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G. C. ARMSTRONG

2,381,243

MECHANICAL INTERLOCK

Filed May 23, 1944

2 Sheets-Sheet 1

Fig. 1.

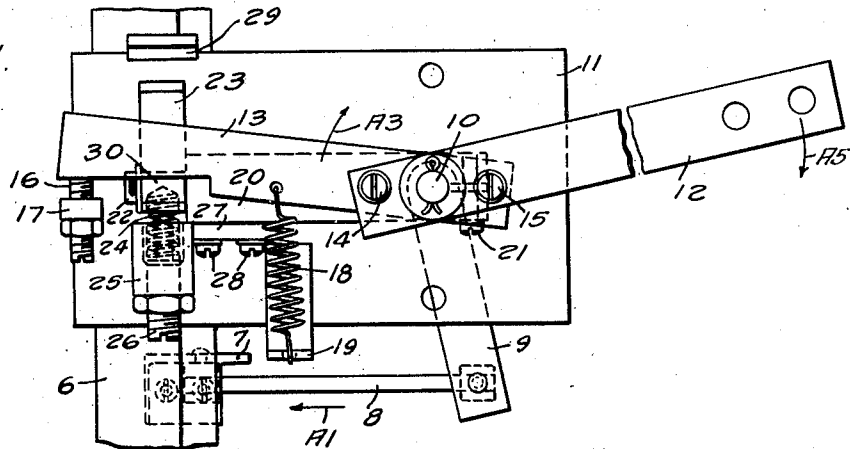


Fig. 2.

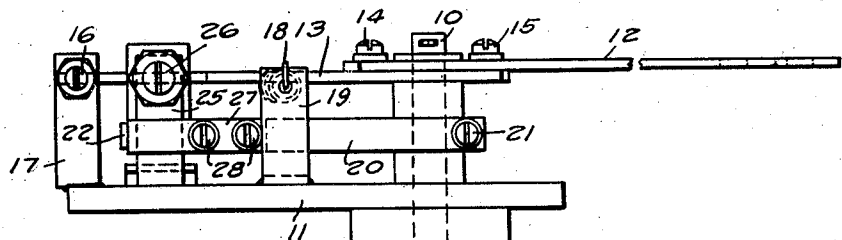
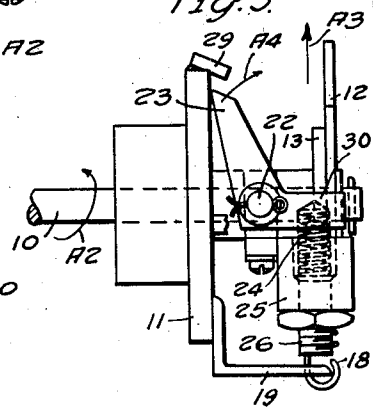


Fig. 3.



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Fig. 4.

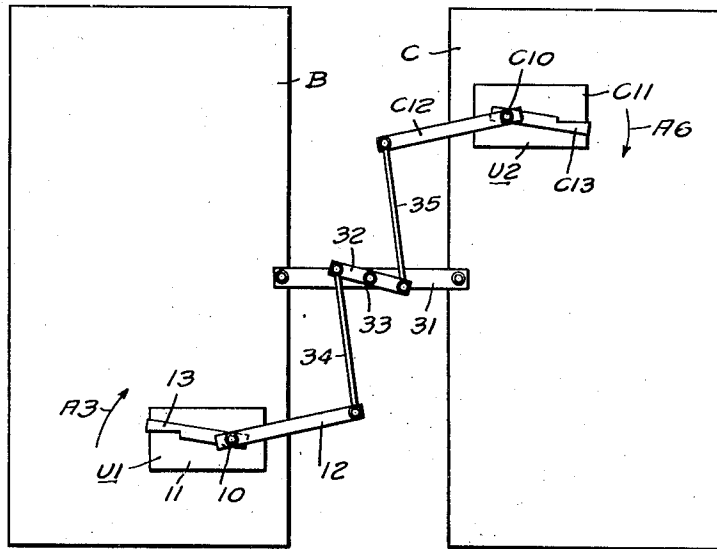
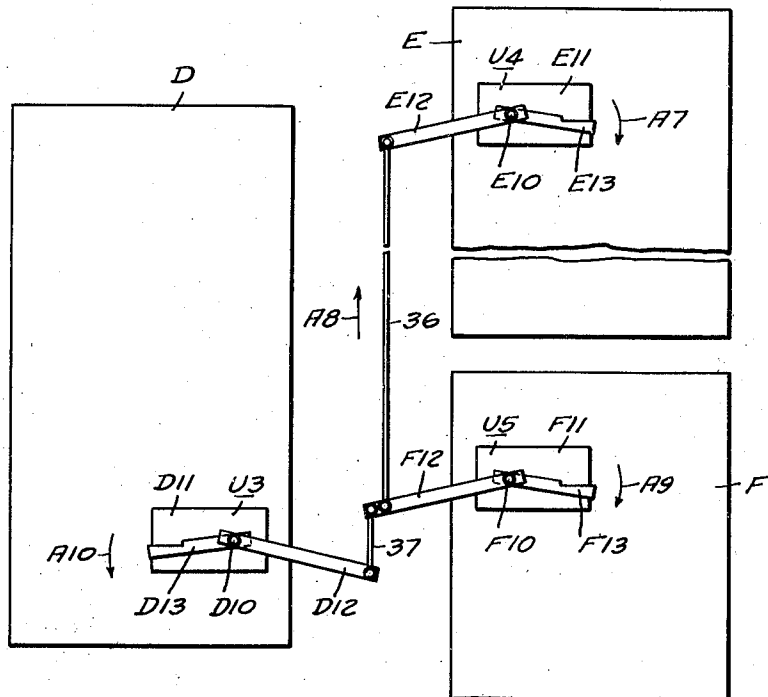


Fig. 5.



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MECHANICAL INTERLOCK

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5 Claims. (Cl. 200—50)

My invention relates to mechanical interlocks for preventing the actuation of apparatus when other apparatus are actuated, and more particularly to interlocks for electric relays, circuit breakers and other contactors.

It is well known and customary to provide a mechanical interlock between two electric contactors with a movable bar which is displaced when either contactor is closed and then blocks the closure of the other contactor. When three or more contactors or other apparatus must be interlocked so that the actuation of any one of them blocks all others, devices of the known type become impractically complicated, or do not lend themselves readily to widely different layouts of the contactor arrangement or installation, or require a special design of the contact-actuating mechanism proper of the contactors.

It is an object of my invention to provide mechanical interlock means of the general kind above referred to that are applicable with similar ease and simplicity to two, three, or larger numbers of apparatus and permit a great variety of different arrangements of these apparatus relative to one another without requiring a special design of the apparatus or contactor mechanism proper.

Another object of the invention, allied to the foregoing, is to provide interlock means whose main function is performed by individual locking units so that the addition of such a unit to a contactor or other apparatus will render the apparatus interlocked with one or several other apparatus to which such a unit has been added.

A further object, subsidiary to the one just mentioned, is to devise individual locking units which, even for comparatively large apparatus to be interlocked, have a compact and sturdy design of small compass and are composed of simple-shaped parts permitting a low-cost manufacture.

These and other, more specific objects as well as the means provided by the invention for achieving them, will be understood from the following description in conjunction with the appertaining claims, in which:

Figure 1 shows a top view of an interlocking unit according to the invention,

Fig. 2 is a lateral elevation of the same unit and shows also, in a diagrammatic manner, a portion of an electric contactor to which the unit is connected.

Fig. 3 is a front elevation of the interlocking unit according to Figs. 1 and 2, while

Figs. 4 and 5 illustrate two different groups of electric contactors in conjunction with inter-

locking means whose individual locking units are designed as exemplified by Figs. 1, 2 and 3.

Referring to the locking unit shown in Figs. 1, 2 and 3, numeral 1 in Figs. 1 and 2 represents the frame or supporting structure of an electric contactor. This structure carries an insulated stationary contact 2 and forms a bearing for a contact arm 3 which is pivoted at 4 and carries a movable contact 5 for cooperation with the stationary contact 2. An electromagnet, not shown, acts to rotate the contact assembly about the pivot 4. An insulator 6 mounted on contact arm 3 is provided with a bracket 7 which forms a pivot for link 8. This link, in turn, is pivoted on a crank arm 9 of a transmission shaft 10. This shaft forms part of the locking device proper and serves to transmit the movement of the contact arm 3 to the locking and releasing elements proper of the interlock means. It will be understood that the illustrated contact structure of the electric contactor is only one of a large number of possibilities and that any other mechanism or transmission capable of imparting a revolution to the transmission shaft 10 in dependence upon the closing and opening motion of the contact assembly of the contactor can be used for the purpose of the invention.

The shaft 10 passes through a bearing formed by, or mounted on, a base plate 11. This plate has openings or is otherwise designed for attachment to the stationary supporting structure or housing of the electric contactor and forms a support for the other elements of the locking unit to be described presently.

An arm or crank member 12, hereinafter called "transmission arm" in order to distinguish it from other members of the device, is mounted on shaft 10 for free rotation about the shaft. Another arm 13 hereinafter, for the purpose of distinction, called "release arm" is likewise rotatable about shaft 10. The two arms 12 and 13 are firmly connected with each other by means of fastening screws 14 and 15 so that they form together a single lever structure. It will appear from this connection of the transmission and release arms that they may consist of an integral body, if desired. A set screw 16, adjustably held by a stud 17 of base plate 11, serves as an abutment for the release arm 13. A spring 18, having one end attached to arm 13 and the other held by another lug 19 of base plate 11, imposes a rotational bias on arms 13 and 12, tending to hold arm 13 against the stationary stop formed by screw 16. Hence the arms 12 and 13 tend to as-

sume the position of rest shown in Figs. 1, 2 and 3.

Another arm 20, hereinafter for the sake of distinction called the "pawl arm," is keyed on shaft 10 and is tightened thereto by means of a screw 21 so that it is prevented from rotating relative to the shaft. The peripheral end 22 of the pawl arm is machined to form a round bearing shaft. A pawl or latch 23 of angular shape is pivotally mounted on the shaft end 22. Hence the axis of rotation of pawl 23 extends radially with respect to the axis of the transmission shaft 10. The pawl is biased by a spring 24 so that its pawl edge tends to rest against the surface of the base plate 11 (Fig. 3). Spring 24 is accommodated by a holder 25 and can be adjusted, with respect to its biasing effect, by means of a screw 26. The spring holder 25 has a bracket portion 27 (Fig. 1) which is firmly secured to the pawl arm 20 by means of screws 28. Consequently, the spring holder 25 forms part of the pawl arm structure and rotates together with this arm when the shaft 10 revolves.

The base plate 11 is provided with a stationary stop 29 (Figs. 1 and 3) to be engaged by the pawl edge of pawl 23. The stop 29 is spaced from the pawl edge when the above described elements are in the illustrative position of rest, and hence catches the pawl only after the shaft 10 and the pawl 20 have performed some initial motion which, however, is insufficient for establishing a contact closure between the contacts 2 and 5 of the contactor.

The above described locking unit operates as follows.

When the contact assembly of the electric contactor is moved into its contact closing position, by manual or automatic means not illustrated in the drawing and not essential with respect to the invention proper, the link 8 or other connection between the contact assembly and the transmission shaft 10 moves in the direction denoted by the arrow A1 in Fig. 1 and causes the crank 9 to revolve the shaft 10 a limited angle in the direction denoted by the arrows marked A2 in Figs. 2 and 3. This revolution is clockwise with reference to the illustration of Fig. 1. The pawl arm 20 rotates also in the clockwise direction corresponding to the direction indicated by the arrows A3 in Figs. 1 and 3. That is, as represented in both Figs. 1 and 3, the shaft end 22 of the pawl arm is moved upwardly so that the pawl 23 is lifted. When the transmission arm 12 is in the illustrated position, with the release arm 13 held against the stationary stop screw 16 by the biasing force of spring 18, it lies immediately above the end 30 of pawl 23. As a result, the upward motion of the shaft end 22 has the effect of causing a rotation of pawl 23 about its pivot as indicated by the arrow A4 in Fig. 3. This rotation moves the pawl edge clear of the stationary stop 29, the spacing between the stop and the pawl being dimensioned to permit such a release motion. Consequently, the shaft 10 with its pawl arm 20 is free to rotate and the contactor can be placed into its circuit closing position without hindrance by the pawl and stop means. In order to secure the just-mentioned releasing function of the arm 13, it is necessary that the biasing force of spring 24 be so rated that the torque thereby imposed on pawl 23 is lower than the opposing torque imposed on the pawl by the biasing spring 18 of pawl arm 20 or rather by the resultant biasing effect of this spring 18 together with all other corresponding pawl-arm

springs located in the locking units of the other contactors to be interlocked. Consequently, the adjustment of spring 24, made possible by the above-described screw 26, is not critical and involves no appreciable difficulty.

During the motion of shaft 10 and pawl arm 20 after the pawl edge has been cleared of the stop 29, the portion 30 of the pawl abuts against the spring housing 25 and is then blocked from rotating further about the shaft end 22 of arm 20. From then on, the arm 20, through the blocked pawl, entrains the release arm 13 and moves it away from the stop 16 (Fig. 1) in the clockwise direction. This causes the transmission arm 12 to move downwardly as indicated in Fig. 1 by the arrow A5.

As will be apparent from the following description of Figs. 4 and 5, the motion of the transmission arm 12 is transmitted by suitable connecting rods or the like transmission means to the corresponding transmission arm of the locking units of the other contactors. This has the effect of adjusting these other locking units so that their locking pawl is prevented from being released from the appertaining stationary stop. The effect of this adjusting operation will be understood from the following reference to the unit according to Figs. 1, 2 and 3.

Let us assume that the locking unit shown in Figs. 1, 2 and 3 has its transmission arm 12 connected with the locking unit of another contactor, and let us consider the effect of a circuit closing operation of this other contactor on the illustrated locking unit. The closure of the other contactor has the effect of moving the transmission arm 12 of the illustrated unit in the direction denoted by the arrow A5. As a result, the release arm 13 is moved clockwise away from the stop screw 16 in opposition to the biasing force of its spring 18. Referring to Fig. 3, this rotation of arm 13 has the effect of lifting it away from the portion 30 of the latching pawl 23. If now an attempt is made to close the contacts of the contactor illustrated in Fig. 2, the shaft 10 revolves through its limited initial range of angular travel but, since the release arm 13 does not retain the pawl portion 30 in its original position, no rotation of the pawl 23 about its pivot shaft 22 occurs. The pawl spring 24 remains effective in holding the pawl edge against the surface of base plate 11 so that the pawl is caught by the stop 29 and then prevents a further rotation of the pawl arm and shaft. In this manner, the closing motion of the movable contact assembly is blocked.

Locking units of the type described in the foregoing can be applied with equal facility to two, three, or more, apparatus to be interlocked. According to Fig. 4, for instance, two separate contactors B and C are each provided with a locking unit denoted as a whole by U1 and U2, respectively, both units being designed in accordance with Figs. 1, 2 and 3. Only the shaft 10, transmission arm 12 and release arm 13 of this unit are shown in Fig. 4. The illustrated elements of the locking unit U2 are denoted by C10, C11, C12 and C13, the numbers included in these reference characters having the same meaning as the corresponding reference numbers applied to the unit U1 or to the illustrations of Figs. 1, 2 and 3. A mounting bar 31 is connected between the contactors B and C and carries a transmission lever 32 which is pivoted at 33. Two linking rods 34 and 35 connect the lever 32 with the transmission arms 12 and C12, respectively. Assuming that both contactors are at first in the

circuit opening position, the closure of contactor B, as described previously, will cause the release arm 13 to move in the direction indicated by the arrow A3, this direction being identical with the one indicated by the arrow A3 in Figs. 1 and 3. The transmission arm 12, moving downwardly, causes the lever 32 to rotate counterclockwise about its pivot 33 and to lift the transmission arm C12 of locking unit U2. As a result, the release arm C13 is moved in the direction of the arrow A6 with the effect of rendering the latch pawl of unit U2 operative as described in the foregoing with reference to Figs. 1, 2 and 3. Therefore, a closure of contactor C is prevented by the latching action of its locking unit once the contactor B has been placed in circuit-closing condition. Since the operation of the two units is mutual, the contactor B is blocked from closing its contacts if the contactor C is first placed into closing condition.

Referring to Fig. 5, it will be seen that the locking means according to the invention are not limited to only two interconnected apparatus. Fig. 5 shows three contactors D, E and F, which are provided with locking units denoted as a whole by U3, U4 and U5, respectively. These units are designed in accordance with Figs. 1, 2 and 3 except that the unit U3 is constructed symmetrically with respect to that shown in Figs. 1 to 3. That is, the releasing motion of the release arm of unit U3 is opposite to that in units U4 and U5. It is not necessary for assembling groups of contactors in any desired arrangement and number and for interlocking them by means according to the invention, that two differently, i. e., symmetrically designed types of locking units be provided because, if a reversal of operating direction is required, a reversing mechanical transmission between the corresponding locking units may be used as is the case with the arrangement shown in Fig. 4. However, the interconnection between the locking units can be simplified in certain cases of application if locking units of opposite operating direction are available as in the example shown in Fig. 5.

The three locking units are represented diagrammatically by their base plate D11, E11, F11, their shaft D10, E10, F10, their transmission arm D12, E12, F12 and their release arm D13, E13, F13, respectively. The transmission arms E12 and F12 are connected by a rod 35. A similar connecting rod 37 is provided between arms F12 and D12. In the illustrated position of the transmission and release arms, all three contactors are in the opening condition. When one of them is closed, the motion of its transmission arm (for instance the motion of arm E12 in the direction of arrow A7) is transmitted to rod 36 (see arrow A8) and to the transmission arms of the two other locking units (arrows A9 and A10) thereby blocking the other contactors from being placed into closing condition.

The arrangements shown in Figs. 4 and 5 will suffice to indicate that virtually any feasible spatial arrangement and number of contactors or other apparatus to be interlocked can be applied in conjunction with locking means according to the invention.

It will be understood by those skilled in the art that the design of locking devices according to my invention can be modified in various respects, especially as regards the shape, dimension and location of the individual elements of the releasable latching devices, without departing from the objects and essential features of the in-

vention as set forth in the claims following hereinafter.

I claim as my invention:

1. An interlock mechanism for preventing actuation of apparatus when other apparatus are actuated, comprising shaft members to be connected with one of said apparatus for revolving a limited angle during actuation of said latter apparatus and blocking such actuation when prevented from revolving, an arm firmly mounted on said shaft member to revolve together therewith, a pawl movably mounted on said arm, a stationary stop disposed in the path of said pawl, said pawl being biased toward said stop for blocking the revolution of said arm and shaft member, a lever structure having a release arm and a transmission arm and being rotatable about said shaft between two positions in one of which said release arm is located so as to engage said pawl when said shaft member starts revolving thereby moving said pawl away from said stop in order to release said shaft for continued revolution, said transmission arm being designed for connection to said other apparatus in order to move said release arm out of said one position when said other apparatus is actuated.

2. Mechanical interlock means for a plurality of apparatus each having a member movable from one to another position only when none of the members of said other apparatus are moved to said other position, comprising a shaft, means on said shaft for connecting it to one of said members so as to revolve a limited angle when said member is moved between said positions, a pawl arm mounted on said shaft to be rotated when said shaft revolves, a pawl pivoted on said pawl arm for rotation about an axis substantially radial with respect to said shaft and having a pawl edge arranged so as to move substantially tangentially to said shaft while leading said axis when said shaft revolves in a given direction, a stationary stop arranged for catching said pawl upon limited initial revolution of said shaft in order to block further revolution of said shaft, a release arm rotatably mounted on said shaft and biased toward a release position close to said pawl so as to form, when in said position, an abutment engageable by said pawl during said initial revolution for clearing said pawl edge from said stop thus permitting a continued revolution of said shaft, and transmission means connected with said release arm for rotating it out of said release position in dependence upon the motion of said member of said other apparatus.

3. Mechanical interlock means for electric contactors having an opening and a closing position, comprising a shaft, means on said shaft for connecting it to one of said contactors so as to revolve a limited angle when said contactor is moved from opening to closing position, a pawl arm mounted on said shaft to be rotated when said shaft revolves, a pawl pivoted on said pawl arm for rotation about an axis substantially radial with respect to said shaft and having a pawl edge arranged so as to move substantially tangentially to said shaft while leading said axis when said latter contactor is moved to its closing position, a stationary stop arranged for catching said pawl upon limited initial revolution of said shaft in order to block further revolution of said shaft, a release arm rotatably mounted on said shaft and biased toward a release position close to said pawl so as to form, when in said position, an abutment engageable by said pawl during said initial revo-

lution for clearing said pawl edge from said stop thus permitting a continued revolution of said shaft, and transmission means connected with said release arm for rotating it out of said release position in dependence upon the movement of another of said contactors into its closing position.

4. The combination of a plurality of electric contactors with mechanical interlock means connecting said contactors for causing the closure of one to prevent the closure of others, in which said interlock means are formed by a plurality of similar locking units attached to said plurality of contactors respectively and having each a shaft revoluble a limited angle when the apertaining contactor is closed, an arm firmly mounted on said shaft, a pawl pivoted on said arm away from said shaft for pivotal pawl motion about an axis substantially radial to said shaft, a stationary stop for catching said pawl when said arm and shaft move in the closing direction of said contactor, release means movable into a release position for engaging said pawl so as to move it away from said stop in order to release said pawl for revolution of said arm and shaft, and linkage means connecting said release means with the

respective release means of said other units so as to move said first release means out of said release position in dependence upon the closure of another contactor.

5. The combination of a plurality of electric contactors with mechanical interlock means connecting said contactors for causing the closure of one to prevent the closure of others, in which said interlock means are formed by a plurality of similar locking units, each having a base structure attachable to one of said contactors respectively, a stationary stop on said structure, a member movably disposed on said structure for motion between two positions, means for connecting said member to said one contactor so as to change its position when said contactor is being closed, releasable latch means movably mounted on said member and engageable with said stop to block the closure motion of said member and contactor, and release means movably mounted on said structure for connection with the respective release means of said other locking units and disposed for engaging said latch so as to cause its release when said other contactors are open.

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