ADMIRALTY
AIR MINISTRY

ELECTRICAL MANUAL—GENERAL
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Section 7. List of Chapters: *delete "(to be issued later)"* after the title of Chapter 3 and *write* "(A.L. 18)" in the outer margin against the deletion. *Insert* this Chapter 3 to follow Chapter 1. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

Chapter 3

CIRCUIT BREAKERS

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Introduction

1. Thermal circuit breakers are employed in electrical installations to protect the equipment from damage which might otherwise result from overloading, misuse, or other faulty conditions. Those used in aircraft are usually designed to control the operation of the equipment, combining the functions of fuse and switch in one unit.

2. Only those features and principles of operation which are common to all circuit breakers are described in this chapter. For information relating to individual types of circuit breakers reference should be made to A.P.4343B, Vol. 1, Sect. 10 and 11.

Functioning

3. The normal airborne circuit breaker consists of a switch and an automatic tripping device combined in one unit. Although the operation of the switch may be either mechanical or electrical, the general principle of the tripping device is the same for all types of breaker. Its action is dependent upon the distortion produced in a bi-metal strip by an increase in its temperature.

4. This strip, sometimes referred to as the thermal element or thermal strip, is, in its simplest form, composed of two flat strips of metal firmly secured to each other. As the two metals employed have different coefficients of expansion, the metal strip having the greater coefficient of expansion will expand the most in the event of the temperature of the thermal strip being raised; the consequent distortion of the strip is proportional to the rise of temperature.

5. The equipment protected and controlled by a thermal circuit breaker is normally connected in series with the breaker and the supply. When the switch contacts of the breaker are closed, the thermal strip carries full line current and the heating of the strip is produced by this current.

6. In the event of the current for which the circuit breaker has been set being exceeded for a pre-determined time, the thermal strip will become distorted to a degree sufficient to operate a trip lever. This lever releases the switch contacts, which are opened by a spring, thus cutting off the supply to the equipment.

7. It is possible to vary the current rating of a circuit breaker by varying the composition, thickness, or shape of the thermal strip, different ratings being obtained by using combinations of these factors.

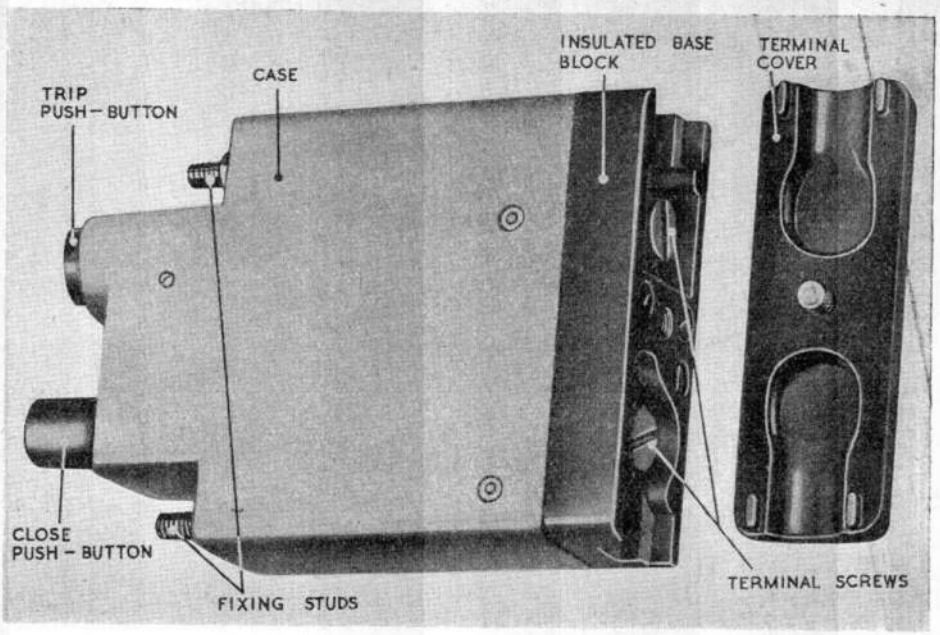

Fig. 1. Hand-operated circuit breaker

8. The rise of temperature, and consequently the amount of distortion produced, is proportional to the value of the current and the time for which it is applied. Therefore, a slightly excessive current will, over a long period, produce the same rise of temperature as a much higher current applied over a comparatively short period. Equipment which is subject to varying load currents, e.g., starter motors under cold and warm ambient conditions, can, therefore, be afforded a measure of graded protection.

9. Fuses and magnetically-operated circuit breakers are designed to function on a maximum permissible current basis, and in general, are not suitable for limiting light overloads of long duration.

Application

10. Much of the electrical equipment installed in aircraft is designed for intermittent operation over brief periods, and the current applied would cause damage if maintained for any length of time. Short-time rated operation is possible because the rise of temperature of the thermal strip lags behind the current, and some time elapses before the safe limit is exceeded. As thermal circuit breakers will only interrupt the supply when the controlled apparatus approaches a dangerous temperature, they are of special value when used with this type of equipment.

11. When tripping occurs through temporary overload, these circuit breakers can, by re-switching, be re-set almost immediately. Equipment such as turrets, undercarriages, flaps and propeller pitch control motors can, after temporary overload, be restored to use with a minimum of delay, whereas the replacement of fuses would take much longer and prove more difficult.

Airborne thermal circuit breakers

12. Typical thermal circuit breakers are illustrated in fig. 1 and 2; both have automatic tripping devices which function as described in the previous paragraphs.

13. The hand-operated model shown in fig. 1 has two push-buttons which are used for opening and closing the contacts. This particular design is only suitable for circuits of fairly low current rating, the electrically-operated breaker (*fig.* 2), being used to control installations with heavy current ratings.

14. A solenoid located in the circuit breaker housing is used to control this type of breaker. It is possible to operate the solenoid through

push-buttons, switches or other suitable control apparatus situated in a position convenient to the operator. The circuit breaker can then be installed as near as practicable to the controlled apparatus, using a minimum of heavy cable. The current flowing in the solenoid circuit will be small and only light cables need be used.

15. Although the weight of a thermal circuit breaker may be greater than the combined weight of a switch and fuse, if the weight of the associated wiring is considered, it is often possible to obtain a reduction in overall weight.

Servicing

16. Instructions for the servicing of individual units will be found in the appropriate chapter of A.P.4343B, Vol. 1, Sect. 10. In general, all terminals must be kept free from corrosion and firmly tightened down. All gap settings must be correctly maintained, and should any fault occur requiring specialized attention, a new unit should be fitted and the old one returned to a repair depot.

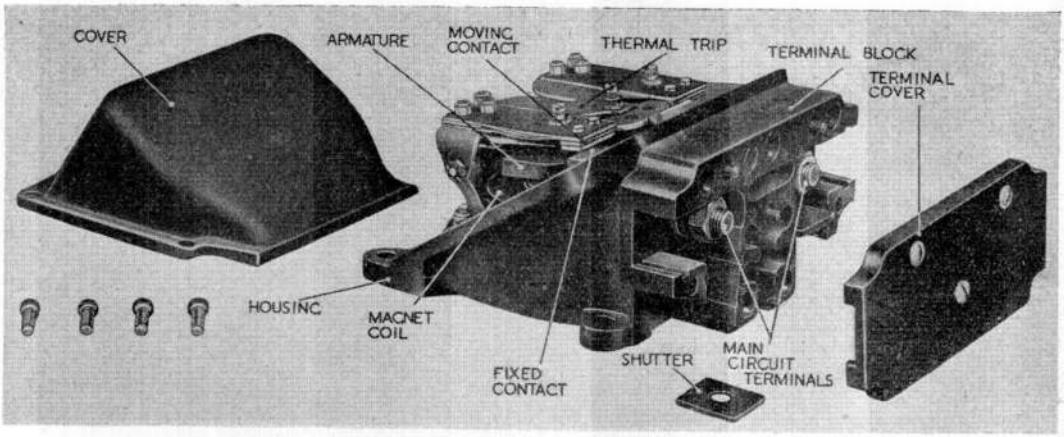

Fig. 2. Electrically-operated circuit breaker

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