Sept. 5, 1967 G. STADE ET AL 3,339,537

PROFILE GRINDING WHEEL DRESSINC DEVICE

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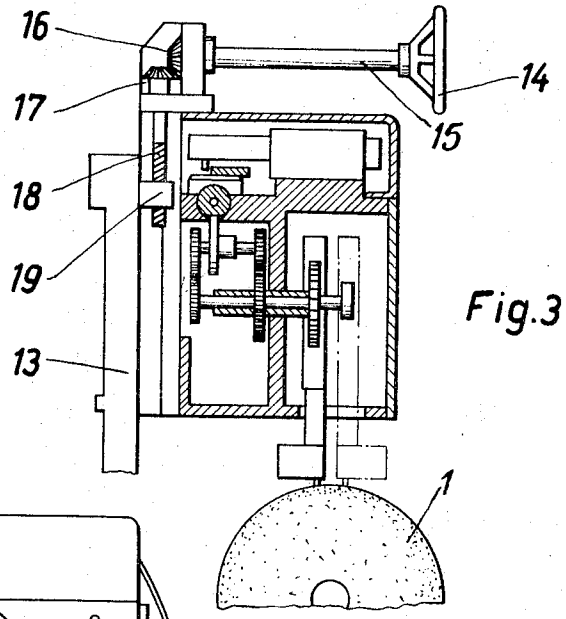

Fig. 3

Fig. 2

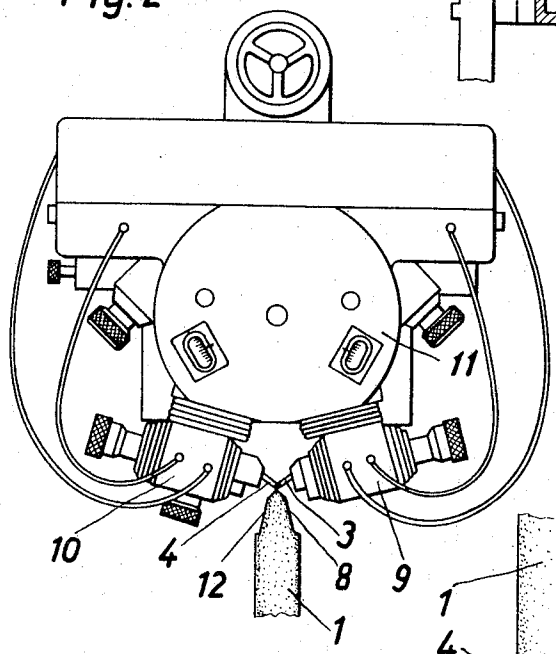

Fig. 1

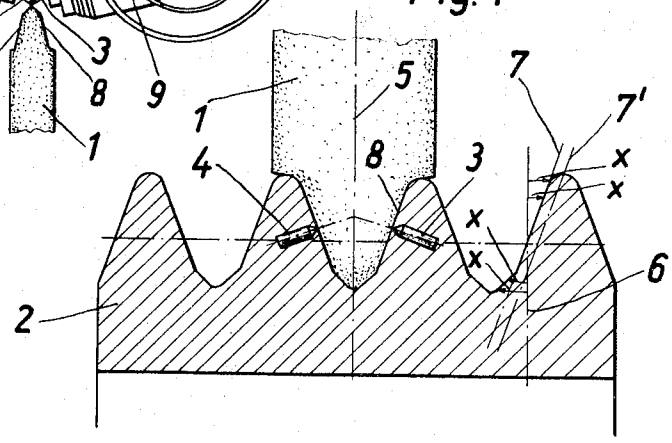

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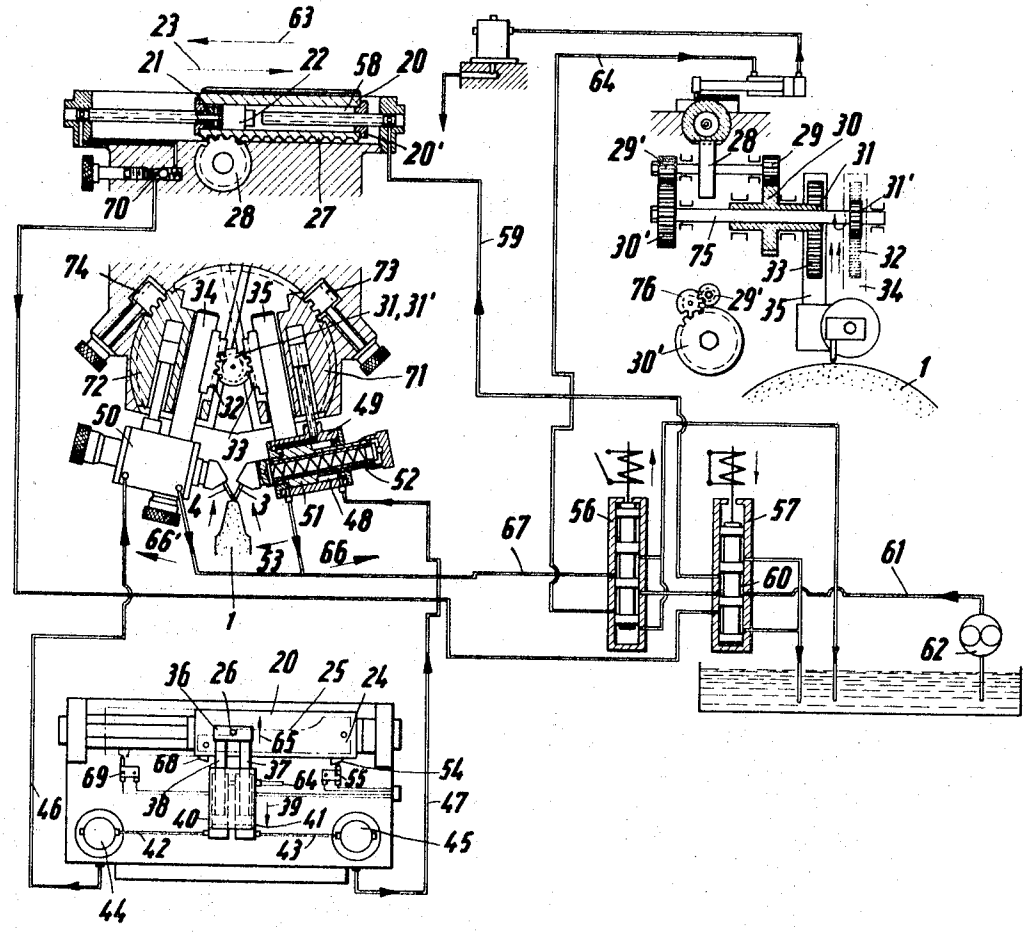
Fig. 4



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PROFILE GRINDING WHEEL DRESSING DEVICE

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13 Claims. (Cl. 125—11)

This invention relates to the dressing or trimming of profile grinding wheels used to impart predetermined contours to mechanical elements such as gears and the like. More particularly, the present invention relates to an improved apparatus for automatically controlled diamond dressing of profile grinding wheels with the reduction of the path of movement of the tracer stylus.

Hitherto, automatically controlled diamond dressing of profile grinding wheels has been effected by transmitting the displacement of a tracer stylus, guided along a template, through the medium of cross slide means on which the tool holder for the diamond tool is mounted. This cross slide means comprises one slide which is movable parallel to the axis of the profile grinding wheel while the other slide is movable perpendicular to the axis thereof. This known method has the disadvantage that the dressing diamond, with respect to the perpendicular frame of reference of the tool slides, must produce sharply curved segments along the profile to be shaped and thus must come into engagement with the grinding wheel at several places along its cutting edge. As a result, radial diamonds must be used and these, due to their shape, are not effective to trim sharp or steep profiles unless their sockets are at least partly ground away. Furthermore, a special swivelling device must be provided in order to be able to maintain the axis of the radial diamond always approximately perpendicular to the profile of the grinding wheel, no matter at which place on such profile the diamond is working. A particularly complicated control means for the dressing diamond is required for this purpose.

An object of the invention is to provide a device for automatically controlling dressing of profile grinding wheels and with which the path of travel of the tracer stylus is substantially reduced.

In accordance with the invention, the dressing diamond is fed parallel to a straight main flank line which is coordinated with the respective profile and which is inclined to the perpendicular on the axis of the thread to be produced, while the flanks of the profile are produced by superposed advance of the tool effected perpendicularly to such main flank line. In this manner, the basic movement of the dressing tool is already approximate, to a substantial degree, to the actual shape of the flank, and therefore additional lateral displacement of the dressing tool or diamond need be effected through only relatively short adjustment paths. The aforementioned main flank line, which is determined geometrically, may be selected for many customary or standard profiles such as, for example, the profiles of grinding wheels for generating roller cutting operations. The selection may be made in a simple manner such that the dressing diamond, during its entire engagement with the grinding wheel along a profile line, is operated only with either an increased or forward feed or without any feed. Thereby, reverse feed movements can be avoided in the majority of cases.

A further object of the invention is to provide a means for automatically controlled dressing of profile grinding wheels in which the grinding wheel profile is produced by two dressing diamonds operating simultaneously on opposite sides of the grinding wheel and staggered in a circumferential direction, with the feed of the dressing diamonds starting from the bottom of the profile and working toward the head thereof.

With such a device, each dressing diamond has to follow only one side of the entire flank of the profile, and therefore can be easily controlled in the sense mentioned above. Correspondingly, the template for controlling the movement of the dressing diamond or diamonds can be of a simple design.

The apparatus in accordance with the invention preferably comprises a rack and pinion means connecting the template with the tool slide, and a hydraulic, static powered transmission system connecting the tracing stylus with the diamond holder, this system always containing a constant volume of hydraulic fluid such as, for example, oil or the like. Thus, the drive for the main feed of the dressing diamond, and the drive for the cross feed thereof, are fully separated and two very simple and strong transmission systems are provided. The rack and pinion means for feeding the tool slide along such predetermined main flank line can have a relatively simple construction if a particular pinion is coordinated with each tool slide, this pinion engaging the respective rack arranged at the tool slide. The two drive pinions are arranged coaxially and one of the pinions is mounted on a hollow or tubular shaft through which the shaft of the other pinion is concentrically telescoped. Both pinions can therefore be turned in opposed directions, and the racks, being arranged opposite each other on the peripheries of the pinions, can thus be displaced in the same direction. By such an arrangement, the simultaneous feeding of two dressing diamonds, one on each side of the wheel to be dressed, can be effected.

In accordance with a further concept of the invention, the racks, which also form the mounting slides for the dressing diamonds, can be arranged for relative angular adjustment in such a manner that they are in engagement with their respective drive pinions at every angular position corresponding to a certain angle of the main flank line. For this purpose, the racks are mounted slidably on worm gear segments, and these worm gear segments can be adjusted conjointly with respect to the required angle of the main flank line by means of suitable worm operators. The axes of the worm gear segments are so arranged that the racks are swiveled about the common axis of their drive pinions so that the racks always remain in engagement with their respective drive pinions.

With the apparatus of the invention, every tool slide can be adjusted exactly relative to a predetermined main flank line. The common hydraulic control of the dressing diamonds working on opposite sides of the shaping wheel is derived from the tracer stylus sliding along the template and in such a manner that the tracer stylus controls two separate hydraulic cylinders, each part a respective separate hydraulic system. The volume of hydraulic fluid in both systems is maintained constant. However, the effective piston cross section areas of the hydraulic cylinder being actuated by the tracer stylus and that of the other cylinder, which is part of the same hydraulic system but which is connected with the holder for the diamond, may differ in size. For example, it may be advantageous to make the section of the piston driving the dressing diamond five times as large as that of the piston connected with the tracer stylus. In such a case, a reduction ratio of 5 to 1, between the displacement of the tracer stylus and the displacement of the diamond, can be achieved. Thus, the template may be magnified five times as respects the profile to be dressed. Such dimensioning of the hydraulic system is particularly advantageous because this reduction assures an exceptionally high accuracy of the dressed grinding wheel profile. Smaller or larger reduction ratios are also possible in accordance with the profile to be dressed, and the reduction ratios

of the movement in the direction of the main flank line and that of the movement in a direction perpendicular to the main flank line may be different.

The driving of the template, in accordance with the invention, can also be effected hydraulically. The template slide is designed as a rack from which the feed movement of the two tool slides can be derived. At the beginning and at the end of the path of movement of the template slide, a hydraulic reversal of the diamond holder is effected by actuation of limit switches by respective stops on the template slide. These limit switches control electromagnetic valves within the hydraulic drive system of the template, and effect the control in such a manner that the valves, for example at the beginning of the trimming operation, supply pressure fluid under pressure to one end of the drive cylinder of the template in the direction of operation, and simultaneously connect the opposite end of the drive cylinder with an outlet conduit having an adjustable throttle.

The supply of fluid pressure medium to the drive pistons of the diamond tool holders, each of which is designed as a double acting piston, is maintained constantly and, in each instance, that side of the piston which faces the respective diamond, has pressure fluid delivered thereto by means of a special pressure fluid pump. That is, this pressure tends to move the diamond tool holder in a direction away from the work. The opposite surface of the piston of the diamond tool holder is subjected to a static hydraulic pressure, such as a closed hydraulic system which can be termed "hydraulic structure or linkage." The control impulses due to movement of the tracing stylus, and transmitted through the hydraulic pistons connected with the tracing stylus, are transmitted to the last-mentioned piston surfaces of each diamond holder with a pressure which is greater than the counter pressure working upon the other face of each piston. This assures a working pressure for each of the dressing diamonds. The drive piston of each tool holder is thus biased in a direction away from the work by the same hydraulic system serving for driving the template and, when the pressure within the static hydraulic system, and transmitting the displacement of the tracing stylus, disappears, each tool holder is displaced in a lifting direction such that the dressing diamond therein is disengaged from the work piece.

In such a case, and as soon as the tracing stylus runs off the profile edge of the template when the dressing diamonds are at the end of an operation, the pressure medium supply to the double acting drive cylinder of the template is reversed by a limit switch operated by the template slide, and this drive cylinder is thus moved reversely to return the template to its starting position. The already lifted diamond, through the medium of its slide connected to the rack of the template by a transmission system, is moved back to its starting position simultaneously with the retraction of the template, and to the bottom of the profile of the grinding wheel to be dressed.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a somewhat schematic sectional view illustrating a cutter reference profile having a certain modulus for a grinding wheel which is to be dressed in accordance with the invention;

FIG. 2 is a front elevation view of apparatus embodying the invention;

FIG. 3 is a side elevation view of the apparatus shown in FIG. 1, with a gear box being shown partly in section; and

FIG. 4 is a composite and partly exploded schematic, elevation, plan, and sectional view of apparatus embodying the invention.

Referring to FIG. 1, a grinding wheel **1**, of which only the grinding profile is illustrated, is designed to produce the cutting profile **2**, and the wear of the grinding wheel due to the grinding operation, and varying with location, is designed to be compensated in a known manner by either constant or intermittent dressing of the grinding wheel by means of dressing diamonds **3** and **4** in such a manner that the grinding wheel is dressed to its true profile. The flanks of the profile of the grinding wheel **1** therefore must be dressed to the greatest accuracy by means of the dressing diamonds **3** and **4**.

If the known template arrangement is used for this purpose, and if the displacement of a tracing stylus engaged with the template is used for controlling the movement of the dressing diamonds shown in FIG. 1, considerably longer working paths x for the dressing diamonds result when operating, in a known manner, with two tool slides, one of which is displaced parallel with the axis of symmetry **5** of the grinding wheel profile and the other of which is displaced perpendicular to such axis of symmetry. For example, in known arrangements, such displacements are made with reference to a displacement axis **6** of the longitudinal slide of the known apparatus rather than, as in accordance with the invention, being effected with respect to a reference line **7** hereinafter called the "main flank line."

From FIG. **1**, it can be seen that a dressing diamond operating, for example, from a base line **7'** parallel to the main flank line **7**, and perpendicular to such base line **7'** relatively to the flank **8** of driving wheel **1**, has only to cut along the flank and with unchanged clearance angle, on only a considerably smaller part of its cutting edge than does the dressing diamond of the rectangular coordinate system in which one slide moves parallel to the axis of symmetry **5**. A criterion for determining the main flank line is that the flank curvatures of the profile to be dressed change as little as possible in relation to the cutting edge of the diamond, as above described.

Referring to FIG. 2, two dressing diamonds **3** and **4** are operatively associated with the grinding wheel, which latter is only partly illustrated. The two diamonds are arranged in such a manner that dressing diamond **3** operates on the flank **8** of the grinding wheel and dressing diamond **4** on the flank **12** of the grinding wheel profile. Both diamonds **3** and **4**, by their respective drive and adjustment devices **9** and **10** connected with gear box **11**, are moved over the entire respective profile flank associated therewith.

The entire apparatus, of which the individual elements will be further explained and described in connection with FIG. 4, may be mounted, for example, in a known guide on an upright or column **13** and the apparatus may be displaced downwards, in the sense of the tool feed, or upwardly in the sense of retraction from grinding wheel **1**, by means of a hand wheel **14** on a spindle **15** which, through bevel gears **16** and **17**, drives a lead screw **18** threaded through a nut **19** secured to column **13**.

Referring to FIG. 4, a template slide **20** is designed with a cylinder space **58** which is closed at its right end by an apertured end member **20'**, and which contains a piston **22** having a pressure medium space **21** to the left thereof as viewed in FIG. 4. As shown, pressure medium tubes or conduits extend slidably through end wall **20'** and through the other end wall adjacent the piston **22**, these pressure medium conduits being fixed at their outer ends. During displacement of the slide in the direction of arrow **23**, template **24** is moved to the right past the tracing stylus **26** which is in engagement with the profile edge **25** of template **24**. This profile edge is magnified or enlarged in accordance with the desired reduction ratio of the reduction gearing which will be described. Tracing stylus **26** is displaced in accordance with the contours of profile **25**.

During advance of template slide **20**, rack **27** which is fixed therewith rotates a pinion **28** which, through pinion **29** and spur gear **30**, drives a pinion **31** engaged with

a rack 33. The interconnection between spur gear 30 and pinion 31 is designed as a tubular shaft concentrically or coaxially receiving a shaft or axle 75. A pinion 31' engaged with a second rack 32 facing oppositely to rack 33 is driven from gear wheel 28 through pinion 29' and spur gear 30', the latter being secured to shaft 75 as is also the pinion 31'. Due to the coaxial shaft 75 and tubular shaft interconnecting the elements 30 and 31, pinions 31 and 31' can be rotated, about a common axis, in opposite directions, so that racks 32 and 33, which are in opposition to each other, can be moved in the same direction. Such movement of racks 32 and 33 in the same direction may be effected, for example, by means of an intermediate pinion 76 interengaged between pinion 29' and spur gear 30'. In accordance with the invention, the gearing 29–30' can be made interchangeable so as to change the reduction ratio as desired.

In FIG. 4, tool slides 34 and 35 are shown in their uppermost position which they occupy at the end of a trimming operation, and stylus 26 is illustrated as at the left or termination end of profile edge 25 of template 24. During advance of template 24, pistons 37 and 38, interconnected by a cross head 36, are conjointly displaced in the direction of an arrow 39, thereby displacing the fluid pressure medium in cylinders 40 and 41. This pressure fluid medium is also in communication with the cylinder space 48 of tool holder 49 (9) for dressing diamond 3 and the corresponding space of tool holder 50 (10 for diamond 4. Such intercommunication is provided by the conduits 42 and 43, the compensating cylinders 44 and 45, and the conduits 46 and 47.

The displaceable portion 52 of tool holder 49 (9), which carries diamond 3 and which is connected with piston 51, is therefore displaced in the direction of arrow 53, and a similar displacement takes place with respect to the displacement portion of the tool holder 50 (10) for diamond 4. Inasmuch as both hydraulic transmission systems have a constant volume of pressure fluid medium between cylinders 40 and 41 and the cylinder spaces such as 48, diamonds 3 and 4 follow every displacemment of stylus 26 with the greatest accuracy. Furthermore, since the effective surface of piston 51, as illustrated in FIG. 4, is five times as large as that of piston 37, each displacement of stylus 26 is reduced by a factor of five when transmitted to dressing diamonds 3 and 4.

Hydraulic control of the start and finish of the operation, in accordance with a further feature of the invention, is effected in the following manner. During the dressing operation, a right-hand stop 54 on template slide 20 actuates a limit switch 55 which, through circuits which are not shown in the drawing, reverses the position of two electromagnetic valves 56 and 57 in such a manner that the left cylinder space 21 within template slide 50 is connected to a pump 62 for the fluid pressure medium through a throttle valve 70, the electromagnetic valve 57, and a conduit 61. Therefore, template slide 20 returns in the direction of arrow 63 and, furthermore, stylus 26, due to the dual pistons 37, 38 having lost the pressure of conduit 64, is disengaged or retracted from profile edge 25 of template 24 in the direction of arrow 65. The pistons, such as 51, of tool holders 49 and 50 are displaced in the direction of arrow 66 (66'), and thus diamonds 3 and 4 are retracted from the work to be dressed. The pressure in cylinder space 48, due to the retraction of stylus 26 from profile edge 25 and template 24, is now less than the counter-pressure.

Correspondingly, the reversing of the system to commence the next trimming operation is effected by means of a left-hand stop 68, on slide 20, operating a limit switch 69. Due to the further reversal of the positions of the electromagnetic valves, the dual pistons of stylus 26 are subjected to the pressure of the fluid pressure medium through conduit 64, and this pressure fluid medium presses stylus 26 to engage template 24. At the same time, diamond 3 is pressed, through piston 51 and conduit 47, in the direction of arrow 53 to engage the grinding wheel in accordance with the particular profile of template 24. The counter pressure on piston 51 is maintained through conduit 67 in order to provide the required accuracy for the system through back pressure bias.

At this time, the pressure acting on the dual pistons and stylus 26 is greater than the back bias pressure acting on piston 51 through conduit 67. Cylinder space 58, after the aforementioned reversal of valves 56 and 57, and through conduit 59, valve space 60, and conduit 61, is subjected to the pressure of pump 62. Template slide 20 is then displaced in the direction of the arrow 23 or in the operating direction. By means of throttle valve 70, it is possible, in a simple manner, to adjust the rate of oil flow out of cylinder space 21 and thereby control the timing of the operation as desired.

The inclination of the tool slides 34 and 35 may be adjusted to determine the starting line for the hydraulically effected displacement movements of dressing diamonds 3 and 4, and this inclination is predetermined in correspondence with the main flank line as earlier defined. Such inclination adjustment is effected by means of two worm gear segments 71 and 72 and worms 73 and 74, respectively, engaged therewith. Worm gear segments 71 and 72 are coaxial with the common axis of pinions 31 and 31' at any angular position. Thus, racks 32 and 33 are in engagement with the pinions 31 and 31' in all angular positions of the longitudinal axes of tool slides 34 and 35. Thereby, a perfect drive of tool slides 34 and 35 from rack 27 of template slide 20 is assured.

In the position of the hydraulic system shown in FIG. 4, the working stroke corresponds to template slide 20 moving in the direction of arrow 23. A reversal of direction, as indicated by arrow 63, has not yet been effected. The direction of flow of the fluid pressure medium is shown by the several arrows in the interconnecting conduits.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a tool holder slidably supported in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide spaced from said tool slide and arranged to have templates interchangeably secured thereon; a stylus cooperable with a profiled edge of a template on said template slide; mechanical transmission means interconnecting said tool slide and said template slide for coordinated movement; and a hydraulic fluid-filled line directly interconnecting said stylus and said tool holder for coordinated movement of said stylus and said tool holder.

2. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a tool holder slidably supported in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a stylus cooperable with a profiled edge of a template on said template slide; mechanical transmission means interconnecting said tool slide and said template slide for coordinated movement; a hydraulic transmission means interconnecting said stylus and said tool holder for coordinated movement of said stylus and said tool holder; said hydraulic transmission means being a static power transmission system having a constant volume of fluid pressure medium therein; and means maintaining a constant back pressure on

said tool holder resisting movement thereof by said stylus through said static power transmission system.

3. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a longitudinally displaceable tool holder slidably mounted in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a displaceable stylus cooperable with a profiled edge of a template secured on said template slide; rack and pinion means mechanically interconnecting said tool slide and said template slide for conjoint longitudinal displacement, said rack and pinion transmission means including speed reduction means; and hydraulic transmission means interconnecting said stylus and said tool holder for conjoint displacement of said tool holder in accordance with the displacement of said stylus.

4. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a longitudinally displaceable tool holder slidably mounted in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a displaceable stylus cooperable with a profiled edge of a template secured on said template slide; rack and pinion means mechanically interconnecting said tool slide and said template slide for conjoint longitudinal displacement, said rack and pinion transmission means including speed reduction means; and hydraulic transmission means interconnecting said stylus and said tool holder for conjoint displacement of said tool holder in accordance with the displacement of said stylus; said hydraulic transmission means providing a relative reduction of displacement of said tool holder with respect to said stylus.

5. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a longitudinally displaceable tool holder slidably mounted in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a displaceable stylus cooperable with a profiled edge of a template secured on said template slide; rack and pinion means mechanically interconnecting said tool slide and said template slide for conjoint longitudinal displacement, said rack and pinion transmission means including speed reduction means; and hydraulic transmission means interconnecting said stylus and said tool holder for conjoint displacement of said tool holder in accordance with the displacement of said stylus; said hydraulic transmission means providing a relative reduction of displacement of said tool holder with respect to said stylus; the reduction ratio of said rack and pinion mechanical transmission differing from the reduction ratio of said hydraulic transmission means.

6. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a longitudinally displaceable tool holder slidably mounted in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a displaceable stylus cooperable with the profiled edge of a template secured on said template slide; rack and pinion transmission means mechanically interconnecting said tool slide and said template slide for conjoint longitudinal displacement, said rack and pinion transmission means including speed reduction means; and hydraulic transmission means interconnecting said stylus and said tool holder for conjoint displacement of said tool holder in accordance with the displacement of said stylus; said hydraulic transmission means providing a relative reduction of displacement of said tool holder with respect to said stylus; the reduction ratio of said rack and pinion transmission means differing from the reduction ratio of said hydraulic transmission means; said rack and pinion transmission means including interchangeable gear components whereby the speed reduction thereof can be preselected as desired.

7. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a pair of longitudinally displaceable tool slides each associated with a respective dressing diamond, with the diamonds operating on respective opposite flanks of the grinding wheel; a pair of racks, each secured to a respective tool slide; a pair of coaxial pinions, each engaged with a respective rack; a longitudinally displaceable template slide arranged to have templates interchangeably mounted thereon; reduction gearing interconnecting said template slide and said pinions for conjoint operation of said tool slides in accordance with displacement of said template slide, said reduction gearing rotating said coaxial pinions in opposed directions; means mounting said tool slides for angular adjustment about the common axis of said coaxial pinions for adjustment of the direction of displacement of said tool slides; a pair of tool holders, each mounted in a tool slide for longitudinal displacement in a direction substantially perpendicular to the direction of displacement of the associated tool slide; a stylus engageable with a profiled edge of a template mounted on said template slide; and means interconnecting said stylus and said tool holders for conjoint displacement of said tool holders in accordance with displacement of said stylus along said profiled template edge.

8. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a pair of longitudinally displaceable tool slides each associated with a respective dressing diamond, with the diamonds operating on respctive opposite flanks of the grinding wheel; a pair of racks, each secured to a respective tool slide; a pair of coaxial pinions, each engaged with a respective rack; a longitudinally displaceable template slide arranged to have templates interchangeably mounted thereon; reduction gearing interconnecting said template slide and said pinions for conjoint operation of said tool slides in accordance with displacement of said template slide, said reduction gearing rotating said coaxial pinions in opposed directions; means mounting said tool slides for angular adjustment about the common axis of said coaxial pinions for adjustment of the direction of displacement of said tool slides; a pair of tool holders, each mounted in a tool slide for longitudinal displacement in a direction substantially perpendicular to the direction of displacement of the associated tool slide; a stylus engageable with a profiled edge of a template mounted on said template slide; and a hydraulic transmission system interconnecting said stylus and said two tool holders for conjoint displacement of said tool holders in correspondence with the displacement of said stylus by said profiled template edge.

9. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a pair of longitudinally displaceable tool slides each associated with a respective dressing diamond, with the diamonds operating on respective opposite flanks of the grinding wheel; a pair of racks, each secured to a respective tool slide; a pair of coaxial pinions, each engaged with a respective rack; a longitudinally displaceable template slide arranged to have templates interchangeably mounted thereon; reduction gearing interconnecting said template slide and said pinions for conjoint operation of said tool slides in accordance with displacement of said template slide; said reduction gearing rotating said coaxial pinions in opposed directions; means mounting said

tool slides for angular adjustment about the common axis of said coaxial pinions for adjustment of the direction of displacement of said tool slides; a pair of tool holders, each mounted in a tool slide for longitudinal displacement in a direction substantially perpendicular to the direction of displacement of the associated tool slide; a stylus engageable wth a profiled edge of a template mounted on said template slide; and means interconnecting said stylus and said tool holders for conjoint displacement of said tool holders in accordance with displacement of said stylus along said profiled template edge, said means mounting said tool slides for angular displacement comprising a pair of worm gear segments angularly displaceable about said common axis of said coaxial pinions, and a pair of worms, each meshing with a respective worm gear segment, operable to independently adjust the relative angular orientation of the associated tool slide.

10. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a pair of longitudinally displaceable tool slides each associated with a respective one of a pair of dressing diamonds, each diamond being operatively associated with a respective opposite flank of the grinding wheel to be dressed; a pair of tool holders each slidably mounted in a tool slide for longitudinal displacement in a direction perpendicular to the direction of longitudinal displacement of the associated tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably supported thereon; transmission means interconnecting said template slide and said tool slides for conjoint displacement of said tool slides in accordance with longitudinal displacement of said template slide; a stylus arranged to engage the profiled edge of a template mounted on said template slide; a pair of first fluid pressure actuators each including a displaceable member, said displaceable members being rigidly interconnected and connected to said stylus for movement with said stylus; a pair of second fluid pressure actuators each associated with a respective tool holder to effect longitudinal displacement thereof; and separate hydraulic transmission systems each interconnecting a respective first hydraulic actuator to a respective second hydraulic actuator.

11. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a tool holder slidably supported in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a stylus cooperable with a profiled edge of a template on said template slide; mechanical transmission means interconnecting said tool slide and said template slide for coordinated movement; a hydraulic actuator for displacing said template slide in a tool feeding direction; hydraulic actuator means maintaining said stylus engaged with said profiled template edge; means operable to adjust the rate of displacement of said template slide by said hydraulic actuator; and a hydraulic fluid-filled line directly interconnecting said stylus and said tool holder for coordinated movement of said stylus and said tool holder.

12. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a tool holder slidably supported in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a stylus cooperable with a profiled edge of a template on said template slide; mechanical transmission means interconnecting said tool slide and said template slide for coordinated movement; a hydraulic actuator for displacing said template slide in a tool feeding direction; hydraulic actuator means maintaining said stylus engaged with said profiled template edge; a hydraulic transmission system for said actuator and said actuator means, said hydraulic transmission system maintaining a positive pressure for one direction of operation of said hydraulic actuator and said hydraulic actuator means; and means maintaining a constant back bias pressure opposing said positive pressure; said hydraulic transmission system including a hydraulic fluid-filled line directly interconnecting said stylus and said tool holder for coordinated movement of said stylus and said tool holder.

13. Apparatus for automatically controlled dressing of profile grinding wheels by dressing diamonds comprising, in combination, a longitudinally displaceable tool slide; a tool holder slidably supported in said tool slide for displacement in a direction perpendicular to the direction of displacement of said tool slide; a longitudinally displaceable template slide arranged to have templates interchangeably secured thereon; a stylus cooperable with a profiled edge of a template on said template slide; mechanical transmission means interconnecting said tool slide and said template slide for coordinated movement; a hydraulic actuator for displacing said template slide in a tool feeding direction; hydraulic actuator means maintaining said stylus engaged with said profiled template edge; a hydraulic transmission system for said actuator and said actuator means, said hydraulic transmission system maintaining a positive pressure for one direction of operation of said hydraulic actuator and said hydraulic actuator means and a constant back bias pressure opposing said positive pressure; electromagnetically operated valves controlling application of said positive pressure to said hydraulic actuator and said hydraulic actuator means; switch means operable to reverse the positions of said electromagnetically operated valves; and stop means on said template slide effective to operate a respective one of said switch means at each limit of displacement of said template slide.

References Cited

UNITED STATES PATENTS

2,248,463	7/1941	Ott	125—11
2,602,437	7/1952	Tancred	125—11
3,067,733	12/1962	Pernack	125—11

FOREIGN PATENTS

240,933	10/1925	Great Britain.
397,718	8/1933	Great Britain.
806,629	12/1958	Great Britain.

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