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Morton et al.

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[54] ELECTRICAL CONTACTORS

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[52] **U.S. Cl.**.....**335/133**, 200/166 J, 335/200

[51] **Int. Cl.**.....**H01h 1/12**

[58] **Field of Search**.....335/133, 192, 200, 335/195; 200/166 J, 67 DA, 67 D

[56] **References Cited**

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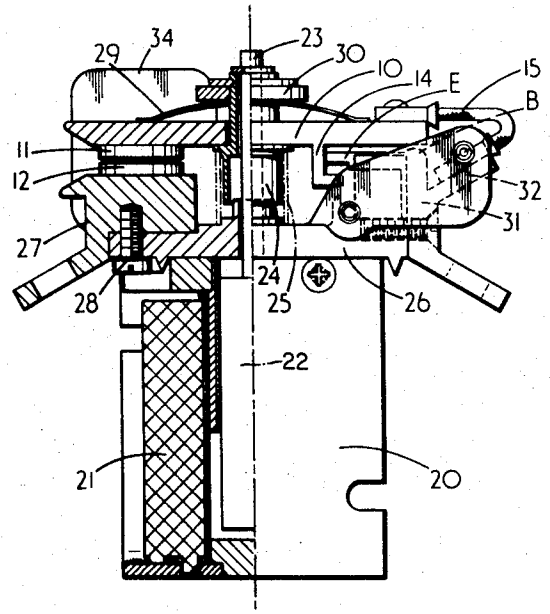
[57] **ABSTRACT**

A solenoid operated contactor is disclosed which provides a larger than armature travel air gap, higher contact pressures and rolling or wiping action of the main contacts, by providing a conductive strap supporting the main moving contact, which strap is coupled intermediate its ends to the solenoid armature and has alternative fulcra, one nearer and one more distant from the armature-strap junction.

9 Claims, 5 Drawing Figures



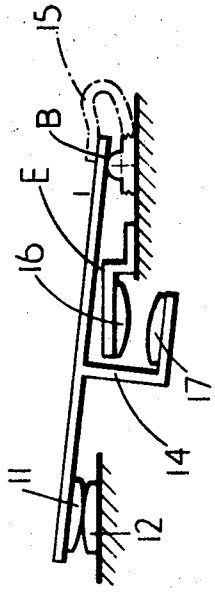


FIG. 3

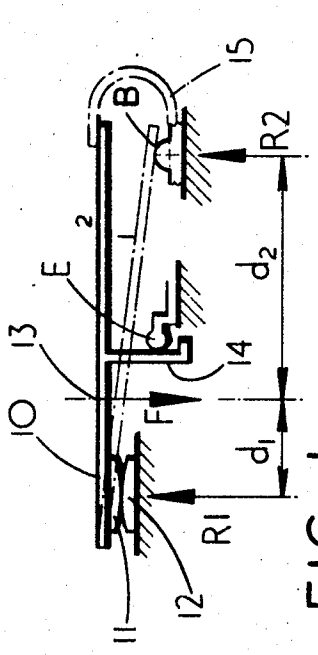


FIG. 1

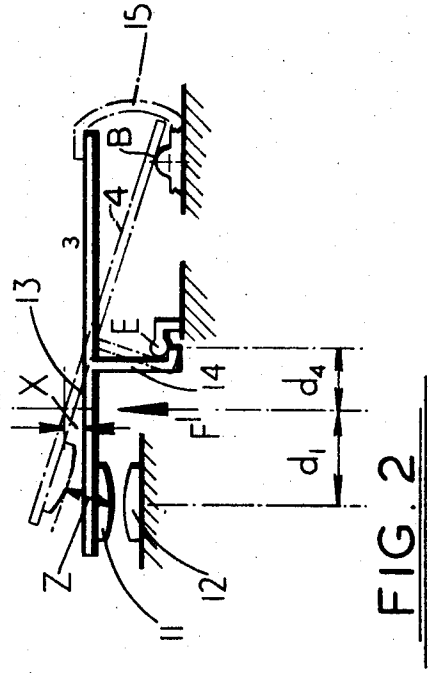


FIG. 2

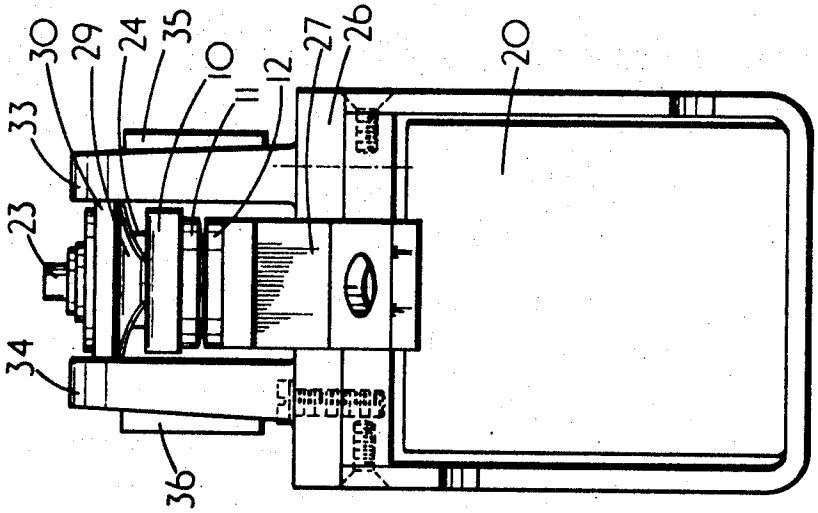

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FIG. 5

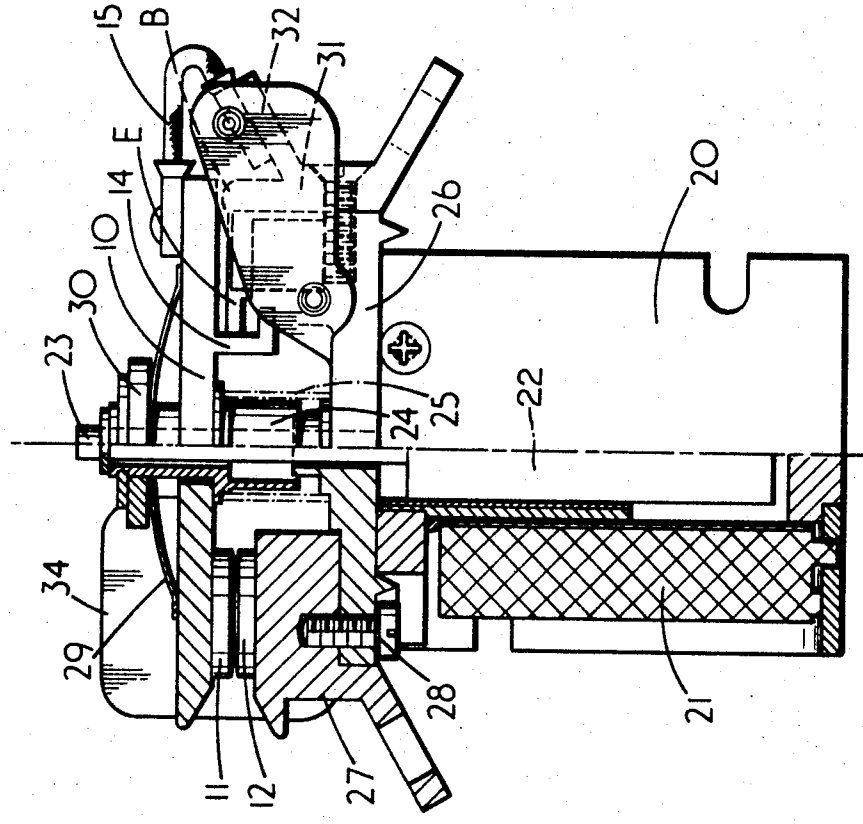
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FIG. 4

ELECTRICAL CONTACTORS

This invention relates to electrical contactors for making and breaking the supply of electrical current to a load.

Two main types of contactors are presently in use, the attracted armature or 'clapper' type and the solenoid operated type. Of these two, the attracted armature type is much more widely used, although it tends to be larger and more expensive, as its geometry is more convenient for incorporating arc blow out devices, wiping or rolling actions on the main contacts and larger air gaps between main contacts for a given air gap in the magnetic circuit. To achieve this larger air gap it is necessary to have a velocity ratio which has the disadvantage of giving the lowest of the two or more reactions to the armature force at the main contact and therefore less contact pressure for a given force on the armature.

A solenoid contactor has the advantage that it can be constructed in a smaller volume and with less parts but in general rolling or wiping action on the main contacts is not available nor is the facility for arc blow out, greater air gaps between main contacts than armature travel or a greater air gap between main contacts than armature travel and yet still maintaining the largest reaction to the armature force on the main contact.

An object of the present invention is to provide an improved solenoid operated contactor in which the above mentioned disadvantages are obviated or mitigated.

According to the invention, a solenoid operated contactor comprises a fixed contact and a co-operating moving contact, the latter being carried at or towards one end of a conductive strap which is coupled intermediate its end to the solenoid armature, the strap in the portion beyond the armature-strap coupling remote from the moving contact having alternative fulcra of different spacings from the armature-strap coupling, the arrangement being such that when the solenoid is de-energized the fulcrum nearer the armature-strap coupling is operative and when the contactor is fully operated the fulcrum more distant from the armature-strap coupling is operative.

Preferably the strap is electrically connected to the more distant fulcrum by a flexible conductor which as will be explained latter provides means enabling the reduction of duration of contact bounce for a given mass of moving components and closing velocity.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawing, in which:

FIG. 1 is a diagrammatic representation of the contact assembly in the closed condition, in accordance with the invention,

FIG. 2 is a similar representation to that of FIG. 1 but showing the open condition,

FIG. 3 is a similar representation of a change-over contact assembly,

FIG. 4 is a part-sectional view of a contactor in accordance with the invention, and

FIG. 5 is a view at right angles to that of FIG. 4.

Referring to FIGS. 1 and 2, the contact assembly comprises a strap 10 carrying a moving contact 11 co-operating with a fixed contact 12. The strap is coupled to a solenoid armature (not shown) at 13 so that the strap experiences the force F when the solenoid is energized and a spring return force F_1 when it is de-

energized. The strap operates against alternative fulcra, the near one being shown at E and the more distant one at B. To co-operate with the fulcrum E the strap 10 is provided with an L-shaped projection 14. The distance between the armature-strap coupling 13 and the point of contact of the contacts is shown as $d1$, from the coupling to fulcrum B as $d2$ and from the coupling to the fulcrum E as $d4$. The strap 10 is electrically coupled to the fulcrum B by a flexible conductor 15 in the form of braid. The clearance in the direction of the solenoid axis is so arranged that when the solenoid is energized the contacts close (positions 2) and the solenoid continues to travel until the other end of the conducting strap closes on to the fulcrum B (Position 1), thus causing the moving contact 11 to roll on the fixed contact 12.

In this closed position the reaction on the main contact is $R = (Fd2/d1 + d2)$ i.e., being larger than the reaction when fulcrum E is operative.

When the solenoid is de-energized the conducting strap moves from position 1 to position 2 (the effect being to roll the contacts) due to the throw off spring. It then continues up to position 3 at which point the vertical movement of the strap is arrested at the fulcrum E. The solenoid then continues through distance X up to its fully open position, throughout this latter movement the conducting strap pivots about fulcrum E and the extra air gap between the contacts that is obtained during this movement is $Z = (X\ d1 + d4/d4)$

Current begins to flow through the contactor when the contacts touch, the current path being through the flexible conductor 15 which shorts the moving contact assembly to the cable terminal, fulcrum B. The velocity of the moving contact assembly only undergoes a small change at this moment due to a slight change in direction, the velocity of the whole assembly being relatively unaffected. The assembly continues to travel until the moving contact assembly is brought into contact with the fulcrum B. The velocity of the moving contact assembly now undergoes a major change and oscillation of the moving contact assembly with respect to the fulcrum B now takes place.

However, it can be seen that the flow of current through the contactor is only interrupted if the moving contact assembly is lifted to beyond the level position thus opening the contacts 11 and 12. This required amplitude of oscillation, if reached at all, is only present for a small period of time compared with the time required for the exponential decay of the oscillation. Also since fulcrum B is of a conducting material it can be seen that when the contactor is in the closed position the current flow is diverted from the flexible conductor 15 which allows the flexible conductor to be smaller in cross sectional area and therefore more flexible and still not limit the thermal rating of the contactor.

Referring to FIG. 3, there is shown diagrammatically a similar contact assembly with the exception that contacts 16 and 17 are provided at the fulcrum E and projection 14. As can be seen from FIG. 1 and 2 contact between fulcrum E and projection 14 is open when contacts 11 and 12 are closed and closed when contacts 11 and 12 are open. Thus a change-over contact assembly is provided, the movement between the position 3 and 4 shown in FIG. 2 providing a very positive wiping action for the contacts 16 and 17.

Referring to FIGS. 4 and 5 there is shown a completely assembled contactor in accordance with the in-

vention. The contactor comprises a solenoid **20** having an operating coil **21** and a plunger **22** from which extends an operating rod **23** carrying an insulating collar **24** which is urged upwards by a coil spring **25** bearing on a base plate **26.** Collar **24** supports the conductive strap **10** carrying the moving contact **11** co-operating with the fixed contact **12** mounted on a terminal assembly **27** which is secured to the base plate **26** by bolt **28.** Strap **10** is held on the collar **24** by a light blade spring **29** and retaining ring assembly **30.** Strap **10** is provided with the L-shaped projection **14** which co-operates with fulcrum E which is an extension from a terminal assembly **31** which is mounted on base plate **26** and also provides fulcrum B. The flexible conductor **15** extends from a lug **32** on terminal assembly **31** to the end of strap **10.** The operation of the contactor is as already described in relation to FIGS. **1** and **2.**

An arc chute assembly **33, 34** provided with permanent magnets **35, 36** is positioned adjacent the contacts **11, 12** to act as an arc blow out device. The magnets are positioned to achieve maximum flux density across the contact gaps to pull the arc out as quickly as possible. The arc chute assembly serves to locate the assembly of the moving contact and the overtravel spring to the desired position relative to the fixed contact.

What is claimed is:

1. A contactor operated by a solenoid having an armature, said contactor comprising

a fixed contact,

a conductive strap which is coupled intermediate its ends to said solenoid armature,

a moving contact carried on said conductive strap at a point remote from the point of said coupling and positioned to enable it to cooperate with said fixed contact,

a first fulcrum positioned for contact with said conductive strap at a point on the opposite side of the point of said coupling from the point at which said moving contact is carried,

a second fulcrum, also positioned for contact with said conductive strap at a point on the opposite side of the point of said coupling from the point at which said moving contact is carried, but at a point more distant from the point of said coupling than the point at which said first fulcrum is positioned,

said first and second fulcra being operatively associated with said conductive strap so that, when the solenoid is de-energized, said first fulcrum is operative and, when the contactor is fully operated, said second fulcrum is operative.

2. A contactor as claimed in claim **1** wherein said conductive strap is electrically connected to said second fulcrum by a flexible conductor and said second fulcrum has an extension forming a terminal of the contactor.

3. A contactor as claimed in claim **1** wherein said conductive strap has

a main member which carries said moving contact and which co-operates with said second fulcrum and

a generally L-shaped projection which co-operates with said first fulcrum, said first fulcrum extending into the space between the remote leg of said L-shaped projection and said main member.

4. A contactor as claimed in claim **3** wherein the part of said first fulcrum nearer to the point of said coupling is an extension from a part of said first fulcrum more distant from the point of said coupling.

5. A contactor as claimed in claim **1** wherein

a first additional contact is mounted on said conductive strip at the point where it contacts said first fulcrum and

a second additional contact is mounted on said first fulcrum,

whereby said first and second additional contacts are closed when said first fulcurm is operative and open when said second fulcurm is operative.

6. A contactor as claimed in claim **4** wherein said second additional contact forms said first fulcrum.

7. A contactor as claimed in claim **1** wherein the point of said coupling is approximately midway between the point at which said moving contact is carried on said conductive strap and the point at which said conductive strap contacts said second fulcurm.

8. A contactor as claimed in claim **1** wherein said solenoid armature is coupled to said conductive strap via an insulating collar which also serves as an abutment for one end of a throw-off coil spring, said conductive strap being steadied on said insulting collar by a blade spring.

9. A contactor as claimed in claim **1** further comprising an arc chute including permanent magnets adjacent said fixed contact and said moving contact, the arc chute serving to locate the assembly of said moving contact and said conductive strap to the desired position relative to said fixed contact.

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