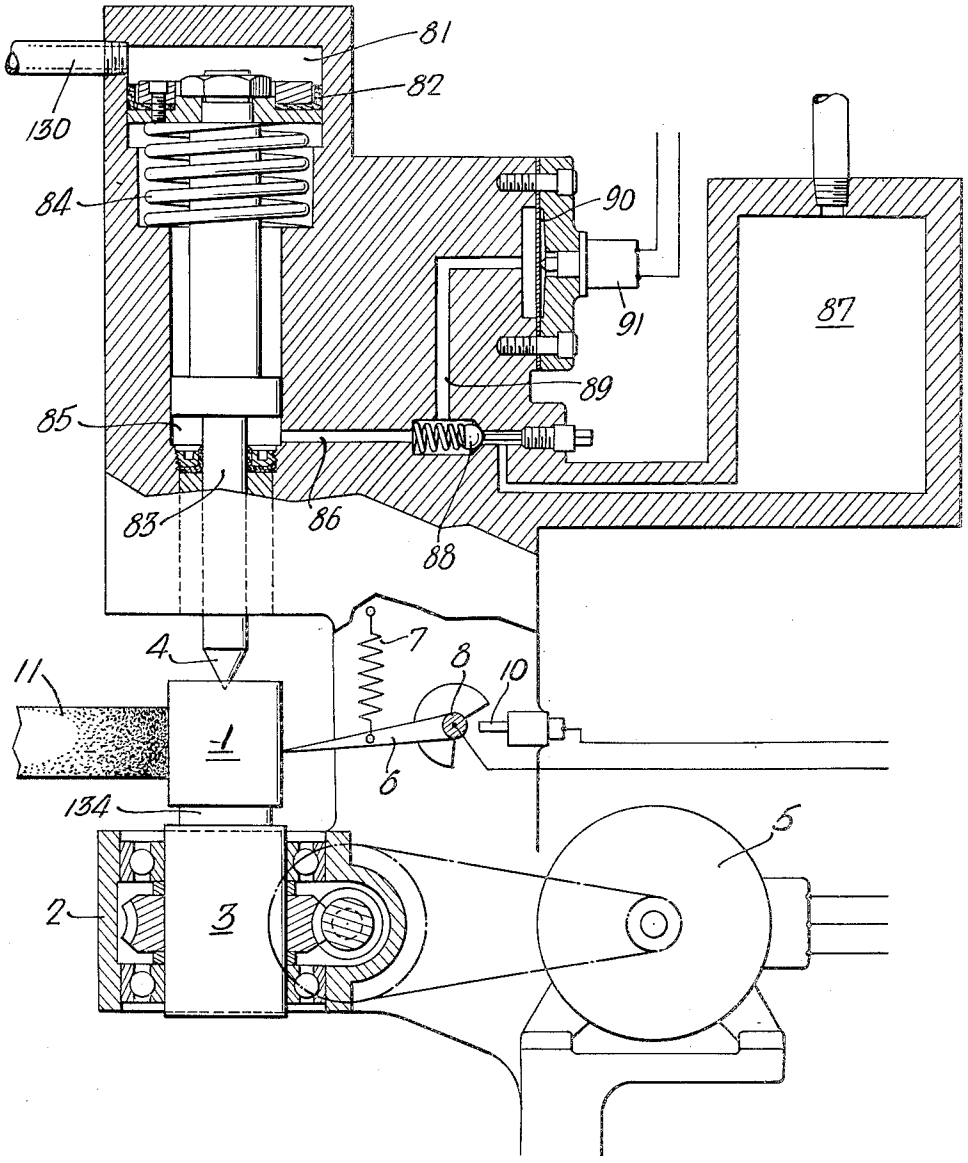
Sept. 20, 1955 E. G. HJÄRPE 2,718,100

AUTOMATIC FEED MECHANISM FOR MACHINE TOOLS, ESPECIALLY GRINDING MACHINES

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FIG. 1.




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FIG. 2.

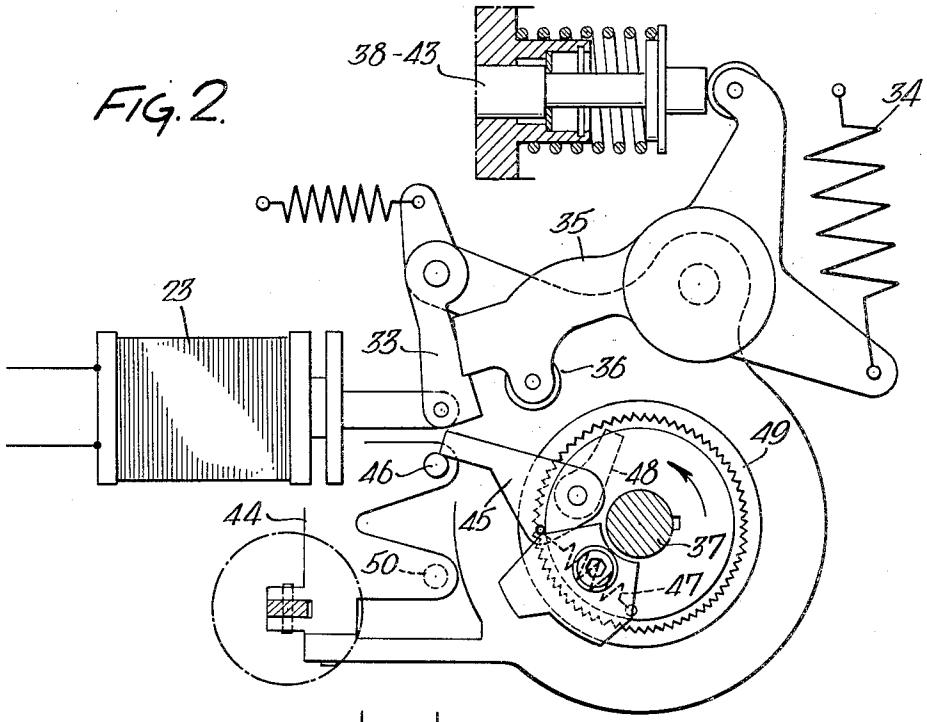



FIG. 4.

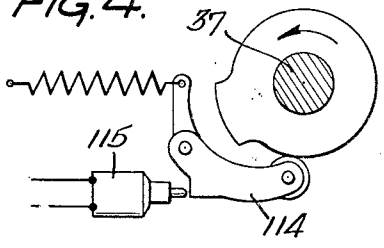



FIG. 3.



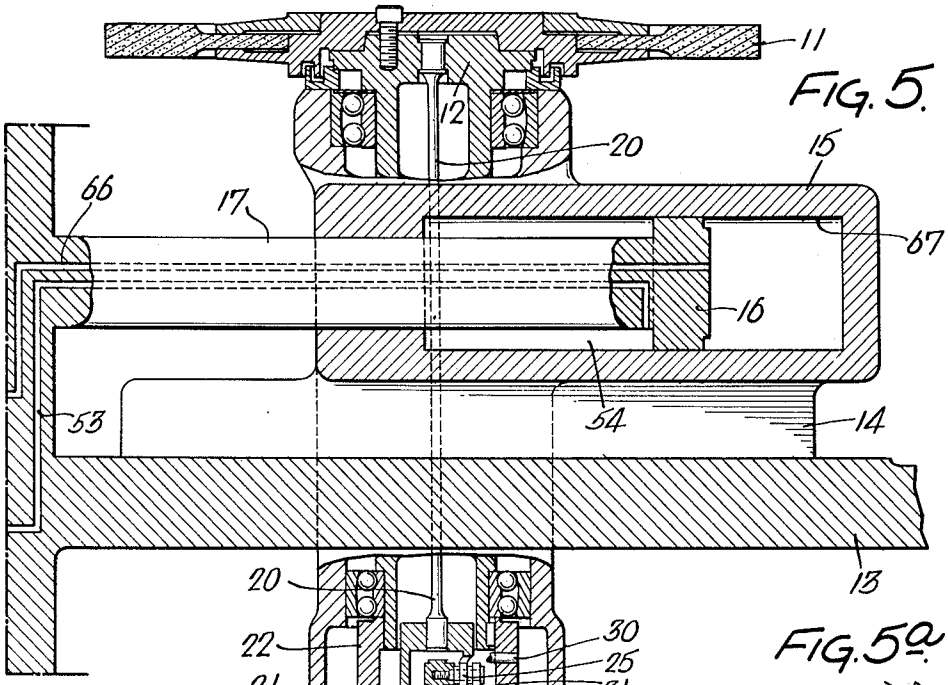

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FIG. 5.



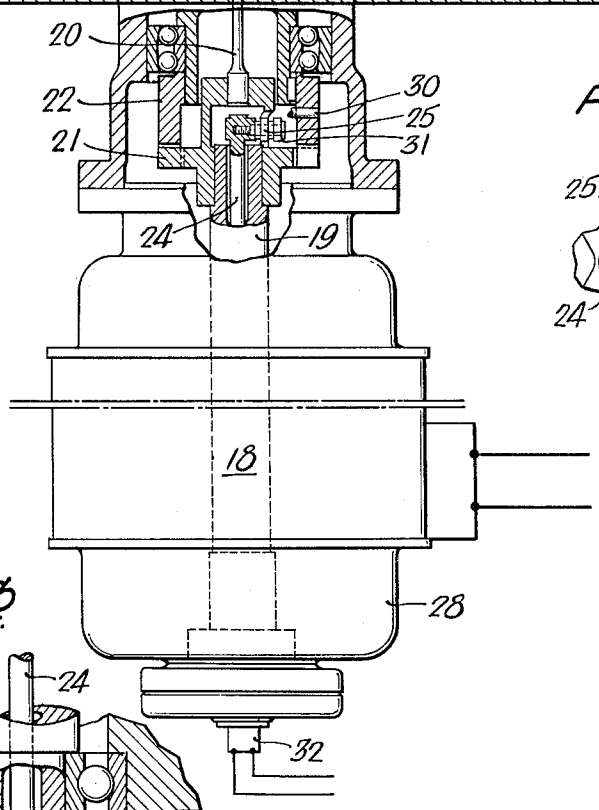




FIG. 5a.

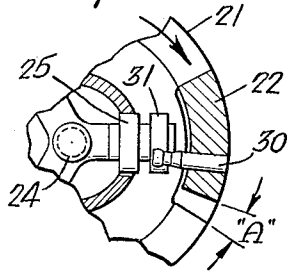
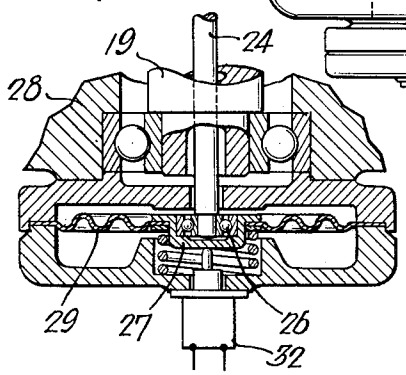



FIG. 5b.



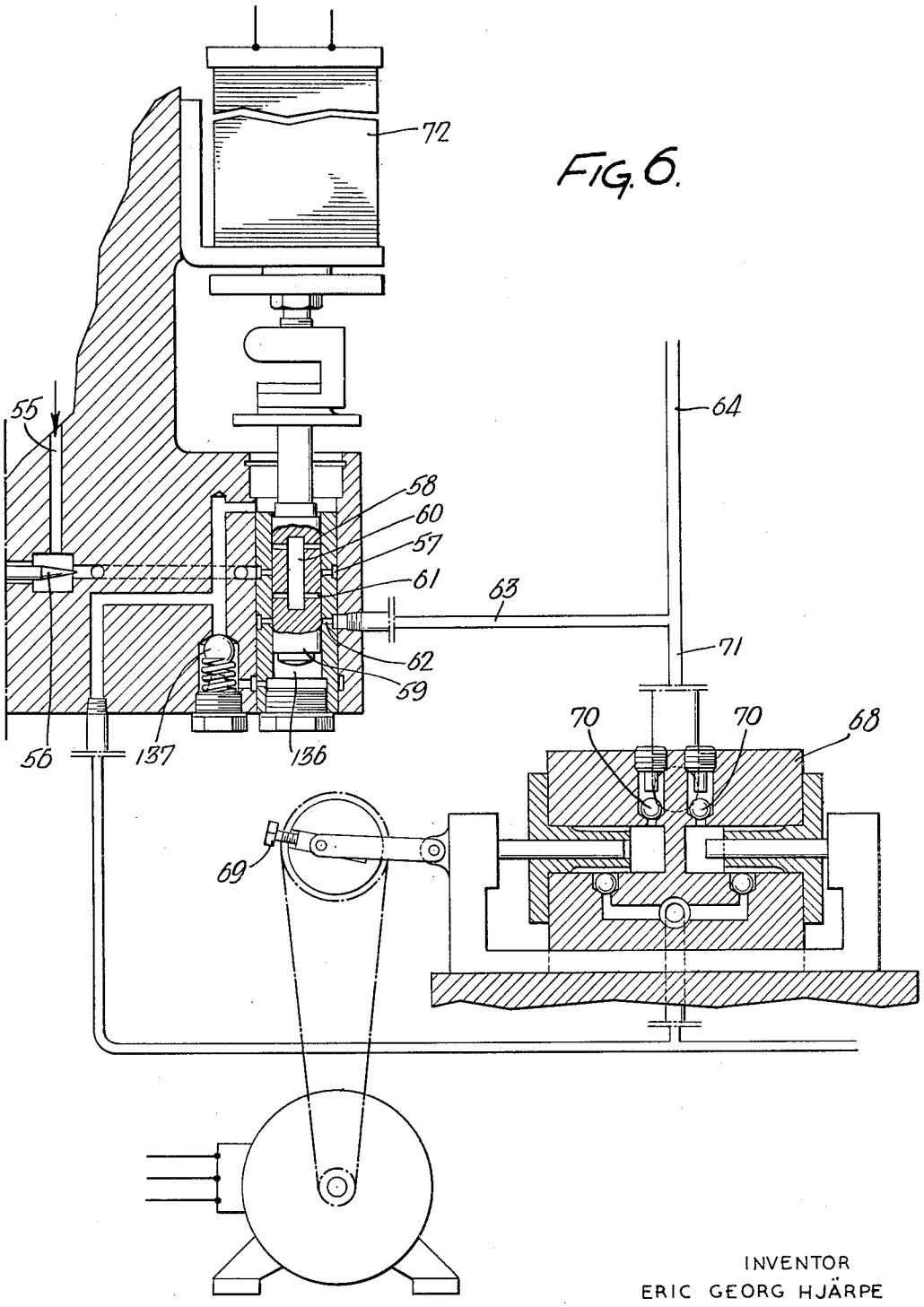

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FIG. 6.




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*Fig. 8.*

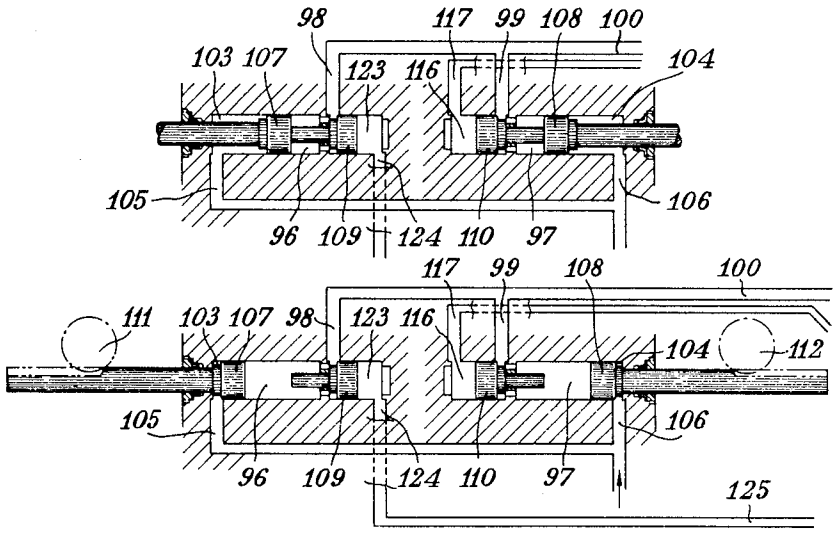



*Fig. 7.*

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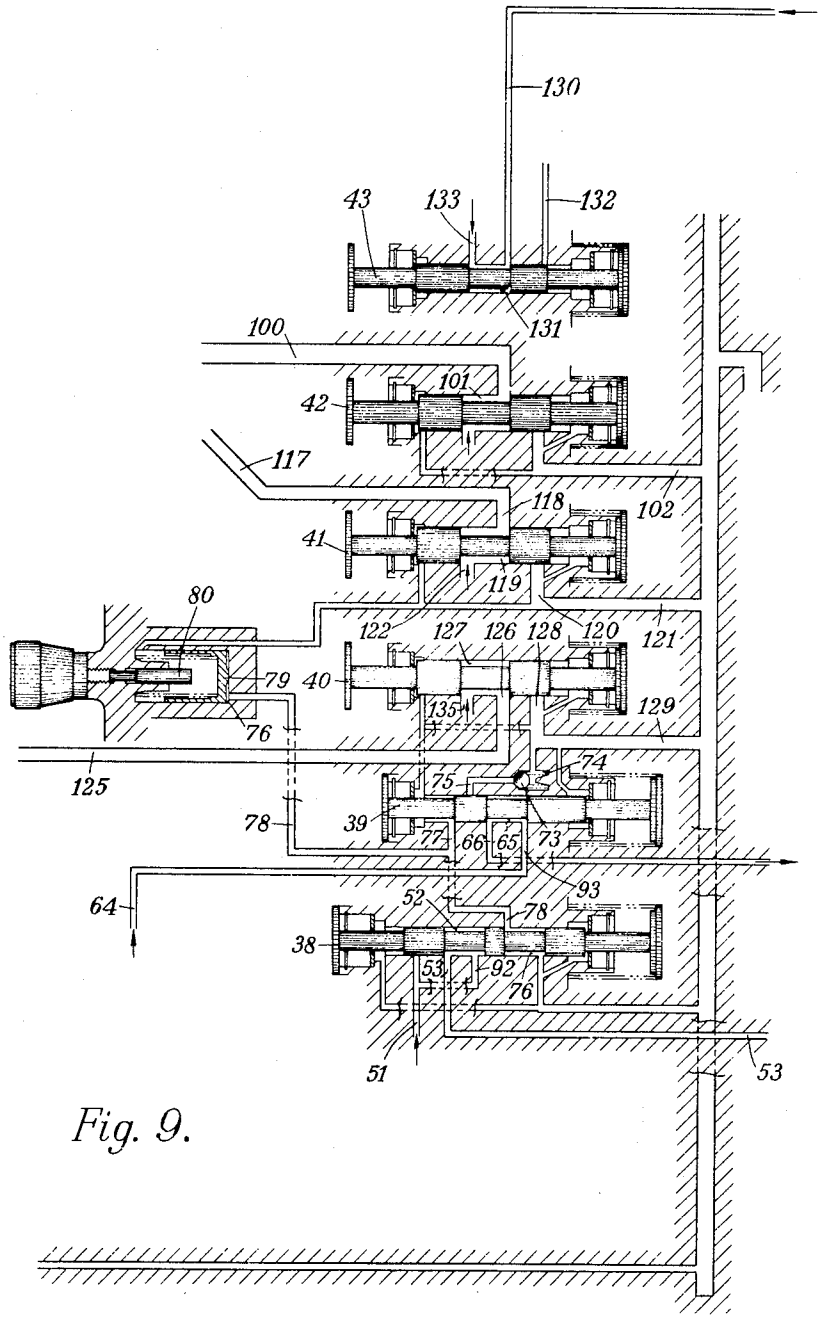



Fig. 9.

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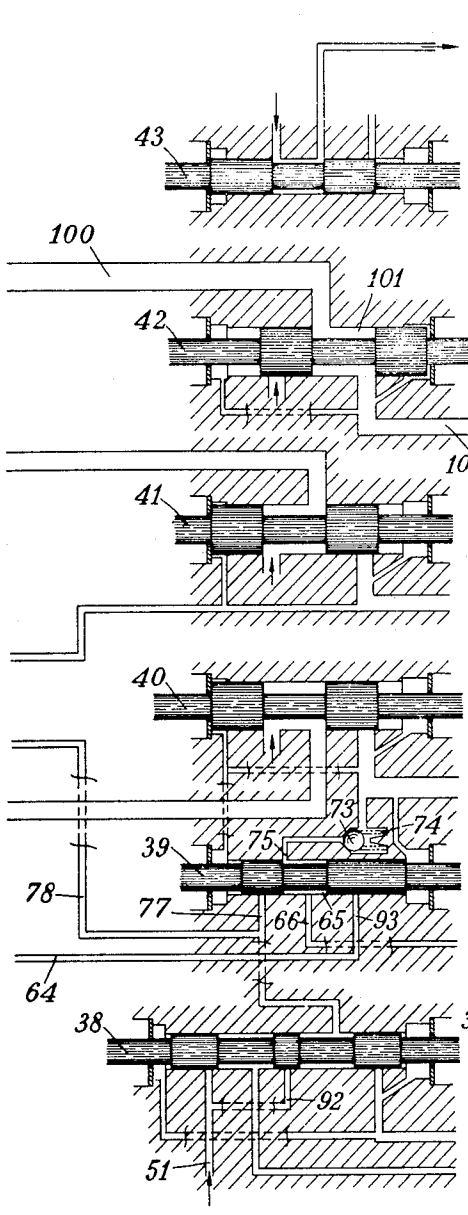



Fig.10.

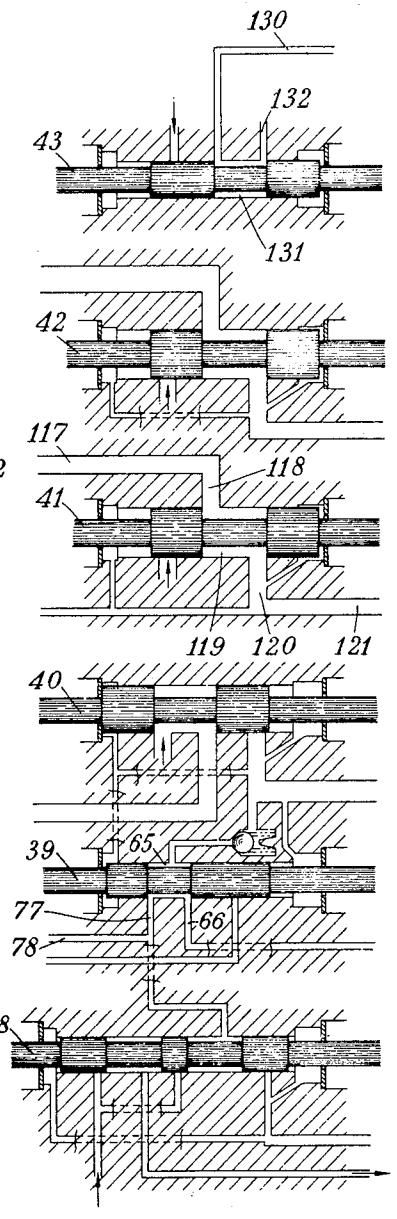



Fig.11.

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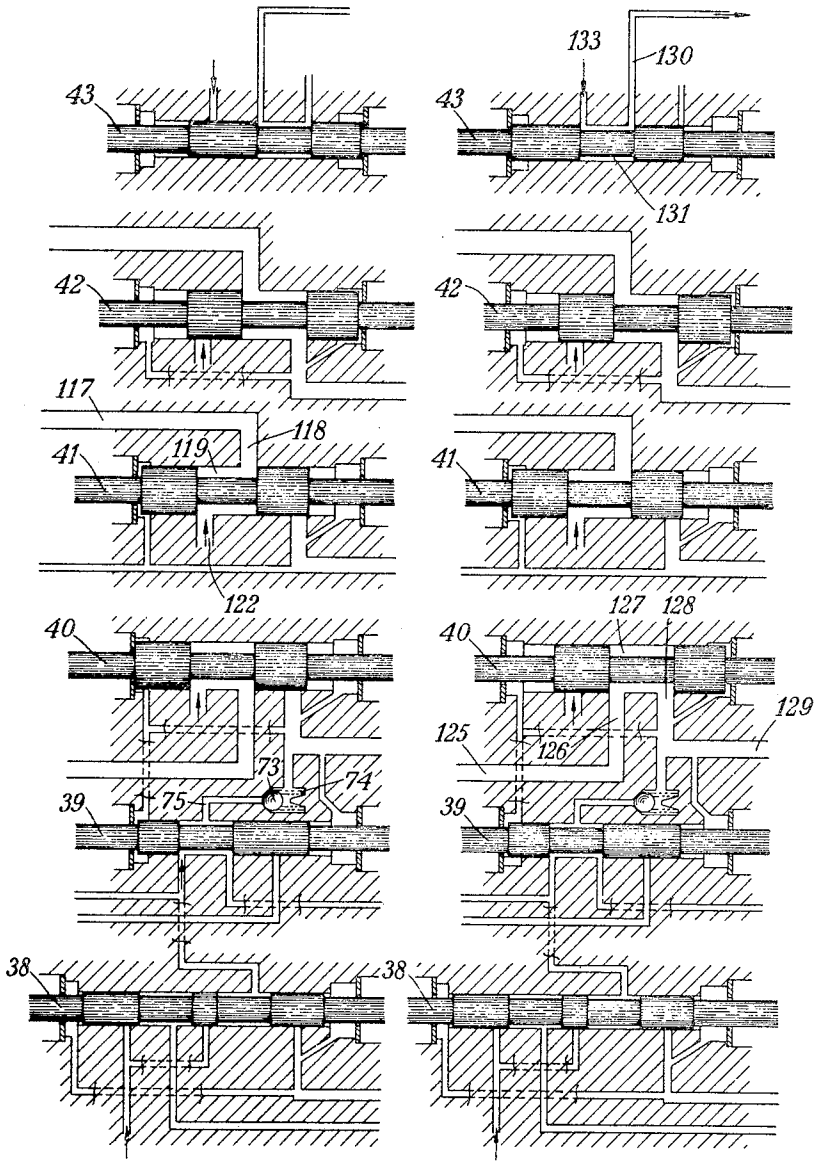



Fig. 12.




Fig. 13.

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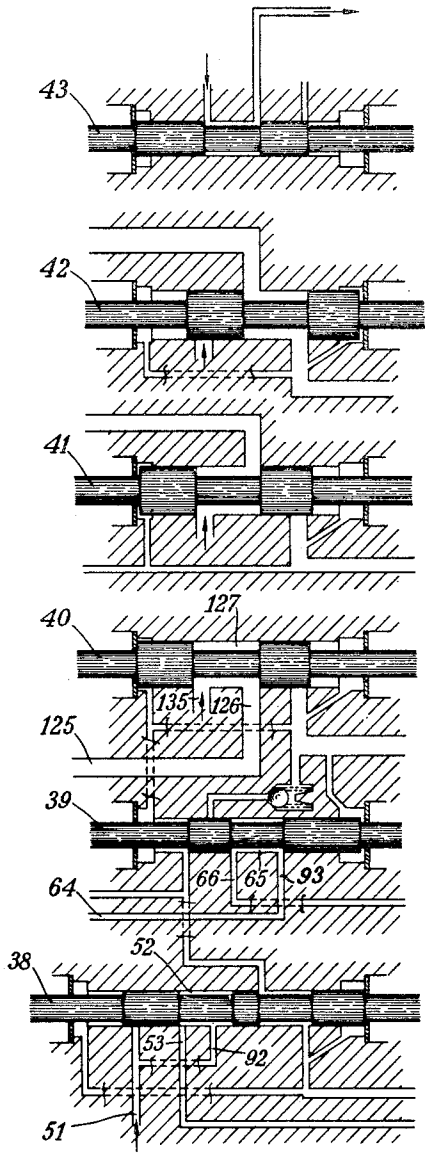



Fig. 14.

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United States Patent Office 2,718,100 Patented Sept. 20, 1955



2,718,100

# AUTOMATIC FEED MECHANISM FOR MACHINE TOOLS, ESPECIALLY GRINDING MACHINES

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Application October 31, 1952, Serial No. 318,122
Claims priority, application Sweden November 3, 1951
5 Claims. (Cl. 51—165)

In grinding work pieces in the form of bodies of revolution it is necessary, in order to permit the insertion of a new work piece, that the grinding-wheel carriage be retracted from the working position sufficiently to permit the work piece to be introduced into the chuck and caused to rotate without coming into contact with the grinding wheel until the automatic feed has been connected. A certain margin of safety must always be provided for because of variations in the diameter and excentricity of the work piece.

In machines of the usual type the work piece is first inserted in the chuck after which the operator feeds the grinding-wheel carriage forwards by hand to a position in which the grinding-wheel is immediately adjacent to the work piece. Only when this has been done is the automatic feed started.

In completely automatic machines, however, this comparatively quick manual feeding cannot be utilized. Instead the automatic feed must also function when the grinding-wheel is not actually engaged with the work. Since the automatic feed, as a rule, is less than 1 mm./min., it is apparent that there will be a considerable loss of time, since no material is being removed during the period in which the grinding-wheel is being fed toward the work piece.

The present invention relates to a device which automatically governs the feed of the wheel carriage so that it is much faster as long as the grinding-wheel has not come into contact with the work, but assumes a preadjusted normal rate at the moment the grinding-wheel contacts with the work piece.

The invention is illustrated on the accompanying drawings in which Fig. 1 shows mainly in diagrammatic form the devices for chucking the work piece. Figures 2, 3 and 4 show cam devices for governing the valves of the hydraulic mechanism. Fig. 5 is a partial section through the grinding-wheel spindle and its motor and Fig. 5*a* a cross section through the coupling between the motor axle and the grinding-wheel spindle. Fig. 5*b* is a cross section through a portion of the motor shield **28**. Fig. 6 shows diagrammatically the pump and governing valves for the feed piston of the grinding-wheel carriage. Figs. 7 and 8 show in different positions hydraulic pistons for the mechanism for introducing and ejecting the work piece. Figures 9–14 show various positions of the valves of the hydraulic system.

Parts of the mechanism which do not directly concern the invention are only indicated. For instance the ejector mechanism and the mechanism for inserting work pieces are indicated only by the driving mechanism with a rack and pinion.

In Fig. 1, the work piece **1** is held between the spindle **3** of the work carriage and a center point **4**. The work spindle **3** is driven by a motor **5**. A gaging finger **6** is urged by a spring **7** in a clockwise direction about its axle **8**, but is prevented from carrying out this movement by the work piece **1**, as long as the work piece has a diameter greater than that for which the mechanism is adjusted. As long as the gaging finger **6** is prevented from swinging by the work piece **1**, a circuit in which a pair of electromagnets **9** and **23** (Figures 2 and 3) are connected is broken, but when the finger can pass the work piece **1**, the



circuit is closed by a pin **10**, as shown in Fig. 1. The grinding-wheel **11** is fixed to a spindle **12** (Fig. 5) which is carried in bearings on a carriage **14** movable on the frame **13**. The carriage **14** is provided with a cylinder **15**, in which is a piston **16** connected to the frame **13** by means of a bar **17**. A motor **18** mounted under the carriage **14** is provided with a shaft **19**, which is coupled to the grinding-wheel spindle **12** through a torsion bar **20** and also through a coupling member **21** on the motor shaft **19** and another coupling member **22** on the grinding wheel spindle **12**.

Between the teeth of the two coupling members **21** and **22**, there is a certain amount of play, "A," which remains unaltered, as long as the torsion bar **20** alone can transmit the torque required to drive the grinding-wheel **11**. If the torque thus required is so great that the torsion bar **20** is twisted a certain angle, the coupling members **21** and **22** will turn relative each other, whereby the play will partially or completely disappear and a corresponding play arise in the opposite direction. A bar **24** is located within the motor axle **19** and is at its upper end carried by three rollers **25** in such a manner, that it rotates at the same speed as the motor axle **19**, but can be axially displaced a short distance relative the latter.

The lower end of the bar **24** is mounted in a ball bearing **26**, the outer race ring of which is fitted in a housing **27** connected to a metal diaphragm **29** connected to the motor shield **28**. When the coupling members **21** and **22** turn relative each other, pins **30** connected to the coupling member **22** actuate the rollers **31**, so that the bar **24** is pressed downwards whereby the housing **27** presses against an electric switch **32** (micro-switch) causing the latter to close a circuit shown in Fig. 6 in which is connected an electro-magnet **72**.

A number of piston valves **38**, **39**, **40**, **41**, **42** and **43** (see Fig. 9) are each manoeuvreable by means of cams, mounted on a common cam shaft **37** (Figures 2–4) driven by a motor **138** through worm wheel gearing **94** and **95** and a one revolution coupling **48** and **49**, having a pawl **48**, which is disconnected from the ratchet **49**, as soon as an arm **45** comes into contact with either of a pair of pins **46** and **50** on an arm **44**. All the valves **38–43** are actuated by the cams in the manner, as shown in Fig. 2, except that valves **38**, **39** (Fig. 9) are provided with pawls **33** actuated by the electro-magnet **23** (Fig. 2).

The movement of the grinding-wheel carriage **14** (Fig. 5) takes place under the influence of hydraulic pressure in the following manner. Pressure fluid is admitted to the valve **38** (Fig. 9) through a channel **51** and flows through a chamber **52** and a channel **53** to a cylinder chamber **54** (Fig. 5). Further pressure fluid flows through a channel **55** (Fig. 6) past a needle valve **56** to an annular channel **57** and channels **58** into the chamber **60** of a valve **59** and further through channels **61** to an annular channel **62** and from there through channels **63** and **64** to the valve chamber **65** (Fig. 9) through a channel **66** to a cylinder chamber **67** (Fig. 5). A small separately driven piston pump **68** (Fig. 6) is provided in which the capacity can be varied by adjusting the length of the stroke by means of a screw **69**. The fluid delivered by this pump flows past ball valves **70** into a channel **71**, where it joins fluid, which as described above, flows through the channel **64** to the cylinder chamber **67** (Fig. 5).

Since the effective piston area in the cylinder chamber **67** is about twice as great as the piston area in the cylinder chamber **54**, the grinding wheel carriage **14** will be moved to the right at a speed determined by the amount of fluid, which can pass the needle valve **56** (Fig. 6), plus the amount of fluid delivered by the piston pump **68**. During the time which the electromagnet **72** is active, it keeps the valve **59** in raised position, as shown in the drawing. During this interval, the pressure fluid cannot

om the channel 55 to the channel 63 and thus the
of the grinding-wheel carriage 14 depends only on
pacity of the pump 68. This speed is that which
has been called the normal feed. When the valves
are in the position shown in Fig. 10, the grinding-
carriage 14 will not be fed forward, because the
74 of the ball valve 73 is so adjusted that the spe-
luid pressure in a channel 75 and thus in a cylinder
ber 67 (Fig. 5) is only half as great as in the inlet
nels, which are in communication with the cylinder
ber 54. The pressures acting upon the cylinder
in both the cylinder chambers 54 and 67 keep
other in equilibrium, even if air is enclosed in cham-
connected to the cylinder chambers. In the position
hich the valve 39 is shown in Fig. 11, the cylinder
nber 67 (Fig. 5) is in communication with a valve
nber 76 (Fig. 9) through the channel 66, the valve
mber 65 and channels 77 and 78. The fluid pressure
he valve chamber 76 forces a piston 79 against an ad-
able stop 80. The quantity of fluid required for this
vement has thus been taken from the cylinder cham-
67 (Fig. 5) under the influence of the pressure in the
inder chamber 54 and the grinding-wheel 11 has thus
en moved from the work piece 1 a corresponding dis-
nce.

The valve 43 (Fig. 9) governs the flow of air pressure
a cylinder chamber 81 (Fig. 1) in which a piston 82,
hich exerts the pressure on a member 83, which is nec-
sary to enable the center point 4 to retain the work
iece 9 in correct position against a holder on the work
pindle 3. As soon as the valve 43 assumes a position in
hich the cylinder chamber 81 is in communication
ith the atmosphere, the piston 82 and the mandrel 83

orrect position against a holder on the work
As soon as the valve 43 assumes a position in
ylinder chamber 81 is in communication
osphere, the piston 82 and the mandrel 83
upwardly by a spring 84 and the work
[illegible] by the ejector (not

sure in this chamber is determined by the spring 74 of the ball valve 73 (Fig. 10), which is so adjusted that the valve 73 opens for a specific pressure, which is half as great as the pressure on the pressure fluid, which has been introduced into the cylinder chamber 54 (Fig. 5) through the inlet 51 (Fig. 10). There is thus equilibrium between the pressures acting on the piston surfaces in both the cylinder chambers 54 and 67. The grinding wheel carriage 14 is now stationary. The electro-magnet 9 (Fig. 3) which became activated upon the turning of the finger 6 (Fig. 1) brings the lever 44 into such a position that the pin 46 loosens the arm 45 which is then turned anticlockwise by the spring 47 (Fig. 2), so that the pawl 48 will engage the ratchet wheel 49 and the cam shaft 37 is turned anticlockwise by the worm gear 94 and 95. This turning movement is interrupted when the arm 45 engages the other stop 50 of the lever 44, the cams of the cam shaft 37 having during this rotation acted upon valve 38–43, so that the relative positions of the valves is now that shown in Fig. 10.

Through the altered position of the valve 42, the cylinder chambers 96 and 97 of the ejector and work piece inserting mechanisms (Fig. 7) have been put in communication with the outlet through channels 98, 99 and 100, the valve chamber 101 and a channel 102 (Fig. 10). Since the cylinder chambers 103 and 104 are always under pressure through channels 105 and 106, the pistons 107 and 108 in these chambers will be pressed in toward the smaller pistons 109 and 110, as shown in Fig. 8. A pair of gear wheels 111 and 112 are thereby turned anticlockwise and clockwise respectively, whereby the ejector and workpiece-inserting-mechanisms (not shown) are moved to the immediate vicinity of the working spindle. In this position, the grinding wheel 11 (Fig. 1) contacts the work piece 1, without being fed against the latter. The length of this period is determined by an adjustable time relay which after a certain period breaks the cir-

workpiece-inserting-mechanisms
to the immediate vicinity of the working spindle
position, the grinding wheel 11 (Fig. 1) contacts the work
piece 1, without being fed against the latter. The length
of this period is determined by an adjustable time relay
which after a certain period breaks the cir-
[illegible] 22 and 23 (Figs. 2
[illegible] the valve is decreased

through a channel **130**, the valve chamber **131** and a channel **132** and the spring **84** presses the piston **82** and the mandrel **83** upwards and the point **4** releases the work piece **1**.

During the continued rotation of the cam shaft **37** cams have acted upon the valve **41**, so that the relative positions of the valves is now that shown in Fig. 12. Pressure fluid now flows through a channel **122**, the valve chamber **119**, channels **118** and **117** to a cylinder chamber **116** (Fig. 8) and moves the pistons **110** and **108** to the right, as far as the piston **110** can move. The driving wheel **112** of the ejector mechanism has thereby been rotated counterclockwise through a certain angle, which thus removes the ejector mechanism together with the work piece. Immediately thereafter during the rotation of the shaft **37**, cams act upon valves **40** and **43** so that the relative positions of the valves is according to Fig. 13.

A cylinder chamber **123** (Fig. 8) is now in communication with the outlet through channels **124**, **125** and **126**, a valve chamber **127** and channels **128** and **129**. The pressure in cylinder chamber **103** is sufficient to move the pistons **107**, **108** to the right, whereby the driving wheel **111** of the work inserting mechanism is turned counterclockwise and the work inserting mechanism (not shown) transports a new work piece to a position opposite the centre point **4** (Fig. 1). An air pressure inlet **133** in a valve **43** has been put into communication with the cylinder chamber **81** through a valve chamber **131** and a channel **130**. The piston **82** is thus moved downwards together with the mandrel **83**, whereby the centre point **4** engages the centre hole of the work piece and presses the work piece **1** against the supporting plate **134** of the work spindle **3**. Upon continued rotation of the cam shaft **37** other cams have acted upon valves **40**, **39** and **38**, whereby the positions of the valves is now that shown in Fig. 14.

In their new positions the valves **38** and **39** are again held by the pawls **33** (Fig. 2) and are thus retained in their positions by the latter even after their cams have lost contact with the rollers **36** of the levers **35**. At the same time, as the valves **38** and **39** are displaced, the switch **115** (Fig. 4) which is also manoeuvred by a cam on the cam shaft **37** starts the electromotor **5** (Fig. 1), so that the work spindle **3** and the work piece **1** will rotate. In the new positions of the valves **38** and **39** (Fig. 14), pressure fluid again reaches the cylinder chamber **67** (Fig. 5) through the inlet channel **55** (Fig. 6), the needle valve **56**, the annular channel **57**, channels **58**, **61**, **62**, **63**, **64** and **93**, the valve chamber **65** and a channel **66**. The fluid pressed out into the channel **71** by the pump **68** also flows through the same channels.

Pressure fluid reaches the cylinder chamber **54** through channels **51** and **92**, valve chamber **52** and channel **53**. Because of the greater piston area in the cylinder chamber **67**, the grinding wheel carriage **14** is moved toward the right, in other words, the grinding-wheel **11** approaches the work piece **1** at a speed determined by the rate of flow past the needle valve **56** and the capacity of the pump **68**.

As soon as the grinding-wheel **11** comes into contact with the work piece **1**, a resistance is set up at the periphery of the grinding wheel, which tends to diminish the speed of the grinding-wheel. Hereby the torsion bar **20** (Fig. 5) is twisted and a relative movement takes place between the coupling member **21** of the motor shaft and the coupling member **22** of the grinding-wheel spindle, whereby the pins **30** in the coupling member **22** of the grinding-wheel spindle press the rollers **31** downwards, taking with them the bar **24** in the manner previously described. The switch **32** is thus caused to close a circuit activating the electro-magnet **72** (Fig. 6) and the latter then lifts the valve **59** to its upper position, shown in the figure. The pressure fluid which passes the needle valve **56** is thus prevented from passing the valve **59** and only pressure fluid from the pump **68** now reaches the cylinder chamber **67**.

Upon continued rotation of the cam shaft **37**, the valve **42** is shifted so that the valves now again assume the position shown in Fig. 9.

Pressure fluid now flows to the cylinder chambers **96**, **97** and moves the pistons **107**, **108** to their outer positions, as shown in Fig. 7. In other words, the gear wheel **112** has been turned clockwise, whereby the ejector releases the work piece removed from the work spindle **3** and the gear wheel **111** has been turned clockwise. The work introducing mechanism has picked up a new work piece. The cam shaft now stops in this position because the arm **45** (Figures 2 and 3) engages the stop pin **46**. The mechanism has now returned once more to the position assumed at the beginning of the cycle described above which will be repeated continuously. The valve **51** (Fig. 6) can move downwards only slowly because the fluid in a chamber **136** can only pass a ball valve **137** at a certain adjustable speed, but can pass quickly in the opposite direction.

Since the valves **38–43** are not directly acted upon by the cams of the cam shaft **37**, but only through the levers **35**, the valves **38–43** can be manually adjusted independently of the positions of their respective cams. The various movable members of the machine can thus be caused to carry out their movement manually and independently of each other.

I claim:

1. In a machine tool, a rotary tool, work supporting means, mechanism for feeding the tool towards the work, a drive motor for the tool, a torsion bar connected at one end to the motor and at the other end to the tool, said bar being dimensioned so that it is capable of rotating the tool when the latter is not in working contact with the work but not capable of rotating the tool when the latter is in working contact with the work, means responsive to twisting of the torsion bar for transmitting the torque from the motor to the tool under load independently of the bar, and mechanism also responsive to twisting of the said bar for altering the speed of the feed of the tool towards the work by said feeding mechanism.

2. A machine tool according to claim 1, characterized thereby that the said torque transmitting means is disposed concentrically with respect to and embraces the torsion bar.

3. A machine tool according to claim 2 wherein the said torque transmitting means comprises relatively movable members connected respectively to the tool and the motor and having contact surfaces held out of contact with each other by said torsion bar when the tool does not contact the work and brought into contact by twisting of the bar under load.

4. A machine tool according to claim 1 wherein the said mechanism for altering the speed of the feed comprises a rod disposed within a longitudinal bore in the motor shaft, together with means at one end of the rod responsive to twisting of the torsion bar for longitudinally displacing the rod in the bore, and speed control devices operatively connected with the other end of said rod.

5. A machine tool according to claim 4 wherein the said speed control devices comprise a hydraulic system, a valve operatively connected in said system, an electric circuit containing an electric magnet, said magnet having an armature connected to the valve, and an electric switch controlling said circuit and arranged for actuation by displacement of said rod.

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