SAFETY DEVICE FOR MACHINE TOOLS
11 Claims, 4 Drawing Figs.

ABSTRACT: A safety device for machine tools with a tool advancing member in the form of a tool holder performing a tool operating motion during operation and having mechanism for the interruption of the operating motion in the presence of adverse or anomalous operating conditions. According to important aspects of the invention a primary switching or control means is provided for the purpose of interrupting the tool operating motion of the tool holder during a portion of its operating stroke if there is exerted on the tool member a pressure opposing the operating motion. Additionally, secondary switching or control means bridge the primary switching or control means or prevent such from moving into a breaking position as soon as the portion of the operating stroke of the tool has exceeded a predetermined value.
SAFETY DEVICE FOR MACHINE TOOLS

The present invention relates to a new and improved safety device for machine tools wherein there is provided a tool operating motion in operating, and means for the interruption of the tool operating motion in the presence of anomalous conditions.

With many machine tools it is particularly difficult to provide precautionary measures for effective accident protection and protection against anomalous operating conditions since the space available for safety devices is very commonly limited. On the one hand and, on the other, the operator must not be hampered.

While accident protection or safeguard devices are known, by way of example with a two-hand starting system, they render very difficult or impossible, particularly in riveting machines, the nesting of small components. In addition, light barriers are known which are comparatively costly and can be accommodated in many machine tools only with difficulty.

This invention is designed to provide an effective safety device which is comparatively simple in design and does not make operation of the machine tool difficult or cumbersome.

This invention is characterized by the presence of primary switching or control members which cause an interruption of the feeding member during a portion of the operating stroke thereof if a pressure counteracting the operating motion is exerted, while secondary switching or control members are provided which bridge the first switching or control members or prevent them from passing into disconnecting position as soon as the portion of the operating stroke of a tool holder has exceeded a predetermined value.

This ensures not only good accident protection for the operators but, in addition, protection of the machine and the tool if anomalous conditions prevail, be it that a workpiece has been improperly or doubly inserted or if the tool holder or advancing members operate incorrectly. Since no components or feelings impeding vision of the tool are present, insertion work is not hampered.

An embodiment of the invention is shown in the drawing in which FIG. 1 is a section of a spindle with a riveting anvil or set in nonoperative position;

FIG. 2 is a section analogous to that shown in FIG. 2 with the anvil in operative position;

FIG. 3 shows a detail with the anvil and a rivet; and

FIG. 4 is a sectional view illustrating a further modified embodiment of the invention.

Describing now the drawing, it will be seen that arranged in a machine housing 1 is a tool holder in the present case in the form of a spindle 2, so as to be axially displaceable. Located at the lower end of spindle 2 is a tool bushing 3 which is also movable in the axial direction. A spring 4 urges this tool receiving bushing 3 into an outer extreme position where it rests against a shoulder 5 of the spindle 2. In this tool receiving bushing 3 a tool, viz a riveting anvil or set 6, is inserted and held in position inside by a permanent magnet 7.

Resting on the upper end face of the tool receiving bushing 8 which cooperates with a metal ball 9. Together with a stationary contact piece 15 this ball 9, biased by a spring 18, forms an electrical switch which can be opened by raising the ball 9 so that the electrical circuit is interrupted.

This switch 9, 15 is connected, via an electrical circuit 23, with a further electrical switch 10. The second switch 10 is arranged outside the spindle 2 and held on the machine housing by means of a screw 16. Loosening of this screw 16 enables the height of the switch 10 to be adjusted, possibly with the aid of a setscrew (not shown). An actuating roller 12 rests against the surface of the spindle 2 which is provided with an exterior annular shoulder 13. When this tool holder or spindle 2 moves in the downward direction, the switch 10 is closed by roller 12 compressing shoulder 13. The annular shoulder 13 may also be replaced by other actuating means which cause a switching motion when the spindle 2 performs an axial movement. The two switches 9, 15 and 10 are electrically connected in parallel and, via the electrical circuit 23, to a control device 11 of the machine.

The actuating roller 12 is arranged in such a manner relative to the annular shoulder 13 that the spindle 2, starting from the inoperative position shown in FIG. 1, first performs a portion of its operating stroke before the switch 10 is closed. On the other hand, the spindle 2 may move further in the operating direction or direction of tool advance after this switching operation without influencing the switch 10 in its closed position. In order that the switching position can be adjusted and adapted to requirements, the switch 10 in the machine housing can be adjusted in height or the annular shoulder 13 can be adjusted along the spindle axis.

This safety device is preferably used in conjunction with a riveting machine as described in the Swiss Pat. specification No. 450,118 where the riveting set or anvil and, respectively, its holder performs not only an axial motion but, in addition, a nonconcentric motion in order to deform the rivet head. The tool receiving bushing 3 and, along with it, the tool can thus be moved relative to the spindle 2 either only in the axial direction or, additionally, concentrically or nonconcentrically, or perform a wobbling motion with or without simultaneous rotation about its own axis. The mode of operation of this safety device is as follows: The device is designed to ensure that the operating motion of the spindle accommodating the tool is interrupted in the presence of anomalous operating conditions, i.e. if, by way of example, a finger is placed under the riveting anvil 6, a rivet is not properly inserted or the object to be riveted is not in the proper position.

It is assumed that the machine is started and the spindle 2 together with the riveting anvil 6 inserted in the tool receiving bushing 3 move in the downward direction under the control of the controlling device 11. The riveting anvil 6 and, respectively, the tool receiving bushing 3 assumes the position shown in FIG. 1. Under normal operating conditions, the spindle and along with it, the riveting anvil 6 first perform a portion of the operating stroke without actuating one of the switches. When there is only a comparatively small space 14 (FIG. 3) between the front 24 of the riveting anvil 6 and the head of a rivet 20 inserted in a workpiece 21, a switching operation, i.e. the closing of switch 10, is performed. This switching operation is thus effected before the riveting anvil 6 contacts the rivet 20.

During the further downward motion of the spindle 2 the riveting anvil 6 rests on the rivet head and the tool receiving bushing is forced into the space 19 against the action of the spring 4 until its upper end abuts against an intermediate wall of the spindle 2 or some other projection provided for the purpose. This movement of the tool receiving bushing 3 causes the ball 9 to rise and thus opens the first switch since the electrical connection between the contact piece 15 and the ball 9 is interrupted. This interruption has, however, no effect on the control device 11 since the switch 10 connected in parallel in the same circuit has been closed so that the operation is continued and actual deformation of the rivet begins.

If an obstacle to the downward motion of the riveting anvil 6 is met before the latter has reached the switching position shown in FIG. 3, the ball 9 being thrust upwards opens the first switch 15 which causes, in the control device 11, either immediate stoppage of the further spindle feed or an opposite movement of spindle 2 since the second switch 10 is still open. The switching position defined by the height of the space 14 is so selected that the space 14 is as small as possible, at all events less than the thickness of a finger, so as to provide the best possible protection against injuries to the hand.

It is thus possible to provide a reliable safety device which enables work to be performed under normal conditions without adverse effect of the safety device and so that the operating motion of the spindle 2 is promptly interrupted only under anomalous conditions. This is important mainly for automatic machines where improperly supplied or inserted work should be damaged or the tool to be broken.

Apart from this use in riveting machines, this safety device may also be employed in other machine tools, by way of example in production lines equipped with rotating tools or machines with turntables.
The switch 9, 15 could also be arranged outside the spindle 2 on a member motionally connected therewith, transmission of movement of the tool receiving bushing 3 being effected by mechanical links. The embodiment of the switch 9, 15 shown in the drawing could also be replaced by a commercial microswitch.

The electrical switching means could also be replaced by switching or control means that operate mechanically, pneumatically or hydraulically and produce a similar effect.

It is also possible to transmit the movement of the tool receiving bushing 3 mechanically—by way of example by a bellcrank lever—to the outside of the spindle 2 so that this movement is operative on a single switch 10. This switch is opened when the tool receiving bushing 3 moves upwards into the position shown in FIG. 2, except if the portion of the operating stroke of the spindle 2 and thus of the tool 6 have already passed the switch 10 position according to FIG. 3 so that the annular shoulder 13 prevents the switch 10 from moving into open position.

Such a modified form of the invention has been depicted in FIG. 4 wherein the same or analogous elements have been substantially designated by the same reference characters. It will be seen that the switch 2 carries the pivotably mounted bellcrank lever 30 which acts upon its switch mechanism 10 through the agency of a pivotably mounted arm member 32 pivotally supported at the machine frame at location 34. The switch mechanism 10 possesses a normally closed switch contact 10a corresponding to the condition of the switch arrangement 9, 15 shown and discussed in connection with the embodiment illustrated in FIGS. 1 and 2. The switch 2 defining the tool 6 likewise possesses a tool receiving bushing 3 for the riveting anvil or set 6. Here also there is provided a spring 41, corresponding to the spring 4 of the embodiment of FIGS 1 and 2, which serves to urge the tool receiving bushing 3 into an outer extreme position where it rests against a shoulder 5 of the spindle 2. During the portion of the operating stroke H of the tool holder 2 the bellcrank lever 30 is capable of transmitting displacements of the anvil 6 and the tool receiving bushing 3 relative to the tool holder or spindle 2 to the pivotably mounted arm member 32. Pivoting of the arm member 32 in counterclockwise direction under the action of the bellcrank lever 30 will open switch contact 10a of the switch mechanism 10 and thereby interrupt downward movement, that is the operating movement of the tool holder. If downward movement of the spindle or tool holder 2 has progressed beyond the part of the operating stroke H, then displacement of the tool receiving bushing 3 and the bellcrank lever 30 does not have any effect upon the pivotal arm member 32 since this arm member 32 is then no longer within the operable zone of the bellcrank lever 30. While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. A safety device for machine tools comprising a tool holder for a tool and which performs a tool operating motion during operation of the machine tool, said tool holder moving towards a workpiece through a portion of its operating stroke, means for the interruption of said tool operating motion when anomalous operating conditions prevail at the machine tool, said interruption means comprising primary switching means for initiating interruption of the operating motion of said tool holder during said portion of its operating stroke if a pressure countering the tool operating motion of said tool holder is exerted against the tool, and secondary switching means operably coupled with said primary switching means for preventing interruption of said tool operating motion as soon as said portion of the operating stroke of said tool holder has exceeded a predetermined value.

2. A safety device for machine tools as defined in claim 1, wherein said secondary switching means is electrically coupled in parallel with said primary switching means.

3. A safety device for machine tools as defined in claim 1, further including a tool receiving member carried by said tool holder, said tool receiving member being displaceably mounted for movement substantially parallel to the direction of the operating motion of said tool holder and relative to said tool holder, means for urging said tool receiving member in its inoperative position into an outer extreme position, the operable position of said primary switching means being dependent both on the relative position of said tool receiving member with respect to said tool holder and the feed position of said tool holder such that said tool operating motion is interrupted if said tool receiving member, during a predetermined portion of the operating stroke, is displaced from its extreme position against the action of said forcing means.

4. A safety device for machine tools as defined in claim 1 wherein said primary switching means incorporates a primary electrical switch and said secondary switching means incorporates a secondary electrical switch, a tool receiving member operatively associated with said primary electrical switch, said secondary electrical switch being positionally to cooperate with said tool holder such that the switching position thereof depends on the operating position of said tool holder, control means for controlling the tool operating motion of said tool holder, said two switches being connected in parallel with respect to one another and to said control means, said primary electrical switch cooperating with said tool receiving member being in closed condition when in inoperative position and shiftable into an open position by a force acting in opposition to said tool operating motion of said tool receiving member, said secondary electrical switch being normally open in inoperative position and closing after said tool holder moves through said portion of its operating stroke and prior to the opening of said primary electrical switch cooperating with said tool receiving member.

5. A safety device for machine tools as defined in claim 4, further including a stationary machine part, said secondary electrical switch being secured to said stationary machine part, an actuating member for said secondary electrical switch, said actuating member cooperating with said movable tool holder.

6. A safety device for machine tools as defined in claim 4, wherein said tool holder comprising a spindle, projection means provided at the outside of said spindle for operating said actuating member of said secondary electrical switch, said secondary electrical switch and said projection means defining cooperating members, at least one of said cooperating members being adjustable elevationally in order to change its switching position.

7. A safety device for machine tools as defined in claim 1, further including control means for controlling the tool operating motion of said tool holder, a tool receiving member, said secondary switching means comprising a secondary electrical switch, the switching position of which is dependent upon the tool operating position of said tool holder, means for operatively connecting said tool receiving member with said secondary electrical switch, said secondary electrical switch being coupled with said control means such that said secondary electrical switch will open in the presence of anomalous conditions during said portion of the operating stroke, opening of said secondary electrical switch under normal conditions being suppressed after performance of said portion of the operating stroke.

8. A safety device for machine tools as defined in claim 1, said machine tool being a riveting machine and said tool holder comprising a spindle.

9. A safety device for machine tools as defined in claim 8, further including a tool receiving member, said primary switching means comprising a primary electrical switch actuated by said tool receiving member, said spindle being provided with a hollow portion, said primary electrical switch being located within said hollow portion.

10. A safety device for machine tools as defined in claim 8, wherein said spindle includes a hollow portion, a tool receiv-
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A safety device for machine tools comprising a tool holder for a tool and which performs a tool operating motion during operation of the machine tool, said tool holder moving towards a workpiece through a portion of its operating stroke, means for the interruption of said tool operating motion when anomalous operating conditions prevail at the machine tool, said interruption means comprising switching means for initiating interruption of the operating motion of said tool holder during said portion of its operating stroke if a pressure counteracting the tool operating motion of said tool holder is exerted against the tool, and means operatively associated with said switching means for selectively operating said switching means and for preventing interruption of said tool operating motion as soon as said portion of the operating stroke of said tool holder has exceeded a predetermined value, said last-mentioned means incorporating bellcrank lever means mounted at said tool holder which when said tool holder is located throughout a portion of its operating stroke is in operable association with said switching means whereas when said tool holder has moved completely through said portion of its operating stroke said bellcrank lever means is located in a position where it no longer can operatively act upon said switching means.