May 25, 1943. E. G. HJÄRPE ET AL 2,320,235

FEEDING DEVICE FOR MACHINE TOOLS

Filed Dec. 5, 1940 2 Sheets-Sheet 1

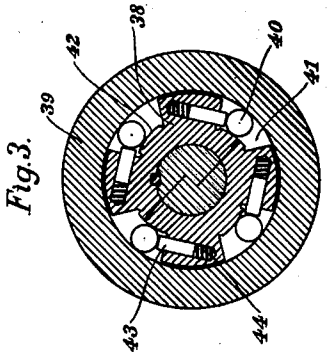


Fig. 3.

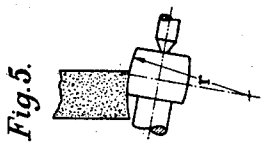


Fig. 5.

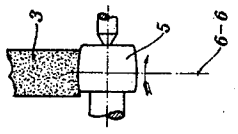


Fig. 4.

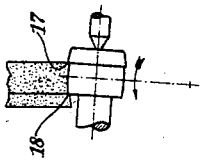


Fig. 6.

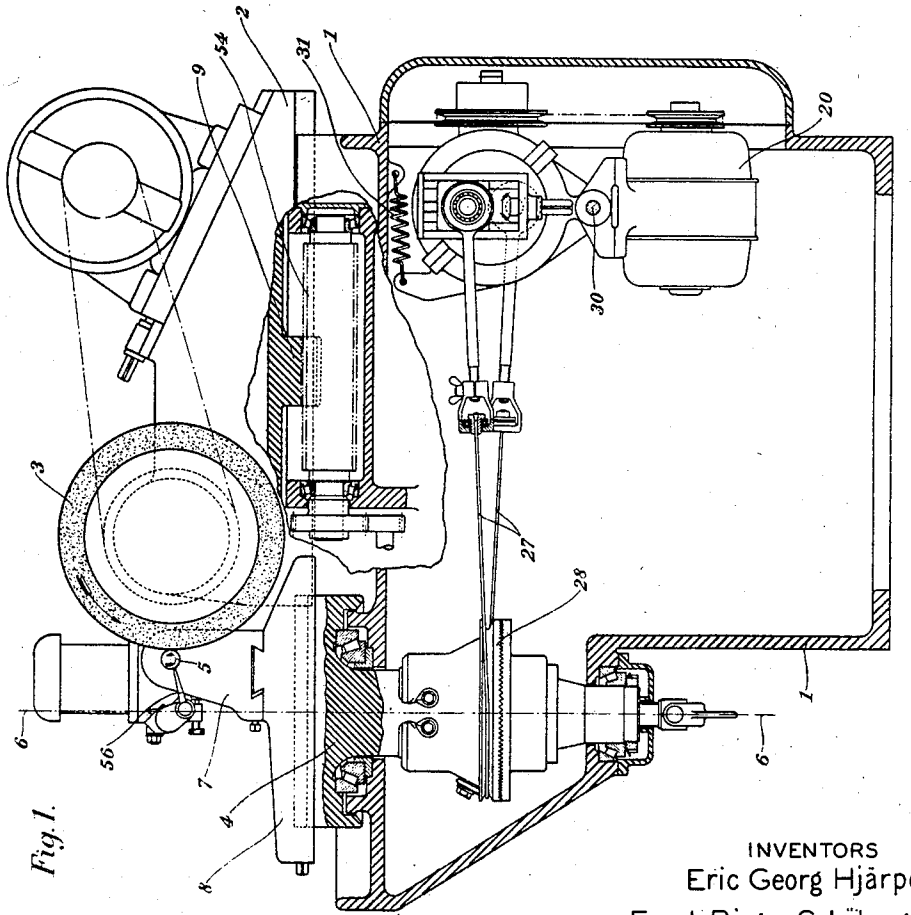


Fig. 1.

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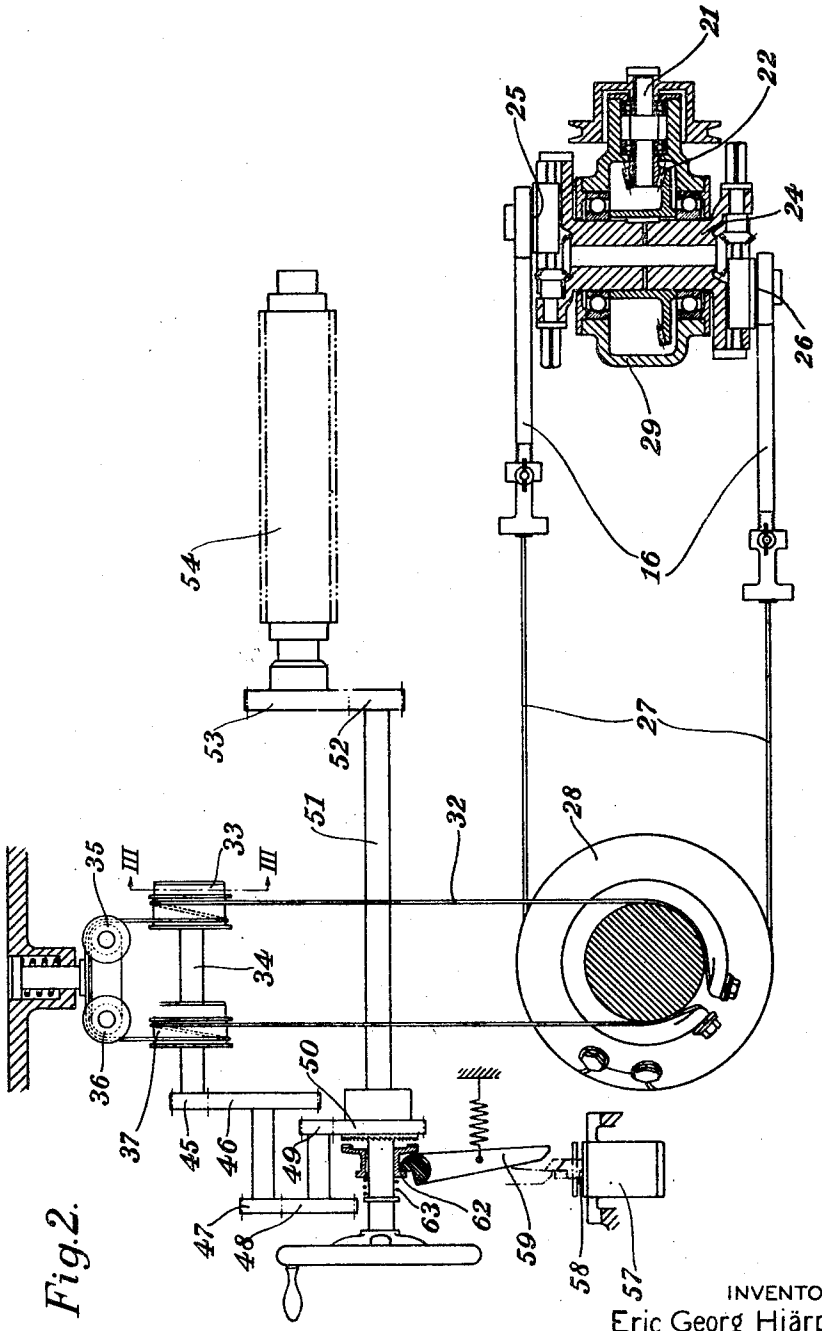


Fig. 2.

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FEEDING DEVICE FOR MACHINE TOOLS

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5 Claims. (Cl. 51—97)

Some machine-tools are provided with a pivotable or slidable head, which carries either the work-piece or the tool and during the operation is moved to and fro to effect a relative movement between workpiece and tool. Besides this alternating movement there is also a relative feeding movement between the workpiece and the tool. The speed of the feeding movement, as a rule, is much smaller than that of the alternating movement. Examples of such machine tools are grinding machines having pivotable work- or grinding-wheel-head, such as used in the ball and roller bearing industry.

The speed of the alternating movement, as a rule, varies so that it has its greatest magnitude in the middle of the stroke and successively decreases towards the turning points, where the speed has the value zero. In most machines the speed approximately varies in accordance with a sinus-curve. In machine tools hitherto known the feeding device has been made according to one of two different principles.

Thus in some machines the feeding device receives an impulse once or more times during a stroke, i. e. the feeding is intermittent. In this case a momentary high pressure will occur between the workpiece and the tool, and the magnitude of the feeding must be limited in view of the risk for damages on the tool or on the workpiece.

According to the second principle the feeding takes place continuously and with constant speed during the alternating movement of the head. However, as the speed of the alternating movement varies for every stroke, the feeding movement taken per angular or longitudinal unit of the stroke, will be different during different parts of the stroke, i. e. the relative feeding movement will have its greatest value at the ends of the stroke and its smallest value at the middle of the stroke. On account thereof the parts of the tool and the workpiece which are in contact in the turning points will be subjected to a maximal pressure. In these known machines the feeding movement as a whole must be kept at a low value with a view of the risk for damages on the tool or the workpiece.

The present invention has for its purpose to overcome the disadvantages stated above. The feeding device according to the invention is characterized thereby that the feeding device is operatively connected with members which take part in the alternating movement in such a manner that the feeding takes place continuously and with varying speed, the magnitude of which is determined by the variations in the speed of the alternating movement.

The invention is illustrated in the accompanying drawings.

Figs. 1–3 show as an embodiment of the invention a roller grinding machine for rollers for spherical roller bearings. Fig. 1 shows in part in section a vertical projection of the roller grinding machine, and Fig. 2 shows a horizontal projection of the drive and transmission devices of the machine, and Fig. 3 shows on a larger scale a section along the line III—III in Fig. 2.

Figs. 4–6 are intended to illustrate a disadvantage in the known feeding arrangements for roller grinding machines, said last-mentioned figures showing three different relative positions of the workpiece and the grinding wheel.

The roller grinding machine shown in Figs. 1–3 has a bed 1, which supports both a grinding wheel slide 2 having a grinding wheel 3 and being mounted on guides and a pivot-head 4 mounted on conical roller bearings and supporting the workpiece 5 between a drive plate (Figs. 4–6) and a centre.

During the grinding operation the grinding wheel and the workpiece rotate in the directions indicated by arrows in Fig. 1, and simultaneously the workpiece is pivoted to and fro about the axis 6—6 and the grinding wheel is fed against the workpiece. The mantle surfaces of the rollers are hereby formed as surfaces of rotation having a curved generatrix in the shape of a circular arc having its centre located on the axis 6—6 and having the radius r (Fig. 5)—the distance between the axis 6—6 and the contact between the roller and the grinding wheel. The grinding wheel on account of its wearing against the roller is simultaneously so shaped that the generatrix of its working surface becomes a circular arc with the same radius as the generatrix of the roller. The drive plate and the centre are carried by an upper slide 7, which is slidable in parallel with the axis of rotation of the grinding wheel. The upper slide 7 in its turn is carried by a lower slide 8 which is slidable perpendicularly to the axis of rotation of the workpiece in a plane perpendicular to the axis 6—6. The shape of the generatrix of the roller and its position in relation to the axis of the roller can be varied as desired by sliding the slides 7, 8.

During grinding the roller 5 is swung from the position shown in Fig. 4 and further on to the

position shown in Fig. 5 and then backwards to the position shown in Fig. 6 and so on to and fro until the roller has been given the desired shape and dimensions. The angular velocity of the pivoting movement approximately varies in accordance with a sinus-curve, and thus has its greatest value on the middle of the stroke (Fig. 4) and then decreases and becomes zero in the turning point (Fig. 5).

In roller grinding machines of the previously known type the feeding takes place either intermittently or with a constant speed during the whole pivoting movement. In the firstmentioned case the grinding wheel is subject to shockwise strains entailing risk for burning or bursting of the grinding wheel. In the lastmentioned case the feeding movement taken per angular unit is different, i. e. has its greatest value in the turning points and its smalles value in the middle of the stroke. Fig. 6 shows in an exaggerated manner the deformations of the grinding wheel and the workpiece which occur in using a constant feeding velocity in a roller grinding machine with a pivotable work-head.

In the turning point (Fig. 5) where momentarily no side movement of the workpiece takes place, the grinding wheel in the hitherto known machines is fed against the workpiece with an unreduced speed and effects a disproportionally great removal of material from the parts of the workpiece and the grinding wheel which are in contact in the turning position. Furthermore the specific surface-pressure between the workpiece and the grinding wheel becomes higher in the turning points than in the middle of the stroke. Hereby the risk for burning of the grinding wheel occurs. By eliminating this risk through the feeding device according to the invention one can allow a high average feeding speed and thereby increase the capacity of the machine-tool.

According to the present invention the feeding speed of the grinding wheel slide is accommodated to the angular velocity of the pivotal head, so that the feeding movement has its greatest speed in the middle of the stroke and decreases to zero in the turning points. Figs. 1–3 show how the feeding device is connected with the pivoting device in a roller grinding machine according to the invention.

The pivotal work-head 4 is driven from an electric motor 20 shown in Fig. 1, said motor being connected with a spindle 21 (shown in Fig. 2) over a keybelt-transmission. The spindle 21 is connected with a spindle 24 by means of a conical gearing 22, the spindle 24 carrying two adjustable eccentric pins 25, 26 on its opposite end. The eccentric pins are connected with a rope-pulley 28 fixed to the pivotshaft by means of connecting rods 16 and ropes 27. The spindles 21 and 24 are mounted in a casing 29 by means of ball bearings, and the casing 29 is pivotal about a pin 30 (Fig. 1) and is acted upon by a pulling spring 31 so as to hold the ropes 27 tensioned. The rotation of the motor 20 is transformed into alternating swinging movements of the pivot-head 4. The angular velocity of this swinging movement approximately varies in accordance with a sinus-curve.

In the shown embodiment the connection between the swinging device and the feeding device consists of a rope 32 (Fig. 2) which is fixed to the pivot shaft with its two ends. The rope 32 from its one end extends to and around a rope-pulley 33 on a shaft 34 and further over two spring break-pulleys 35, 36 acted upon by springs to a second pulley 37 mounted on the shaft 34 and from the second pulley back to the pivot-shaft where it is fixed. The two rope-pulleys 33, 37 are mounted on the shaft 34 by means of overrunning clutches of the construction shown in Fig. 3.

Each clutch has an inner ring 38 keyed onto the shaft and an outer ring 39 firmly connected with the rope-pulleys 33 and 37 respectively, and four cylindrical rollers 40 inserted between the rings. The inner ring is formed with four pockets 41 for the rollers 40, the bottoms of said pockets being shaped as circular arc having their centres located besides the center of the outer ring as shown. The roller pockets thus become narrower taken in the clockwise direction in Fig. 3. The four rollers 40 are acted upon by plunger 43 and pressure springs 44, inserted in bores in one sidewall of the pocket. The plungers 43 hold the rollers 40 in contact with the opposite converging surfaces of the inner and outer ring. When the outer ring 39 rotates in clockwise direction as seen in Fig. 3 the rollers 40 are locked between the inner and outer ring, so that these are firmly connected with each other. When the outer ring 39 is rotated in anti-clockwise direction, however, the rollers run freely between the rings, so that the outer ring can rotate in relation to the inner ring.

When the pivot-shaft is swung in the one direction for instance clockwise in Fig. 2, the rope 32 rotates the rope-pulley 33 which is then firmly coupled to the shaft 34 through the clutch shown in Fig. 3. The shaft 34 is thus rotated in the one direction. Simultaneously the rope-part extending from the break-pulley 36 turns the rope-pulley 37 in the opposite direction, in which direction the pulley 37 runs freely on the shaft 34. When the pivot-shaft is swung in the opposite direction the rope 32 has a pulling effect on the pulley 37, which is then firmly coupled to the shaft 34. Hereby the shaft 34 is again turned in the same direction as before. In this lastmentioned case the pulley 33 runs freely on the shaft 34. The alternating swinging movements of the pivot shaft are thus transformed into a unidirectional turning of the shaft 34 with a speed which varies in accordance with the angular velocity of the swinging movement. In the turning points the angular velocity of the shaft 34 becomes zero.

The shaft 34 is connected with a gear wheel 50 on a shaft 51 by means of gears 45, 46, 47, 48, 49, and the shaft 51 is connected with the feeding screw 54 of the machine by means of gears 52, 53. The feeding screw 54 is mounted on conical roller bearings below the grinding wheel slide 2 and is in thread-engagement with a halfnut 9 formed on the underside of the slide 2.

The machine is provided with an automatic disengaging arrangement for the feeding movement, which comes into operation when the workpiece has been ground to the intended dimension. This disengaging arrangement is of principally the same construction as shown in the Swedish patent specification No. 97,947 and is therefore only shortly described in the following.

A gauging finger 56 (Fig. 1) is pivotally mounted on the upper slide 7 and is during the grinding bearing against the workpiece as shown in Fig. 1. When the workpiece has attained its intended dimension the gauging finger 56 is

swung by spring force in anticlockwise direction as seen in Fig. 1. The gauging finger then closes a circuit (not shown). In the same circuit there is a solenoid schematically shown at 57 in Fig. 2. Within the solenoid there is a movable iron core 58. The iron core is arranged for coaction with one end of a turnably mounted double-armed spring-operated lever 59, the opposite end of which is in coaction with a coupling member 62. When grinding is performed and the feeding arrangement is engaged the iron core 58 and the lever 59 are in the positions shown in Fig. 2 with dot and dash lines. The coupling member 62 is slidably but not rotatably mounted on the shaft 51 and is acted upon by a pressure spring 63 towards the gear 50 mounted on the same shaft. This gear is freely turnably but not axially slidably mounted in relation to the shaft 51 and is provided with coupling teeth for coaction with the coupling member 62.

The function of the disengaging arrangement described above is as follows:

When grinding of a workpiece takes place the gauging finger is bearing the workpiece as shown in Fig. 1. At this moment the solenoid 57 is free of current and the iron core 58 is held by spring force in the projecting position shown in dash and dot lines in Fig. 2. The double-armed lever 59 is bearing against the projecting end of the iron core, and the spring 63 holds the coupling member 62 in engagement with the loosely mounted gear wheel 50. Now the feeding power is transmitted from the rope pulley 28 on the pivot-shaft over the rope 32, the rope pulley 33, 37, the shaft 34, the gears 45, 46, 47, 48, 49, 50, the shaft 51, the gear wheels 52, 53, the feeding screw 54, the nut 9 to the grinding wheel slide 2.

When the work piece has been given such dimensions that the gauging finger can pass it, the gauging finger 56 by spring force is swung in anticlockwise direction past the work-piece. Hereby the circuit is closed and the solenoid 57 conducts current. The iron core 58 is pulled by the electromagnetical force into the solenoid 57 whereby the double-armed lever 59 becomes free to turn in anticlockwise direction under the action of the spring forces. The other end of the lever 59 is now acting upon the coupling member 62 so as to bring it out of engagement with the coupling teeth of the gear wheel 50. Hereby the feeding is disengaged. The positions of the different parts after the disengagement of the feeding is shown in full lines in Fig. 2.

The invention is not restricted to the embodiments described above and shown in the drawings.

Having thus described our invention, we claim and desire to secure by Letters Patent the following:

1. In a machine tool having a tool head and a work head, means for oscillating one of the heads, a feeding device for causing a relative feeding movement between the tool and the work, and means for operatively connecting the oscillatable head with the feeding device so that the latter is driven in one and the same direction by the alternating movements of the head in opposite directions and with a speed which is proportional to the speeds of said movements; said connecting means comprising a pair of pulleys, an overrunning clutch connecting each of the pulleys with the feeding device, said clutches being substantially free from backlash and being automatically engageable by rotation of the respective pulleys in one and the same direction, and a rope transmission operatively connecting the pulleys with the oscillatable head so that in each direction of movement of the head the pulleys are simultaneously rotated in opposite directions.

2. In a machine tool having a tool head and a work head, means for oscillating one of the heads, a feeding device for causing a relative feeding movement between the tool and the work, and means for operatively connecting the oscillatable head with the feeding device so that the latter is driven in one and the same direction by the alternating movements of the head in opposite directions and with a speed which is proportional to the speeds of said movements; said connecting means comprising a pair of pulleys, an overrunning clutch connecting each of the pulleys with the feeding device, said clutches being substantially free from backlash and being automatically engageable by rotation of the respective pulleys in one and the same direction, a rope transmission operatively connecting the pulleys with the oscillatable head so that in each direction of movement of the head the pulleys are simultaneously rotated in opposite directions, and resilient take-up means operatively associated with the said rope so as to preclude backlash in the said transmission.

3. In a machine tool having a tool head and a work head, means for oscillating one of the heads, a feeding device for causing a relative feeding movement between the tool and the work, and means for operatively connecting the oscillatable head with the feeding device so that the latter is driven in one and the same direction by the alternating movements of the head in opposite directions and with a speed which is proportional to the speeds of said movements; said connecting means comprising a shaft, a pair of pulleys, an overrunning clutch connecting each of the pulleys with the shaft, said clutches being substantially free from backlash and being automatically engageable to connect the pulleys with the shaft by rotation of the respective pulleys in one and the same direction, a continuous rope connecting both of the pulleys with the oscillatable head so that in each direction of movement of the head the pulleys are simultaneously rotated in opposite directions, means for guiding the rope between the pulleys, and resilient means associated with the guide for tensioning the rope.

4. In a machine tool having a tool head and a work head, means for oscillating one of the heads, a feeding device for causing a relative feeding movement between the tool and the work, and means for operatively connecting the oscillatable head with the feeding device so that the latter is driven in one and the same direction by the alternating movements of the head in opposite directions and with a speed which is proportional to the speeds of said movements; said connecting means comprising a pair of pulleys, an overrunning clutch connecting each of the pulleys with the feeding device, said clutches being substantially free from backlash and being automatically engageable by rotation of the respective pulleys in one and the same direction, a continuous rope connecting both of the pulleys with the oscillatable head so that in each direction of movement of the head the pulleys are simultaneously rotated in opposite directions, means for guiding the rope between the pulleys,

and resilient means associated with the guide for tensioning the rope.

5. In a machine tool having a tool head and a work head, means for oscillating one of the heads, a feeding device for causing a relative feeding movement between the tool and the work, and means for operatively connecting the oscillatable head with the feeding device so that the latter is driven in one and the same direction by the alternating movements of the head in opposite directions and with a speed which is proportional to the speeds of said movements; said connecting means comprising a pair of pulleys, an overrunning clutch connecting each of the pulleys with the feeding device, said clutches being substantially free from backlash and each being automatically engageable by rotation of the associated pulley in a given direction, and a rope transmission operatively connecting the pulleys with the oscillatable head so that in each direction of movement of the head the pulleys are simultaneously rotated in directions respectively for engagement and disengagement of the clutches.

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