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Arbogast et al.

[11] **3,747,142**

[45] **July 24, 1973**

[54] **BROKEN TOOL DETECTOR**

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[52] **U.S. Cl.** **10/7,** 83/62, 10/13

[51] **Int. Cl.** **B21h 3/00**

[58] **Field of Search** 10/5, 7, 13; 83/62

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[57] **ABSTRACT**

A broken tool detector utilized to check for the presence of any protrusion on the face of a tool, such as the second blow punch on a two blow header or similar machine, where the detector includes a probe which travels with the ram and is mounted on the ram on which the punches are mounted. The probe is positioned so that the second punch passes it as the punch is moved between its inactive and active punching positions. The probe is isolated electrically from the machine and wired to a low voltage circuit connected to the drive motor starter circuit by isolated detector relay contacts. Each time the probe contacts the end of the punch, a capacitor charge is restored which supplies energy to maintain the detector relay contacts. If the punch is broken or worn and fails to make contact with the probe, the capacitor discharges and the detector relay drops out, stopping the machine.

7 Claims, 9 Drawing Figures

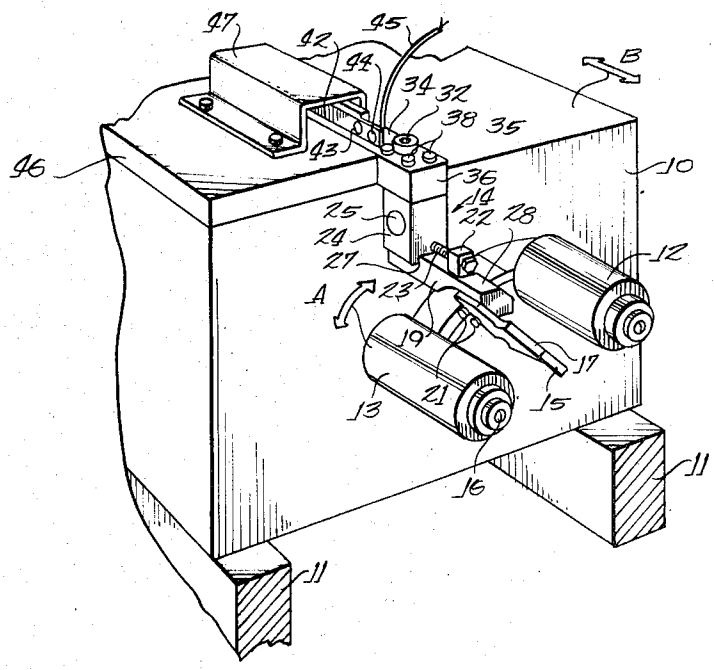


Fig. 1.

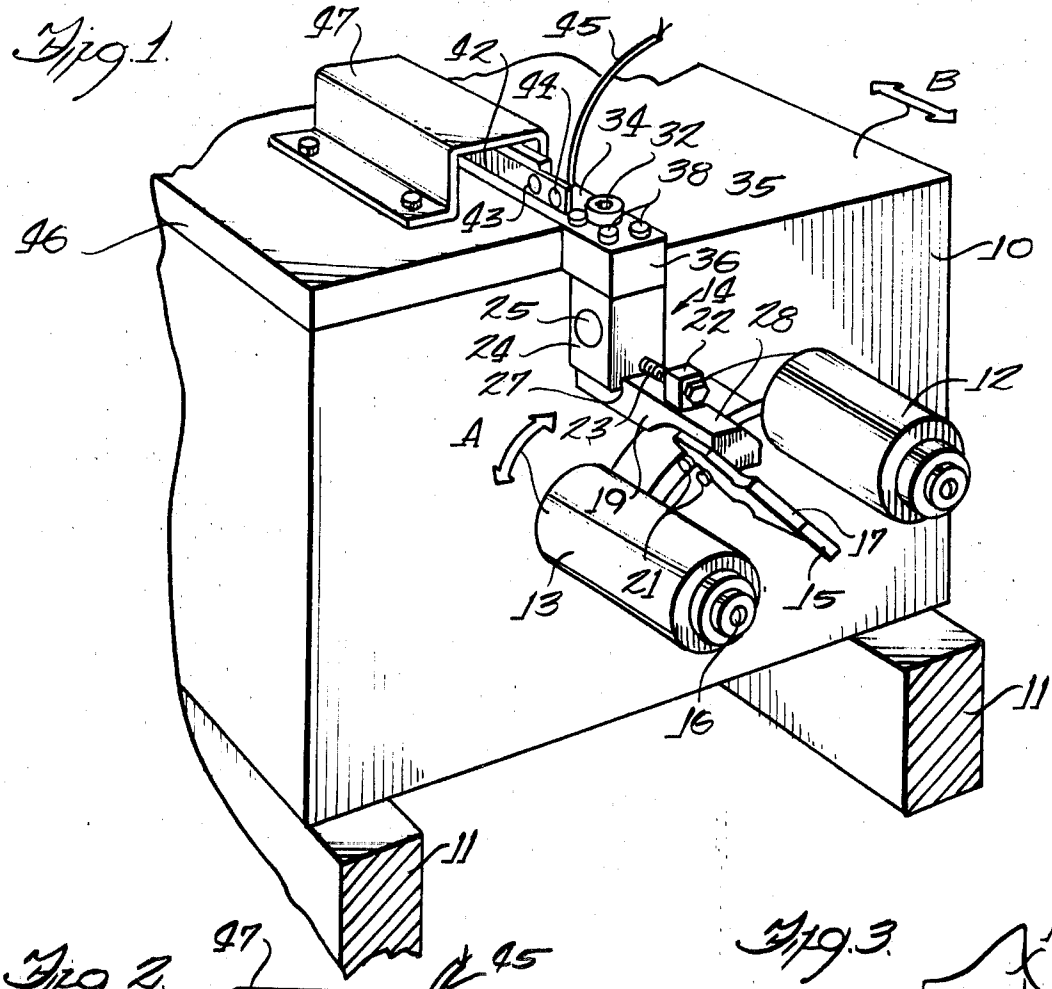


Fig. 2.

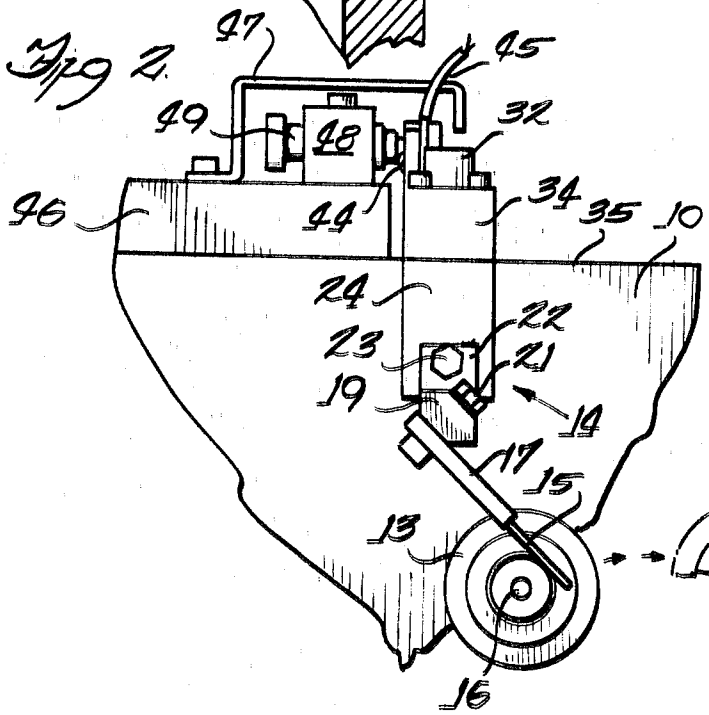


Fig. 3.

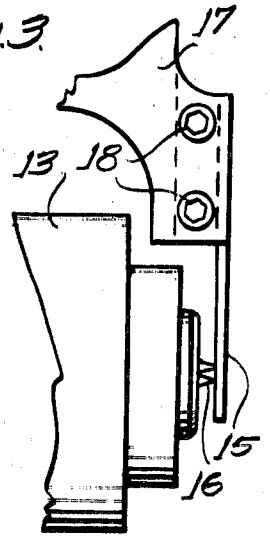


Fig. 4

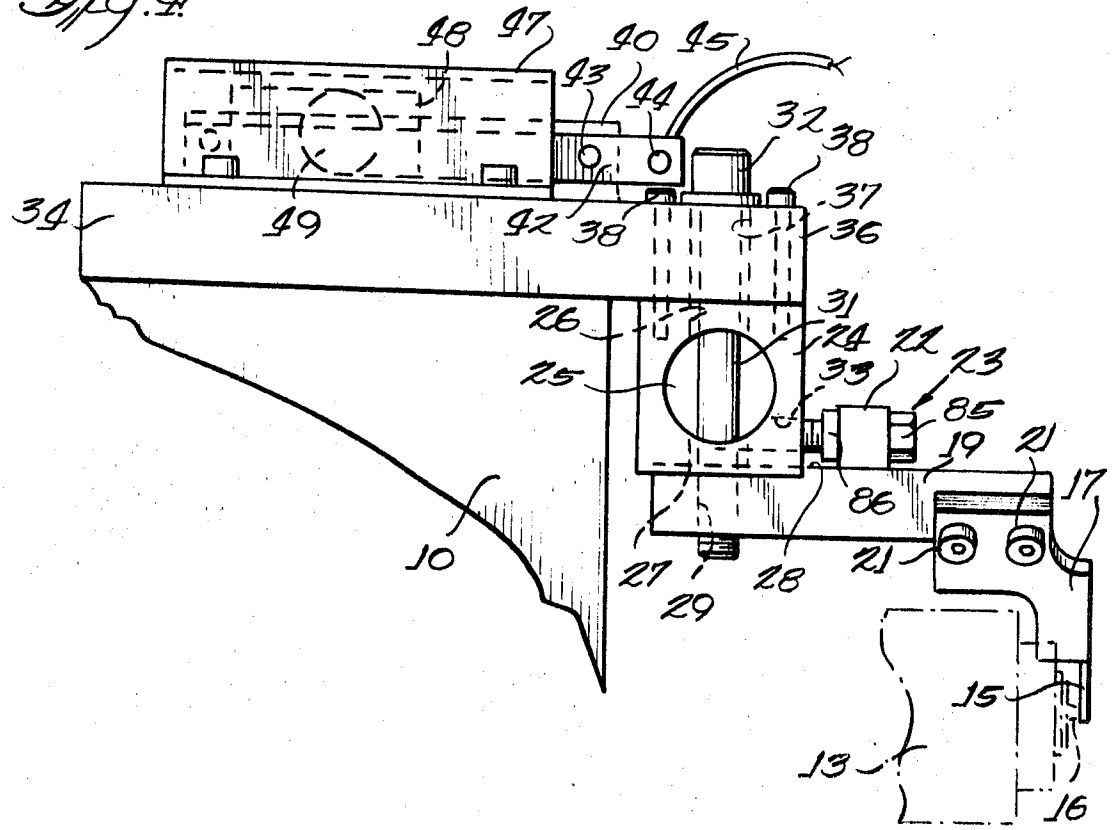

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Fig 5.

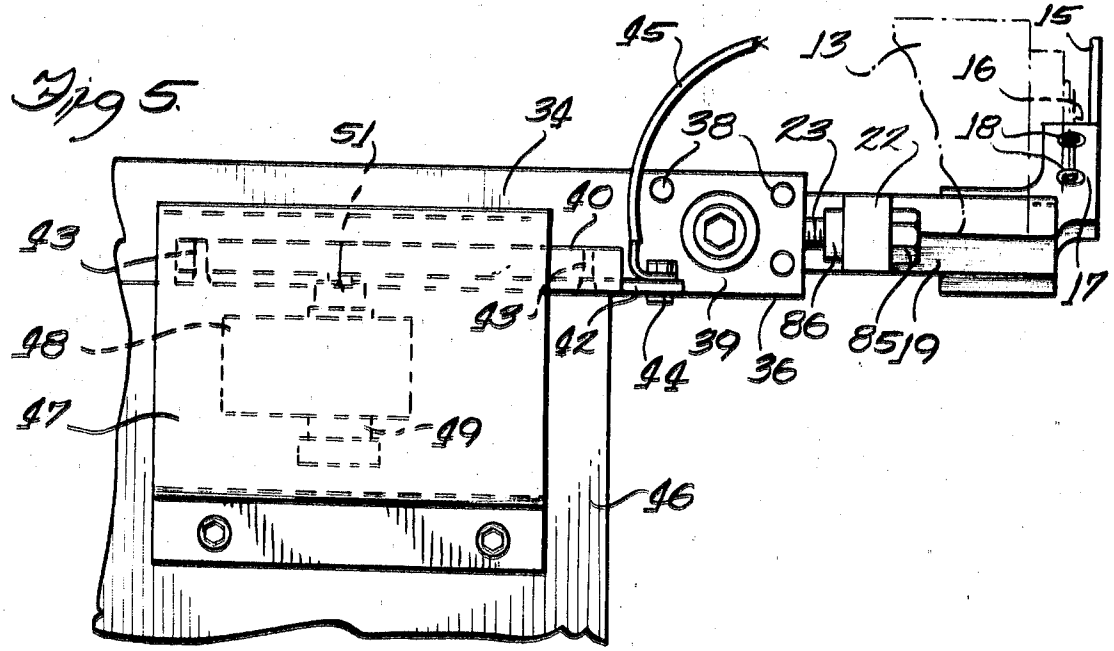

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Fig. 6.

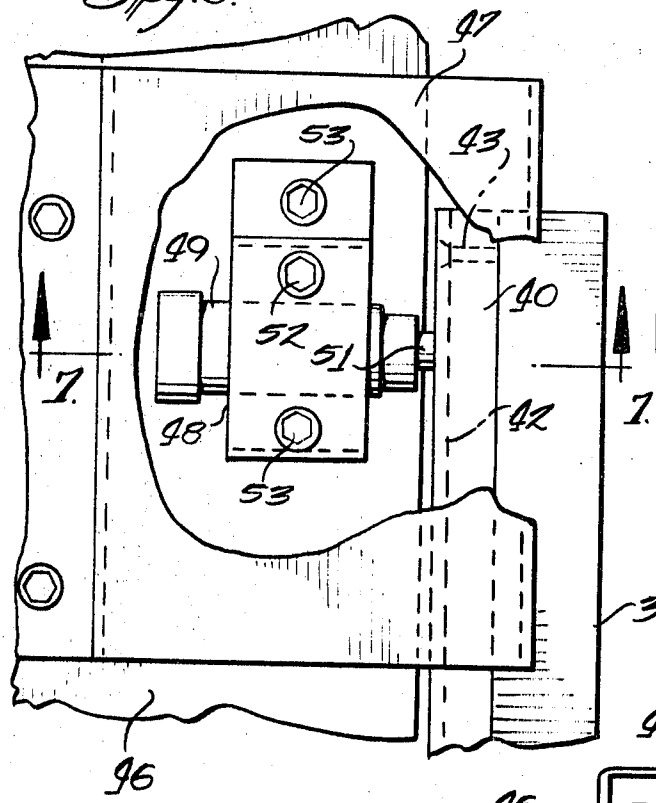


Fig. 7.

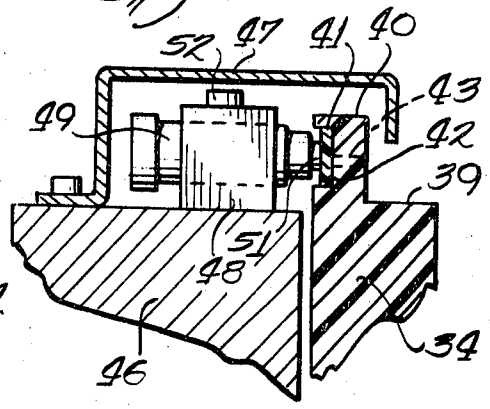


Fig. 8.

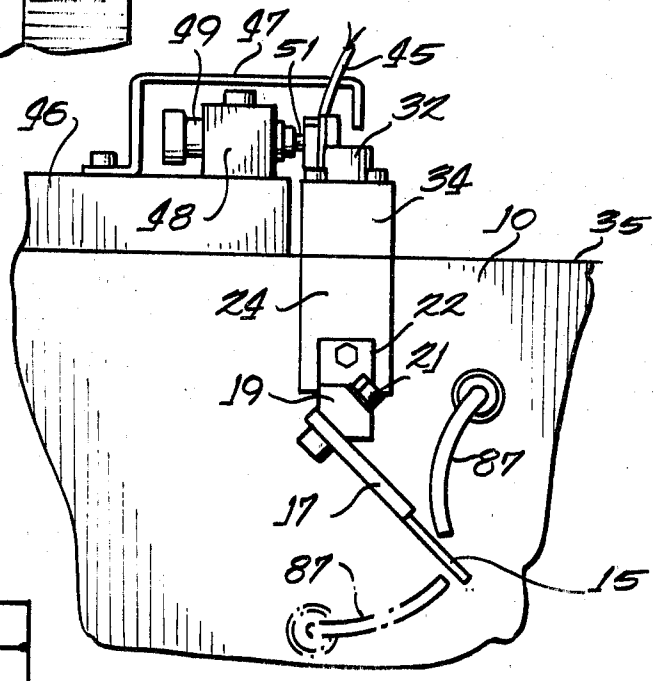
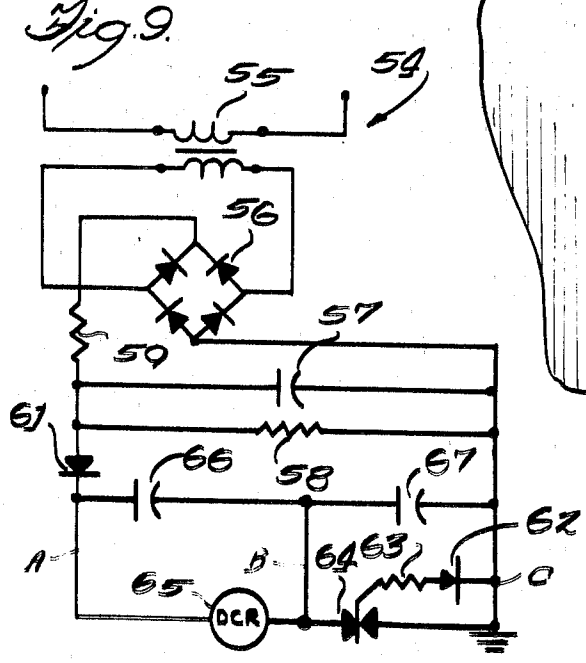


Fig. 9.



BROKEN TOOL DETECTOR

The present invention relates to a broken tool detector and more particularly to a probe adapted to contact the end of a punch and complete an electric circuit which maintains operation of the drive motor, or if contact is not made, acts to stop the machine.

The use of high speed and/or automated machinery is widespread and increasing in industry. Such machines perform operations on workpieces automatically in continuously repeating cycles for operations of drilling, tapping, reaming, broaching, punch forming, etc. However, a problem arises where a tool becomes dull, worn or broken and parts or workpieces from the machine are not properly formed. If such a machine produces defective parts for a substantial period of time before detection, the cost of operation and efficiency of the machine is impaired. The present invention overcomes this problem in a punching or similar machine by automatically detecting when the tool is worn or broken and stopping the machine before a substantial number of defective parts are formed.

Among the objects of the present invention is the provision of a boken tool detector which will automatically stop the machine involved where the tool is broken or otherwise defective. The detector includes a probe mounted on the machine in a position where the tool will pass laterally thereby between inactive and active positions for the tool. Under normal conditions, the probe engages the and of the tool unless the tool is broken, worn or otherwise defective. If the probe does not contact the tool, the operation of the machine is stopped so that defective parts or workpieces will not result.

Another object of the present invention is the provision of a boken tool detector that is connected with an electric circuit controlling operation of the machine. The probe is isolated electrically from the machine and is wired to a low voltage circuit which is connected to the drive motor starter circuit by isolated detector relay contacts. When the probe makes contact with the tool, voltage is provided to the relay and to a capacitor. The capacitor holds the relay energized until the voltage drops beyond a minimum value, at which time the relay is deenergized stopping the machine.

A further object of the present invention is the provision of a broken tool detector for a punch or other similar machine where a simplified control circuit provides the certainty of machine shut down within several seconds or less of detection of the error or breakage of the tool. When contact of the probe is made with the tool, the capacitor in the circuit controlling the relay coil is charged and, if on the next cycle, the probe does not make contact, the capacitor begins to lose voltage to a minimum value. The time intervals of the voltage drop provides a time delay during which the relay is actuated and the machine continues to operate. Once the minimum voltage is reached, the machine will automatically shut down until the defect in the tool is corrected.

Further objects are to provide a construction of maximum simplicity, efficiency, economy and ease of assembly and operation, and such further objects, advantages and capabilities as will later more fully appear and are inherently possessed thereby.

In the drawings:

FIG. 1 is a partial perspective view of the movable ram of a punch press or machine showing the positioning of the punches and the detector for the second blow punch.

FIG. 2 is a partial front elevational view of the broken punch detector.

FIG. 3 is a partial side elevational view of the detector probe contacting a punch.

FIG. 4 is a partial side elevational view of the ram and the details of the broken punch detector and its support.

FIG. 5 is a top plan view of the structure of FIG. 4.

FIG. 6 is a top plan view partially broken away to show the slide contact on the ram and a stationary brush member.

FIG. 7 is a horizontal cross sectional view on a reduced scale taken on the line 7—7 of FIG. 6.

FIG. 8 is a front elevational view similar to FIG. 2 with the punch omitted but with the addition of an air jet to clean the end of the punch.

FIG. 9 is a schematic view of the control circuit for the broken punch detector.

Referring more particularly to the disclosure in the drawings wherein is shown an illustrative embodiment of the present invention, FIG. 1 discloses a reciprocable ram **10** for a two blow header machine making recessed head screws which moves on the parallel rails **11, 11** of the machine. The ram cooperates with a conventional die block (not shown) to form the recessed head screws in a two blow operation; the screws being then ejected to a suitable container in the base of the machine (not shown).

The ram **10** is provided with a first blow punch **12** and a second blow punch **13** which are of conventional design and are mounted on the ram with the punch **12** aligned with a workpiece and the punch **13** in an inactive position as seen in FIG. **1.** Once the first blow has been struck, provision is made to shift the first punch **12** to an inactive position and shift the second punch **13** into alignment with the workpiece as indicated by the arrow A. After the ram **10** reciprocates, as indicated by the arrow B, the punches then shift back to their original positions to begin another cycle.

During extended operation of the machine, a punch may become worn, broken or otherwise defective, which would result in imperfect or defective pieces being turned out by the machine. If the defective articles and defect in the punch is not quickly ascertained, the machine may turn out a substantial number of defective parts which decreases the production, economy and efficiency of the machine. Therefore, a broken tool detector **14** is utilized on the ram **10** to indicate if the second punch **13** becomes worn or broken during use of the machine. The detector includes a punch probe or contact wire **15** which is positioned in the path of movement of the second punch **13** to engage the end **16** of the punch twice during a complete cycle of the machine.

The probe or contact wire **15** is clamped in a punch contact member **17** by screws **18, 18** which member in turn, is mounted on a front bar **19** by bolts **21, 21.** The bar **19** has an upstanding ear **22** with a passage therethrough receiving a push-pull screw **23.** An alignment block **24** has a laterally extending opening **25** therethrough and a vertical opening **26** (FIG. **4**) elongated in the direction of the axis of the screw **23.** A channel **27** is formed in the lower surface of the alignment block **24** to conformably receive the top edge **28** of the bar **19**; the bar having an internally threaded opening

29 vertically therethough to be vertically aligned with the opening 26 in the alignment block 24.

An elongated clamping bolt 31 having a flanged head 32 is received in the opening 26 in the block and threadingly engages the threaded opening 29 in the bar 19 to clamp the bar in adjusted position relative to the punch. The block 24 also has a threaded opening 33 extending horizontally into the block to intersect the opening 25 and to receive the threaded end of the screw 23 for adjustment of the probe to be later described. An elongated body 34 formed of a non-conducting plastic material, such as Delrin, is suitably secured onto the upper surface 35 of the ram 10 with an end 36 of the body projecting outwardly beyond the ram. The end 36 has an elongated opening 37 aligned with the opening 26 in the block 24, and the block 24 is secured to the body 34 by screws 38. The flanged head 32 of the bolt 31 abuts the upper surface 39 of the body 34.

The body 34 is provided with an upstanding flange 40 adjacent one edge with a channel 41 therein (FIG. 7) adapted to receive an electrically conductive contact bar 42 secured to the flange by suitable fastening means 43 (FIGS. 5 and 6). The bar has a terminal 44 at its forward end to clamp one end of a contact lead 45 which extends to and is connected to the probe 15. As clearly seen in FIG. 4, the body 34 is positioned relative to the ram 10 so that the alignment block 24 is spaced from the ram, and the probe 15 and contact lead 45 connected to the contact bar 42 are electrically isolated from the ram and machine.

Mounted on a stationary flange 46 of the machine is a cover 47 having a generally inverted U-shape which extends beyond the flange to partially cover the contact bar 42 and the body 34. Mounted on the flange 46 within the cover 47 is a brush holder block 48 which is partially split horizontally and has a passage to receive a brush holder 49 formed of an insulating plastic material. A renewable brush 51 of an electrically conductive material is received in and projects from the brush holder 49 to slidably engage the contact bar 42. The holder 49 is clamped in the passage in the block 48 by a clamping screw 52, and screws 53 secure the block 48 onto the flange 46 of the machine. Although not shown, the brush 51 is electrically connected into the circuit 54 schematically shown in FIG. 9.

In operation, the probe 15 is adjusted so as to contact the end 16 of the punch 13 as the punch passes from its inactive to its punching position and again on its return. Adjustment is accomplished by loosening the bolt 31 in the opening 26 to allow movement of the bolt in the elongated openings 26 and 37 and allow movement of the front bar 19 relative to the alignment block 24 and the body 34 which are stationarily mounted on the ram 10. Movement of the bar 19 occurs by rotating the push-pull screw 23, which screw has an enlarged head 85 on one side of the ear 22 and as flange 86 on the opposite side of the ear and a smooth shank therebetween to allow rotation of the screw in the ear. The threaded engagement of the screw 23 with the threaded opening 33 in the alignment block 24 provides accurate and precise adjustment of the bar 19 and probe 15 relative to the punch 13 to insure proper contact between the probe 15 and the punch 13.

Engagement of the probe 15 with the punch 13 makes contact 55 in the circuit 54 and repetitious closing of the contact maintains the machine in operation, but if contact is not made in the time desired, the machine will stop.

The electrical circuit includes a transformer 55, a bridge rectifier 56, a capacitor 57, a resistor 58, a current limiting resistor 59, a protective diode 61, a probe contact 62 where the probe 15 contacts the work piece, a diode 63, a triac 64, a detector relay 65, and capacitors 66 and 67.

In the operation of the electrical circuit 54 a transformer input of 120 volts AC is reduced to 24 volts AC and rectified by the bridge rectifier 56 whose pulsating direct current output is raised to intentional roughly regulated 32 volt DC by the capacitor 57 and resistor 58 through current limiting resistor 59 and applied to balance of circuit through the protective diode 61 to points A and C. When the probe contacts the grounded work piece at 62 it triggers current 3l4w through the limiting flow 63 to triac 64 energizing points A and B of the detector relay 65 and capacitor 66, the probe making repeated contacts maintains about 24 volt DC across the points A and B of the detector relay and parallel capacitor 66. When the probe fails to make contact with the punch or other work piece, the charge on capacitor 66 decreases and at approximately 11 volt DC the detector relay 65 drops out and stops the machine. At the time of drop out, the capacitor 67 absorbs transient voltage which prevents arcing at the contact of the probe and punch, thereby reducing weat to mechanical wear only.

The variables affecting delay time between a detected part failure and machine stoppage are compensated for by selecting value of capacitor 66. These variables are: resistance of detector relay 65, millisecond closure time of probe 15 and punch 13 (contact 62 in FIG. 9), resistance of dirt and oil on both punch 13 and brush slide or contact bar 42, and machine cycles per minute. Due to use of the triac 64, reliable fast operation exists through dirt and oil resistance of as much as 2,000 ohms. Voltages and current at probe 15 are minimal and cannot be sensed by the operator in any way. The circuit is positive and failure safe as any failure such as vibratory shock breakage of improperly mounted component automatically stops the machine. Although a small number of defective parts are produced by the machine over the time delay until the relay is deenergized, the machine will positively shut down within a second or less after detection of breakage occurs.

FIG. 8 discloses the ram 10 and probe 15, with the punch omitted, with the addition of an air jet tube 87 mounted on the ram 10 to direct a jet of air onto the end of the punch to clean the punch from any debris, dirt or particles or metal which may occur during the punching operation. Removal of any dirt or debris will aid in extending the life of the punch as dirt or metal particles will enhance or advance the rate of wear or likelihood of breakage.

Although the broken tool detector has been shown in conjunction with a two blow punch operation, we do not wish to unnecessarily limit our invention, as this simple and positive device is contemplated for use in any application where it is possible to detect a causative dimensional change with an electrical contact.

I claim:

1. A broken tool detector for an automatic machine having elements movable in continuously repeating cycles for performing operations on workpieces, compris-

ing an elongated probe mounted on the machine to make contact with the end of a tool at at least one point during the time of a cycle of the machine, and an electrical circuit including the probe, the tool and a detector relay for controlling the machine, and a capacitor in parallel with the detector relay, whereby, when the probe contacts the tool, voltage in the circuit actuates the detector relay and the capacitor by means of a controlled rectifier and, if the tool is broken, the capacitor is charged from the previous cycle to retain the detector relay actuated until the voltage in the capacitor drops below a minimum value, at which time the relay is deenergized.

2. A broken tool detector as set forth in claim **1**, in which the machine and the tool are grounded and the probe is electrically insulated from the machine but is electrically connected to the circuit.

3. A broken tool detector as set forth in claim **2**, including a reciprocating ram in the machine, said probe and the tool being mounted on the ram, and the tool is adapted to move laterally past the probe in shifting between inactive and active positions, the probe contacting the end of the tool during each lateral movement thereof.

4. A broken tool detector as set forth in claim **3**, including an alignment block, said probe being adjustably mounted on the alignment block, and a non-conductive elongated body is mounted on the ram and is secured to the alignment block.

5. A broken tool detector as set forth in claim **4**, including a conductive contact bar mounted in the non-conductive body and connected to said probe, and a stationary brush or brushes slidably engaging the contact bar is connected to the circuit.

6. A broken tool detector as set forth in claim **4**, including a punch contact carrying the probe, a front bar having the punch contact secured at one end and the other end slidably received in the lower end of the alignment block, a push-pull screw mounted for rotation on the front bar and threadingly engaging the alignment block for adjustment of the front bar and the probe relative to the alignment block, and a clamping bolt in the alignment block and threadingly engaging the front bar adjacent its inner end to clamp the front bar in adjusted position on the alignment block.

7. A broken tool detector as set forth in claim **2**, in which said circuit includes a source of low DC voltage, and a controlled rectifier in series with the detector relay and connected to the probe contact, whereby closure of the probe contact triggers the rectifier to provide voltage to energize the detector relay and charge the capacitor.

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