# United States Patent [19]

**Kushigian**

[11] **3,711,997**

[45] **Jan. 23, 1973**


[54] **AUTOMATIC DRILL POINTING MACHINE WITH AUTOMATIC DRILL LOCATER SYSTEM**


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[22] Filed: **July 6, 1971**

[21] Appl. No.: **159,921**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 872,670, Oct. 30, 1969, abandoned.

[52] **U.S. Cl.** .....**51/105 R,** 51/165 R, 51/215 H, 51/219 R

[51] **Int. Cl.** .....**B24b 3/26**

[58] **Field of Search**...51/105 R, 165 R, 215 CP, 215 H, 51/219 R



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*Primary Examiner*—Donald G. Kelly

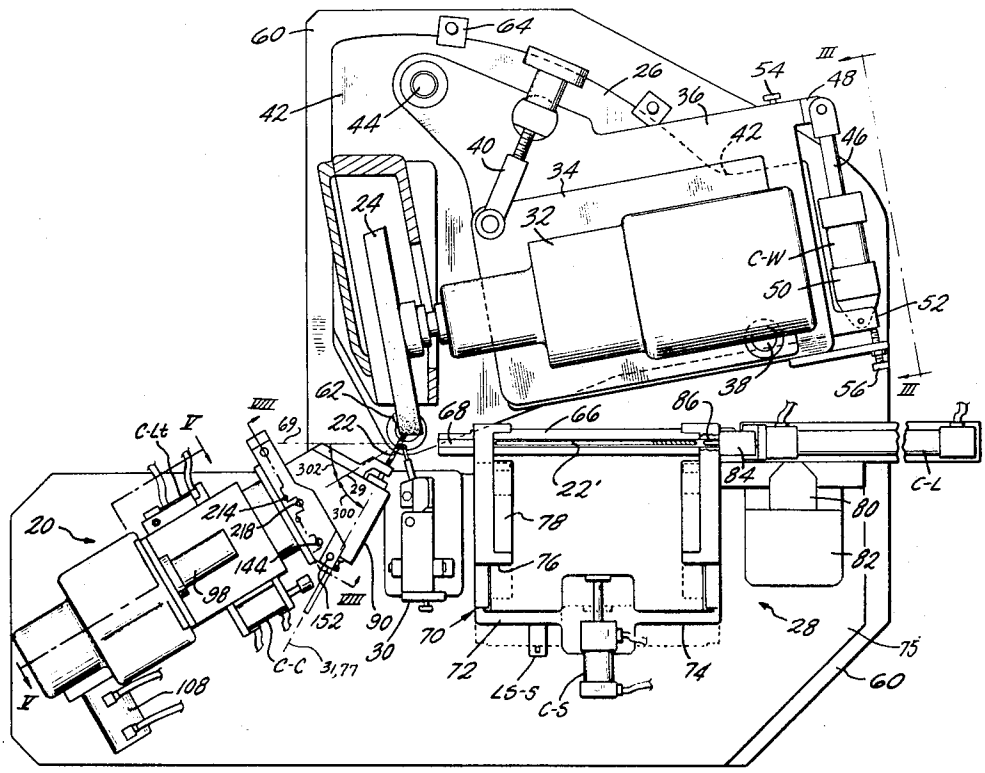
*Attorney*—Barnes, Kisselle, Raisch & Choate



[57] **ABSTRACT**

An automatic drill pointing machine wherein unpointed drills are automatically fed to a loader from a hopper, loaded into the chuck of a work head, properly located and then ground. A particular locater assembly is provided to sense the angular position of a drill about its rotational axis as the drill is fed into the head. The locater includes a probe that tends to track in a flute of the drill so that at the end of the chucking operation the drill is at the correct angular position. However, if the probe does not properly orient the drill, the locater assembly initiates automatic indexing to bring the drill into proper orientation. The drill is carried eccentrically in the head. During successive rotation of the head, the drill rotates about its axis and revolves about the head axis to automatically present each drill face to a grinding wheel.


**32 Claims, 15 Drawing Figures**



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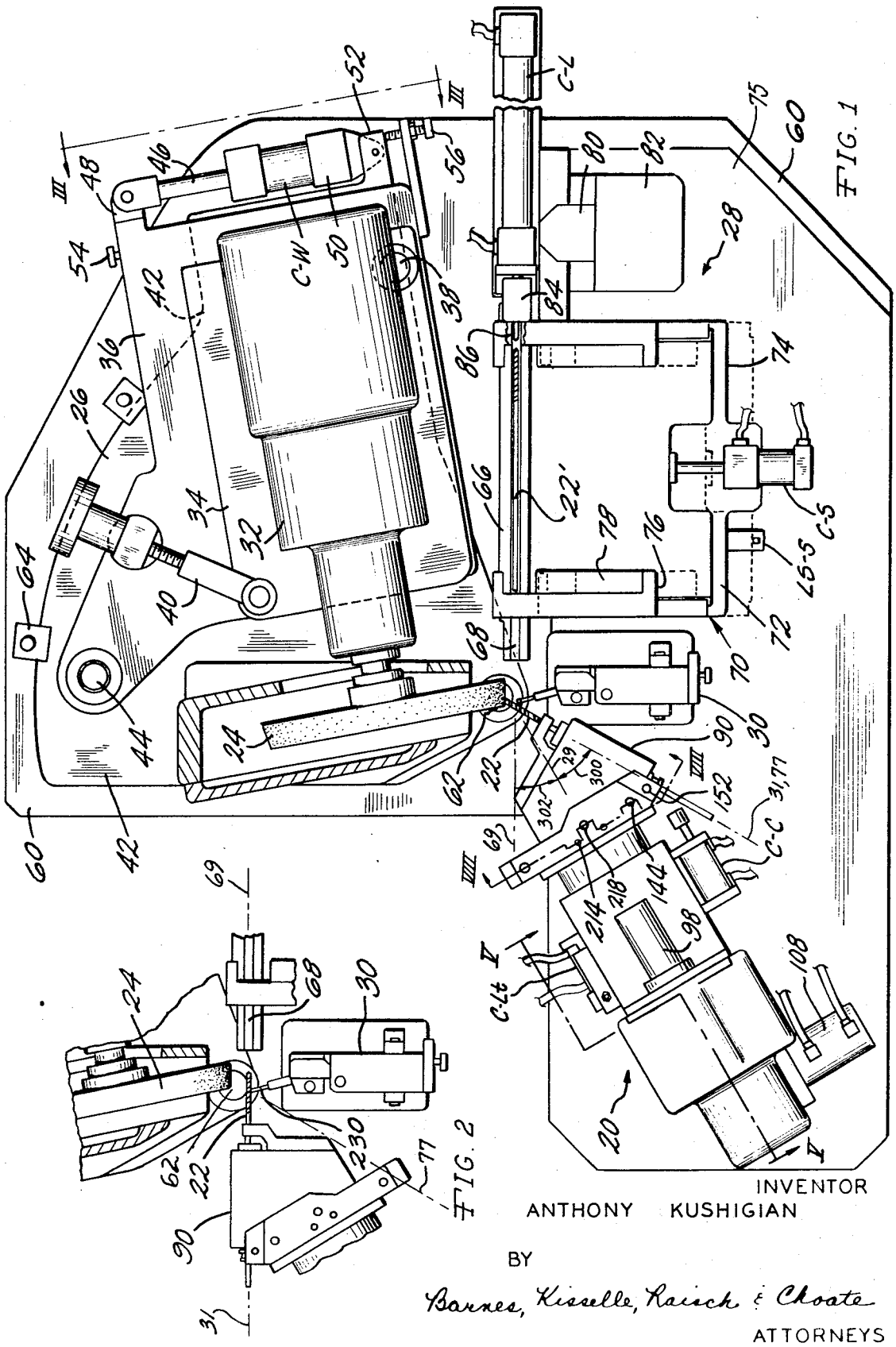


FIG. 1



FIG. 2

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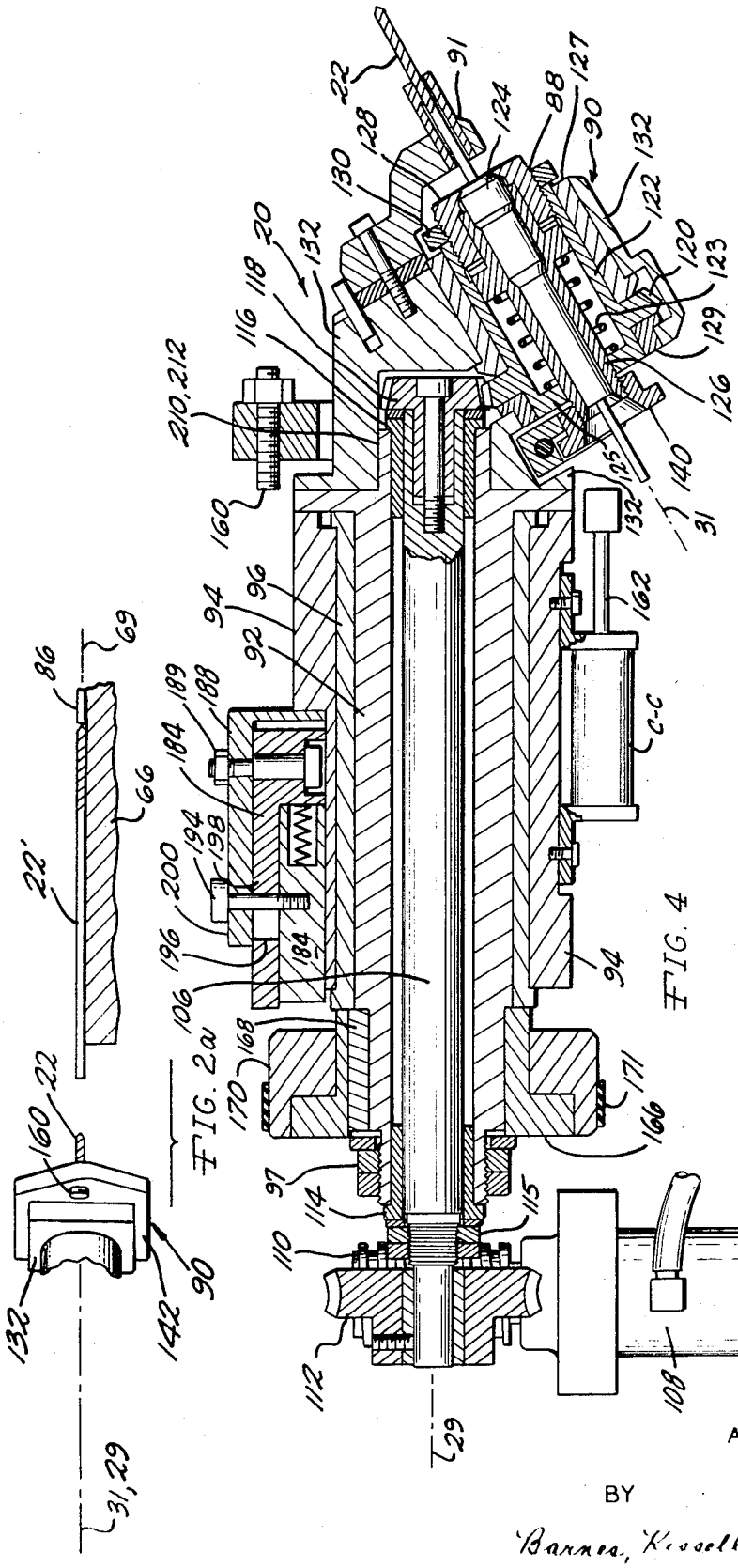


FIG. 2a

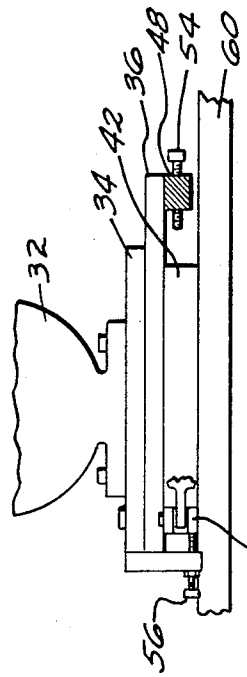


FIG. 3

FIG. 4

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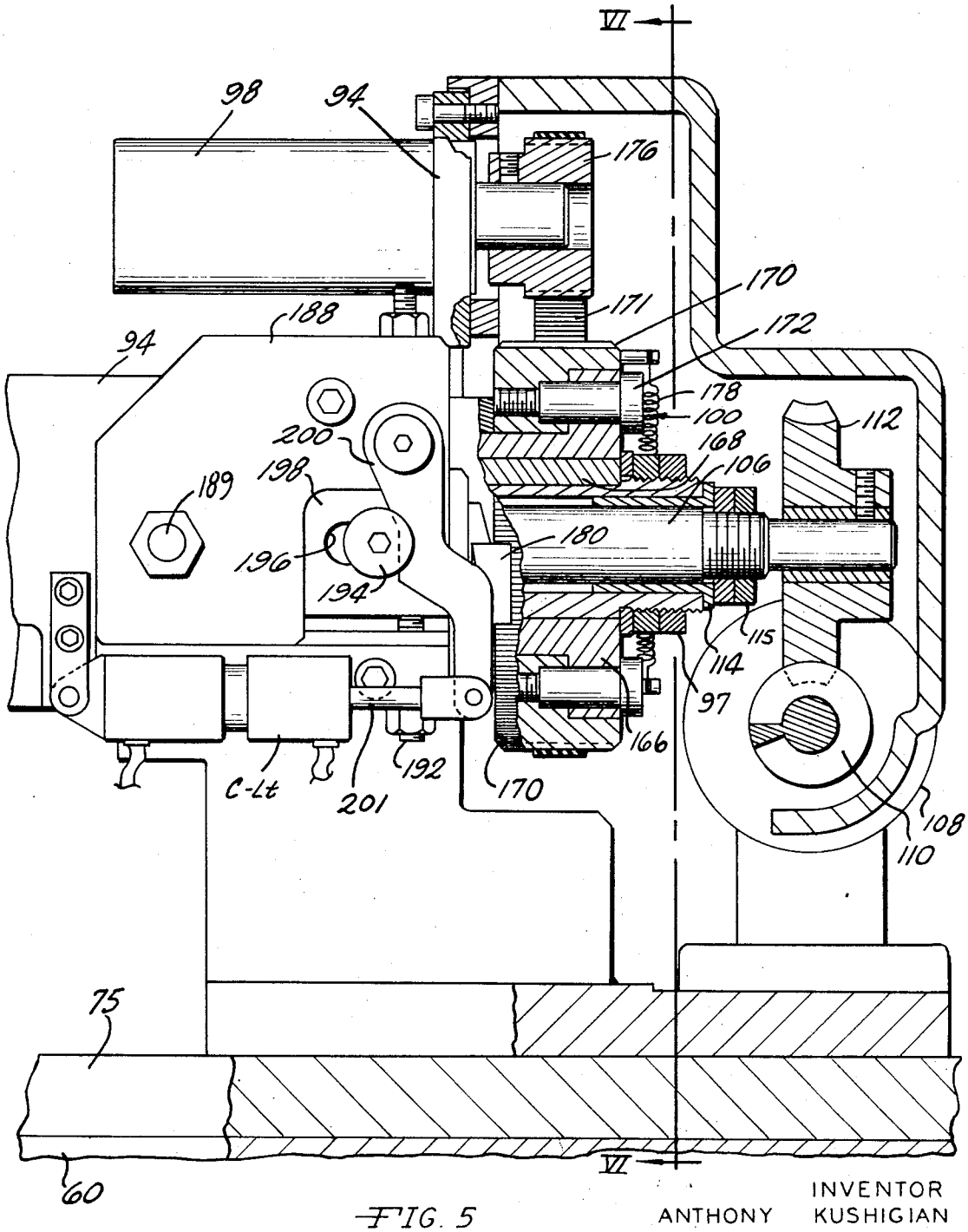



FIG. 5

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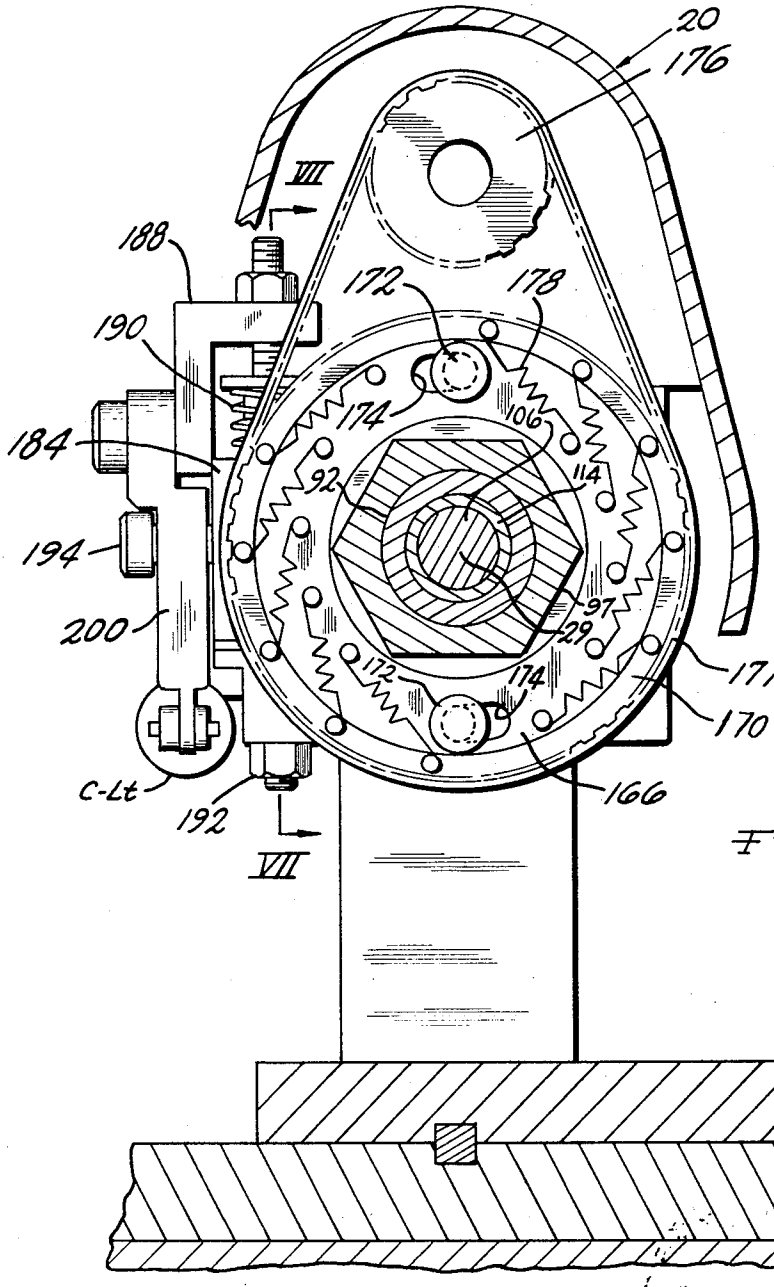



FIG. 6

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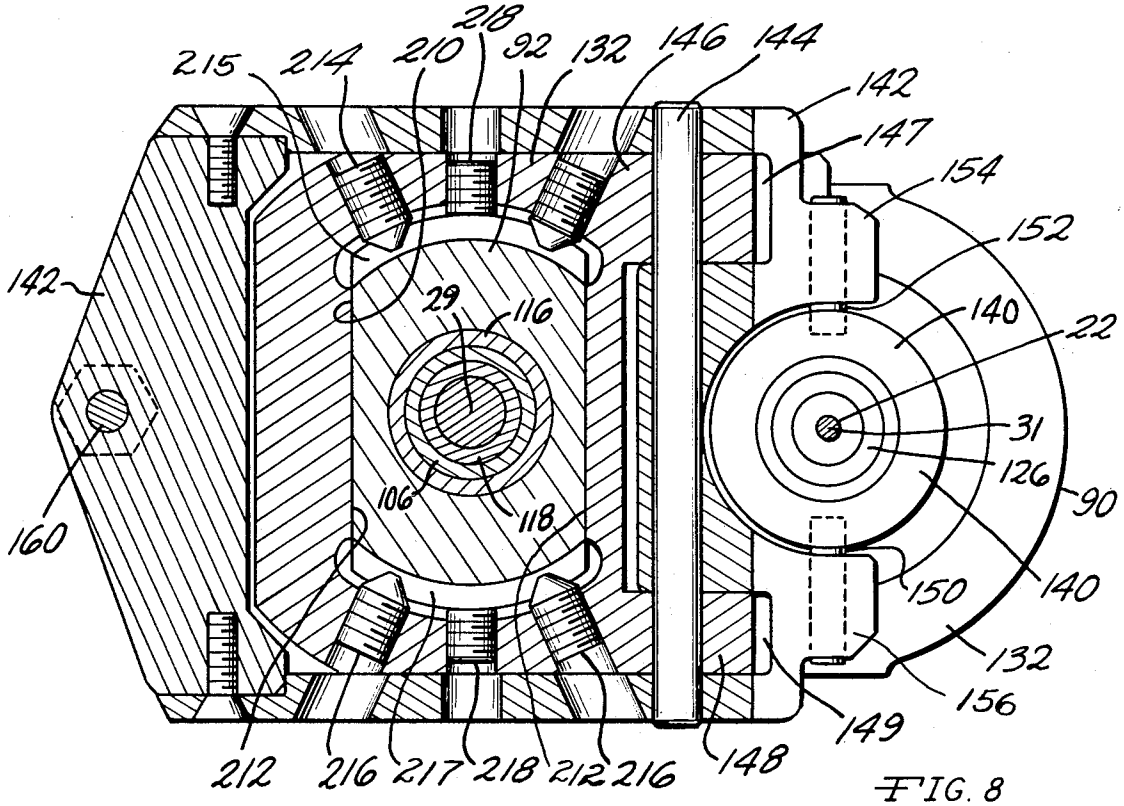



FIG. 8

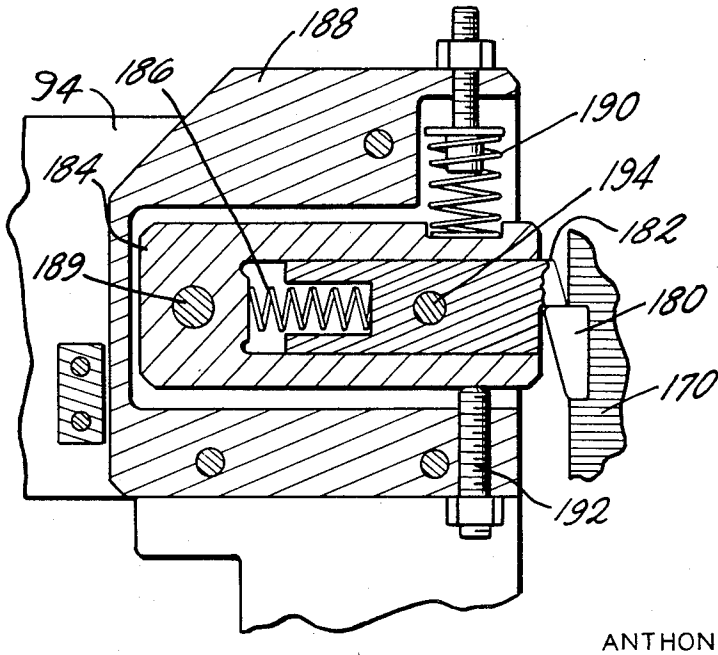



FIG. 7

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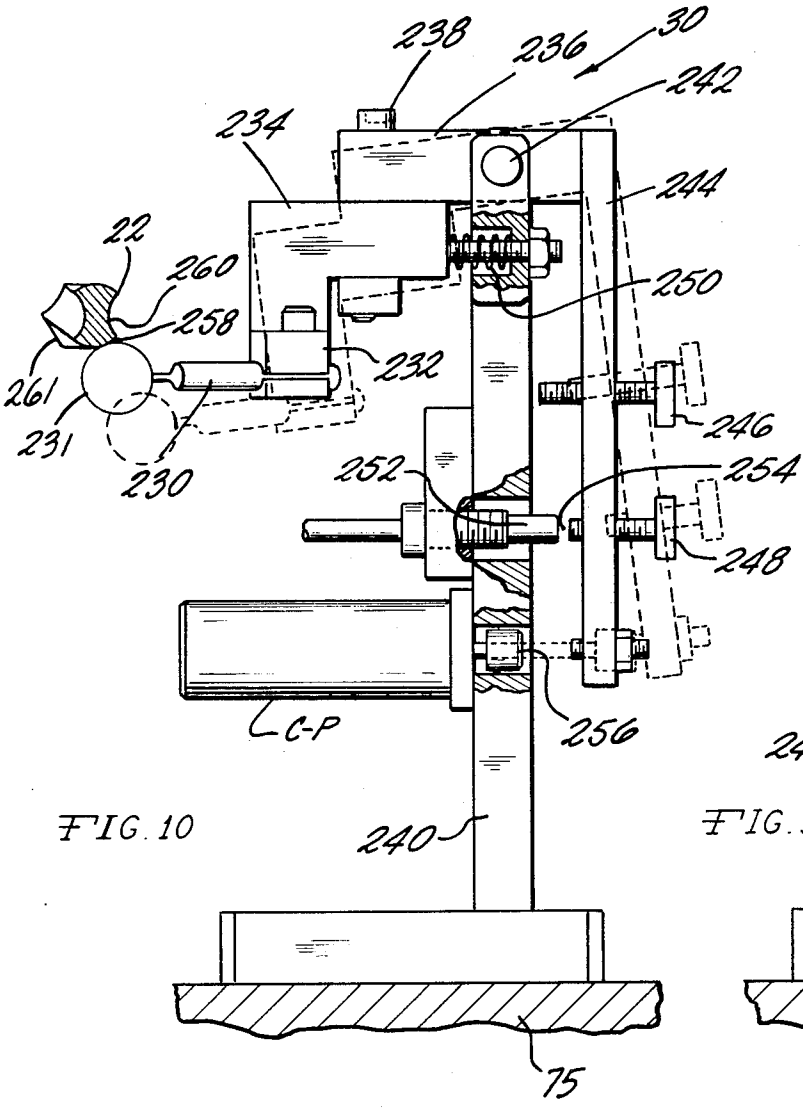



FIG. 10

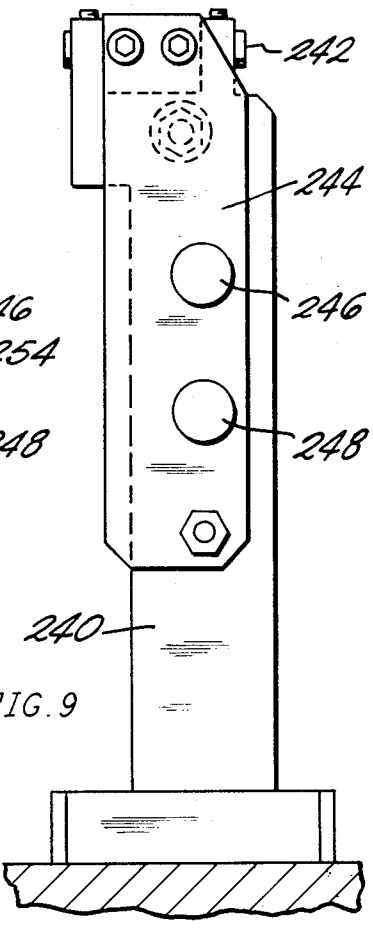



FIG. 9

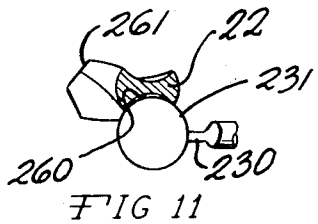



FIG 11

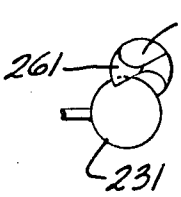
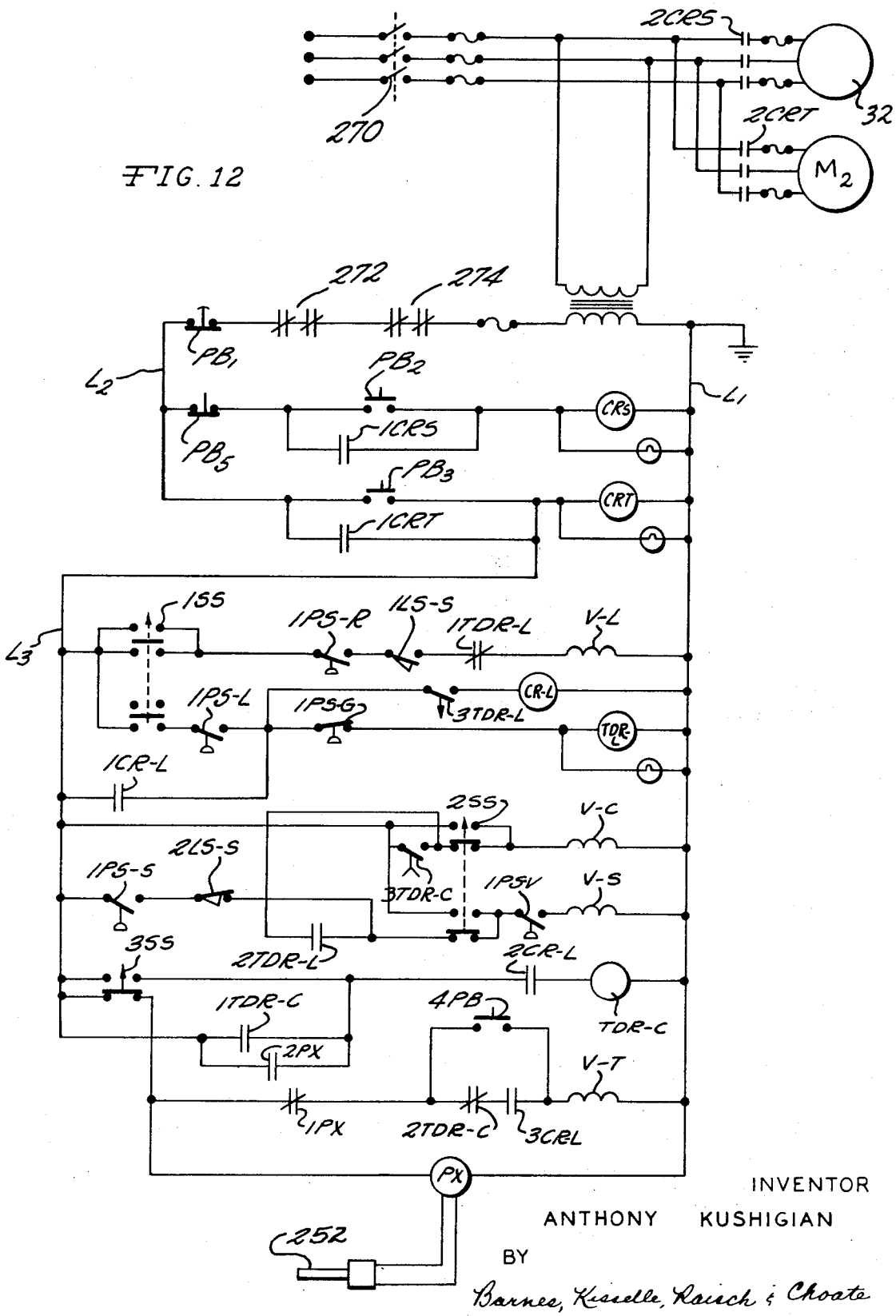



FIG. 11a

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FIG. 12




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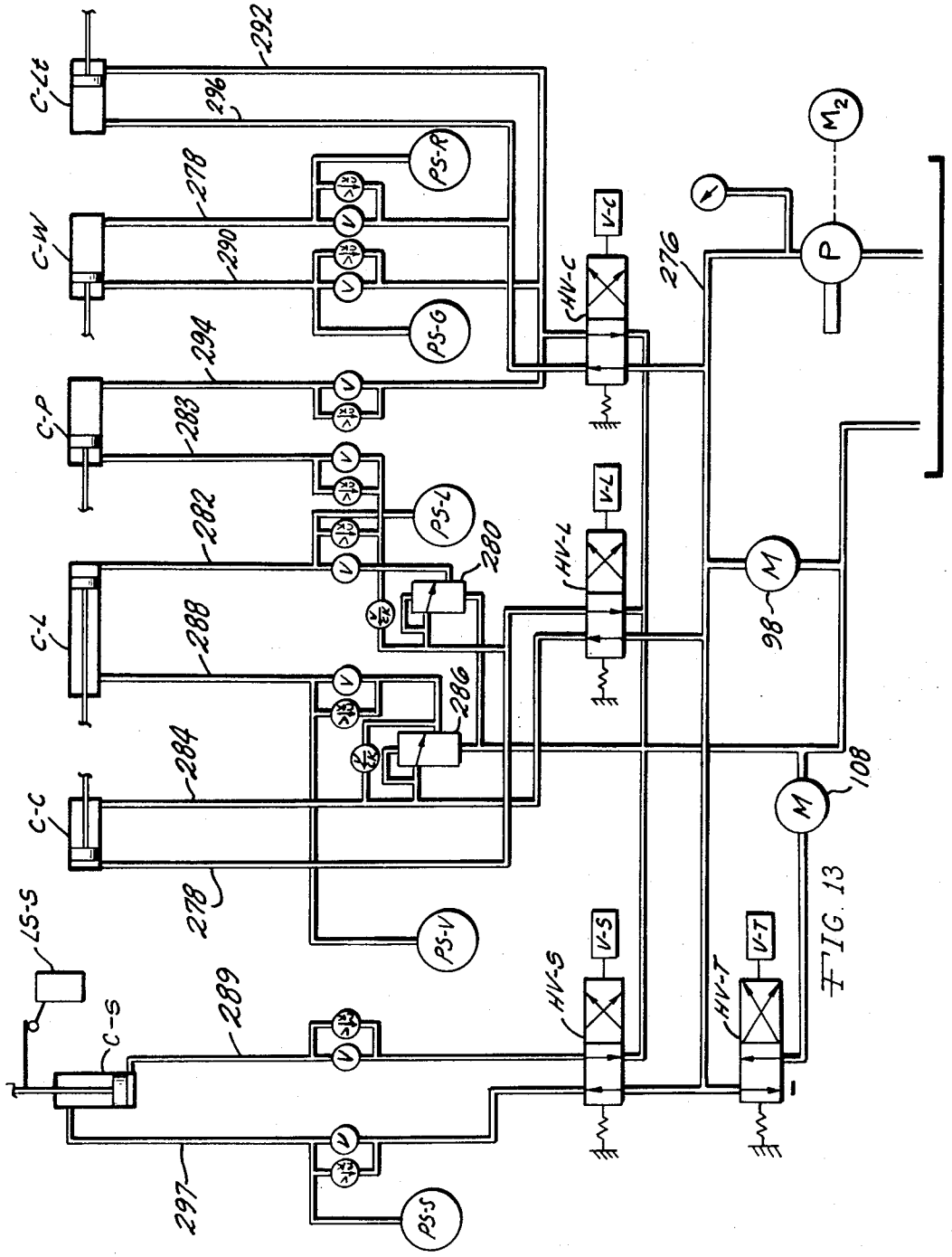



FIG. 13

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# AUTOMATIC DRILL POINTING MACHINE WITH AUTOMATIC DRILL LOCATER SYSTEM

This application is a continuation of my copending application Ser. No. 872,670, filed Oct. 30, 1969, and entitled "Automatic Drill Pointing Machine with Automatic Drill Locater System," and now abandoned.

This invention generally relates to automated machines for machining fluted cutting tools and more particularly to automated drill pointing machines and to an automatic locater to accurately locate the angular position of the cutting tool about its rotational axis before machining is initiated.

Certain hand operated and semiautomated grinders for pointing twist drills and other fluted cutting tools are not easily automated without increasing the cost of the grinder to the point where it is not competitive. For example, drill point grinders of the type disclosed in U.S. Pat. No. 965,952, issued to Friedrich Schmaltz on Aug. 2, 1910; U.S. Pat. No. 3,158,969, issued to Wilhelm Cawi on Dec. 1, 1964; and U.S. Pat. No. 2,682,736, **issued to Wilhelm Cawi on July** 6, 1954, use a particular head for revolving a drill in a particular manner so that each face of the drill point is presented to the grinding wheel. This is accomplished without intermittent indexing of the drill by mounting the drill eccentrically in a rotating head so that the drill revolves with the head and in addition rotates about the drill axis. In general, the required drill motion is obtained because the rotational axes of the head and of the drill cross each other in space. The axes are not parallel and they do not intersect.

Hand loaded grinders of the type disclosed in the Schmaltz and Cawi patents operate effectively. However, fully automated versions of these grinders are not commercially available at reasonable cost. This is believed to be based in part on the particular geometry of the heads and of the location of the head relative to the grinding wheel that are used in hand loaded grinders. With this geometry, it is difficult to include automatic loading unless the head (or the grinding wheel) is retracted from a grinding position to a loading position to receive a drill and then moved back into a grinding position. This motion is time consuming and thus undesirable in automated production lines. Moving the work head (or grinder) complicates the construction of the machine; substantially increases the cost; and may under certain conditions lack reliability and repeatability. It is also essential that the drill be properly oriented in the head at the beginning of a grinding operation and this in turn further complicates automation of the drill point grinder.

Objects of the present invention include providing an improved drill pointing machine of the type described hereinabove that is fully automatic, relatively low cost and fast operating; that does not require moving either the grinder or the work head to a remote loading location; and that achieves effective drill pointing.

Another object of the present invention is to provide automatic location of a drill in the aforementioned type of pointing machine to assure correct orientation of the drill point faces as they are presented to the grinding wheel during a grinding operation.

A further object of the present invention is to provide an automatic locater for use in machining a workpiece wherein the workpiece must have a particular angular orientation about its rotational axis.



A still further object of the present invention is to provide an automatic workpiece locater of the aforementioned type that achieves effective angular orientation of the workpiece in response to sensing of a radial discontinuity such as the flute of a drill or other cutting tool.

Other objects, features and advantages of the present invention will become apparent in connection with the following description, the appended claims and the accompanying drawings in which:

FIG. **1** is a top plan view of the automatic drill pointing machine with the work head positioning the drill for a grinding operation;

FIG. **2** is a fragmentary top view of the pointing machine of FIG. **1** showing the head positioned to receive a drill during a loading operation;

FIG. **2***a* is a schematic elevational view of the head, the drill and a loader during a loading operation;

FIG. **3** is a fragmentary end view of a grinding wheel slide plate assembly taken generally from the right of FIG. **1** along line **3—3**;

FIG. **4** is a horizontal sectional view of the work head and its drive when positioned as illustrated in FIG. **1**;

FIG. **5** is a fragmentary view of the drive for the work head taken on line **5—5** of FIG. **1** with certain parts repositioned to better illustrate the drive when the head is in the loading position shown in FIG. **2**;

FIG. **6** is a horizontal section taken on line **6—6** of FIG. **5**;

FIG. **7** is a fragmentary vertical section taken on line **7—7** of FIG. **6**;

FIG. **8** is a vertical section taken on line **8—8** of FIG. **1**;

FIG. **9** is an enlarged end view of a probe assembly that is used to locate the drill for proper engagement with the grinding wheel;

FIG. **10** is an elevational view of the probe assembly taken from the left side of FIG. **9**;

FIG. **11** is a fragmentary view illustrating the probe engaged in the flute of a drill;

FIG. **11***a* is an end view of the point of the drill with the probe engaged in the flute;

FIG. **12** is a schematic circuit diagram of the electrical controls for the pointing machine of FIG. **1**; and

FIG. **13** is a schematic diagram of the hydraulic control for the pointing machine of FIG. **1**.

Referring more particularly to FIG. **1**, the pointing machine of the present invention generally comprises a work head assembly **20** that moves a drill **22** into engagement with a grinding wheel **24** of a grinder assembly **26**. Drills are automatically fed into the work head assembly **20** by a loader assembly indicated generally at **28** when the work head assembly has rotated 180° about the work head axis **29** as illustrated in FIG. **2**. During a loading operation, the correct angular position of the drill about its rotational axis **31** that is required for proper engagement of the point faces with the grinding wheel **24** is set by a probe assembly **30**.

Referring more particularly to the grinder assembly **26**, a grinder motor **32** is fastened on a top slide plate **34** which in turn is pivotally mounted on an intermediate slide plate **36** for pivotal movement in a horizontal plane about a pivot axis at pin **38**. Plates **34**, **36** are interconnected by a manually adjustable linkage **40** so that the grinding wheel **24** can be fed inwardly,

counterclockwise about pin 38 when the wheel is periodically dressed. Plate 36 is in turn pivotally mounted on a second intermediate slide plate 42 for pivotal movement in a horizontal plane about a pivot axis at pin 44. Plate 36 is pivoted about pin 44 by means of a hydraulic cylinder C-W having its piston rod 46 connected to an integral lug 48 on the plate 36 and its case 50 fastened on a lug 52 integral with plate 42. Plate 36 and hence wheel 24 are pivoted in a clockwise direction about pin 44 by cylinder C–W during the grinding operation and in a counterclockwise direction when wheel 24 is retracted. An adjustable stop 54 mounted on plate 36 to engage plate 42 limits clockwise travel of plate 36. An adjustable stop 56 on plate 36 is disposed to abut lug 52 and limit counterclockwise travel of plate 36. Plate 42 is mounted on a machine bed 60 for pivotal movement about pin 62. Pin 62 is in vertical alignment with the grinding face of wheel 24. Linkage 40 is adjusted to maintain this alignment when wheel 24 is dressed. Plate 42 is locked in a selected pivoted position on bed 60 by clamps 64. The position of plate 42 determines the point angle being ground on drill 22, i.e., the included angle between drill point faces. Although the plates 34, 36 and 42 and bed 60 are illustrated in FIG. 3 as sliding directly on adjacent plates, it will be understood that suitable replaceable wear pads can be provided at the interfaces between the various beds and plates.

The loader assembly 28 generally comprises an open drill guide 66 having a longitudinal V-shaped channel 68 therein to receive a drill 22′ from a suitable hopper supply and direct the drill along an axis 69 into the work head assembly 20. One important aspect of the present invention includes continuous automatic loading into the head assembly 20. However, the details of the loader to feed individual drills into the channel 68 are not an essential feature of the present invention and will be described only to the extent necessary to understand the automatic operation of the present invention. Hence for purposes of illustration, there is shown a hopper-shuttle assembly 70 which generally comprises a shuttle 72 mounted on a plate 74 for reciprocating movement toward and away from guide 66. Shuttle 72 is moved by a hydraulic cylinder C–S mounted on plate 74 and plate 74 in turn is fastened on a base plate 75. Plate 75 and guide 66 are mounted on bed 60 for rectilinear adjustment in a direction along an axis 77, e.g., downwardly and to the left as viewed in FIG. 1. A limit switch LS–S fastened on plate 74 is actuated by shuttle 72 when the shuttle is in its retracted position illustrated in dotted lines in FIG. 1. The shuttle 72 has upstanding sides 76 spaced apart to form a hopper. Each side has a ramped shoulder 78 that is inclined downwardly toward guide 66. A supply of drills (not shown) resting on the two shoulders 78 will feed toward the front of shuttle 72. The V-shaped channel 68 is dimensioned to receive a single drill therein as the shuttle moves over the guide 66 so that when the shuttle is retracted only a single drill is left. At the right end of guide 66 is a long-stroke hydraulic cylinder C–L mounted on plate 75 by a vertical riser 80 and a base plate 82. The piston rod 84 of cylinder C– L carries a short push rod 86 that rides in channel 68. When shuttle 72 is retracted and the cylinder C–L is actuated, the push rod 86 moves drill 22′ from right to left as viewed in FIG. 1 into the work head during a loading operation. It will be understood that other suitable automatic feeding such as a magazine feed could be used to deliver drills to channel 68.

Referring to the work head assembly 20, drill 22 is firmly clamped in a collet chuck 88 rotatably mounted in a rotating head 90. A sleeve guide 91 on head 90 accurately positions drill 22 in chuck 88 to set the orientation of the axis 31. Head 90 is fastened on a hollow drive shaft 92 that is journalled in a case 94 by a sleeve bearing 96 to rotate on axis 29 and fastened in place by lock nuts 97. Case 94 is mounted on plate 75 so that the head assembly 20 and the loader assembly 28 can be moved as a unit to adjust the position of head 90 relative to wheel 24 for different diameter drills. The position of plate 75 is chosen so that the point face of drill 22 contacts wheel 24 when head 90 is disposed as shown in FIG. 1 to obtain a desired radius of curvature of the point face. With head 90 positioned as shown, axis 31 is parallel to axis 77. Shaft 92 is driven at its end opposite head 90 by means of a hydraulic motor 98 through a shock-absorbing drive 100, as will be subsequently described in greater detail. A second drive shaft 106 is journalled in the hollow drive shaft 92 by two bearings 114, 116 and lock nuts 115 to run inside shaft 92 and also rotate on axis 29. Shaft 106 is driven at one end by a second hydraulic motor 108 through the worm 110 and a worm wheel 112. A sun gear 118 rigidly fastened on the opposite end of shaft 106 meshes with a planetary gear 120 integral with an outer sleeve 122 of the chuck 88 to provide epicyclic gearing of the chuck.

In general, when the chuck is oriented as illustrated in FIG. 2 and the drill is loaded into the chuck, shaft 92 and head 90 are locked. Shaft 106 and gear 118 may then be driven to rotate the chuck and hence the drill until the drill point faces are properly located for subsequent grinding. During a grinding operation, shaft 106 and gear 118 are locked so that rotation of shaft 92 causes chuck 88 to revolve around the sun gear 118. As chuck 88 revolves about axis 29, the epicyclic gearing also causes the chuck to rotate in head 90 about axis 31 to index drill 22 during a grinding operation. For a drill having two point faces, the gear ratio between the sun gear 118 and the planet gear 120 is 2:1 so that the drill is indexed 180° for each full revolution of head 90. Hence during alternate revolutions of head 90, alternate faces of the drill point are ground in a manner that will be apparent from the aforementioned Schmaltz and Cawi patents. If a three-faced point is being ground, the gear ratio would be changed to 3:1.

Referring in greater detail to the construction of head 90 and chuck 88 (FIGS. 1, 4 and 8), a collet sleeve 124 is slideably mounted in a camming sleeve 126 which in turn is slideably mounted in the outer sleeve 122. Sleeves 124, 126 are held in the outer sleeve 122 by a collar 128 threaded in sleeve 122 and a lock nut 130. Sleeve 122 is in turn rotatably mounted in the body 132 of head 90 by front and rear thrust bearings 127, 129, respectively. Sleeve 124 is suitably constructed (as with slits) to be compressed circumferentially by inclined camming faces coacting between sleeves 124, 126 as sleeve 126 is urged from left to right as viewed in FIG. 4 by a compression spring 123 mounted between a rear flange 125 on the outer sleeve

122 and a stepped shoulder on the camming sleeve 126.

Chuck 88 is arranged to be opened by a yoke 142 pivotally fastened on the head body 132 by a pin 144. The head body 132 has upper and lower lugs 146, 148 that ride in corresponding notches 147, 149 in the yoke 142. Pin 144 is pressed in yoke 142 and pivots in lugs 146, 148. A pair of opposed pins 150, 152 fastened on lower and upper arms 154, 156 of yoke 142 are arranged to engage a flanged nut 140 threaded on the rear end of the camming sleeve 126 which extends through an aperture in the flange 125. With the yoke 142 positioned as shown in FIGS. 1 and 2, pins 150 do not interfere with free rotation of chuck 88. Although it is not intended that chuck 88 be opened when head 90 is in the grinding position illustrated in FIGS. 1 and 4, it will be apparent that when yoke 142 is pivoted on pin 144 in a clockwise direction as viewed in FIG. 4, pins 154, 156 pull nut 140 downwardly and to the left to retract the camming sleeve 126. The collet sleeve 124 opens due to its own spring action. When head 90 is rotated 180° to the loading position illustrated in FIG. 2, a stop 160 at the side of yoke 142 opposite pin 144 will be disposed for engagement by the actuated piston rod 162 of a hydraulic cylinder C–C fastened on the case 94. Hence with the head 90 oriented in the loading position illustrated in FIG. 2, when cylinder C–C is actuated plunger 162 engages stop 160 to pivot yoke 142 in a counterclockwise direction causing the collet sleeve 124 to open.

Referring to the drive for shaft 92 as shown in FIGS. 4–6, an inner ring 166 is fastened on the rear end, the left end as viewed in FIG. 4, of shaft 92 by a key 168. Ring 166 is drivingly engaged with an outer ring 170 by two screws 172 that are threaded in the outer ring 170 and ride in respective slots 174 in the inner ring 166. Ring 170 is driven by a timing belt 171 trained about ring 170 and a drive pulley 176 on motor 98. Motor 98 drives pulley 176 in a clockwise direction as viewed in FIG. 6 so that the screws 172 bottom in the hidden end of the slots 174 to drive the inner ring 166 in a clockwise direction as viewed in FIG. 6. The outer ring 170 is also connected to the inner ring 166 by a plurality of tension springs 178. Ring 166 can rotate relative to the outer ring 170 against the spring action of springs 178 within the rotational limits set by slots 174 when the outer ring is braked.

The outer ring 170 has an integral circumferential lug 180 (FIGS. 5 and 7) that is arranged to be engaged by a latch bar 182 actuated by a hydraulic cylinder C–L*t*. Bar 182 is mounted in a notched holder 184 for generally horizontal reciprocating movement and is urged outwardly of the holder by spring 186. Holder 184 is pivotally mounted in a notched block 188 by a pin 189. Block 188 is in turn fastened on the work head case 94. A compression spring 190 mounted between holder 184 and block 188 restrains holder 187 against pivoting upwardly in a counterclockwise direction as viewed in FIG. 7. The position of holder 184 is set by an adjustable stop 192. Stop 192 is set so that when latch bar 182 stops lug 180, chuck 88 will be aligned with axis 69 to receive a drill as shown in FIGS. 2 and 2*a*. A follower screw 194 fastened in bar 182 projects laterally outwardly through a slot 196 in a cover plate portion 198 of the block 188. Screw 194 is disposed to be engaged by an actuating arm 200 pivoted on block 188. The hidden end of slot 196 limits outward travel of screw 194 and bar 182. The free end of arm 200 is fastened to the piston rod 201 of cylinder C–L*t* which in turn is fastened on case 94. Actuation of cylinder C–L*t* pivots lever 200 to the left to retract the bar 182 and disengage bar 182 from lug 180.

It will be appreciated that for purposes of simplifying the disclosure, the position of the bar 182 and its actuating mechanism including lever 200 and cylinder C–L*t* are illustrated in FIG. 5 in a position locking ring 170 whereas the corresponding parts are illustrated in an unlocked position in FIG. 4. Similarly, the outer ring 170, drive shaft 92 and head 90 have been rotated 180° from their positions shown in FIG. 4 to the position shown in FIG. 5. During a grinding operation, motor 98 drives ring 170 in a clockwise direction as viewed in FIG. 6 so that the drill point sweeps upwardly over the grinding wheel 24. At the end of a grinding operation, cylinder C–L*t* is actuated to release bar 182 into engagement with the lug 180. Ring 170 is stopped at a precise angular position about the axis 29 with chuck 88 aligned on axis 69 (FIGS. 2, 2*a*). When bar 182 engages lug 180, the bar pivots against the spring action of spring 190 to absorb the shock. After the initial shock is absorbed into spring 190, spring 190 returns holder 184 to the position set by stop 192. When ring 170 is stopped by bar 182, additional shock absorbing between ring 170 and ring 166 can occur since ring 166 can rotate slightly relative to ring 170 against the spring action of springs 178. After the initial shock is absorbed in springs 178, the springs return the ring 166 to the position where screws 172 again engage the hidden ends of slots 174. Motor 98 stalls when ring 170 is locked by bar 182. When ring 170 is released, motor 98 has sufficient torque to immediately rotate head 90. Motor 98 is a rotary hydraulic motor so that it can be stalled intermittently in this fashion without damaging the motor.

Referring again to FIG. 8, the right end of drive shaft 92 has a pair of opposed flats 210 mating with flats 212 on the head body 132 to drivingly engage head 90 on shaft 92. Flats 210, 212 allow for vertical adjustment (as viewed in FIG. 8) of head 90 relative to the drive shaft 92 by means of a pair of upper adjusting screws 214 and a pair of lower adjusting screws 216. Screws 214, 216 are threaded in head body 132 and have conical camming faces on their inner ends engaged with associated beveled flanges 215, 217, respectively, on shaft 92. Upper and lower locking screws 218 are also provided to firmly lock head 90 in a selected vertical position relative to the drive shaft 92. For the arrangement illustrated in FIG. 8, it will be apparent, for example, if the bottom set screw 218 and adjusting screws 216 are loosened when the upper adjusting screws 214 are tightened, they will shift the head upwardly relative to the drive shaft 92. The set screws 218 are then tightened to tightly secure the head 90 to the drive shaft 92. This adjustment sets a slight offset between the axes 29, 31 of say several thousandths of an inch, for example, 200 thousandths for pointing a one-quarter inch drill. This slight offset provides a clearance on the drill point face during a grinding operation in a manner similar to that provided in the aforementioned Cawi patents. The drill axis 31 and the

axis **29** of shaft **92** cross in space and lie in parallel planes that are spaced apart by the amount of offset but the axes are neither parallel nor intersecting. The above-described offset adjustment is particularly useful because the offset can be set after the head assembly **20** has been fully assembled. Additionally, the amount of offset can be changed for pointing drills of different sizes when required.

Referring to the probe assembly **30** shown in FIGS. **9–11**, a probe **230** having a ball tip **231** is adjustably fastened in a clamp **232** integral with the L-shaped bracket **234**. Bracket **234** is in turn clamped on one end of a generally horizontal pivot arm **236** by a screw **238** to allow for adjustment of bracket **234** and further adjustment of probe **230**. Arm **236** is mounted on an upright **240** by a pin **242** for free swinging movement in a vertical plane. Arm **236** has an integral downwardly depending arm **244** that carries an adjustable stop screw **246** and a sensor actuating screw **248**. Also mounted on upright **240** is a spring **250**, a sensor **252** and a hydraulic cylinder C–P. Probe **230**, bracket **234** and arms **236**, **244** are urged by spring **250** in a clockwise direction about pin **242** so that ball **231** is maintained against drill **22** during a locating operation as will be described. Upward travel of probe **230** is limited by stop **246** when it engages upright **240**. Sensor **252** is part of a proximity switch PX (FIG. **12**) that is actuated by the proximity of screw **248** to the right end of the sensor. Switch PX is a highly sensitive switch that is actuated without direct engagement of screw **248** with sensor **252** when the gap **254** closes to a predetermined dimension which can be set very precisely. In one specific embodiment, switch PX was a Transistorized Proximity Switch, sold commercially by Electro Products Laboratoires, 6125 West Howard Street, Chicago (Niles), Illinois, and advertised as being manufactured under U.S. Pat. Nos. RE 24,779 and 2,922,880. These switches are conventionally used as a sensitive limit switch for positioning controls. Cylinder C–P has its piston rod **256** disposed to engage arm **244** and pivot arm **244** in a counterclockwise direction to move probe **230** away from drill **22** during grinding operations.

With head **90** oriented as illustrated in FIG. **2** and chuck **88** opened by cylinder C–C, the drill **22** is loaded in the chuck by cylinder C–L. The angular position of the drill about its longitudinal axis will be at random when the drill is in the guide channel **68**. The drill **22** must be positioned precisely in chuck **88** at a predetermined angular position to assure that the point faces will be properly presented to the grinding wheel **24**. Also the drill must project a fixed distance from the guide **128**. The longitudinal position of drill **22** in chuck **88** is set by the outer travel limit of cylinder C–L whereas the angular position of the drill about axis **31** is set by means of the probe assembly **30**. After the drill is loaded in chuck **88** by cylinder C–L and properly positioned, the drill **22** is then clamped firmly in the chuck.

During initial setup, the position of the probe **230** is adjusted so that ball **231** seats in flute **260** closely adjacent the point of drill **22** with the point faces **261** precisely located so that when head **90** is revolved to the position illustrated in FIGS. **1** and **4**, faces **261** will be accurately presented to wheel **24**. During a loading operation, the drill first encounters ball **231** and deflects the probe **230** downwardly. Ball **231** is maintained in engagement with the drill by spring **250** as the drill moves into the chuck. When ball **231** seats in a flute **260** as the drill is pushed into the chuck, the ball will tend to track in that flute and thus serve as a guide for the drill so that the drill rotates as it moves into the chuck. Hence at the end of the loading operation, if the ball **231** is located in flute **260**, the drill point faces **261** are properly oriented for the grinding operation. If, however, ball **231** did not track in the flute during a loading operation, ball **231** will be resting on a land **258**. Stop **248** is adjusted so that if ball **231** rests on land **258**, gap **254** is relatively large and switch PX will not be actuated. As will later be described in greater detail in connection with the overall operation of the drill pointing machine, if ball **231** is not located in the flute **260**, chuck **88** and drill **22** will be rotated automatically until the probe **230** drops into the flute **260** as illustrated in FIG. **11**. With ball **231** disposed in flute **260**, gap **254** is relatively small and switch PX is actuated in response to the proximity of screw **248** to the sensor **252** to terminate rotation of the drill.

The electrical controls illustrated in FIG. **12** and the hydraulic controls illustrated in FIG. **13** will be described in connection with the overall operation of the pointing machine. The electrical circuit components are shown in FIG. **12** in their normal condition, i.e., unactuated condition. However, the hydraulic components are shown in their positions corresponding to the beginning of a cycle, i.e., shuttle **72** retracted, wheel **24** retracted, probe **230** retracted, loader cylinder C–L retracted, chuck **88** closed and latch bar **182** engaged with dog **180**. In FIG. **13**, flow control valves are labelled "V" and check valves are labelled "V CK" with an arrow designating the direction of free flow in the unchecked direction. The flow control valves V and the check valves V CK will not be described in detail since their operation in the hydraulic control is apparent upon inspection of FIG. **13**. Relays and pressure switches are designated by letters. Contacts operated by a relay or by a pressure switch have a corresponding letter designation preceded by a number prefix. Valves designated "HV" are four-way, solenoid-operated directional valves.

Closing the main circuit breaker **270** energizes the supply lines $L_1$, $L_2$. Contacts **272** are part of a conventional overload protection circuit to open line $L_2$ if the grinder motor **32** is overloaded. Similarly, contacts **274** are part of an overload protection circuit to disconnect line $L_2$ in the event of an overload at the hydraulic pump motor $M_2$. Push button switch $PB_1$ is an emergency stop switch. Grinder motor **32** is started by closing switch $PB_2$ to energize relay CRS through a wheel stop switch $PB_5$. Relay CRS is sealed by contacts 1CRS and energizes motor **32** via contacts 2CRS. Switch $PB_3$ is closed to energize line $L_3$ and simultaneously energize relay CRT which is sealed by contact 1CRT and energizes motor $M_2$ via contacts 2CRT. Motor $M_2$ drives the pump P (FIG. **13**) in the hydraulic control to pressurize the main supply line **276**.

Automatic operation is initiated by actuating the main cycle switch 1SS to close its lower contacts as viewed in FIG. **12**. For a complete automatic cycling, switches 2SS and 3SS are also moved to close the lower contacts. The switches 1SS, 2SS and 3SS may also be

selectively set to their upper position for manual sequencing by an operator. Closure of the lower contacts of switch 1SS energizes valve solenoid V-L through the closed contact 1TDR-L, the closed shuttle limit switch contact 1LS-S and the closed wheel out pressure switch 1PS-R. Contacts 1LS-S are normally open but are closed because the shuttle 72 is in its retracted position illustrated in dotted lines in FIG. 1. Contacts 1PS-R are normally open and are closed when the grinding wheel 24 is in the retracted position illustrated in FIG. 1. The wheel 24 is retracted at its counterclockwise limit of travel corresponding to valve HV-C being in its normal position, shifted to the right as viewed in FIG. 13, to connect the supply line 276 to the input line 278 of wheel cylinder C-W. The increased pressure in line 278 when the piston of cylinder C-W is at its limit of travel actuates pressure switch PS-R and closes contacts 1PS-R.

When valve solenoid V-L is energized by closing switch 1SS, valve HV-L is shifted to the left from its normal position to connect the supply line 276 to the input line 278 of the collet cylinder C-C. The collet cylinder piston rod 162 is actuated to pivot yoke 142 and open the collet chuck 88. Shifting of the valve HV-L also initiates operation of the sequencing valve 280 which, after a short time delay to assure that chuck 88 is open, connects the input line 282 of the drill loading cylinder C-L to the supply line 276. Cylinder C-L pushes a drill from the loader assembly 28 into the open chuck 88. Simultaneously, sequence valve 280 also connects input line 283 of the probe cylinder C-P to the supply line 276 to retract the rod 256 and release probe 230. Probe 230 swings upward, clockwise as viewed in FIG. 10, into the path of the drill 22 as it is loaded into the chuck 88. Ball 231 tracks in flute 260 as previously described to angularly position the drill.

At the end of the stroke of cylinder C-L, the increased pressure in line 282 energizes the pressure switch PS-L to close normally open contacts 1PS-L and energize the time delay relay TDR-L through the closed contacts 1PS-G. Contacts 1PS-G are normally closed and hence are closed when the grinding wheel 24 is in its retracted position. Relay TDR-L has a normally closed, instantaneously operating contact 1TDR-L; a normally open, instantaneously acting contact 2TDR-L and a time delay contact 3TDR-L which is normally open, closes instantaneously and delays reopening when the relay is deenergized. When contact 1TDR-L opens, valve solenoid V-L is deenergized so that valve HV-L returns to its normal position shown in FIG. 13 to connect the input line 284 of collet cylinder C-C to the supply line 276 and close chuck 88 to lock drill 22. When cylinder C-C reaches the end of its travel, the increased pressure line 284 operates the sequencing valve 286 (providing a short time delay to assure that the drill is firmly chucked) to connect the input line 288 of loader cylinder C-L to the supply line 276 and retract the loader. It is noted that the loader push rod 86 stabilizes the drill while the chuck 88 is closing. Closing of contact 2TDR-L readies the circuit for the valve solenoid V-S for actuation of shuttle 72. Closure of the third contact 3TDR-L energizes relay CR-L through contacts 1PS-L and switch 1SS.

Relay CR-L is sealed by its normally open contacts 1CR-L and its normally open contacts 2CR-L close to ready the relay TDR-C for initiation of the grinding operation. Relay CR-L also closes contacts 3CR-L to energize valve solenoid V-T through normally closed contacts 2TDR-C and 1PX. Contact 1PX is part of the proximity switch PX and is normally closed unless the gap 254 between sensor 252 and screw 248 is less than the critical preset value required to actuate the proximity switch. Hence if ball 231 is not engaged in a flute 260 at the end of the loading operation, contacts 1PX will remain closed and valve solenoid V-T will be energized to shift valve HV-T to the left and actuate the hydraulic motor 108. Valve HV-T is suitably plugged to operate as a two-way directional valve. Motor 108 drives shaft 106, causing chuck 88 to rotate via the sun gear 118 and planet gear 120. The drill will continue to rotate until ball 231 seats in flute 260 at which point the gap 254 decreases below its critical value to actuate the proximity switch PX. Actuation of switch PX opens the normally closed contact 1PX and closes the normally open contact 2PX which in turn energizes relay TDR-C through the contacts 2CR-L which were previously closed at the end of loading travel of the loader cylinder C-L.

If ball 231 properly tracks in the flute 260 and is seated in the flute at the end of the loading operation, contact 1PX will be opened by switch PX before contacts 3CR-L close. Therefore, valve solenoid V-T will not be energized and hence the above-described stop of indexing drill 22 to its correct angular position will be bypassed.

When relay TDR-C is energized through contacts 2PX, it is sealed by its contacts 1TDR-C and its contacts 2TDR-C open to deenergize valve solenoid V-T and stop motor 108 to terminate indexing of the drill. The contacts 2TDR-C remain open to assure that the valve solenoid V-L will not be operated during the grinding operation. Energization of relay TDR-C also initiates closure of contacts 3TDR-C which, after a short delay of say one-half second, close to energize the grinding cycle valve solenoid V-C through the closed lower contacts of selector switch 2SS. Contacts 3TDR-C simultaneously energize shuttle valve solenoid V-S through the closed contacts 2TDR-L, the lower contacts of switch 2SS and the closed contacts 1PS-V. Contacts 1PS-V were closed when the loader cylinder C-L retracted fully due to the increased pressure in line 288. Solenoid V-S shifts valve HV-S to the left as viewed in FIG. 13 to connect input line 289 of the slide cylinder C-S to the supply line 276. Cylinder C-S operates the shuttle 72 to feed a drill 22' into the guide channel 68 for the next cycle.

Valve solenoid V-C shifts valve HV-C to the left as viewed in FIG. 13 to connect the supply line 276 to input line 290 of the wheel cylinder C-W, input line 292 of latch cylinder C-Lt and input line 294 of the probe cylinder C-P. Line 292 actuates cylinder C-Lt to release the latch bar 182. As previously mentioned, when latch bar 182 is engaged with lug 180, motor 98 is stalled; and as soon as the latch bar 182 is released, motor 98 drives the head 90. Line 294 actuates the probe cylinder C-P to swing the probe 230 away from the drill 22. Line 290 actuates wheel cylinder C-W to pivot plate 36 in a clockwise direction as viewed in FIG. 1 and feed the grinding wheel 24 across the drill faces 261.

During the grinding operation, the head **90** is rotated via the drive shaft **92** while shaft **106** is held against rotation by the worm drive **110, 112**. Hence the drill **22** revolves around the axis **29** as the planet gear **120** walks around the sun gear **118**. In addition, for each revolution of the head **90**, the drill will be indexed 180° so that during alternate revolutions of the head, opposite faces **261** of the drill point are ground by the wheel **24** in a manner that will be apparent from the aforementioned Schmaltz and Cawi patents. During the grinding operation, each face **261** of the drill point will be passed over wheel **24** several times depending on the feed rate set by cylinder C–W. At the end of grinder in feeding, plate **36** bottoms on stop **56** at which point the increased pressure in line **290** actuates the pressure switch PS–G. Pressure switch PS–G has normally closed contacts **1PS–G** which open to deenergize relay TDR–L at the end of the grinding operation. Deenergization of relay TDR–L permits contacts **3TDR–L** to open after a short time delay of say one-half second to in turn deenergize relay CR–L.

Deenergization of relay CR–L essentially resets the pointing machine to its original condition at the beginning of the cycle. More particularly, contacts **2CR–L** open to deenergize relay TDR–C which in turn opens contacts **3TDR–C** to deenergize the grinding cycle valve solenoid V–C and the shuttle valve solenoid V–S. Hence valve HV–C returns to its normal position connecting supply line **276** to input line **296** of the latch cylinder C–Lt to release the latch bar **182** and thereby lock ring **170** against further rotation and locate head **90** at its loading position. Simultaneously, valve HV–C connects input line **278** of the wheel cylinder C–W to supply line **276** to retract wheel **24**. Valve HV–C also readies the probe cylinder C–P for the next cycle but the cylinder C–P maintains the probe away from the drill until the cylinder C–P is actuated via line **283** during the next cycle. Valve HV–S returns to its normal position to retract shuttle **72**. The next cycle will begin automatically when wheel **24** is fully retracted and increased pressure in line **278** actuates switch PS–R to reclose contacts **1PS–R** and thereby energize valve solenoid V–L.

Shuttle valve solenoid V–S can also be energized through a path including pressure switch contacts **1PS–S** and limit switch contacts **2LS–S**. If at the end of a grinding cycle the shuttle **72** jambs before it is fully retracted by cylinder C–S, for example, the shuttle jambs on a drill that did not fall into the guide channel **68**, the increased pressure in input line **297** of the shuttle cylinder C–S actuates the pressure switch PS–S to close contacts **1PS–S** and energize valve solenoid V–S through contacts **2LS–S**. Contacts **2LS–S** are normally closed and are opened only when the shuttle **72** retracts fully. Energization of valve solenoid V–S again shifts the control valve HV–S to move the shuttle forward toward guide **66**. The contacts **1PS–S** have a slightly delayed opening so that the shuttle will be moved inwardly sufficiently to shake loose the jambed drill. However, if shuttle **72** remains jambed, it will continue to oscillate backward and forward due to the repeated recycling of pressure switch contacts **1PS–S** until the shuttle is unjambed or until the machine is shut off by the operator.

With the automatic drill pointing machine and controls therefor described hereinabove, the head assembly **20** does not move to a remote loading location to receive drill **22** from the loader assembly **28**. This result is achieved in part due to the geometry of head **90** and the geometry of the head assembly **20** relative to the loading assembly **28** and the grinding assembly **26**. The included angle **300** (FIG. **1**) between the rotational axis **29** of the head assembly **20** and the rotational axis **31** of the chuck **88** is equal to the included angle **302** between axis **29** and the axis **69** of the loader assembly **68**. Since axes **29** and **31** do not actually intersect, more precisely, the angle **300** is between vertical planes as viewed in FIG. **1** containing axes **29** and **31**. However, the offset between axes **29** and **31** is so slight that they may be considered as intersecting for purposes of selecting the angle **300**. Although head **90** rotates from the loading position illustrated in FIG. **2** to the grinding position illustrated in FIG. **1**, this motion is the same motion that is required to index the drill and hence does not further complicate construction of the head assembly **20**. It has been found that if the angles **300, 302** are approximately 30°, the construction of the head assembly **20** required to properly present the drill faces **261** to the grinding wheel **24** is compatible with an effective and compact geometry of the grinding assembly **26**, the loading assembly **28** and the automatic locater assembly **30**. By contrast, the included angle between the head rotational axis and the drill rotational axis in machines of the type disclosed in the aforementioned Schmaltz and Cawi patents, that is, the angle corresponding to angle **300**, has conventionally been less than 20°. In this regard, when the head **90** is in the loading position illustrated in FIG. **2**, and the chuck **88** is open to receive drill **22'** for the next grinding operation from the guide **66**, as drill **22'** is pushed into the chuck **88**, drill **22** from the preceding cycle is pushed through the chuck **88** from right to left as viewed in FIG. **2** into a suitable bin (not shown). By selecting angle **300** to be approximately 30°, there is ample clearance behind chuck **88** so that the ejected drill **22** clears the head assembly **20** rearwardly of the head **90**. It is difficult to provide this clearance as the angle corresponding to the angle **300** is reduced to below 20°. It is again noted that the entire work head assembly **20**, the entire loader assembly **28** (including guide **66** and cylinder C–L) and the probe assembly **30** are all mounted on plate **75** for coadjustment to maintain their orientation for the above-described loading and unloading of a drill in chuck **88**. With angles **300, 302** of 30°, it will be apparent that the axis **77** along which plate **75** is adjusted will be at an acute included angle of 60° to the loading axis **69**.

A reduction of the angles **300** to below 20° also creates other problems. For example, a common included angle between the drill point faces **261** is 118°. For pointing drills having this included angle, when angle **300** is approximately 30°, the point face and hence the line of contact between the drill face **261** and grinding wheel **24** are generally parallel to the axis **69**. Wheel **24** is dressed to maintain this relationship when linkage **40** is changed. The radial location of pin **44** substantially perpendicular to the grinding contact line causes the wheel **24** to feed along a long radius arc in continuous contact with drill **22** during a grinding

operation. The loader assembly **28** does not interfere with this motion of the grinding wheel assembly **26**. Because the axis of pin **62** is vertically aligned with the point face, i.e., the line of contact during grinding is located substantially at the intersection of the axis **31** and a vertical plane containing the axes of pins **44, 62**, continuous contact can be achieved by properly dressing wheel **24** even though the exact face angle is changed by loosening clamp **64** and pivoting bed **42** about the pin **62** over a relatively wide range of point angles.

Although angle **300** could be increased above 30°, it will be apparent that a substantial increase in this angle would interfere with the placement of the locater assembly **30**. Moreover, such an increase would require major rearrangement of the plates **36** and **42** and result in an undesirable arrangement of the corresponding assemblies as contrasted to the compact arrangement of assemblies **20, 26** and **28** illustrated in FIG. **1**. This compact arrangement is particularly effective because it is either necessary or highly desirable to accomplish several different results in a limited area around the drill point. For example, it is desirable, if not essential, that the drill **22** extend only a short distance out of guide **91** so that the drill will be accurately positioned during the grinding operation. This also minimizes drill breakage during the grinding operation and facilitates loading of short drills. Thus the relatively bulky head **90** is located closely adjacent the limited area. For most drills, it is desirable that the ball **231** engage in a flute closely adjacent the tip of the drill. This is essential for drills with very short flutes. The guide **66** also extends into this limited area to facilitate loading short drills into chuck **88** without requiring that the guide **66** be retracted during a grinding operation. The limited area is further congested by the grinding wheel **24** because it is desirable to keep the grinding wheel at its grinding location at all times to minimize cycle time and maintain a compact arrangement.

It will be understood that the automatic drill pointing machine with automatic drill locater system has been described hereinabove for purposes of illustration and is not intended to indicate limits of the present invention, the scope of which is defined by the following claims.

I claim:

**1**. In a machine tool wherein a workpiece has a predetermined angular orientation about an axis of said workpiece relative to a machining tool at the initiation of a machining operation and wherein said workpiece has an irregular peripheral contour about said axis with a predetermined portion of said contour being located at a predetermined angular position about said axis when said workpiece is disposed in said predetermined angular orientation, rotatable chuck means having a rotational axis and being adapted to receive and clamp said workpiece and to rotate said workpiece about said rotational axis when said workpiece is clamped therein, means for loading said workpiece in said chuck means at random angular orientations about said workpiece axis, drive means to rotate said chuck means, probe means for sensing said contour when said workpiece is clamped in said chuck means and for providing a first output signal when said predetermined contour portion is at said predetermined angular position and a second output signal when said predetermined contour portion is located at other than said predetermined angular position, and control means operatively coupled to said probe means and said drive means and responsive to said output signals for causing said drive means to rotate said chuck means until said predetermined contour portion is located at said predetermined angular position.

**2**. The machine tool set forth in claim **1** wherein said loading means comprises guide means to direct said workpiece into said chuck means during a loading operation along a loading axis aligned with said rotational axis of said chuck means and means for feeding individual workpieces to said guide means with said workpiece axis aligned with said loading axis and said workpiece at random angular orientations about said loading axis.

**3**. The machine tool set forth in claim **2** wherein said workpiece has a predetermined longitudinal position along said chuck rotational axis at the initiation of a machining operation, said control means includes switch means operable in a first state to actuate said drive means in response to said second signal and operable in a second state to inhibit actuation of said drive means, and means actuated by said loading means to switch said switch means to said first state when said workpiece is disposed in said predetermined longitudinal position.

**4**. The machine tool set forth in claim **1** wherein said workpiece is a fluted cutting tool and said predetermined contour portion is a flute of said cutting tool, and wherein said probe means comprises a movable probe member adapted to seat in said flute when said cutting tool is clamped in said chuck means, and transducer means responsive to motion of said probe member to develop said output signals.

**5**. The machine tool set forth in claim **4** wherein said probe means is mounted on said machine tool generally between said chuck means and said loading means with said probe member being movable to a location adjacent said loading axis, and wherein said probe means further comprises spring means urging said probe member in a first direction generally toward said loading axis to thereby move said probe member into contact with said cutting tool and cause said probe member to track in said flute while said cutting tool is being loaded in said chuck means, and wherein said transducer means is responsive to movement of said probe in an opposite direction to provide said second output signal if said probe moves out of said flute.

**6**. The machine tool set forth in claim **5** wherein said probe means further comprises an arm mounted for free swinging movement in a vertical plane about a horizontal pivot axis, said probe member is mounted on one end of said arm, said spring means is mounted in said probe means to pivot said arm and thereby move said probe member in said first direction into contact with said cutting tool, and wherein said transducer means comprises a proximity switch having a sensor mounted in said probe means so that said arm moves toward and away from said sensor and stop means adjustably mounted on said arm to move toward and away from said sensor so that said probe means provides said first signal when said stop means is disposed at a first predetermined gap with said sensor and provides said

second signal when said stop is disposed at a second predetermined gap with said sensor.

7. The machine tool set forth in claim 4 wherein said loading means comprises guide means to direct said cutting tool into said chuck means during a loading operation along a loading axis aligned with said chuck rotational axis, and feeding means for feeding individual cutting tools to said guide means with said cutting tool axis aligned with said loading axis and said cutting tools at random angular orientations about said loading axis.

8. The machine tool set forth in claim 7 wherein said cutting tool has a predetermined longitudinal position along said chuck rotational axis at the initiation of a machining operation, said control means includes switch means operable in a first state to actuate said drive means in response to said second signal and operable in a second state to inhibit actuation of said drive means, and means actuated by said loading means to switch said switch means to said first state when said cutting tool is disposed in said predetermined longitudinal position.

9. The machine tool set forth in claim 7 wherein said machining tool is a grinding wheel, said machine tool is adapted to grind a point at one end of said cutting tool and wherein said chuck means is carried in a head rotatable about a head axis that is disposed at substantially a first included angle with said chuck rotational axis and disposed at substantially a second included angle with said loading axis substantially equal to said first angle.

10. The machine tool set forth in claim 9 wherein said first and second included angles are on the order of 30 degrees.

11. The machine tool set forth in claim 9 wherein said drive means further comprises means to rotate said head about said head axis during a machining operation and wherein said control means is operatively coupled to said probe means and to said head rotating means to cause said head rotating means to rotate said head in response to said first output signal.

12. The machine tool set forth in claim 9 wherein said drive means comprises a hollow first drive shaft rotatable on said head axis, said head being drivingly connected to said first drive shaft for rotation thereby, said chuck means is rotatably mounted in said head with said chuck rotational axis at said first angle to said head axis, a second drive shaft also rotatable on said head axis and extending concentrically through said first drive shaft to said head, a sun gear fixedly mounted on said second shaft and disposed in said head, and a planet gear integral with said chuck means and meshed with said sun gear to rotate said chuck means.

13. The machine tool set forth in claim 12 wherein said drive means further comprises drive selection means operative in a first state to cause said first shaft to rotate and restrain rotation of said second shaft and operative in a second state to cause said second shaft to rotate and restrain rotation of said first shaft, and wherein said control means is operatively coupled to said drive selection means to actuate the same to its first state in response to said first output signal and to its second state in response to said second output signal.

14. The machine tool set forth in claim 13 wherein said drive selection means comprises a movable latch member, stop means drivingly connected to said first shaft to rotate therewith, said latch means being disposed on said machine tool to move into and out of engagement with said stop means, and actuating means operated in response to said output signals to move said latch means into and out of engagement with said stop means.

15. The machine tool set forth in claim 14 wherein said stop means is located at an angular position about said head rotational axis for engagement by said latch means when said chuck rotational axis is aligned with said loading axis.

16. The machine tool set forth in claim 15 wherein said stop means is mounted on a first ring member adapted to be driven, and wherein said drive selection means further comprises a second ring member keyed on said first shaft and drivingly connected to said first ring member through a lost motion connection.

17. The machine tool set forth in claim 13 further comprising means to open and close said chuck means and wherein said control means includes sequence controller means to sequentially cause said chuck means to open, cause said loading means to load a cutting tool into said chuck means, cause said chuck means to close, sense the angular orientation of said cutting tool about its axis, drive said second shaft to rotate said chuck means if said cutting tool is not in said predetermined angular orientation, terminate rotation of said chuck means when said cutting tool is in said predetermined angular orientation and then drive said first shaft to rotate said head.

18. A drill point grinding machine comprising a rotatable drive sleeve, a head body keyed on said sleeve for rotation therewith on a first axis, chuck means rotatably mounted in said head body eccentrically to said sleeve for rotation on a second axis, epicyclic gear means including a sun gear to rotate said chuck means, a drive shaft journalled in said sleeve to rotate on said first axis independently of said sleeve, said sun gear being fixedly mounted on said shaft for rotation therewith, and means for driving said shaft and said sleeve independently of each other.

19. The machine set forth in claim 18 wherein said chuck means includes a collet sleeve open at both ends and said sleeve is mounted in said head with a longitudinal axis of said sleeve coincident with said second axis so that when a first drill is disposed in said collet sleeve, a second drill directed into one end of said collet sleeve will eject said first drill from the other end of said collet sleeve.

20. The machine set forth in claim 18 wherein said first and said second axes are disposed in first and second planes but said axes are neither parallel nor intersecting, and wherein said head includes means for adjusting said head on said sleeve in a direction radially of said first axis to thereby vary the separation between said first plane and said second plane.

21. The machine set forth in claim 18 wherein said drive means comprises stop means carried by said sleeve and latch means adapted to engage said stop means to restrain rotation of said sleeve.

22. The machine set forth in claim 21 wherein said latch means comprises a latch bar movable into and out

of engagement with said stop means along a first direction, means mounting said latch bar for pivotal movement in a second direction generally perpendicular to said one direction when said latch bar is engaged with said stop means, and spring means engaging said latch bar to restrain pivotal movement in said second direction.

23. The machine set forth in claim 21 wherein said drive means further comprises an outer ring adapted to be driven and an inner ring keyed on said sleeve, said rings being concentric with each other and with said sleeve, said stop means being fixedly mounted on said outer ring for engagement by said latch means, and means drivingly connecting said first ring to said second ring comprising at least one pin fastened on one of said rings and riding in a slot in the other of said rings so that when said pin bottoms in one end of said slot said outer ring drives said inner ring and spring means interconnecting said rings to urge said pin toward said one end of said slot.

24. A drill pointing machine comprising a horizontal machine bed, a first pivotal slide plate mounted on said bed for pivotal movement in a horizontal plane about a first pivot axis, a second pivotal slide plate mounted on said first plate for pivotal movement in a horizontal plane about a second pivot axis, a grinding wheel mounted on one of said plates for comovement therewith and having a grinding face that moves through an arc during a grinding operation, a work head assembly mounted on said bed and having head means rotatably mounted therein for rotation on a generally horizontal axis, chuck means rotatably carried in said head means to rotate on a chuck axis disposed at substantially a first acute included angle to said head rotational axis, drill loading means mounted on said bed and adapted to deliver a drill to said chuck means along a loading axis aligned with said chuck rotational axis when said head means is at a first predetermined angular position about said head rotational axis, and wherein said work head assembly and said loading means are mounted on said bed so that said head rotational axis intersects said loading axis at substantially a second acute included angle substantially equal to said first included angle so that said head means may be rotated to said first predetermined angular position during a loading operation to receive a drill from said loading means and rotated to a second predetermined angular position at which said chuck rotational axis intersects said grinding wheel face during a grinding operation.

25. The machine set forth in claim 24 wherein said first and said second acute included angles are approximately 30°.

26. The machine set forth in claim 24 wherein said pivot axes of said first and said second plates are disposed in a vertical plane intersected by said chuck rotational axis when said head means is in said second predetermined angular position, and wherein said intersection of said vertical plane and said chuck rotational axis is substantially vertically aligned with the pivot axis of the other of said plates.

27. The machine set forth in claim 24 further comprising locater means including a probe adapted to engage said drill while said drill is being loaded in said chuck means, means urging said probe in a direction to cause said probe to track in a flute of said drill, transducer means responsive to motion of said probe to provide a first output signal when said probe is seated in said flute and a second output signal when said probe is engaged with a land of said drill, drive means to selectively rotate said chuck means and control means responsive to said first and second output signals to actuate said drive means in response to one of said output signals to rotate said chuck means and thereby rotate said drill and to actuate said drive means in response to the other output signal to terminate rotation of said drill.

28. The machine set forth in claim 27 wherein said probe is arranged and disposed to seat in said flute when said drill has a predetermined angular position about said chuck rotational axis required to present point faces of said drill to said grinding wheel face when said head means rotates to its second predetermined angular position and wherein said drill also has a predetermined position longitudinally in said chuck means required to present said point faces of said drill to said grinding wheel when said head means rotates to its second predetermined angular position, and wherein said control means further comprises second transducer means providing a third output signal when said drill is at said predetermined longitudinal position, and gate means operable upon occurrence of both said one output signal and said third output signal to actuate said drive means.

29. The machine set forth in claim 27 wherein said drive means comprises a rotatable drive sleeve, said head means is drivingly connected to said sleeve for rotation therewith on said head axis, epicyclic gear means including a sun gear to rotate said chuck means about its rotational axis, a drive shaft journalled in said sleeve to rotate on said head axis independently of said sleeve, said sun gear being drivingly connected to said shaft for rotation therewith, and means for driving said shaft independently of said sleeve to thereby rotate said chuck means in response to said one output signal.

30. The machine set forth in claim 29 further comprising second drive means to rotate said sleeve independently of said shaft and wherein said control means further comprises means responsive to said other output signal to actuate said second drive means and cause said sleeve to rotate.

31. The machine set forth in claim 30 further comprising means to open and close said chuck means and wherein said control means further comprises sequence controller means to cause said chuck means to open when said head means is in said first predetermined angular position, cause said loading means to load said drill into said chuck means, cause said chuck means to close, sense the angular position of said drill about said chuck rotational axis, drive said shaft to rotate said chuck means in response to said one output signal, terminate rotation of said shaft in response to said other output signal and then drive said sleeve to rotate said head means through its second predetermined angular position.

32. The machine set forth in claim 24 wherein said chuck means includes a collet sleeve open at both ends and said sleeve is mounted in said head means on said chuck rotational axis so that when said head means is at said first predetermined angular position and a first

drill is disposed in said collet sleeve, a second drill directed into one end of said collet sleeve by said loading means ejects said first drill from the other end of said collet sleeve.

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