# United States Patent

**Rohraff, Sr.**

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## [54] BROKEN TOOL DETECTOR


[72] Inventor: **Harry E. Rohraff, Sr.,** 16104 Pierson Avenue, Detroit, Mich. 48219



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[52] **U.S. Cl.** .....**200/61.42,** 408/6, 200/61.18

[51] **Int. Cl.** .....**H01h 35/02**

[58] **Field of Search** .....408/6; 200/61.42, 61.18; 137/67–70



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*Primary Examiner*—David Smith, Jr.

*Attorney*—Harness, Dickey & Pierce



[57] **ABSTRACT**

Accessory apparatus for a machine tool, to detect breakage of a tool bit and stop the machine, consists of a combined valve body, valve-actuating feeler and antideflection member mounted on the bushing plate of the machine, and a pneumatic system responsive to actuation of the valve by the feeler for stopping the machine and for resetting the feeler.


**20 Claims, 18 Drawing Figures**

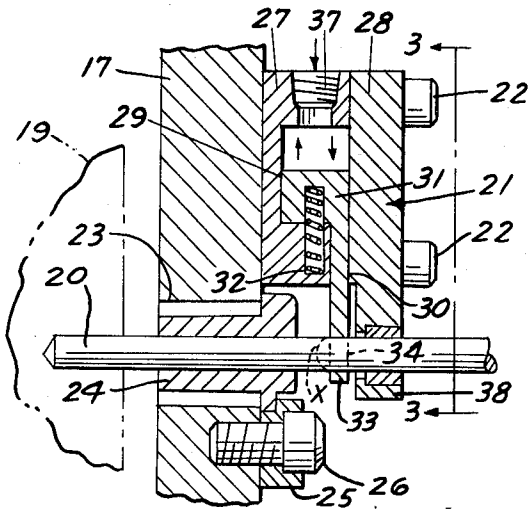

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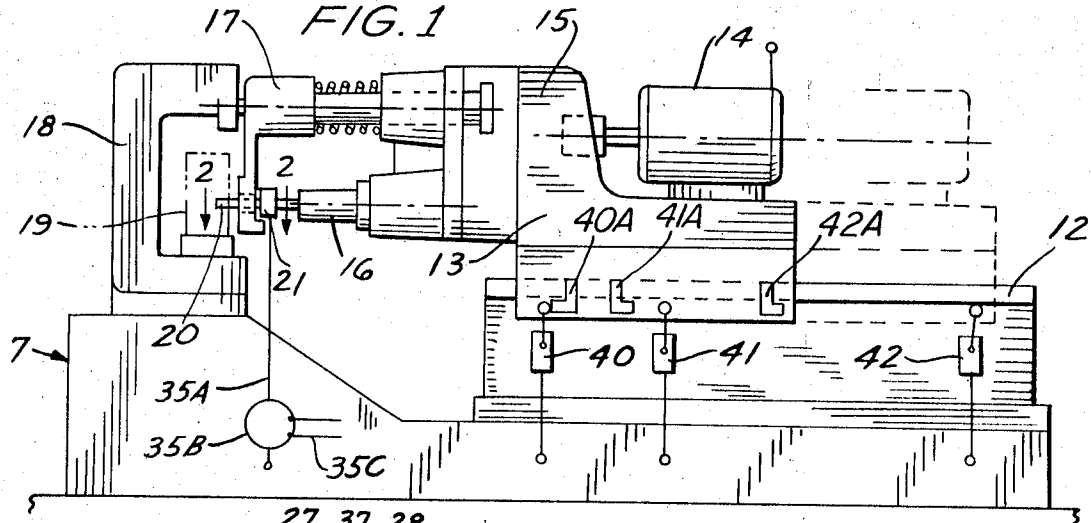
FIG. 1



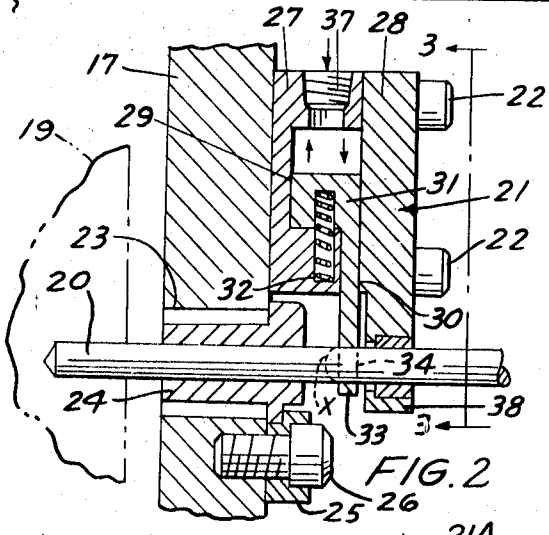




FIG. 2

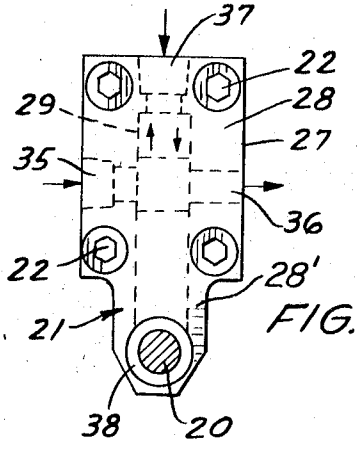



FIG. 3

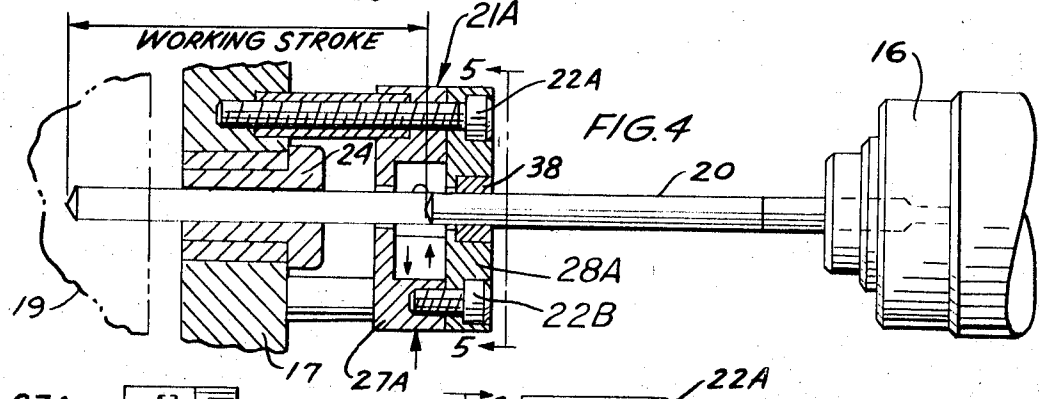



FIG. 4

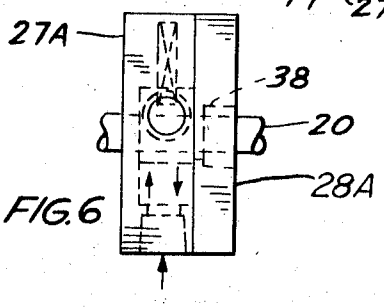



FIG. 6

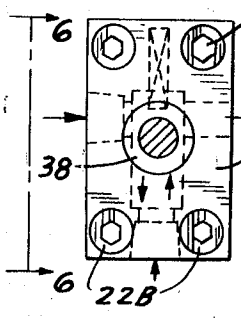



FIG. 5

HARRY E. ROHRAFF, S.R.
INVENTOR.

BY Edward M. Apple

ATTORNEY

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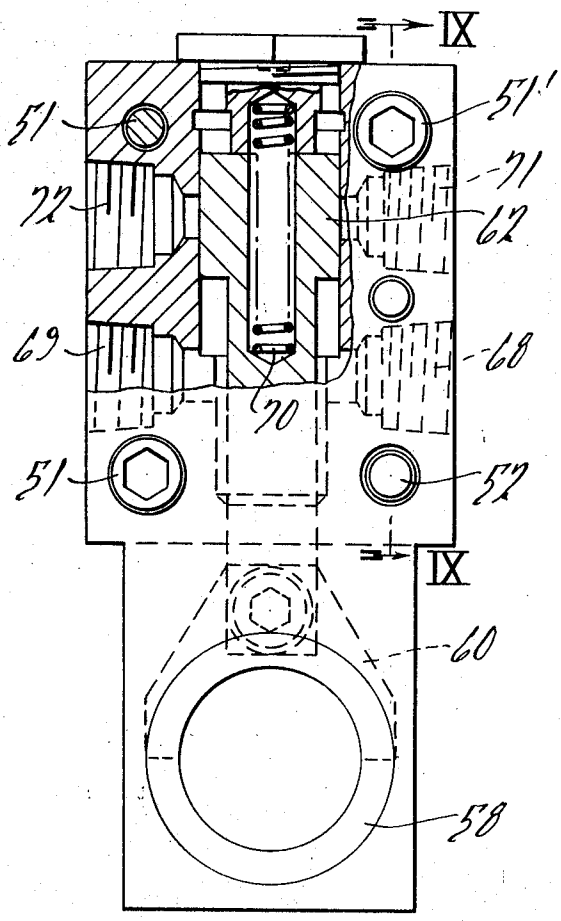



Fig. 7.

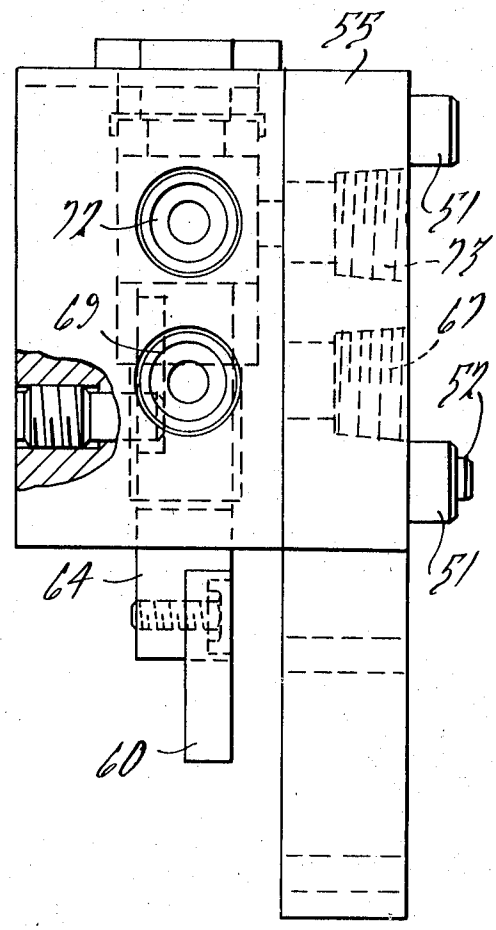



Fig. 8.

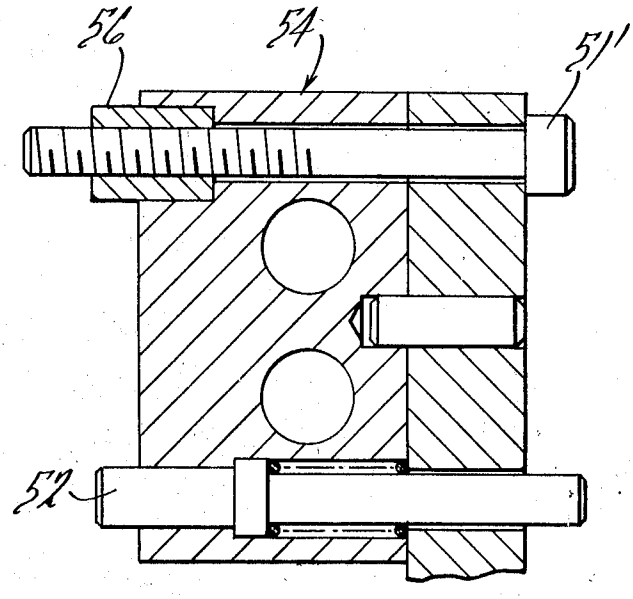
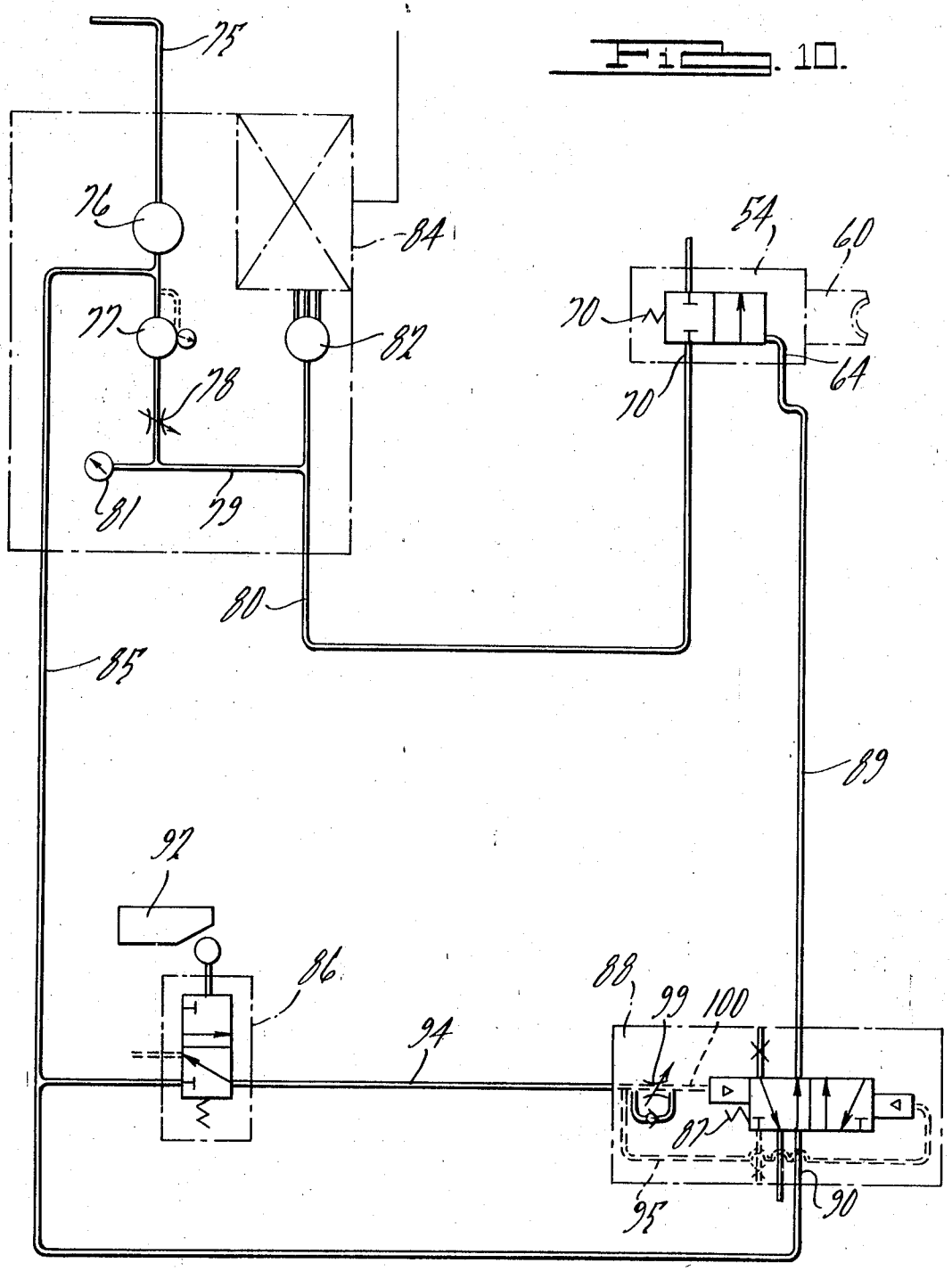



Fig. 9.

INVENTOR.
Harry E. Rohraff, Sr.
BY
Harness, Dickey & Pierce
ATTORNEYS.

Fig. 10.




INVENTOR.
Harry E. Rohraff, Sr.
BY
Harness, Dickey & Pierce
ATTORNEYS

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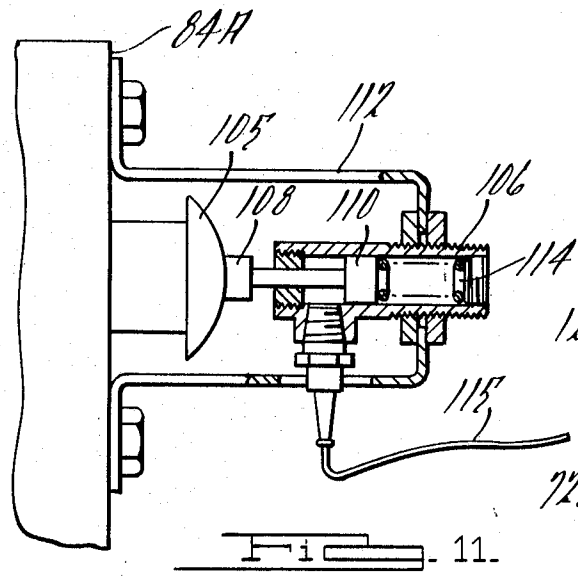


Fig. 11.

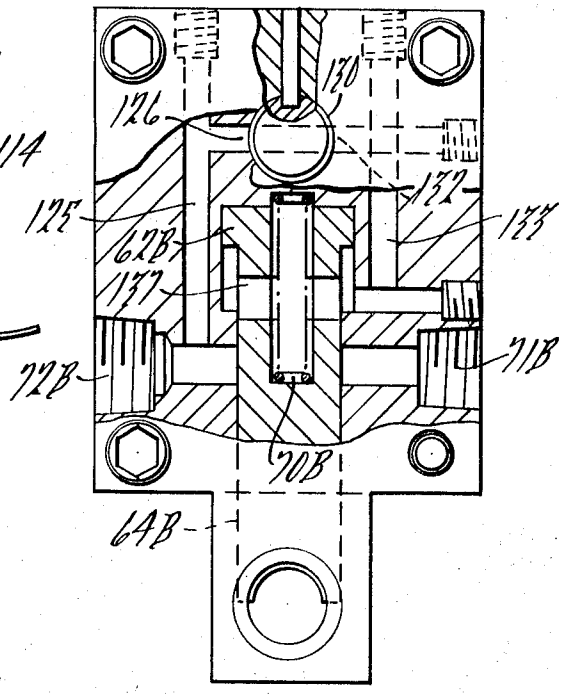


Fig. 13.

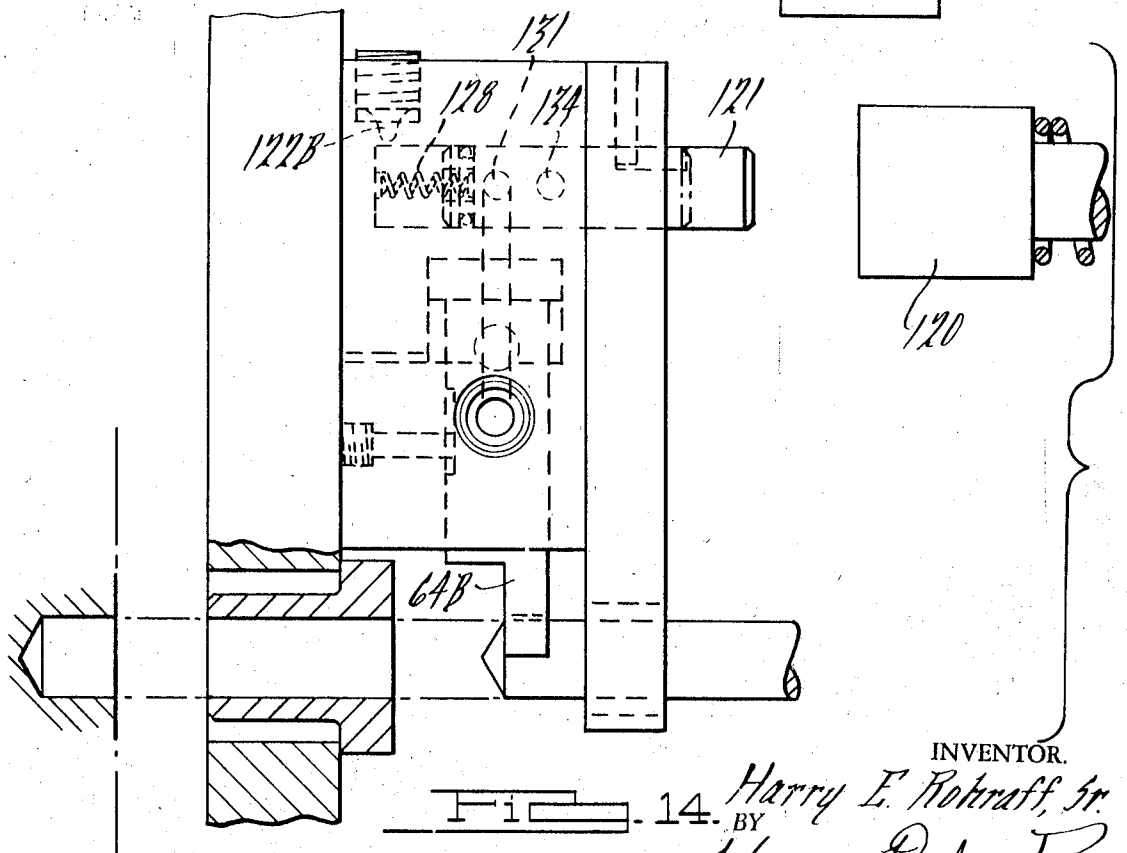


Fig. 14.

INVENTOR.
Harry E. Rohraff, Sr.
BY
Harness, Dickey & Pierce
ATTORNEYS

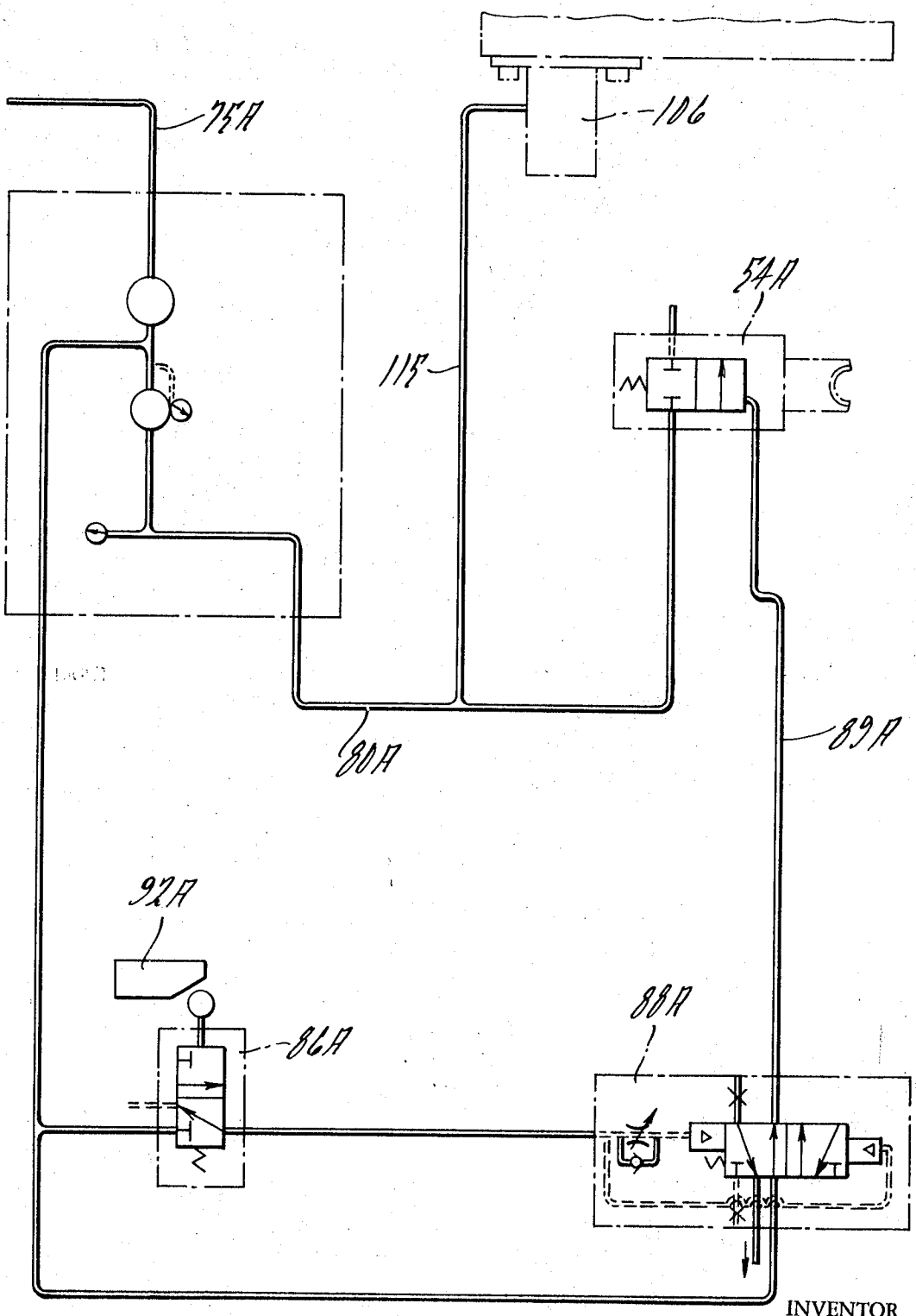


Fig. 12.

INVENTOR.
Harry E. Rohraff, Sr.
BY
Harness, Dickey & Pierce
ATTORNEYS

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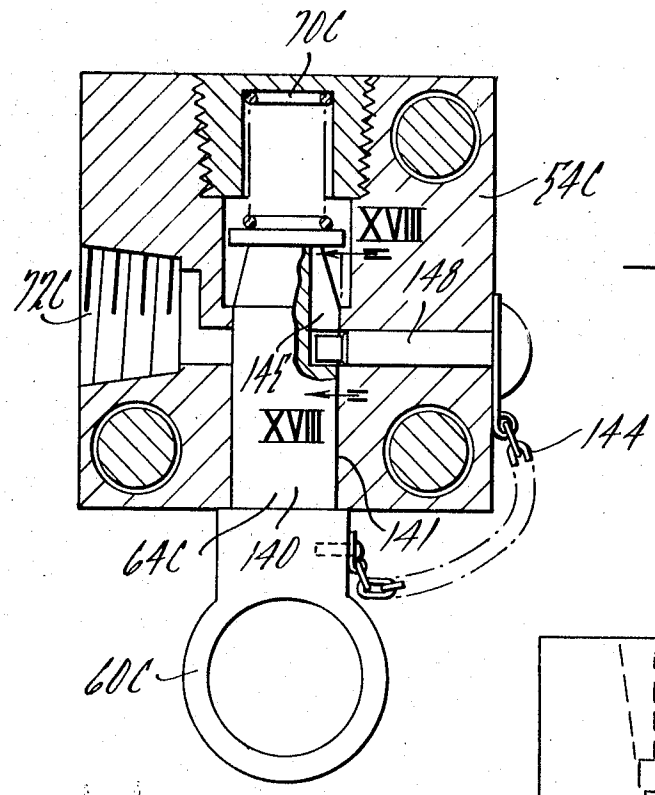
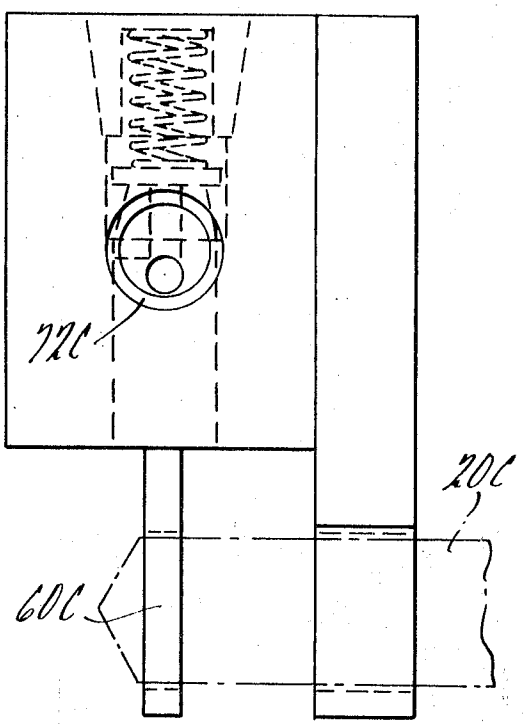



Fig. 15.

Fig. 16.



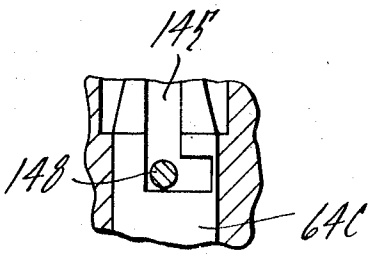




Fig. 18.

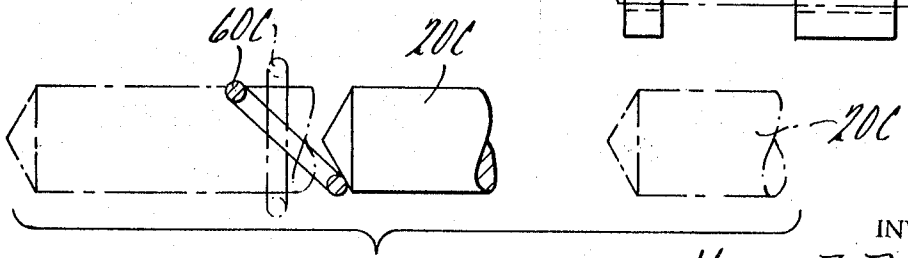



Fig. 17.

INVENTOR.
Harry E. Rohraff, Sr.
BY
Harness, Dickey & Pierce
ATTORNEYS

# BROKEN TOOL DETECTOR

## RELATED APPLICATION

This application is a continuation-in-part of my previously filed copending application Ser. No. 284, filed Jan. 2, 1970.

## BACKGROUND OF THE INVENTION

This invention relates to power tools and has particular application to devices for locating a broken tool, such as a drill, reamer, punch or the like, used with high-production machinery, and for preventing continued operation of the machinery in a manner which might cause damage or the production of imperfect work.

An object of the invention is to provide an improved system and device arranged to indicate the existence of a broken tool and to automatically shut down the machine when such broken tool is detected.

Another object of the invention is to provide an improved system and device of the character indicated which is comparatively inexpensive to manufacture and install, compact, simple and reliable.

Another object of the invention is to provide an improved broken tool detecting device having a sensing element movable across the path of but normally blocked by the tool bit, when the tool is in normal working condition, but which permits and causes the sensing element to move across such path, and shut down the machine when the tool bit is broken.

Another object of the invention is to provide apparatus of the character indicated which may be used on transfer machines, dial machines, trunnion machines, or any other type of multiple station large equipment.

Another object of the invention is to provide an improved sensing device adapted to be mounted on a guide bushing carrier and which is adapted to check the condition of tool bits operating on close center distances.

Another object of the invention is to provide an improved broken tool detector which is formed with limited built in leakage and arranged so that the operating air pressure may keep the parts of the detector clean.

Another object of the invention is to provide such an improved mechanism incorporating an antideflection bushing arranged to maintain alignment of the tool bit while the same is being checked and guided into the drill bushing.

Other objects and advantages will become apparent upon consideration of the present disclosure in its entirety.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a somewhat diagrammatic side elevational view of a machine equipped with the invention;

FIG. 2 is an enlarged horizontal section taken substantially on line 2—2 of FIG. 1;

FIG. 3 is an end view taken on the line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken as indicated by the line and arrows 4—4 of FIG. 2 but showing a modified construction;

FIG. 5 is a sectional elevational view taken substantially on the line 5—5 of FIG. 4;

FIG. 6 is a view taken substantially on the line 6—6 of FIG. 5;

FIG. 7 is a plan view of a modified sensing unit;

FIG. 8 is a side elevational view thereof;

FIG. 9 is a cross section taken substantially on the line 9—9 of FIG. 7 and looking in the direction of the arrows;

FIG. 10 is a schematic diagram of a preferred control system;

FIG. 11 is a somewhat diagrammatic sectional elevational view of a modified stop mechanism;

FIG. 12 is a schematic view similar to FIG 10, showing a modified control system adapted for use with the stop mechanism of FIG. 11;

FIGS. 13 and 14 are plan and elevational views, respectively, of a modified sensing and time delay mechanism;

FIGS. 15 and 16 are similar plan and elevational views of another modified sensing mechanism;



FIG. 17 is a diagrammatic end view of the same showing positions assumed by a drill bit during resetting of the sensing unit; and

FIG. 18 is a detailed section taken substantially on the line 18—18 of FIG. 15.

## DETAILED DESCRIPTION OF THE PREFERRED FORMS OF THE INVENTION

Referring now more particularly to the drawing, reference character 7 indicates the base of a production machine having ways 12 and a reciprocating head 13, on which is mounted a conventional electric motor 14, gear reduction 15, tool-holding spindle 16, bushing plate carrier 17, and a work-holding fixture 18 in which is mounted a workpiece 19 which is being drilled by the drill bit 20, which rotates with the tool spindle 16. In other types of machines the work may rotate while the tool bit remains stationary. The bushing plate carrier 17 has an opening 23 therein in which is mounted a tool guide bushing 24 in which the tool 20 reciprocates during its normal cycle of operation. The guide bushing 24 is held in position by means of a retainer 25 and a machine screw 26.

All of the elements just described constitute conventional parts of a well-known machine and comprise no part of the invention except as they are combined with elements hereinafter described.

A combined valve housing and feeler support body 21 is secured by machine screws 22 (FIGS. 2 and 3) to the bushing plate carrier 17. The assembly 21 is preferably made of two parts, comprising a blocklike body 27 and a cover plate 28. The body 27 (FIG. 2) is provided with a rectangular valve chamber 29, an extension 30 of which defines an opening and slideway for a feeler arm 33 integral with a valving element 31 slidable in chamber 29. Arm 33 is movable radially across the path of the drill 20. The valving element and feeler arm are biased away from the drill path by spring 32. Near its free end the feeler arm 33 is provided with a bore 34 through which the tool bit 20 slidably extends during normal operation of the machine so that under normal conditions, when the tool bit 20 is unbroken, its periphery will hold the feeler and valve element 31 against the pressure of the spring 32.

A pair of ports 35, 36 in opposite sides of body 27 open into chamber 29 in positions to be blocked by valve member 31 when the latter is in the position in which it is held by an unbroken tool bit (spring 32 compressed). Port 35 is illustrated as the air inlet port and 36 as an exhaust port open to the atmosphere (FIG. 3), although these connections can be reversed where such is more convenient. A third opening 37 communicates with the chamber 29 at the end opposite the feeler arm 33 and serves as a reset air inlet, the purpose of which will appear hereinafter. The ports 35 and 37 are supplied with air under pressure from a suitable source (not shown).

In normal operating work cycles, the tool bit 20 will reciprocate in the guide bushing 24, and in an antideflection bushing 38 carried by an extension portion 28′ of top plate 28. In the normal retracted position of the tool bit, indicated at "X" in FIG. 2, only the end of the bit overlaps the feeler. If breakage of the bit occurs, when the portion attached to the spindle 16 is thereafter withdrawn, on the next cycle, there will be nothing to hold the feeler in its normal position, and the feeler and valve will be moved away from the tool by spring 32, unblocking ports 35, 36 and venting the main air supply line 35A connected to port 35. This will cause a reduction in pressure in the air line 35A, tripping a pressure switch 35B and opening the circuit through an electric line 35C connected to the control panel of the machine and causing the machine to stop, or at least stopping the head 13 (depending upon the details of the preferred machine control setup, which of course do not form a part of the present invention).

After the machine stops, the operator may manually control the head 13 through the control panel (not shown) in such manner as to cause the head 13 to bypass the limit switch 41

which limits the normal full retract position so that the head 13 will move farther back and actuate the switch 42, which in turn actuates the reset air supply, returns the feeler to projected position, and reblocks port 35. In this position the head 13 and the spindle are retracted far enough so the tool may be replaced. When the tool is replaced, the head is again manually operated forwardly to bypass the switch 41 and resume its normal position wherein its switch-actuating shoes 40A, 41A are between and controlled by the limit switches 40 and 41 for automatic cycling.

When the head has moved forwardly far enough so that the cam 40A strikes switch 40, the tool bit, if present and unbroken, is in the feeler opening, and so is in position to restrain movement of the feeler. The position of switch 40 corresponds to the full-in position of the tool bit, and it is so connected as not only to reverse the head but also to return the circuit of reset air switch 42 to the "air off" position and so cut off the reset air supply to port 37. The tool bit then restrains the feeler and the reset limit switch 42 remains inactive and the reset air off until the head is again moved all the way to the rear after another broken tool is encountered or when it is desired to remove a dull tool.

In FIG. 4 I show a modified form of the device in which the cover plate 28A of the housing 21A is secured to the body 27A by means of one long machine screw 22A, hollow dowel 45, and three short machine screws 22B. The long machine screw 22A is threaded into a suitable tapped hole in the bushing plate carrier 17, so that upon removal of the short machine screws 22B, the cover 28A may be pivoted around the long machine screw 22A, so the broken tool may be removed and replaced with another. The device functions in other respects as herein previously described.

Another modified sensing mechanism, shown in FIGS. 7–9, is similarly adapted to be attached to the bushing plate of a machine by machine screws 51, 51′ positioned at three of the corners of the rectangular body 54 and a spring-pressed latching and locating pin 52 at the fourth corner, which is one of the corners closest to the bit path. Screws 51, 51′ extend through and retain the cover plate 55 as well as serving to attach the assembly to the bushing plate. At one of the corners farther from the bit path the screw 51′, which is the pivot screw, extends through a hollow dowel 56 which is accurately fitted in the bushing plate and in the bottom of the body 54. In order to move the sensing assembly away from the alignment bushing in the bushing plate, the screws 51 are removed, pin 52 is lifted, and the assembly is pivoted around screw 51′ and dowel 56.

The cover plate 55 similarly extends outwardly across the path of the tool bit where it carries an antideflection bushing 58 closely overlying the feeler tip 60. In this embodiment the feeler tip 60 is formed as a separate and renewable element removably secured to the feeler stem 64 of the valve element 62. The feeler stem 64 is of reduced diameter and the valve element 62 is formed as a piston which is movable upwardly, as viewed in FIGS. 7 and 8, by resetting air introduced through one of the opposed side ports 68, 69 or cover port 67, the other two of such ports being permanently blocked. A spring 70 behind the valve piston 62 biases the feeler tip outwardly against the tool, while resetting air maintains the valve piston in the left end position, and the spring compressed, in which position the main control air inlet and exhaust ports 71 and 72 and cover port 73 are blocked. In this embodiment, in order to provide maximum accessibility for the making of connections, cover plate 55 contains an additional port 67 usable in place of the side ports 68, 69, as noted above, and the cover plate is also provided with a port 73 usable, in place of one of the ports 71, 72, as a control air or vent port. Thus the specific connections shown and described are variable as may be convenient or necessary to accommodate other parts.

FIG. 10 shows in diagrammatic form a preferred control system adapted to be used with the sensing mechanism of FIGS. 7–9. A source of air under pressure delivered by a conduit 75 through suitable filtering an regulating means 76 and 77 is connected through an adjustable pressure regulator 78 and via conduits 79, 80 to a pressure switch 82 which by such pressure is normally held closed to maintain operation of the machine in the normal manner under the control of the electrical master control panel 84. A pressure gauge 81 is preferably provided in the line 79 beyond the regulator 78. Line 80 is also connected to the side port 72 of the sensing unit.

The main air supply upstream of the regulator 78 is also connected by a conduit 85 to an air limit valve 86 and a time delay valve 88. The time delay valve is in series with the reset air port 69 of the sensing unit, to which it is connected by a conduit 89. Conduit 85 is connected to a side inlet port 90 of the time delay valve, which port is during normal operation of the machine maintained in communication with conduit 89 and reset air port 69 by the valve 88.

The machine is equipped with a cam 92 for actuating the air limit valve 86 at the same time the rear reversing switch corresponding to the switch 41 of the first embodiment is actuated. At other times the valve 86 is held closed by its biasing spring, and the biasing spring of time delay valve 88 therefore maintains the latter valve in the aforementioned position to constantly supply air to the reset port 69 and maintain the sensing tip 60 slightly spaced from the tool bit.

At each retraction of the slide in normal operation of the machine, the cam 92 opens the normally closed valve 86, which then supplies air through branch lines 94, 95 to one end of the valve spool of valve 88. Valve 88 is thereby immediately shifted to closed position, by air pressure delivered to its right end, as the parts are shown in FIG. 10, interrupting the supply to the reset port 69 and permitting the feeler tip to move into engagement with the tool bit under the influence of the biasing spring 70. Assuming the tool to be unbroken, the feeler tip, by engagement with the tool bit, arrests movement of the valve piston 62 before the latter is moved far enough to unblock the air inlet port 72, and the machine accordingly continues operation, the head reversing and moving forwardly in the normal manner. At the same time that air is delivered to the right end of the time delay valve via line 95, it is delivered to the left end of the valve through an adjustable orifice 99 and a conduit 100. By virtue of the presence of the orifice 99, however, the pressure via line 100 is not sufficient, for a predetermined interval, to prevent closing of the valve 88. However, the pressure via line 100 is augmented by the biasing spring 87 so that when the pressure builds up to an equalized condition, valve 88 reopens the supply to the reset port under the influence of its biasing spring. This setting is preferably such that the time interval is short and merely of sufficient length to check the tool bit.

As previously explained, the normal travel of the tool bit with relation to the work is such that, at full retraction, the tip of the tool bit remains in overlapping relation with respect to the tip of the feeler. If the tool has broken so that such overlapping relation does not exist, when the reset air to port 69 is interrupted as described above, the feeler moves across the path of the tool bit far enough to permit the valve piston 62 to unblock ports 71 and 72. The air pressure in line 80 thereupon drops, and the pressure switch 82, being biased to the position to interrupt the circuit to the machine, is actuated to stop the machine. Thereafter the head may be moved back and the tool replaced as described above in connection with the first embodiment.

It will be understood that the air pressure delivered via line 85 and the time delay valve to the reset port will be substantially higher than the pressure delivered through regulator 77 to the control line 80 leading to the pressure switch and to the main air inlet port 72 of the sensing unit. The regulated air pressure in the control line may nevertheless be substantial (e.g.: 25–90 p.s.i.) so that the pressure drop when line 80 is vented through the sensing unit will be substantial and actuation of the pressure switch 82 correspondingly positive. Due to the quick dumping of the reset air, the feeler spring may be relatively light, but the actuation of the feeler is rapid. If the

pressure differential between the supply and the control line **80** established by the regulator **77** is sufficient the adjustable orifice **78** may be entirely omitted.

The clearances between the sensing valve and its valve chamber, and between the feeler stem and the passage in which it slides, are great enough to allow a continuous limited escape of air which tends constantly to clean the parts and prevent fouling and sticking under the effects of the cutting oil and chips which are normally present in the environment in which these parts operate.

In FIGS. **11** and **12** a modified arrangement is shown for arresting operation of the machine in event of tool breakage. In place of the special pressure switch **82** which must of course be connected into the control circuit in the master control panel of the machine, means are provided for stopping the machine by automatically depressing the regular stop button **105** with which the control panel **84A** is conventionally equipped. A servo-cylinder **106** is provided with a plunger **108** adapted to engage and depress the stop button when actuated by the piston **110** of the servo-cylinder. The cylinder is suitably mounted over the button as by bracket **112**, and its piston is biased to the stop position by a spring **114** but normally held off by the main air supply which acts upon the opposite side of the piston, to which it is delivered by a branch line **115** connected to the air supply conduit **80A**, and which corresponds to the line **80** shown in FIG. **10**. Other parts of this embodiment corresponding to parts of the embodiment last described are designated by like reference characters distinguished by the letter "A" and will not require detailed redescription. It will be seen that in event of tool breakage and the consequent venting of the pressure in lines **80A** and **115** through the sensing unit, the fall of pressure on the left side of the piston **110** permits the spring **114** to stop the machine by depressing the button **105**.

FIGS. **13** and **14** show a further modified sensing unit incorporating time delay means and which eliminates the air limit valve **86**, the time delay valve **88** and also the reset air port. The feeler mechanism itself and the means for actuating the same are basically similar to the arrangement shown in FIGS. **7–9** and corresponding parts are designated by like reference characters distinguished by the letter "B," but the main air supply, which is delivered to a side port **72B** of the sensing unit also acts as the reset air supply. A spring-pressed plunger **120** attached to the head of the machine is adapted to engage the end of the spool valve **121** which projects from the sensing unit, such engagement occurring each time the tool and head commence to move inwardly during normal operation. During the first portion of such normal forward movement the plunger **120** moves the valve **121** through its full stroke, which is relatively short, and the plunger is thereafter restrained by the bottoming of the valve as the head and tool bit continue their forward movement. The reset air is conducted from the inlet port **72B** through a branch passage **125** to a side port **126** in the valve chamber bore **130**. The valve **121** is biased outwardly by a compression spring **128** beneath its inner end. When the valve is fully projected (head and tool bit retracted) a cross-connecting passage **131** in the valve is aligned with port **126** and with an opposite port **132** which communicates via a branch passage **133** with the space below a valve spool **62B** on the inner end of the feeler stem **64B**. Thus the reset air is normally effective to maintain the feeler tip retracted except when the valve **121** is moved inwardly by the plunger **120**. The valve **121** also contains a second cross-connecting passage **134** so spaced from the passage **131** that when the valve is fully depressed, the passage **134** reestablishes communication between passages **125** and **133** to permit resumed conduction of reset air. Thus the delivery of reset air is only interrupted during the interval required for the valve **121** to move between its projected and fully depressed positions, and such interruption occurs in a short interval at the commencement and at the conclusion of each normal operative stroke of the head and tool bit. The rate of travel of the valve **121** is variable by an adjustable needle valve **122** which imparts a controllable dashpot effect to the chamber space beneath valve **121**.

At the time of interruption of reset air only the tip of the tool bit overlaps the feeler, as shown in FIG. **14**. Accordingly, if the tool is broken so that the tip is not present, the feeler will move farther down. The stem **64B** also acts as a valve which normally blocks communication between inlet port **72B** and a vent port **71B** in the opposite side of the body. A cross-communication passage **137** in stem **64B** is so positioned that if the feeler moves all the way down during the interruption interval, due to the absence of the blocking effect of the tool bit, passage **137** registers with ports **72B–71B**, vents the main air supply line connected to port **72B** and stops the machine in the manner previously described.

FIGS. **15–17** disclose another modified sensing mechanism wherein the feeler tip **60C** is attached to an ejectable feeler stem portion **64C** which also acts as a piston and as a blocking valve for the main air line connected to the side port **72C**. The portion **64C** is of circular cross section and together with the feeler tip **60C** is also rotatable about its longitudinal axis in the body **54C**. The feeler is normally urged against the side of the tool bit by a compression spring **70C** behind the stem **64C**. When a tool bit breaks, the tip and stem are ejected completely from the body, and the main controlling air line connected to port **72C** is thereby vented through the open outer end of the cylindrical bore **141** in which the stem is slidable, the machine thereby being stopped either by pressure switch mechanism such as is shown in FIG. **10** or by stop button operating means such as disclosed in FIG. **11**. The control air aids projection of the plunger after its full diameter stem portion moves out far enough to establish communication between port **72** and the space behind the stem of the plug. A loose chain **144** may connect the sensing tip and stem assembly to the body to prevent loss, as in the construction shown, or these assemblies may be treated as expendable, and a new one substituted whenever a tool breaks.

In view of the fact that air is being supplied to the sensing unit at the time the operator reinstalls the feeler assembly after a tool breakage, the wall of the stem **64C** is provided with an L-shaped slot **145**. Pin **148** which also anchors the chain **144** extends into the slot **145**. Slot **145** has a straight longitudinal portion extending to the free end of the stem and a short peripheral leg at a position corresponding to full insertion of the feeler assembly. The straight portion of slot **145** is so located that when such part of the slot overengages the pin **148** the feeler tip is perpendicular to the path of the tool bit **20C** as required in the normal operative position shown in full lines in FIG. **17**, while when the feeler assembly has been fully inserted and turned to the maximum angle permitted to the peripheral leg of the slot, the feeler tip assumes the angular position shown in broken lines in FIG. **17** wherein it is tipped approximately 45°. After a tool breakage, the feeler assembly is inserted and turned to such angular position, so that the peripheral leg of the slot overengages pin **148** to prevent the feeler assembly from being immediately blown out of the sensing unit by the control air. When the tool advances on the first operative stroke, it strikes the tilted feeler tip, as shown in FIG. **17**, straightens it to the transverse operative full line position and thereafter overlaps the tip to restrain it, so that although the restraining effect of the bit prevents the feeler from being ejected until a tool breakage occurs, the straight section of the slot is aligned with the pin and permits such ejection in event of breakage of the bit.

Where multiple drills (or other tool bits) are grouped to move to and from the work simultaneously, a single time delay valve may serve the sensors for all of such bits. In the case of the embodiment of FIGS. **13** and **14**, therefore, only a single plunger **120** and valve **121** will be required for each head. Of course, the same principles apply whether the tools move with relation to the work or vice versa.

This "Detailed Description of Preferred Forms of the Invention," and the accompanying drawings, have been furnished in compliance with the statutory requirement to set forth the best mode contemplated by the inventor of carrying out the invention. The prior portions consisting of the "Abstract of the Disclosure" and the "Background of the Invention" are

furnished without prejudice to comply with administrative requirements of the U.S. Pat. Office.

What is claimed is:

1. Means for detecting breakage of a tool bit or the like in a machine tool of the type wherein a bit and workpiece are movable relatively to each other, comprising a body adapted to be attached to a bushing plate of such a machine, a valving member in the body, a feeler movably supported by the body and operatively connectable to the valve to actuate the latter, fluid-operable means controllable by the valve for preventing unwanted relative movement of the workpiece and bit in response to breakage of the bit, and means for biasing said feeler toward a portion of the bit, whereby in event said portion of the bit is absent due to breakage, said feeler and valve are movable to a detecting position not otherwise attainable.

2. Means as defined in claim 1 wherein said body is of blocklike form having a bottom face adapted to bear against the bushing plate of a machine in a position adjacent a bushing through which a tool bit extends during operation of the machine, the feeler projecting from the body in a position spaced outwardly from said bottom face to overlie the bushing, and an antideflection bushing carried by the body and also overlaying the aforementioned bushing at a position spaced farther from said bottom face than, but relatively close to, the feeler.

3. Means as defined in claim 2 wherein the valving member is movable in a cavity in the body, and a closure plate for the cavity defining the outer face of the body and extending laterally therefrom and carrying said antideflection bushing, the feeler being movable in the space beneath the laterally extending portion of the closure plate.

4. Means as defined in claim 2 wherein the valving member is movable in a cavity in the body, and a closure plate for the cavity defining the outer face of the body and extending laterally therefrom and carrying said antideflection bushing, the feeler comprising an extension connected to the valve and slidably extending from the body into, and movable in, the space beneath the laterally extending portion of the closure plate.

5. In combination with means as defined in claim 1, means for attaching said body to a bushing plate in a position such that the feeler may overhang a bushing in the plate, said means including a fulcrum screw extending through the body at a position spaced from the bushing and about which the body may be pivoted to displace the feeler from the overhanging position.

6. Means as defined in claim 1 wherein said valve is a vent valve biased to venting position, the feeler having a sensing portion movable toward the tool bit as the valve commences movement from closed position toward venting position, the feeler and valve being normally blocked from movement to venting position by the tool bit, whereby a pressure change induced by venting may be utilized to arrest an operation of the machine in event breakage of the tool bit permits the feeler and valve to move to venting position under the influence of the biasing means.

7. In combination with means as defined in claim 6, a servomotor for returning said valve and feeler from venting position to closed position.

8. Means as defined in claim 7 wherein said servomotor is operable by air pressure in a direction counter to said bias and to move the valve and feeler to a closed position of the valve wherein said feeler is somewhat spaced from the path of the tool bit.

9. Means as defined in claim 7 wherein said servomotor is operable by air pressure in a direction counter to said bias and to move the valve and feeler to a closed position of the valve wherein said feeler is somewhat spaced from the path of the tool bit, means normally maintaining counterbiasing pressure in said servomotor, and means including a timer and a valve operable in response to movement of the tool bit carrying portion of the machine to a predetermined position for interrupting delivery of air pressure to said servomotor during a timed interval, whereby the biasing means may move the feeler against, or into the path of, the tool bit, whereby if the bit is not present the feeler and valve move to the venting position.

10. In a broken tool detecting apparatus adapted for use with a machine tool having a work-supporting portion and a tool bit supporting portion, one of which portions is movable in a predetermined path toward and from the other to the extent of a normal travel during operation of the machine, the novelty which comprises, in combination, a vent valve biased to venting position, means for holding the valve closed against the effect of the bias including a feeler operatively connected to the valve and engageable with the tool bit in a direction lateral to said path when said portions are near the fully withdrawn part of said normal travel, fluid pressure responsive control means for the machine, said control means being biased to a position to arrest relative movement of said portions of the machine and counterbiasable by fluid pressure, and fluid conducting means connected to said control means and to said vent valve and adapted to be connected to a source of fluid pressure, whereby such relative movement will be arrested by the control means if the vent valve opens to the venting position due to failure of engagement between the feeler and tool bit.

11. In a broken tool detecting apparatus adapted for use with a machine tool having a work supporting portion and a tool bit supporting portion, one of which portions is movable in a predetermined path toward and from the other to the extent of a normal travel during operation of the machine, the novelty which comprises, in combination, a valve biased to one position, counterbiasing means for holding the valve in another position comprising a feeler operatively connected to the valve and biased to engage the tool bit in a direction lateral to said path when the tool bit supporting portion is near the fully withdrawn part of said normal travel, fluid pressure responsive control means actuatable to arrest relative movement of said portions of the machine, and means connecting said valve to said control means to actuate the latter in response to movement of the valve when the feeler moves beyond its position of engagement with the tool bit due to failure or absence of the tool bit.

12. Apparatus as defined in claim 11 wherein said feeler is biased toward the tool bit throughout said normal travel, a second counterbiasing means operable by fluid pressure for moving the feeler away from the tool bit, and means responsive to movement of said portions to said withdrawn part of the normal travel for disabling said second counterbiasing means.

13. Apparatus as defined in claim 10 wherein said feeler and valve are connected for simultaneous movement and the biasing means for the valve biases the feeler toward the tool bit.

14. Apparatus as defined in claim 10 wherein said feeler and valve are connected for simultaneous movement and the biasing means for the valve biases the feeler toward the tool bit, counterbiasing means for moving the feeler away from the tool bit and the valve away from venting position, and means responsive to movement of said portion to said withdrawn part of the normal travel for disabling said counterbiasing means.

15. Apparatus as defined in claim 10 wherein said feeler and valve are connected for simultaneous movement and the biasing means for the valve biases the feeler toward the tool bit, fluid-actuatable counterbiasing means for moving the feeler away from the tool bit and the valve away from venting position, and means including a timing valve responsive to movement of said portion to said withdrawn part of the normal travel for disabling said counterbiasing means.

16. Apparatus as defined in claim 11 wherein said feeler and valve are movable as a unit and throughout said entire normal travel the biasing means urges the feeler toward the tool bit and the valve toward the position which actuates the control means.

17. Apparatus as defined in claim 16 wherein the valve is a vent valve and the biasing means urges the same to venting position.

18. Apparatus as defined in claim 17 wherein the vent valve includes a body having an open ended bore and a valving element slidable and rotatable in the bore and ejectable therefrom in the venting position, the feeler being rigidly attached to the valving element to rotate therewith and having a bit-engaging tip rockable into and out of axial alignment with the tool bit with such rotation and contoured to be rocked into axial alignment by the tool bit, and keying portions carried by the body and valving element for holding the valving element against ejection when it is in the bore and is turned to nonaxially aligned position.

19. In combination with apparatus as defined in claim 11, a second counterbiasing means operable by fluid pressure and acting on the valve and feeler to urge the feeler away from the bit and the valve away from said first-mentioned position, and a second valve actuatable by said relatively movable portions of the machine to interrupt the supply of fluid pressure to said second counterbiasing means during movement of said portions in a part of said normal travel.

20. Apparatus as defined in claim 19 including a valve body adapted to be attached to the machine appurtenant to the path of travel of the tool bit, a valving element of said first-mentioned valve being movable in said body and the feeler being attached to said valving element, said second counterbiasing means including a piston portion of said valving element, and means for delivering fluid pressure to said piston portion including said second valve, said second valve being movable in the body.

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