DRAWOUT MECHANISM FOR K-LINE CIRCUIT BREAKERS

INTRODUCTION

In order to make the K-Line circuit breakers mobile for operation, testing, storage, maintaining and removal from its switchboard compartment, a four position drawout unit has been made an integral part of the breaker design. Such an arrangement is shown in Fig. 1. During the moving of the circuit breaker to and from the basic four positions, interlocking provisions have been made to prevent moving of the circuit breaker when the circuit breaker mechanism is in the closed position.

The same interlocks prevent closure of the circuit breaker when positioned between the basic operation positions.

The drawout cradle is a separate unit which can readily be inserted into a switchboard compartment. This cradle is assembled in the compartment by four mounting bolts in the bottom of the unit. The rear of this cradle forms a steel isolation barrier between the circuit breaker and the bus compartment of the switchboard.

In the CONNECTED or operating position, the circuit breaker's primary and control electrical circuits are so engaged as to perform their functions of carrying load currents to provide protection for the equipment and afford switching means of that circuit.

In the TEST position, the operator is permitted to safety test and inspect the circuit breaker and its associated electrical control circuits without disturbing the primary electrical system.

In the DISCONNECTED position, the circuit breaker is completely isolated electrically and may be safely stored in this position when the primary circuit is to remain de-energized for some definite period. The withdrawal mechanism may be padlocked in this position to prevent being manipulated by unauthorized persons.

The WITHDRAWN position permits the removal of the circuit breaker from the compartment, for ease of maintenance, or parts replacement, and transferring the circuit breaker to a more essential load circuit because of more effective load dispatching.

The operator is fully protected from contact with live parts by a completely dead-front design, complemented with dependable and reliable visual indications which show when the circuit breaker is in any of the four basic positions. The position indicator can be seen on the upper left side plate of the cradle housing and a cooperating pointer on the right-front breaker frame. Provisions are also furnished to permit padlocking the breaker in the open position in any of the basic locations, and the breaker can be left in TEST or DISCONNECTED positions with doors closed for safety, or for storage, and as protection against dust or moisture. It also serves to prevent operation by unauthorized personnel. In these positions, the door may be opened for inspection without disturbing the locking provisions.

DESCRIPTION AND OPERATION

Drawout Contacts

The primary separable contacts are sturdy and self-aligning which provide positive electrical contact engagement between the circuit breaker separable contacts and the stationary separable contacts.

Silver-to-silver contacts are furnished. Positive electrical contact is made through the use of heavy compression springs bearing upon a group of individual contact fingers, thus affording multiple contact areas. Strong insulating moldings provide protection from accidental voltage failures. In the TEST, DISCONNECTED and WITHDRAWN positions of the circuit breaker, the primary contacts of the circuit breaker are safely isolated from the primary circuits of the system. The primary separable contacts are engaged only in the CONNECTED position of the circuit breaker.

The secondary contacts are compact contacts which are used to provide connection from the internal circuit breaker control circuits to the external control circuits. They can be furnished so that they are engaged only in the CONNECTED or only in the TEST position. They are disengaged in the DISCONNECTED and WITHDRAWN positions. These contacts ordinarily are continually engaged in the CONNECTED and TEST positions. The connection in the TEST position provides means whereby the circuit breaker control circuits can be electrically tested with the primary circuits isolated.

If the circuit breaker primary separable contacts separate when carrying load current, the contacts will be called upon to perform a function for which they are not designed-the interrupting of an electrical circuit. Under such conditions, the resulting arcing will badly erode the contact surfaces, and the ionized gases generally will provide a conducting path between terminals of opposite electrical polarity. Thus, serious fault currents will be permitted to flow, which could cause extensive damage to the whole switchboard. For this reason safety interlocking is furnished which will prevent changing the circuit breaker position without

DRAWOUT MECHANISM (Cont.)

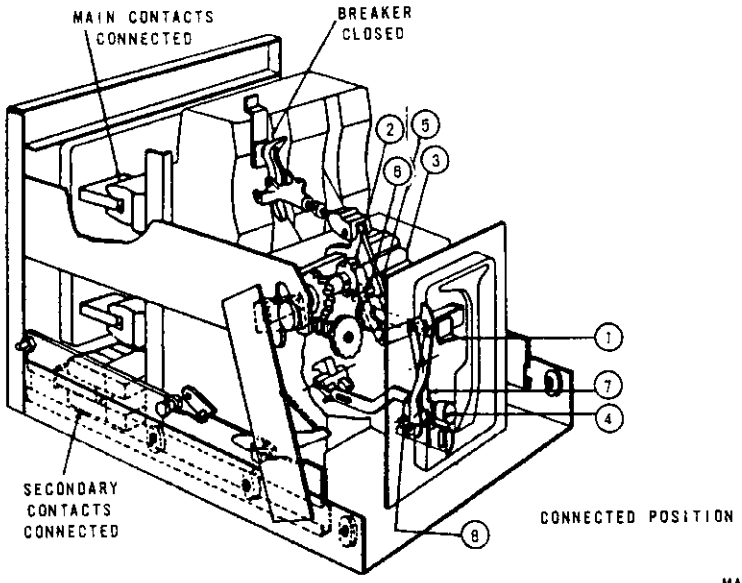

Fig. 1(a)

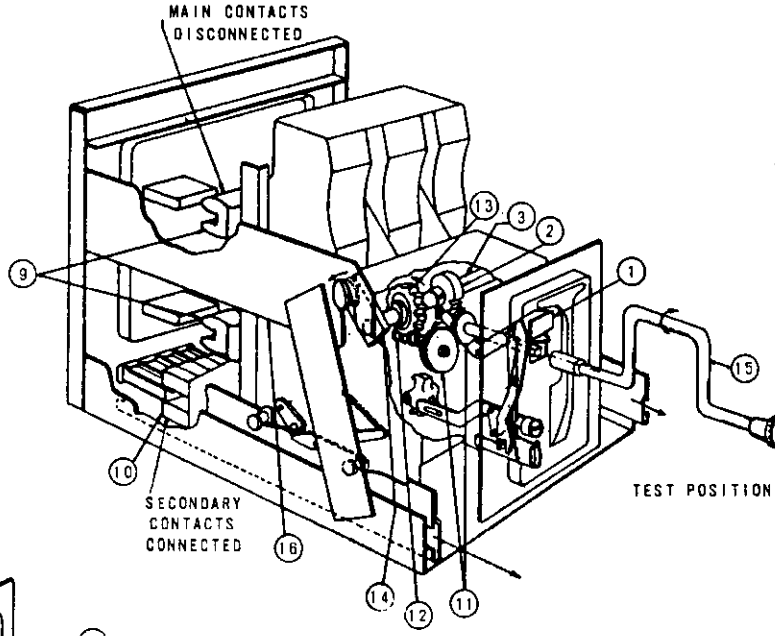

Fig. 1(b)

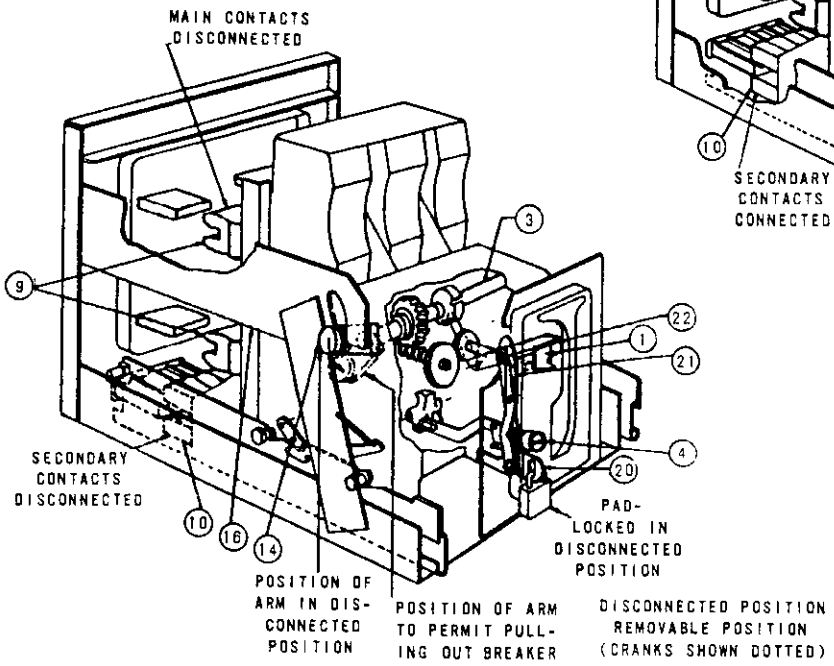

Fig. 1(c)

DRAWOUT MECHANISM (Cont.)

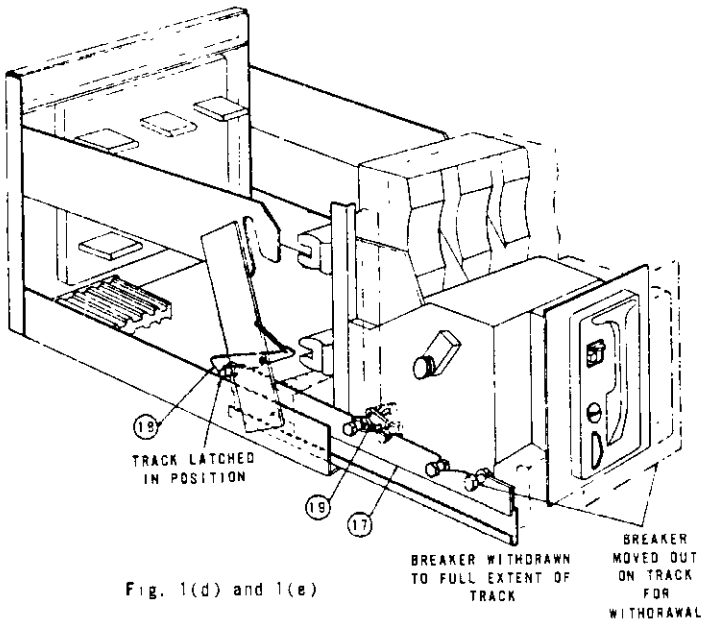

Fig. 1(d) and 1(e)

LEGEND
1. Shutter
2. Cam
3. Gear shaft
4. Trip button
5. Jack shaft
6. Pin (jack shaft)
7. Link
8. Bell crank
9. Separable contacts (main)
10. Separable contacts (secondary)
11. Gears
12. Worm drive
13. Worm wheel
14. Crank arms
15. Crank handle
16. Cradle housing bars
17. Tracks
18. Latch (track)
19. Latch (breaker)
20. Lockout plate (padlock)
21. Lever
22. Pin

first tripping open circuit breaker contacts.

The drawout mechanism on the K-3000 and K-4000 circuit breakers is similar to the K-800 to K-2000 breaker, with the following exceptions:
1. Tracks must be pulled down prior to racking
2. The mechanism has positive stops in all positions
3. Replacing the drawout shutter is a lever that is raised when the breaker is open to allow racking.

Racking Operation (Fig. 1(b))

The means of racking the breaker from one position to another is done by inserting a hand crank into an escutcheon opening and rotating this crank (15). A normally-closed shutter is interlocked to prevent movement of the circuit breaker drawout mechanism when the circuit breaker contacts are closed.

Should the operator in cranking from one position to another remove the crank when the circuit breaker is between positions, the shutter (1) will be held up by cam (2) on shaft (3). This cam is so positioned on the shaft to allow the shutter (1) to be raised and lowered only in the CONNECTED, TEST and DISCONNECTED positions of the circuit breaker. The circuit breaker cannot be closed while the shutter is raised. This provides a definite interlock which guards against the circuit breaker being closed unless properly positioned.

A ground contact maintains electrical contact from the CONNECTED to the TEST position, thus providing continued safety to the operator from contact with hazardous voltages.

It requires fourteen turns of the hand crank to reach TEST position from the CONNECTED position. Six additional turns is required to reach the DISCONNECTED position, and five more turns to the WITHDRAWN position.

Connected Position

Figure 1(a) shows the circuit breaker in the CONNECTED position. At this point, the shutter (1) can not be raised unless the circuit breaker contacts are tripped open. This is done by pushing in the trip button (4). Rotation of the jack-shaft (5) to open position of the circuit breaker contacts, moves interference pin (6) which permits raising the shutter. While the shutter is raised, the circuit breaker is held in a maintained trip-free position through link (7) and bell crank (8). This prevents the circuit breaker from being closed when the drawout mechanism is in a position for moving the circuit breaker from one position to the other.

Test Position

Rotating the drawout hand crank counter-clockwise moves the circuit breaker to TEST position Fig. 1(b). In this stage, the main separable contacts (9) are disconnected, while the secondary separable contacts (10) are still connected.

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DRAWOUT MECHANISM (Cont.)

Through a series of gears (11), worm drive (12), worm wheel (13), gear shaft (3) and crank arms (14) the rotation of the drawout crank handle is transformed into linear motion of the circuit breaker as the crank arms (14) move against the cam surfaces in the cradle housing (16). Removal of the crank in TEST position allows the shutter to drop, thereby releasing the interlock system. The circuit breaker may now be closed electrically or manually since the secondary control contacts are still connected. In this position, the various devices on the circuit breaker and their associated electrical circuits can be checked and tested without disturbing the primary electrical system.

Disconnected Position

Continued rotation of the crank from TEST position to DISCONNECTED position as shown in Figure 1(c) serves to disconnect the main contacts (9) and the secondary contacts (10) which leaves the circuit breaker electrically isolated but still retained in the cradle (16) by the arms (14) being interlocked with the cam surfaces of the cradle bars.

This position is used to provide storage of the circuit breaker when the electrical circuit which it serves is to remain de-energized.

Withdrawn Position (Figs. 1(c) and 1(d))

From the DISCONNECTED position, a continued counter-clockwise rotation of the crank will turn the shaft (3) so arms (14) are clear of cradle bars (16) and the circuit breaker and tracks (17) out to the position shown in Figure 1(d). This shows the withdrawn track latched in position against the cradle support and latch (18). The track is held in this position, while the circuit breaker is removed from the tracks.

Prior to racking the circuit breaker in, the tracks are released from these latches by press-

In the fully WITHDRAWN position, the circuit breaker may be inspected or it may readily be removed from its cradle. By lifting the retaining latches (19), the circuit breaker may be pulled forward and out of the retaining notches to the fully extended position where it may be readily removed by a simple vertical lift.

Padlocking (Fig. 1(c))

The circuit breaker may be padlocked in the CONNECTED, TEST or DISCONNECTED position by removing the crank and pushing in trip button (4) which then permits pulling out the lockout plate (20). This exposes a slot to which one to three standard padlocks may be attached to lock the circuit breaker in the tripped position, and also to lock the circuit breaker in a definite chosen position relative to the cradle. Locking between positions is prevented by lever (21) which interlocks lockout plate (20) with shutter (1) by pin (22) so that the circuit breaker can not be padlocked unless the shutter is closed.

STORED-ENERGY OPERATING MECHANISM

BASIC REQUIREMENTS OF STORED-ENERGY CLOSING MECHANISMS

1. Adequate closing power
2. High contact speed in closing
3. Trip-free operation with high speed opening
4. Ease and simplicity of operation
5. Long life and low maintenance
6. Compact size

The stored energy mechanism accepts a predetermined amount of energy from the operator and then releases this energy to close and latch the breaker contacts closed. The operator may supply the energy at any desired rate, but the energy cannot be released to close the contacts until the predetermined amount of energy has been supplied. After the required energy has been released, the operator can in no way impede the "snap-action" closing of the breaker.

The stored energy closing mechanism must perform four basic steps in its normal cycle of operation, as follows:

1. Receive and store energy supplied by the operator.
2. Release and transform this energy into a closing force on the breaker contacts.
3. Latch the breaker in a closed position.
4. Allow the breaker to trip under fault or other specified conditions.

The functions listed above are illustrated in photographs attached. These photographs present, in phantom form, the principal parts of the circuit breaker involved in the operation of the manually-operated stored energy closing mechanism. Also attached is a perspective view, Figure 1 of the manual-operated spring-close mechanism. This view is shown with the mechanism ready to be charged by the operator, preparatory to closing of the circuit breaker contacts.

Manual Stored Energy Closing Mechanism

The circuit breaker must be open and the closing handle must be in the reset position, shown in Figure 2, before breaker closing operation may be initiated. The following sequence of operations then occur within the mechanism as the operator pulls downward on the closing handle:

Figure 2 shows the breaker in the open position with the closing mechanism springs ready to be charged so as to subsequently close the circuit breaker contacts.

In Figure 3 it is shown that the operator supplies the stored closing energy by a single downward thrust of the operating handle (1). This handle acts as a lever and forces the hand closing cam (2) to rotate in a clockwise direction. This action extends the closing springs (3) downward. Continued motion of the operating handle extends the springs until sufficient energy is stored. This stored energy is ultimately used to vigorously force the breaker contacts closed. At some late part of the downward motion of the operating handle, a pin on the hand closing cam engages a camming surface of the hold-up latch (4) and rotates the latch in a counter clockwise direction. The continued extension of the closing springs have meanwhile forced the first stage closing cam (5) to tend to turn in a clockwise direction, being restrained from moving downward by the left-hand roller carrier (6) which in turn is prevented from moving by the latch surface of the hold-up latch and the positioning of the primary latch (7). When the hold-up latch continues to pivot, by the downward motion of the operating handle the roller carrier is permitted to slip by the latching surface of the hold-up latch.

Figure No. 4 shows where the exertion of pressure of the closing springs on the first stage closing cam with the release of the latch roller carrier in a counter clockwise direction being pivoted about the center roller of the roller carrier resting on the latch surface of the primary latch. The other end of the roller carrier moves upward forcing the jackshaft cam (8) to rotate in a clockwise direction very rapidly, moving the contact arm assembly (9) into closed position with regard to the stationary contact structure (10). The prop latch

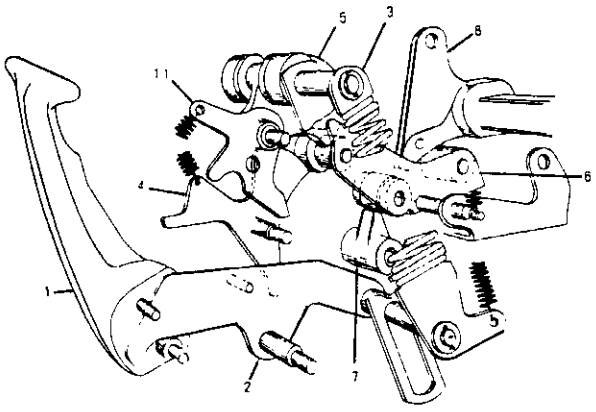

Fig. 1 - Mechanism ready to be charged by operator preparatory to closing of the circuit breaker contacts.

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STORED-ENERGY MECHANISM (Cont.)

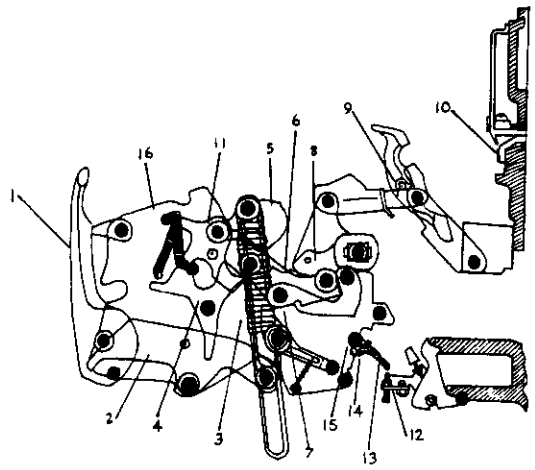

Fig. 2 - Open position.

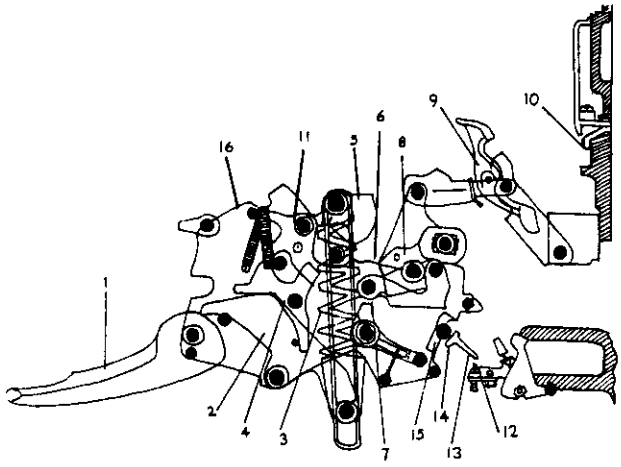

Fig. 3 - Open position with spring almost fully charged just before latch release.

(11) meanwhile has been rotated in a counter clockwise direction by the downward motion of the first stage closing cam, latching the roller carrier, which in turn holds the breaker contacts in the closed position. Figure 5 shows where the operating handle, after being released by the operator, will then return to the normal position.

Figure 6 shows the tripping of the circuit breaker by overcurrent trip devices. This automatic trip of the breaker starts action when the overcurrent armature trip screw (12) strikes the tripper (13) on tripper bar (14), rotating it. This in turn releases the latch on the latch bar assembly (15). This action, at the same time, allows the primary latch to rotate in a counter clockwise direction, releasing the support under roller carrier and allowing it to move in a downward direction being guided in the diagonal slot in the mechanism housing (16) under the influence of the opening springs of the circuit breaker. The jackshaft will then rotate in a counter clockwise direction thus opening the circuit breaker contacts. The mechanism then resets automatically to the conditions shown in Figure 2 by the action of an auxiliary spring pulling the roller carrier assembly back to supported position on primary latch.

Figure 7 shows the hand trip operation done by manual pressure applied to the hand trip button on face plate of the breaker. This moves a link that cams the latch bar assembly in a counter clockwise direction, thereby releasing the primary latch and allowing it to rotate in the same direction, unlatching the roller carrier, therefore giving same action as is accomplished in automatic tripping of the circuit breaker.

The stored energy closing mechanism thus provides a safe, positive, and economical method of attaining high speed closing with manually operated low voltage power circuit breakers.

Electrical Stored-Energy Closing Mechanism

In addition to the manually-operated spring-closed mechanism described above, there is also available a motor-operated spring-close mechanism which is operable from a remote location by means of an electrical contact.

This motor-operated spring-close mechanism is similar in principle to the manually-operated spring-close mechanism described and pictured in preceding text. It differs only in that the closing-springs are charged by means of a small, fractional horsepower electric motor. The speed of this motor is geared down to provide the proper speed most suited to operate the closing mechanism.

The springs are charged immediately upon application of the control power by the energization of the motor circuit through limit switches on the closing-spring linkage and on the circuit breaker. The closing springs are held in this charged position, by a holding latch, until released by the energization of a small electromagnetic solenoid. The release of this latch then allows the spring to exert a thrust to close the circuit breaker contacts.

Electrical circuits are furnished which allows the circuit breaker to be closed and opened from a remote location by means of a control switch.

STORED-ENERGY MECHANISM (Cont.)

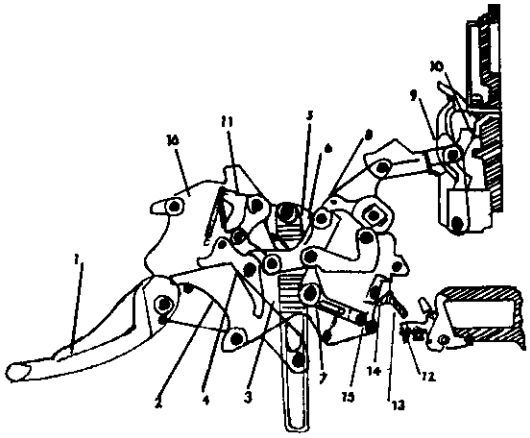

Fig. 4 - Closed position just after close of contacts.

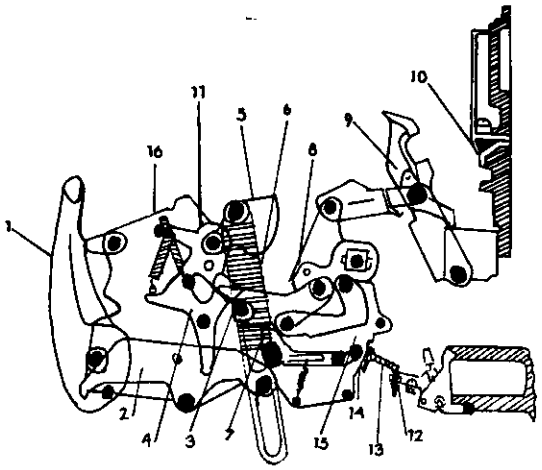

Fig. 6 - Overcurrent trip just after trip operation.

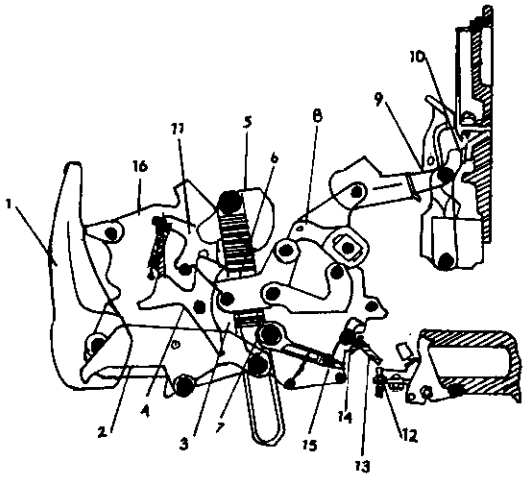

Fig. 5 - Closed position with closing spring and operating handle back to normal position.

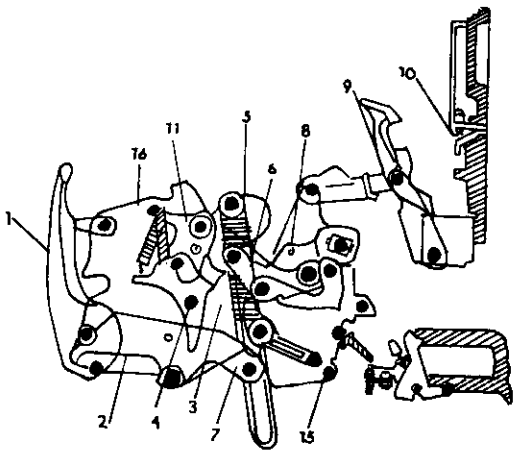

Fig. 7 - Hand trip just after trip operation.