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MOTION TRANSLATING DEVICE

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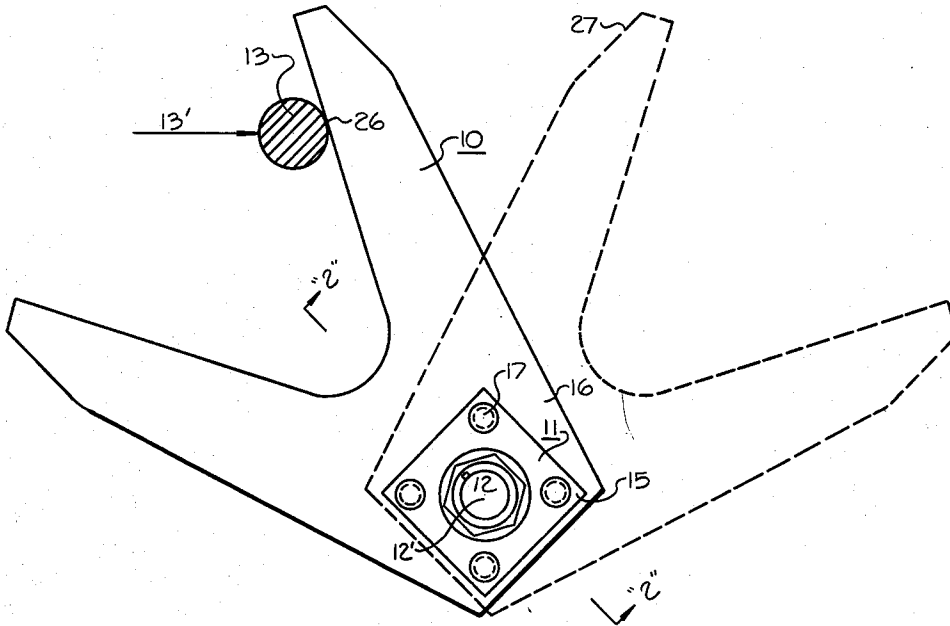


Fig. 1

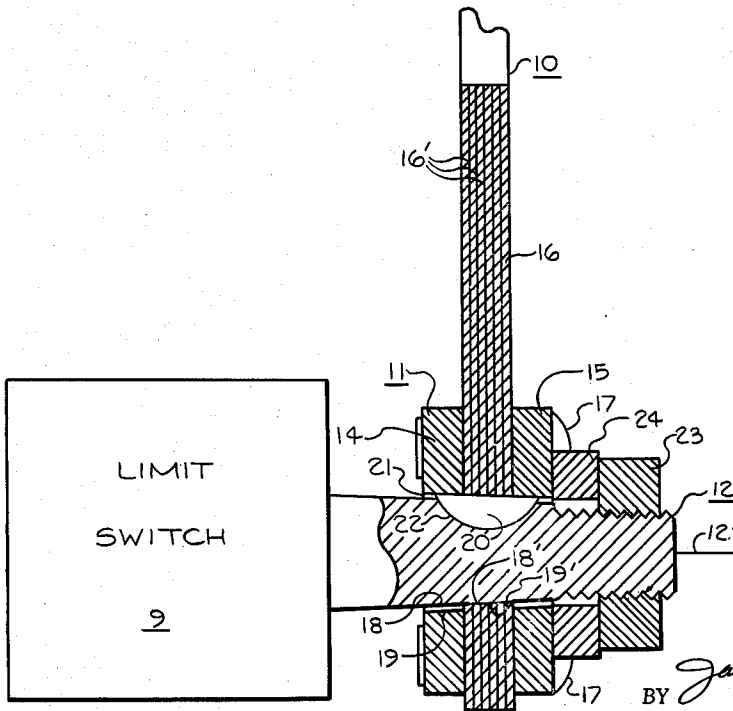


Fig. 2

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This invention relates to improvements in a shaft and lever assembly wherein the lever has a hub fitted on and encircling the shaft to impart rotary movement to the shaft upon receipt of impact blows upon the lever and more in particular to the construction of the hub and the shaft.

The invention is particularly applicable to limit switches wherein a moving object or impact bar strikes the lever to partially rotate the operating shaft of the switch. In prior devices the lever was generally formed from a single or several pieces of metal secured to the shaft.

In actual tests it was found that abrasive wear was an important destroyer of metallic levers or forks. On the test machine the heat-treated steel forks wore out a cold-rolled steel impact bar every day. Abrasion of the hardened fork was slower but by 600,000 operations the impact bar had worn into the fork so deeply that it locked into the cavity and jammed the testing machine. Wear was more rapid with softer ferrous materials.

Non-ferrous metals greatly reduced the wear on the impact bar and left it in a smoother condition so that wear on the fork was less serious, but these materials were more subject to fatigue failure.

It was also found that the hub and shaft assembly of prior devices would not withstand the extremely long life tests and several million operations required of the switch. In some instances, the hub would become loose and wear the shaft, or the shaft would gradually fatigue and break.

In attempting to improve upon prior art, levers of various configurations including resilient and non-resilient levers, were constructed from various metals including steel, aluminum, beryllium copper, and other metals, in an effort to find a lever which would (1) withstand the repeated impacts to which the lever is subjected without fracture, chipping, or abrasive wear of the lever, (2) have a minimum of weight opposition to acceleration, (3) have a minimum moment of inertia, (4) be sufficiently resilient that contact pressures at impact would not reach destructive levels, (5) be sufficiently rigid to convert an impact blow on the lever to rotary motion of the shaft, (6) have a long service life at high operating speeds, (7) be capable of withstanding the repeated severe impacts of the impact transmitting bar without breaking off of the struck portion of the arm, and (8) have a means of attachment of the lever to the shaft which would not fail under millions of impact operations. No satisfactory metal lever was found which would meet all these conditions through an extremely long operating life.

In actual tests of herein referred to prior metal lever devices, it was found that the prior levers would begin to crack and break off, or that the impact portions would disintegrate to the point where the lever and shaft assembly was no longer safely useable after life tests as low as approximately 50,000 to approximately 600,000 operations. Simply substituting nylon or asbestos mat phenolics for metal did not appreciably increase the operative life of the prior devices.

Following these tests the present invention was constructed and tested. Contrary to expectations, it was found that the herein described, illustrated, and claimed lever and shaft arrangement showed little wear, no failure, and was still in a perfectly safe and useable oper-

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ative condition after more than two and one half million operations. Thus, the present invention withstood the repeated impact to which the lever was subjected, without fracturing or chipping, and provided sufficient rigidity to convert an impact blow on the lever to rotary motion of the shaft for over four times as many operations as the prior devices would withstand.

An object of the present invention is to provide structure which overcomes the aforementioned deficiencies of prior structures.

Another object of the invention is to provide an electrical limit switch having an operating shaft partially rotatable to operate the switch and a lever arm secured to the shaft to impart rotary movement to the shaft upon receipt of impact blows upon the lever and in a direction perpendicular to the shaft, at least part of the lever and shaft assembly being constructed from laminated thermoplastic material so that an exceedingly long operating life of the lever is obtained.

A further object of the invention is to construct the impact receiving lever of a limit switch from laminated thermo-setting plastic material wherein the laminations and the direction of impact blows extend in a common plane.

Another object of the present invention is to provide a shaft and lever assembly wherein the lever has a hub fitted to the shaft to impart rotary movement to the shaft upon receipt of impact blows upon the lever and which has a useful operating life several times that of prior devices before the lever or shaft are destroyed, ruined or worn out.

Further objects and a fuller understanding of the present invention will become apparent from the following description of a specific embodiment thereof taken in conjunction with the appended claims and the attached drawing in which:

FIG. 1 is a side elevational view of the lever and shaft assembly and illustrates the features of the invention; and

FIG. 2 is an enlarged cross sectional view taken along the line 2-2 of FIG. 1 of the lever and shaft extending from a limit switch, the limit switch being shown in block diagram.

Referring to the drawings, there is illustrated a shaft and lever assembly for an electrical switch 9 wherein a lever 10 has a hub 11 fitted on a shaft 12 and attached thereto to impart rotary movement to the shaft 12 upon receipt of impact blows upon the lever 10 from an impact transmitting bar 13 of an operative apparatus traveling in a direction (arrow 13') perpendicular to the axis 12' of the shaft 12.

The specific hub 11, illustrated in the drawings, comprises plates 14 and 15 and a portion of a sheet 16 sandwiched between the plates 14 and 15. The plates 14 and 15 are, in this instance, constructed of metal. Rivets 17 or other suitable holding means extend parallel with the shaft axis 12' and through the sheet 16 and engage the plates 14 and 15 to hold the plates 14 and 15 against the sheet 16. The hub 11 and the shaft 12 have tapered opposing surfaces including surfaces 18 and 18' on the shaft 12 and surfaces 19 and 19' on the plates and sheet 16, respectively.

As exaggerated in FIG. 2, the plates 14 and 15 and the shaft 12 have a more positive allowance between opposing surfaces 18 and 19 than between the surfaces 18' and 19', whereby the sheet 16 engages the shaft 12 in a friction fit to retard relative rotational movement therebetween even when surfaces 18 and 19 are not in a friction fit contact.

In actual practice, a negative tolerance or allowance is used between the sheet 16 and the shaft 12 to insure

good friction and a tight fit between the sheet 16 and the shaft 12. In an actual sample, a shaft 12 was coated with ordinary bluing, inserted in the hub 11 and twisted by hand. The bluing was wiped from shaft 12 by the sheet 16 and the hub plates 14 and 15 did not wipe bluing from the shaft 12.

In addition to the above desired friction fit and allowances between the shaft 12 and hub 11, and more particularly between the opposing surfaces 18 and 19 or 18' and 19', the hub 11 and the shaft 12 are interjoined by a key 20, or equivalent mechanical means, to angularly align the hub on the shaft. In actual practice, the hub 11 and the shaft 12 are provided, respectively, with aligned slots 21 and 22 which jointly and cooperatively receive the key 20.

Means provided with a resilient portion, for example a nut 23 threaded on shaft 12 and a nylon washer 24, urge the hub axially of said shaft to maintain the allowances between said opposing surfaces 18; 18' and 19, 19', respectively. The nut 23 and nylon washer 24 also prevent the hub and lever from becoming disengaged from the shaft. It is noted that if, for some unexpected reason, and in case of emergency, the friction fit between the shaft and hub becomes lost, the lever will still rotate the shaft at least a few times because of the key 21; thus making the operation of the switch more safe.

The present structure thus continuously holds the lever assembly tightened on the tapered surface 18 of shaft 12, with a heavy interference fit between the laminated plastic sheet 16 and shaft 12 at 18' and 19'. This interference fit may be considered the principal means of transferring the motion resulting from impact blows on the lever to the shaft 12, and the rivets or other fastening means 17, and attaching plates 14 and 15 will transfer no forces, or only an inconsequential part of the motion. Hub plates 14 and 15 are attached by rivets 17 to provide stability in a direction transverse to the plane of motion, to resist spreading of laminated plastic sheet 16, and to prevent damage to the tapered hole 19' of sheet 16 by overtightening nut 23.

In accordance with the invention, the sheet 16 is constructed at least partly from laminated thermosetting plastic sheet material in which laminations 16' are impregnated with and bonded together by a thermosetting material. Vulcanized fibre phenolic of the type commonly available under the trade name "Diamond Dilecto" or canvas base phenolic of the type commonly available under the trade name "C-1513 Dilecto" have been found to be very satisfactory materials for this purpose.

Further, and as illustrated, the sheet 16 of lever 10 extends radially outwardly from the plates 14 and 15 with the individual laminations 16' thereof disposed in planes transverse to the axis 12' of the shaft 12 and provides a radially extending impact receiving portion 26 to be struck by the impact bar 13. The impact is thus directed against the edges of the laminations 16'.

As previously set forth, the lever and shaft assembly herein described is subjected to repeated operation over a long period of time and must continue to operate effectively for several million times under all types of operating conditions. During normal usage of a switch having an operating shaft 12 provided with the lever 10, the switch is mounted so that the axis 12' of the shaft 12 is perpendicular to the direction of movement of the impact bar 13. The solid lines of FIG. 1 illustrate the position of the lever arm 10 and shaft 12 at the instant an impact bar 13, moving in the direction of the arrow 13' engages the impact portion 26. Upon impact, the bar 13, or any other similar object, causes the lever 10 to rotate the shaft 12 until the entire assembly reaches a new angular position, such as the position illustrated by the phantom lines 27 in FIG. 1.

Many times it is desirable to have a reverse movement of the impact bar 13, i.e. movement in a direction opposite to that of arrow 13', reposition the switch and thus

reposition the lever arm 10 in its original position, as indicated in the solid line of FIG. 1. Such reverse movement is very common in track-type limit switches wherein the limit switch is operated upon movement of a member to and away from the end of its travel.

In such instances, the sheet 16 of lever 10 is bifurcated or made fork-shaped. To provide a fork-shaped lever, the sheet 16 and laminations 16' are formed into a somewhat fork-shaped or bifurcated shape to provide more than one radially extending impact portion 26. These extended impact portions are angularly disposed about the hub 11.

It is believed that the present lever and shaft assembly meets the objects of the present invention because the sheet 16, i.e. laminations 16' impregnated with phenolic material and coupled with the plates in the hub 11, provides a structure which has the least amount of weight opposition to rotary acceleration of the lever and shaft upon impact. In other words, the major portion of the weight is in the hub so that the moment of inertia of the assembly is maintained at a minimum. In addition, the impact of the bar 13 is against the edges of the laminations 16' and they provide sufficient resiliency to be able to receive the repeated impacts without becoming destroyed and at the same time provide sufficient stiffness to rotate the shaft when they are struck.

Having thus described my invention, I claim:

1. In a switch assembly for operating a limit switch including a non-resilient operating shaft at least partially rotatable to operate the switch, a lever having a hub and an impact arm extending radially outwardly beyond said hub, said hub being on and encircling said shaft to impart rotary movement to the shaft upon receipt of impact blows upon the impact arm in a direction to rotate the lever about the axis of the shaft, said arm comprising a sheet of laminated cured resilient plastic with its laminations lying in planes normal to the axis of the shaft, said hub comprising non-resilient face plates and an annular end portion of said laminated sheet coaxial with the shaft and sandwiched between said plates under pressure to resist spreading of the laminations of said laminated sheet at said end portion, each of said plates having a positive radial clearance relative to the shaft, said laminated sheet having, at its inner periphery, a negative radial allowance relative to the shaft for providing a frictional fit directly between the inner edges of the laminations and the periphery of the shaft to transmit the full moment of the arm directly to the shaft, said arm having its impact surface radially outwardly beyond the plates so that the impact blows are directly on the surface and are thereby directly applied to the laminations, and said surface being positioned so that the impact blows are edgewise of the laminations.

2. The assembly as set forth in claim 1 wherein said opposing surfaces on said shaft and said hub are tapered surfaces, and means provided with a resilient portion urge said hub axially of said shaft to maintain said allowance between said opposing sheet and shaft surfaces negative.

3. The assembly as set forth in claim 1 wherein said plastic is a phenolic thermo-setting plastic material.

4. The assembly as set forth in claim 1 wherein said laminations are vulcanized fiber and said plastic is a phenolic thermo-setting plastic.

5. The structure as set forth in claim 1 wherein said laminations are canvas-base and said plastic is a phenolic thermo-setting material.

6. The structure as set forth in claim 1 wherein said laminations are a base of interwoven strands of flexible material bonded together by a set plastic material.

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