Aug. 1, 1967 A. S. CZUBAK ETAL 3,333,366

APPARATUS FOR PARALLEL FACE FINISHING

Filed Dec. 23, 1964 3 Sheets-Sheet 1

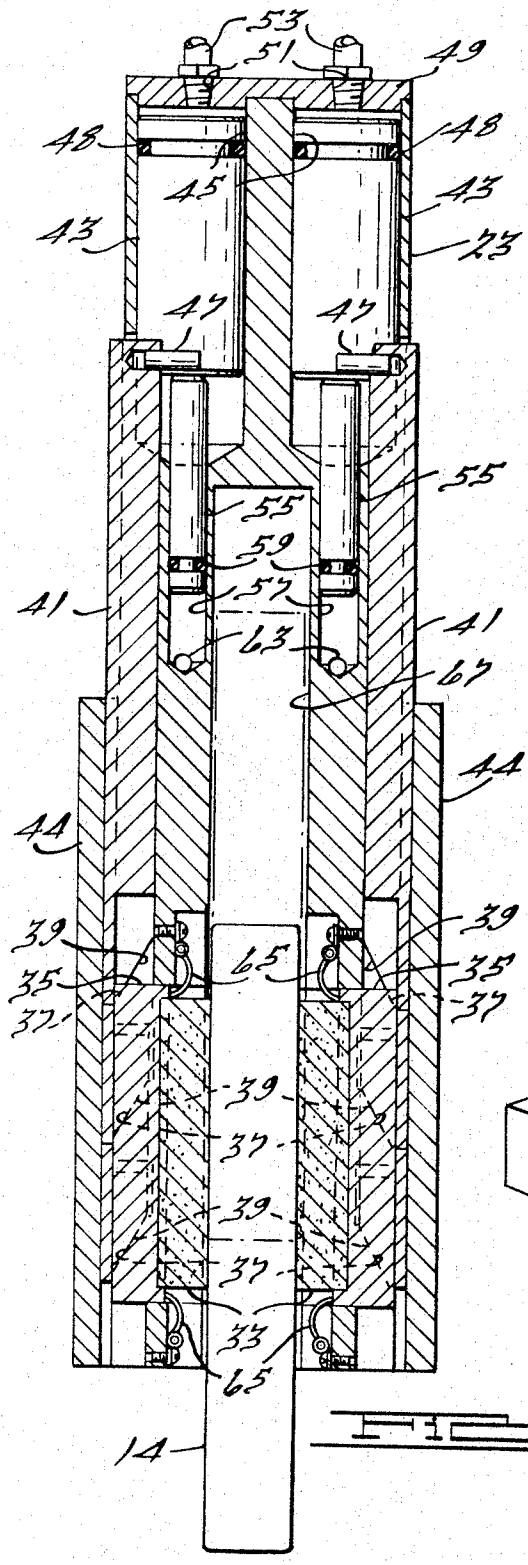

FIG. 3.

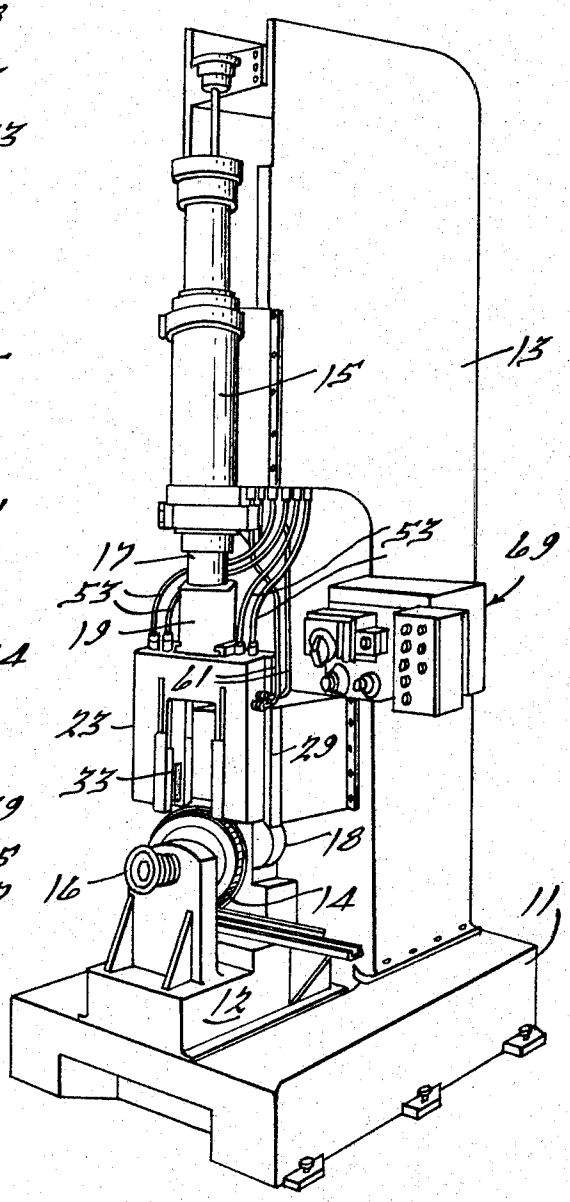

FIG. 1.

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APPARATUS FOR PARALLEL FACE FINISHING

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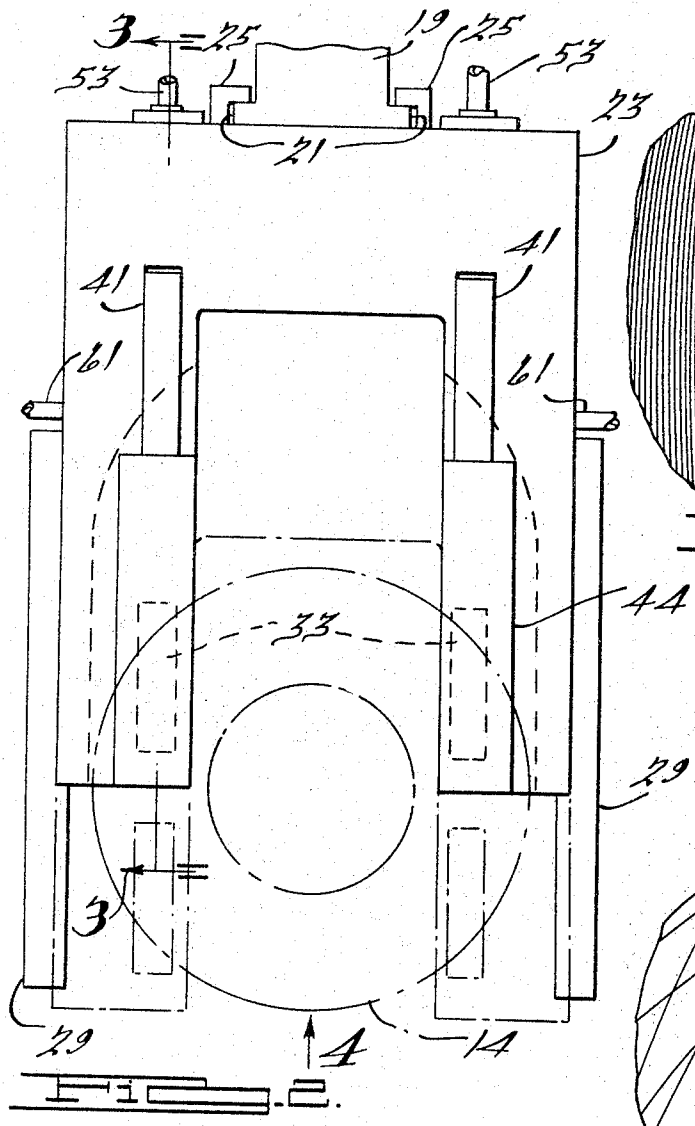

FIG. 2.

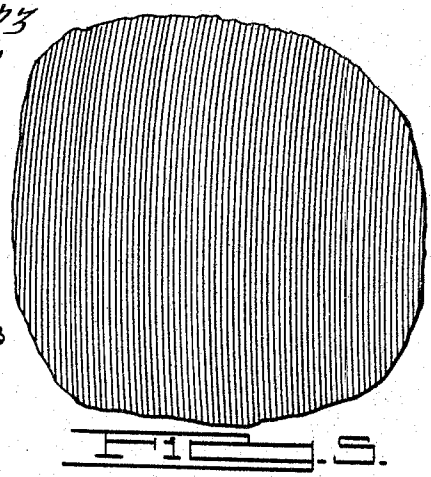

FIG. 5.

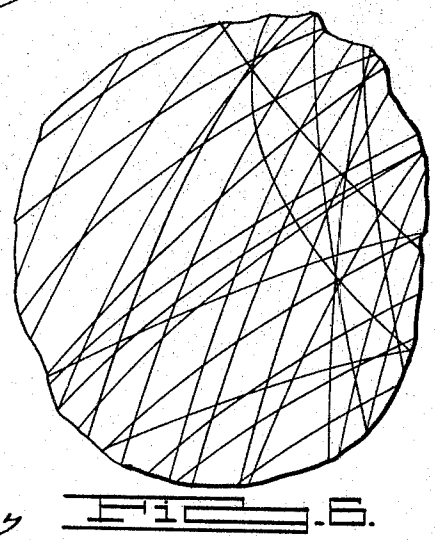

FIG. 6.

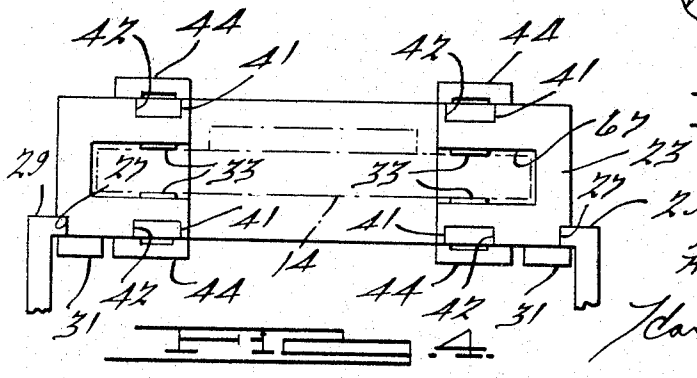

FIG. 4.

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APPARATUS FOR PARALLEL FACE FINISHING

Filed Dec. 23, 1964 3 Sheets-Sheet 3

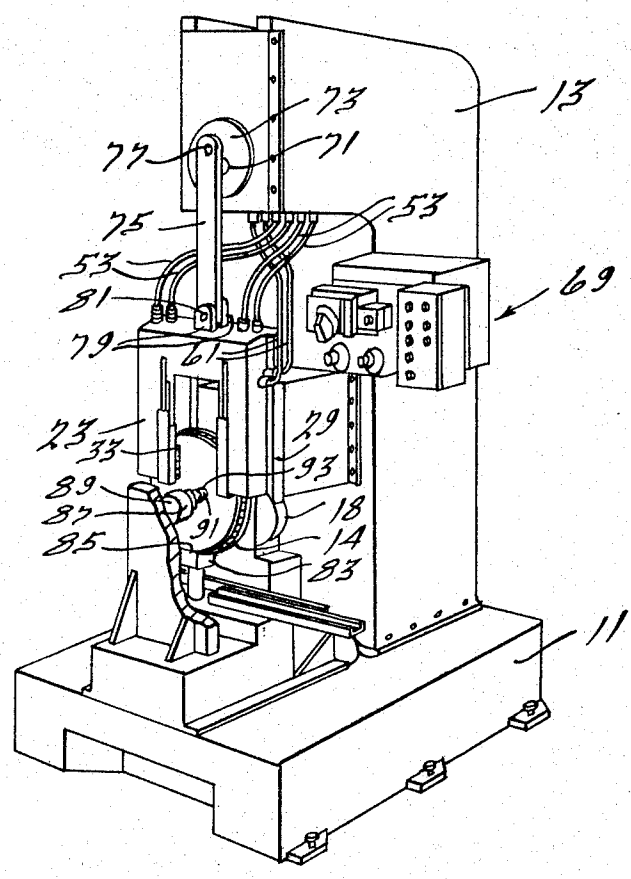

FIG. 7.

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3,333,366

APPARATUS FOR PARALLEL FACE FINISHING

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7 Claims. (Cl. 51—67)

This invention relates to abrading devices, and particularly to an improved apparatus for finishing parallel faces of particular workpieces.

In machining work faces of some workpieces, it is important that these surfaces be finished flat and to a high degree of parallelism. An example of this type workpiece is the disc of a disc brake assembly. Such a disc has a pair of outwardly facing parallel annular flat faces which are engaged by brake pads. The flatness and parallelism of these faces must be established to a high degree of accuracy in the finishing operation; otherwise, uneven braking forces would be experienced in use and these faces would be subject to uneven wear and the useful life of the brake materially shortened. It is also important in finishing the parallel faces on rotatable workpieces like the above disc-type brakes that the finished faces be accurately designed perpendicular to the workpiece rotational axis. Otherwise, the brake shoes would be caused to wobble and apply uneven braking forces, reducing braking efficiency and subjecting the brake assembly to high fatigue stresses.

The present invention deals with apparatus adapted to finish work faces of this type to a high degree of accuracy. Briefly, the invention includes an improved abrading tool housing and tool guiding assembly of relatively simple but sturdy construction adapted to finish work surfaces to a high degree of accuracy as to flatness and parallelism, as well as to provide the work surfaces with a highly accurate surface finish, finish pattern and dimension control. A frame is provided which rigidly supports the workpiece adjacent the tool housing and may be adapted to rotate the workpiece about its central axis. The abrading tool assembly is adapted to move transversely of the workpiece rotational axis whereupon abrasive tools provided thereon are displaced relative to the tool assembly into contact with the parallel faces of the workpiece. Thus, by then rotating the workpiece about its central axis and engaging the work faces with abrasive tools, the parallel faces will be accurately finished. In use, the tool assembly is reciprocated at a controlled rate in a plane disposed perpendicular to the workpiece rotational axis while the workpiece undergoes rotation. In this way, the finished work faces may be designed to possess a variety of surface grain contour. After the finishing operation is completed, the tools are retracted from the workpiece and the tool assembly withdrawn.

It is an object therefore of the present invention to provide an improved method and apparatus capable of establishing a high degree of flatness and parallelism on finished faces of a workpiece.

It is a further object of the present invention to provide an improved apparatus of the above type wherein the finished faces of the workpiece are accurately dimensioned and perpendicular to a central axis therethrough and have an accurately controlled surface finish.

It is a further object of the present invention to provide an abrading tool assembly of the above type having an improved tool guiding assembly.

It is a further object of the present invention to provide an abrading tool assembly of the above type movable into and out of a work engaging position as a unit.

It is a further object of the present invention to provide an abrading tool assembly of the above type adapted to be reciprocated at a controlled rate during the abrading operation.

It is a further object of the present invention to provide an abrading apparatus capable of providing a variety of surface finish patterns.

It is a further object of the present invention to provide an abrading tool assembly of the above type which is relatively inexpensive to manufacture, rugged in construction and reliable in operation.

Further objects and advantages of the present invention will become more apparent from the following detailed description taken in conjunction with the drawings in which:

FIGURE 1 is a perspective view of a honing machine embodying the principles of the present invention;

FIG. 2 is an enlarged fragmentary view of the structure of FIG. 1 showing the abrading tool assembly of the present invention at the upper and lower reciprocatory limits of its abrading movement as illustrated by the full dot-dash lines, respectively;

FIG. 3 is a sectional view of the structure of FIG. 2 taken along the line 3—3 thereof;

FIG. 4 is an end view of the structure of FIG. 2 taken in the direction of the arrow 4;

FIG. 5 is an enlarged view of a workpiece showing one type of surface grain structure attainable with the device of the present invention;

FIG. 6 is an enlarged view of a workpiece showing another type of surface grain structure attainable with the device of the present invention; and

FIG. 7 is a view similar to FIG. 1 showing a modified form of tool housing drive.

Referring now more specifically to the drawings, FIG. 1 illustrates a honing machine which is seen to include a base **11** to which an upright frame **13** is suitably affixed. A fixture frame **12** is suitably supported upon the base **11** and is adapted to support and position a workpiece during the finishing operation. In the illustrated embodiment, a workpiece consisting of a conventional disc-type automotive brake **14** is supported between suitable fixtures (not shown), one of which may be rotatably supported by an adjustable hand wheel **16** and the other carried by the output shaft (not shown) of an electric motor **18**. Both the hand wheel and motor are supported upon the fixture frame **12** and these fixtures are of a conventional type which will rigidly support the workpiece for rotation and are readily fixed thereto. Thus, rotation of the output shaft of motor **18** will, through the fixtures, impart rotation to the workpiece about its central axis.

A hydraulic cylinder **15** is suitably fixed to frame **13** and has disposed therein a piston **17** for vertical movement relative thereto. A suitable source of hydraulic fluid may be supplied to the cylinder in the usual manner by a means (not shown) to cause vertical reciprocation of the piston. An adapter **19** may be formed integral with the lower end of piston **17** and is provided with a pair of flanges **21** at its lower end. A tool housing **23** is provided at its upper end with a pair of retainers **25** each of which snugly receives a respective one of flanges **21**. Thus, the tool housing will reciprocate vertically with piston **17**.

Each rear side edge of the tool housing is formed with an elongated notch **27**, each of which slidably receives a guide rail **29** suitably carried by and fixed to frame **13**. Each of these guide rails is snugly but slidably retained within its respective notch by a retainer plate **31** suitably fixed to the rear of the tool housing. Thus, movement of the tool housing will be accurately controlled by the guide rails.

Disposed within the tool housing for movement therewith are a plurality of abrasive tool assemblies each consisting of an abrasive stone **33** fixed to a stone holder **35**. While the number of these tool assemblies provided may

vary by choice, for finishing the disc-type brake illustrated, two opposing pairs of stones and stone holders are used. Each of the stone holders shown is provided with a plurality of longitudinally spaced identical tapered faces 37 at its rear edge positioned to engage complementary tapered faces 39 formed on each of four expander plates 41. As shown, these expander plates are closely but slidably retained each within a longitudinally extending groove 42 formed in the tool housing by a plurality of retainer plates 44 suitably fixed thereto. By carefully machining the longitudinal surfaces of these expander plates and grooves 42 in which they slide, and by maintaining a close sliding relationship therebetween, the abrasive stones will be maintained in accurate parallelism with themselves and each other when moved into contact with the workpiece and the work faces finished accordingly.

A plurality of primary pistons 43 are each positioned within a corresponding primary cylinder 45 formed within the tool housing and are adapted for vertical reciprocating movement relative thereto. Each of the primary pistons is operatively connected to a respective one of expander plates 41 by suitable means such as a pin 47 to thereby impart corresponding reciprocatory movement thereto and each of the pistons is provided with a conventional O-ring 48 to sealingly engage the wall of cylinders 45. An end cap 49 is suitably attached atop tool housing 23 to close the ends of primary cylinders 45 and is provided with a plurality of inlet openings 51 adapted to threadedly receive fluid conduits 53. Thus, as fluid is supplied under pressure to each conduit 53 in a conventional manner, downward movement will be imparted to pistons 43 and therefore to expander plates 41. This will in turn cause movement of each of the tool assemblies inwardly toward the workpiece, by engagement between tapered faces 37 and 39 on the tool holders and expander plates, respectively, until the tools engage workpiece 14.

To retract the tool assemblies outwardly away from the workpiece at the conclusion of the finishing operation, a plurality of secondary pistons 55 are provided and each has one end disposed for vertical movement within a plurality of secondary cylinders 57 formed in housing 23, while the other end of each of the secondary pistons abuts the lower end of a respective one of the primary pistons. Each of pistons 55 carries a conventional O-ring 59 which sealingly engages the wall of the corresponding cylinder 57 while a plurality of fluid conduits 61 are suitably connected to cylinders 57 at openings 63 to supply hydraulic fluid thereto. Thus, upon completion of the honing operation, the pressure on fluid to conduits 53 may be released and fluid under pressure may be supplied by conduits 61 to the secondary cylinders. This will move pistons 55, and therefore pistons 43, upwardly with tapered faces 39 on the expander plates moving away from faces 37 on the stone holders. A suitable means, such as leaf springs 65 fixed to the tool housing with one end of each engaging a respective end of each stone holder 35, will then move each of the tool assemblies outwardly away from the workpiece.

As shown, the tool housing is movable from a position completely above and away from the workpiece (FIG. 1), to a position where the workpiece is received within a longitudinal opening 67 formed therein (FIG. 3), and is adapted to be cycled reciprocally at a controlled rate through a finishing stroke illustrated by the full line and dot-dash positions shown in FIG. 2 by controlling the rate of flow of fluid to cylinder 15. Also, the tool assemblies are movable from a position retracted from the workpiece (not shown) to a position where stones 33 engage the workpiece (FIG. 3) by suitably controlling the flow of fluid to cylinders 45 and 57. While the details of these controls, including a suitable fluid source, pumps, and valves have not been illustrated, it is to be understood that the same will be of a conventional nature and within the realm of the skilled hydraulics engineer. The fluid system provided will be controlled from suitable control panel 69 mounted upon the machine frame.

In the operation of this machine, the workpiece is mounted between the fixtures carried by hand wheel assembly 16 and motor 18 and the motor is actuated to rotate the workpiece. With the tool assemblies in their retracted positions, which can be accomplished by normally maintaining fluid under pressure to openings 63 of cylinders 57 and exhausting fluid from cylinders 45, fluid is supplied to cylinder 15 to move piston 17 downwardly. Thereafter, fluid is supplied to cylinders 45 by conduits 53 and is exhausted from cylinders 57 by conduits 61 thereby moving stones 33 into engagement with workpiece 14. Depending upon the surface grain structure desired on the workpiece, the tool housing will then be reciprocated at a fast rate of travel, through a preselected stroke, one example of which is indicated by the full line and dot-dash positions of FIG. 2, or the tool housing will reciprocate through this stroke at a reduced rate of travel. In the former, a random type surface grain structure or lay pattern, as illustrated by FIG. 6, will be formed on the workpiece by the rapid rate of relative longitudinal movement between the stones and workpiece during the finishing operation. In the latter, a concentric lay pattern, as illustrated in FIG. 5, is formed since a reduced rate of relative longitudinal movement takes place between the stones and workpiece. Thus, the resulting surface grain structure may be varied according to customer desires.

After completion of the abrading operation, which may be determined by either a timer or by a suitable gauging device, fluid is exhausted from the primary cylinders and is supplied to the secondary cylinders with springs 65 retracting the tool assemblies, whereupon fluid may be supplied to cylinder 15 to move piston 17 upwardly and the finished workpiece removed from the fixtures.

FIG. 7 illustrates a modified form of reciprocating drive means for the tool housing and workpiece positioning means. This structure is, in all other respects, substantially identical to that of FIG. 1 and like numerals indicate identical parts.

Thus, a drive motor (not shown) is fixed to the frame 13 and is provided with a rotary output shaft 71 having a crank disc 73 fixed thereto adjacent the end thereof. A connecting rod 75 is pivotally connected at one end to the disc 73 by a pin 77 and at its other end by a pin 81 to a spaced pair of ears 79 fixed to the tool housing 23. The pin 77 is disposed eccentrically of the disc 73 so that rotation of the disc by the drive motor (not shown) causes the tool housing to reciprocate vertically. As in the device of FIG. 1, the tool housing 23 is guided by guide rails 29 fixed to the frame 13.

The tool housing drive means of FIG. 7 is energized to reciprocate the tool housing 23 at a rapid rate when it is desired to form a random type surface grain structure or lay pattern, as illustrated by FIG. 6 and described above in the device of FIG. 1. Conversely, this tool housing drive means reciprocates the tool housing 23 at a relatively slow rate when it is desired to form a concentric lay pattern shown in FIG. 5 and also described above. This variable rate of tool housing reciprocation is achieved by using a variable speed drive motor to drive the crank 73.

In the device of FIG. 1, the tool assembly was moved adjacent and retracted from the workpiece 14 by supplying fluid to the cylinder 15 to move the piston 17. In the device of FIG. 7, the workpiece 14 is raised into position in preparation for the finishing operation by a movable lift 83 which is hydraulically or otherwise suitably actuated. As shown, the lift 83 is formed concave as at 85 to cradle the workpiece 14 and is moved upwardly to raise the workpiece 14 to a position adjacent the rotatable fixtures one of which is shown at 87. The fixture 87 is reciprocable, as by a fluid motor 89 or by a hand wheel as shown in FIG. 1, and is extended to grip the workpiece 14. For

handling the disc brake **14** shown, the fixture **87** has a tapered end portion **91** positionable within an opening **93** centrally of the workpiece **14** to raise it slightly from the lift **83** and press it into engagement with the other fixture (not shown) whereupon the motor **18** which drives the fixtures is energized. Thereafter, the tool assemblies are moved into engagement with the workpiece **14** and the finishing process is carried out as described above. Upon completion of the finishing process, the tool assemblies are retracted and the lift **83** lowered. The finished workpiece is removed and a new workpiece **14** is placed on the lift cradle surface **85** in preparation for the next finishing process.

The lift device **83** can be motivated by any suitable drive means such as a fluid motor. In addition, the workpieces **14** can be manually placed on and removed from the cradle surface **85** or they can be handled automatically as desired. In addition, suitable guide means may be provided to prevent the workpiece **14** from falling off the lift **83** during its raising and lowering sequence.

Thus, by the present invention there has been provided an abrading device for finishing parallel faces on a workpiece which will form flat finished faces accurately parallel to each other and perpendicular to the workpiece axis of rotation.

While preferred embodiments of the present invention have been illustrated and described in detail, various additions, substitutions, modifications and omissions may be made thereto without departing from the spirit of the invention as encompassed by the appended claims.

What is claimed is:

1. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a housing mounted for reciprocation in a plane perpendicular to the axis of rotation of said workpiece,
- said housing having two pairs of parallel spaced longitudinally extending guide rail surfaces formed thereon, one of each of said pairs adjacent a respective one of said work faces,
- a plurality of abrasive stones carried by said housing, one each adjacent a respective one of said rail surfaces for movement therewith,
- and means carried by said housing and movable in unison along said rail surfaces for moving said stones into engagement with a respective one of said workpiece faces.

2. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a frame,
- a housing mounted for reciprocation in a plane perpendicular to the rotational axis of said workpiece and guided by said frame,
- means defining two pairs of parallel spaced elongated guide rail surfaces formed on said housing and extending in the direction of reciprocation thereof,
- an abrasive stone supported adjacent each of said guide rail surfaces,
- and means carried by said housing and movable relative thereto along said guide rail surfaces for moving said stones into contact with said workpiece faces.

3. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a frame,
- a housing mounted for reciprocation in a plane perpendicular to the rotational axis of said workpiece and guided by said frame,
- means defining two pairs of parallel spaced elongated guide rail surfaces formed on said housing and extending in the direction of reciprocation thereof,
- an abrasive tool assembly supported adjacent each of said guide rail surfaces and each having at least one cam surface formed thereon,
- cam means carried by said housing and movable relative thereto along said guide rail surfaces,

- and a cam surface formed on each said cam means and engageable with the cam surface on a respective one of said tool assemblies whereby said stones are moved into contact with said workpiece faces upon movement of said cam means along said guide rail surfaces.

4. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a frame,
- a housing mounted for reciprocation in a plane perpendicular to the rotational axis of said workpiece and guided by said frame,
- means defining two pairs of parallel spaced elongated guide rail surfaces formed on said housing and extending in the direction of reciprocation thereof,
- an abrasive tool assembly supported adjacent each of said guide rail surfaces and each having at least one cam surface formed thereon,
- means biasing each said tool assembly toward its respective guide rail surface,
- cam means carried by said housing and movable relative thereto along said guide rail surfaces,
- and a cam surface formed on each said cam means and engageable with the cam surface on a respective one of said tool assemblies whereby said stones are moved against said biasing means and into contact with said workpiece faces upon movement of said cam means along said guide rail surfaces.

5. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a frame,
- a housing guidably mounted on said frame for reciprocation along a plane perpendicular to the rotational axis of said workpiece,
- said housing being formed with at least one pair of spaced parallel elongated guide rail surfaces extending in the direction of reciprocation thereof,
- an abrasive tool positioned adjacent each said guide rail surface,
- resilient means normally biasing each said tool toward its respective guide rail surface,
- cams means carried by said housing and movable relative thereto along each said guide rail surface from a first position spaced from said abrasive tools to a second position in engagement with a respective one of said abrasive tools to thereby move said tools into engagement with a respective one of said work faces,
- and means for controllably reciprocating said housing during engagement between said abrasive tools and said workpiece.

6. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,
- a frame,
- a housing guidably mounted on said frame for reciprocation along a plane perpendicular to the rotational axis of said workpiece,
- said housing being formed with at least one pair of spaced parallel elongated guide rail surfaces extending in the direction of reciprocation thereof,
- an abrasive tool positioned adjacent each said guide rail surface,
- resilient means normally biasing each said tool toward its respective guide rail surface,
- elongate means supported by said housing one each movable along a respective one of said guide rail surfaces,
- each said elongate means being formed with a plurality of longitudinally spaced tapered cam surfaces engageable with complementary surfaces formed on each said abrasive tool,
- means for moving each said elongate means from a first position where said cam surfaces are spaced from said complementary surfaces to a second position where said cam surfaces engage said complementary

surfaces to thereby move each said abrasive tool into engagement with a respective one of said work faces,

and means for reciprocating said housing during engagement between said abrasive tools and said workpiece.

7. In a device for finishing parallel faces of a workpiece rotatable about an axis perpendicular to said faces,

a frame,

a housing guidably mounted on said frame for reciprocation along a plane perpendicular to the rotational axis of said workpiece,

said housing being formed with at least one pair of spaced parallel elongated guide rail surfaces extending in the direction of reciprocation of said housing,

an abrasive tool positioned adjacent each said guide rail surface,

resilient means normally biasing each said tool toward its respective guide rail surface,

elongate means supported by said housing one each movable along a respective one of said guide rail surfaces,

each said elongate means being formed with a plurality of longitudinally spaced tapered cam surfaces engageable with complementary surfaces formed on each said abrasive tool,

fluid pressure actuated means for moving each said elongate means from a first position where said cam surfaces are spaced from said complementary surfaces to a second position where said cam surfaces engage said complementary surfaces to thereby move each said abrasive tool into engagement with a respective one of said work faces,

and means for reciprocating said housing during engagement between said abrasive tools and said workpiece.

References Cited

UNITED STATES PATENTS

2,127,071	8/1938	Schmalz	51—56
2,195,065	3/1940	Wallace	51—60
2,315,859	4/1943	Indge	51—67
2,703,470	3/1955	Porter	51—67 X

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