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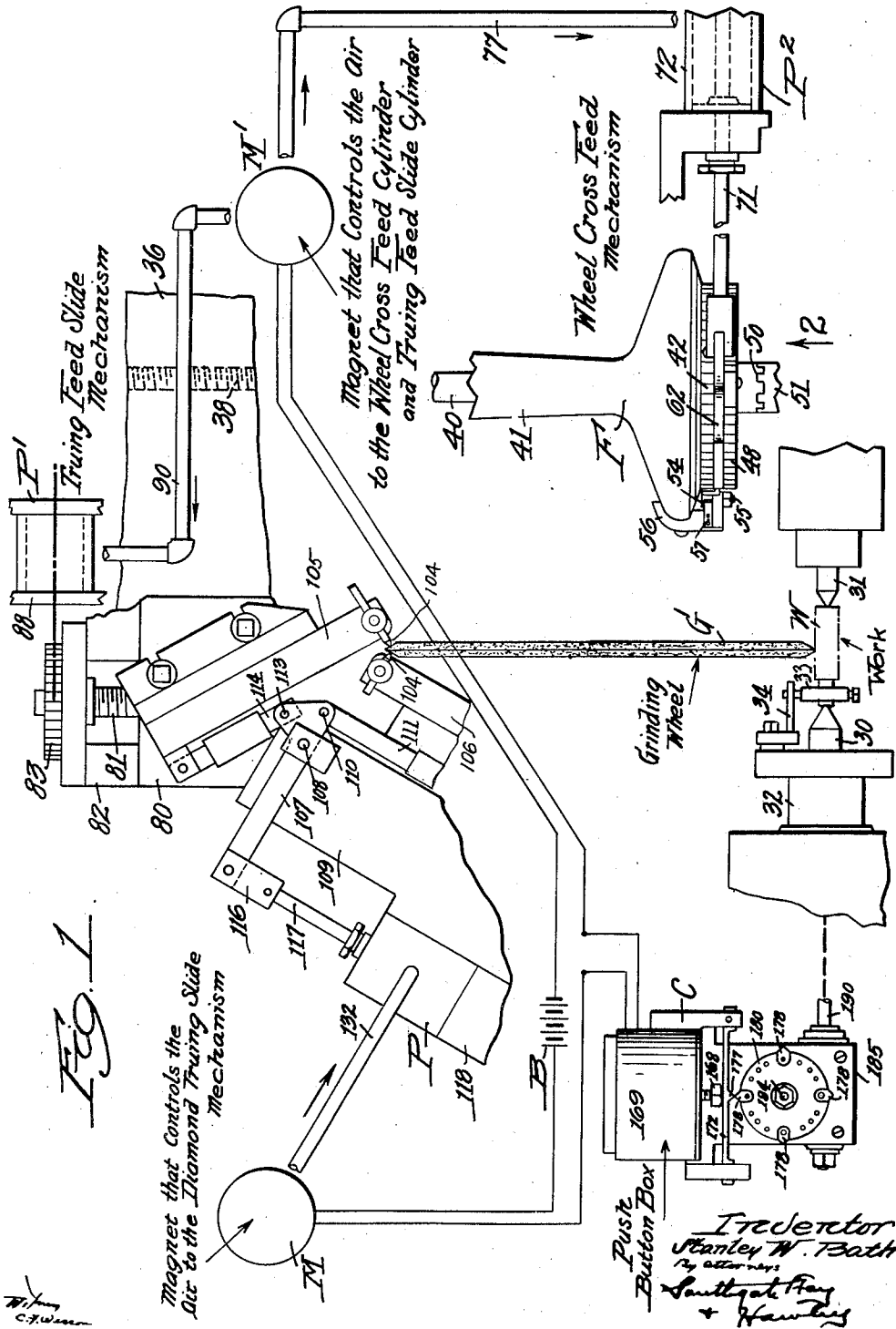
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METHOD AND APPARATUS FOR TRUING A GRINDING WHEEL

Filed May 4, 1931

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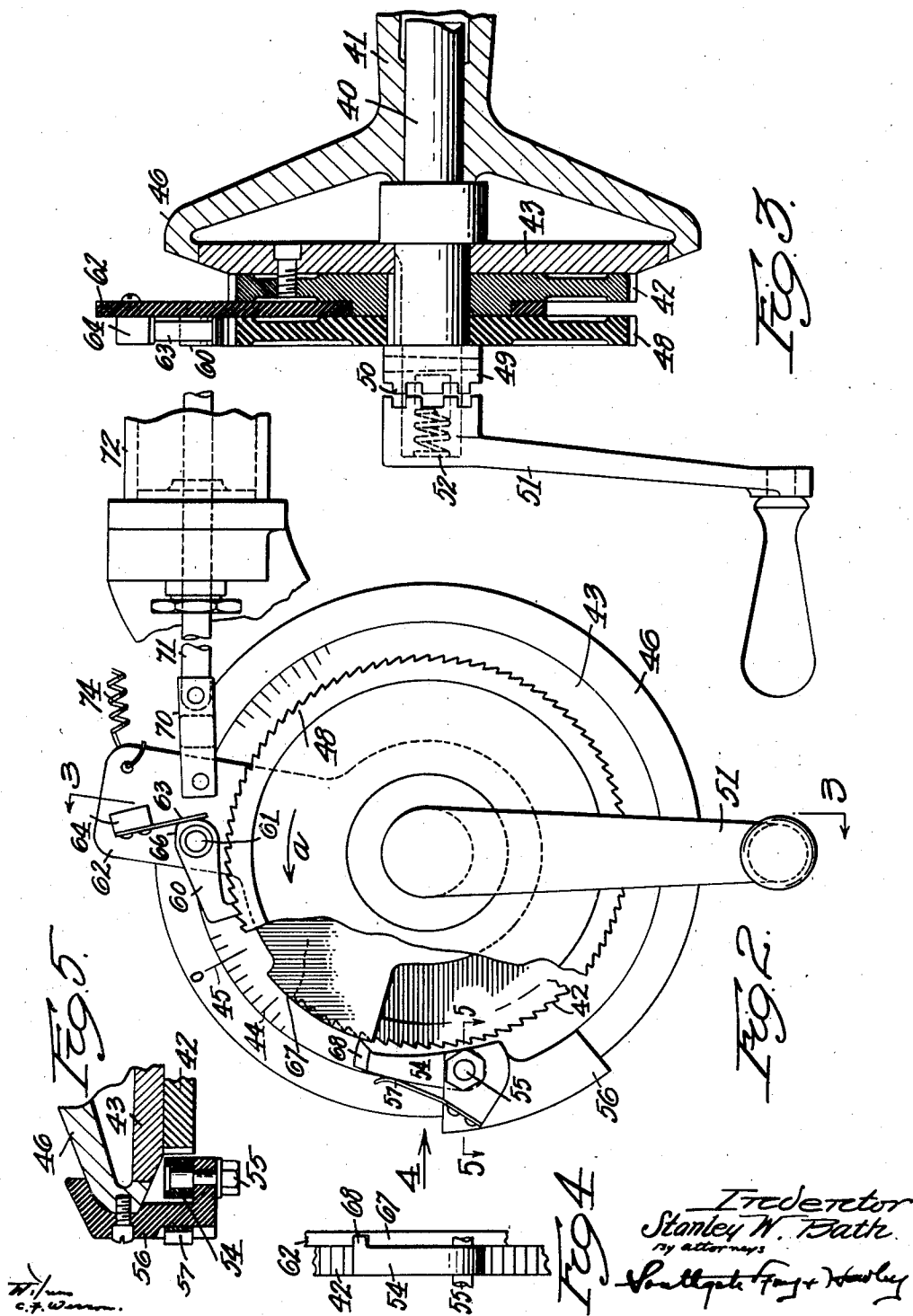
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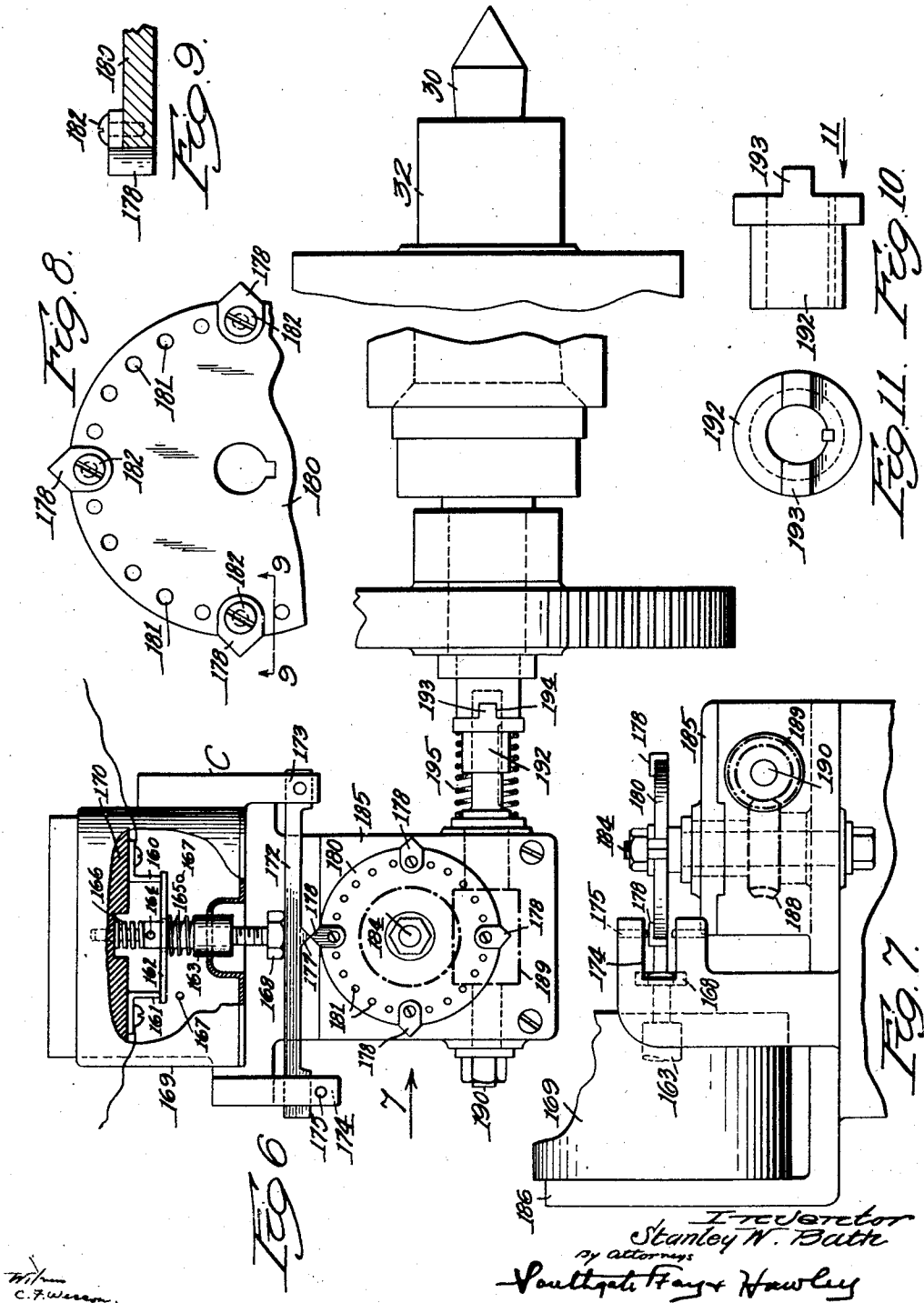
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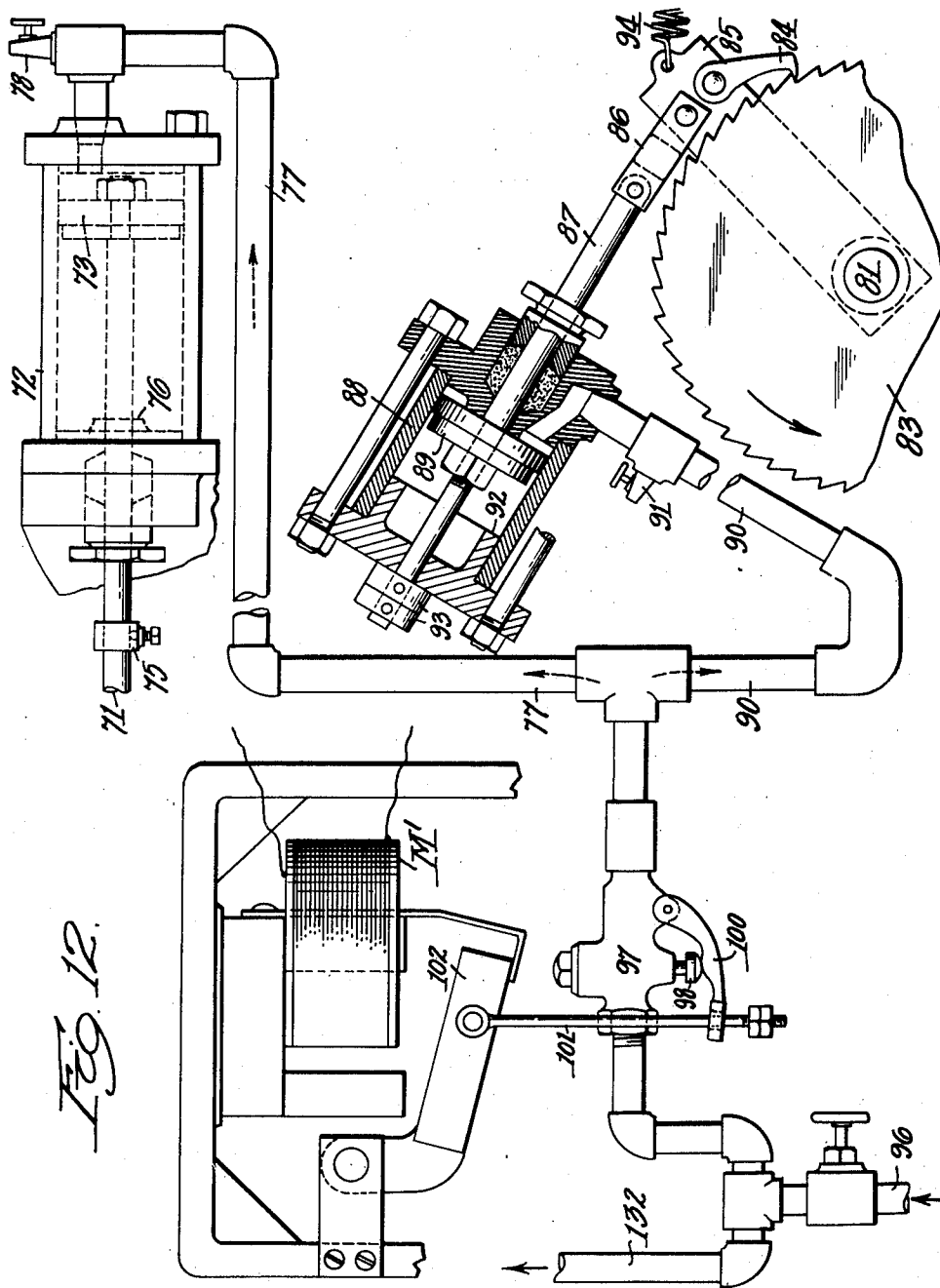
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METHOD AND APPARATUS FOR TRUING A GRINDING WHEEL

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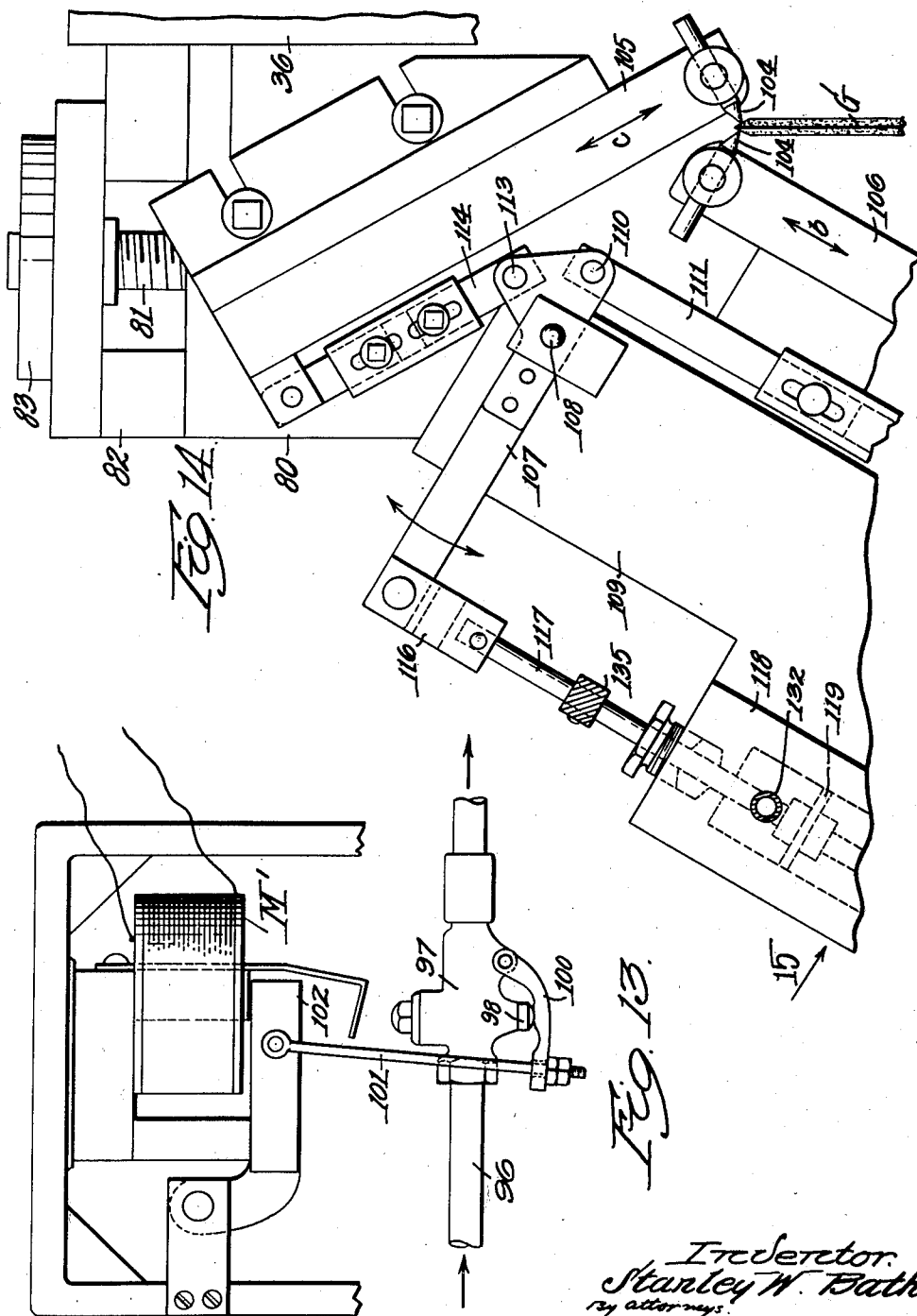
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METHOD AND APPARATUS FOR TRUING A GRINDING WHEEL

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8 Sheets-Sheet 5



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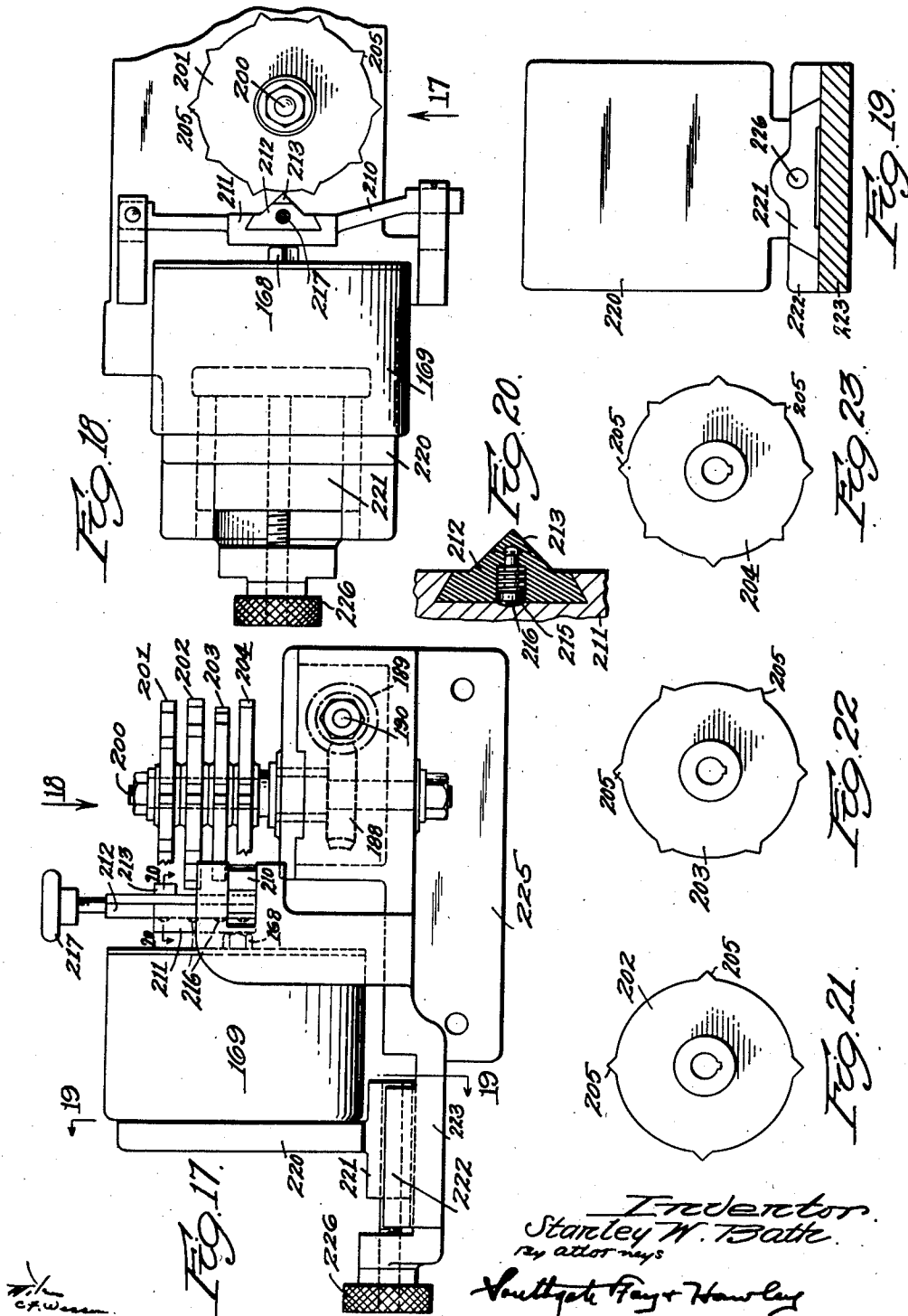
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METHOD AND APPARATUS FOR TRUING A GRINDING WHEEL

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR TRUING A GRINDING WHEEL

Application filed May 4, 1931. Serial No. 534,796.

This invention relates to grinding machines and more particularly to a method and apparatus for holding the edge of a grinding wheel to a desired section and for maintaining the edge of the wheel in a desired operative position. In accurate grinding operations, it is necessary that the cutting edge of the grinding wheel be very accurately maintained, both as to cross section and as to position relative to the work, as the work produced on modern grinding machines must be held within extremely close limits, the permissible variation being stated in ten-thousandths of an inch.

If the work is of large diameter or of an extended length, the wear of the wheel during a single grinding cut may cause a perceptible variation in the diameter of the work or in the cross section of the threads of a ground screw or tap.

It is the general object of my invention to provide an improved method of truing a grinding wheel in such manner that the desired cross section of the wheel is constantly maintained and that the wheel itself is also continuously held in predetermined and correct grinding position.

It is a further object of my invention to provide an improved wheel truing apparatus by means of which the wheel may be trued at frequent predetermined intervals and at selected rates of movement of the truing device and by which apparatus the wheel will be automatically advanced toward the work to compensate for the reduction in wheel radius caused by wear and by the truing of the wheel.

My invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawings, in which

Fig. 1 is a diagrammatic plan view showing the general relation of the different parts of the wheel truing devices and the control apparatus therefor;

Fig. 2 is a front elevation of a portion of the cross feed mechanism, looking in the direction of the arrow 2 in Fig. 1;

Fig. 3 is a sectional side elevation, taken along the line 3—3 in Fig. 2;

Fig. 4 is a detail side elevation, looking in the direction of the arrow 4 in Fig. 2;

Fig. 5 is a detail sectional plan view, taken along the line 5—5 in Fig. 2;

Fig. 6 is a plan view, partly in section, of the work spindle and certain circuit-closing mechanism associated therewith;

Fig. 7 is a partial end elevation, looking in the direction of the arrow 7 in Fig. 6;

Fig. 8 is an enlarged partial plan view of a control cam;

Fig. 9 is a detail sectional elevation, taken along the line 9—9 in Fig. 8;

Fig. 10 is a side elevation of a clutch collar;

Fig. 11 is an end view thereof, looking in the direction of the arrow 11 in Fig. 10;

Fig. 12 is a side elevation of certain air-control devices and pneumatic mechanism to be described;

Fig. 13 shows a part of an air-control device in a different position;

Fig. 14 is a partial plan view of the wheel truing devices;

Fig. 15 is a side elevation of the mechanism for actuating the wheel truing devices, looking in the direction of the arrow 15 in Fig. 14;

Fig. 16 is a sectional plan view of certain valve mechanism, taken along the line 16—16 in Fig. 15;

Fig. 17 is a side elevation of a modified circuit-closing mechanism;

Fig. 18 is a plan view thereof, looking in the direction of the arrow 18 in Fig. 17;

Fig. 19 is a detail sectional view, taken along the line 19—19 in Fig. 17;

Fig. 20 is a detail sectional plan view, taken along the line 20—20 in Fig. 17,

Figs. 21, 22 and 23 are plan views of different control cams;

Fig. 24 is a front elevation partly in section, showing a modified construction, and

Fig. 25 is an enlarged sectional elevation, showing certain parts appearing in Fig. 24 but in a different position.

General description

Referring to Fig. 1, I have shown the

several parts of my improved wheel truing devices and control apparatus in diagrammatic relation. The work W is mounted on head and tail centers 30 and 31 and is rotated by a work spindle 32 through any suitable driving connections, such as a dog 33 and driver 34.

Wheel truing mechanism T is provided by which the edge of the grinding wheel G may be held to a desired cross section, such as a V-shaped section adapted to grind a screw-thread in the work W. The grinding wheel G is mounted on a wheel slide which may be advanced toward the work W by cross feed mechanism F which may be both manually and automatically operated.

Circuit-closing mechanism C is actuated by a suitable driving connection from the work spindle 32 and is connected in series with control magnets M and M' and a battery B or other source of current. The magnet M controls the supply of air to pneumatic mechanism P by which the wheel truing mechanism T is actuated, and the magnet M' controls the supply of air to pneumatic mechanism P' by which the wheel truing mechanism T is fed toward the grinding wheel G, and also controls the supply of air to pneumatic mechanism P² by which the cross feed mechanism F is operated.

Briefly described, the operative relation of these several parts is as follows:

A cam in the circuit-closing mechanism C rotates in timed relation with the work spindle 32 and periodically closes the circuit through the magnets M and M' at predetermined frequent intervals. The magnet M, when energized, admits air to the pneumatic mechanism P which actuates the truing devices, so that the diamond points are moved one or more times past the edge of the grinding wheel G.

At the same time, the magnet M', being energized, admits air to the pneumatic mechanism P', causing the truing devices to be advanced a predetermined amount toward the grinding wheel. At the same time the pneumatic mechanism P² advances the wheel slide toward the work by an amount equal to the feed of the truing devices, these truing devices being mounted on the wheel slide and partaking of the cross feed movement.

By this combination of devices I am thus able to true the grinding wheel at predetermined frequent intervals during the grinding of a single piece of work W, and at each truing of the wheel the wheel is advanced toward the work an amount equal to the reduction in radius of the wheel by wear and by the truing operation.

I thus maintain the cutting edge of the grinding wheel in the desired cross section and in the desired cutting position, and this relationship will be maintained without attention from the operator until the grinding

wheel is worn away to its smallest useful diameter.

Other advantages and capabilities of my improved apparatus and other features of my improved method will be disclosed as the detailed description of the mechanism proceeds.

Cross feed mechanism

The details of the cross feed mechanism F are shown in Figs. 2 to 5 inclusive. The grinding wheel G (Fig. 1) is mounted on a wheel slide 36, movable toward and from the work W by a cross feed screw 38. A feed shaft 40 is connected to operate the cross feed screw 38 and is rotatable in a support 41 (Fig. 3) fixed on the wheel slide 36.

A ratchet wheel 42 (Fig. 3) is keyed to the shaft 40 and an index plate 43 is secured to the wheel 42 and is rotatable therewith. The plate 43 is graduated as indicated at 44 (Fig. 2) and rotates adjacent an index line 45 on the edge of an enlarged portion 46 of the support 41.

A second ratchet wheel 48 is keyed to the shaft 40 and is held thereon by a collar 49 having clutch teeth 50 on its outer face, which teeth are positioned for engagement by similar teeth on the hub of a handle 51, normally disengaged from the clutch collar 49 by a spring 52.

A hold-back pawl 54 is pivoted on a stud 55 mounted in a bracket 56 (Fig. 5) secured to the edge portion 46 of the support 41. A spring 57 yieldingly presses the pawl 54 toward the ratchet wheel 42. The hold-back pawl 54 prevents forward movement of the cross feed shaft 40 except when the pawl 54 is disengaged.

A feed pawl 60 is pivoted at 61 on a feed lever 62, which is mounted for free angular movement on a hub portion of the ratchet wheel 42 (Fig. 3). A spring 63 (Fig. 2) is secured to a block 64 on the lever 62 and engages the pawl 60, holding it yieldingly in operative engagement with the ratchet wheel 48. The pawl 60 is provided with a flat surface 66 which may be turned into contact with the spring 63 to hold the pawl 60 inoperative when desired.

The feed lever 62 has a shield portion 67 which is normally positioned for engagement by a lug 68 (Fig. 4) on the side of the hold-back pawl 54. When the feed lever 62 is moved backward or clockwise, as viewed in Fig. 2, the shield 67 is moved under the lug 68 and raises the pawl 54 to inoperative position.

At the end of each feeding stroke, however, the shield 67 passes beyond the lug 68, allowing the pawl 54 to engage the ratchet wheel 42 and thus prevent overfeeding.

It will be understood that the feed lever 62 moves anticlockwise or in the direction of the arrow a in Fig. 2 on its feeding stroke, and that this feeding stroke always termi-

nates at the same point. Variation in the amount of cross feed is attained by varying the extent of the return or idle movement of the feed lever 62.

15 The feed lever 62 is connected by a link 70 (Fig. 2) to one end of a piston rod 71, which extends into a pneumatic cylinder 72 and is secured to a piston 73 (Fig. 12) therein. Return movement of the feed lever 62 and piston rod 71 is effected by a spring 74 (Fig. 2) and the extent of return movement is determined by the position of a stop collar 75 (Fig. 12) on the piston rod 71. The advance limit of the feeding movement of the piston rod is determined by the engagement of the piston 73 with a hub or shoulder 76 in the cylinder 72. As such advance limit is reached, the shield 67 passes from under the lug 68 on the hold-back pawl 54 and the pawl 54 prevents any overthrow of the ratchet wheel 48 or feed shaft 40.

Air is admitted to the cylinder 72 through a feed pipe 77 (Fig. 12), and a small bleed valve 78 permits gradual exhaust of the cylinder and return of the piston 73 to rearward position under the influence of the spring 74.

By the mechanism described, I obtain a predetermined advance movement of the cross feed shaft 40 as often as air is admitted through the pipe 77 to the cylinder 72, the amount of feed for each such actuation being controlled by the position of the stop collar 75.

Truing device feed

35 A similar mechanism is provided for simultaneously advancing the truing devices of the mechanism T toward the grinding wheel G. The truing mechanism is mounted on a cross slide 80 (Fig. 1) engaged by a feed screw 81 mounted on a support 82 formed integral with or attached to the wheel slide 36.

A ratchet wheel 83 (Fig. 12) is fixed to the feed screw 81 and is engaged by a pawl 84 mounted on a feed lever 85, which is connected by a link 86 to a piston rod 87 extending into a cylinder 88 and secured to a piston 89. Air is admitted to the cylinder 88 through a pipe 90 provided with a bleed valve 91.

45 The forward end of the feeding stroke is determined by engagement of the piston 89 with an annular shoulder 92 within the cylinder 88, and the extent of return movement of the feed pawl is adjustably determined by collars 93 on the outer end of the piston rod 87.

55 A spring 94 effects the return or idle movement of the pawl 84, during which return movement the air in the cylinder escapes through the bleed valve 91.

Air control

60 Air for the cylinders 72 and 88 is provided through a supply pipe 96 from any suitable source of air pressure. The flow of air to the feed pipes 77 and 90 is controlled by a valve 97 having a valve rod 98 engaged by a lever

100. The lever 100 is connected by a link 101 to the armature 102 of the magnet M'. When the magnet is energized, the armature 102 is raised, lifting the valve rod 98 allowing air to flow to the feed pipes 77 and 90. This operative position of the armature and valve mechanism is shown in Fig. 13.

Truing device and actuating mechanism therefor

75 A suitable construction for the truing devices is shown in Fig. 14, in which diamond points 104 are mounted on slides 105 and 106, suitably supported for straight line reciprocation as indicated by the arrows *b* and *c*.

80 An actuating lever 107 is pivoted at 108 on a plate 109 fixed to the truing mechanism slide 80. The lever 107 is pivotally connected at 110 to a link 111, adjustable in length and pivotally secured to one end portion of the slide 106. The lever 107 is also pivotally connected at 113 to a link 114, similarly adjustable in length and pivoted to an end portion of the slide 105. The outer end of the lever 107 is connected by a link 116 to a piston rod 117 extending through a cylinder 118 (Fig. 15) and having a piston 119 secured to the rod and slidable in the cylinder.

90 The opposite ends of the cylinder 118 are connected by pipes 120 and 121 (Fig. 15) to a reversing valve mechanism comprising a cylinder 122 (Fig. 16) in which a piston valve V is slidable. The valve V comprises piston portions 124, 125 and 126, separated by reduced portions 127 and 128 which provide 100 annular air passages between the piston portions.

Exhaust pipes 129 and 130 and an air supply or intake pipe 132 are connected to suitable parts in the cylinder 122.

105 When the piston valve V is in the right hand position indicated in Fig. 16, the air intake 132 is connected to the pipe 120 extending to the right hand end of the cylinder 118, as viewed in Fig. 15, while the pipe 121 from the left hand end of the cylinder 118 is connected to the exhaust pipe 130.

110 If the valve V is moved to the left hand end of the cylinder 122, the intake pipe 132 will be connected to the pipe 121 and the pipe 120 will be connected to the exhaust pipe 129.

115 The air intake pipe 132 is connected to the air supply pipe 96 (Fig. 12) below the valve 97, and the flow of air through the pipe 132 is controlled by the magnet M (Fig. 1) which is arranged to operate valve mechanism not shown but identical in construction with the valve 97 which controls the truing device and wheel slide feeds.

120 A hand valve 133 (Fig. 15) in the pipe 132 may be set to control the rate at which air can flow through the pipe 132 to the pneumatic mechanism P which actuates the truing mechanism T.

125 An arm 135 (Fig. 15) is secured to the

piston rod 117 and is connected to a rod 136, slidable in suitable fixed bearings and provided with dogs 137 axially adjustable thereon and engaging the lower end of a rocking lever 138, connected through a second rocking member 139 and link 140 to an arm 141 (Fig. 16) mounted on the end of the piston rod 142 for the piston valve V.

Through these connections, the valve V is automatically reversed, thus correspondingly reversing the travel of the piston 119 and piston rod 117.

In order to secure a smooth and even motion of the piston rod 117 and the truing device slides connected therewith, I connect the piston rod 117 by a coupling 144 (Fig. 15) to a piston rod 145, which is provided with a piston 146 slidable in a cylinder 147.

The ends of the cylinder are connected together through piping 148 and a manually adjustable valve 149. A branch pipe 150 extends from the piping 148 to a tank or oil supply 151. A check valve 152 is placed in the branch pipe 150 and opens away from the tank 151.

The cylinder 147 and piping 148 is filled with oil or some similar liquid, which flows back and forth from one end of the cylinder 147 to the other as the piston rod 117 is reciprocated.

By suitable setting of the valve 149, the rate of flow of oil may be adjusted as desired, with a corresponding determination of the rate of movement of the piston rod 117. The cylinder 147 and piping 148 is constantly maintained full of oil by the in-flow of oil from the tank 151 to make up for any leakage.

By thus attaching an oil brake to the air-operated piston rod 117, I avoid the objections heretofore encountered in operating such mechanism by direct air pressure, which operates too quickly and is difficult to control.

Circuit closing mechanism

I will now describe the mechanism by which the circuit through the magnets M and M' is closed at frequent predetermined intervals.

Referring particularly to Figs. 6 to 10, I have shown the circuit-closing mechanism C as mounted at the end of the head stock and as being connected to be driven in timed relation thereto. The circuit-closing mechanism comprises terminal or contact members 160 and 161 (Fig. 6) inserted in the circuit which connects the magnets M and M' (Fig. 1) with the battery B.

A contact plate 162 is loosely mounted on a stud or plunger 163 and is normally held against a cross-pin 164 by a light spring 165. The plunger 163 is yieldingly pressed outward by a coil spring 166 and the outward movement of the stud 163 is limited by engagement of the plate 162 with stop pins 167. A contact screw 168 is adjustably

threaded into the end of the plunger 163.

The plunger 163 is slidable in bearings in a casing 169, and the contact members 160 and 161 are mounted on a disc or base 170 of insulating material secured in the casing 169. The contact screw 168 is positioned for engagement by a lever 172, pivoted to a projection 173 of the casing 169, with the free swinging end of said lever extending through a slotted guide 174 and engaging a stop-pin 175.

A V-shaped projection 177 on the front side of the lever 172 is positioned for engagement by cam blocks 178 secured in spaced relation on a cam disc 180. The disc 180 is provided with a large number of holes 181 to receive clamping screws 182 for the cam blocks 178. Any desired number of cam blocks may be thus secured in spaced relation about the periphery of the disc 180.

The disc 180 is secured to the upper end of a short vertical shaft 184 (Fig. 7), rotatable in suitable bearings in a stand 185 mounted in fixed relation to the head-stock and having a rearwardly and upwardly projecting portion 186 supporting the contact casing 169. A worm gear 188 is secured to the lower end of the upright shaft 184 and is engaged by a worm 189 on a worm shaft 190, rotatable in bearings in the stand 185 and aligned with the work spindle 32.

A clutch collar 192 is keyed to the end of the worm shaft 190 and is provided with a driving projection 193 adapted to enter a corresponding notch or recess 194 in the end of the work spindle 32 when pressed outward by a coil spring 195. This clutch connection is provided to permit convenient removal of the circuit-closing mechanism C when desired.

As the work spindle 32 rotates, the cam disc 180 rotates in definite speed relation thereto and the cam blocks 178 periodically engage the V-shaped projection 177 (Fig. 6) forcing the lever 172 and plunger 163 rearward to close the circuit between the contact members 160 and 161.

The frequency with which the circuit is closed may be varied by increasing or decreasing the number of cam blocks on the disc 180, and the length of time that the circuit remains closed may be varied by adjustment of the screw 168. If the screw is adjusted outward toward the lever 172, the circuit will obviously remain closed for a longer period at each engagement of the lever 172 by a cam block 178.

In Figs. 17 to 23, I have shown a construction which permits convenient changing of the intervals between successive closings of the circuit, and also permits more convenient adjustment of the length of time that the circuit is maintained closed.

In this modified construction, I provide the upright shaft 200, corresponding to the

shaft 184 previously described, with a plurality of cam discs 201, 202, 203 and 204, which discs are keyed to the shaft 200 and rotate together with the shaft but are provided with differently spaced cam projections 205 on their peripheries.

A lever 210, corresponding to the lever 172 previously described, is provided with an upwardly extended guiding portion 211 (Figs. 17 and 18) having a dove-tailed guideway for a slide 212 having a contact projection 213 (Figs. 17 and 20).

A spring plunger 215 in the slide 212 cooperates with recesses 216 in the upright projection 211 to maintain the slide 212 and projection 213 in the plane of a selected cam disc as 201. With this construction, the frequency of the closing of the circuit which controls the truing devices and cross feed may be varied by simply moving the slide 212 manually upward or downward. A handle 217 (Fig. 17) is provided to facilitate this adjustment.

In this modified construction, I have also mounted the casing 169 for the contact members on an upwardly extending arm 220 of a slide 221, mounted in guideways 222 on a rearward projection 223 of a stand 225, corresponding to the stand 185 previously described.

An adjusting screw 226 is threaded into the slide 221 and by rotation of the screw 226 the slide 221 and casing 169 can be adjusted forward or rearward relative to the lever 210 and cam discs 201 to 204. I am thus able to adjust both the time interval between contacts and also the length of contact in a very convenient manner and without stopping the machine.

While I have described the circuit closing mechanism as driven in definite speed relation with the rotation of the work, it is obvious that many of the advantages of this construction will be retained if the circuit closing mechanism is operated independently from the rotation of the work as by a separate belt or motor drive.

Having described the general method of operation and also the details of construction of my invention, the important advantages of my improved method and apparatus will be readily apparent.

The invention is of substantial value in producing duplicate work, as the wheel edge will be held to the desired section and will be maintained in the desired position for an indefinite period without attention by the operator and will in fact be maintained in such condition and position until the diameter of the wheel has been reduced to its limit of usefulness.

The invention is of even greater value in the production of work of large diameter or of extended length and of extreme accuracy. For instance, in the production of a ground

thread lead screw, the length of the screw is such that the wear of the wheel will introduce substantial inaccuracies before a single passage of the wheel over the entire length of the screw thread can be completed.

With my improved wheel truing apparatus operated by my improved method, the wheel may be trued and advanced to the predetermined operative position as often as may be desired during the continued operation of the grinding wheel. By advancing the wheel simultaneously with the operation of the truing devices, and by truing the wheel frequently, so that only a very slight amount of material is removed from the wheel, at each truing, no perceptible inaccuracies are produced by the truing and feeding of the wheel during a continued grinding operation.

The frequency of the wheel truing operations may be determined as desired by providing the proper number of cam blocks on the cam disc 180, or by providing cam discs 201 to 204 having any desired number of projections. Obviously also, the speed ratio between the worm shaft 190 and the upright shaft 184 or 200 may also be varied.

By adjustment of the contact screw 168 (Fig. 6) or the adjusting screw 226 (Fig. 17) the length of time during which the contact remains closed may be varied, thus varying the number of passes of the diamond-points across the wheel face at each truing operation.

The rate of movement of the truing devices may be controlled, as previously stated, by adjustment of the oil brake valve 149, and the extent of feed of the truing mechanism and the compensating feed of the wheel slide may be varied by adjustment of the collar 75 (Fig. 12) for the cross feed and the collars 93 for the truing device feed.

My improved truing mechanism is thus extremely flexible and capable of adaptation to every operative condition. The provision of these several adjustments is extremely important, as the conditions of wheel truing and operation vary greatly with different grinding wheels and under different conditions of operation.

If the grade of the grinding wheel is relatively soft, the wheel truing operation should be performed more frequently and the speed of movement of the wheel dressing tools may be increased. If the diamond points are dull or of softer substance, a slower movement of the wheel dressing tools is indicated.

The diamond point should also be moved more slowly when dressing a wheel for a finishing cut and more rapidly when dressing a wheel for a roughing cut. All of these various conditions can be taken into account with my improved mechanism, in which extensive and convenient adjustment is provided for varying the wheel truing operation to suit operative conditions.

In Figs. 24 and 25 I have shown modified reversing mechanism for the wheel truing devices, this mechanism having the advantage of always bringing the truing devices to rest at the end of the stroke and out of contact with the grinding wheel.

In this construction, the piston rod 117, piston 119 and reversing rod 136 operate as in Fig. 15, and the reversing valve V is similarly connected to the cylinder 118. The supply pipe 230 (Fig. 24) is directly connected to the main air supply of the machine, so that when the shut-off valve 231 is open the air supply is continuously connected to the cylinder 122 in which the reversing valve V is mounted.

The magnet M, previously described, is utilized to control a shut-off valve 232 located in a branch pipe 233 connecting the air supply pipe 230 to a pneumatic reversing mechanism R. This mechanism comprises an upper cylinder 240 in which a piston 241 is slidable, and a lower cylinder 242 in which a piston valve 243 is slidable. The piston 241 is connected to a piston rod 245 to the piston rod 142 connected to the reversing valve V.

The piston valve 243 has a valve stem 247 on which is mounted a cross arm 248. The upper end of the cross arm is provided with an opening to receive a guide-pin 249 fixed in the end of the casing for the reversing mechanism R. The lower end of the cross arm 248 extends into the path of reversing dogs 250 and 251 on the reversing rod 136. Springs 252 are provided at each side of the arm 248 to cushion the contact of the dogs 250 and 251 therewith and to permit a slight continued motion of the reversing rod 136 during the action of the pneumatic reversing mechanism.

The upper cylinder 240 is connected by passages 260 and 261 (Fig. 25) with the lower cylinder 242, and the cylinder 242 is provided with an annular port 263 connected to the branch supply pipe 233. The lower cylinder 242 also has two exhaust ports or vents 234 and 235. The piston valve 243 is formed with three cylindrical piston portions, separated by reduced connecting portions providing annular air passages.

The operation of the pneumatic reversing mechanism is as follows:—

The parts are shown in Fig. 24 with the valve V in its right hand position, connecting the supply pipe 230 to the pipe 120 which supplies air to the right hand end of the cylinder 118. The piston 241 in the upper cylinder 240 is also at its right hand limit of travel, and the piston valve 243 is at the right hand end of the cylinder 242.

The piston 119 and piston rod 117 will thereupon proceed to move toward the left or in the direction of the arrow α in Fig. 24 until the dog 251 engages the lower end of the cross arm 248, which will cause the piston valve 243 to move to the position indicated in

Fig. 25. In this position the supply pipe 233 is connected through the port 263 and passage 261 to the right hand end of the upper cylinder 240, and the left hand end of the upper cylinder is connected through the passage 260 to the exhaust pipe 234. The piston 241 will thereupon move to the left hand end of the cylinder 240, causing simultaneous movement of the reversing valve V in the cylinder 122, whereupon the piston 119 and piston rod 117 will commence a reverse movement to the right in Fig. 24.

At the end of the reverse stroke, when the dog 250 engages the cross arm 248, the piston valve 243 will be returned to its first position, causing return movement of the upper piston 241 and the reversing valve V to their initial positions.

The reversing mechanism R will continue to operate so long as the magnet M holds the valve 232 open. When the circuit is broken by the cam operated circuit-controlling mechanism C, the valve 232 will close, preventing further action by the reversing mechanism R, but this does not effect the air supply of the cylinder 118, which is continuous so long as the shut-off valve 231 is open.

Consequently, the piston 119 and piston rod 117 will continue their movement to the end of the stroke, regardless of the closing of the valve 232. At the end of the stroke the piston valve 243 will be reversed in position but no movement of the upper piston 241 and reversing valve V will take place until air is again admitted by the opening of the valve 232.

Consequently, the movement of the truing devices will stop at the end of the stroke immediately following the closing of the valve 232, but the truing devices will not stop at any intermediate point in the stroke and consequently cannot stop in contact with the grinding wheel. This is a substantial advantage, as such continued contact will cause a slight groove in the grinding surface which will produce a corresponding irregularity in the work.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:—

1. The method of producing a piece of work having an extended and substantially continuous surface of rotation which consists in continuously moving a grinding wheel lengthwise of the work and along the axis of the wheel during the rapid rotation thereof, in feeding a truing mechanism a predetermined distance toward the grinding wheel during the grinding operation and truing the wheel to a selected grinding face, in substantially simultaneously feeding the wheel and truing mechanism forward as a unit toward the work by an amount equal to the feed

of the truing mechanism, and in repeating said feeding and truing operations at predetermined short intervals during a single continuous movement of the wheel lengthwise of the work and during a single continuous grinding engagement of the wheel with the work.

2. In a grinding machine, means for supporting and rotating a piece of work, a grinding wheel, wheel truing devices, actuating mechanism therefor, and control means operable to cause actuation of said truing devices at predetermined intervals during rotation of the grinding wheel in continuous grinding engagement with the work and in predetermined relation to the rotation of the work.

3. In a grinding machine, means for supporting and rotating a piece of work, a grinding wheel, wheel truing devices, actuating mechanism therefor, control means for said actuating mechanism rendered operable after each of a plurality of successive predetermined periods of work rotation and during a single continuous grinding engagement of the wheel with the work, and means to give said wheel a compensating feeding movement substantially simultaneous with each wheel dressing operation.

4. In a grinding machine, means for supporting and rotating a piece of work, a grinding wheel, wheel truing devices, actuating mechanism therefor, control means operable to cause actuation of said truing devices at a plurality of predetermined intervals during a single continuous grinding engagement of the grinding wheel with the work, and means to selectively adjust the rate of movement of the truing device relative to the rate of rotation of the grinding wheel, said adjusting means being operable to effect a relative speed adjustment during a continuous grinding operation on the work.

5. In a grinding machine, means for supporting and rotating a piece of work, a grinding wheel, wheel truing devices, actuating and feeding mechanism therefor, a wheel slide supporting said truing devices, means to feed said wheel slide, and a single control device for said actuating and feeding mechanism and said wheel slide feeding means, said control device being rendered repeatedly and periodically operative during a single continuous grinding engagement of the wheel and work and in timed relation to the rotation of the work.

6. The combination in a grinding machine as set forth in claim 5, in which said control device includes an electric circuit and a circuit-closing device therefor, and in which mechanism is provided effective to close said

circuit at predetermined intervals in definite relation to the rotation of the work.

7. The combination in a grinding machine as set forth in claim 5, in which said control device includes an electric circuit and a circuit-closing device therefor, and in which cam mechanism is provided effective to close said circuit at predetermined intervals in definite relation to the rotation of the work.

8. The combination in a grinding machine as set forth in claim 5, in which said control device includes an electric circuit and a circuit-closing device therefor, and in which cam mechanism is provided effective to close said circuit at predetermined intervals relative to the rotation of the work and for a selected predetermined period.

9. The combination in a grinding machine as set forth in claim 5, in which said control device includes an electric circuit and a circuit-closing device therefor, and in which cam mechanism is provided effective to close said circuit at predetermined intervals relative to the rotation of the work, and in which means is provided for adjustably determining the period during which the circuit remains closed.

10. The combination in a grinding machine as set forth in claim 5, in which said control device includes a plurality of cams mounted to rotate in timed relation to the work, a circuit-closing member, and a contact device on said member manually adjustable to engage a selected cam.

11. In a grinding machine, a grinding wheel, a wheel truing device, pneumatic mechanism for moving said truing device across a face of said wheel, automatic means to repeatedly reverse said pneumatic mechanism at the ends of the path of travel of said truing device, and additional means to cause said truing device to come to rest only at the end of a truing movement.

12. In a grinding machine, a wheel truing device, pneumatic actuating mechanism therefor having a continuous air supply, a reversing valve for said mechanism, a cylinder and piston, one of which is connected to move said valve, a valve controlling the air supply to said cylinder, automatic means to move said latter valve to cause said reversing valve to repeatedly reverse said pneumatic actuating mechanism at the ends of the path of travel of said truing device, and additional means to periodically admit air to said latter valve, said additional means being rendered operative in predetermined relation to the rotation of the work.

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