March 4, 1969 G. GABRIELLI 3,430,388

AUTOMATIC OR SEMI-AUTOMATIC MULTI-SPINDLE GRINDER FOR DIESEL ENGINE FUEL NOZZLES

Filed Feb. 8, 1966 Sheet 1 of 3

Fig. 2

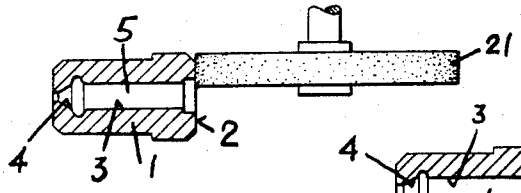


Fig. 3

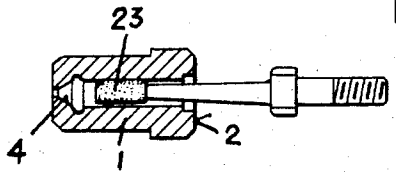
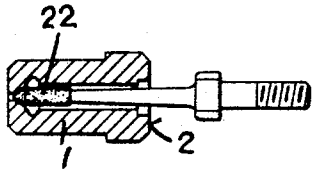


Fig. 4



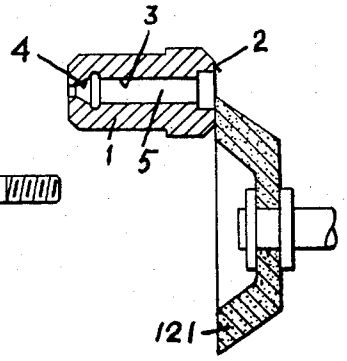


Fig. 5

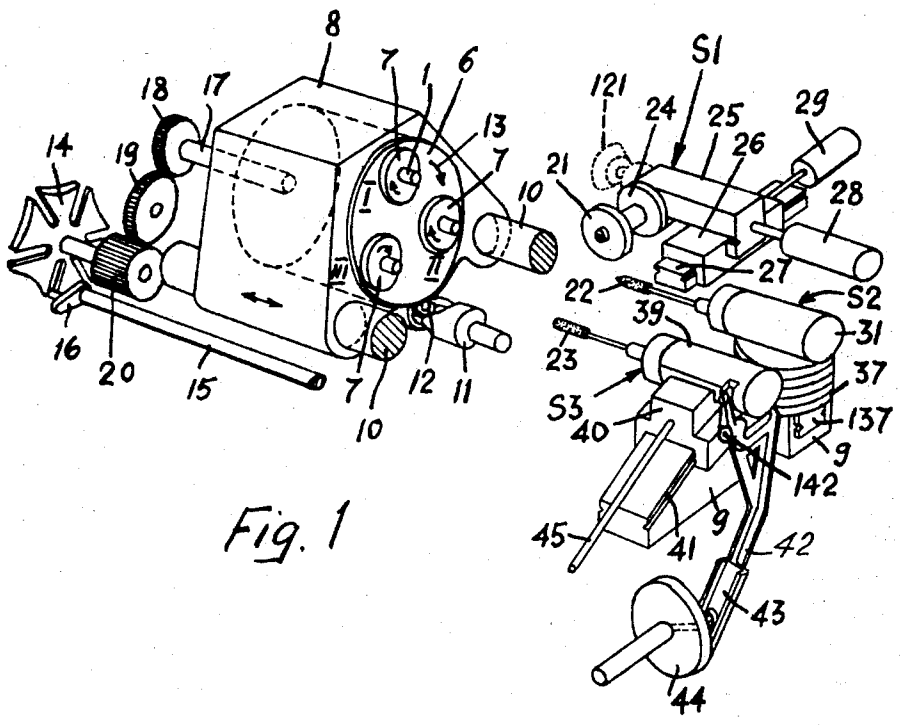


Fig. 1

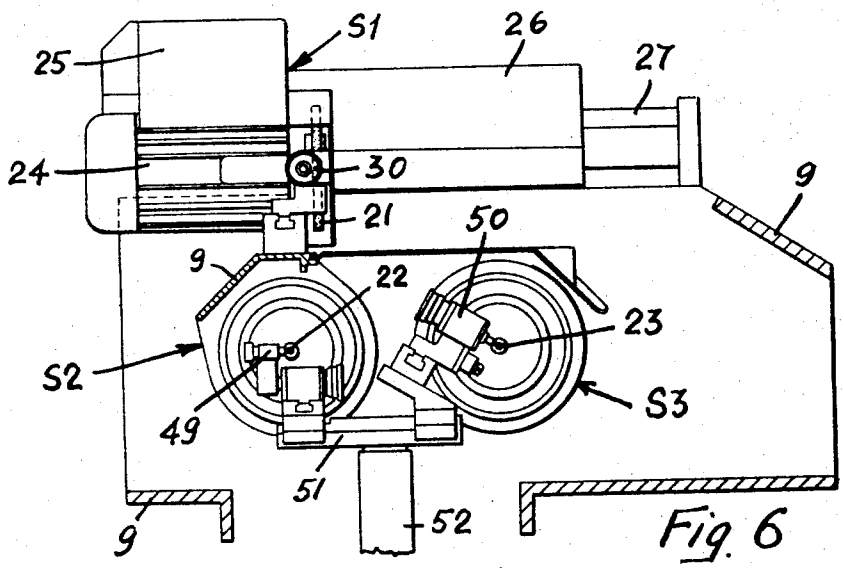

S1
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27
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24
30
21
50
9
22
23
S2
S3
49
51
52

Fig. 6

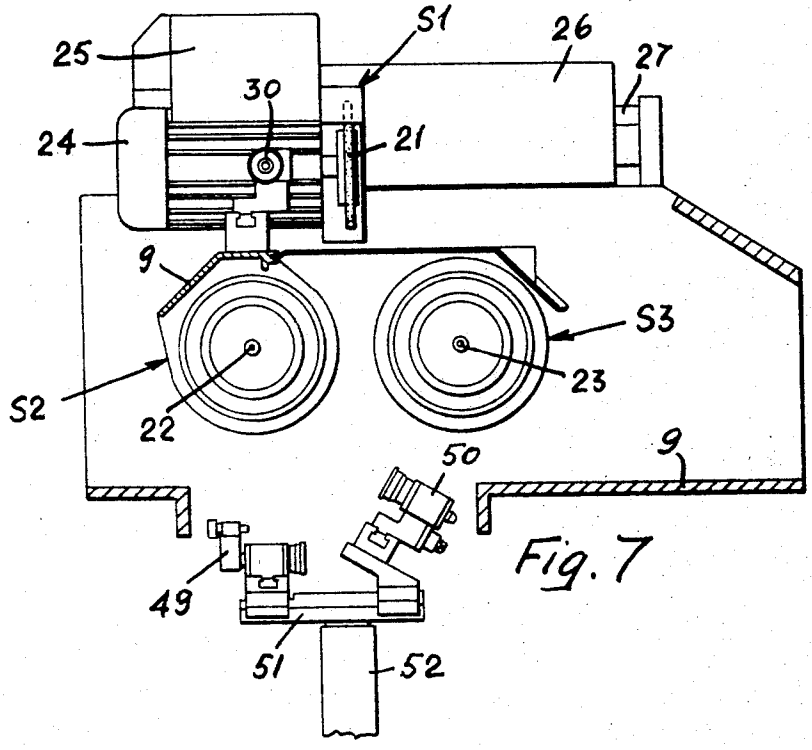

S1
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21
9
S3
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S2
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49
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Fig. 7

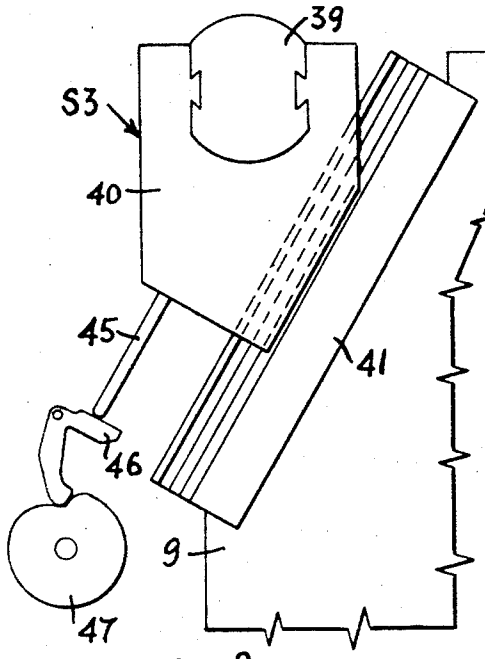


Fig. 8

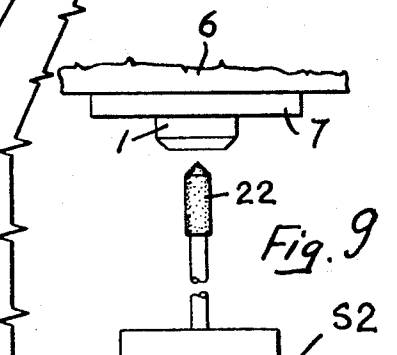
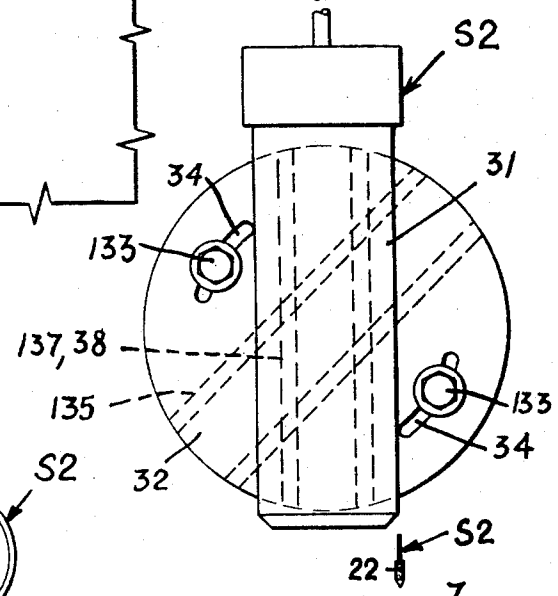


Fig. 9



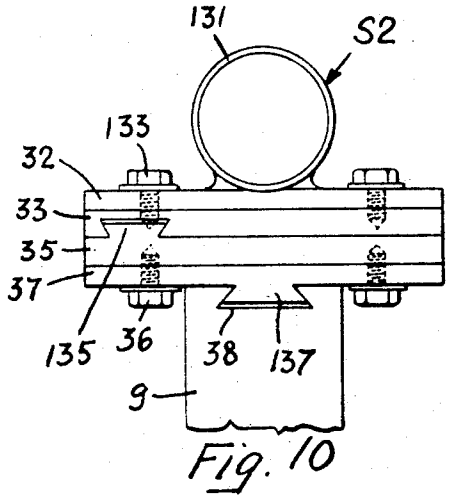


Fig. 10

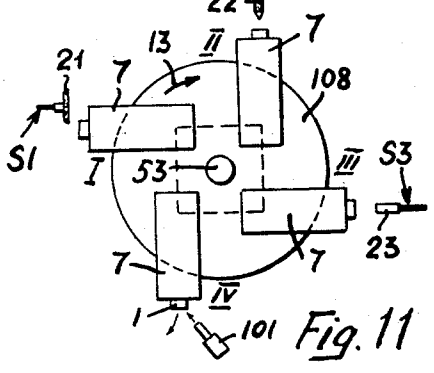


Fig. 11

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AUTOMATIC OR SEMI-AUTOMATIC MULTI-SPINDLE GRINDER FOR DIESEL ENGINE FUEL NOZZLES

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U.S. Cl. 51—3 7 Claims
Int. Cl. B24b 5/12

ABSTRACT OF THE DISCLOSURE

A multi-spindle grinding machine for diesel fuel nozzles in which a slidable drum-supporting member is axially reciprocated and rotated stepwise to carry therewith a plurality of work spindles which successively pass through three working stations. A grinding device is mounted in correspondence with each work spindle at each working station to effect successive grinding operations of the nozzles carried by the spindles while permitting removal of a finished nozzle.

The invention relates to an automatic or semi-automatic multi-spindle grinder for diesel engine fuel nozzles.

It is known that in the manufacture of diesel engine fuel nozzles it is necessary to grind the rear flat surface, the interior of the cylindrical needle guide surface and the interior of the conical needle seat. For this purpose multi-spindle grinders are known which grind only the interior or the cylindrical needle guide surface and the interior of the conical seat of said needle valve. On the contrary, the grinding of the rear flat end surface of the nozzle must be ground upon a separate grinding machine so that, presently, for the complete grinding of fuel nozzles it was necessary to employ two separate grinders, which entailed a double chucking and removal of the piece and considerable time losses.

The invention aims first to overcome these drawbacks by providing an automatic or semi-automatic multi-spindle grinding machine for diesel engine fuel nozzles which comprises a stepwise rotatable supporting member provided with at least three workpiece spindles and advancing stepwise so as to cause said spindles to pass through three subsequent working stations (in correspondence of each of which a grinder is arranged viz.) in correspondence of one of said working stations an external grinder device is mounted for flattening the end of the nozzles; in correspondence of another station an internal grinder device is provided for grinding the conical needle seat of the nozzle and a third grinder for the internal grinding of the cylindrical needle-guiding surface, in correspondence of a third station.

By this embodiment of nozzle grinder, each fuel nozzle, after it has been chucked to a single working spindle, is subjected, in a single working cycle of the grinder, i.e. by passing twice through three working stations, to a complete grinding both of the cylindrical and conical internal surfaces and of the outer flat surface.

It is also possible to provide a four-spindle supporting member, effecting a four-step cycle, three stations being employed for the working of the pieces and the fourth station for the removal of the finished nozzles and the mounting of a new nozzle to be ground.

However the preferred embodiment of the invention, is such that at the working station at which the flattening of one of the nozzle ends is effected, also the removal of the finished nozzles and the chucking of the nozzles to be ground are effected. For this purpose, the flat end grinding wheel is mounted so as to be withdrawn from a working position to a rest position, clear of the nozzles.

This particularly simple embodiment of the invention is rendered possible by the fact that the flat end grinding requires less time than the grinding of the internal cylindrical and conical surfaces.

The supporting member for the workpiece spindles may be in form of a drum which is provided with three axially parallel chuck members arranged in a circle at 120° interval from one another and projecting from the front end of the spindle drum. In this embodiment, the two internal grinders and the outer flat grinder are arranged in front of this end of said drum, which is mounted on a supporting member which is rotatably mounted parallel to the spindle axes and is slidably mounted for movement away and towards the grinding devices. In this case the dressing devices of the two internal grinders are mounted for transverse displacement relative to the axis of the spindle drum, while the dressing means of the external flat grinder is mounted so as to operate when said grinder is in withdrawn position.

A method which is particularly adapted for the operation of said three-spindle diesel fuel nozzle grinder consists in advancing and then withdrawing the spindle drum supporting means twice during each working cycle of the machine. By this arrangement and method of operation, after the first advancing movement of the drum, the rough grinding of the internal surfaces and the complete grinding of the nozzle end are effected, and afterwards, after the first withdrawal of the drum supporting means, the grinding pins of the internal surfaces of the nozzles are dressed while the flat-grinding wheel is removed from its working position to its rest or sizing position. Thereafter, after the second advancing movement of the drum-supporting member the fine grinding of the inside surface is effected while in correspondence of the station where the flat grinder is mounted, the finished nozzle is removed and a new nozzle is mounted. After the second withdrawal of the said drum, said drum is advanced by a further step and the front surface grinder is driven to working position.

Further characteristic features and advantages will be apparent from the following specification of a preferred embodiment of the invention, which has been shown by way of example in the accompanying drawings, in which:

FIGURE 1 shows in an exploded perspective view the essential parts of a three-spindle diesel fuel nozzle-grinding machine;

FIGURES 2, 3 and 4 show in axial section through said nozzles the single end grinding and the two internal grinding operations which are effected successively on a nozzle;

FIGURE 5 shows a variation of the end-grinding operation of a nozzle;

FIGURES 6 and 7 show in front view the three grinding devices of the machine in dressing and in working position, respectively;

FIGURE 8 is a view of the internal grinder of the hollow cylindrical nozzle surface;

FIGURES 9 and 10 show in plan view and in rear elevation the internal grinder of the nozzle valve seat.

FIGURE 11 shows diagrammatically in plan view another embodiment of a multi-spindle grinder.

In the manufacture of diesel nozzles, such as that shown by way of example in FIGURES 2 through 5, the following grinding operations must be effected: Outside upon the flat rear nozzle end **2**, and inside within the cylindrical bore **5**, serving as needle valve guide and within the conical valve seat **4** at the nozzle end.

This triple grinding of the said three nozzle surfaces may be effected according to the invention simultaneously on three different nozzles by employing the automatic or semi-automatic multi-spindle grinding machine as diagrammatically shown in FIGURE 1. This machine comprises a substantially horizontal drum **6** which carried the three workpiece spindles **7** which project parallel to each other with their workpiece chucking ends beyond the front drum end and are rotated by an electric motor mounted within the same drum, which carries also the control devices of the workpiece-chucking means. The spindle **7** are arranged on drum **8** in a circle at 120° intervals.

Drum **6** is rotatably mounted in a supporting member **8** which is slidably mounted for movement in both directions upon horizontal guide members **10** fastened to the machine frame **9**. The reciprocation of the drum-supporting member **8** may be controlled by means of a cam groove formed in a cylindrical piece **11** and in which a cam roller **12** mounted upon the drum supporting member **8** is engaged. Thus by rotation of piece **11**, the supporting member **8** is driven in reciprocation.

Drum **6** is driven stepwise in its supporting member **8** in the direction of arrow **13**, so that each spindle **7** accomplishes a complete revolution during a complete machine cycle, by passing through three working stations I, II and III, in each of which it stops for a predetermined time. The stepwise movement is effected by driving a Geneva wheel **14** by a pawl **16**. On the shaft of wheel **4** is a long cylindrical gear **20** which meshes with a gear **19** which in turn meshes with gear **18** fastened to drum shaft **17**, the arrangement being such as to permit a reciprocation of drum **6**, while gears **18**, **19** and **20** are always in mesh.

Facing the front end of drum **6**, are three grinding devices or grinders S1, S2, S3 each mounted to correspond with a working station I, II or III, respectively. The grinder S1 in front of station I is a flat surface grinder for the end surface **2** of nozzles **1**. The grinding wheel of grinder **1** may be either disc-shaped, as shown at **21**, FIG. 1 or cup-shaped, as shown at **121**, FIG. 5. Grinding wheel **21** or **121**, together with their motor and gear unit **24** are mounted upon cross slides **25**, **26**. Lower slide **26** is slidable upon substantially horizontal guides **27** fastened to the machine frame **9**. Upper slide **25**, upon which the grinding wheel and the corresponding driving means **24** are mounted is slidable upon lower slide **26** parallel to the axes of workpiece spindles **7**. The sliding of slides **25**, **26** may be controlled by suitable means, such as hydraulic cylinders **28** and **29**.

By shifting the lower slide **26**, the grinding wheel of the flat grinder S1 may be brought into a working position, in the direction of the drum axis, as shown in FIGURE 7 and into a dressing position, as shown in FIGURE 6, in which the grinding wheel is shifted sidewise outwardly. When the grinder S1 is in working position, the flat end **2** of the nozzles is ground. Said nozzles are carried by spindle **7** in working station I.

When on the contrary, the grinding wheel is shifted sidewise outwardly, it can be brought into contact with a dressing device **30** mounted on said machine frame, as shown in FIGURE 6. The movement of grinding wheel **21** or **121** in the direction of the workpiece is effected by shifting upper slide **25** parallel to the axis of spindle **7**.

The grinding device S2 arranged in correspondence of the working station II serves for grinding the conical needle valve seat **4** of the diesel nozzle **1** and is provided with a tapered grinding pin **22** which lies substantially co-axially to spindle **7** at station II and to nozzle **1** chucked thereon. Grinding pin **22** is mounted together with its motor and gear unit **31** upon a horizontal disc **32** which is mounted so as to be angularly shiftable upon an upper intermediate disc **33** to which it is adjustably fastened by means of fastening screws **133** passed through slots **34** in the form of arcs of circle, as particularly shown in FIGURES 9 and 10. The upper intermediate disc **33** is slidably mounted upon a guide member **135** formed upon a lower intermediate disc **35** which is fastened by means of screws **36** passed through arc-shaped slots upon a bottom disc **37** the whole being so arranged as to permit limited angular movements. Disc **37** is provided with a dovetail key member **137** slidable in a dovetail slot **38** provided in the machine frame member **9**. Guide member **135** extends parallel to the axis of grinding pin **22** and to the axis of the conical needle valve **4** of nozzle **1** fastened onto spindle **7** at working station II. The feed movement of grinding pin **22** during the grinding of needle valve seat **4** of nozzle **1** is effected by shifting the grinding unit **22**, **31** together with discs **32**, **33** upon slide guide **135** of the lower intermediate disc **35**. Slide guide **137**, **38** upon frame **9** is directed, on the contrary, parallel to the axis of grinding pin **22**.

The shifting of grinding unit **22**, **31** together with all discs **32**, **33**, **35** and **37** upon slide guide **38** of frame **9** serves for bringing grinding pin **22** to an operative grinding position.

The shifting upon guides **135** and **38**, respectively, may be controlled by any suitable conventional means such as hydraulic cylinders, cam control devices or the like.

The grinding device S3 at station III serves for grinding the cylindrical needle valve guide **3** of nozzle **1**, and is provided with a cylindrical grinding pin **23** mounted coaxially of spindle **7** at station III and of nozzle **1** chucked thereon. Grinding pin **23** is provided with a driving unit **39** and is mounted together therewith for slidable movement in a transverse slide **40**, as shown particularly in FIGURES 1 and 8. Slide **40** is slidable in a slide guide **41** fastened to the machine frame **9** and directed perpendicularly to the hollow cylindrical needle valve guide **3** of nozzle **1**.

The shifting of the grinding unit **23**, **39** upon the transverse slide **40**, parallel to the axis of said unit serves as a feed movement for the grinding pin **23**, when the same is dressed and/or during the working of the hollow cylindrical guide **3** of the needle valve of nozzle **1**. The shifting of the transverse slide **40** upon the slide guide **41** provides on the contrary the feed movement of the grinding pin **23** during the grinding of said hollow cylindrical guide **3**.

Also in this case, the control of the sliding movements of grinding unit **23**, **39** upon transverse slide **40** and of the said slide **40** upon slide guide **41** can be performed by means of any suitable conventional control and driving means. In the embodiment as shown, the rear end of the grinding unit **39** is engaged by the upper arm of a double-arm swinging lever **42** pivotally mounted at **142** upon transverse slide **40**. The lower arm of lever **42** is provided with a longitudinal slot **43** in which is engaged the crank pin of crank disc **44**, which, by revolving of said pin causes the swinging of lever **42** and the axially parallel shifting of grinding unit **53** upon slide **40**. Slide guide **41** of transverse slide **40** is inclined with respect to the horizontal plane so as to remain substantially parallel to the connecting line between the axes of the workpiece spindles lying at stations I and III respectively. In the example as shown, the inclination of slide guide **41** amounts to about 60°. Thus slide **40** tends to slide downwardly by gravity along guide **41** and to push by means of push rod **45** an arm of a swinging angle lever **46**, as particularly shown in FIGURE 8. The other arm of said lever **46** bears against a cam disc **47**. Thus by rotating said cam

disc 47, slide 40 is either shifted upwardly along slide 41 by cam action, or slides downwardly by gravity. In this manner a reliable forward and rearward movement of grinding pin 23 is attained.

The internal grinding devices S2, S3 are provided with dressing devices 49, 50, which are arranged below the corresponding grinding pins 22, 23 upon a common supporting member 51 which can be lifted and lowered by means of a hydraulic piston rod 52, as particularly shown in FIGURES 6 and 7. Thus the dressing devices 49, 50 may be either lifted to the working position as shown in FIGURE 6, in which they act on the side of the corresponding grinding pins 22, 23, or can be lowered to the rest position, as shown in FIGURE 7, in which they leave the space free between the internal grinding devices S2, S3 and the workpiece spindle-carrying drum 6.

The operation of the above-described three-spindle grinding machine is as follows:

Each nozzle 1 to be ground is chucked to the corresponding spindle 7 at station I, where the flat end grinding is effected and, after this first grinding, by stepwise advancing through stations II and III, is returned to station I, where the completely ground nozzle is removed and replaced by a new nozzle.

By further advancing by one step, drum 6 is revolved so as to bring said nozzle 1 from station I to station II, where the conical internal valve seat is ground, after which the drum 6 is further revolved by one step and nozzle 1 is brought to station III, where the cylindrical bore 3 is ground, while at the same time, other nozzles are brought to station II and I. The stay times at said three stations are the same.

During each operation of the machine, viz. between two subsequent advancing steps of drum 6, the drum-supporting member 8 is advanced twice in its working position against the grinding devices S1, S2 and S3, and then it is again withdrawn. By the first advancing of said supporting member 8, the flat-grinding unit 21, 24 comes to its working position, while dressing devices 49, 50 of the internal grinders S2, S3 are lowered in their rest position. In said advanced working position of supporting member 8, the grinding pins 22, 23 engage the corresponding internal walls of nozzles 1 at stations II and III, while the grinding wheel 21 or 121 of flattening grinder S1 works against the end of nozzle 1 at station I. During this step, the first or rough internal grinding of nozzles 1 at stations II and III and the complete end grinding of nozzle at station I is effected.

The drum supporting member 8 is then withdrawn to its starting position. Subsequently the flat grinding unit 21, 24 is removed to its rearward sidewise dressing position while the dressers 49, 50 are lifted and shifted against the grinding pins 22, 23 of S2, S3 (FIG. 6), so as to dress said pins. Also the grinding wheel 21 or 121 places itself against the corresponding dresser 30 and may be dressed, although this operation is not necessary at each working cycle, but may be performed after a suitable number of cycles, as desired.

Subsequently the dressers 49, 50 are again lowered and the drum-supporting member 8 is again shifted towards the grinders S1, S2, S3. In this working step, the grinding pins 22 and 23 at stations II and III are advanced so as to finish-grind the internal surfaces of the corresponding nozzles 1, while the grinding wheel unit 21, 24 is maintained in its sidewise dressing position as shown in FIGURE 6, and in the meanwhile the freely accessible completely ground nozzle 1 at station I may be removed and replaced to a new one. This operation can be effected by hand or automatically, by employing conventional means.

After the finish grinding of the inside surfaces 3 and 4 and the chucking of a new nozzle at station I, the drum-supporting member 8 is again withdrawn to its starting position, then drum 6 is revolved by one step and the flat grinding unit 21, 24 is again advanced to working position and thus the two-step cycle of the machine may be again started.

By the described method of operation of the machine, in the working station I, in the first working step of each cycle, viz. after the first advancement of the supporting member 8, the grinding unit 21, 24 is advanced and flat-grinds the nozzle end 2.

In the second working step of the same cycle, viz. after the second advancing of member 8, the finish-ground nozzle is replaced by a new nozzle to be ground.

It is possible to invert the sequence of these two operations, i.e. to put aside the flat-grinding unit 21, 24 and to replace the completely ground nozzle by another nozzle to be completely ground and in the subsequent working step to advance the unit 21, 24 and to flat-grind the new nozzle end 2.

Of course, the position of the three stations may be angularly shifted, by arranging station I in a lower position, in front of the service side.

FIGURE 11 shows diagrammatically a variation of the above-described grinding machine, according to which, as supporting member for the workpiece spindles a horizontal stepwise advancing disc 108 is rotatably mounted upon a shaft or axle 53 and upon which disc are mounted four substantially radial workpiece spindles 7 provided with outwardly arranged chucks.

To said four spindles 7 correspond four stations I, II, III and IV, the first three stations being working stations in which the end flattening and the internal grindings are effected ad the fourth being the nozzle-chucking and removing station.

Of course, the invention is not limited to the above-disclosed embodiments, but may be modified within the scope of the invention as defined in the appended claims.

I claim:

1. A multiple spindle grinder for diesel engine fuel nozzles, said grinder comprising a support, means for reciprocably moving said support, three parallel workpiece spindles, a rotatable disc on said support carrying said spindles, said spindles being connected to said disc along a circle at equal angular intervals, means for rotating said disc and said spindles therewith, stepwise, through three successive working stations, a grinding device at each staiton, one being an external flat-grinding device with a grinding disc for grinding the external flat end surface of a fuel nozzle, the second being an internal conical grinding device with a conical grinding surface for grinding the internal conical needle seat of the nozzles, the third being an internal cylindrical grinding device with a cylindrical grinding surface for grinding the internal cylindrical needle guiding surface, means supporting the flat grinding device at the first working station for movement between an operative position and an inoperative position, said means for reciprocally moving the support being capable of producing two advancing and withdrawing movements of the support and spindles to and from the grinding devices for each rotation step of the disc, and means for moving the flat grinding device to its inoperative position after each second advance movement of the support to enable removal of a finished ground nozzle at the first working station.

2. A grinder as claimed in claim 1 comprising dressing means at each station for dressing the grinding device thereat, means for moving the dressing means at the second and third stations conjointly to their associated grinding devices.

3. A grinder as claimed in claim 2 comprising means supporting the dressing means at the first station at a position to dress the grinding device thereat when it is in its inoperative position.

4. A grinder as claimed in claim 1 wherein said grinding device at said first station is arranged above the grinding devices at said second and third stations, the latter being disposed laterally of the grinding device at the first station and at the same level.

5. A grinder as claimed in claim 4, wherein said means which supports the grinding device at the first station is a transverse slide for said first grinding device.

6. A grinder as claimed in claim 1 comprising means supporting the grinding device at the second station for axial movement towards and away from said disc and for angular movement about an axis perpendicular to the axis of rotation of said disc.

7. A grinder as claimed in claim 6 comprising means supporting the grinding device at the third station for axial movement towards and away from said disc, and for adjustable displacement along an axis which is inclined with respect to the axis of rotation of said disc.

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U.S. Cl. X.R.

51—5, 108, 134