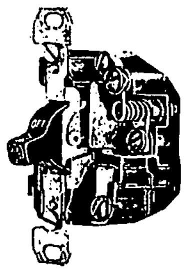
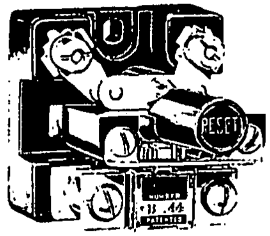
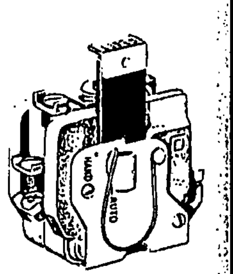
PROTECTIVE DEVICES EQUIPPED WITH THERMAL OR MAGNETIC ELEMENTS TO DETECT OVERCURRENT FLOW



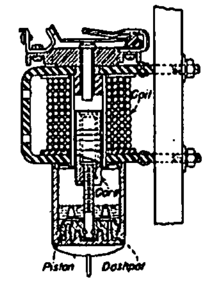
11 Switch used for starting fractional-hp motor. Thermal element is shown



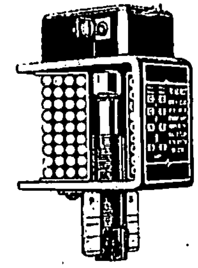
12 Relay having an alloy-pool element. Top terminals in series with line



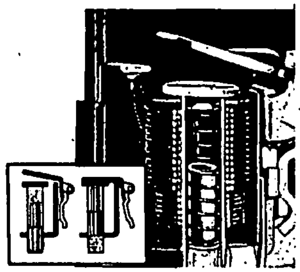
13 Relay may be adjusted to reset automatically or manually as shown



14 Magnetic overload relay with dashpot for time lag on short overloads



15 Heat to operate results from current induced in center copper tube by coil



16 Magnetic trip provided with time lag for surges. Fast trip on short circuit

that the motor is reaching a dangerous temperature.

Ambient Temperature. Most thermal devices are affected by changes in the surrounding temperature. This is illustrated in Fig. 9. It is thus good practice to have both motor and protective device subjected to the same ambient temperature. Where this is not practicable, the variation in surrounding temperature should be taken into consideration in selecting the proper thermal relay.

To illustrate, if the motor is outdoors and the thermal relay inside, both will generally be at the same temperature in warm weather. In winter, the relay will be subjected to a higher temperature than the motor. This is not serious since we will obtain adequate motor protection, even though we do limit the motor output. If the motor is located at a point where the ambient temperature is higher than that surrounding the protective thermal relay, it will be necessary to select a heater coil with lower rating to get adequate protection.

A thermal device is available to compensate for variations in the ambient temperature about the relay. When conditions are such that the relay ambient temperature changes, a compensating element built into this type of relay recalibrates the tripping mechanism. As a result, the thermal element is not affected by local temperature conditions, but trips only on motor current.

Maintenance. Thermal relays ordinarily require little maintenance other than occasional inspection. Relay terminal connections should be checked for tightness since any heat generated at these points will affect the relay's normal operation. One of the most frequent causes of false tripping or failure to trip on overload is poor selection of the thermal heater or coil. Manufacturer's recommendations should be followed in selecting thermal relays.

The tripping point of an overload protective device may be checked by passing a low-voltage current through it. For thermal relays used for motor protection, the point of tripping may be checked without removing the relay from its normal mounting. Through the use of a step-down transformer, in which the secondary voltage is but a few volts, high current can be obtained to check thermal relays. When so used, the secondary of the test transformer is connected directly to the thermal device; the value of current may be varied by selecting the proper taps on the secondary of the transformer. A clamp-on ammeter simplifies current measurement. A comparison should be made between the tripping characteristic curve supplied with the relay and the result obtained through this test.

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Magnetic Devices. The earliest overload device, other than the fuse was the simple magnetic relay. It consists of a wire coil connected in series with the circuit being protected. A metal plunger located within the coil is mechanically connected to some type of circuit interrupter. When a predetermined value of current flows through the coil, the resulting magnetic action raises the plunger, which in turn opens the circuit.

This relay will operate instantaneously when its calibrated value of current passes through the coil. It is thus not suited for motor protection for two reasons: (1) If the relay is calibrated to operate at a point slightly above the normal full-load rating of the connected motor, the relay will trip under the current surge on starting. (2) If the relay is calibrated to carry the heavy starting current it will not offer overload protection to the motor once it is running.

Time delay was originally introduced in this typo relay by the addition of leather bellows and a calibrated air valve. On overload the plunger acted to force trapped air within the leather bellows out through the calibrated air valve. The length of time delay is controlled by adjustment of the valve opening. The leather bellows introduced a maintenance problem in that it is necessary to keep the bellows soft with oil. If allowed to dry out they will crack.

Time delay is also introduced by the addition of a dashpot as shown in Fig. 14. The attachment prevents the relay from operating on harmless surges and short-time overloads. When overload current flows, the plunger is pulled upward by magnetic action. Time delay is introduced by regulating the size of opening through which the dashpot oil must pass. In addition, the viscosity of the oil used will affect the period of time lag. A variation in the dashpot arrangement is shown in Fig. 16.

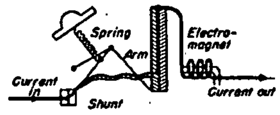
Thermo-Magnetic Devices. The circuit breaker shown in Fig. 19 combines the magnetic and thermal principles, giving accurate inverse-time overload protection. As in the curve of Fig. 20, the resulting graph is a combination of both thermal and magnetic characteristic curves. Magnetic action protects the connected motor on starting and quickly disconnects it on large load peaks. Continuous overload or a series of load peaks, which would in effect add up to a dangerous overload on the motor, are controlled by the thermal element.

Circuit breakers, which use a magnetic element to detect the flow of false current, shown in Fig. 16, operate instantaneously on short circuits, and provide time delay for short period overloads. Owing to the absence of any heating process, there is little heat loss within the relay. This is an important consideration where circuit breakers have to be grouped together. Relays of this type are not affected by changes in ambient temperature.

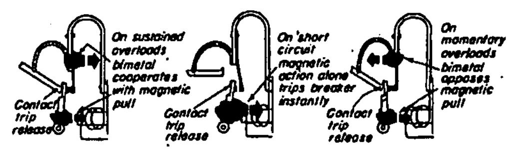
Both thermal and magnetic devices are usually rated at 125% of full-load current rating of the connected motor. For an alternating-current squirrel-cage motor, this point would correspond to the maximum allowable temperature that would be produced in the motor.

For direct-current motors the maximum safe commutating ability, in addition to winding temperature, must be considered in determining the maximum current.

COMBINED THERMAL MAGNETIC

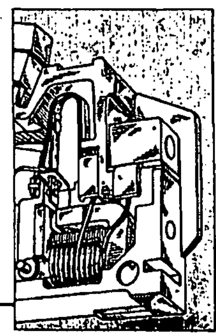


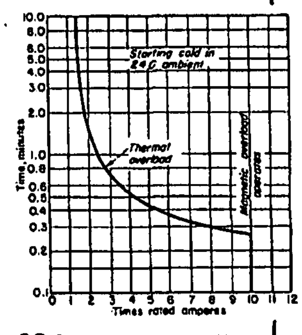
17 Combining features of both elements. Thermal operates on overloads while magnetic trip handles short-circuit faults



18 Retarding action of bimetallic, which operates against pull of magnetic element, prevents breaker from operating on momentary surges

19 Both elements are contained in the circuit breaker shown below





20 Tripping characteristics of both devices combined in above curve