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### (54) Sheet metal working machine

(57) The machine has two turrets (2, 6) supporting punch assemblies (3) and die assemblies (7); a hammer (11); and two devices (17, 18) for rotating the punch and die assemblies (3, 7) about a vertical axis. The devices each have a body (125, 135) supporting a gear (126, 137); a motor (128, 138) for rotating the gear about a vertical axis (T2); and an actuator (140, 141) for moving the body (125, 135) between an engaged position, wherein the punch and die assemblies mesh with the gear, and a release position.

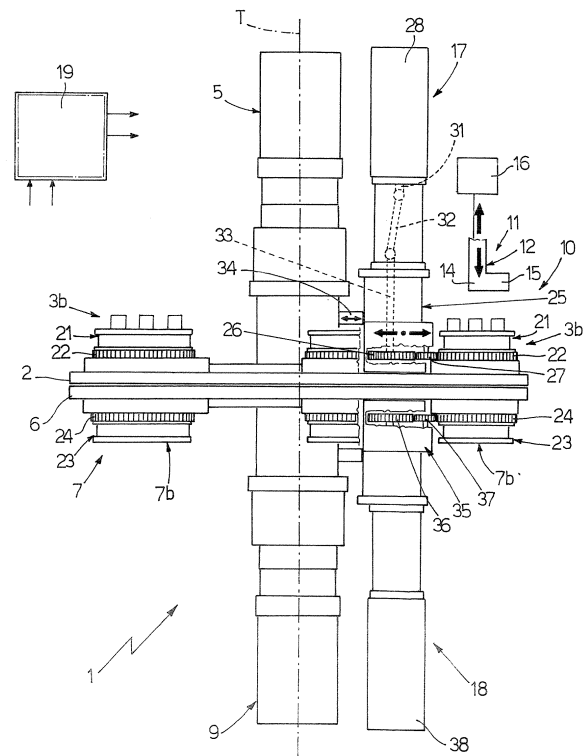


Fig.1

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## Description

**[0001]** The present invention relates to a sheet metal working machine.

**[0002]** Currently used sheet metal working machines substantially comprise a top turret supporting a number of punch assemblies, some with one punch and others with a number of punches; a bottom turret supporting a number of die assemblies, some with one die and others with a number of dies; a hammer having a striker defined by a central portion, coaxial with the vertical operating axis of the hammer and used to strike the coaxial punches underneath, and by a horizontal portion used to strike the punches offset with respect to the operating axis of the hammer; and a device for rotating the punch about the vertical longitudinal axis of the relative punch assembly.

**[0003]** The rotation device provides, in the case of single-punch assemblies, for rotating the punch to set the tip of the punch to a given angular position, and, in the case of multiple-punch assemblies, for moving the desired punch into the area beneath the horizontal portion of the striker.

**[0004]** The rotation device comprises a vertical sleeve, along which the striker slides; two teeth on the bottom end of the sleeve; means for translating the sleeve vertically between a bottom position, in which the teeth engage corresponding slits on the top end of the punch assembly toolbox, and a top release position; and means for rotating the sleeve about its own vertical axis. In actual use, when the sleeve is in the bottom position, rotation of the sleeve rotates the toolbox and so, in the case of single-punch assemblies, rotates the punch to set the tip of the punch to a given angular position, and, in the case of multiple-punch assemblies, moves the desired punch into the area beneath the horizontal portion of the striker.

**[0005]** Machines of the above type have several drawbacks. In particular, the striker being angularly fixed and axially free with respect to the sleeve, rotation of the sleeve also rotates the striker, thus changing the position of the horizontal portion of the striker. Consequently, to adjust the angular position of the tip of a single-punch assembly punch, the sleeve must first be connected to the toolbox, then rotated to set the tip of the punch to the desired position, and finally released from the toolbox. If the next stage in the machining cycle, however, calls for a punch offset with respect to the central portion of the striker, or a punch of a multiple-punch assembly, first the previous punch and then also the horizontal portion of the striker must be restored to its original position.

**[0006]** To move a punch of a multiple-punch assembly into the punching position, the sleeve must be connected to the toolbox, rotated to set the punch to the punching position, released from the toolbox, and finally rotated to move the horizontal portion of the striker into the area over the selected punch.

**[0007]** In other words, positioning single-punch assembly punches and selecting multiple-punch assembly

punches are long, painstaking jobs which increase machining time and cost. Moreover, the complex design of the device for performing the above operations will be obvious from the foregoing description.

**[0008]** It is an object of the present invention to provide a sheet metal working machine designed to eliminate the aforementioned drawbacks, and which, in particular, features a straightforward, fast-operating punch positioning and selection device.

**[0009]** A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a side view of a first embodiment of a machine in accordance with the teachings of the present invention;

Figure 2 shows a plan view of a turret of the Figure 1 machine;

Figure 3 shows a larger-scale, partly sectioned side view of a punching station;

Figure 4 shows a plan view of a multiple-punch assembly;

Figure 5A shows a plan view of a first configuration of a number of devices of a second embodiment of a machine in accordance with the teachings of the present invention;

Figure 5B shows a plan view of a second configuration of the same devices as in the second embodiment in Figure 5A;

Figure 6 shows a side view of the Figure 5A and 5B devices.

**[0010]** Number 1 in Figure 1 indicates as a whole a sheet metal working machine comprising:

a top turret 2 rotating about a vertical central axis T; a number of punch assemblies 3, of which those indicated 3a are single-punch assemblies having only one punch 4, and those indicated 3b are multiple-punch assemblies having a number of punches 4; punch assemblies 3 being fitted to top turret 2, some along a circular line A, and others close to line A;

means 5 for rotating top turret 2 about axis T;

a bottom turret 6 rotating about vertical central axis T; a number of die assemblies 7, some of which are single-die assemblies, and some of which, indicated 7b, are multiple-die assemblies; die assemblies 7 being fitted to bottom turret 6, some along a circular line, and others close to said line, which is coaxial with and of the same diameter as line A;

means 9 for rotating bottom turret 6 about axis T;

a punching station 10 comprising a hammer 11 in turn comprising a striker 12 defined by a vertical central portion 14, the longitudinal axis Z of which intersects line A, and by a horizontal portion 15;

known means 16 (shown schematically) for moving hammer 11 along axis Z;

a first device 17, which, for certain punch assemblies 3a with a vertical axis intersecting line A, rotates punch 4 to set the tip of punch 4 to a given angular position, and, for punch assemblies 3b with a vertical axis intersecting line A, moves the selected punch 4 into the area beneath horizontal portion 15 of striker 12;

a second device 18, which, for certain die assemblies 7 with a vertical axis intersecting line A, rotates the die into a given angular position, and, for die assemblies 7b with a vertical axis intersecting line A, moves the selected die into a position coaxial with the corresponding punch 4; and

an electronic central control unit 19 for controlling all the above assemblies, members, means, and devices, and any similar described below.

**[0011]** Punch assemblies 3b and some of punch assemblies 3a installed along line A each have a punch-box 21 having a toothed annular appendix 22; similarly, die assemblies 7b and some of the single-die assemblies installed along the circular line coaxial with line A each have a die-box 23 having a toothed annular appendix 24; and the top end of punch-box 21 has two open-topped, diametrically opposite slits 19 (Figure 3) .

**[0012]** Device 17 comprises a box body 25 supporting a drive gear 26 and an idler gear 27, which mesh with each other and each have a respective vertical axis of rotation. Device 17 also comprises an electric motor 28 having a vertical output shaft 31 connected angularly integral with a hub 33 of gear 26 by a Universal joint 32. And finally, device 17 comprises an actuator 34 for moving box body 25, along a horizontal axis, between an engaged position, wherein gear 27 meshes with toothed appendix 22 of the punch assembly 3 located at punching station 10, and a release position.

**[0013]** Similarly, device 18 comprises a box body 35 supporting a drive gear 36 and an idler gear 37, which mesh with each other and each have a respective vertical axis of rotation. Device 18 also comprises an electric motor 38 having a vertical output shaft connected angularly integral with a hub of gear 36 by a Universal joint. And finally, device 18 comprises an actuator 44 for moving box body 35, along a horizontal axis, between an engaged position, wherein gear 37 meshes with toothed appendix 24 of the die assembly 7 located at punching station 10, and a release position.

**[0014]** With reference to Figure 3, punching station 10 comprises a horizontal plate 51 having a through hole 52 formed along axis Z; and a hollow cylindrical body 53, of axis Z, having a top portion 54 extending upwards beyond hole 52, and a bottom portion 55 located inside hole 52 and which is larger in outside diameter and shorter in length than the outside diameter and length of top portion 54. Working downwards along axis Z, striker 12 comprises a cylindrical head 56 resting on an annular shoulder 57 formed inside portion 54 of cylindrical body 53; a cylindrical portion 58 which extends downwards to project

from portion 55 of cylindrical body 53; a cylindrical portion 61 larger in outside diameter than the diameter of hole 52 and located beneath plate 51; and said portion 14, from which said portion 15 extends along a horizontal axis. As described in more detail below, body 53 translates along axis Z, and striker 12 rotates about and translates along axis Z.

**[0015]** With reference to Figure 3, punching station 10 also comprises a hollow cylindrical body 62 of axis Z. Body 62 houses cylindrical body 53, and has a bottom portion 63 housed inside hole 52 and smaller in outside diameter than the rest of body 62, so as to define an annular shoulder resting on the edge of hole 52. The top end of body 53 is fitted integrally with a circular horizontal plate 64 of a diameter substantially equal to the outside diameter of body 62. A number of vertical dead holes are formed in the top portion of body 62, are equally spaced along the annular rim defining the top wall of body 62, and each define a seat 65 for a respective pin 66 pushed towards plate 64 by a spring 67 housed between the bottom end of pin 66 and the bottom of respective seat 65. Hammer 11 also comprises a ram 68 translated along axis Z by said means 16.

**[0016]** In actual use, at the punching stage, ram 68 translates downwards along axis Z to also press down sheet 64 and body 53. Body 53 translates downwards in opposition to springs 67, so that, when ram 68 is restored to its original position, pins 66 translate upwards and, contacting sheet 64, also restore body 53 to its original position. Downward translation of body 53 produces an equal translation of striker 12, by portion 55 of body 53 contacting portion 61 of striker 12.

**[0017]** With reference to Figure 3, punching station 10 comprises a device 71 which, at a given stage, provides for attaching punch-box 21 to a ring 72 angularly fixed and axially free with respect to striker 12. Device 71 comprises an actuator 73 supported on the top face of plate 51 and having a vertical rod 74, which extends downwards past the bottom face of plate 51 and is integral with an appendix 75 extending horizontally from the outer annular wall of an annular member 76.

**[0018]** Member 76 is located beneath plate 51, is coaxial with axis Z, and coaxially houses ring 72, in turn housing portion 61 and portions 14 and 15 of striker 12. More specifically, the lateral wall of ring 72 has an annular groove 77 engaged by a diametrical pin 78 extending from the inner annular face of annular member 76; and the bottom end of ring 72 has two diametrically opposite teeth 81. In actual use, rod 74 translates between a top position and a bottom position. Translation of rod 74 into the bottom position produces an equal translation of member 76 and, via pin 78, of ring 72, which, being connected as described to member 76, is nevertheless free to rotate about axis Z. Downward translation of ring 72 engages teeth 81 inside slits 19, so that rotation of punch-box 21 about axis Z produces an equal rotation of ring 72.

**[0019]** With reference to Figure 3, the inner annular

face of ring 72 has an axial groove 82 engaged by a projection 83 formed on a lateral face of portion 15 of striker 12. This type of connection between ring 72 and striker 12 allows them to translate independently of each other, and connects them angularly to each other so that rotation of ring 72 about axis Z produces an equal rotation of striker 12.

**[0020]** Operation of machine 1 is clear from the above description. To begin with, a machining cycle, defined by the number and location of punching operations to be performed and by the succession of punches 4 to be used, is set in central control unit 19, which, throughout the machining cycle, obviously knows the type, location, and angular position of punches 4 and the dies on machine 1.

**[0021]** To punch the sheet using a punch 4 of a punch assembly 3a installed along line A, turrets 2 and 6 are simply rotated to position the punch assembly 3a and corresponding die assembly 7a coaxially with axis Z, and hammer 11 is then operated. In the case of punch assemblies 3a and die assemblies 7 whose respective boxes 21 and 23 have respective toothed annular appendices 22 and 24, the angular position of the punch and die can be adjusted by means of devices 17 and 18 prior to performing the punching operation.

**[0022]** To punch the sheet using a punch 4 of a punch assembly 3b, turrets 2 and 6 are simply rotated to position the punch assembly 3b and corresponding die assembly 7b coaxially with axis Z; punch assembly 3b and die assembly 7b are then rotated about axis Z by means of devices 17 and 18 to bring the selected punch 4 and corresponding die up to portion 15 of striker 12; and hammer 11 is then operated.

**[0023]** To punch the sheet using a punch 4 of a punch assembly 3b with a given angular position of punch 4, turrets 2 and 6 are simply rotated to position the punch assembly 3b and corresponding die assembly 7b coaxially with axis Z; punch assembly 3b and die assembly 7b are then rotated about axis Z by means of devices 17 and 18 to bring the selected punch 4 and corresponding die up to portion 15 of striker 12; punch-box 21 is then attached to striker 12 by means of device 71, so as to adjust the angular position of the selected punch 4 and corresponding die and the position of portion 15 of striker 12, which remains directly beneath the selected punch 4, by means of devices 17 and 18 and by rotating punch assembly 3b and die assembly 7b about axis Z; and hammer 11 is then operated. Obviously, if the machining cycle calls for using the same punch 4, but with a different angular position for each punching operation, punch-box 21 and striker 12 need simply be maintained angularly integral and, for each successive punching operation, rotated together to set punch 4 to the required angular position before performing the punching operation. In this way, a sequence of punching operations can be performed rapidly using the same punch in different angular positions.

**[0024]** To punch the sheet using a punch 4 of an as-

sembly 3a alongside line A, striker 12 need simply be rotated into position to punch, for example, using an assembly 3b; and the selected assembly 3a need then simply be moved into punching station 10.

**[0025]** Figures 5A, 5B and 6 show a second embodiment of a machine 1 in accordance with the present invention.

**[0026]** Any devices common to both embodiments are indicated using the same reference numbers.

**[0027]** The second embodiment comprises two bodies 125, 135, one relating to punch assemblies 3, and the other to die assemblies 7.

**[0028]** Bodies 125, 135 are box-shaped and rotate about an axis T1 (Figures 5A and 5B).

**[0029]** Body 125 is fitted with a gear 126 rotating about a fixed axis T2 with respect to body 125; a pulley P1 is integral with gear 126 and connected to a pulley P2 by a belt (or chain) C; and pulley P2 is rotated by an electric motor 128 (Figure 6) on body 125.

**[0030]** Body 125 is also fitted with an idler gear 127 rotating about a fixed axis T3 with respect to body 125.

**[0031]** The whole of body 125 is rotated about axis T1 by a linear actuator 140 hinged at F1 to the frame of machine 1 and connected to body 125 by an articulated joint S1.

**[0032]** A punch assembly 3b, for example, is therefore rotated by simply switching from the Figure 5B release configuration to the Figure 5A engaged position, in which idler gear 127 meshes with toothed annular appendix 22, and then rotating gears 126 and 127 by means of motor 128.

**[0033]** The switch from the release configuration (Figure 5B) to the engaged configuration (Figure 5A) is made using a device 117 comprising actuator 140. In which case, body 125 is rotated by actuator 140 about axis T1 in the direction of arrow FR (Figure 5B) and in a plane P substantially containing gear 126, idler gear 127, and toothed annular appendix 22.

**[0034]** This also applies to body 135 and die assemblies 7 (Figure 6) using a device 118.

**[0035]** Body 135, in fact, comprises an electric motor 138, a gear 136, an idler gear 137, and an actuator 141 (Figure 6).

**[0036]** The numerous advantages of the present invention will be clear from the foregoing description.

**[0037]** In particular, a multifunction machine is obtained for easily performing various types of punching operations and for also selecting the type and angular position of the punch. Moreover, for certain punch assemblies, a sequence of punching operations can also be set using the same punch in different angular positions.

## 55 Claims

1. A sheet metal working machine comprising:

a top turret (2) rotating about a first vertical axis (T);  
 a number of punch assemblies (3) fitted to said top turret (2) along a first circular line (A);  
 means (5) for rotating said top turret (2) about said first vertical axis (T); 5  
 a bottom turret (6) rotating about said first vertical axis (T);  
 a number of die assemblies (7) fitted to said bottom turret (6) along a second circular line; 10  
 means (9) for rotating said bottom turret (6) about said first vertical axis (T);  
 a punching station (10) comprising a hammer (11) in turn comprising a striker (12);  
 means (16) for moving said hammer (11) along a second vertical axis (Z); 15  
 a first device (117) for rotating said punch assembly (3) about said second vertical axis (Z);  
 a second device (118) for rotating said die assembly (7) about said second vertical axis (Z); 20

**characterized in that** said first (117) and said second (118) device each comprise a respective body (125 and 135) supporting a respective gear (126 or 127 and 136 or 137); a respective motor (128 and 138) for rotating the corresponding gear (126 or 127 and 136 or 137) about a respective third vertical axis; 25  
 and respective actuating means (140 and 141) for moving the corresponding said body (125 and 135), in a horizontal plane (P) and in a given direction (FR), 30  
 between an engaged position, wherein said gear (126 or 127) of said first device (117) meshes with a toothed annular appendix (22) formed on a punch-box (21) of said punch assembly (3), and wherein said gear (136 or 137) of said second device (118) meshes with a toothed annular appendix (24) 35  
 formed on a die-box (23) of said die assembly (7), and a release position.

2. A sheet metal working machine as claimed in Claim 1, **characterized in that** said actuating means (140 and 141) each comprise a linear actuator (140 and 141) hinged to the frame of the machine by a hinge (F1 and F2) and connected in articulated manner to said body (125 and 135) by a respective articulated joint (S1 and S2). 40  
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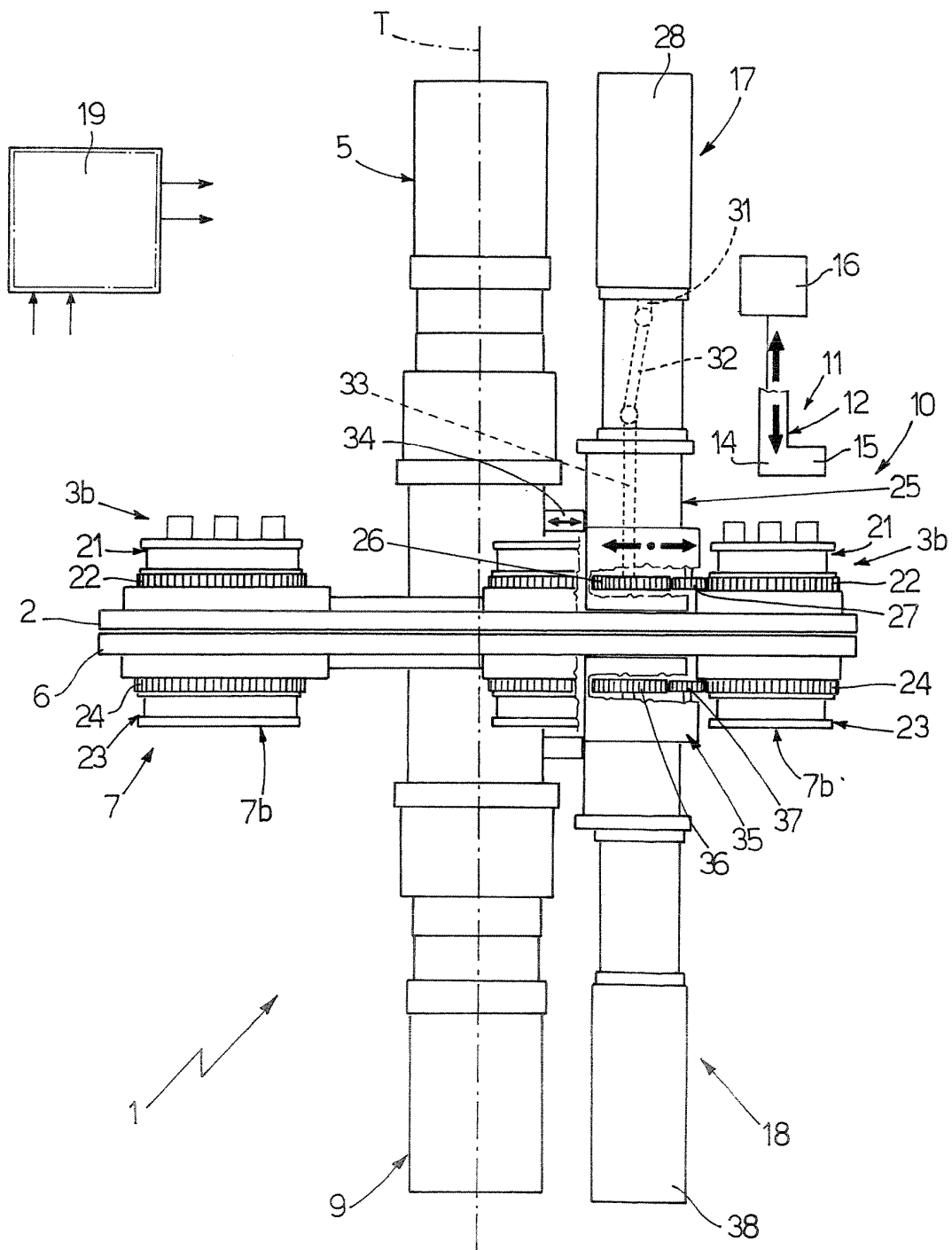


Fig.1

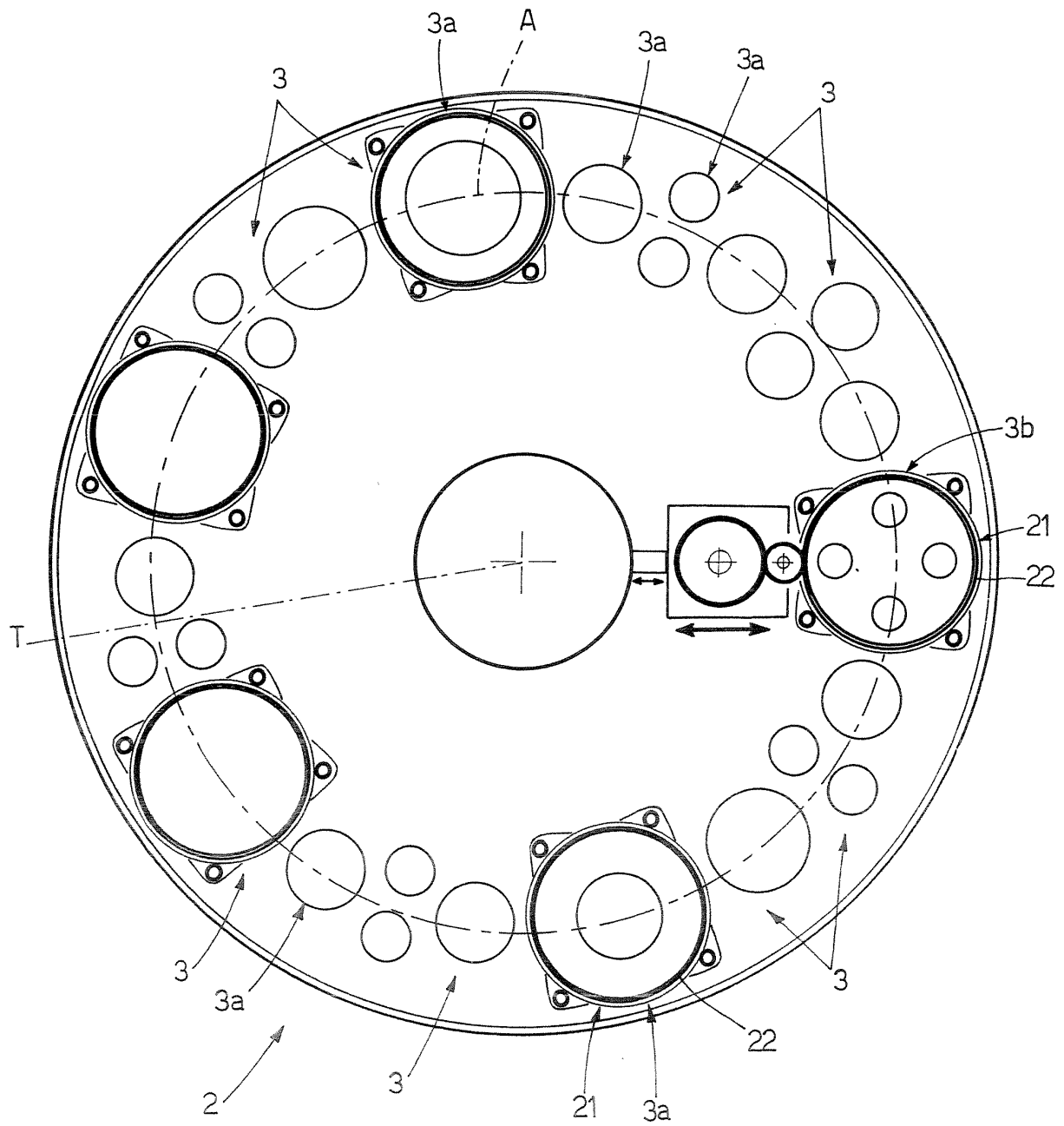


Fig.2

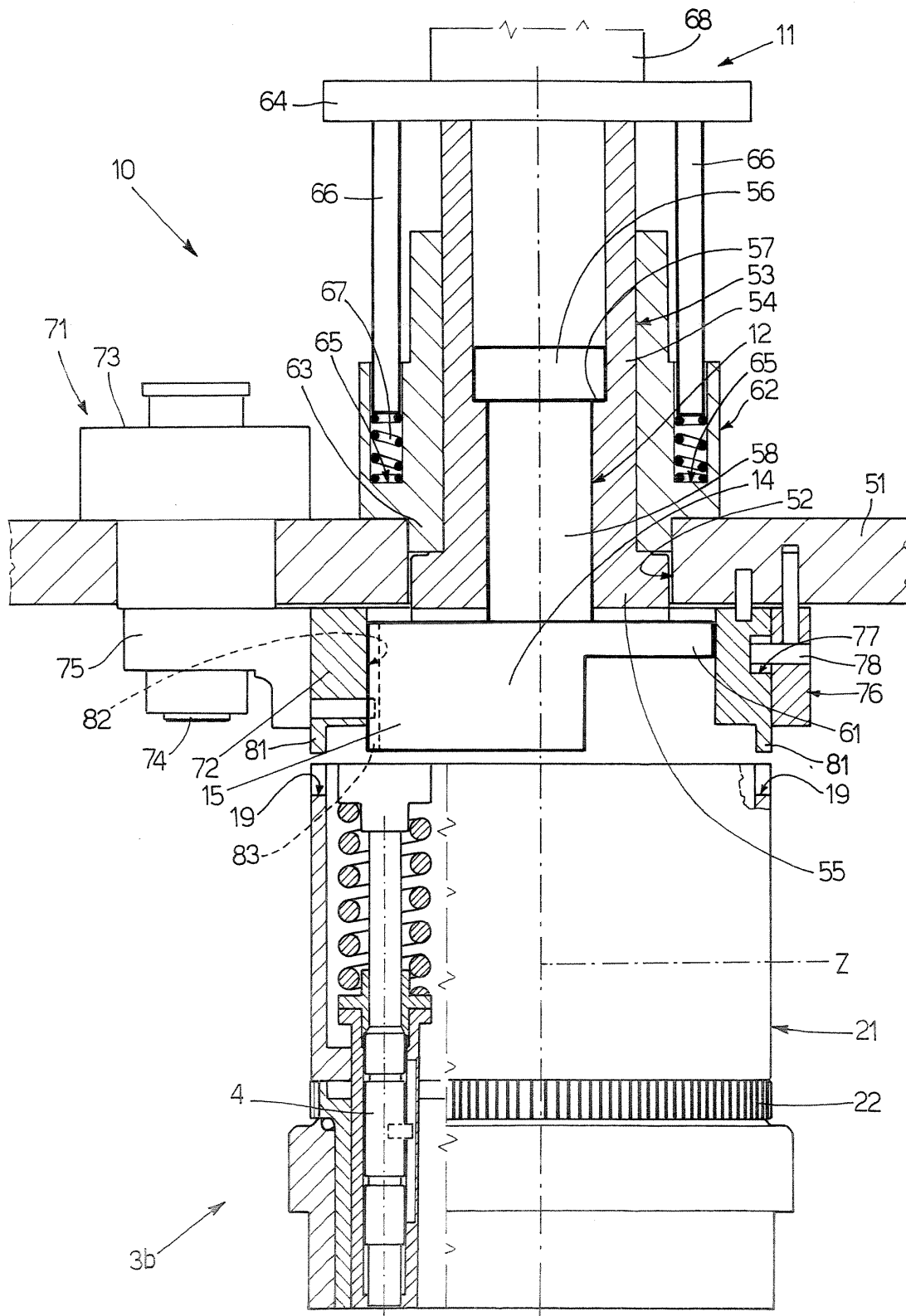


Fig.3



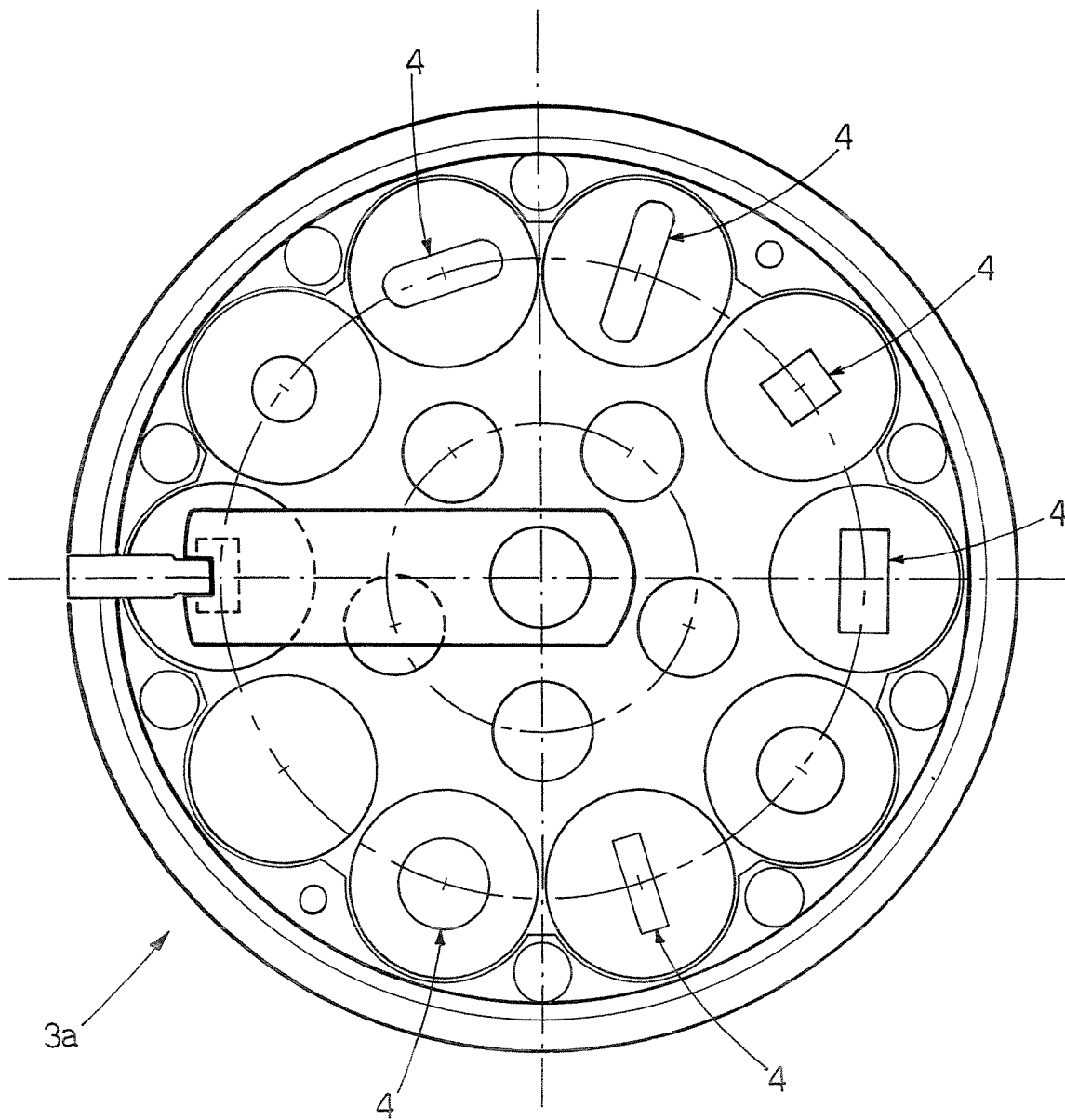
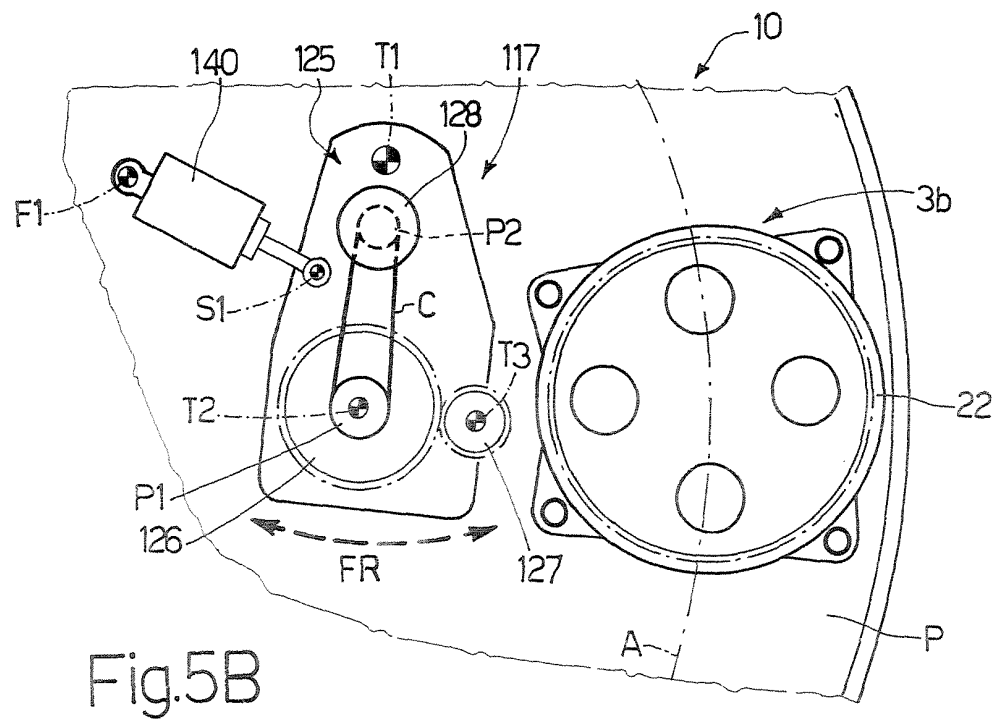
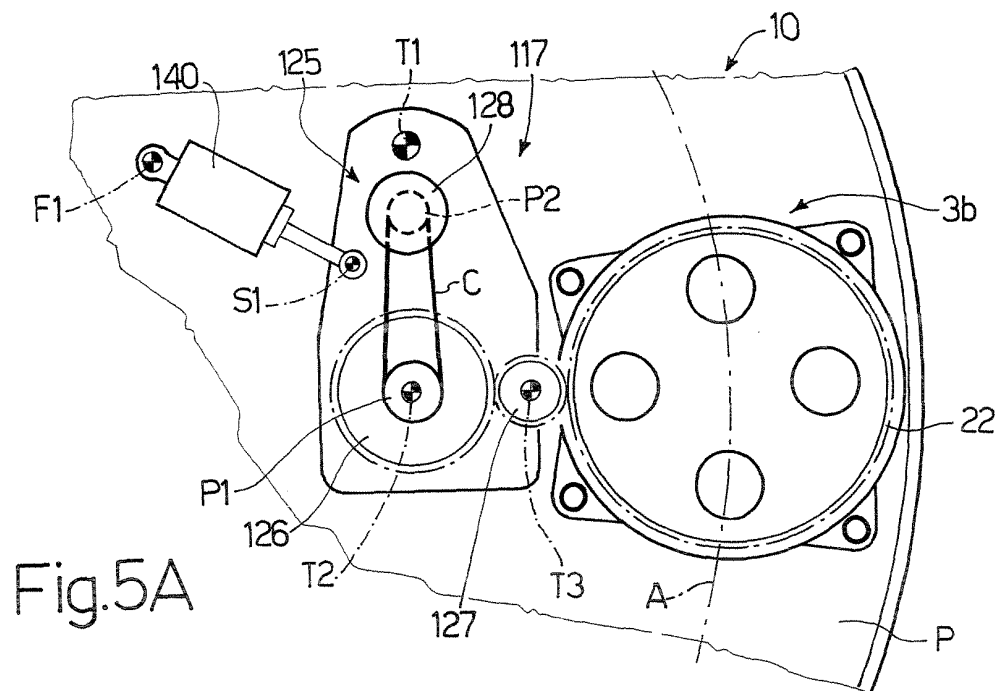


Fig.4



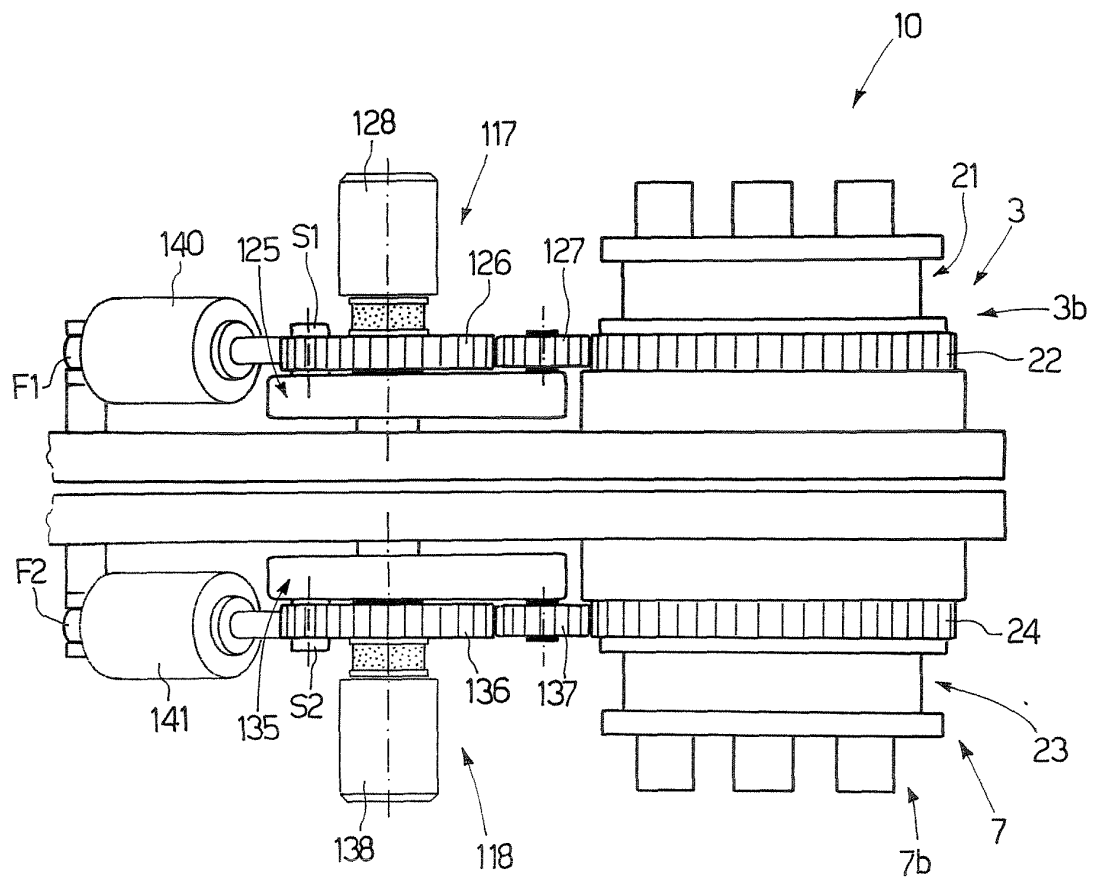


Fig.6



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The present search report has been drawn up for all claims			
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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