Nov. 11, 1941. F. LAESSKER 2,262,103

DIVIDING APPARATUS FOR GRINDING MACHINES

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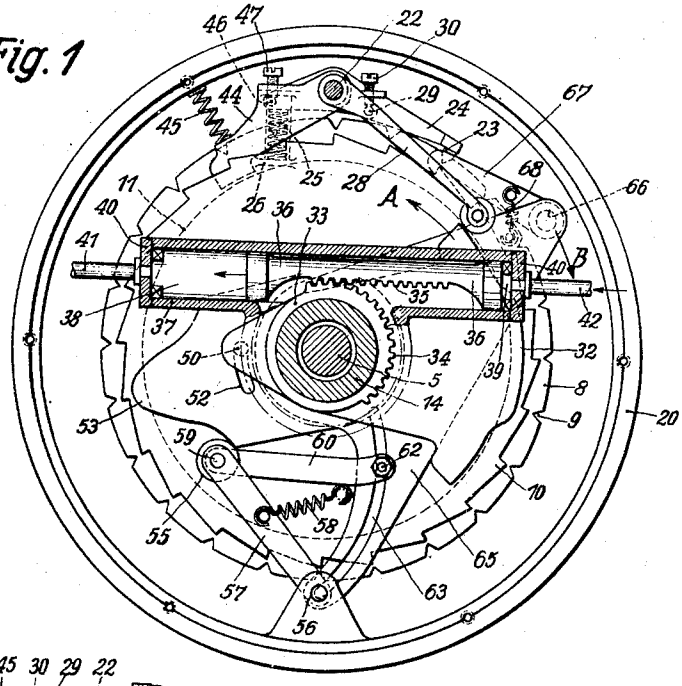
Fig. 1



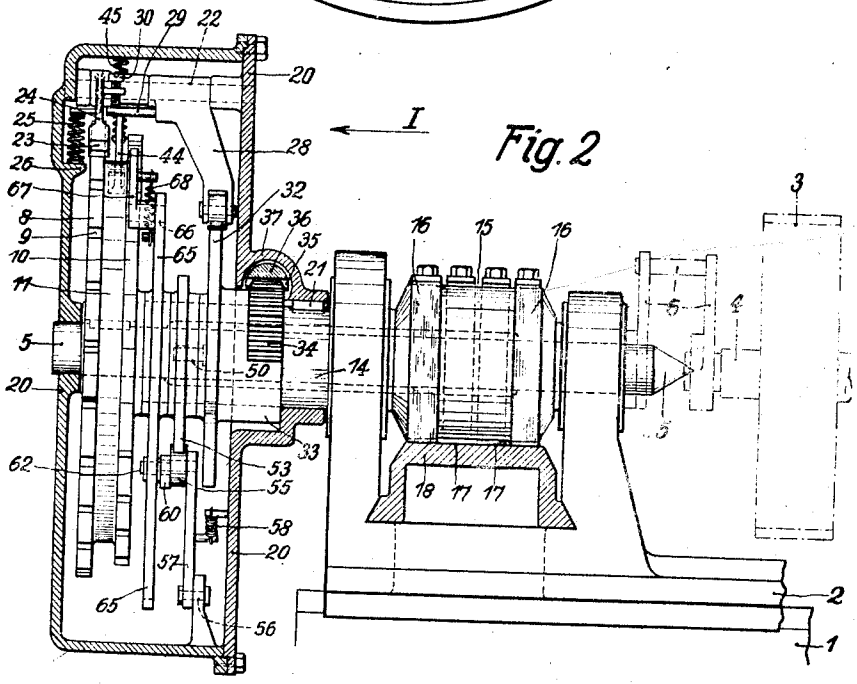


Fig. 2

Inventor:
FRITZ LAESSKER
by Edmund H. Parry
Attorney

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Fig. 3

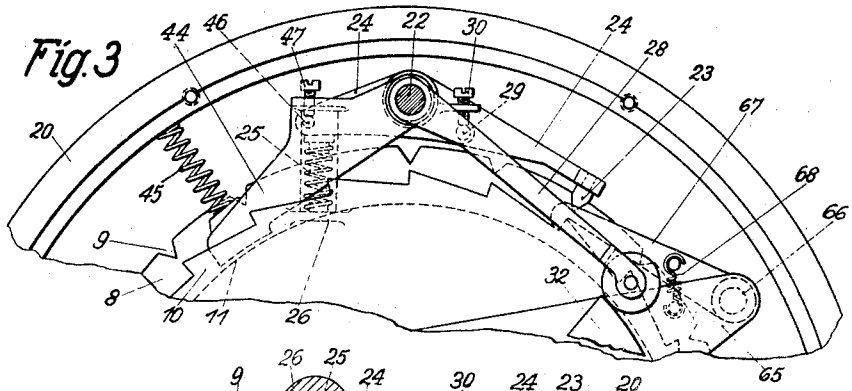


Fig. 4

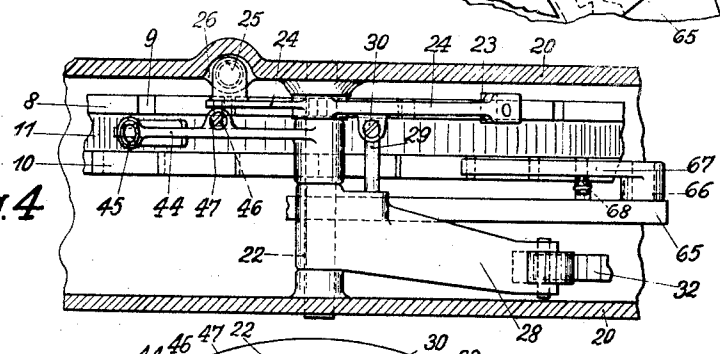
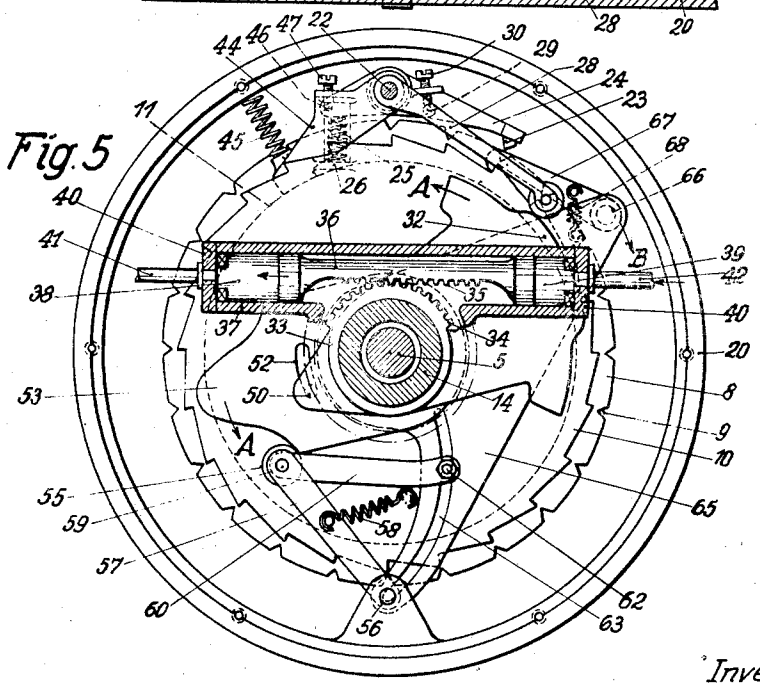


Fig. 5



Inventor:
FRITZ LAESSKER
by Edmund H. Parry Jr.
Attorney

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DIVIDING APPARATUS FOR GRINDING MACHINES

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Fig. 6

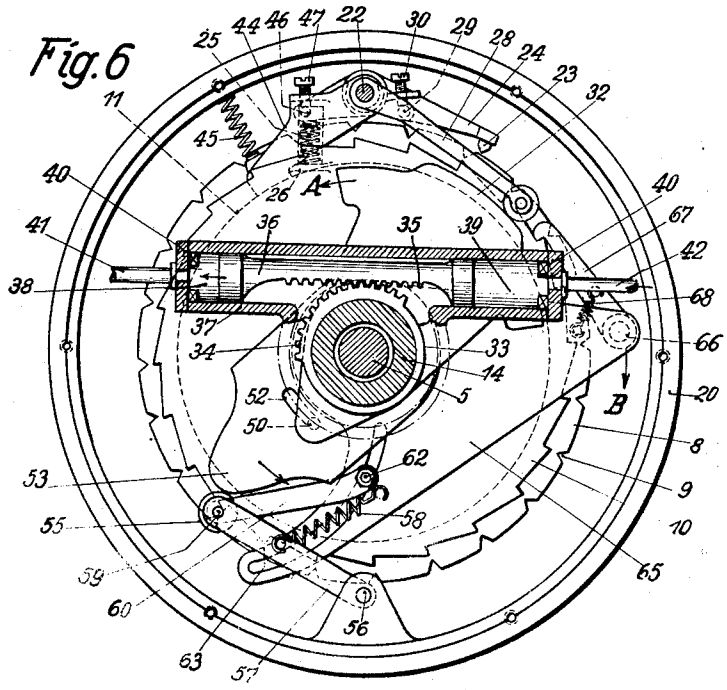
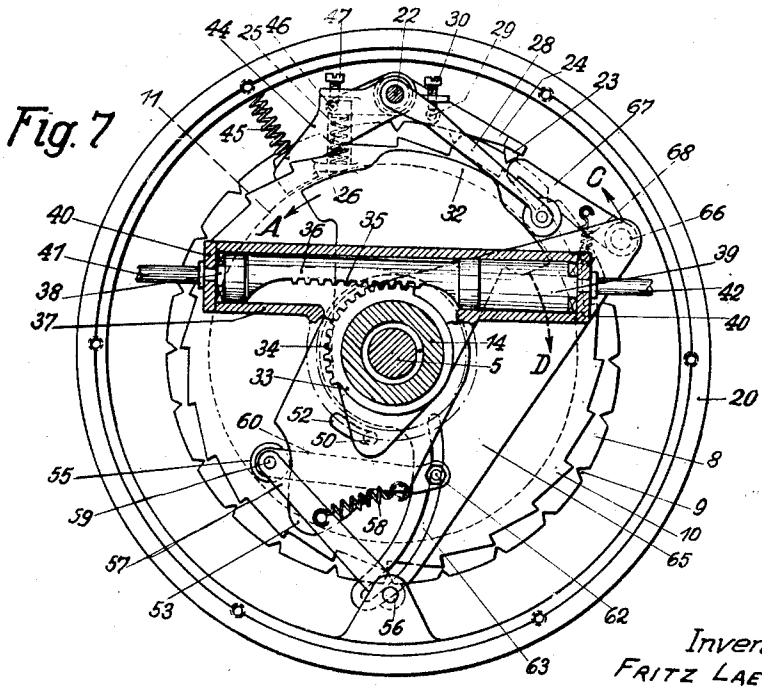


Fig. 7



Inventor:
FRITZ LAESSKER

By Edmund H. Parry
Attorney

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DIVIDING APPARATUS FOR GRINDING MACHINES

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Fig. 8

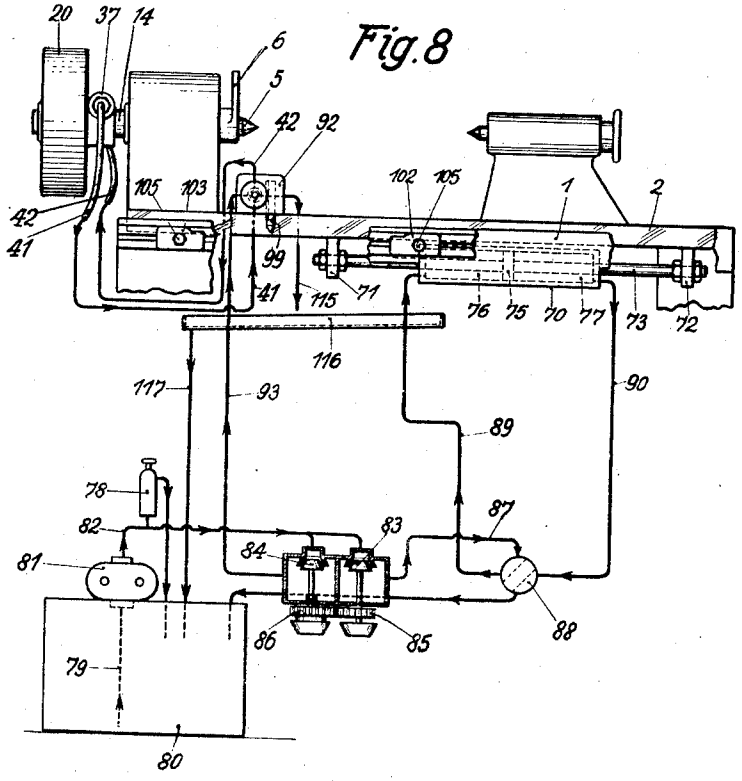


Fig. 9

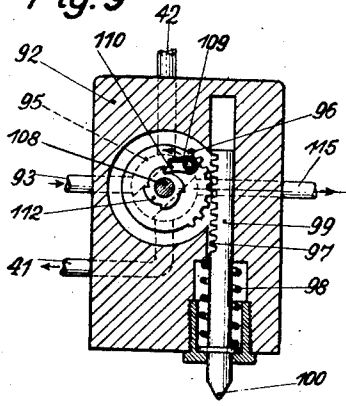
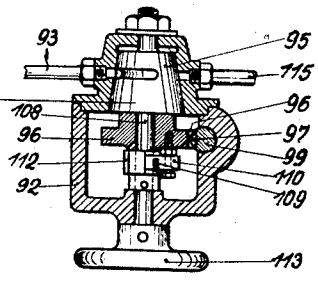


Fig. 10



Inventor:
FRITZ LAESSKER
By Edmund H. Parry Jr.
Attorney

Patented Nov. 11, 1941 2,262,103

UNITED STATES PATENT OFFICE

2,262,103

DIVIDING APPARATUS FOR GRINDING MACHINES

Fritz Laessker, Friedrichshafen-Bodensee, Germany, assignor to Zahnradfabrik Friedrichshafen Aktiengesellschaft, Friedrichshafen-on-the-Bodensee, Germany

Application September 27, 1939, Serial No. 296,846
In Germany September 27, 1938

14 Claims. (Cl. 51—216)

This invention relates to an improved dividing apparatus for grinding machines for the grinding of spur pinions, grooved shafts or the like having a dividing disc provided with notches corresponding to the number of the tooth spaces or grooves of the workpiece, and an insertible and removable index pin co-operating therewith together with a control mechanism therefor.

Dividing apparatus for pinion- and grooved shaft-grinding machines as heretofore proposed are operated by the relative movement between the machine bed and the table slide by means of cams, the dividing operation taking place during the end portion of the movement of the table, and the control members returning, after the reversal of movement of the table, during the starting movement of the table into their initial position. Such an arrangement has two disadvantages, that is to say the table-travel necessary for the dividing movement has to be utilised twice, whereby the idle run time is considerable and the grinding capacity low, and, moreover, a separate mechanism, which effects the control of the index pin movement in the one direction of movement of the table but is switched out in the other direction, is necessary.

In the case of other proposed dividing apparatus which are driven electrically or hydraulically, these disadvantages do not exist, but according to the number of teeth to be divided, exchange-pinions have to be inserted and also kept in readiness in a considerable number for exchanging purposes.

This invention, whilst avoiding the aforesaid disadvantages, provides a particularly simple construction of an automatic dividing apparatus in which the highest grinding capacity is attained with the utilisation of the end portion of the slide table movement, the rest period and the re-starting movement thereof for effecting the dividing operation. Moreover, the dividing apparatus constructed in accordance with the invention is universally usable for dividing workpieces having only a few or a great number of teeth and is also suitable for use with grinding machines for the grinding of pinions with straight or screw-like teeth.

A particular characteristic of the invention consists in the use of the fluid pressure provided for actuating the table slide for operating the dividing apparatus. The control cams for the feed and index pin operation are constructed with symmetrical rising and falling portions, such that both the control and also the return movement is effected by only one direction of movement of the cams. The drive of the control cams in the other direction of movement then likewise produces in the same sequence the control and the return movement of the parts.

By the use of this improved mechanism separate control members for controlling the index pin movement can be omitted and the drive by means of fluid pressure by a fluid cylinder is very simple. The latter preferably consists of a cylinder arranged on the dividing apparatus and having a double acting piston therein, which receives the pressure oil flow from a control change-over valve located on the machine bed. By means of stops arranged on the table slide the oil flow through the valve is reversed when a dividing operation is to take place. The dividing, with the return of the control members, lasts only as long as the piston is in movement, but the operating pressure continues in the cylinder from the beginning of the dividing operation to the commencement of the next dividing operation and thus acts after the piston movement on the latter until it is changed over.

In order that the invention may be fully understood I shall now describe one embodiment thereof by way of example by reference to the accompanying drawings, which show a dividing apparatus embodying the invention together with means for actuating the same,

Figure 1 being a front view of the most essential parts seen in the direction of the arrow I of Fig. 2. The casing of the apparatus has been omitted. In this figure all the parts are shown in the position of rest with the index pin engaging one of the spaces of the dividing disc.

Fig. 2 is a part sectional elevation of the apparatus.

Fig. 3 shows a portion of Fig. 1 to a larger scale.

Fig. 4 is a view of Fig. 3 seen from above.

Fig. 5 is a front view and shows the individual parts in a position differing from that shown in Fig. 1, that is to say with the index pin withdrawn at the commencement of the dividing operation of the dividing disc.

Fig. 6 is a similar view to Fig. 5 but showing another position of the parts in which the index pin is withdrawn from the dividing disc and the dividing movement has been practically completed.

Fig. 7 is a similar view to Fig. 6 but showing the parts at the end of the dividing movement, the feed pawl being located on the return path.

The index pin has entered the next groove in the disc.

Fig. 8 is a partly diagrammatic view of the control mechanism for actuating the dividing apparatus.

Fig. 9 is a sectional view of the cock serving for the automatic control of the supply and cutting off of the pressure means to and from the dividing apparatus together with the actuating parts therefor, and

Fig. 10 is a longitudinal sectional view of the cock shown in Fig. 9.

On the machine bed 1 (Figs. 2 and 8) is longitudinally movably arranged the table slide 2 on which, in the usual manner, is carried between centres the mandrel 4 for supporting the workpiece 3. One of the centre shafts 5, which engages by means of a carrier device 6 the workpiece mandrel 4, carries the dividing disc 8, the feed disc 10 and the brake surface 11 located between the two discs 8 and 10. The remaining parts are separately mounted. In the example illustrated in the drawings for machines for the grinding of spur pinions with screw-like arranged teeth, a hollow shaft 14, surrounding one of the centre shafts 5, is used for mounting certain parts, which shaft 14 is furnished with a rolling drum 15. To the latter are connected steel bands 16 and 17, which are laid in two directions around the drum 15 and are fastened at their other ends to a slide 18 transversely guided in the table slide 2, and which is actuated in a suitable manner in dependence on the movement of the table slide. If spur pinions with teeth running in the axial direction, thus straight, are to be ground, then the slide 18 is not moved. The casing 20 is non-rotatably connected by the wedge or key member 21 with the hollow shaft 14.

On a pin 22 located in the casing 20 is mounted a lever 24 carrying the index pin 23, and so influenced by a spring 25 that the index pin is normally forced towards the dividing disc 8 and enters one of the spaces 9 thereof. The spring 25 is preferably a compression spring and is supported on a projection or shoulder 26 of the casing 20 and acts against the rearward end of the lever 24, which, for this purpose, is formed with a lateral arm adapted to take the spring pressure. Level with the index pin lever 24 is also mounted on the pin 22 the index control lever 28, which preferably carries a roller which is pressed against the index control cam 32 freely mounted on the hollow shaft 14. The index pin lever 24 and the control lever 28 are adjustable relatively to one another for the purpose of ensuring their correct co-operation with the dividing disc 8 on the one hand and the index control cam 32 on the other hand. For this purpose a stop pin 29 carried in the index control lever 28 and an adjusting screw 30 carried by the index pin lever 24 and directed towards the pin 29 are employed. The index control cam 32 carries on its hub 33 a toothed portion 34 which engages another toothed portion 35, that is to say a rack portion of a double acting piston 36. This piston 36 is guided in a cylinder 37 located in the casing 20. At both ends of the piston 36 are cylinder spaces 38 and 39 to which pressure medium conduits 41 and 42 communicate through the covers 40. Adjacent the index control lever 28 is freely rotatably arranged on the pin 22 a brake lever 44, which is pressed by a spring 45 against the brake surface 11. For the purpose of the correct co-operation of the brake lever 44 with the index pin lever 24, the latter is provided with a carrier pin 46 against which the brake lever 44 bears by means of an adjusting screw 47 arranged laterally thereon. The index control cam 32 carries a carrier pin 50, which engages in an arcuate slot 52 formed in the rotatable feed control cam 53, the slot 52 being so dimensioned that the feed control cam 53 is actuated in unison with the swinging out of the index pin 23 from the dividing disc 8. The actual cam surface of cam 53 is made symmetrically rising and falling on both sides, whereby, regardless of the direction of the working stroke at any time, both the dividing, that is to say feed movement, as well as the return movement of the control members is effected. On the feed control cam 53 bears a roller 55 of a link member 57 swingably carried by means of a pin 56 in the casing 20, which link member 57 is acted on by a tension spring 58. To the pivot pin 59 of the roller 55 is pivoted a second link 60, which carries a pin 62 which projects into an arcuate slot 63 formed in the feed lever 65 and can be adjusted and fixed in this slot as desired by means of a suitable screw, as is necessitated by the size of the feed movement. On one end of the lever 65, which is mounted freely rotatable on the hollow shaft 14, is swingably carried, by means of a pin 66, a feed pawl 67 which is held by means of the tension spring 68 in engagement with the feed disc 10. The centre of the arcuate slot 63 coincides exactly or approximately with the pin 59 and the link members 57 and 60 are both of the same length. By adjusting the second link 60 in the slot 63 of the feed lever 65 the stroke of the latter is controllable. If, for example, the second link 60 lies in a position exactly over the first, then the cam stroke will effect practically no movement of the feed lever 65 as both links swing around a common fixed point of the pin 56. The greater the angle of adjustment enclosed by the two links 57 and 60 is, the greater is the stroke of the feed control lever 65.

The above described mechanism operates in the following manner:

If, in the initial position shown in Figs. 1 to 4, the pressure medium, for example oil, is led through the conduit 42 into the cylinder space 39, the double acting piston 36 commences to move towards the left, whereby, through the medium of the rack 35, the index control cam 32 is swung in the direction of the arrow A indicated in Fig. 1. The index control cam 32 forms a segment of a circle with a raised portion which is made of a definite size, that is to say extends over the middle part of the peripheral surface. On the initial rotation of the index control cam 32 its pin 50 slides in the arcuate slot 52 of the feed control cam 53 and as soon as, on the further rotation of the index control cam 32, the index control lever 28 moves on to the raised portion of the cam 32, the index pin 23 is lifted out of engagement with the dividing disc 8. Directly thereafter, the pin 50 reaches its end position at one end of the slot 52, as shown in Fig. 5. From then on, the feed control cam 53 is moved in the direction of the arrow A (Fig. 5). Consequently, owing to the running of the roller 55 on the cam 53, the link 57 is swung outwardly and the feed lever 65 is drawn in the direction of the arrow B, shown in Figs. 1 and 5, and thus effects, with the aid of the resiliently controlled pawl 67, the rotation of the feed disc 10 and consequently of the dividing disc 8 through the required dividing angle. Fig. 6 shows an intermediate position during the feed movement. At the end of this

feed movement the roller 55 has attained the peak or apex point of the feed control cam 53 and from then on, on the further rotation of this cam 53, with the sliding of the index control lever 28 off the raised portion of the index control cam 32, the index pin 23 is moved into the next space 9 of the dividing disc 8 and immediately thereon the return movement of the feed lever 65 in the direction of the arrow C, Fig. 7, into its initial position is effected by sliding of the roller 55 on the descending portion of the feed control cam 53 located on the other side of the apex point.

If, now, after the pressure in the cylinder part 39 has been removed by supplying the pressure medium to the cylinder part 38, the double acting piston 36 is displaced towards the right, then the index control cam 32 and the feed control cam 53 are swung in the direction of the arrow D, Fig. 7, indicated in dotted lines, and first the index pin 23 is lifted out of the dividing disc 8 and then the feeding of the dividing disc 8, the re-engaging movement of the index pin 23 and finally the return movement of the feed lever 65 and the pawl 67 into their initial position is effected in the same sequence as above, so that the position of the parts shown in Fig. 1 is again obtained.

If the pressure in the cylinder space 38 is then removed and pressure supplied to the cylinder space 39, the first described operation will be repeated.

For the correct timing of the control of the pressure medium the dividing apparatus is, for example, provided with a control mechanism shown in Figs. 8, 9 and 10. It is assumed in this case that a pressure fluid, for example oil, is employed for effecting the reciprocating movement of the table slide 2.

In the machine frame 1 is provided a pressure medium cylinder 70 through which passes a piston rod 73 on which is mounted a piston 75, which rod 73 is carried on the table slide 2 by means of projections 71 and 72. By supplying pressure alternately to one cylinder space 76 or to the other cylinder space 77, the table slide reciprocating movement is produced.

For the operating medium, in the present case oil, a storage container 80 is provided together with a suitable pump, preferably a geared pump 81. The pump 81 sucks through the medium of the conduit 79, and forces the oil through the conduit 82 to the throttle valves 83 and 84 which are adjustable by hand. In the conduit 82 is arranged an overflow valve 78. One of the valves 83 is intended for feeding the device for moving the table slide 2, whilst the other valve 84 serves for the adjustment of the pressure oil supply to the dividing apparatus. Both valve spindles are located adjacent one another and carry pinions 85, 86 which interengage. A slipping clutch is provided in the spindle of the valve 84. As the oil supply for effecting the dividing operation is connected to that for effecting the movement of the table, both working speeds are controlled together and in the same proportion by the common control valve 83. The second valve 84 for controlling the dividing is provided adjacent the table control valve 83 for the purpose of adjusting the dividing speed relatively to the speed of the table slide 2 in the case of particularly large or small workpieces. The two valves 83 and 84 are coupled together through the friction clutch coupling and, in the case a relative adjustment of the two speeds is desired, the friction coupling is adjusted on the second operating knob. A conduit 87 leads from the valve 83 to the control cock 88 for the table slide movement, and the conduits 89 and 90 lead from this cock 88 to the cylinder spaces 76 and 77. For the control of the dividing apparatus a cock 92 secured to the table slide 2 is provided, which cock is fed through the conduit 93 from the valve 84. The cock 92 is provided with a cock plug 95 formed with suitable cut-out portions, which cock plug can be rotated on its shaft through the medium of a pinion 96 and a rack 97. The rack 97 is formed of a vertically displaceable bolt 99 held by a spring 98 in the lower rest position and having a lower bevelled end 100 projecting out of the body of the cock 92. This bolt end 100 which can also, if desired, be provided with a roller, projects into the path of cam pieces 102 and 103 which are arranged longitudinally adjustably on the machine bed 1 and fixable thereon by screws 105. These cam pieces 102 and 103, are, in accordance with the invention, located at positions where, in relation to the position of the table slide 2, it is desired to effect a dividing operation, so that, on the said end 100 striking one or the other of the cam pieces 102 and 103, the change-over of the cock plug 95 is effected in such a manner that the pressure oil is fed alternately through the conduits 41, 42 to the cylinder spaces 38 and 39 of the dividing apparatus. An inward movement of the bolt 99 causes the movement of the cock plug 95 through the amount of one tooth division of the control wheel 112. The pinion 96 is freely mounted on the shaft 108 of the cock plug 95 and is provided with a pawl 110 influenced by a spring 109, which pawl 110 acts on the ratchet wheel 112. The ratchet wheel 112 is fixed on the shaft 108 and consequently on the upward movement of the bolt 99 the cock plug 95 is moved by means of the pawl 110 in the direction of the arrow shown in Fig. 9. So as to be able to control the cock plug 95 also by hand, a hand wheel 113 is fixed on the shaft 108. An outlet pipe 115 is provided in the body of the cock 92 opposite the conduit 93. It will therefore be understood that cock 92 constitutes a four-way valve. The cock plug 95 is provided with opposed circumferential recesses, one of which is shown in Fig. 10. Each recess connects to adjacent ports. In the position shown in Fig. 10, supply conduit 93 is connected to line 42 and cylinder space 39, and line 41 from cylinder space 38 is vented to outlet pipe 115. A ninety degree rotation of plug 95 under actuation of bolt 99 reverses the connections and connects supply conduit 93 to line 41 and cylinder space 38, and vents cylinder space 39 through line 42 to outlet pipe 115. This actuates the piston 36 and causes the mechanism to perform the dividing operation. A further ninety degree rotation interchanges the positions of the recesses, and reestablishes the connections between the conduits that existed originally in the position shown in Fig. 10, effecting another dividing operation. A catching gutter or channel 116 from which a conduit 117 leads to the oil storage container 80 is provided below the conduit 115. This is necessary owing to the movement of the table slide 2, of which movement the cock 92 partakes.

The conduits 41 and 42 are preferably formed of hose pipes, particularly in the case where the whole dividing apparatus is rotated by means of a rolling device when pinions with screw-like running teeth are to be ground.

I claim:

1. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table slide; actuating means for reciprocating the table slide dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof, and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam having a lost-motion connection with said first-mentioned cam; means operating to rotate the first mentioned cam independently of the movement of said table slide; and control means for said last mentioned means operated by said table-slide for initiating operation of said cam-rotating means to effect a dividing operation.

2. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; control mechanism for actuating said index pin; a rotatable cam for operating said index pin control mechanism, said cam having symmetrical rising and falling surfaces whereby said control mechanism is moved in operative direction and returned to its normal inoperative position by movement of said cam in one direction; control mechanism for actuating said dividing disc; a rotatable cam for operating said dividing disc control mechanism, said cam also having symmetrical rising and falling surfaces whereby said control mechanism is moved in operative direction and returned to its normal inoperative position by movement of said cam in one direction; means, operating to rotate said cams independently of movement of said table-slide, and means for reciprocating said table slide and for initiating operation of said cam-rotating means to effect a dividing operation.

3. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; fluid pressure operated actuating means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam being operatively connected to said first-mentioned cam; fluid pressure operated means for actuating said first-mentioned cam independently of operation of the table slide actuating means; a source of fluid pressure supply and means for simultaneously connecting both said fluid pressure operated means to said supply source.

4. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; fluid-pressure operated means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof; and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam having a lost-motion connection with said first-mentioned cam; a cylinder associated with said dividing apparatus; a double-acting piston movable in said cylinder, said piston being operatively connected to said index pin control cam; a source of fluid pressure supply communicating with said table-slide-actuating means and said cylinder to operate said piston therein and control means for controlling the supply of fluid to said cylinder operated by the table slide to initiate supply of fluid, and operative thereafter independently of the table slide to maintain the supply of fluid to said cylinder.

5. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; fluid-pressure operated actuating means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof; a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam having a lost-motion connection with said first-mentioned cam; a cylinder associated with said dividing apparatus; a double-acting piston movable in said cylinder, said piston being operatively connected to said index pin control cam; a source of fluid pressure supply communicating with said table-slide-actuating means and said cylinder to operate said piston therein and control means for controlling the supply of fluid to said cylinder operated by the table slide to initiate supply of fluid and being operative thereafter independently of the table slide to maintain the supply of fluid to said cylinder to complete the dividing operation.

6. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; fluid-pressure operated actuating means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof; a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam having a lost-motion connection with said first-mentioned cam; a cylinder associated with said dividing apparatus; a double-acting piston movable in said cylinder, said piston being operatively connected to said index pin control cam; a source of fluid pressure supply communicating with said table-slide-actuating means and said cylinder to operate said piston therein and control means for controlling the supply of fluid to said cylinder comprising valve means carried by the table slide operative to supply fluid selectively to either end of the cylinder, operating means for said valve means operable to position the valve means to supply fluid and operative thereafter to maintain the valve in said position, and cam actuating means engageable with the valve operating means by movement of the table slide for operating the valve means.

7. In a grinding machine of the kind specified,

the sub-combination of: a reciprocating table-slide; fluid pressure operated means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam being operatively connected to said first-mentioned cam; fluid pressure operated means for actuating said first-mentioned cam; a source of fluid pressure supply and means for simultaneously connecting both said fluid pressure operated means to said supply source, said means comprising a pair of valves, one of said valves controlling the fluid pressure supply to said table-slide and the other controlling the supply to the dividing apparatus and said valves being operatively interconnected such that actuation of said first-mentioned valve causes simultaneous actuation of said other valve.

8. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; fluid pressure operated means for reciprocating said slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a second rotatable cam for actuating said dividing disc, said second cam being operatively connected to said first-mentioned cam; fluid pressure operated means for actuating said first-mentioned cam; a source of fluid pressure supply and means for simultaneously connecting both said fluid pressure operated means to said supply source, said means comprising a pair of valves, one of said valves controlling the fluid pressure supply to said table-slide and the other controlling the supply to the dividing apparatus and said valves being operatively interconnected such that actuation of said first-mentioned valve causes simultaneous actuation of said other valve; and a friction coupling between said valves to allow of regulation of the dividing speed relative to the speed of said table-slide.

9. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; dividing apparatus including a rotatable dividing disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for operating said index pin; a control lever for actuating said dividing disc; a second rotatable cam for operating said lever; means for varying the amount of movement of said lever by said second cam to vary the amount of rotation of said dividing disc; means operating to rotate said cams independently of movement of the table slide, and control means for initiating operation of the last mentioned means operated by the table slide.

10. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; dividing apparatus including a spindle; a rotatable dividing disc mounted on said spindle, said disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam for actuating said index pin; a control lever for actuating said dividing disc, said lever being pivoted on said spindle and having an arcuate slot therein; a second rotatable cam for actuating said control lever; a link member pivoted at one end to a fixed point on said machine; a roller on the other end of said link member; spring means for holding said roller in engagement with said second cam; a second link member pivoted at one end to the roller-carrying end of said first-mentioned link member and engaging said arcuate slot at the other end thereof; means for adjusting and fixing said second link member in any desired position along said slot for the purpose of varying the degree of movement imparted to said lever by said second cam; means operating independently of the movement of said table-slide to rotate said cams, means for reciprocating said table-slide and for initiating operation of said cam-rotating means to effect a dividing operation.

11. In a grinding machine of the kind specified, the sub-combination of: a reciprocating table-slide; dividing apparatus including a spindle; a rotatable dividing disc mounted on said spindle, said disc having a plurality of notches around the periphery thereof and a retractable index pin co-operating with said dividing disc, said pin being adapted to be moved into and out of engagement with the notches in said disc; a rotatable cam arranged centrally on said spindle for actuating said index pin; a control lever for actuating said dividing disc, said lever being pivoted on said spindle and having an arcuate slot therein; a second rotatable cam arranged centrally on said spindle for actuating said control lever; a link member pivoted at one end to a fixed point on said machine; a roller on the other end of said link member; spring means for holding said roller in engagement with said second cam; a second link member pivoted at one end to the roller-carrying end of said first-mentioned link member and engaging said arcuate slot at the other end thereof; means for adjusting and fixing said second link member in any desired position along said slot for the purpose of varying the degree of movement imparted to said lever by said second cam; actuating means, operating independently of the movement of said table-slide to rotate said cams, means for reciprocating said table-slide and control means operated by the table slide for initiating operation of the cam actuating means.

12. In a grinding machine, a reciprocating table slide, actuating means for the table slide, a rotatable spindle, a notched dividing disc and a ratchet ring fixed to the spindle, a retractable index pin engageable with the notches in the dividing disc to lock the disc against rotation, a movable feed pawl engageable with the ratchet ring for rotating said ring, power operated actuating means for effecting the dividing operation, a movable member operated by the power operated actuating means, first cam means carried by the movable member operatively connected to the index pin for retracting the same to permit movement of the dividing disc and for returning the pin for locking the disc, second cam means to move the feed pawl and return the same to rest position for rotating the ratchet ring, and lost motion means connecting the second cam means to the movable member for operation after retraction of the index pin by

the first cam means, said power operated actuating means being operative to actuate the movable member independently of operation of the table slide actuating means.

13. In a grinding machine, a rotatable spindle, a notched dividing disc and a ratchet ring fixed to the spindle, a retractable index pin engageable with the notches in the dividing disc to lock the disc against rotation, a movable feed pawl engageable with the ratchet ring for rotating said ring, power operating actuating means for actuating the pawl and index pin, a movable member operated by the actuating means, first cam means operated by the movable member operatively connected to the index pin for retracting the same to permit movement of the dividing disc and for returning the pin for locking the disc, second cam means operated by said movable member operative to move the pawl and return the same to rest position for rotating the ratchet ring, and adjustable coupling means connecting the second cam means to the pawl for varying the movement of the pawl under operation of the second cam means.

14. In a grinding machine, a rotatable spindle, a notched dividing disc and a ratchet ring fixed to the spindle, a retractable index pin engageable with the notches in the dividing disc to lock the disc against rotation, a movable feed pawl engageable with the ratchet ring for rotating said ring, power operated actuating means for actuating the pawl and index pin, a movable member operated by the actuating means, first cam means operated by the movable member operatively connected to the index pin for retracting the same to permit movement of the dividing disc and for returning the pin for locking the disc, second cam means operative to move the pawl and return the same to rest position for rotating the ratchet ring, lost motion means connecting the second cam means to the movable member for operation after retraction of the index pin by the first cam means, and adjustable coupling means connecting the second cam means to the pawl for varying the movement of the pawl under operation of the second cam means.

FRITZ LAESSKER.