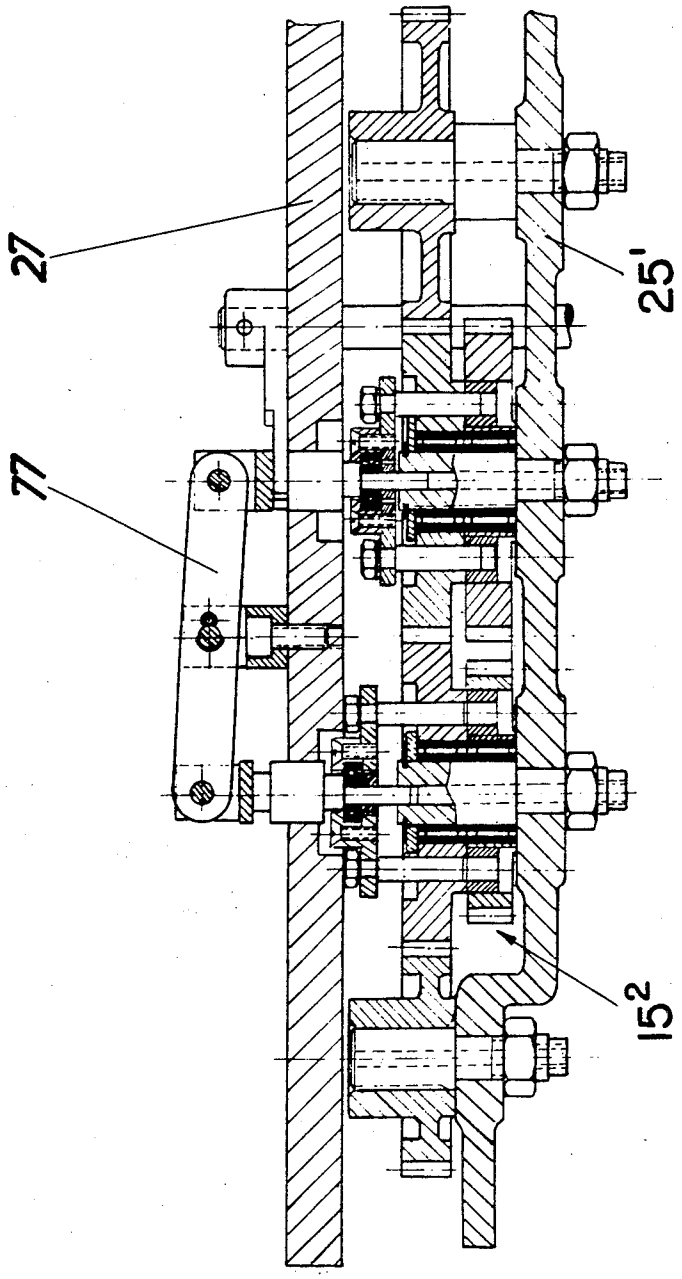

Fig. 6

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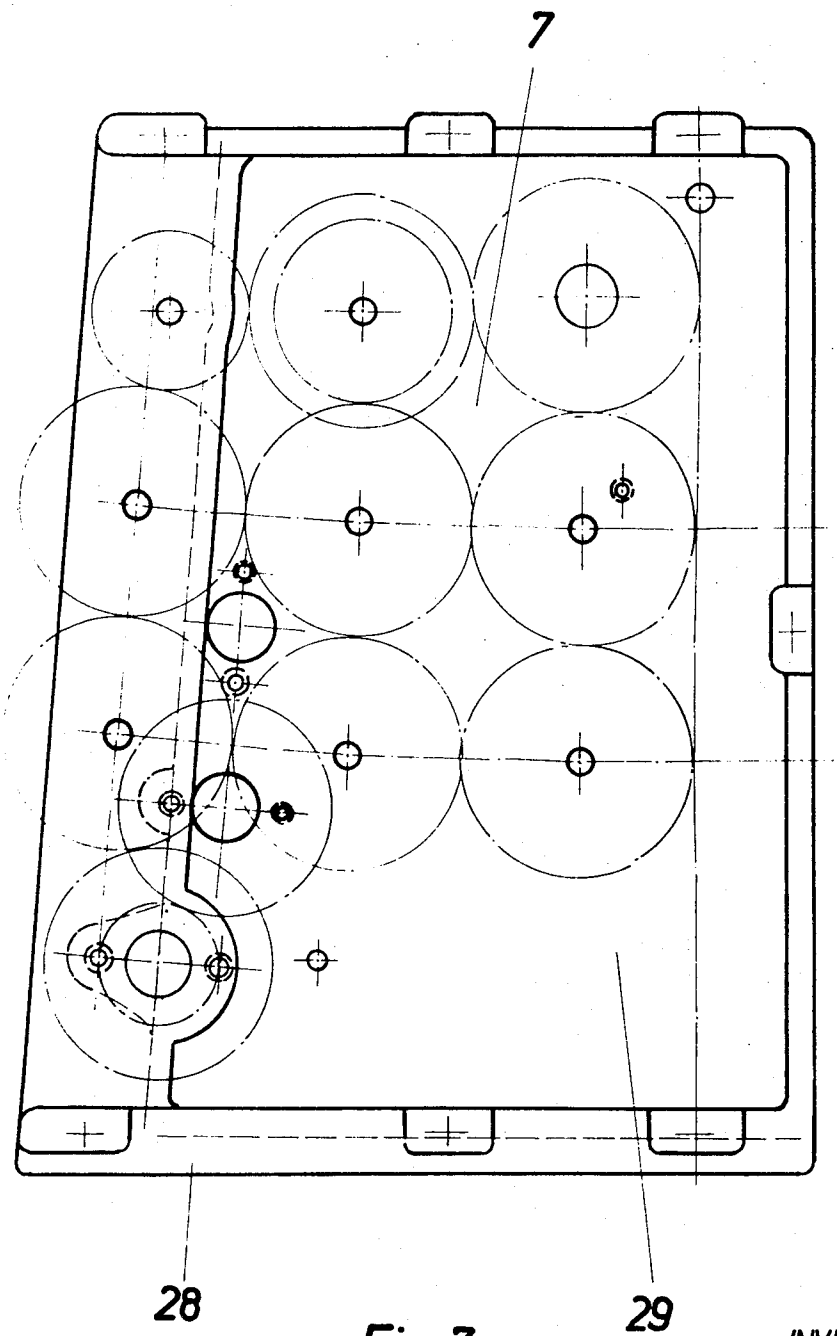

Fig. 7

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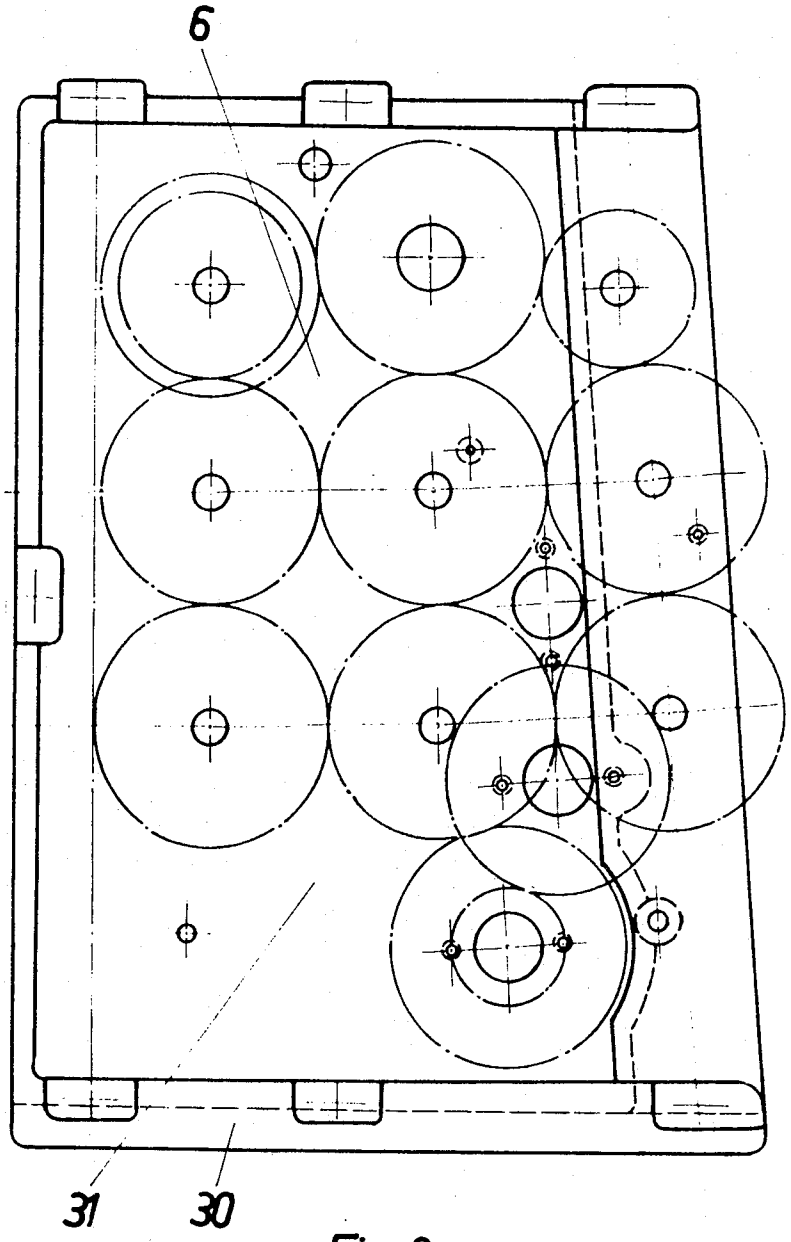

Fig. 8

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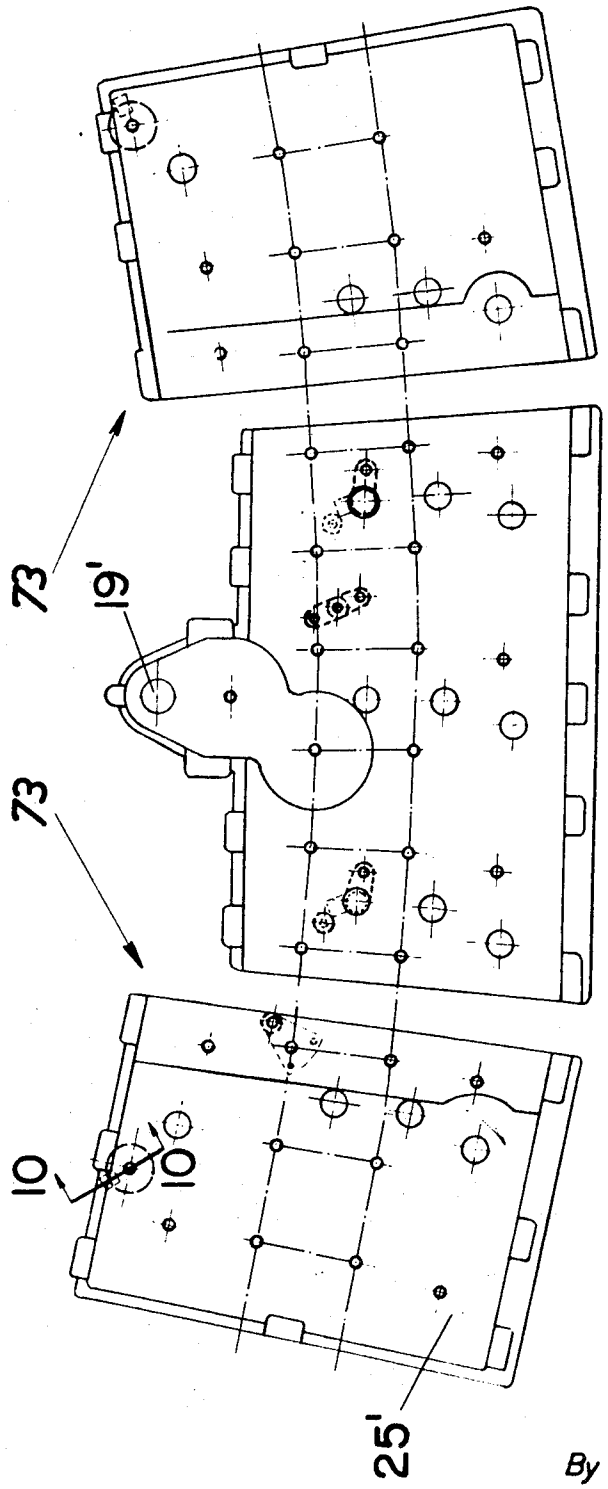

Fig. 9

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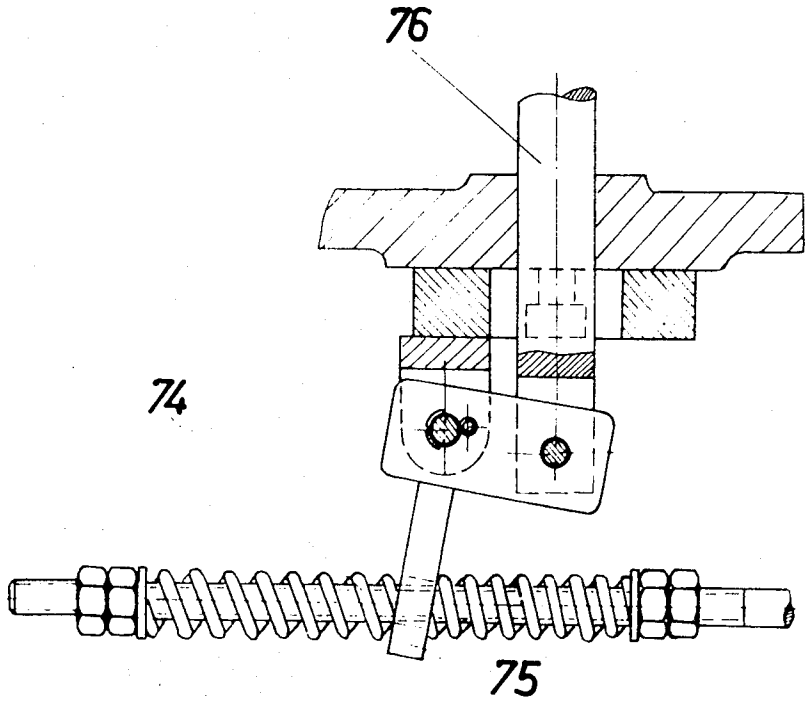

Fig. 10

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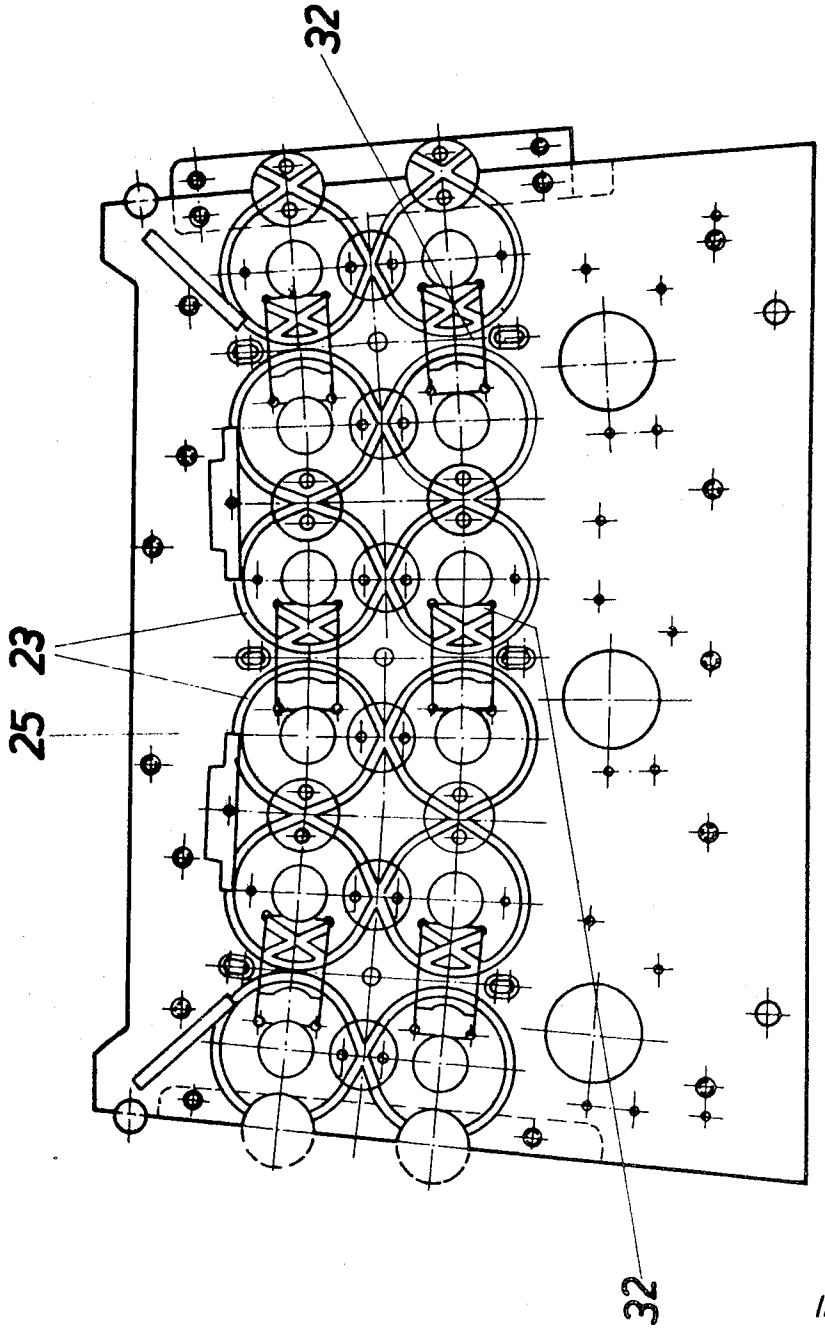

Fig.11

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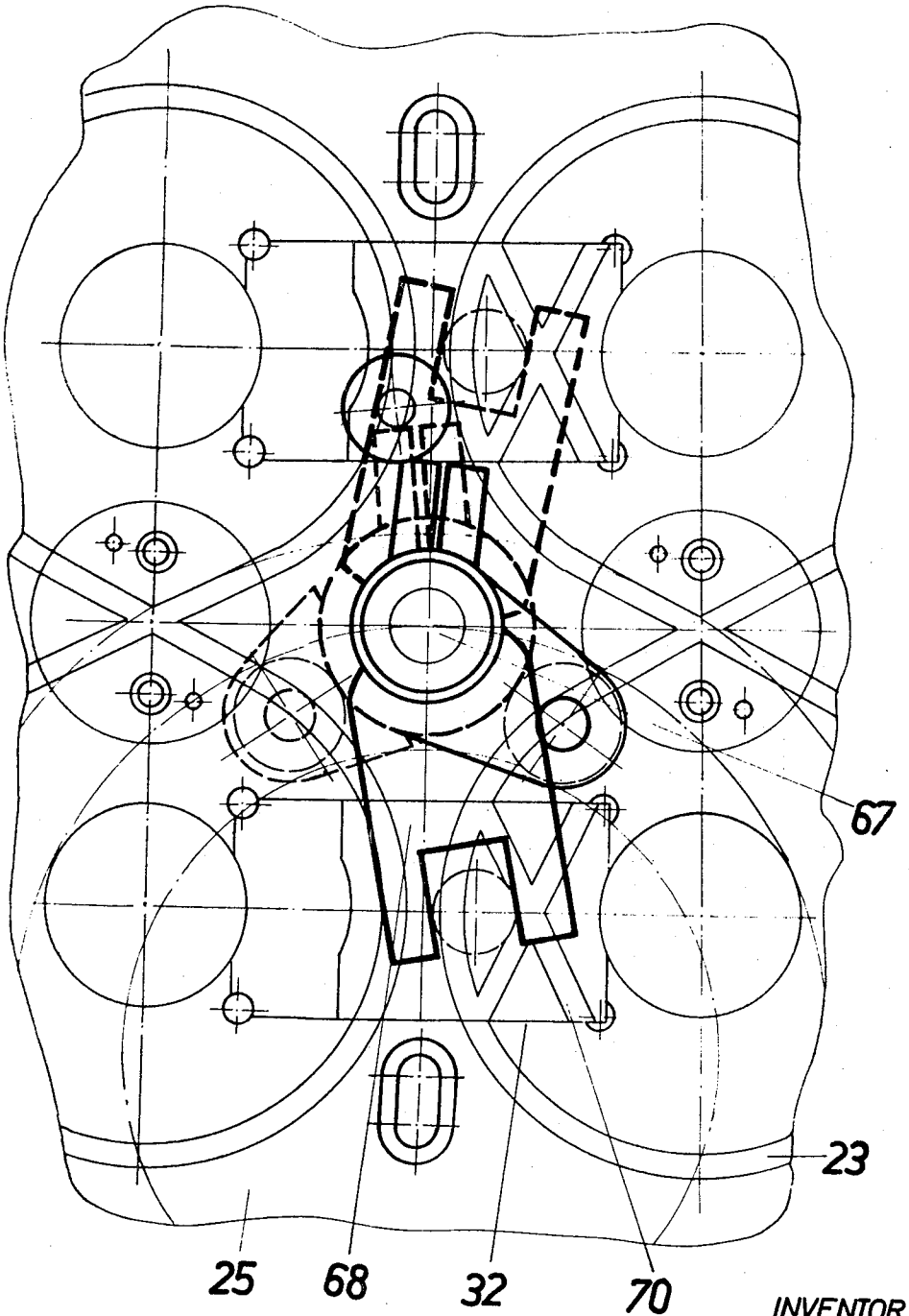

Fig. 12

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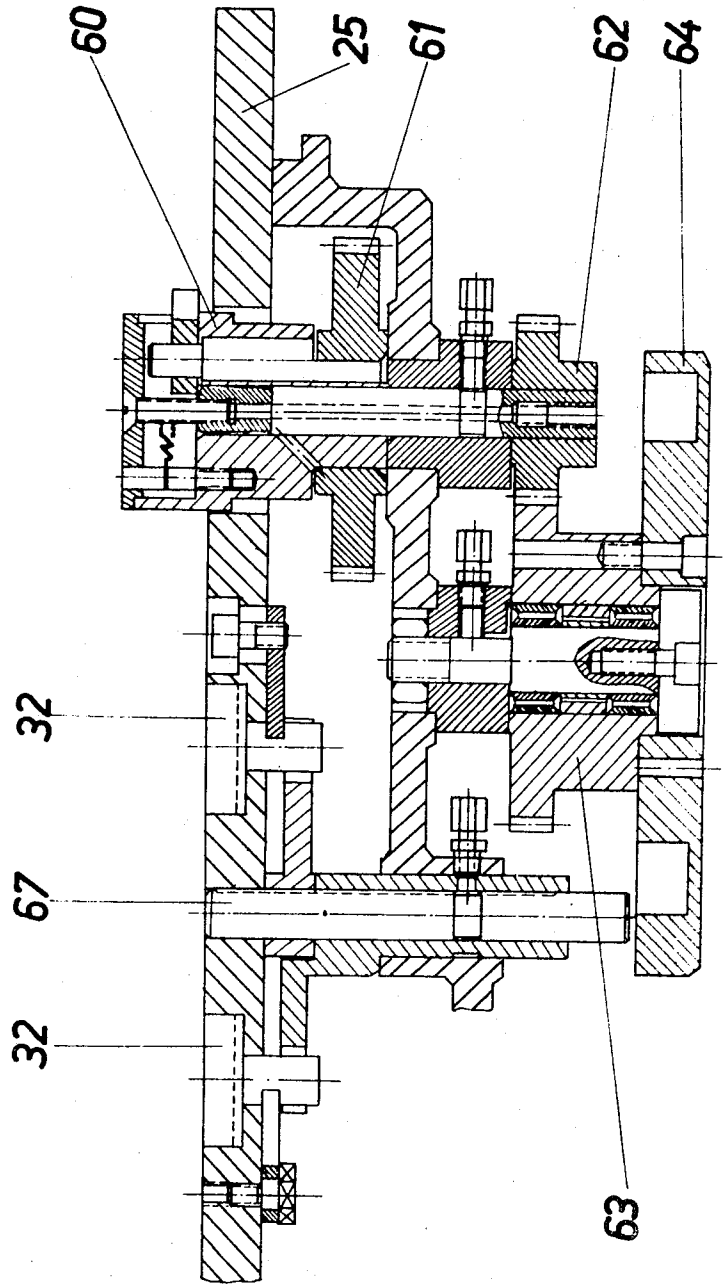

Fig. 13

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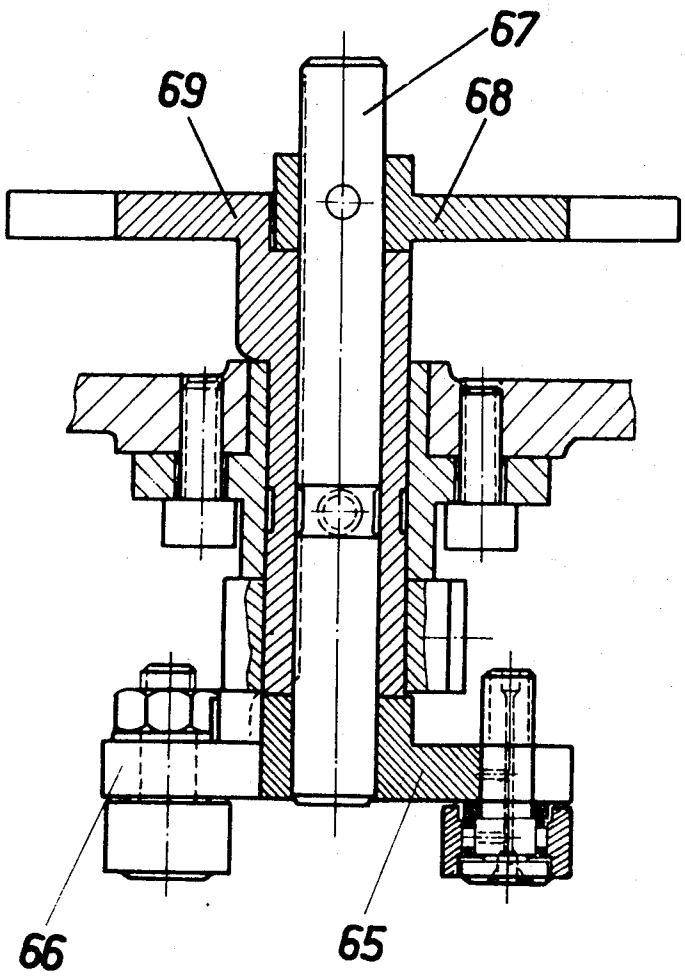

Fig. 14

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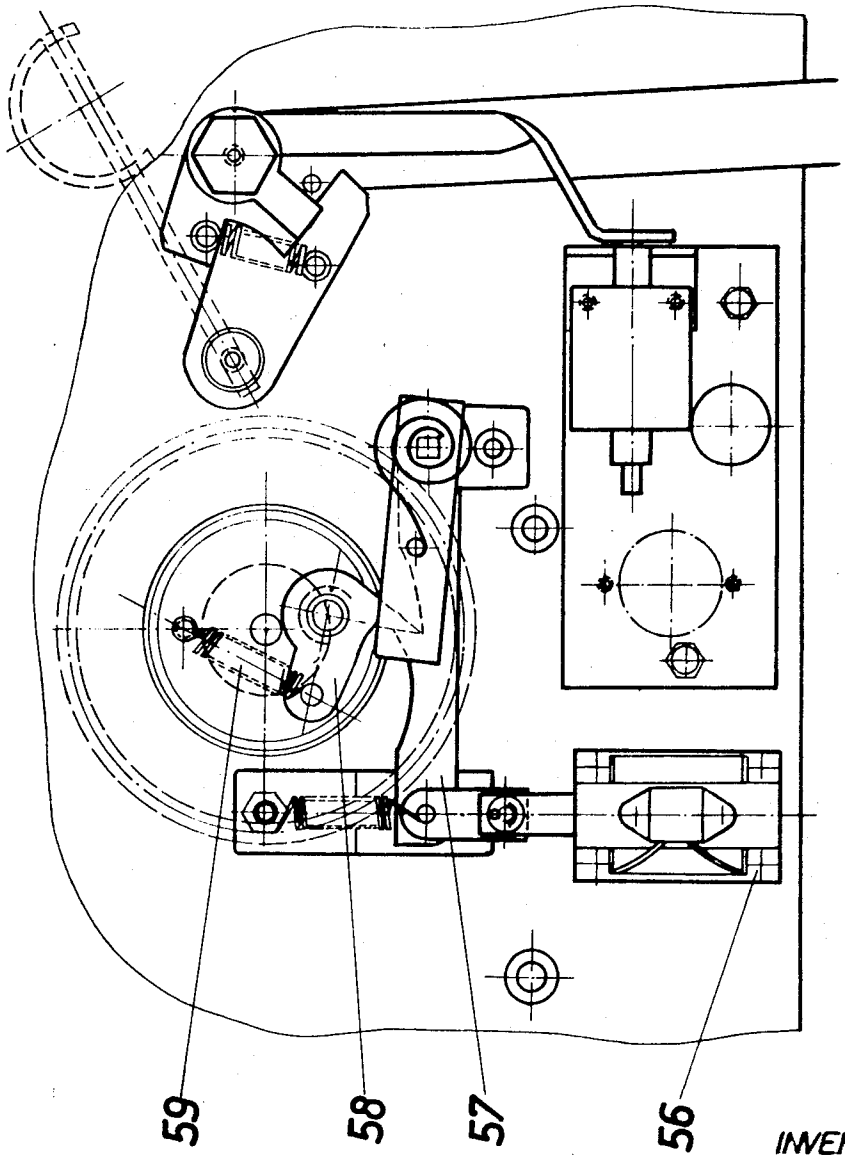
Fig. 15



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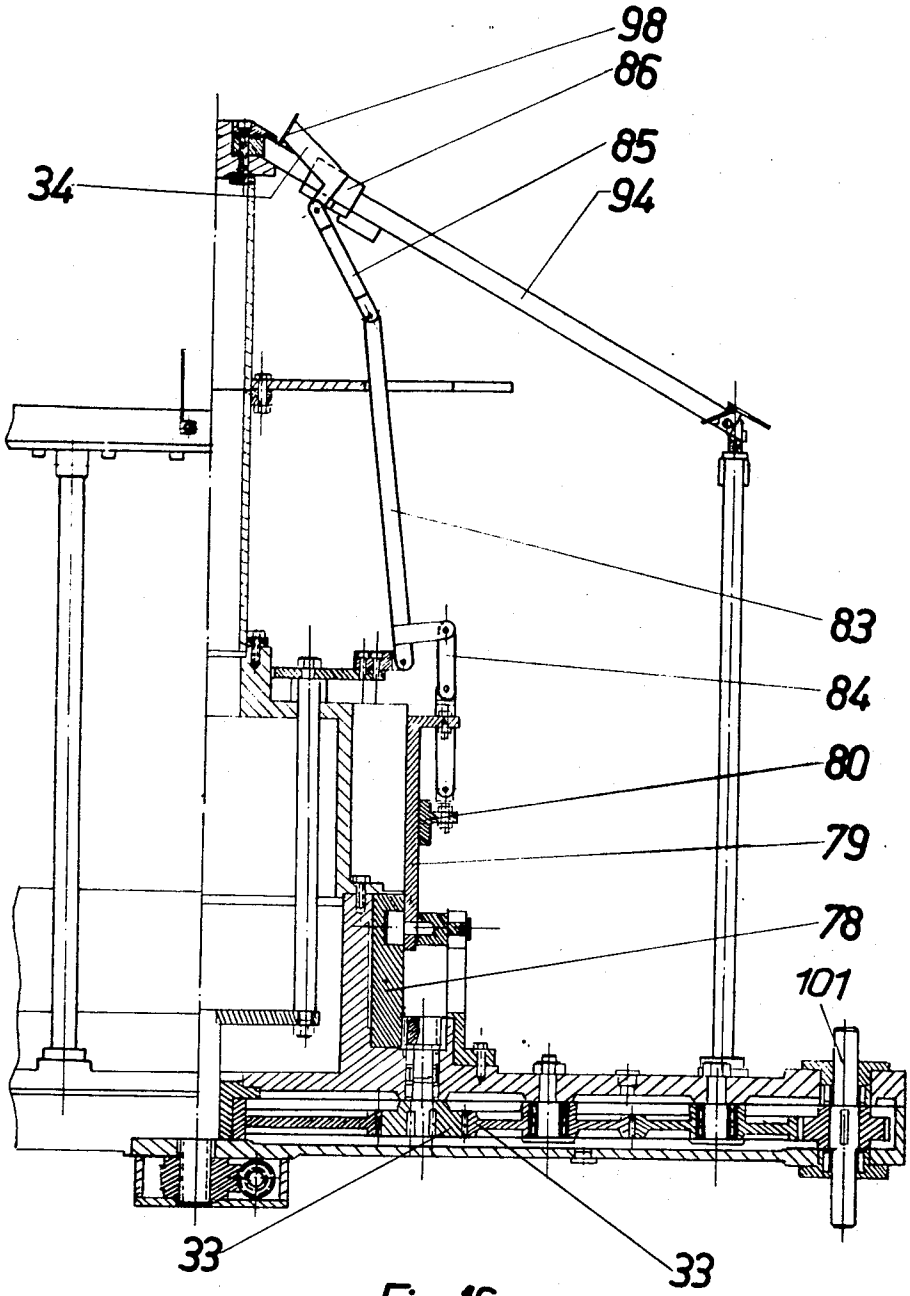

Fig. 16

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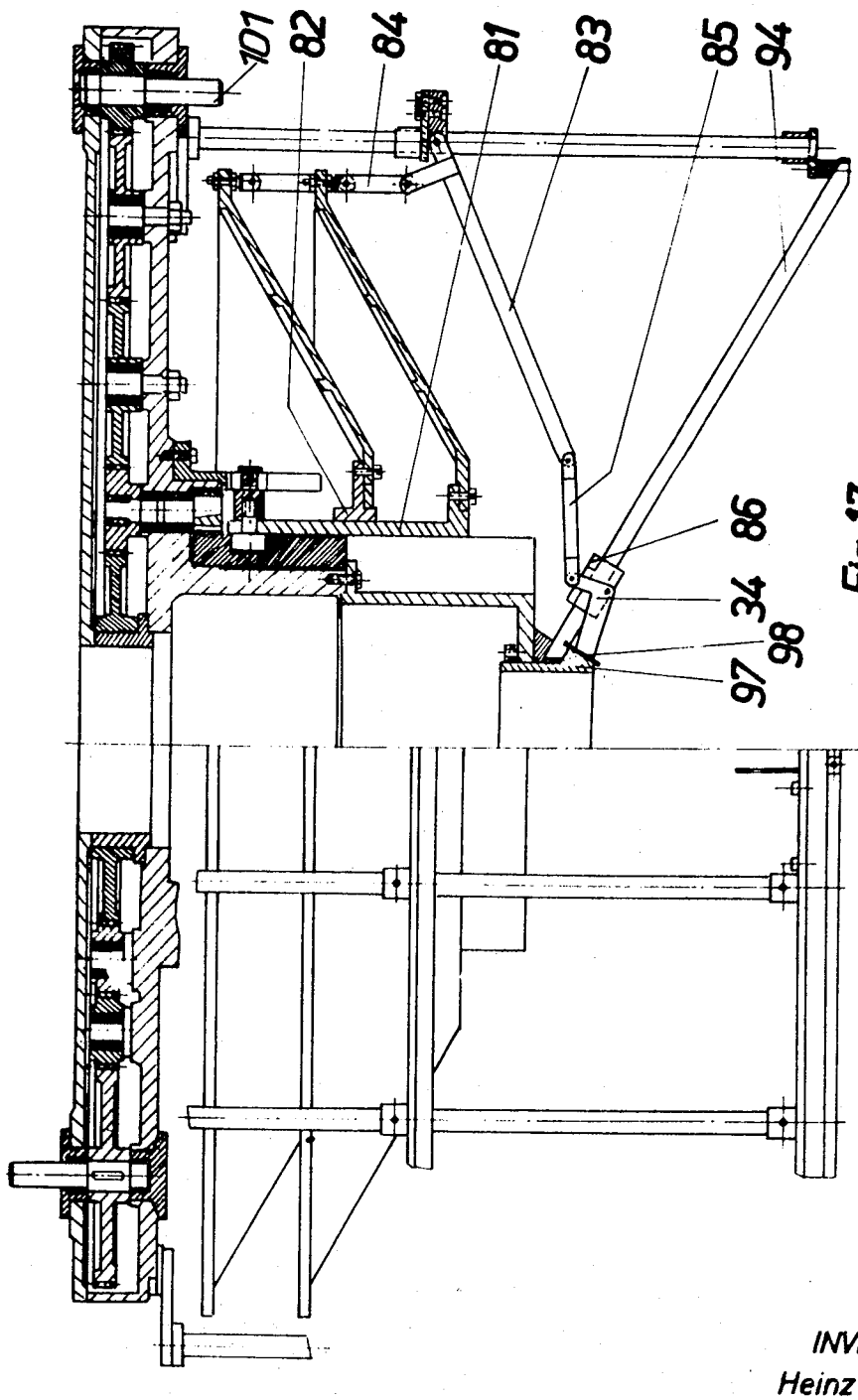

Fig. 17

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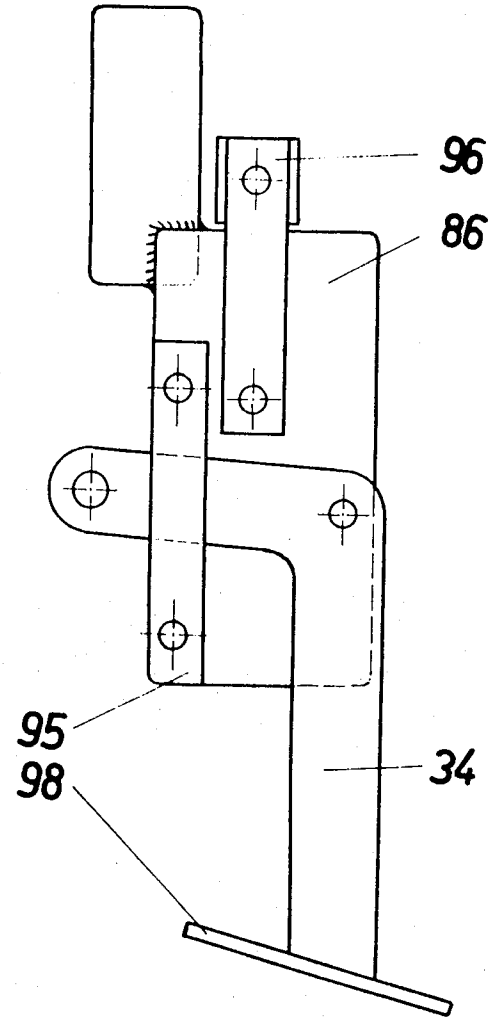

Fig. 18

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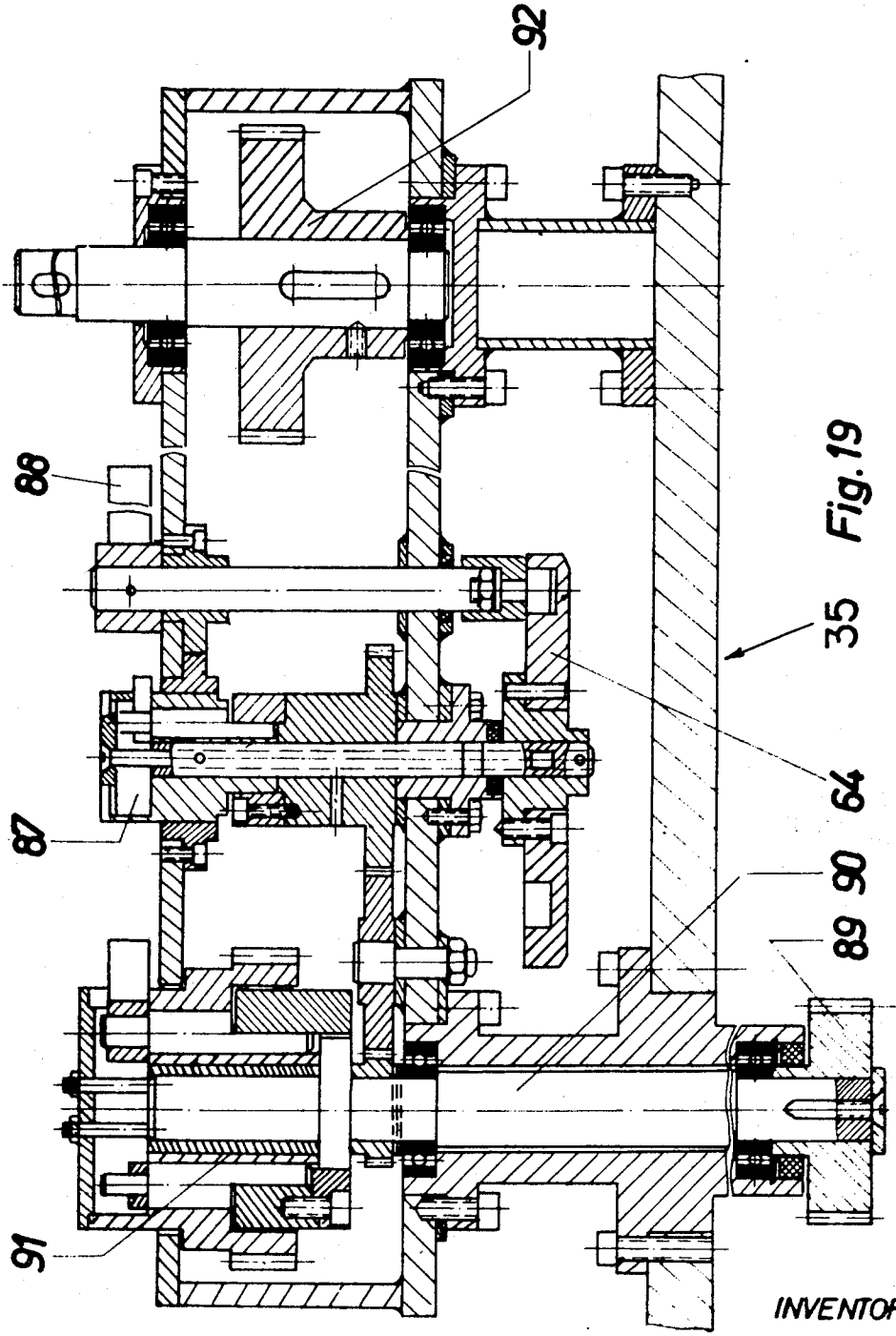

Fig. 19

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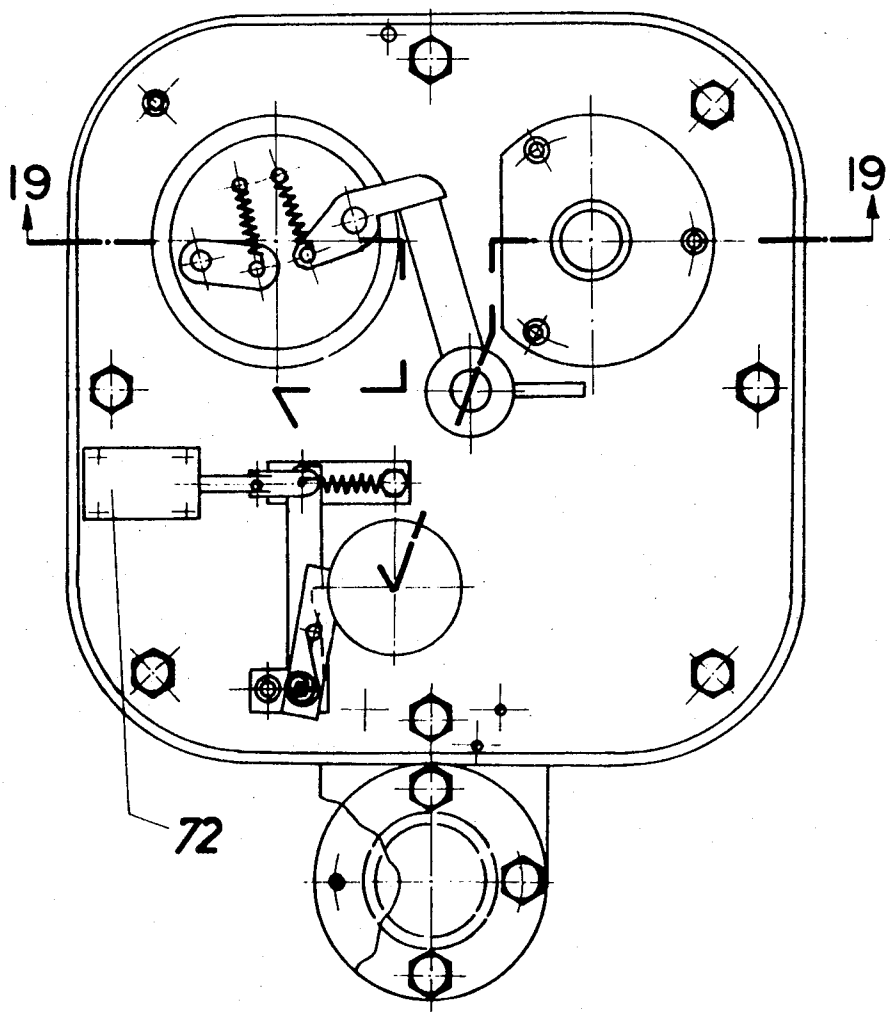

Fig. 20

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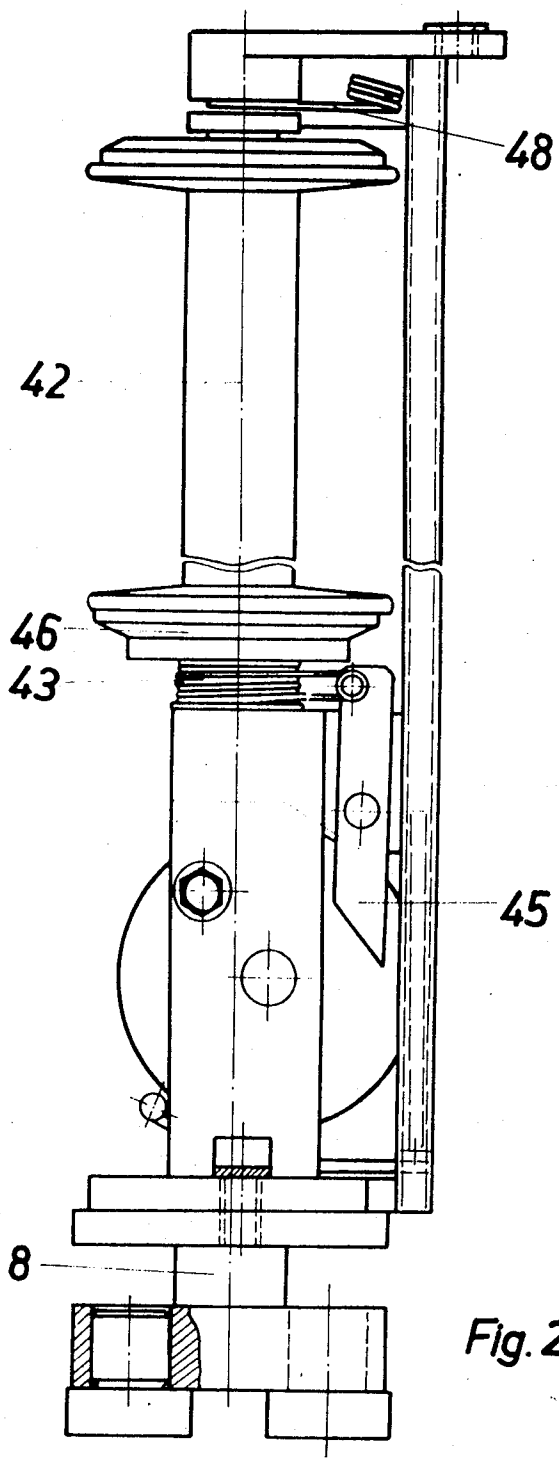

Fig. 21

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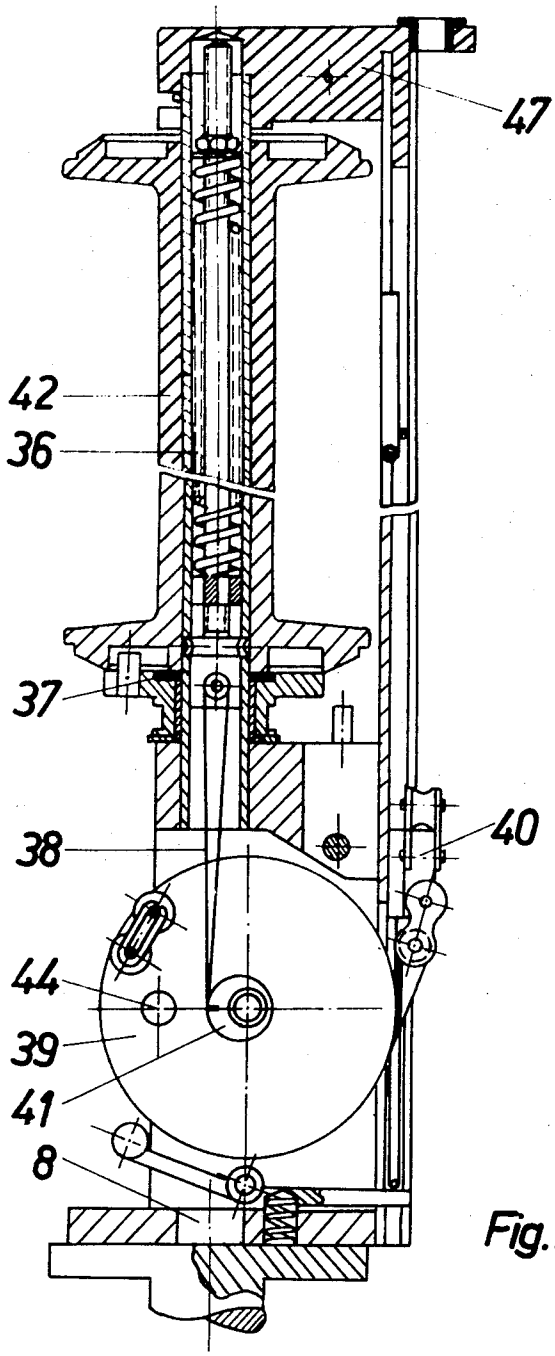

Fig. 22

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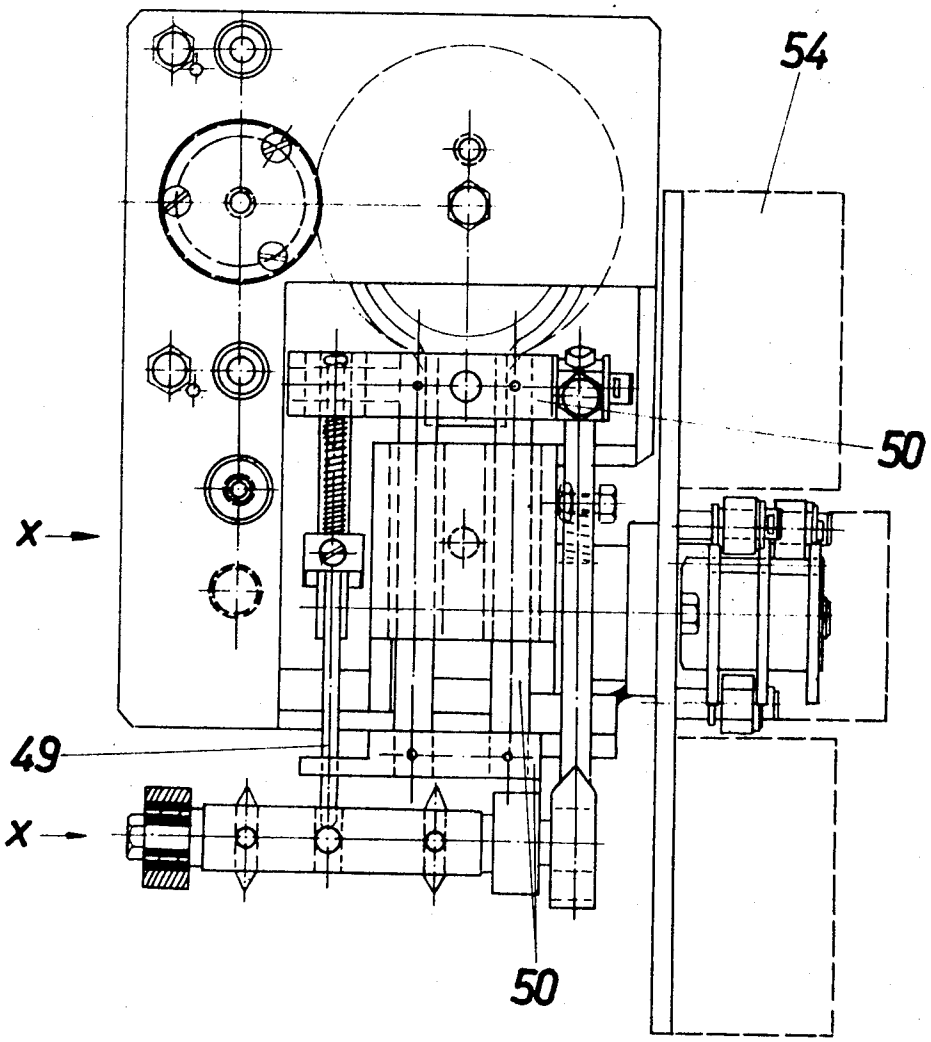

Fig. 23

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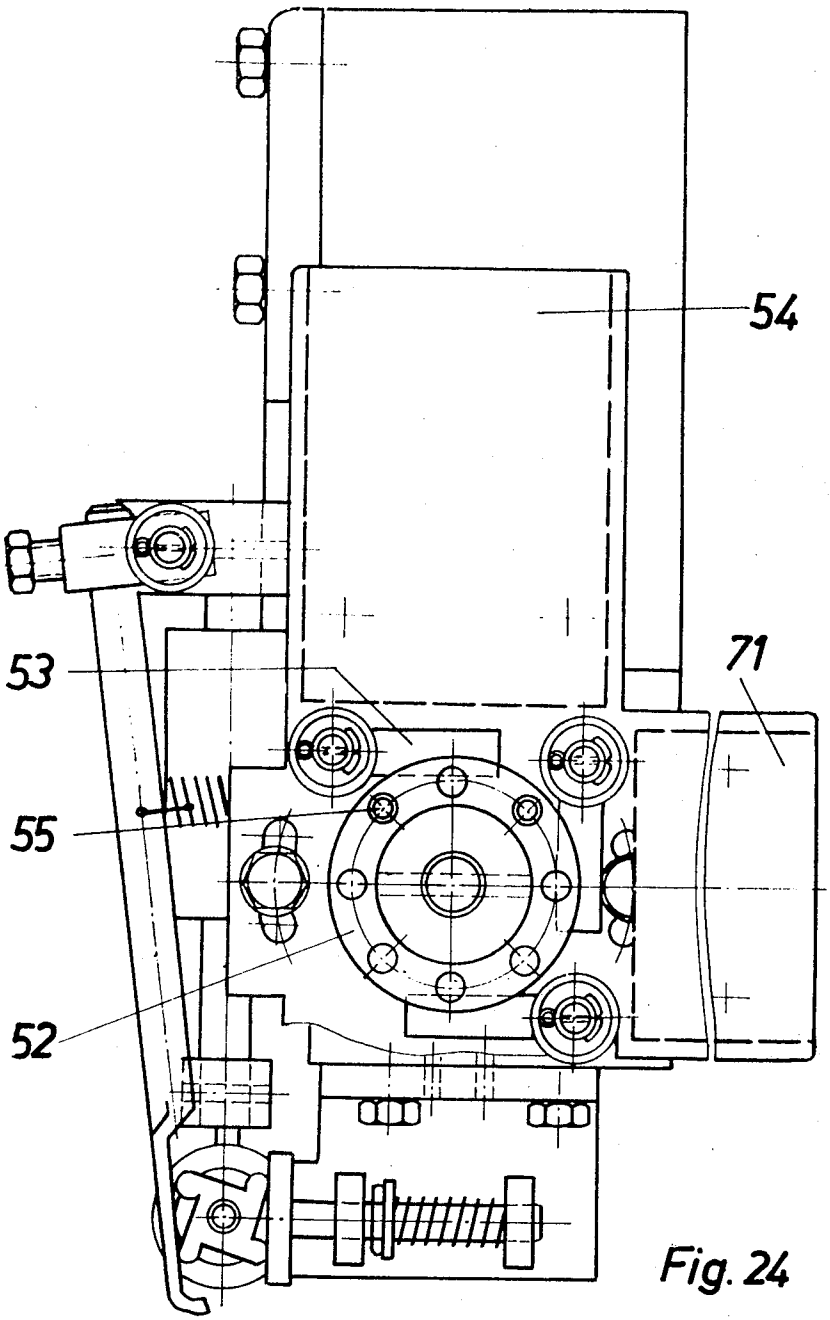

Fig. 24

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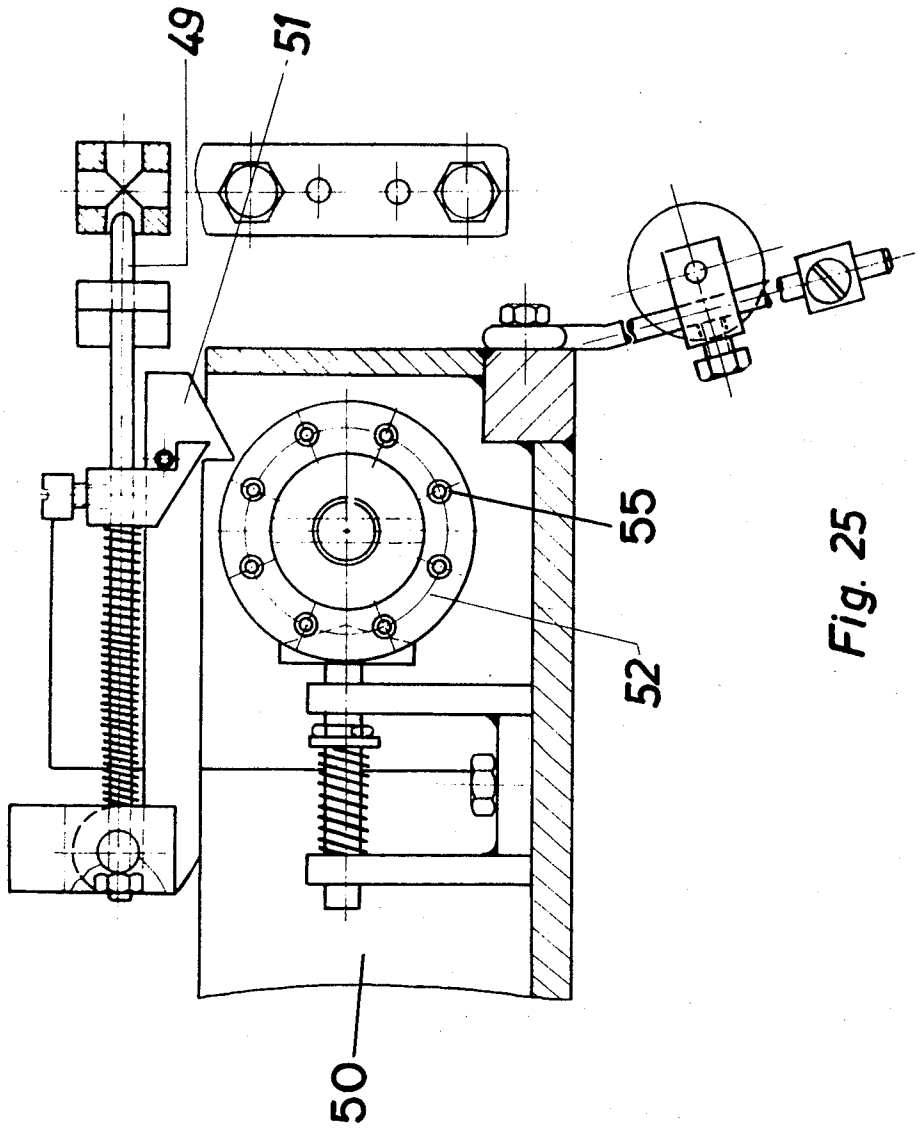

Fig. 25

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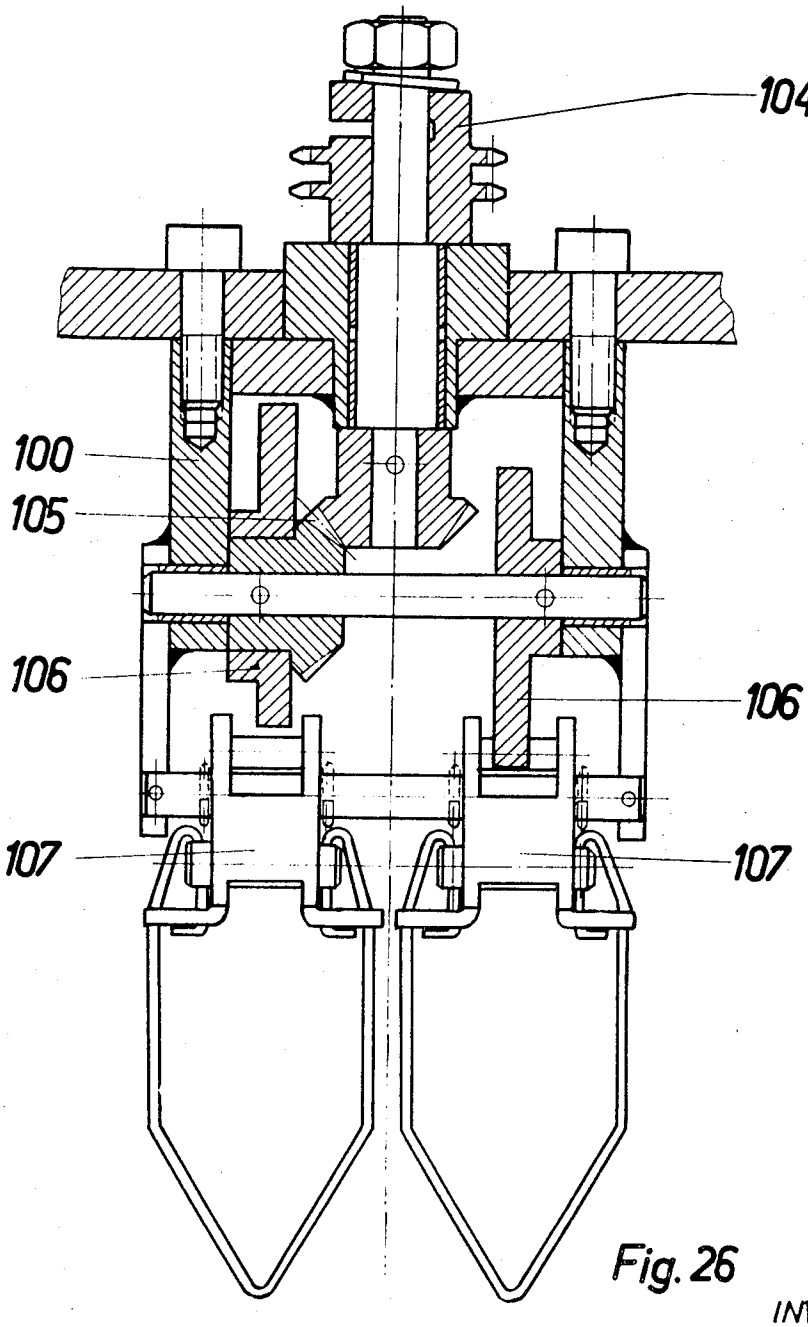

Fig. 26

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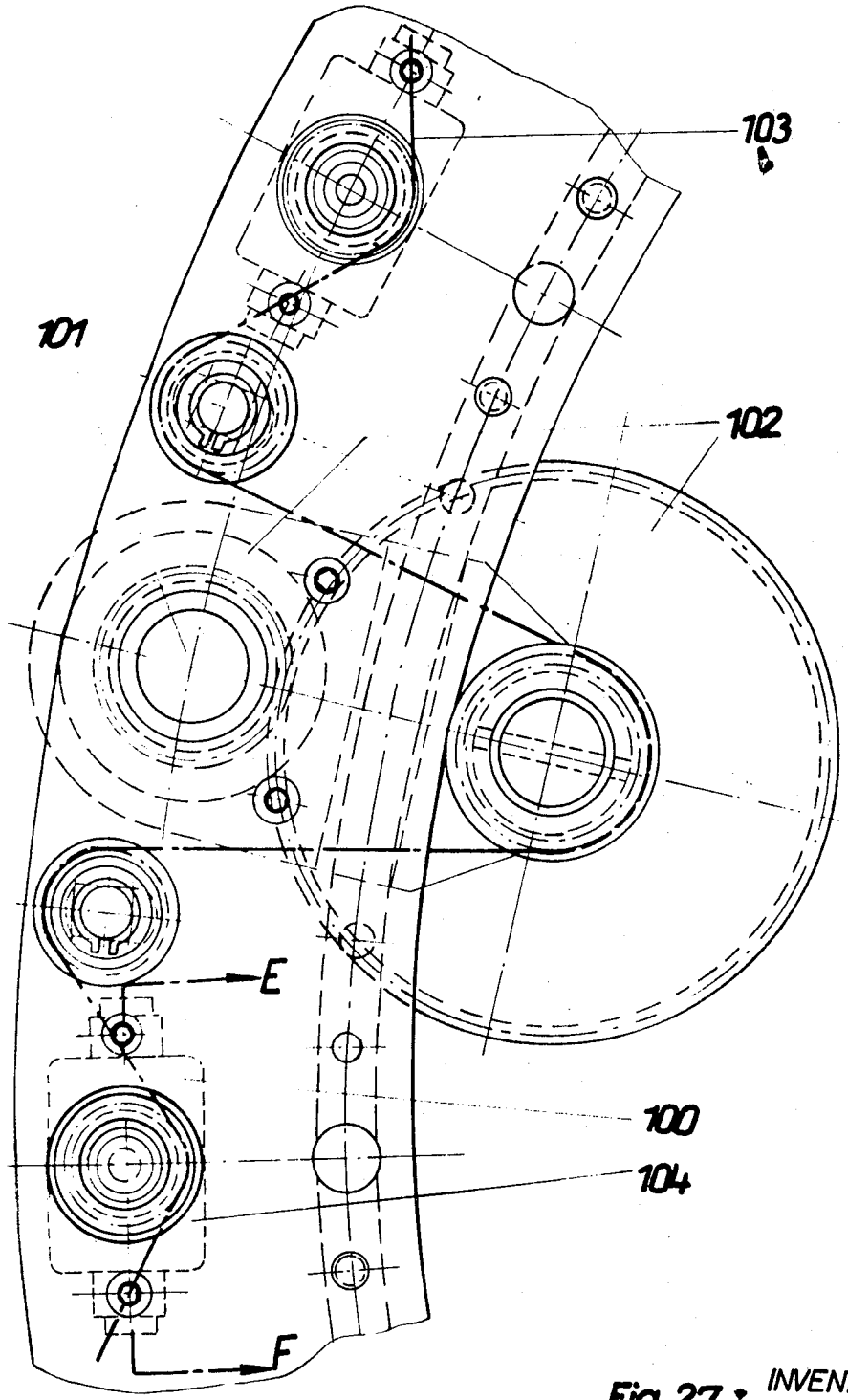

Fig. 27

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BRAIDING MACHINE FOR BRAIDING KNOTLESS NETTING

BACKGROUND AND NATURE OF THE INVENTION:

Knotless braided nets, preferably with four yarns to the net segment, are known by themselves. They are usually constructed so that in each segment, two yarns always are crossed clockwise in the form of the numeral eight, while the other two threads are always crossed counterclockwise and brought into similar form, the crossings of one set of eight-shaped formations, provided by one set of yarns, being disposed in the eyes of the eight-shaped formations of the other set as is shown for example in FIG. 3^2 of the drawings presented here. At the connecting points at least one set of threads changes through the neighboring net segments.

A method and apparatus have become known which provide for mechanical production of the net segments and interconnections for loop formation in knotless braided nets. In a braiding machine of this type knotless braided net webs are produced on a braiding table with lacing needle paths divided into individual sections according to certain patterns. The tracks are divided into individual paths crossing in the form of figure eights, by means of track switches. Each needle path of this form, together with certain wheels underlying the path, constitutes a braiding head for making a net segment. In every second braiding head the lacing needles occupy uniform positions, while they are at a phase angle relative to the lacing needles of adjoining braiding heads. After the braiding of net segments, the track switches between each second and adjacent braiding head are opened until a yarn connection has been produced by transfer or change of lacing needles. The other track switches, closed until then, are opened after the ensuing braiding of net segments.

If the system of tracks forms a close circle, the resulting netting is tubular. If netting with fixed edges is to be made, edge braiding heads are needed. These require a phase shift of lacing needles relative to the general run of such needles as provided in the normal braiding heads. For such a phase shift it is known to provide bypass tracks for the edge braiding heads. Their disadvantage is that they make the braiding table complicated near the edges. It also becomes impossible to subdivide the braiding assembly so as to make it possible to produce netting webs of different widths and mesh.

Another machine, known by itself, transfers the braid element, formed directly above the braiding heads, to the upper central region of the circular machine. Such upward transfer of the braid element, for interconnecting interchange of the braid strands, is a condition for the making of net fabrics of small mesh. The known devices for this purpose have an inclined base plate, similar to that of Japanese yarn braiding machines. The base plate has the form of a conical surface so arranged that all normals at right angle thereto intersect in one point of the central axis of the machine. Above the base plate and parallel thereto, an upper plate is provided and is connected with the base plate by columns; it also has the form of a conical surface and the lines normal thereto intersect in the same point of the central axis. The upper plate has yarn guides

which are moved synchronously to the motion of the net lacing needles. The base plate and upper plate are provided with the individual guide and braiding tracks corresponding to the net characteristics desired. The upper plate with the yarn guides has discs provided thereabove, between which there are separating elements. In order to guide the braided material, suitably controlled cogs or controlled and programmed discs can be provided.

These machines with inclined base plates have disadvantages due to their use of the inclined base plate. The transitions from one braiding head to another are at an angle, which is not to be overcome when the guide system for the net lacing needles is the usual one. Even parabolic plates lead to unsuitable results. Other disadvantages lie in the complications of the drives for the braiding unit, and in the fact that stopping of the braiding unit is difficult. Still further, uniform lubrication is impossible and operation as well as construction of the system is expensive. Another problem connected with the provision and arrangement of the upper plate is the following: circular form of the base plate has the effect that a certain diameter of the circle becomes necessary when a certain number of braiding heads is used, and constructed in predetermined size. Since every braiding head has the same distance from the central point, spreading of yarns can only equal the diagonal width of the braiding head, thus predetermining the angularity and convergence. Since the spreading angle depends on the effectiveness of yarn tensioning for each form and density of mesh, the aforementioned upper plate has been provided with auxiliary braiding heads. The dimensioning of the upper plate depends on the angle subtended by the braiding head. These conditions require miniaturization of the upper plate at the level of the braid element naturally formed, but the resulting miniature size cannot be realized in practice. On the other hand, construction of an upper plate in practically possible size leads to a distance thereof from the theoretical braiding point, for small mesh netting, which is too large to be actually effected.

The invention overcomes the difficulties of a braiding machine with inclined base plate for transporting the net braiding area into the upper central region of the machine. The invention also has the object to avoid the difficulties caused by the use of a braiding system with phase change for braiding needles in the edge units, and the associated bypass systems. A further object is to make sure that knotless nets can be produced with fixed edges, with variable widths of the netting, and with variable mesh. Another object is to transpose the braid elements, naturally formed directly above the braiding heads of the braiding assembly, into the upper central part of the machine in such a way that only minimum travel is needed for the interchange of yarn strands to form the interconnections, required for realization of netting with various mesh characteristics.

According to the invention there is provided a braiding machine characterized by an arrangement of separating braiding units and edge braiding units, with special needle positions, in addition to the known normal braiding units, and track switch control producing suitable successive needle positions with the use of pairs of crossing grooves for simultaneous movement in the control switches. In order to accurately adjust the

level of all braiding units, there is provided between every two adjacent braiding units, a suspension in form of a carrying column, in addition to suspension for each braiding unit. The braiding units are suspended from the corresponding upper plates. Also provided are means for production of knotless braided nets of different widths and mesh, comprising the use of three types of braiding heads including separating heads, normal heads, and edge forming heads. The separating heads are constructed so that they can work either as normal or edge type units. The normal units have a control device rigidly secured thereto, using a limit feeler and associated devices including a pull magnet for interchange of lacing needles from braiding head to braiding head. In the edge braiding heads, phase transfer of needles, by two wings of a four wing wheel, is effected with the aid of an adjacent track switch control device, preferably with the use of pull wires, balance rod and balance rocker.

In order to maintain uniform yarn tension over the entire distance between braiding point and needle, there is provided a compression spring mechanism which among other things compensates the linear force increase of the compression spring by an eccentrically arranged cam.

The invention is also characterized by the use of a braid lifting system having lower and upper braid lifters for transferring the braiding point into the upper center of the machine. For each braiding head there is provided a braid lifter knife, in the system of upper and lower braid lifters, one knife being always in engagement with yarn. By means of suitable leverage and other mechanisms the braid lifter knives secure the yarn crossings produced by the lacing pin operation, and transport the crossing element to the braiding area. A central drive for the entire machine drives both the braiding assembly and the braid lifter mechanism, as will be described hereinafter. When the net lacing needles are interchanged from braiding head to braiding head the braid lifter knives are newly arranged under the control of the control device and its terminal feeler and pull magnet.

In order to reinforce the yarn spreading, generated by the lacing needle motion, and for a short while to maintain the same, the upper braid lifter has a special opener arranged for it, together with suitable drive. Pursuant to its use the netting is received in the take off unit, known by itself.

DRAWINGS:

FIG. **1** is a front view of the new machine;

FIG. **2** is a perspective diagram;

FIG. **3** is a schematic plan view of the lacing needle arrangement;

FIG. **3'** is a modification of FIG. **3**.

FIGS. 3^2 to 3^2E and 3^3 and 3^3D to 3^3N are schematic views of operations, in the arrangements of FIGS. **3** and **3'**, respectively.

FIG. **4**, drawn on a somewhat larger scale, shows a normal unit of the braiding assembly;

FIG. **5** shows a separation unit thereof;

FIG. **6** shows a phase shift drive of the same, or of an edge unit in the braiding assembly, the section being taken along lines **6** — **6** in FIG. **5**;

FIG. **7** shows, an edge unit of the braiding assembly;

FIG. **9** is a plan view, on the scale of FIG. **3**, of the phase shift control means in the braiding assembly;

FIG. **10** is a partial section through the same taken along lines **10** — **10** in FIG. **9**;

FIG. **11** shows the guide grooves in an uppermost plate of the braiding assembly;

FIG. **12** shows part of the same, and the mechanism thereof, on a somewhat larger scale;

FIG. **13** shows the drive for the control track switches, in a section taken along lines **13** — **13** in FIG. **4**;

FIG. **14** shows the lever mechanism for driving the control switches, in a section along lines **14** — **14** in FIG. **4**;

FIG. **15** shows a control unit for controlling the entire machine;

FIG. **16** and **17** are respectively a general view and a larger partial view of upper parts of the braid lifting structure according to the invention, both being shown partly in elevation and partly in vertical central section, and in somewhat different positions of certain parts;

FIG. **18** shows a lifter knife subassembly of the braid lifters;

FIG. **19** shows an intermediate drive for driving the same, the section being taken along the irregular broken line in FIG. **20**;

FIG. **20** is a plan view of the intermediate drive;

FIGS. **21** and **22** are respectively an elevation and an elevational central section of a yarn feed and braid transfer structure;

FIG. **23** is a plan view of a control device for the entire machine;

FIG. **24** is a right side elevation thereof;

FIG. **25** is a partial section through the same, the section being taken at line x in FIG. **23**;

FIG. **26** is a cross sectional view of the opening device in the upper braid lifter mechanism; and

FIG. **27** is a plan view of the drive for this opening unit.

BRIEF REVIEW OF THE DRAWINGS:

FIGS. **1** and **2** show the basic construction of the new braiding machine.

FIGS. 3^3 to 3^3N shows the arrangement of lacing needles for the various braiding units. Normal, separation and edge units for the braiding assembly are shown, in the indicated sequence, in FIGS. **4**, **5**, and **7**. The means for switching and controlling the operations therein are shown in FIGS. **6**, **9** – **14** and **23** – **25**.

FIGS. **23** – **25**, along with FIGS. **2** and **15** also show the general control means, for the entire machine.

FIGS. **16** – **18** show the braid lifter mechanism. FIGS. **19** and **20** show its drive, and FIGS. **21** and **22** show details of the yarn feed mechanism. The opening device in the upper lifting mechanism, and the drive of this opening device are shown in FIGS. **26** and **27**.

DETAILED DESCRIPTION OF THE FIRST EMBODIMENT:

General Construction of the Machine, FIGS. 1 and 2:

A central drive **1**, comprising motor reducer **16**, drives a number of connecting elements and thereby drives the braiding units, which are circularly disposed on frame **2** of the braiding assembly. Motor reducer **16**

effects the drive of the entire machine by a central drive gear 17. It also powers auxiliary devices of the machine, as will be described hereinafter. Central gear 17 is in mesh with numerous follower gears 18 which rotate shafts 19 and bevel gear drives 99 and thereby actuate the braiding units 4.

Braiding Units, First Embodiment:

In addition to normal braiding units 4 there are provided separation units 5 and edge units 6 and 7, the arrangement of which is schematically shown in FIG. 3 with the understanding that the figure shows only one normal braiding unit between separation and edge units, whereas actually several normal units may be interposed, which can form a large ring, shown in cross-section in FIG. 1. The separation units 5 make it possible to produce webs of netting with different numbers of loops across the web. Edge units 6 and 7 establish the edges of the web, the width of which is determined by the number of normal braiding units 4, circularly juxtaposed to one another in the machine. Depending on the number and arrangement of separation units 5, netting of different numbers of loops can be produced, since the separation units 5 can be operated as normal units or edge units.

A preferred machine, described herein has 27 normal braiding units 4, two separation units 5, one edge unit 6 at left and another, 7, at right, in the braiding assembly of the machine. Each normal braiding unit 4 and each separation unit 5, as illustrated in FIG. 3, comprises three braiding heads, each head in turn comprising four wheels arranged to form a square and corresponding to one pair of threads to be braided into the netting. The threads are supplied to the braiding units from external creel spools 42 (FIG. 1), to be discussed later.

While normal and separation units, 4, 5 have three braiding heads each, every edge unit has one and a half braiding heads, so that the present machine has a total of 90 braiding heads, for braiding ninety pairs of yarns into 45 loops. By interposing separation units 5 as 10th and 20th braiding units, it is also possible for the present machine to produce netting of 15 or 30 loops width. By interposing separations units 5 in other positions, and/or differently arranging edge units 6, 7, it is possible to produce netting of practically any number of loops and widths, up to 45 loops, in steps of one and a half loops, provided by the three braiding heads of each normal unit.

Each braiding head as already noted has four wheels. These are constructed as wing type wheels 15, carrying the net lacing pins or needles 8. The complete series of wing wheels constitutes two rows, closely adjacent one another and curved to form a pair of arcs, from one edge unit 6 to the other 7, which advantageously occupy the major part of a complete circle. In each braiding head, two of which are most clearly illustrated in FIGS. 3^2C, 3^2D (representing the operation according to FIG. 3^2) as illustrated in FIG. 5, the four wing wheels normally carry a total of four braiding needles 8, in various arrangements as indicated by different symbols in the small circles which identify the needles, in FIGS. 3^2A to 3^2E; a modified diagram being shown in FIGS. 3^3D to 3^3N, where the needles and braid lifters are shown in such positions as they occupy when the connecting parts between net elements are produced in a system according to FIGS. 2 and 3'.

As indicated in FIGS. 4, 5 each normal braiding unit 4 has a mechanism comprising drive gears 15' (for wing wheels 15), which mechanism is driven at 19'. It is contained in a housing, which is approximately rectangular in plan view and is composed of an upper plate 25 having edge 24 and a lower pan 25 bolted thereto. The cross section of the housing formed in this way is shown in FIG. 13, where the upper plate is shown on top and the lower pan, generally parallel thereto, in the middle of the figure. Separation and edge units 5, 6, 7 have, respectively, upper plates and edges shown at 27, 26 in FIG. 5, at 29, 28 in FIG. 7 and at 31, 30 in FIG. 8. In each case, the upper plate has, suspended therefrom, the lower pan and the entire braiding unit mechanism, with wing wheels 15 inside the housing formed by plate and pan or outside and adjacent the same. The several upper plates are held accurately at the same level by vertical adjustment means, not shown, the operation of which is facilitated by providing a carrier column 3, on frame 2, between every two braiding units. As indicated by FIG. 1, the entire machine may have a base plate 20 and slightly above the same a bottom 22 for servicing the machine.

The Braid Lifter System (General Arrangement):

As indicated in FIGS. 1, 2 the upper central portion of the machine is occupied by lower and upper braid lifter units 9, 10, actuated by central drive 1 via central gear 17 and intermediate drive unit 35 and vertical shafting extending therefrom. Braid lifters 9, 10 have, for each braiding head, a pair of braid lifter blades 34. At least one blade 34 of each pair is always engaged with yarn material from the lower braiding assembly. All blades 34 lie in planes radial of the machine and each of these planes intersects the center of one braiding head. Each pair of blades 34 serves to transport a yarn crossing, generated by lacing needles in the braiding head, to a braiding point in the upper center of the machine, and temporarily to hold it for generation of the loop-connecting interchange of yarns between yarn crossings.

Yarn Spools:

As also indicated in FIGS. 1, 2, each braiding head has a creel of four yarn spools 42. These are shown in detail in FIGS. 21 and 22 and are provided with compression springs 36 for generating suitable yarn tension, the force of the spring being transmitted by a rod 37 and connecting band 38 of high quality watch spring to rotatably journalled discs 39, subject to compensation of decreasing spring force by a cam 41 on disc 39 to insure uniform yarn tension over the entire extent of the travel (42 – 34) of tensioned yarn. There is also provided a flexible steel band for connection between disc 39 and tension slider 40. A braking spring 43 counteracts the running off of yarn from spool 42. A pin 44 on disc 39 moves release lever 45 which releases the torsion engagement of brake spring 35 with brake drum 46. Interchange of spools is allowed by removal of head closure 47, which is returned to proper position by the closing spring 48. It is believed that these details of the mechanism will be understood, by themselves, without further explanation.

Take-Off Bridge:

Above the braiding assembly, as shown in FIG. 1, a take-off bridge 12 is erected. From this bridge upper braid lifter unit 10 is suspended in a position corresponding to that of lower braid lifter unit 9 which rests on columns supported by bottom plate 20. Between the upper and lower braid lifter units, there is a narrow slot, clearly visible in FIG. 1, for upward-inward passage of yarn crossings to be braided, which are represented by the diagonal lines from adjacent the creel spools 42.

Take-off bridge 12 supports take-off drive 11 which actuates take-off drums 13. The drive is effected by a vertical shaft, shown in central position and actuated by upper braid lifter unit 10, the drive unit 11 containing suitable change gear and worm gear provisions for actuating the drums. The change gears are used for simplification of the transmission and speed change from braid lifter to take-off unit. Also included in drive 11 is an override clutch, whereby a suitable hand wheel, not shown, can turn take-off drum 13 forwardly without interference with the drive connections.

The braided material produced in the braid lifter system is conducted upwardly over a suitable path, not shown, to one of the drums 13, and can be taken off from one of these drums.

The Control Unit (FIGS. 10 – 15 and 24, 25):

Control is needed for the lacing process performed in the lower braiding assembly, the corresponding interlacing effected in the braid lifter assembly, the interchange of lacing needles in the lower assembly, and other partial processes. This control includes, among other things, a control portion for control of track switches in the lower assembly (FIGS. 11 – 14) and other elements to be discussed hereinafter.

The several lacing needles 8 as shown in FIG. 3 have the same respective positions in every second and even numbered braiding head and correspondingly in all odd-numbered heads. Such positions are shown by numbers 8_1 to 8_4 in head I at left, and being repeated, as shown by corresponding needle symbols, in heads III, V and VII, following at right. This is necessary since otherwise, when needles 8 are interchanged between the braiding heads, collision would ensue. If lacing needles 8 of the embodiment described here had the same position in each braiding head I, II, etc they would have to be interchanged by means of rotary positioners according to the Volkenborn system or by complex bypass means.

In FIG. 3, where a normal unit 4 is shown with separation unit 5 and one of the edge units 6, the lacing or braiding of one set of loops requires that the four lacing needles 8_1 to 8_4 or 8_5 to 8_8 of a braiding head are moved along pathways crossing one another in form of figure eights, which pathways can be observed on consideration of FIGS. 3^2A to 3^2B (also see 3^2). They appear in modified form in FIG. 33 and are shown most clearly in FIG. 11. Such guidance produces a quadrature of interlacing yarns. For controlling the length of the legs of the net so produced, there is provided a control device 14 connected to one of the normal braiding units 4 as shown in FIG. 2. The device operates according to the principle of a Jacquard machine controlled by a punch card, the braid number of the leg of mesh being determined by the punch card number and being in turn a measure for the length of the leg. Device 14 also controls the length of penetration produced when the connection between the loops is made.

In the braiding assembly, in order to achieve interconnection of the several legs, needles 8 are guided from one braiding head to an adjacent one via track switches 32, FIGS. 11 and 12.

This interchange is triggered by control device 14 as soon as a predetermined length of netting leg has been laced. Since device 14 is rigidly connected with a braiding head, the drive of these heads is transmitted into this device, synchronously with the braiding process performed in the assembly. Accordingly, each revolution of wing wheels 15 causes a card feeler process on a card, moving in a stationary plane.

The feeler pin 49 in control device 14 (FIGS. 23 – 25), held on moveable sled 50, is brought to the card, and as a result triggers a switching process depending on whether it finds a punch hole in the card or not. If the card, at the point in question, has a punch hole to cause an impulse for switching, needle 49 is moved forward longitudinally, whereby a lever 51 can drop and come into engagement with switching drum 52. This drum is mounted on sled 50 which also has lever 51 pivoted thereto. Thereupon a pin 55 moves a small flapper 53, thereby closing an electric circuit in limit switch 54. The switch closes a circuit which actuates several pulling solenoids 56; see FIGS. 2 and 15.

The duration of actuation of the solenoids is determined by the construction of drum system 52. When solenoid 56 seals in, lever 57 is turned to release rotary latch 58 so that by means of tension spring 59 the rotary latch establishes connection between drive wheel 61 (FIGS. 13, 14) and track switch head 60. This operation establishes a fixed interconnection of the turning motion with the position of lacing needles. A pinion 62 secured to switch head 60 drives a wheel 63 carrying cam 64. A cam groove on this cam causes, on rotation of the cam, motion of lever 65 with roller 66 in the groove, thereby effecting the phase control of the motion of track switches 32. This phase control is needed since in view of the lacing needle arrangement (FIG. 3) the track switches must be operated at different moments. Roller lever 65 by shaft 76 moves a forked lever 68 (FIGS. 11 and 12) which performs the shifting of track switches 32 and arrests and secures the final position of each. Roller lever 66 is also connected, by this forked lever 68, with a hub 69, to transmit motion to track switches 32. When these track switches have been shifted so that crossing grooves 70 connect with guide grooves 23, lacing needles 8 are guided from one braiding head to another, by the continued motion of the mechanism. Simultaneously, by further motion of switching drum 52 (FIG. 24), limit feeler 71 is actuated. The circuit closed thereby powers a pull solenoid 72 (FIG. 20) and thereby actuates intermediate drive 35 (FIGS. 1 and 19) for actuation of the braid lifter system (FIGS. 16 and 17).

Before the needle exchange is completed, control device 14 (FIGS. 23 – 25) triggers a further switching process. Further motion of switching drum 52 (FIG. 24) by means of limit feeler 54 again actuates pull solenoid 56.

When the rest position has been overcome, switching head 60 (FIG. 13) performs a further rotary motion causing track switches 32 to return to their initial position. The process described up to here is performed, in the indicated sequence, not only between braiding heads 1 and 2, but also, at the same time, between braiding heads 3 and 4, and the other, successive, odd and even-numbered braiding head couples. The next switching process, again as described above, occurs between braiding heads 2 and 3, heads 4 and 5 and the other even and odd numbered braiding head couples. The processes are the same except that at one time they occur from odd number to even numbered braiding heads and the next time, from even numbered to odd numbered ones.

The edge units cannot provide for exchange with further needles; therefore a shift of needle position is required in these units. In the embodiment shown here, the shift amounts to two wings of the winged wheels during one rotation of needles. The shift is performed by the switch drive shown in FIGS. 5 and 6, wherein a double wheel structure is interposed, with double wheel stages in ratio of 1:1 and 4:5. By means of the double wheel, the four drive gears 15' of wing wheels, of each head in the unit, are driven at the speed of wheels having five wings. Accordingly, after two revolutions, needles 8 are retarded by two wings. The switching process is released by an adjacent track switch operation, which will be understood by reference to FIG. 9. By wire pull means 73, via tensioning spring 74 (FIG. 10) a lever 75 is tensioned with switching rod 76. Thus at the switching moment, switching rocker 77 (FIG. 6) is moved, thereby causing:

1. disconnection of track switch stage 1:1 and simultaneously,
2. connection in track switch stage 4:5.

Reverse switching for normal operation in switching stage 1:1 is also effected by the adjacent track switch.

The same switching of lacing needles, as described for edge braiding units 6 and 7, is similarly applicable to separation units 5. This becomes necessary when the separation units are to be operated as edge units, that is, when narrower netting shall be generated.

Braid Lifting System (Continued)

The braiding point formed directly above the braiding heads is transferred to the upper central region of the machine by means of the braid lifter system 9, 10 (FIG. 2). This system serves to support the braid yarns in the course of the braids motion from needle unit 8 to the elevated braiding point. At a moment when the position of lacing needles on the several braiding heads allows access to space between the yarns, braid lifter blade 34 (FIG. 18) is swung into the yarn area. The motion of blade 34 is in fixed relation to the braid formation. As blade 34 moves towards the braiding point, the yarn crossing is driven thereby to this point, whereupon it is held at this point. Before blade 34, FIG. 16, reaches its end position, a similar blade 34 (FIG. 17) is swung out of the yarn area into an outer position.

When open yarn position is reached, the blade 34 according to FIG. 7 is inserted between the yarns and performs the same operation as the other blade 34 did according to FIG. 16.

The two blades 34 of each braiding head are driven by a system including gear drive 33 connected with central drive 1 by intermediate drive 35, FIG. 1. In this process, drive 33 (FIG. 16) rotates a groove drum 78. By means of this groove drum, plungers 79 and 80 (FIG. 16) and 81, 82 (FIG. 17) are axially moved.

This axial motion initiates motion of swinging levers 83 which is transmitted by rods 84, 85 to sled 86 for the braid lifting blades, which are swingably pivoted to the sled. As shown in FIG. 18, sled 86 has the general form of a chest sliding on tracks 94. Driving of blade 34, having needle 98, is effected by connector rod 85 and causes blade 34 to be turned to stop 95 and only thereafter, motion to be transmitted to sled 86. In order to secure this sequence, sled 86 is provided with a brake 96, retarding it. Return motion of the sled causes, by connecting rod 85, a turning of blade 34 prior to return sliding of sled 86 itself.

The time controlled lifting motion is once and for all arranged to occur in the following typical sequence, applicable to all braiding heads:

1. insertion, by turning braid lifter blade 34 associated with the braiding head, between the braid yarns running from needle feed unit 8 to braiding lace holder 97 (FIG. 17);
2. transportation of the yarn braid lying ahead of needle 98 of lifter blade 34, to lace holder 97;
3. securement in final position so that normal return of the blade element cannot occur;
4. counterblade 34 of braiding head 1 returns on track 94 into its initial position before the first mentioned braid reaches final position;
5. during this time, the braid lifting blades for the next braiding head operate in the same way as has been described under numbers 1 to 4. However, they move with phase shift as determined by the different needle positions of the braiding head.

The blade motion described above is in fixed relation to the braid formation. It is unchangeable. Only during the exchange of lacing needles from one braiding head to another is it necessary newly to correlate the position of the braid lifter blade 34 relative to the changed braiding motion. This new correlation is initiated by control unit 14 (FIGS. 23 to 25), as already mentioned, said unit operating by a limit feeler 71 therein, which causes pull solenoid 72 (FIG. 20) to actuate latch coupling 87 (FIG. 19). Latch coupling 87 by cam disc 64 causes a lever 88 to be turned.

In normal operation, power is transmitted by pinion 89 meshing with central drive wheel and connected by shaft 90 to switch gear head 91. When connected, this system leads rotary motion, generated by gear 92, into the braid lifter system 9, 10 of FIGS. 16 and 17. When lever 88 is swung into the area of switch gear head 91, positive connection is interrupted by removal of the latch connection.

During the ensuing rest period, lever 88 is swung into its initial position. Thereupon reestablishment of latch connection in switch gear head 91, pursuant to one revolution thereof, becomes possible.

This interruption of the drive connection produces rhythmic shift and rearrangement of the braid lifter motion relative to the lacing needle position changed by the needle exchange.

In order to strengthen and briefly to secure the yarn braiding means generated by the needle motion during the braiding process, upper braid lifter unit **10** has loop opener **100**, FIGS. **26** and **27**. This device serves to secure the spreading of yarns until needle **88** has been inserted into the open loop formed from the braid yarns. Opener **100** is driven by shaft **101**, FIGS. **16, 17**, which connects lower and upper braid lifter units **9** and **10**. By means of reduction gearing **102** and endless chain **103**, sprocket **104** of loop opener **100** is driven. A bevel gear drive **105** having cooperating cam discs **106**, rotates flappers **107** provided with wire yokes.

The basic construction of the second embodiment is the same which is shown in FIGS. **1** and **2**, but use is made of a different lacing needle arrangement, wherein lacing needles **8** of each braiding head are in the same position, as indicated in FIG. **3'** (although with different needle symbols for different heads). This is made possible by means of particular construction and arrangement of track switches **32'**. By omission of separation units **5** (FIG. **5**) the first mentioned method of subdividing the net width becomes inapplicable, but reduction or subdivision of the width of the netting web can be performed by removal of drive connection, at any one of the track switches of the second embodiment, so that the net becomes changeable by one half loop. Otherwise the width of the netting is determined by the provision of 29 normal braiding units having three braiding heads each, and left and right end units each having one and one-half braiding heads. Since all braiding heads have the same position of lacing needles, it is no longer necessary to provide for a shift in needle position on the edge or terminal units. Similarly, it becomes unnecessary newly to arrange the position of braid lifter blades relative to the needle positions of the corresponding braiding heads, at the time of needle exchange. The lifter system **9, 10** remains in uniform connection with the braiding heads throughout the braiding process.

The process performed in the modified unit is believed to be understandable on brief description. The figures of the drawing not provided with a raised number or sign are applicable to the modified system as well as the first-mentioned one, but the devices of FIGS. **6, 9, 10, 19** and **20** are not used in the modified machine. The loops are again formed by needles guided in tracks crossing one another in form of figure eights, under the control of control device **14**. In order to interconnect the loops, needles **8** are guided by guide tracks **32'** from one braiding head to the adjacent one under control of device **14** which actuates pull solenoids **56'** (FIG. **2**). Motion of these magnets causes lever **57'** to turn, which releases latch **58'**, so that tension spring **59'** can establish connection between connection between drive wheel **71'** and switching **60'**.

The modified machine accordingly has the braid lifter system moved synchronously to the modified needle motion, in a two-tack motion. Lifting plungers **80** and **82** (FIGS. **16** and **17**) are not needed for the modified machine. The braid lifter unit is driven by the remaining and simplified intermediate drive **35**.

What is claimed is:

1. A machine for knotless net braiding comprising: a generally circular, horizontal braiding assembly having normal braiding units for braiding yarns into interlaced net elements; wing wheels in each braiding unit for said braiding; lacing needles on said wheels; track switches generally interposed between such wing wheels; power and control means for the braiding assembly, to move the lacing needles by the wheels and to interchange them therebetween in a predetermined program, said assembly also having edge braiding units for generally similar braiding, modified by marginal return motion of lacing needles; an elevated central braid lifter assembly having blade means coordinated with the wing wheels, the track switches and the control means, to receive braided yarn elements in inward, upward motion therefrom and to complete their interlacing; supports, slideable in directions generally parallel to said inward upward motions; means for pivotally mounting said blade means on said supports; and power means for operating the braid lifter assembly.

2. A machine as described in claim **1** wherein the power means for operating the blade lifter assembly is arranged to be operated by the power means of the braiding assembly.

3. A machine according to claim **1** also including lace holder means in the braid lifter assembly, and wherein each normal braiding unit has several braiding heads and each braiding head has several wing wheels arranged in a regular pattern, while the braid lifter assembly has a pair of blades for each pattern, each blade lying in a plane which intersect the center of the corresponding pattern and being cyclically moveable toward and apart from the lace holder and from another, similarly oriented blade, along said planes.

4. A machine for knotless net braiding, comprising: a generally circular, horizontal braiding assembly having braiding units for braiding yarns into interlaced net elements; winged wheels in each braiding unit for said braiding; latching needles on and movable by said winged wheels; all of said braiding units having mutually similar groups of even numbers of winged wheels, each group being arranged according to a regular pattern, whereby the yarns are interlaced in form of 8-shaped braid elements; track switch means between successive ones of said groups of winged wheels; elevated control braid lifter means for interlacing different ones of said braid elements into a knotless net; and means for controlling and moving the winged wheels, track switch means and braid lifter means in unison.

5. A machine according to claim **4**, including a series of generally horizontal, plate-like structures providing pivot and housing means for said winged wheels of the braiding assembly.

6. A machine as described in claim **5**, additionally including a series of column support means for the braiding assembly, one column means being provided between every two braiding units.

7. A machine according to claim **4** additionally including separation braiding units generally similar to the normal braiding units and containing the same number of braiding heads while also including means whereby they can be operated as edge braiding units.

8. A machine as described in claim **7** wherein each normal braiding unit and each separation braiding unit has three braiding heads.

9. A machine as described in claim **8** wherein each braiding head has four winged wheels.

10. A machine according to claim 4 wherein the control means includes feeler means for cooperation with a control card, the braiding assembly having magnets controlled by the feeler means and controlling the track switches.

11. A machine according to claim 4 wherein the braiding assembly includes a series of said normal braiding units, a pair of said edge braiding units, and at least one pair of separation braiding units generally similar to the normal braiding units and interposed between such units, each unit comprising at least one braiding head having four winged wheels and the assembly having means for controlling the track switches of the normal braiding units in one way and for controlling those of the edge braiding units and potentially those of the separation braiding units in another way.

12. A machine according to claim 4 also including yarn spools on said lacing needles for feeding yarn into each braiding unit, each spool having spring means for maintaining uniform tension in the yarn, each spring means having a compression spring and cam means concentrically connected therewith for compensating variations of pressure of said spring.

13. A machine according to claim 1, wherein the braid lifter assembly has a power unit including a groove drum and a plurality of plungers engaging the same for actuation of the braid lifter blades.

14. A machine according to claim 13 additionally having a central drive gear driven by the power means for the braiding assembly and directly driving said assembly by transmissions arranged radially of the machine, said gear being arranged also to drive an intermediate transmission for actuating the power unit of the braid lifter assembly.

15. A machine according to claim 13 including a power and control transmission for each braid lifting blade, said transmission including means for rearranging the coordination of the blades to the winged wheels whenever the lacing needles are interchanged between said wheels.

16. A machine according to claim 13 additionally including brake means for the sliding supports of the braid lifting blades.

17. A machine according to claim 13 additionally including mechanism in the braid lifting assembly for holding yarns separated from one another for insertion of the braid lifting blades therebetween.

18. A machine according to claim 17 including means for moving the yarn separating means to response to motion of the power means for the braid lifting assembly.

19. A method of knotless braiding of a net comprising the steps of forming, on a first horizontal level, a circular series of braids; inwardly lifting said braids to a second horizontal level; interlacing them on said second level; and completing a portion of the net by forming successive series of braids.

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