A device is disclosed for detecting a variation in position from normal of a work material as located in a work fabricating machine. The device includes a sensor system that communicates with a work station in said machine and includes a sensing unit through which a fluid under pressure is directed, an equilibrium condition of said sensing unit being established in accordance with the flow of fluid therethrough when the work material is in the normal position thereof at the work station. Should the work material be located out of the normal position at the work station, the equilibrium condition of the sensing unit is disturbed and the sensing unit is operative to discontinue the operation of the machine.

15 Claims, 3 Drawing Figures
SENSOR SYSTEM FOR AUTOMATIC TOOLING

BACKGROUND OF THE INVENTION

The apparatus as embodied herein is for use in automatic tooling and has particular application in a power press which automatically performs a series of work operations on a work material such as strip stock that is progressively transferred through a work station in the apparatus, a work tool such as a punch being vertically movable relative to the work material to perform the series of predetermined work operations thereon. However, it will be understood in the description of the invention following hereinafter that the concept of the invention may be incorporated in various kinds of tooling, wherein the work piece may be in strip form or individual work parts.

In the operation of automatic tooling, the work piece or parts are progressively transferred to a work station at which a work operation is performed thereon. Often times the work material will misfeed; and unless the operator is on hand to notice the misfeed, damage to the tooling in the machine can occur.

Prior to the instant invention, various kinds of safety devices have been proposed for detecting the misfeed of work material or work parts at a work station of automatic tooling, and generally these prior known safety devices have included a mechanical detecting or sensing mechanism that was designed to sense a misalignment of the work material and thereafter actuate an appropriate device for discontinuing the operation of the machine. Other devices for detecting misfeeding in power tooling have been used and have incorporated fluid systems that were responsive to pressure variations for detecting a misfeed of the work part to the machine work station. Although such devices were operable to detect misfeeding, the fluid systems incorporated therein did not function in a practical sense to immediately detect misfeeding; and oftentimes injury to the tooling occurred before the machine operation was discontinued. Further, such systems incorporated relatively complicated mechanical parts and electrical circuitry that prohibitively increased the cost of the apparatus.

SUMMARY OF THE INVENTION

The present invention relates to a safety device for detecting a variation in position from normal of a work material as located in a work fabricating machine and is operable to discontinue the operation of the machine so as to prevent damage to the tooling therein. The safety device includes a sensor system having a sensing unit through which a fluid under pressure is directed, a fluid conduit communicating with the sensing unit and the work station at which the work material is received for directing fluid under pressure thereeto. The fluid under pressure discharges at the work station in a continuous uninhibited stream unless there is a variation in position from normal of the work material, in which case the flow of the fluid is reduced or varied in some manner to create a back pressure in a portion of the sensing unit that communicates with the fluid conduit. A second fluid conduit also communicates with the sensing unit for receiving fluid under pressure therefrom and continuously discharges the fluid at a constant rate. The sensing unit is designed so that an equilibrium condition is maintained in the sensing unit so long as the fluid is being discharged through the fluid conduits without interruption. Should the work material located at the work station become misaligned or misfed for any reason, the fluid directed through the first fluid conduit is varied in the discharge thereof, thereby creating a back pressure in the portion of the sensing unit that communicates with the first fluid conduit and thus causing an imbalance in the sensing unit. When the equilibrium condition in the sensing unit is disturbed due to a variation of flow of fluid through the first fluid conduit, a switch is actuated to cause the operation of the machine to be discontinued. When the detecting device is utilized in a punch press, the operation of the machine is discontinued on the upstroke; and the ram of the press is thus prevented from returning on its downstroke. The tool in the punch press is thereby prevented from striking the misfed work material.

Accordingly, it is an object of the present invention to provide a safety device that senses a variation in position from normal of a work material as located in a work fabricating machine.

Another object of the invention is to provide a device for detecting a misfeed of a work material in a metal working machine that includes a sensing unit that is located in an equilibrium condition during normal operation of the machine, but that is disturbed from the equilibrium condition if a misfeed of a work piece occurs, wherein the sensing unit is operative to discontinue operation of the machine.

Still another object is to provide a sensing unit for use in a material misfeed detecting system of a work fabricating machine and that includes a piston located in a chamber therein, the piston being normally located in an equilibrium position by pressure of fluid on both sides thereof, the fluid being discharged from the sensing unit to a work station of the work fabricating machine, and the piston being movable under pressure when a misfeed occurs to energize a contact means to discontinue the operation of the operating mechanism of the machine.

Still another object is to provide a sensor system for use in detecting the presence or absence of a member at a work station and/or a misfeed of a work material at the work station, the system including a sensing unit that is maintained in an equilibrium condition during normal feed of the work material through the machine and that is operable on disturbing the equilibrium condition to discontinue operation of the machine; the sensing system also including a detecting unit for detecting the presence or absence of feed of the material to the machine, the detecting unit cooperating with the sensing unit to discontinue operation of the machine in the absence of the work material at the work station or in the event of an over accumulation of the work material as it is fed to the work station.

Other objects, features and advantages of the invention shall become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

DESCRIPTION OF THE DRAWING

In the drawing which illustrates the best mode presently contemplated for carrying out the present invention:
FIG. 1 is an elevational view with parts shown in section and in diagrammatic form of the sensor system embodied herein and as employed in a machine such as a punch press;

FIG. 2 is an enlarged sectional view of the sensing unit illustrated in FIG. 1 and that is operable to control the operation of the machine; and

FIG. 3 is a sectional view with parts shown in elevation of a material detecting device that is used in cooperation with the sensing unit illustrated in FIG. 2 for controlling the operation of the machine.

DESCRIPTION OF THE INVENTION

Referring now to the drawing and particularly to FIG. 1, a portion of a machine with which the present invention is employed is illustrated and for purposes of the subject invention, the machine is shown as a conventional punch press and is generally indicated at 10. As will be apparent hereinafter, the invention has particular application in apparatus that automatically performs a preselected work operation on a work material such as strip stock that is progressively transferred through a work station of the punch press 10; and it is also understood that the concept of the invention may be incorporated in other machines that perform a similar work operation. As will be further described, the concept of the invention has application with equipment for indicating the presence or absence of a work part or element at a work station. Since the safety device of the present invention is particularly useful with a punch press that is automatically operated and that progressively performs an operation on strip stock, the description as follows hereinafter will be directed to use of the punch press 10.

The motor and operating mechanism for the punch press 10 is not illustrated in the drawing since this is conventional structure and forms no part of the subject invention. The operating mechanism of the punch press 10 is interconnected to a ram 12 also of conventional construction to which a sub-tool assembly is interconnected. The sub-tool assembly includes an upper punch block 14 with which the ram 12 engages during a punching operation. Secured to the upper punch block is a backup plate and tool holder 16. Interconnected to the upper punch block 14 through the usual shoulder screws is a floating pressure pad 18, springs 20 being interposed between the pressure pad 18 and the tool holder 16. A base 22 is mounted on a support and is fixed in position with respect to the movable sub-tool assembly. Mounted on the base 22 is a plate 24 that may be cut out to accommodate a work material that in the present invention is in the form of an elongated metal strip 26. It is understood that in the operation of the punch press 10, the ram 12 is moved downwardly in a cyclical operation to engage the upper punch block 14, thereby producing downward vertical movement of the pressure pad 18 toward the plate 24 as mounted on the base 22. The tool, not shown, carried by the tool holder 16 extends through an opening in the pressure pad 18 and is brought into engagement with the work material 26 as the ram is moved in its downward stroke toward the base 22. As previously described, the operation of the punch press 10 is conventional; and the parts of the punch press illustrated and described in FIG. 1 are also of conventional design and form no part of the present invention.

The punch press 10 progressively performs a series of punching operations on the work material 26; and after each operation, the work material is advanced and as it is progressively transferred through the work station, a series of work operations are performed thereon so as to produce a specific configured article. It is understood that a final punching operation will be performed on the strip to cut out the article as produced by the progressive operations of the punch press.

In the feeding of the work material 26 to the work station in the punch press 10, the work material must be precisely located at the work station on the base plate 24 so that as the tool in the punch press is driven downwardly into the work material, a precisely formed operation is achieved. If the work piece is not in proper alignment, it is possible to damage the tool; and unless the operator is closely observing the punching operation, any misalignment of the work material may not be timely detected; and consequently, it is desirable to provide a safety device for promptly detecting the misfeed or misalignment of the work material and for discontinuing operation of the press before the tool is damaged. For this purpose, the present invention includes a sensing system that incorporates a sensing unit therein generally indicated at 30. Fluid under pressure, such as compressed air, is directed through the sensing unit 30 and to the work station. As will be described, the sensing unit is responsive to variations in pressure of the fluid to detect a misfeed of the work material 26 at the work station.

Referring now to FIGS. 1 and 2, a passage 32 is shown extending horizontally through the base 22 in the punch press and communicating with a vertical passage 34, the vertical passage projecting through the plate 24 and terminating in an outlet port 36. The horizontal passage 32 extends outwardly from the base 22 through a fitting 38 and communicates with a conduit 40, the conduit 40 being connected to a detecting device generally indicated at 42, the purpose of which will hereinafter be described. Interconnecting the detecting device 42, and the sensing unit 30 is a conduit 44 that communicates with an interior passage 45 formed in the sensing unit 30 through a fitting 46. Also formed in the base 22 is a horizontal passage 48 that communicates with a vertical passage 50 that extends through the plate 24 and outwardly thereof through a port 52. The horizontal passage 48 communicates with an exterior conduit 54 through a fitting 56, the conduit 54 being interconnected to the sensing unit 30 and an interior passage 57 therein through a fitting 58.

Referring now to FIG. 2, the sensing unit 30 is illustrated in detail and as shown includes a body generally indicated at 60. Formed in the body 60 is a chamber defined by the first chamber portion 62 and a second portion 64, the second chamber portion 64 having a diameter that is somewhat reduced with respect to the first chamber portion. A plug 66 is threadably received in the body 60 and seals the open end of the chamber portion 62. Located in the chamber portion 62 and movable therein is a piston 68 having a grooved formed therein for receiving an O-ring 70, the O-ring 70 engaging the walls of the chamber portion 62 in sealing relation. Secured to the piston 68 and movable therewith is a piston rod 72 that projects through the second chamber area 64 and through a reduced bore 74 that communicates with the chamber portion 64. The outermost end of the piston 72 extends into a recess 76 in
which a contact 78 of a microswitch 80 projects. The microswitch 80 is fixed in the body 60 of the sensing unit 30 and is electrically interconnected in circuit with a relay 82, as illustrated in FIG. 1. It is seen that movement of the piston 68 to the right as illustrated in FIG. 2 will cause the end of the piston rod 72 to engage the contact 78 for actuating the microswitch 80. A reduced diameter O-ring 84 is located on the piston rod 72 adjacent to the end thereof and effectively seals the chamber portion 64 from the recess 76.

Formed in the body 60 of the sensing unit 30 is a passage 86 that communicates with an inlet passage 88 having access to an exterior conduit 90 through which a fluid under pressure such as compressed air is directed. A value 92 is located in the passage 86 and controls communication of the fluid to the chamber portion 62 by way of a passage 94. A drain plug 95, threadably received in a passage 96, may be removed for draining the chamber portion 62 and passage 94 as required. A second valve 97 controls the flow of the compressed air from the passage 86 to the chamber portion 64 through a passage 98. A drain plug 100 is also threadably received in a passage 102 and may be removed for draining the chamber portion 64 and passage 98 as required. A third plug 103 seals the end of the passage 86. It is seen that the fluid under pressure is introduced into the chamber portions 62 and 64 by way of the conduit 90, passages 88, 86, 94 and 98. Since the pressure of the fluid as contained in the chamber portions 62 and 64 is substantially equal under normal operating conditions, the piston 68 will be located in equilibrium in the position as illustrated in FIGS. 1 and 2; and the piston rod 74 will not engage the switch contact 78. In this connection, the air under pressure in chamber portion 62 communicates with the port 36 for discharge therethrough by way of the passage 45, conduit 44, detecting devices 42, conduit 40, passage 32 and passage 34. Similarly, air under pressure is continuously discharged from the chamber portion 64 by way of the passage 57, conduit 54, passages 48, 50 and port 52. Although not shown, the port 52 as formed in the plate 24 is offset with respect to the work material 26 and therefore continuously and without interruption discharges the air under pressure therethrough to atmosphere. As seen in FIG. 1, the port 36 formed in the plate 24 which communicates with the passage 34 is located directly beneath the intermittently moving work material 26.

As illustrated herein, the work material 26 which is formed in strip form is provided with a plurality of spaced pilot holes 104 which are usually formed in the strip material during the progressive machining operations thereof. The location of the pilot holes 104 are correlated with respect to the port 36 so that as the strip material is progressively moved during the work operations thereon, a pilot hole will be located directly over the port 36. Thus the fluid under pressure as expelled through the port 36 will flow through a pilot hole 104 without deflection. Since the air under pressure in normal operation of the machine is expelled through the ports 36 and 52 without being inhibited in the flow therethrough, the pressure in the chambers 62 and 64 will be substantially the same and the piston 68 will be located in an equilibrium position.

In order to increase the efficiency of the sensor system during high speed operation of the punch press, the inlet passages 94 and 98 for the chamber portions 62 and 64, respectively, are located in direct alignment with the outlet passages 45 and 57 thereof.

During each progressive movement of the work material 26, the port 36 is momentarily blocked during the downward position of the tool and thereafter during the feeding movement of the work material 26 as the tool begins the vertical movement upwardly. Since the port 36 is blocked during this period, it is necessary to prevent discharge of the compressed air through the port 52 or otherwise the pressure in the chamber portion 62 would be increased to overcome the equilibrium condition, and the piston 68 would be forced to move to the right as seen in FIG. 2 to contact the microswitch contact 78. In order to avoid such movement of the piston 68, a probe 106 is provided and is mounted in a housing 108 located in a bore formed in the pressure pad 18. A spring 110 locked in the housing by a cap 112 normally forces the probe 106 outwardly of the pressure pad 18 but also permits the biased retraction of the probe 106 as the pressure pad moves to the downward position thereof. A set screw 114 fixes the housing 108 in position in the pressure pad 18. It is seen that as the pressure pad 18 moves downwardly carrying the tool therewith, the probe 106 will contact the plate 24 and overlie the port 52 closing off the discharge of the compressed air therethrough. This movement of the probe 106 over the port 52 is simultaneous with the work operation of the tool on the work material 26, which operation serves to block discharge of the compressed air through the port 36. As the pressure pad 18 begins to move upwardly carrying the tool therewith, the strip material 26 is progressively moved but the port 36 is still covered by the portion of strip material 26 between the pilot holes and remains covered until the next pilot hole 104 is moved into communication with the port 36. During the progressive movement of the strip material 26, the probe 106 remains in engagement with the port 52 and the equilibrium condition of the piston 68 and piston rod 72 in the chamber portions 62 and 64 is maintained.

After the movement of the strip material to the next work position has been completed and the next pilot hole 104 is located in communication with the port 36, the pressure pad 18 is moved upwardly sufficiently to remove the probe 106 from the port 52. The air under pressure again discharges from both ports 36 and 52 and the equilibrium condition in the chamber portions 62 and 64 remains unchanged.

If for any reason the work material 26 is improperly fed to the work station in the punch press 10, the pilot hole 104 in the strip material adjacent to the port 36 will be misaligned therewith, and the air under pressure that is flowing through the passage 34 will be deflected as it is discharged from the port 36. As a result, a back pressure will be created in the passages 34, 32, conduits 40, 44, passage 45 which results in an increase in pressure in the chamber portion 62. Since the port 52 continues to be unrestricted, the pressure in the chamber portion 64 will be unaffected; and since the pressure in the chamber portion 62 increases with respect to that in the chamber portion 62, the piston 68 will move to the right as illustrated in FIG. 2, causing the end of the piston rod 72 to engage the contact 78 of the microswitch 80. The circuit to the relay 82 is closed and the relay is energized to disconnect the circuit to the power supply indicated at 116. Since the power supply 116 is located in circuit with the motor that controls opera-
tion of the power press, the operation of the press will be discontinued. However, it is necessary that the power press be stopped before return downward movement of the tool, and in order to prevent this happening, the relay 82 also closes a circuit to an emergency brake indicated at 118. The emergency brake circuit is energized and the operating mechanism for the ram 12 is braked prior to the downstroke thereof.

The sensing unit 30 as described normally detects a misfeed of the work material 26 so as to prevent operation of the power press and movement of the ram 12 downwardly, thus protecting the tool in the power press from striking a misaligned work piece. However, it is also desirable to discontinue the operation of the machine should the supply of work material 26 to the work station be exhausted, or should an over accumulation of the work material occur. In order to detect the presence and/or absence of the work material as it is fed to the work station, the detecting device 42 is provided and as illustrated in FIG. 3, includes a body portion 120 in which a bore 122 is formed. Located in the bore 122 is a plunger 124 that has a head portion 126 formed thereon. The head portion 126 is received in an upper cavity 128 that communicates with the bore 122.

A spring 130 also located in the cavity 128 engages the head portion 126 and exerts a downward pressure thereon. A cap 132 is threadably received in the cavity 128 and retains the spring 130 in a biased position. Formed in the body portion 120 is an inlet passage 134 that communicates with the conduit 44 through a fitting 136. A similar passage 138 communicates with the conduit 40 through a fitting 140. Formed in the plunger 126 intermediate the ends thereof is reduced portion 142 that normally communicates with the passages 134 and 138 and provides communication between the conduits 40 and 44. Thus, in normal operation of the sensing unit 30, air under pressure passes through the conduit 44, the detecting device 42 by way of the passages 134 and 138 and into the conduit 140.

The plunger 126 normally contacts the work material 26 as it is fed to the work station in the punch press 10 and is maintained in the position as illustrated in FIG. 3 upon contact at the lower end thereof with the work material. Should the supply of the work material 26 as it is fed to the work station of the punch press become exhausted, the plunger 126 will move downwardly thus closing communication between the conduits 44 and 40. When this occurs, pressure immediately builds up in the chamber portion 62 and the microswitch is actuated to cut off the power to the operating means for the punch press, and the emergency brake 118 is energized to brake the ram 12. The detecting device is also operative to discontinue operation of the machine should an over-balance of the work material occur. In this event, the plunger is forced upwardly to close off communication between the conduits 40 and 44 and the microswitch 80 is actuated as described hereinabove.

As further shown in FIG. 3, the detecting device 42 is mounted in position on a bracket 144 that is pivotally connected to an arm 146 through a pivot pin 147. The bracket 144 is formed with an appropriate slot for receiving the body portion 120 of the detecting device 42, a set screw 151 locking the detecting device to the bracket 144. The pivotal movement of the bracket 144 enables the body portion to shift in response to an excessive over accumulation of work material fed to the work station. A blade spring 148 formed with a projection that engages a detent 150 in the end of the bracket 144 normally locates the bracket 144 and detecting device in the operative position. The set screw 151 extends through the opposite end of the bracket 144 and secures the body portion 120 of the detecting device to the bracket 144. It is seen that the bracket 144 will lift the detecting device 42 upwardly if the plunger 124 reaches its upper limit when an excessive over accumulation of work material is encountered by the plunger 124.

Vertical and horizontal adjustment of the detecting device 42 is provided by mounting the arm 146 on a bracket support having a vertical portion 152 and a horizontal portion 154, slots 156 and 158 being formed in the portions 152 and 154, respectively. A wing-nut 160 extends through the slot 156 of the vertical portion 152 and threadably engages the arm 146, while a similar wing-nut (not shown) extends through the slot 158 for engagement with a fixed support. It is seen that the detecting device is adjustable vertically or horizontally on the bracket support in accordance with the work material used or other existing conditions.

In the operation of the punch press 10 and following a punching operation, the cyclical operation of the ram 12 produces an upward movement thereof. As the pressure pad 18 lifts from engagement with the work material 6 and the tool therein is moved upwardly, the feed mechanism for the press is operated to move the work material 26 in a feeding movement. Normally, fluid under pressure is discharged through the port 36 without deflection to maintain the machine in operation, while the fluid is simultaneously being discharged continuously through the port 52. However, if there is a period of feeding movement of the work material in which the fluid cannot discharge through the port 36, it becomes necessary to block the port 52 in order to maintain the equilibrium position of the piston 68 in the sensing unit 30. As described hereinabove, it is for this purpose that the probe 106 is provided; and after the ram 12 has been moved downwardly, the probe 106 blocks the port 52, and the equilibrium position of the piston 68 is maintained. As the ram 12 moves to an upward position, the probe 106 disengages from the plate 26 and unblocks the port 52; and thereafter, operation of the punch press will continue only if the work material 26 has been fed properly and a pilot opening 104 is located in alignment with the port 36. If for any reason the work material 26 has been moved improperly or has become misaligned after the upward movement of the ram 12, the air under pressure that is discharged through the port 34 will be deflected by the misaligned opening in the work material 26; and the back pressure created in the chamber 62 will cause the piston 68 and the rod 72 to move to the right as seen in FIG. 2, thereby actuating the microswitch 80. The relay circuit is then energized to disconnect the power supply 116 and to energize the emergency brake 118 for preventing movement of the ram 12 in a downstroke. Accordingly, operation of the ram 14 will be discontinued on the upstroke and the movement thereof downwardly cannot occur so long as the work piece 26 is misaligned or misfed. A reset circuit may be incorporated in the circuit; and after the misfed of the work material has been corrected, a reset button is depressed and the operation of the apparatus continues as hereinabove described.
It is significant that in the operation of the subject invention movement of the piston 68 and piston rod 72 does not normally occur since the equilibrium condition in the chamber portions 62 and 64 is maintained in the normal operation of the machine. Thus, the microswitch 80 is not normally actuated during operation of the machine and the switch contacts within the microswitch are engaged, only on those instances when a misfeed or misalignment of the work material occurs or should the supply of the work material be exhausted or over accumulated. This is contrary to the usual detecting mechanism that incorporates a fluid system therein and that utilizes electrical switches. In these prior known devices, the electrical switches are normally actuated in the operation of the system and life expectancy of such switches is relatively short. In the present invention the microswitch is actuated only on a misfeed or other abnormal condition, and maintenance and/or replacement of the microswitch is substantially non-existent.

As described herein, the sensing device 30 is operable to maintain the punch press in operation during a normal feed of the work material 26. It is also contemplated that a sensing unit similar to that illustrated and described herein can be placed in the system for indicating accidental withdrawal of a part of the work material after the ram 12 and the tool carried thereby has moved to the upper position. Thus, if material becomes jammed in the tool and is lifted therewith, a sensing device located in that position of the tool where jamming occurs, will detect the presence of the jammed material and will act to discontinue operation of the machine until the material has been removed from the tool.

It is also contemplated to use a detecting device similar to the detecting device 42 in combination with the sensing device 30 for safety purposes such as detecting the presence of a safety cage around an automated machine. In this connection, it is contemplated that the detecting device 42 will be used in combination with the cage and will detect whether the cage is in position around the operating parts of the machine. If the cage is removed, the plunger 126 will move vertically as described to prevent operation of the machine.

It is further contemplated to include or incorporate the detecting device 42 and the sensing unit 30 in various other combinations in which they will cooperate to provide a safety function in the operation of automated machines.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

I claim:

1. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid under pressure is directed, a first fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto, a second fluid outlet port communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, and contact means in said sensing unit that is maintained in a normally open position in response to an equilibrium condition of said sensing unit, said equilibrium condition of said sensing unit being established in accordance with the flow of fluid through said fluid outlet ports when said work piece is in the normal position thereof at said work station, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said sensing unit is disturbed due to a variation in flow of fluid through said first fluid outlet port as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued, said sensing unit including a chamber in which a piston is mounted for reciprocating movement therein, the first and second fluid outlet ports communicating with said chamber on opposite sides of said piston, and fluid discharge conduits communicating with said chamber on opposite sides of said piston for conducting said fluid under pressure to said fluid outlet ports wherein said fluid passing through said chamber to said fluid outlet ports establishes the equilibrium condition of said piston in said chamber.

2. Apparatus as set forth in claim 1, said piston including a rod, the end of which is normally spaced from said contact means in the equilibrium condition of said piston, said rod being movable into engagement with said contact means in response to an increase in pressure on said piston by said fluid when the work piece is not located in the normal position thereof at said work station.

3. Apparatus as set forth in claim 2, a first fluid inlet passage in said sensing unit communicating with said chamber, wherein said fluid directed thereto exerts a predetermined pressure on the outer surface of said piston in the normal operation of said sensing unit, and a second fluid inlet passage in said sensing unit communicating with said chamber on the inner surface of said piston, wherein fluid directed thereto exerts an equal but opposite pressure on said piston and cooperates with the fluid directed to the opposite side of the piston for locating said piston and the rod joined thereto in the equilibrium condition thereof.

4. Apparatus as set forth in claim 3, a first valve located in the first fluid inlet passage, and a second valve located in the second fluid inlet passage, said valves controlling the flow of fluid into said chamber for establishing an equilibrium condition therein.

5. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid...
under pressure is directed, a first fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto, a second fluid outlet port communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, and contact means in said sensing unit that is maintained in a normally open position in response to an equilibrium condition of said sensing unit, said equilibrium condition of said sensing unit being established in accordance with the flow of fluid through said fluid outlet port when said work piece is in the normal position thereof at said work station, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said sensing unit is disturbed due to a variation in flow of fluid through said first fluid outlet port as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued, said work piece having a plurality of spaced pilot holes formed therein, wherein the first fluid outlet port at said work station normally successively communicates with said pilot holes during operation of said machine for allowing the fluid to be directed unhindered therethrough, the second fluid outlet port communicating exteriorly of said work piece for allowing the fluid to be directed unhindered therethrough, wherein the equilibrium condition in said sensing unit is maintained, the equilibrium condition in said sensing unit being disturbed only when said work piece is misaligned at said work station, wherein the first fluid outlet port is obscured to cause an increase in pressure in the portion of the sensing unit that communicates with said first fluid outlet port for moving the contact means to the closed position thereof, said sensing unit including a chamber in which a piston is located, said first fluid outlet port communicating with said chamber on one side of said piston, and the second fluid outlet port communicating with said chamber on the other side of said piston, and a piston rod connected to said piston and non-rotatingly connected to said work piece at said work station to close off communication between said first fluid outlet port and said sensing unit, wherein the equilibrium condition of said sensing unit is disturbed to cause the operation of said machine to be interrupted, the fluid directed to said first and second fluid outlet ports being normally discharged without deflection when the work piece is in the normal position at said work station, the fluid pressure in the first portion of the chamber that communicates with said first fluid outlet port increasing when the work piece at said work station is shifted from the normal position, wherein the equilibrium condition of said piston is disturbed to cause said piston to actuate said contact means.

7. Apparatus as set forth in claim 6, a bracket for locating the detecting device in the position of use, wherein the plunger therein engages said work material, said bracket being pivotally connected to an arm, and a spring engaging said bracket and normally locating said bracket in the position of use, and being operative to enable the bracket and detecting device to pivot in response to an over accumulation of work material at said work station, wherein the operation of said machine is discontinued.

8. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid under pressure is directed, a first fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto, a second fluid outlet port communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, and contact means in said sensing unit that is maintained in a normally open position in response to an equilibrium condition of said sensing unit, said equilibrium condition of said sensing unit being established in accordance with the flow of fluid through said fluid outlet ports when said work piece is in the normal position thereof at said work station, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said sensing unit is disturbed due to a variation in flow of fluid through said first fluid outlet port as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued, a detecting device communicating with said first fluid outlet port and with said chamber, said detecting device normally engaging said work piece and being responsive to the engagement therewith to permit flow of fluid from said chamber to said first fluid outlet port wherein the equilibrium condition of said sensing unit is maintained, said detecting device being further responsive to the absence of engagement with said work piece or excessive accumulation thereof to interrupt flow of said fluid to said first fluid outlet port wherein the equilibrium condition of said sensing unit is disturbed to cause said contact means to discontinue operation of said machine.

9. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid under pressure is directed, a first fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto,
a second fluid outlet port communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, and contact means in said sensing unit that is maintained in a normally open position in response to an equilibrium condition of said sensing unit, said equilibrium condition of said sensing unit being established in accordance with the flow of fluid through said fluid outlet ports when said work piece is in the normal position thereof at said work station, and contact means communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, said sensing unit including a chamber having a fluid responsive element located therein and separating said chamber into opposed chamber portions, one chamber portion communicating with said first fluid outlet port and the other chamber portion communicating with the second fluid outlet port, said fluid responsive element being maintained in an equilibrium condition that is established in accordance with the flow of fluid through said fluid outlet ports when said work piece is in the normal position thereof at said work station, and contact means communicating with said sensing unit and being maintained in a normally open position in response to the equilibrium condition of said fluid responsive element, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said fluid responsive element is disturbed due to a variation in flow of fluid through said first fluid outlet port as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued, said sensing unit including a body portion in which an interior chamber is located, a piston located in said chamber and having a piston rod joined thereto and movable therewith, a fluid inlet formed in said body portion, a first passage communicating with said fluid inlet and with a first portion of said chamber on one side of said piston, a second passage communicating with said fluid inlet and with a second portion of said chamber on the other side of said piston, said first fluid outlet port communicating with said chamber and with said first passage and receiving fluid therefrom, said second fluid outlet port communicating with said chamber and with said second fluid passage and receiving fluid therefrom.

10. Apparatus as set forth in claim 9, said contact means including a switch having a contact that is normally located in said sensing unit in spaced relation with respect to an end of said piston rod, said switch being actuated only in response to an abnormal condition at said work station and when the equilibrium condition of the piston is disturbed.

11. Apparatus as set forth in claim 9, said second fluid outlet port normally discharging said fluid therefrom in a continuous stream so as to maintain the pressure in the second portion of said chamber at a fixed value, and means at said work station for simultaneously preventing flow of fluid through said second fluid outlet port during a feed operation of said work piece so as to maintain the equilibrium condition of said piston in said chamber.

12. Apparatus as set forth in claim 11, said fluid flow preventing means including an elongated biased probe that is movable into engagement with said second fluid outlet port during the feed operation of said work piece.

13. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid under pressure is directed, a first fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto, a second fluid outlet port communicating with said sensing unit for receiving fluid under pressure therefrom for discharge outwardly of said second fluid outlet port, said sensing unit including a chamber having a fluid responsive element located therein and separating said chamber into opposed chamber portions, one chamber portion communicating with said first fluid outlet port and the other chamber portion communicating with the second fluid outlet port, said fluid responsive element being maintained in an equilibrium condition that is established in accordance with the flow of fluid through said fluid outlet ports when said work piece is in the normal position thereof at said work station, and contact means communicating with said sensing unit and being maintained in a normally open position in response to the equilibrium condition of said fluid responsive element, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said fluid responsive element is disturbed due to a variation in flow of fluid through said first fluid outlet port as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued.

14. Apparatus as set forth in claim 13, said work piece having a plurality of spaced pilot holes formed therein, wherein the first fluid outlet port at said work station normally successively communicates with said pilot holes during operation of said machine for allowing the fluid to be directed from said first fluid outlet port unhindered therethrough, the second fluid outlet port continuously directing fluid therefrom in a direction removed from said work piece, wherein the flow of fluid through said second fluid outlet port is unaffected by the position of said work piece, the equilibrium condition of said fluid responsive element being disturbed only when said work piece is misaligned at said work station, wherein the first fluid outlet port is obscured to cause an increase in pressure in the chamber portion of the sensing unit chamber that communicates with said first fluid outlet port for moving the contact means to the closed position thereat.

15. Apparatus for detecting a variation in position from normal of a work piece as positioned in a work fabricating machine, wherein said machine includes a work station at which said work piece is normally locatable, and operating means for producing an operating cycle of said machine, the improvement comprising a sensor system that communicates with said work station and said operating means to control the operation of said machine in accordance with a selected position of said work piece at said work station, said sensor system including a sensing unit through which a fluid under pressure is directed, a fluid outlet port communicating with said sensing unit and located at said work station for directing fluid under pressure thereto, said sensing unit including a chamber having a fluid responsive element located therein and separating said chamber into opposed chamber portions, one of said chamber portions communicating with said fluid outlet port, the fluid being directed through said one chamber portion to said fluid outlet port and normally maintaining said fluid responsive element in an equilibrium condition that is established in accordance with the flow of fluid through said one chamber portion and said fluid outlet port when said work piece is in the normal position thereof at said work station, said sensing unit further including contact means that is operable in response to movement of said fluid responsive element.
and that is maintained in a normally open position in response to the equilibrium condition of said first responsive element, said contact means being movable to a closed position to actuate said operating means when the equilibrium condition of said fluid responsive element is disturbed due to a back pressure of said fluid created at said fluid outlet port and in said one chamber portion as a result of the position of the work piece being varied from that of normal at said work station, wherein the operation of said machine is discontinued.

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