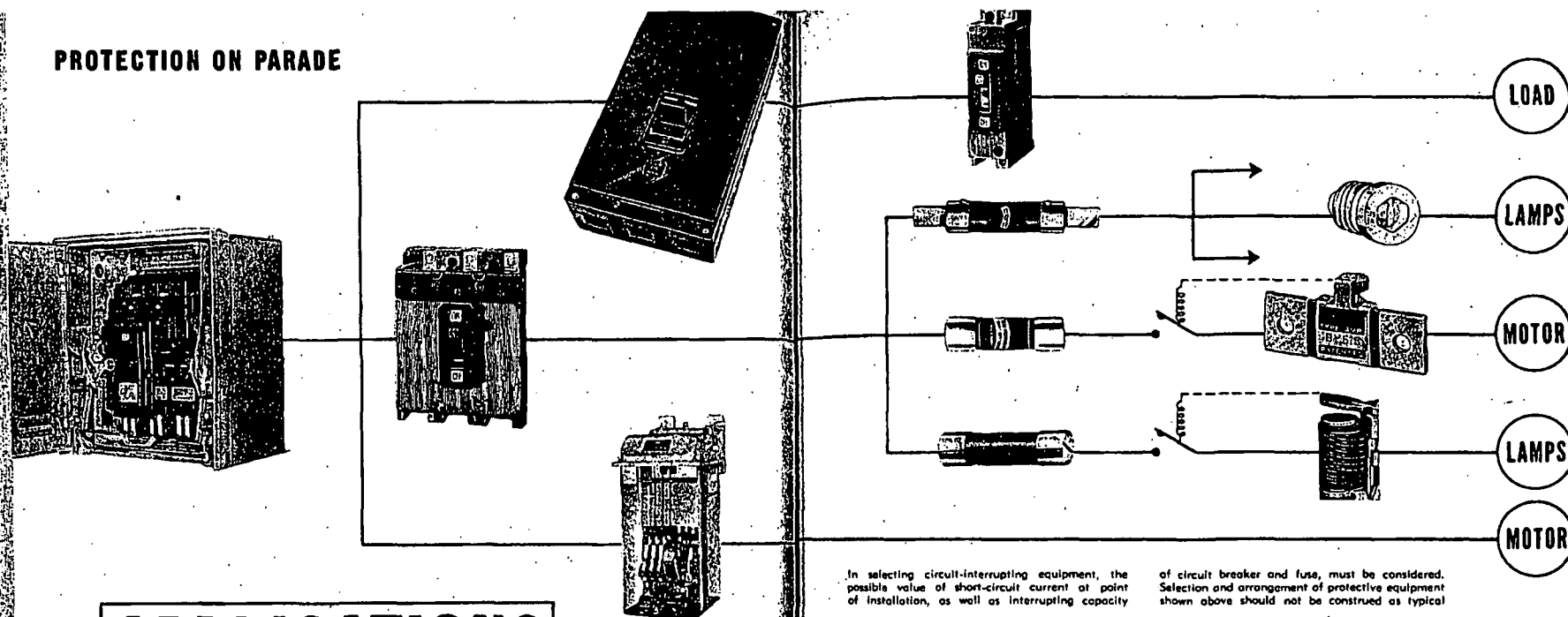


PROTECTION ON PARADE



APPLICATIONS

All electrical circuits use over-current protective devices to guard against short circuit and overload. Strictly speaking, they do not protect against short circuit since some damage has been done at the trouble point by the time the fuse or circuit breaker opens. In applying protective devices in electrical circuits, the aim is to localize the fault quickly, and hence confine or reduce any possible damage.

When selecting a device for short-circuit protection, the unit best suited is the one that opens the circuit quickest. The ordinary non-renewable fuse and the simple magnetic device will act fastest on the flow of short-circuit current. The thermal element on the other hand has an inherent time-lag which makes it suitable for overload but not short-circuit. Circuit breakers equipped with both thermal and magnetic trips offer suitable protection against both conditions.

Motor Protection. The simple thermal overload relay used in a motor starter does not as a rule provide short-circuit protection. A fuse or circuit breaker should be installed ahead of the starter to operate on short circuit. For one alternating-current motor the inrush or transient current is in the neighborhood of 140 to 180% of the locked-rotor current. Locked-rotor current is that value which would flow were the full voltage applied while the rotor was held in a standstill position.

The locked rotor current of alternating-current motors is frequently about 750% of the full-load current. Hence, select a breaker that has an instantaneous tripping point of 140 to 180% of the locked rotor current. Generally speaking, for normal-torque motors the instantaneous tripping point of the breaker under consideration should be 12 to 14 times the full-load current rating. The National Elec-

trical Code states that circuit breakers used for motor protection must have a continuous current rating of not less than 115% of the full-load rating of the motor.

In selecting a circuit breaker to protect a feeder circuit supplying several motors, the instantaneous trip point of the breaker should be eight to nine times the aggregate of the full-load current of the motors; this is a generally accepted rule when full-load current of all motors on this circuit is greater than 100 amp. Where the full-load current is between 100 and 600 amp, the tripping point of the breaker should be six to seven times the full-load value.

The starting current of direct-current motors is generally less than that of alternating-current motors. It is recommended that instantaneous tripping point of circuit breaker, which is to supply short-circuit protection, be set to seven times the full-load cur-

In selecting circuit-interrupting equipment, the possible value of short-circuit current at point of installation, as well as interrupting capacity

of circuit breaker and fuse, must be considered. Selection and arrangement of protective equipment shown above should not be construed as typical

of one motor, or the sum of the full-load current for several motors. Where there are several motors on one feeder, it is assumed they will not all be started at the same time.

Circuit Breakers. An air circuit breaker must have an interrupting rating equal to or greater than the maximum short-circuit current that may flow at that point in the circuit where the breaker is to be installed. For example, when a single circuit breaker is placed between the power source and the load, its interrupting rating must be equal to or greater than the average total calculated current at one-half cycle from the time short circuit was applied.

This is the conventional application, and is the rule when a single circuit breaker is placed between the power source and the load.

Cascading. Consider a distribution system consisting of a main circuit breaker A feeding a bus to

which is connected four feeder breakers B, each of which in turn feeds several subfeeder breakers C. If the tripping points of these circuit breakers are properly coordinated, breakers B and C may be applied beyond their interrupting ratings. Such a sequence of properly coordinated breakers is known as a cascade. Proceeding from the source toward the load, breakers in cascade have a progressively lower standard interrupting rating. The central idea in cascading is to have breaker A set to trip at 80% of the maximum interrupting rating of B. Circuit breaker B in turn should trip at 80% of the maximum interrupting rating of C. All breakers so arranged will trip instantaneously at their set value of current.

The conventional application of circuit breakers is recommended in all cases, but may not be economically justifiable on all installations. Where all breakers are lo-

cated in the same switchgear assembly, cascading is often used.

Selective Operation. Air circuit breakers are available with delayed overcurrent trips designed so the breaker may be used in a completely selective distribution system. The term, selective operation, means that a fault at a remote point in the system will not shut down the whole distribution system, by tripping the main supply breaker. Instead, only the breaker nearest the fault opens; consequently the disturbance is limited to the smallest possible portion of the system. Selective operation is obtained by an accurate tripping device, which introduces time delay into the tripping time of the breaker. Referring to Fig. 1, the tripping time of the main supply breaker is greater than that of the bus tie breaker, which in turn exceeds that of the feeder breaker.

For example, let us assume a fault current of 20,000 amp flowed