Jan. 22, 1957 L. O. CARLSEN ET AL 2,778,353

WHEEL DRESSER

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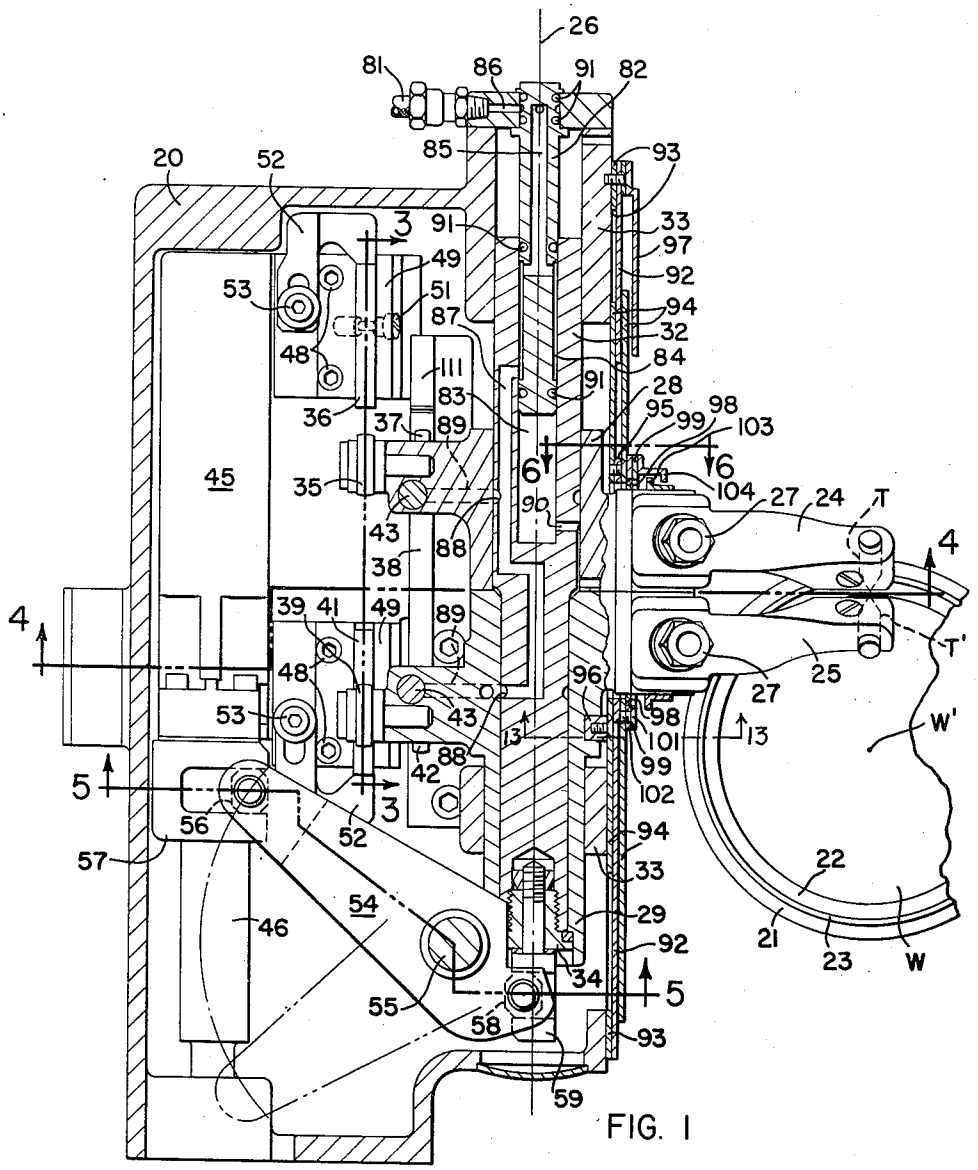


FIG. 1

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FIG. 2

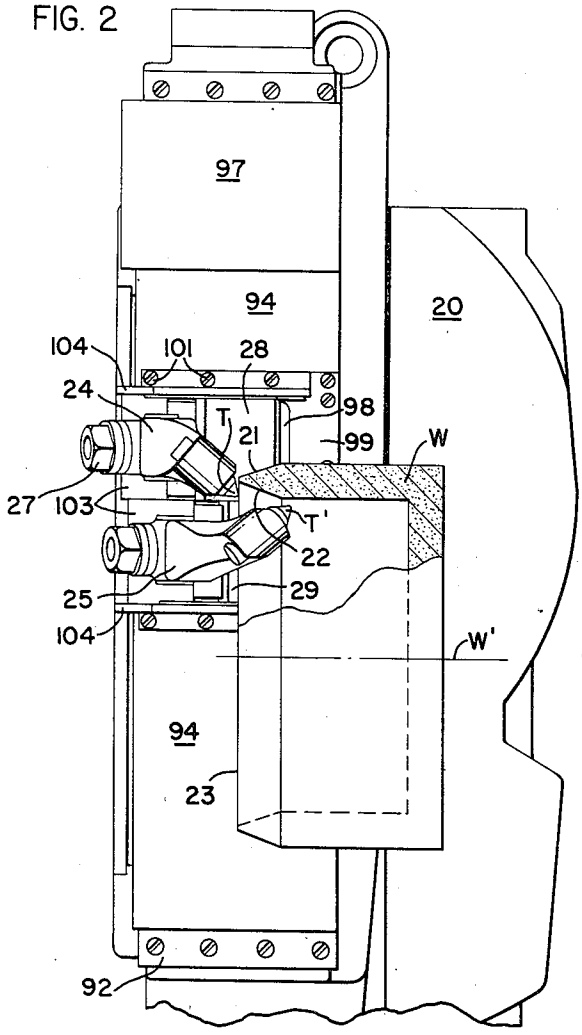
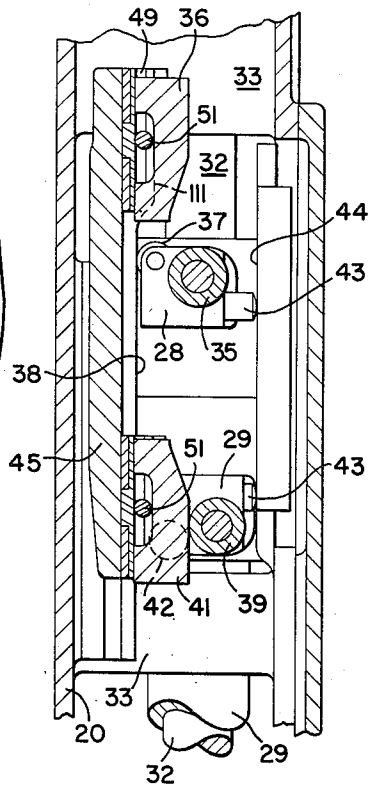


FIG. 3



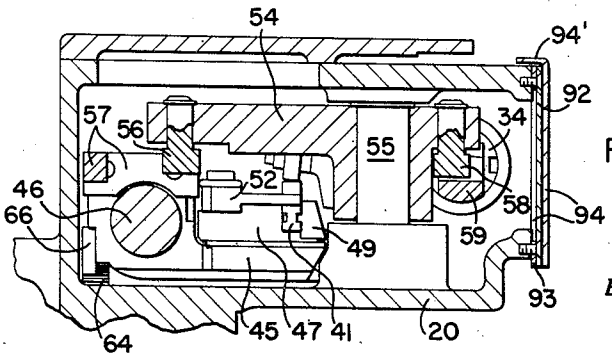


FIG. 5

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FIG. 8

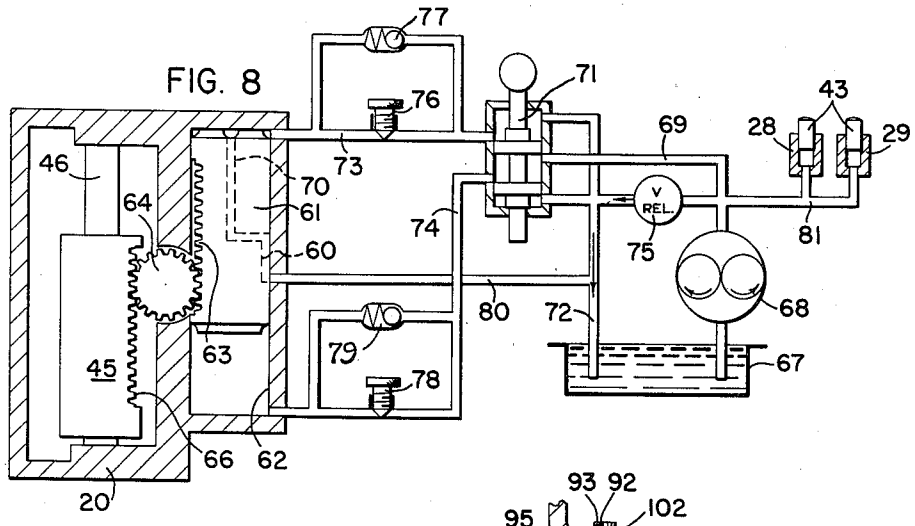


FIG. 6

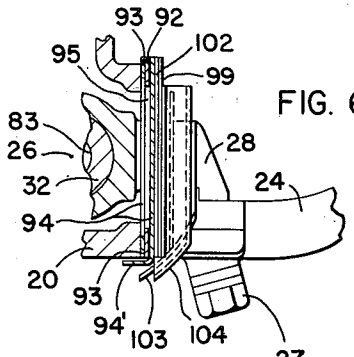
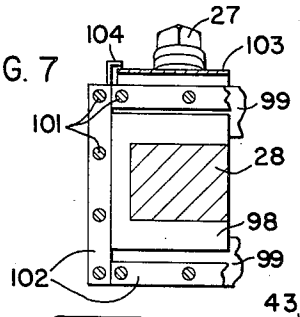


FIG. 7



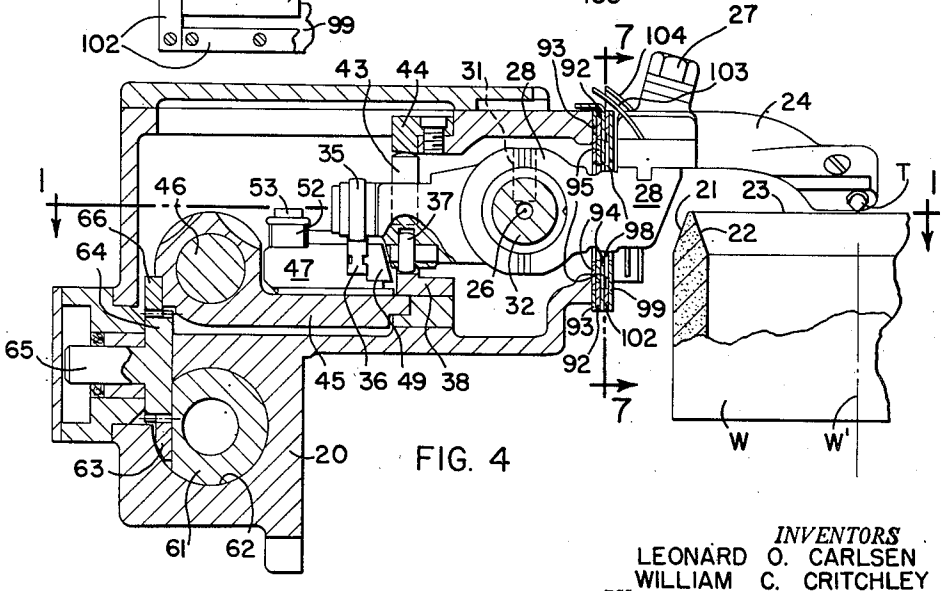


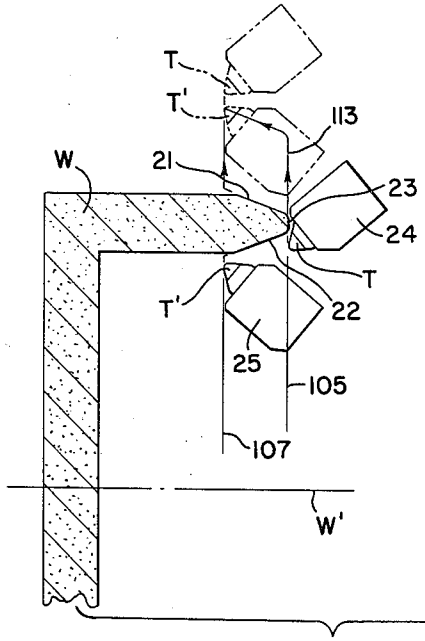
FIG. 4

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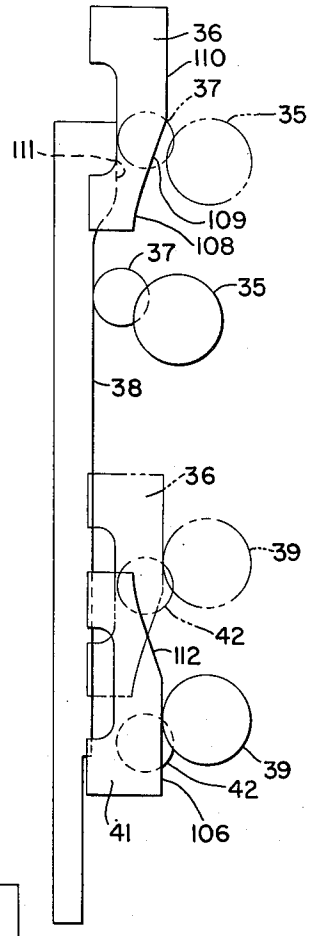


FIG. 9

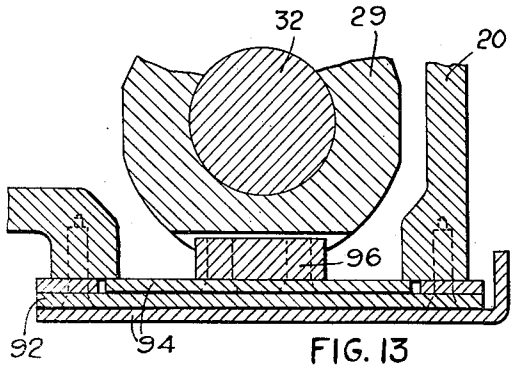
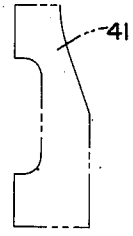


FIG. 13



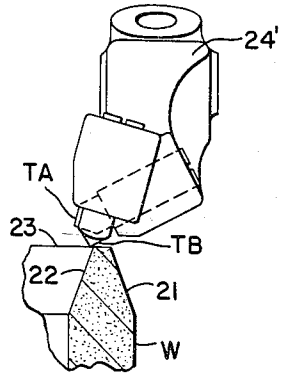
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FIG. 11



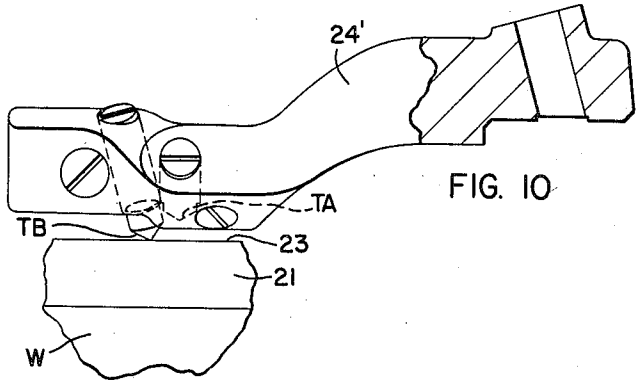


FIG. 10

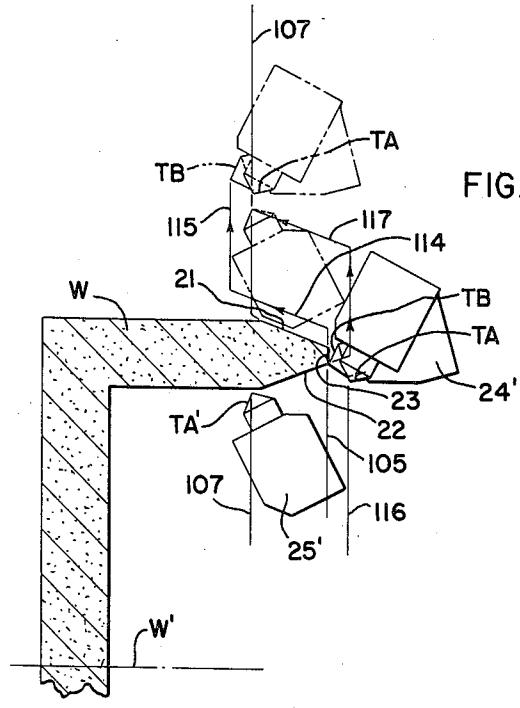


FIG. 12

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United States Patent Office 2,778,353 Patented Jan. 22, 1957

2,778,353

WHEEL DRESSER

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Application January 5, 1954, Serial No. 402,348

12 Claims. (Cl. 125—11)

The present invention relates to dressers for abrasive wheels, and relates particularly but not exclusively to dressers of the type employed on gear grinding machines.

More particularly the invention relates to a dresser of the type wherein the diamond or other dressing tool is carried by an arm which is reciprocated across the face of a rotating abrasive wheel and during such reciprocation is oscillated by cam means about an axis parallel to the path of reciprocation, the cam being so shaped that the cutting tip of the tool will dress the wheel to the desired profile form. A primary objective of the invention is a compact arrangement of parts which nevertheless affords a stroke of the tool carrier relative to the cam that is relatively long in comparison with the stroke of the tool. Another objective is an arrangement in which a plurality of such tool carriers, each controlled by its own cam, may act simultaneously to dress different parts of the wheel profile. Still another objective is an arrangement of rigid guards which will effectively prevent the ingress of abrasive particles and other undesired matter into the dresser frame or housing.

In the preferred form of the invention a pair of tool carriers are mounted on the dresser frame for reciprocation as a unit and for oscillation independently of each other about a common axis which extends in the direction of reciprocation. A pair of cams for oscillating the arms is supported by a carrier which is reciprocable on the frame in a path parallel to the axis oscillation, and a lever pivoted to the frame connects the cam carrier to the tool carriers for reciprocation so that the cams are caused to move oppositely to the tool carriers, with the result that their relative travel is substantially greater than that of either alone. Each tool carrier has follower means, preferably comprising a roller, for engaging the related cam. A stationary guideway on the frame is engaged by the follower means, preferably by another follower roller on the tool carrier, to control the angular position of the carrier when it is beyond control of the cam. For the purpose of keeping the follower means in contact with either the cam or the guideway each carrier has a yieldable plunger engaging another way on the frame. The preferred embodiment of the invention includes a system, for applying fluid pressure to the plunger, in which the passage leading from the frame into the carrier is so arranged that the fluid pressure in the passage does not affect the rectilinear motion of the carrier. The preferred embodiment further includes an improved guard mechanism, composed of telescoping sections arranged to accommodate both the rectilinear and angular motions of the tool carriers, for excluding particles of abrasive and other undesired matter from the interior of the dresser.

The foregoing and other objects and advantages will appear from the following description made with reference to the drawings, wherein:

Fig. 1 is a vertical sectional view through the dresser, taken approximately in the plane indicated by section line 1—1 in Fig. 4;

Fig. 2 is a side elevation of the dresser and the wheel which it dresses, with a part of the wheel broken away;

Fig. 3 is a fragmentary vertical sectional view taken in the plane designated by section line 3—3 in Fig. 1;

Figs. 4 and 5 are horizontal sectional views taken respectively in the planes indicated by section lines 4—4 and 5—5 in Fig. 1;

Fig. 6 is a fragmentary vertical sectional view in the plane designated by section line 6—6 in Fig. 1;

Fig. 7 is a sectional view taken in the plane shown by line 7—7 of Fig. 4;

Fig. 8 is a diagram of a hydraulic circuit which may be employed for operating the dresser;

Fig. 9 is a schematic view showing the relationship between the cam means and the paths of motion of the dressing tools over the wheel;

Figs. 10 and 11 are respectively a side elevation, partly in section, and an end view, of an alternate form of tool carrying arm for the dresser;

Fig. 12 is a schematic view showing the path of the tools over the wheel when the arm shown in Figs. 10 and 11 is employed; and,

Fig. 13 is a fragmentary sectional view taken in the plane designated by section line 13—13 of Fig. 1.

The preferred form of dresser shown in the drawings comprise a frame 20 which may be mounted in any suitable manner, adjustably if desired, upon a grinding machine (not shown) whose abrasive wheel is designated W. The wheel may be of various shapes, the one shown being a cup shaped wheel rotatable about axis W' and having outer conical face 21, inner conical face 22, and plane tip face 23, to be dressed by diamond tools T and T' which are carried by arms 24 and 25 of the dresser. During a dressing operation these arms are moved in unison in the direction of axis 26, Fig. 1, to carry the tools in a radial direction across the face of the wheel. The arms are simultaneously moved angularly, independently of each other, about axis 26, to cause the tip of tool T to traverse tip surface 23 and outer side surface 21 of the wheel, and tool T' to traverse the wheel's inner side surface 22 and tip surface 23.

The tool arms 24 and 25 are detachably but rigidly secured by threaded fasteners 27 to respective carriers 28 and 29. Carrier 28 is secured by dowel 31, Fig. 4, to a shaft 32 which is journaled for sliding and turning, along and about axis 26, in bearing portions 33 of the frame. Carrier 29 is free to turn on shaft 32 but is held against axial motion thereon by being confined between the carrier 28 and the head of a screw 34 that is threaded into the shaft. Carrier 28 has a roller 35 for following a cam 36, and a roller 37 for following a guideway comprising rail 38, when roller 35 is off cam 36. Similarly carrier 29 has a roller 39 for following a cam 41, and a roller 42 to follow guideway 38 when roller 39 is off cam 41. For holding the rollers against the cams and guide rail each carrier 28, 29 has a bore slidably receiving a plunger 43, Figs. 1 and 4, whose outer end rides on a way 44. Fluid under pressure behind the plungers 43, provided by a system to be described hereinafter, reacts against the carriers 28 and 29 to urge them about axis 26, counterclockwise in Fig. 4. The guide rail 38 and way 44 are in effect fixed parts of frame 20.

The cams 36 and 41 are detachably secured to a cam carrier 45 which is supported upon and slidable along a rod 46. It is held against rotation on the rod by guide rail 38, Fig. 6, which acts as a gib. As shown the rod 46 is parallel to axis 26. For mounting each cam there is a block 47 secured to the carrier by screws 48 and a clamp plate 49 drawn toward the block by a screw 51. A back-up strap 52 secured by screw 53 to the carrier abuts one end of the cam to prevent it from creeping

along the block and the plate under the load imposed by the cam follower.

For connecting cam carrier 45 to tool carriers 28, 29 for opposite parallel motion in constant velocity ratio, there is a lever 54, Figs. 1 and 5, pivoted to the frame by a pin 55 which preferably is mounted in antifriction bearings in the frame. A block 56 is pivoted to one end of the lever and is arranged to slide in a yoke 57 provided on the cam carrier. Similarly a block 58 pivoted to the opposite end of lever 54 is slidable in a yoke 59 secured to shaft 32 of the tool carrier assembly. In the illustrated embodiment of the invention the effective length of the lever arm 55—56 is three times that of lever arm 55—58 so that the travel of the cam carrier along rod 46 will be three times the travel of the tool carrier assembly along axis 26. However, since the two motions are in opposite directions the relative travel will be four times the absolute travel of the tool carrier assembly.

For reciprocating the carriers a hydraulic motor is provided which comprises a piston 61 slidable in a cylinder 62 formed in the frame parallel to axis 26. On the piston is a rack 63 meshing with a pinion 64 whose shank 65 is journaled for rotation in the frame. The pinion also meshes with a rack 66 affixed to the cam carrier 45. The hydraulic system employed for operating the motor 61, 62 may be of any suitable type. It may, for example, comprise a sump 67 containing hydraulic fluid, a motor operated pump 68 for drawing fluid from the sump and discharging it under pressure through pressure line 69 to a reversing valve 71, a return line 72 from the valve to the sump, and lines 73 and 74 extending between the valve and opposite ends of cylinder 62. A pressure relief valve 75 may be arranged between lines 69 and 72 to maintain the pressure in line 69 substantially constant. Arranged in parallel in line 73 is an adjustable throttle valve 76 and a check valve 77 adapted to close when fluid flow through the line is toward reversing valve 71. Similarly there are arranged in parallel in line 74 an adjustable throttle valve 78 and a check valve 79 adapted to close when the flow in the line is toward the reversing valve.

According to the present invention the piston 61 has a port in the form of a groove 60 and a restricted passage 70 connecting the port to the upper end of cylinder 62. During the upper portion of the travel of the piston in the cylinder the port 60 registers with a port in the cylinder wall which communicates via branch line 80 with return line 72.

When the valve 71 is in the position shown, in its lower limit position in its housing, fluid under pressure is directed from the pump through line 69, the reversing valve 71 and line 74 into the lower end of cylinder 62, holding the piston 61 in its upper limit position. If the valve 71 is now shifted to its upper limit position, connecting line 73 to pressure line 69 and line 74 to exhaust line 72, the piston 61 will be moved downwardly, and, through the action of pinion 64, the cam carrier 45 will be moved upwardly. During the first part of this action there is a small but inconsequential leakage of fluid from line 73 through passage 70, groove 60 and return lines 80 and 72. The rate of the downward piston motion will depend upon the setting of throttle valve 78, since in this condition check valve 79 is closed. Check valve 77 is open and hence throttle valve 76 has no effect. If the reversing valve 71 is now shifted to its lower limit position, again connecting line 74 to pressure line 69 and line 73 to exhaust line 72, the piston 61 will be moved upwardly, the first part of its stroke being at a rate dependent upon the setting of throttle valve 76, since in this condition check valve 77 is closed and check valve 79 is open. The latter part of the upward stroke of the piston is at a faster rate, since now fluid may also exhaust through passage 70, groove 60 and return lines 80, 72.

The same pump 68 may be employed to maintain fluid pressure in the tool carriers 28, 29 behind plungers 43, by extending from line 69 a branch pressure line 81 (Figs. 1 and 8) which communicates through suitable passages with the bores in the tool carriers that contain the plungers 43. According to the present invention these passages are so arranged that the fluid pressure does not act upon shaft 32 to urge it along axis 26. For this purpose a cylindrical stem 82 secured to the frame telescopes in a cylindrical bore 83 in shaft 32. The cylindrical surface of the stem has an annular recess 84 that is closed at both ends, this recess communicating through ports 85 and 86 with line 81, and through passage 87 and annular recesses 88 in shaft 32, with passages 89 in the tool carriers. Because the passage 87 opens into recess 84 through the cylindrical surface of bore 83, fluid pressure in the passage does not act to urge shaft 32 axially. Any fluid leaking past seals 91 on stem 82 may escape freely from bore 83 through drain openings 90, so as to avoid build-up of pressure in the bore. Accordingly the loads on lever 54, and on its pivots to the frame and to the carriers, are limited to those resulting from mechanical friction of the parts, the action of the tools T and T' on the wheel W, and the action between the cams and the cam followers 35 and 39 which, depending upon the phase of operation, is either resisted or aided by the hydraulic pressure exerted on plungers 43.

The guarding for excluding undesired matter from the interior of the dresser includes a guard plate 92 secured to frame 20 in slightly spaced relation thereto, the spacing being effected by a frame of shims 93 underlying the peripheral portion of plate 92. Plate 92 has a rectangular central opening to pass the tool arm attaching portions of carriers 28, 29 and to accommodate their motions. This opening is partially closed by a pair of parallel plates 94 which are secured to and spaced by a rectangular frame of shims 95, forming a unit that is slidable in telescoping relation upon the plate 92 in the direction of rectilinear motion of tool carriers 28, 29. Secured to this slidable guard unit, for moving it with the carrier assembly, is a key 96 which seats in a keyway in carrier 29, this keyway being of sufficient angular extent about axis 26 to accommodate the angular motion of the carrier. An auxiliary stationary guard plate 97 secured to the upper end of the frame covers the upper end of the outer plate 94, which, as shown in Fig. 6, has an inturned flange 94' along its forward edge.

Plates 94 also have a central opening to accommodate the angular motion of the arm attaching portions of the carriers 28, 29, and this opening is closed by two U-shaped guards 98 each of which embraces the arm attaching portion of one carrier, in the manner shown in Fig. 7. Guards 98 are retained by a plate 99, in the form of a rectangular frame, which is secured to plates 94 by screws 101 and spaced from the outermost plate 94 by a rectangular frame of shims 102. As either carrier 28 or 29 rocks about axis 26, its U-shaped plate 98 is slid laterally relative to the plates 94. The surfaces of the carriers which engage the leg portions of the U-shaped plates are cylindrically curved to accommodate the relative angular motion.

For further guarding the dresser interior there is secured to each carrier 28, 29 a guard member having a vertically projecting flange of which a portion 103 is curved concentrically about axis 26. Overlapping this flange is the flange 104 of a guard part secured to the movable guard assembly which comprises plates 94.

The operation of the dresser will be understood from the foregoing description and explanation of operation of the several parts. However the paths of motion of the tools T and T' over the surfaces 21, 22 and 23 of wheel W will now be further explained with reference to the schematic showing in Fig. 9. There the cam follower rollers 35, 39 are shown in full lines in the same position that is shown in Fig. 1. Roller 35 of tool carrier 28 is out of engagement with cam 36 and roller 37 engages the flat base surface of guide rail 38 to hold the carrier in the angular position thereof wherein the tip of tool T

is in the plane 105 to which the tip surface 23 of the wheel W is to be dressed. Roller 39 of carrier 29 is on the top surface 106 of cam 41, holding the carrier in such angular position that the tip of tool T' is in plane 107. Roller 42 is away from guide rail 38.

As the tool carriers move upwardly, and the cams downwardly, tool T first dresses surface 23 of the wheel. Then the curved lower surface 108 of cam 36 engages the roller 35 and moves it outwardly at an increasing rate, dressing a radius on the wheel at the juncture of surfaces 23 and 21. Next the straight inclined surface 109 of the cam engages the roller, moving the latter outwardly at a constant rate relative to travel of the cam, causing the tip of tool T to dress the outside surface 21 of the wheel. When the top surface 110 of the cam engages the roller the tip of the tool has reached plane 107 in which it remains until the conclusion of its upward stroke. By the time the cam 36 has moved downwardly out of contact with roller 35, roller 37 is on an elevated surface 111 of rail 38, thus maintaining the tool T in plane 107. The tool T and rollers 35 and 37 are shown in broken lines in their upper terminal positions.

Meanwhile, during the upward motion of roller 39 and tool T', and the downward motion of cam 41, the roller 39 is allowed to move inwardly by inclined surface 112 of cam 41, causing the tool to dress the inside wheel surface 22. When the curved surface adjoining straight inclined surface 112 near the upper end of the cam engages the roller the inward motion of the roller is gradually stopped, causing the tool to dress the radius at the junctures of wheel surfaces 22 and 23. When the roller 39 is on the upper end of the cam surface the tip of tool T' is in plane 105, and dresses the top surface 23 of the wheel. At this time roller 42 engages guide rail 38 and causes the tool T' to remain in plane 105 after the cam 41 has moved out of contact with roller 39. Finally the roller 39 is engaged by cam 36 which moves the tool inwardly along the path designated 113 to the plane 107. The terminal position of tool T', rollers 39 and 42, and cams 41 and 36 is shown in broken lines in Fig. 9. After the tool T' has passed beyond surface 23, and tool T beyond surface 21, the further upward motion of the tool carriers is merely for the purpose of moving the tools and their supporting arms well away from the wheel, and hence this further motion is preferably at an increased speed. This increase is effected by the port 60 in the piston 61 registering with the port into passage 80 immediately after the dressing action of tools has been completed, to thereby open a by-pass around the throttle valve 76 to the sump 67.

During the return or reset stroke the tools T and T' retrace the paths described above. Preferably this reset stroke is at a faster rate than the dressing stroke, the desired speeds on the two strokes depending, as explained hereinbefore, upon the settings of adjustable throttle valves 76, 78. In the preferred use of the dresser, at the conclusion of a grinding operation performed by wheel W, the dresser is operated through its reset stroke, bringing the tools T and T' to the relation to the wheel shown in full lines in Fig. 9. Then the wheel is advanced slightly along its axis W' (by any suitable means, not shown) to provide stock for dressing. Then the dressing stroke of the tools T and T' is carried out to thereby condition the wheel for a subsequent grinding operation.

With the arrangement shown in Figs. 1 and 9, each of tools T and T' dresses one side, 21 or 22, of the wheel and also dresses or at least passes over tip surface 23 of the wheel which is substantially inclined to surfaces 21 and 22. This requires the tools to be of a special shape suitable for dressing two relatively inclined surfaces. Dressing may be accomplished with less expensive tools by employing the dresser arm and tool arrangement shown in Figs. 10, 11 and 12 where each of surfaces 21, 22 and 23 of the wheel is dressed by a separate tool. Arm 25', Fig. 12, is identical with arm 25, Figs. 1 and 9, except that the tool TA' which it carries is set more nearly perpendicular to profile 22 of the wheel. Arm 24', which replaces arm 24, carries two relatively inclined tools, one designated TA for dressing side surface 21 of the wheel and the other TB for dressing the tip surface 23. The cutting tips of tools TA and TB are offset from each other in a direction parallel to wheel axis W' and also in a direction radial of the wheel axis.

The cams 36 and 41 used with arms 24' and 25' are so shaped that tool TB after dressing the surface 23 continues well therebeyond in plane 105 before moving inwardly along path 114, Fig. 12, to plane 115 which is parallel to but inwardly offset from plane 107. Tool TA, which starts the dressing stroke by motion in a plane 116 that is spaced outwardly from plane 105, engages and passes over surface 21 of the wheel after tool TB has begun its motion in path 114, and reaches plane 107 when tool TB reaches plane 115. Tool TA' begins its dressing stroke in plane 107, then moves across wheel surface 22 and beyond until it reaches plane 116 along which it moves in spaced relation to tip surface 23. Finally it moves inwardly along path 117 to plane 107.

It will be understood that the dresser herein described and illustrated, while representing the presently preferred embodiment of the invention, is susceptible to various changes, modifications and improvements, any of which may be made in the dresser without departing from the spirit of the invention or from the scope of the appended claims.

What we claim is:

1. A dresser comprising a frame, a pair of tool carriers mounted on the frame for independent angular motion about a common axis and for motion in unison along said axis, a cam carrier mounted on the frame for motion parallel to said axis, means for effecting opposite parallel motions of the tool carriers and the cam carrier, and cam means on the cam carrier and cooperating cam follower means on the tool carriers, and lying in the path of the cam means, for effecting angular motions of the tool carriers in time with their motion along said axis.

2. A dresser comprising a frame, a pair of tool carriers mounted on the frame for independent angular motion about a common axis and for motion in unison along said axis, a cam carrier mounted on the frame for motion parallel to said axis, means for effecting opposite parallel motions of the tool carriers and the cam carrier in constant velocity ratio, cam means on the cam carrier and cooperating cam follower means on the tool carriers, and lying in the path of the cam means, for effecting angular motions of the tool carriers in time with their motion along said axis, a piston reciprocable in a cylinder in the frame parallel to the said axis, a rack on the piston and a rack on the cam carrier, a pinion rotatable on the frame meshing with both racks, and means for applying fluid under differential pressures against opposed surfaces of the piston for effecting reciprocation thereof.

3. A dresser comprising a frame, a tool carrier mounted on the frame for angular motion and for rectilinear motion substantially in the direction of the axis of the angular motion, a cam carrier mounted on the frame for motion parallel to the rectilinear motion of tool carrier, a lever having a pivotal connection with each of said carriers, said lever having a pivotal connection to the frame intermediate of its pivotal connections with the carriers, for causing the rectilinear motions of said carriers to be in opposite directions, two of said pivotal connections being sliding pivots, and cam means on the cam carrier and cooperating cam follower means on the tool carrier, and lying in the path of the cam means, for effecting angular motion of the tool carrier in time with its rectilinear motion.

4. A dresser according to claim 3 in which each of

said sliding pivotal connections comprises a block pivoted to the lever and a yoke on the adjacent carrier slidably receiving the block.

5. A dresser according to claim 3 in which there is a way on the frame and a pressure-backed plunger on the tool carrier engaging the way for urging angular motion of the tool carrier to maintain engagement of the follower means with the cam means.

6. A dresser according to claim 5 in which there is a pair of parts having telescoping cylindrical surfaces coaxial of said axis of angular motion, one of said parts being secured to the frame and the other thereof being movable rectilinearly with the tool carrier, one part having a closed end recess in its said cylindrical surface and the other part having a port opening through its cylindrical surface into said recess, and means, for applying fluid pressure through the tool carrier against the inner end of said plunger, comprising a fluid passage of which said recess and port are parts.

7. A dresser according to claim 3 in which there is a guideway on the frame and the follower means on the tool carrier includes means for engaging said guideway to control the angular position of the tool carrier when the follower means is not controlled by the cam means.

8. A dresser according to claim 7 in which there is a way on the frame and a yieldable plunger on the tool carrier engaging the way for urging angular motion of the tool carrier to maintain the follower means engaged with either the cam means or the guide on the frame.

9. A dresser according to claim 7 in which the follower means on the tool carrier comprises a roller for engaging the cam means and another roller for engaging the guide on the frame.

10. In a dresser having a frame, a carrier mounted for oscillation on the frame and also for reciprocation along the axis of oscillation, the carrier having a tool carrying part projecting from the frame through an opening in the latter larger than said projecting part, and means within the frame for reciprocating and oscillating the carrier, the improvement comprising a first guard secured to the frame, a second guard reciprocable in telescoping relation to the first guard in a path parallel to said axis, the second guard being connected to the carrier for reciprocation therewith, and a third guard

overlapping the second guard and reciprocable relative thereto in a path perpendicular to said axis, said third guard embracing said tool carrying part and being reciprocable thereby upon oscillation of the carrier, said guards substantially closing said opening in all positions of the projecting part.

11. A dresser according to claim 10 wherein the carrier and the second guard are connected by key means which cause them to move in unison in the direction of said axis while permitting relative angular motion of the carrier about said axis.

12. In a dresser having a frame, a carrier mounted for oscillation on the frame and also for reciprocation along the axis of oscillation, the carrier having a tool carrying part projecting from the frame through an opening in the latter larger than said projecting part, and means within the frame for reciprocating and oscillating the carrier, the improvement comprising a first guard secured to the frame, a second guard reciprocable in telescoping relation to the first guard in a path parallel to said axis, the second guard being connected to the carrier for reciprocation therewith, the second guard having a substantially arcuate portion concentric with said axis, and a third guard secured to the carrier and having a substantially arcuate portion also concentric with said axis and disposed in overlapping relationship to the substantially arcuate portion of the second guard, said guards substantially closing said opening in all positions of the projecting part.

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