Sensitivity Control Device

Filed April 30, 1958

Frederick O. Johnson

INVENTOR.

Davis, Lindsey, Kelby & Hayes

Attys.
This invention relates to a sensitivity control device for a safety control switch. Various types of safety control devices have been proposed heretofore in the machine tool and related arts for protecting an operator from injury by a moving machine part as a result of his becoming engaged or entangled with the moving part. Such a device is disclosed and claimed in prior United States Patent No. 2,626,999. The device shown therein comprises a switch having a universally mounted shaft and associated linkage connected to a bar or loop in the vicinity of the work area, such that movement of the bar or loop is effective to operate the switch and break the electrical circuit supplying power to the machine. Variation or adjustment of the sensitivity of the device is possible for a given installation by substituting or changing the rating of a compensating spring in the switch in accordance with the location of the device and the weight and length of linkage used. Larger machines and the inaccessibility or lack of a satisfactory mounting location for the switch mechanism often result in a remote mounting thereof and correspondingly extended linkage between the trip loop or bar and the switch shaft, such that the overall sensitivity of the device could not be maintained merely by substituting a heavier spring for the compensating spring in the switch mechanism. The operating characteristics of the device thus became uncertain and unreliable.

Accordingly, it is a general object of my invention to provide a sensitivity control device for stiffening or increasing the resistance to movement of the actuating shaft of a safety switch mechanism in certain directions without changing the resistance to movement of the shaft in certain other directions. A more specific object of my invention is to provide a sensitivity control device for use in conjunction with the projecting shaft of a safety control switch mechanism to increase the resistance of the shaft to tilting and rotational movement thereof without changing the resistance of the shaft to limited axial and lateral displacing forces.

Another object of the invention is to provide a sensitivity control device of the foregoing character for use as an attachment with a safety switch mechanism. Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view of a sensitivity control device embodying the invention, as applied to a safety control switch;
Fig. 2 is a perspective view of the sensitivity device, with some parts broken away to show underlying parts; and
Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1.

Briefly described, the present invention contemplates a sensitivity control device for increasing the resistance of a universally mounted actuating shaft of a safety control switch against certain displacing forces acting on the shaft and tending to displace it in certain directions from a reference position, without increasing the resistance of the shaft to displacement in any other direction. Specifically, the present invention contemplates a sensitivity control device for use in conjunction with the projecting actuating shaft of a safety control switch mechanism such as is disclosed and claimed in my prior United States Patent No. 2,626,999, to increase the resistance of the shaft against increased moments resulting from a remote location of the switch mechanism and the use of increased linkage length between the shaft and a trip ring or bar at the work station to thus maintain the overall sensitivity of the switch.

Referring first to Fig. 1 of the drawings, the sensitivity control device of the present invention is designated generally by the reference letter C and is illustrated in conjunction with a safety control switch mechanism, indicated at S. Inasmuch as the details of structure and operation of the safety control switch mechanism S form no part of the present invention, it will be only briefly described herein. Thus, the safety control switch S comprises a differential motion translating assembly, indicated generally at 11, and electrical contact assembly, indicated generally at 12.

The safety control switch mechanism S also includes a housing 13 having a transverse partition 14 secured therein, and the differential motion translating assembly 11 is located between the partition 14 and a top wall 15. The top wall 15 of the housing 13 is centrally apertured as at 16 to accommodate the extension of a vertically disposed actuating shaft 17 therethrough. The shaft 17 being connected to the universal differential motion translating assembly 11 to actuate the latter on movement of the shaft. The bottom of the housing 13 is provided with an opening 18 and a tubular conduit fitting 19. Within the housing, a pair of binding posts 21 provide a connection point for wires passing through the conduit fitting 19 and connected to the control of the associated machine tool. The binding posts 21 are respectively connected to a pair of fixed contacts 22, the latter being adapted to be engaged by a pair of movable contacts 26 of the electrical contact assembly 12 to complete the circuit through the safety control switch mechanism S. The contacts are adapted to be opened upon universal movement of the shaft 17 and may be closed by means of a manual reset button 23, this function being described in more detail in my prior patent.

The universal differential motion translating assembly 11 includes a pair of relatively moveable members, which comprise a tubular sleeve 24 and an elongated rod 26 slidably disposed within the sleeve 24 in concentric relation therewith. The sleeve 24 is slidably carried by a fixed sleeve 25 secured to the partition 14. A centrally apertured disc 27 is rigidly secured to the inner end of the sleeve 24 to form an annular flange or collar. A similarly sized disc 28 is normally carried on the disc 27 and is centrally apertured as at 29 to receive the upper end of the rod 26 therethrough in loose fitting relationship, the annular clearance between these two members being indicated at 31.

In order to maintain the disc 28 in engagement with the disc member 27, the upper end of the rod 26 is provided with a retainer in the form of a thrust washer 32 rigidly secured to the end of the rod 26. The thrust washer 32 has a spherical undersurface 33 which rides on a centrally shaped spherical seat 34 formed on an annular centrally apertured retaining plate 36 to accommodate universal pivotal movement between the thrust washer 32 and retainer plate 36, as will hereinafter more fully appear. The thrust washer 32 may be secured to the end of the rod 26 as by means of a snap ring 37.

In order to transmit universal movements from the
shaft 17 to the upper disc 28 and thus provide relative movement between the sleeve 24 and rod 26, an inverted cup-shaped element 39 is provided for rigidly securing the lower end of the actuating shaft 17 thereto. To this end, the element 38 has a tubular collar 41 provided with a set screw 42 for engagement with the shaft 17, the housing 38 being secured to disc 28 as by screws 43. The upper disc 28 is normally held in engagement with the lower disc 27 by means of a compensating spring 44 which coacts with an inturnd flame 46 on the upper end of the sleeve 24.

Thus, tilting of the shaft 17 in any direction serves to tilt the upper disc to resist relative movement between the rod 26 and sleeve 24 to actuate the circuit-breaking mechanism in the lower portion of the switch mechanism housing 13 and open the contacts 20 and 22. The electrical circuit through the switch mechanism S is thus broken and the associated machine stops. In a similar manner upward and downward movement of the actuating shaft 17 is effective to produce differential movement between the sleeve 24 and rod 26 to actuate the switch mechanism in the lower portion of the housing 13 and separate the electrical contacts.

In order to effect differential movement between the sleeve 24 and rod 26 upon rotational movement and lateral movement of the shaft 17, the upper surface of the disc 27 and the lower surface of the disc 28 are provided with a plurality of conical pockets 47 in each of which is seated a ball 48. The balls 48 will normally be in engagement with the surfaces of the pockets 47, but upon relative rotational or lateral movements between the discs 27 and 28, the balls 48 will be effective to cam the discs apart, thereby effecting differential movement between the sleeve 24 and rod 26 to actuate the switch mechanism as previously described.

Once the switch mechanism S has been actuated to break the electrical circuit through the contact assembly 12, an overcenter linkage in the switch mechanism will maintain this relationship until the reset button 23 is depressed and released, which is effective to return the linkage past center and close the contacts to complete the electrical circuit through the switch mechanism S. Actuating movements are transmitted to the shaft 17 from the work station of the associated machine tool as by a rod 49 which is adjustable connected to the shaft 17 by means of clamps 50. The rod 49 may have any suitable trip structure carried at its work station end, such as a ring or bar (not shown).

It will be apparent from the foregoing description of the switch mechanism S that, if a longer rod 49 were necessary in a particular machine, a heavier spring 44 would compensate for the increased tilting and rotational movements resulting from the moments of the rod 49, but a loss in sensitivity of the switch S would result for axial and lateral movements of the shaft 17.

The sensitivity control device C of the present invention overcomes this problem in that it is effective to increase the resistance of shaft 17 to tilting and rotational movements, resulting from the use of a longer rod 49, without changing the resistance of the shaft 17 to axial and laterally displacing forces, thereby maintaining substantially uniform sensitivity of the switch S to all types of actuating movements. To this end, the sensitivity control device C comprises a casing that is adapted to be mounted on the housing 13 of the switch mechanism S as an attachment with the shaft 17 extending therethrough. A supplemental compensating spring is mounted in the casing and carried by support structure 51 that accommodates free movements of the shaft 17 in any direction in a plane transverse to the shaft without affecting the spring, the support structure also including a pair of mating cam surfaces which exert to cause compression of the spring upon tilting or rotation of the shaft 17, thereby augmenting the resistance of the shaft 17 to forces tending to produce these types of displacements. In addition, the mounting of the supplemental compensating spring is such as to accommodate limited axial movements of the shaft 17 without causing compression thereof so that the forces tending to produce this type of displacement are resisted solely by the compensating spring 44 in the switch mechanism S. Thus, the sensitivity control device C comprises a mounting 52 being interposed between the safety switch mechanism S and sensitivity control device C and having an extended portion 53 to provide a convenient means for mounting the assembly. The sensitivity control device C comprises a box-like casing 56 having a pair of centrally disposed vertically aligned openings 57 and 58 in the top and bottom walls thereof. The shaft 17 extends through the openings 57 and 58, which are sufficiently large to accommodate the normal range of universal movements of the shaft.

Disposed within the casing 56 is a support, in the form of a box-like frame structure 60, which is extended generally at 59, that comprises a channel-shaped member 61 having its base or web portion 62 seated on the bottom wall of the housing 56 and secured thereto by the screws 51, the spaced flanges 63 of the channel 61 thus extending upwardly. A shallow second rectangularly shaped frame 64 is carried in notches 65 in each of the upper corners of the flanges 63 at the ends thereof and is secured thereto as by screws 66. An opposite pair of side walls 67 of the frame 64 adjacent the upstanding flanges 63 of the channel-shaped member 61 are formed with laterally extending inturnd flanges 68 disposed in spaced relation to the upper horizontal edges of the flanges 63 to define a pair of parallel slots 69 therebetween, the slots 69 thus extend transversely across the width of the frame structure 59 adjacent the side walls 67.

In order to provide for free lateral movement of the shaft 17 in the support frame 59, that is, movement transverse to the axis of the shaft, transversely movable members 70 are provided which includes a pair of transversely shiftable members, namely, a first rectangularly-shaped plate 70 having opposite edges mounted in the lateral slots 69, and a second open ended box-like member 71 having its top wall resting on the plate 70 for sliding movement therealong. The plate 70 has a transverse width somewhat less than the length of the upper corners of the box-like member 71 to permit sliding movement therein, and the second box-like member 71 has a width substantially equal to the width of the plate member 70 and a length less than the length of the member to accommodate limited sliding movement therealong. The second box-like member 71 is preferably formed from a pair of upper and lower overlapping channel sections 72 and 73 disposed around the plate 70. The upper channel section 72 has its web portion 74 resting on the plate member 70 with its flange portions 75 depending downwardly. The lower channel section 73 is somewhat smaller in width than the section 72 so as to nest between the flange portions 75 of the section 72 in inverted relation to the plate 70 with its flange portions 77 extending upwardly. The downwardly and upwardly extending flange portions 75 and 77 are thus in overlapping engagement and are secured to each other as by screws 78 with the upper transverse edges of the flange portions 77 closely underlying the lower transverse edges to form guideways therebetween. When so connected, the respective upper and lower channel sections 72 and 73 provide the open end box-like configuration for the transversely shiftable member 71. Both the plate 70 and the upper and lower horizontally disposed base portions 74 and 76 of the box-like member 71 are centrally apertured as at 79, 81, and 82, respectively, to receive the shaft.
17 There through, the openings 79 and 81 being generally elliptical in shape (Fig. 3) while the opening 82 is circular and chamfered to provide a spherical seal there around. The depth of the box-like member 71 is somewhat less than the depth of the frame 59 to permit its free movement with the shaft 17.

Through the foregoing structure, the box-like member 71 is freely movable in any direction in a plane transverse to the shaft 17. The web portion 72 of the channel section 71 includes a generally oval cup-like portion 83 tapering inwardly and upwardly and having its lower end disposed in the opening 81 and rigidly secured to the web portion 72, the interior thereof enclosing an internal cam surface 84. A cam member 86 is slidably mounted on the shaft 17 for movement rotatably therewith and longitudinally thereof, this movement being provided for by means of a longitudinally extending slot 87 formed in the cam member 86 adjacent the shaft 17, and a radially extending pin or key 88 extending through the shaft 17 and slidable in the slot 87. The cam member 86 has a generally oval shape tapering inwardly and upwardly (Fig. 3) to define an external cam surface 89 similar to the shape of the internal cam surface 84 of the cup-like member 83 for engagement therewith.

To urge the external cam surface 89 into mating or interfitting relation or engagement with the internal cam surface 84, compensating spring means such as a coil spring 91 is disposed around the shaft 17 for engagement with the lower face of the cam member 86 to urge it upwardly. To provide a seat for the spring 91, an annular member 92, in the form of a tubular sleeve 93 having a radially extending spherically formed flange 94, is carried by the shaft 17 below the cam member 89 with its flange 94 seated in the chamfered opening 82 of the box-like member 71.

In the operation of the sensitivity control device C, movement of the trip structure and rod 49 such as to cause a tilting of the shaft 17, that is, movement of the shaft out of a vertical position, not only results in differential movement between the various members in the universal motion translating mechanism 11 of the switch mechanism S and resistance by the spring 44 thereof, but also results in a downward movement of the cam member 86 in the cup-like member 83, due to the tapering shape of the respective cam surfaces 89 and 84 thereof. Downward movement of the cam member 86 compresses the spring 91 disposed in the box-like member 71, so that its resistance is added to the resistance of the spring 44 in the translating mechanism 11 to the extent of compensating for the effects of the increased linkage length. It will be understood that the rating of the coil spring 91 and the rating of the spring 44 in the switch mechanism S may be varied in accordance with the requirements of a particular installation. Such tilting movement of the shaft 17 may also cause the box-like member 71 to shift on the plate 70, or cause the plate 70 to shift in the slots 69, or both.

In a similar manner, a displacing force imposed on the trip mechanism and rod 49, tending to cause rotation of the shaft 17, also causes rotation of the cam member 86 through the key 88 and consequent downward movement of the cam member 86 and compression of the coil spring 91, due to the generally oval shape of the cam surfaces 89 and 84 and their contacting mating relationship. The resistance of the coil spring 91 is thus added to the resistance of the spring 44 in the switch mechanism S, thereby tending to hold the shaft 17 into a central position.

 Forces imposed on the trip structure and rod 49, which result only in lateral movement of the shaft 17, are transmitted to the universal motion translating assembly 11 of said members by the contact of the cup-like portion 83, since the length of the rod 49 has no effect in this instance. Thus, these forces are resisted only by the spring 44 of the assembly 11. Lateral movement of the shaft 17 is freely permitted, since the box-like member 71 is shiftable on the plate 70 and the latter is shiftable in the slots 69. The member 71 is thus freely movable in any direction in a plane transverse to the shaft 17.

Axial forces imposed on the shaft 17, either from movement of the trip structure and rod 49 or as a result of the increased weight of these components, is not resisted by the sensitivity control device C, due to the slidable mounting of the shaft 17 therein and the pin and slot connection between the shaft 17 and cam member 86. Such axial forces are transmitted directly to the universal motion translating assembly 11 of the switch mechanism S and resisted by the spring 44 thereof.

Thus it will be appreciated that the sensitivity control device C is effective as an attachment to extend the mounting versatility of a typical safety control switch mechanism, such as the switch mechanism S, by increasing the resistance of the projecting shaft of the safety control switch mechanism to increased tilting and rotational moments resulting from a remote mounting thereof or the use of extended or heavier connecting linkage without reducing the sensitivity thereof for lateral or axial forces. The sensitivity control device C thus permits installation of a safety control switch mechanism at points remote from the work station of an associated machine tool.

While only one embodiment of the invention has been herein illustrated and described, it should be understood that the variations and modifications may be effected without departing from the scope of the novel concepts herein disclosed and set forth in the appended claims.

I claim:

1. A sensitivity control device for a projecting universally movable switch actuating shaft of a safety control switch, comprising a support adapted to be mounted in fixed relation to said switch adjacent said shaft, a pair of members having mating cam surfaces, one of said members being mounted on said support for movement in all directions in a plane transverse to said shaft and the other member being mounted on said shaft for movement rotatively therewith and longitudinally therefrom, and said spring means tending to hold said members with their cam surfaces in mating engagement, said cam surfaces being shaped to effect relative movement of said members out of mating engagement on movements of said shaft in certain directions, and said members remaining in mating engagement on movements of said shaft in other than said certain directions.

2. A sensitivity control device for a projecting universally movable switch actuating shaft of a safety control switch, comprising a support adapted to be mounted in fixed relation to said switch adjacent said shaft, a first member mounted on said support for movement in all directions in a plane transverse to said shaft and having an internal cam surface extending about said shaft, a second member mounted on said shaft for movement rotatively therewith and longitudinally thereof and having an external cam surface cooperating with said internal cam surface, and said means tending to hold the latter in predetermined relation to said first member, said cam surfaces being shaped to effect movement of said second member out of said predetermined relation against the action of said spring means, said said spring means tending to hold said second member in said predetermined relation on movement of said shaft axially and laterally.

3. A sensitivity control device according to claim 1, in which said cam surfaces are shaped to effect relative movement of said members out of mating engagement on tilting and rotative movements of said shaft, and said members remaining in mating engagement on axial and lateral movements of said shaft.
4. A sensitivity control device for a projecting universally movable switch actuating shaft of a safety control switch, comprising a support adapted to be mounted in fixed relation to said switch adjacent said shaft, a pair of members having mating cam surfaces, one of said members being mounted on said support for movement in all directions in a plane transverse to said shaft and the other member being mounted on said shaft for movement rotatively therewith and longitudinally thereof, spring means tending to hold said members with their cam surfaces in mating engagement, and an elongated member extending generally transversely from the free end of said shaft and providing relatively large moments in effecting tilting and rotative movements of said shaft and relatively small moments in effecting axial and lateral movements of said shaft, said cam surfaces being shaped to effect relative movement of said pair of members out of mating engagement on movements of said elongated member effecting tilting and rotative movements of said shaft, said pair of members remaining in mating engagement on movements of said elongated member effecting axial and lateral movements of said shaft.

5. A sensitivity control device according to claim 1, in which said cam surfaces are non-circular and tapered.

6. A sensitivity control device according to claim 1, in which said cam surfaces are non-circular and tapered and in which one of said pair of members has a cup-like portion with said cam surface on the interior thereof and the other member has its cam surface formed on its exterior and mating with and shaped similarly to the cam surface on said one member.

7. A sensitivity control device according to claim 6, in which the member having the cup-like portion is the member mounted on said support, and the member having its cam surface on the interior is the member mounted on said shaft.

8. A sensitivity control device according to claim 1, in which said cam surfaces are non-circular and longitudinally tapered, and the spring means tends to force one of said pair of members longitudinally into the other to hold the cam surfaces in mating engagement.

9. A sensitivity control device according to claim 1, in which said cam surfaces are generally oval and are longitudinally tapered.

10. A sensitivity control device according to claim 1, in which said one member has an upstanding inverted cup-like portion with its cam surface on the interior thereof, and said other member has its cam surface formed on its exterior, said cam surfaces being generally oval and tapered downwardly and outwardly, and said spring means tends to force said other member upwardly into the cup-like portion of said one member.

11. A sensitivity control device for a projecting universally movable switch actuating shaft of a safety control switch, comprising a support adapted to be mounted in fixed relation to said switch adjacent said shaft, said support comprising a frame having an opposed pair of upstanding side walls and a pair of laterally extending slots formed therein adjacent the upper edges of said side walls, a pair of slide-able members carried by said support, one of said slide-able members being mounted in said slots for reciprocal movement in a plane transverse to said shaft, the other of said slide-able members having a cam surface thereon and being carried by said first slide-able member for movement therealong in a direction perpendicular to said first direction of movement, a cam member having a cam surface for mating engagement with the cam surface of said other slide-able member and being mounted on said shaft for movement rotatively therewith and longitudinally thereof, and spring means tending to hold said other slide-able member and said cam member with their cam surfaces in mating engagement, said cam surfaces being shaped to effect relative movement of said cam member and said other member out of mating engagement on movements of said shaft in certain directions and to maintain said mating engagement on movements of said shaft in other than said certain directions.

12. A sensitivity control device according to claim 11, in which said one slide-able member is a rectangularly shaped plate and said other slide-able member has guide ways slidably engaging said one slide-able member.

13. A sensitivity control device according to claim 11, in which the mounting of said said shaft comprises a radially extending pin carried by said shaft and engaged in a longitudinally extending slot formed in said cam member to permit limited free relative axial movement between said cam member and said shaft.

14. A sensitivity control device according to claim 12, in which said other slide-able member is of box-like form having its top wall resting on said one slide-able member and its bottom wall spaced below said one slide-able member and having an aperture provided with a spherical seat therein, and an annular seating member surrounding said shaft and having a spherical surface engaging said spherical seat, said seating member providing a seat for said spring member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,696,178 Ahlm Dec. 25, 1928
2,078,663 Hafner Apr. 27, 1937
2,119,880 Horton June 7, 1938
2,153,998 Verderber et al. Apr. 11, 1939
2,540,427 Charles et al. Feb. 6, 1951
2,510,520 Snow Sept. 16, 1952
2,627,560 Eitel Feb. 3, 1953
2,847,870 Exrleben Aug. 19, 1958
2,849,548 Young Aug. 26, 1958
2,817,945 Curtin Dec. 22, 1959