April 23, 1963 W. KNIEL ETAL 3,087,029

LIMIT SWITCH

Filed Oct. 24, 1960

FIG. 2

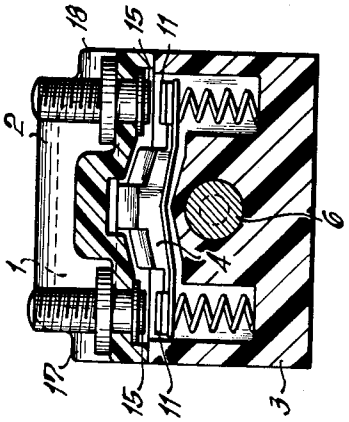


FIG. 4

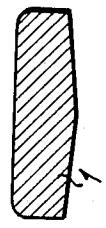


FIG. 1

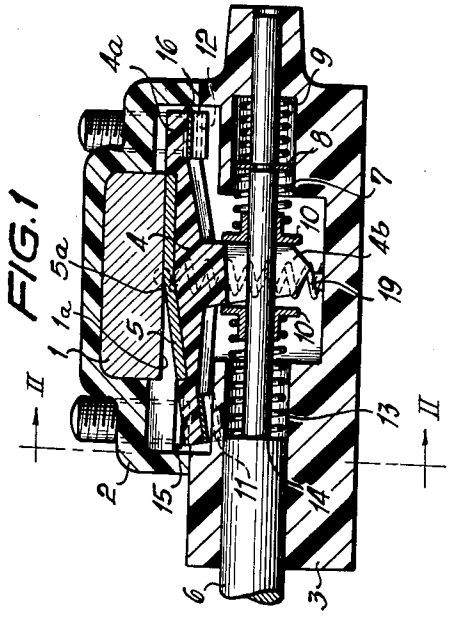
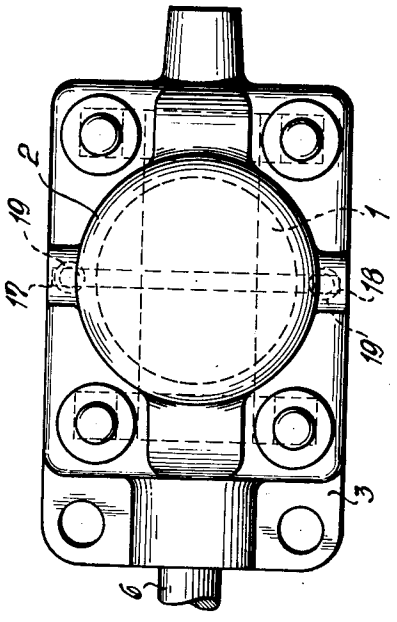


FIG. 3



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United States Patent Office 3,087,029 Patented Apr. 23, 1963

3,087,029

LIMIT SWITCH

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Filed Oct. 24, 1960, Ser. No. 64,410
Claims priority, application Germany Oct. 26, 1959
11 Claims. (Cl. 200—47)

The present invention relates to a limit switch with a so-called quick break action, especially for use in connection with machine tools. A quick break action switch is a switch which at the instant of opening its closing contact, automatically and independently of a further actuation of the actuating push rod closes an opening contact, and vice versa.

Switches of this type are frequently employed especially in connection with the control of machine tools. For this purpose, so-called quick action or snap switches have been developed which are equipped with two movable contact arms urged toward each other by a spring. By actuation of the control push rod, the two arms are adjusted beyond a dead center point, whereupon the spring instantaneously pulls the arms into another position. Such snap switch has the drawback that it is relatively big, and that the switch-over point cannot be precisely located. These two drawbacks make the employment of a limit switch impossible for use in connection with machine tools. It will be appreciated that with controls employed in connection with machine tools it is of foremost importance to employ small and compact switches because as a rule the space for the switches is extremely limited. Moreover, the precision of the switches is of great importance for a precise operation of the machine tool.

There have furthermore been developed so-called micro-switches in which a long leaf spring has one side thereof firmly clamped in and in which the switch-over is effected by pressure upon a certain portion of said leaf spring. However, micro-switches are hardly usable for machine controls because the actuating stroke amounts to only a few tenths of 1 millimeter. Consequently, the control stroke would have to be enlarged by lever rollers, levers or the like in order at all to be able to use such switches for the control strokes customary with machine tool controls. Furthermore, the opening stroke of micro-swtiches is so short that direct current controls with higher induction could either not at all be switched off or at least not in any greater number.

It is furthermore to be noted that snap switches and micro-switches have the additional drawback that they differ considerably from customary switches as to size and shape so that they could not be exchanged for ordinary switches. Moreover, the mechanical life of such snap switches and micro-switches is relatively short with regard to ordinary switch elements.

There has furthermore been developed a limit switch in which for purposes of quick break action there is provided a permanent magnet with a rocker associated therewith. With this type of switches, the rocker rotates about a shaft as pivot so that when tearing off the rocker from the magnet, high friction will occur, and considerable switch forces are required. This in turn brings about considerable wear. Moreover, this type of switch has the further disadvantage that the rocker surface has to fit extremely precisely upon the magnet area in order that a close engagement therebetween will be effected. Thus, the areas of adherence have to be machined very precisely.

It is, therefore, an object of the present invention to provide a limit switch with quick break action, which will overcome the above mentioned drawbacks.

It is another object of this invention to provide a quick break action switch which resembles in structure an ordinary limit switch as far as possible but which will also have the switch precision which has nowadays to be expected from an ordinary limit switch.

It is a still further object of this invention to provide a quick break action switch comprising a permanent magnet and a rocker associated therewith which will not have the drawback that when the rocker tears away from the magnet, high friction will occur and considerable switching forces will be required.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing, in which:

FIG. 1 illustrates a longitudinal section through a quick break action switch according to the present invention.

FIG. 2 is a section along the line II—II of FIG. 1.

FIG. 3 is a top view of FIG. 1.

FIG. 4 is a section through a modified permanent magnet for use in connection with a switch according to the invention.

The limit switch according to the present invention is characterized primarily in that it includes a rocker which comprises a plate forming the area of adherence for the permanent magnet, and in which the rocker is provided with a tipping or tilting edge through which a magnetic flux between permanent magnet and rocker will occur at all times. The rocker of the limit switch according to the present invention furthermore comprises a foot. The arrangement is such that the rocker by means of its plate rests directly and without causing friction upon the magnet, and that it is possible by actuating the control push rod to exert pressure upon the foot of the rocker through the intervention of abutments to such an extent that the rocker is tilted.

According to a particularly advantageous embodiment of the invention, the bottom side of the permanent magnet or the opposing area of adherence of the rocker has two oppositely located sides designed so that they rise toward the center so that either the area of adherence of the rocker or of the permanent magnet is roof-shaped with a slight inclination. The centrally located ridge of the roof-shaped area of adherence thus forms the tilting edge of the rocker, whereas the two inclined areas on both sides of said ridge form the areas of adherence in the two possible positions of the rocker.

In conformity with a further development of the invention, the rocker foot is located between two sleeves mounted on the control push rod. Each of said sleeves has a collar adapted to engage the rocker foot.

At both sides of said sleeves, springs are provided. When pushing the push rod inwardly, one of these springs is compressed to such an extent that the rocker foot will by engagement with the collar of the sleeve be tilted whereby one side of the area of adherence will be torn off from the permanent magnet. The plate of the rocker is provided with the movable contacts. Due to the tearing off of one side of the area of adherence from the permanent magnet, the movable contacts arranged at said side will be lifted off from a fixed contact whereby this contact will be opened. At the same time, the area of adherence at the other side of the rocker will be pressed against the permanent magnet so that the contact at said last mentioned side will be closed. When disengaging the push rod, the return spring, which was compressed by pushing in the push rod, will press through the intervention of an abutment against the spring engaging the collar of the sleeve at the rocker foot. This spring is so preloaded that it will be unable to overcome the force of adherence or attraction of the magnet. Thus, the rocker will tilt when the return spring has pressed the abutment fixedly mounted adjacent thereto on the push rod against

the collar of the sleeve whereby the rocker foot is tilted into its other position.

At the instant the rocker is lifted off from the permanent magnet, the magnetic field at this area of adherence will collapse. Inasmuch as through the tilting edge of the rocker there always prevails a magnetic flux, the rocker will now by means of the pre-loaded spring be pressed into its other position. In view of the tilting of the rocker into its other position, one contact pair will be opened and correspondingly the contact pair on the other side will be closed. The control push rod thus has a pre-load and a post-stroke (Nachlauf).

Referring now to the drawing in detail and FIGS. 1 and 3 thereof in particular, the arrangement shown therein comprises a permanent magnet **1** arranged in a housing **2** and having a straight bottom surface **1***a*. The limit switch of FIG. 1 furthermore comprises a rocker **4** provided with a plate **4***a* and a foot **4***b* which latter is arranged between sleeves **10** movably mounted on the control push rod **6**. Plate **4***a* has inserted thereinto a steel insert **5** which serves as area of adherence for the magnet **1**. As will be seen from the drawing, plate **4***a* rises from its ends toward the central portion in a roof-shaped manner. On both end portions of the rocker there are provided movable contacts **11** and **12** facing fixed contacts **15** and **16**. The control push rod **6** as shown in FIG. 1 occupies its pressed-in or right-hand end position. When the push rod **6** is disengaged, spring **7** will be compressed by return spring **9** through the intervention of snap ring **8**. The pre-load of spring **7** is not sufficient to overcome the adhering force of the permanent magnet **1**. Only when the push rod **6** moves back further until the snap ring **8** engages sleeve **10**, will the rocker be tilted and thereby be torn away from the permanent magnet **1**. It will be appreciated that a continuous magnetic flux prevails through the roof-shaped area of adherence of insert **5** of the rocker **4***a* inasmuch as the tilting edge **5***a* is in continuous contact with permanent magnet **1**.

In reverse direction, spring **13** is pressed against shoulder **14** until the latter engages sleeve **10** and thereby tilts the rocker into its other position.

As will be evident from the above, with the arrangement according to the present invention, the rocker has no friction inasmuch as its area of adherence rests directly on the magnet and does not have to be tilted about a pivot point or axis. When the abutment or collar of sleeve **10** engages the foot **4***b* of the rocker, the rocker will be tilted, the distance of one side of its area of adherence from the magnet will be increased whereby the other side will be pressed against the permanent magnet without the occurrence of any wear or friction of parts. Due to the fact that the tilting edge of the rocker maintains a continuous magnetic flux, de-magnetization of the permanent magnet cannot occur. Since with a quick break action, it is decisive that the contacts will be opened and closed instantaneously, the spring movement obtained with the rocker of the present invention is considerably more favorable for the functioning of a quick action break switch than is the case with heretofore known rockers journalled on a pivot shaft, which rocker has to carry out a circular movement.

It will also be evident from the above, that when one or the other side of the rocker engages the permanent magnet, the magnetic flux will always be distributed over half the magnet surface. During the slightest lifting off, the flux will be concentrated on the tilting edge so that with regard to the magnetic surface there will always prevail a magnetic shunt. As a result thereof, the pulling force or the torque curve in conformity with the tilting angle will be considerably steeper than is the case with a parallel lifting of the rocker or permanent magnet.

The springs which by actuation of the push rod are compressed until an abutment is hit, and also the length of the hollow body in which the rocker rests, may be adjusted at random in conformity with the present invention.

In this way, there exists the possibility of varying at random the advance (Vorlauf) and also the retraction (Nachlauf).

According to a special embodiment of the invention, the rocker may be provided with extensions resting on protrusions in the housing. Thus, the rocker **4** may be provided with extensions **17, 18** resting on protrusions in housing **3**. Instead, or in addition thereto, there may also be provided springs **19** for supporting the rocker. By either one of these arrangements, the rocker will be held in its respective position also when the permanent magnet should lose its force of attraction partially or entirely. The rocker will then automatically be moved by the bolt or push rod in either direction, and the contacts will be opened or closed by actuation of the rocker. The switch according to the invention thus remains operative also if and when the permanent magnet loses its force of attraction. While in such circumstances the limit switch could not be used any more as quick break action switch, it could nevertheless be used as ordinary limit switch.

According to a particularly favorable embodiment of the invention, the plate of the rocker will be designed so wide that the upper contact chamber is covered up with regard to the lower contact chamber containing the actuating means for the switch so that the shape of the rocker will prevent the contact chamber from being soiled by dust or other impurities. The path as to the actuation of the rocker for the third contact may be adjusted in a stepless manner in conformity with the present invention by providing an adjusting nut or the like.

While according to FIG. 1 the rocker is roof-shaped and cooperates with a straight plane surface of the permanent magnet, it is, of course, also possible to reverse the design, which means to use a rocker with a straight plane surface and to design the cooperating bottom surface of the permanent magnet in an inverse roof-shaped manner.

It is, of course, to be understood that the present invention is, by no means, limited to the particular constructions described above and shown in the drawing but also comprises any modifications within the scope of the appended claims.

What we claim is:

1. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a reciprocable control member, and two abutment means mounted on said control member in spaced relationship to each other resiliently urged toward and receiving said rocker foot therebetween for respective actuating engagement therewith in response to a certain movement of said control member in either direction.

2. A limit switch according to claim 1, in which the area of contact of said plate with said magnet is formed by a steel insert in said plate.

3. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having a roof-shaped area of contact to be attracted by and into engagement with said magnet, said roof-shaped area having its ridge located in the central portion of said area with the surfaces at the sides of said ridge declining to the respective ends of said roof-shaped area, said ridge forming a tilting edge continuously engaging said magnet to thereby maintain a continuous magnetic flux between said magnet and said

rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a reciprocable control member, and two abutment means mounted on said control member in spaced relationship to each other resiliently urged toward and receiving said rocker foot therebetween for respective actuating engagement therewith in response to a certain movement of said control member in either direction.

4. In a limit switch with quick break action: a permanent magnet having an inversely roof-shaped surface, a rocker facing said surface and having itself a substantially plane surface, the ridge of said inversely roof-shaped surface forming a tilting edge for said rocker and being in continuous engagement therewith to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot pointing and extending away from said magnet, a reciprocable control member, and two abutment means mounted on said control member in spaced relationship to each other resiliently urged toward and receiving said rocker foot therebetween for respective actuating engagement therewith in response to a certain movement of said control member in either direction.

5. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a reciprocable control push rod, two sleeve members movably mounted in spaced relationship to each other on said push rod and receiving said rocker foot therebetween for respective engagement thereby in either direction of movement of said control push rod, first spring means continuously urging one of said sleeve members into engagement with one side of said rocker foot, and second spring means continuously urging said other sleeve member into engagement with the opposite side of said rocker foot.

6. A limit switch according to claim 5, which includes third spring means arranged near said second spring means, and abutment means interposed between said second and third spring means and engaged thereby and connected to said push rod for longitudinal movement therewith, said second spring means when under load having a thrust less than the attraction force of said magnet.

7. A limit switch according to claim 5, in which the preload of said second spring means and the length of at least one of said sleeve members is adjustable.

8. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a reciprocable control member, two abutment means mounted on said control member in spaced relationship to each other resiliently urged toward and receiving said rocker foot therebetween for respective actuating engagement therewith in response to a certain movement of said control member in either direction, and contact means movably supported by said rocker.

9. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a housing provided with protrusions, said rocker being provided with extensions adapted to rest on said protrusions so that said rocker is also held in its respective position when the attractive force of said permanent magnet is reduced, a control member reciprocably mounted in said housing, and abutment means mounted on said control member in spaced relationship to each other resiliently urged toward and receiving said rocker foot therebetween for respective actuating engagement therewith in response to a certain movement of said control member in either direction.

10. In a limit switch with quick break action: a first member formed by a permanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a housing, spring means mounted in said housing, said rocker being provided with extensions adapted to rest on said spring means so that said rocker will also be held in its respective position when said permanent magnet has a reduced force of attraction, a control member reciprocably mounted in said housing, and abutment means mounted on said control member in spaced relationship to each other and receiving said rocker foot therebetween for respective engagement therewith in response to a certain movement of said control member in either direction.

11. In a limit switch with quick break action: a first member formed by a premanent magnet, a second member formed by a rocker facing a major surface of said magnet and comprising a plate having an area of contact to be attracted by and into engagement with said magnet, one of said members being provided with a tilting edge continuously engaging the other member to thereby maintain a continuous magnetic flux between said magnet and said rocker, said rocker also comprising a foot connected to said plate and extending in a direction away from said plate and said magnet, a reciprocable control member, two abutment means mounted on said control member in spaced relationship to each other and receiving said rocker foot therebetween for respective engagement thereby in response to a certain movement of said control member in either direction, and a housing covering said magnet and said rocker and also said reciprocable member, said plate being sufficiently wide to cover the upper portion of said housing comprising said permanent magnet with regard to the lower portion of said housing comprising said reciprocable member to thereby substantially prevent accumulation of soil and dust in said lower portion.

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