SIEMENS

Current-Limiting Fuses

Type FM

2.4 and 4.8 Kv for Motor Starting Application

Supersedes issue dated July, 78

DESCRIPTION

The Type FM fuse (Fig. 1) is a totally-enclosed current-limiting fuse, designed for motor-starting applications. It is available in basic voltage ranges of 2.4 and 4.8 kv with current interrupting ratings of 80,000 amperes rms asymmetrical.

The Type FM fuse consists of silver elements surrounded by inorganic sand, all enclosed in a strong polyester base insulating tube. Circuit connection is made by silver-plated copper ferrules on each end of the tube. The silver elements are internally connected to the ferrules. When the fuse is mounted, low resistance is maintained in its supports by the completely silver-plated ferrules.

A mechanical-type indicator projects from the lower end of the fuse when the fuse elements melt. The indicator is operated by a mechanism (separate from the fusible elements) that releases the indicator only after the fuse elements have melted.

Current designations 2R through 36R (Table I) are used to distinguish one size of fuse from another in the same voltage rating. Ampere ratings are not associated with the fuses, since fuse selection is determined by application requirements. These requirements involve both motor-starting current and time-current characteristics of the thermal overload relay.

FUSE APPLICATION

For short-circuit protection, high voltage motor starters generally employ either fuses or circuit breakers. The standard fuses that are presently available can be classified as current limiting or non-current limiting.

On short circuit, current-limiting fuses reduce the current before the first current peak (Fig. 2) and open the circuit within the first first cycle. The fuse elements melt before the peak value of available short-circuit current is reached. Non-current limiting fuses open the circuit at least one or two cycles after the inception of the short circuit, allowing the peak current to pass.

Practically all fuses will melt in considerably less than one-half cycle on a 60-cycle basis when subjected to high values of fault current. Because the arc is the conductor, the current will reach its maximum crest value unless some provision is made to reduce the magnitude of the arc current. When such provision is made, the fuses are classified as current limiting.

For the sake of standardization, all fuse interrupting ratings are on the basis of maximum rms current that will flow in the first cycle after the short circuit occurs (refer to Table I). These are the currents that would flow if the fuse did not limit the current.

All types of fuses operate rapidly at, or near, their interrupting ratings. Because of their fast operating time, fuses are generally employed as the last circuit protective device in each voltage level of a primary power system. Typical applications are in motor starters (Figs. 3 and 4).

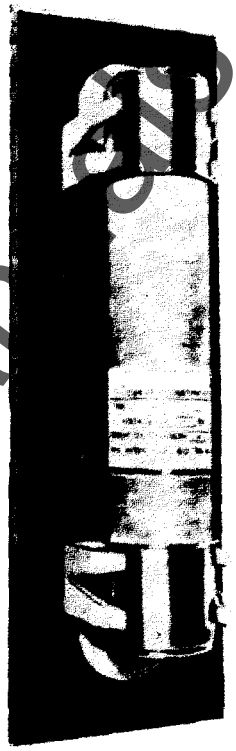

Fig. 1 — Siemens-Allis Type FM fuse and fuse clips.

Current-limiting fuses are preferred for motor-starting circuits because of their fast operating time and current-limiting ability. In cases where co-ordination is not required, non-current limiting fuses which have longer time delays may be used. However, in getting this longer time delay, prevention of damage to the circuit when short-circuit passes is sacrificed. Refer to Fig. 8 for the current-limiting ability of the Type FM fuse.

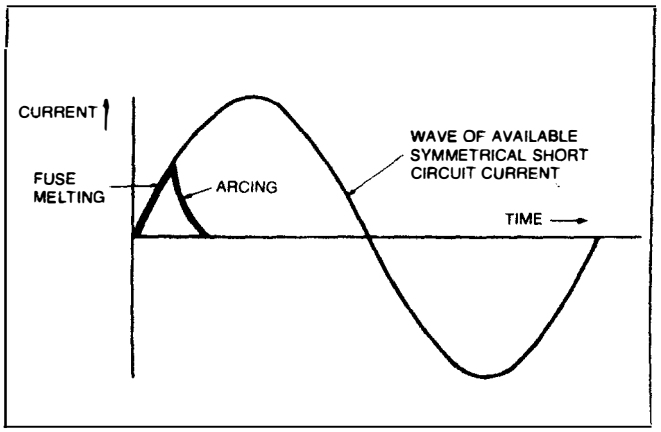

Fig. 2 — Operating characteristics of current-limiting fuse.

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EXPLANATION OF TYPE DESIGNATIONS

Current Designation:

Example: **4R**

Number of elememts — **Cross sectional area**

Fuse Type:

48-FM4R-4

Fuse tube size
Current designation
Nominal voltage kv
Fuse, Motor starting

Size 4 are single barrel fuses.
Size 5 are double barrel fuses.
Size 6 are triple barrel fuses.

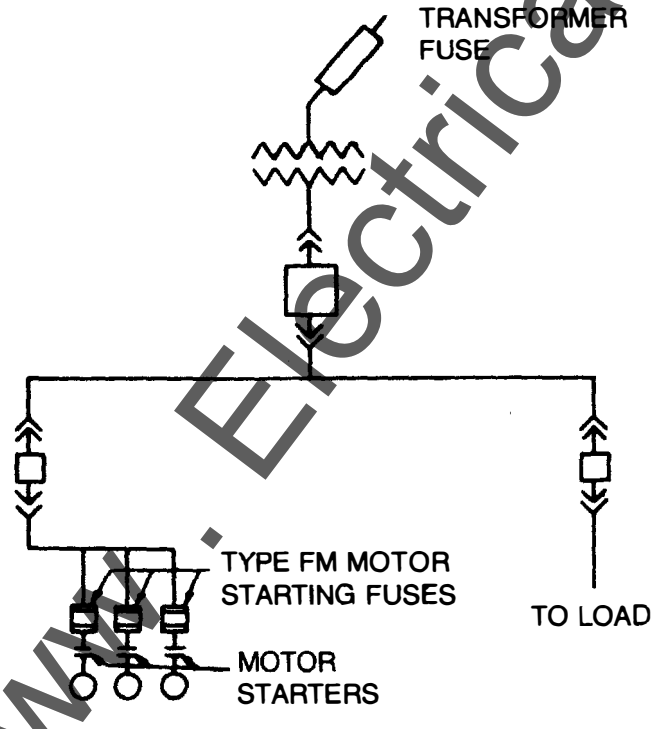

Fig. 3 — Typical motor-starting fuse application.

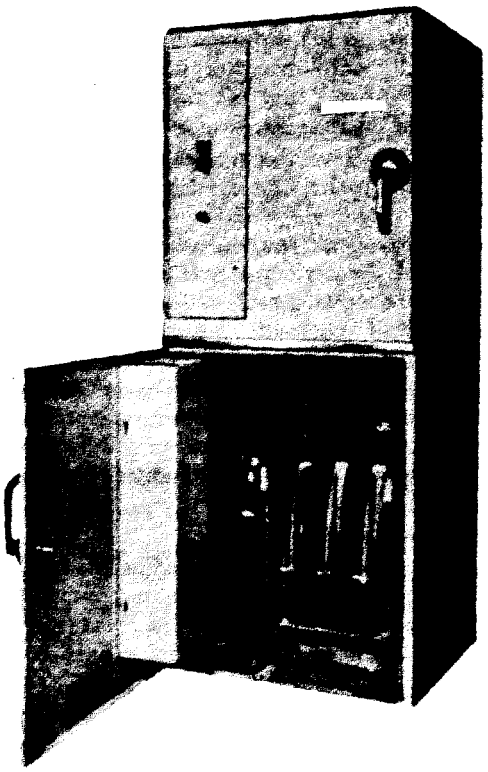

Fig. 4 — SpaceMaker II motor controller with Size 5 double barrel Type FM fuses.

Current-limiting fuses have two important advantages over the non-current limiting type: (1) Because of fast operation, they limit the extreme dynamic and electrical stresses associated with the flow of short-circuit current. (2) They limit the short-circuit current magnitude to far less than the available short-circuit current.

In selecting fuses, all factors affecting a particular application will be considered. It will be necessary to know the motor full-load current, the motor rotor current and the overload relay characteristics to assure a properly coordinated installation.

Other important factors are as follows:

Voltage rating	Coordination
Current rating	Location
Frequency rating	Mounting
Interruption rating	Motor data

FUSE CHARACTERISTICS

Most fuses are self-protecting. This means that they are capable of extinguishing the arc for any value of current within their interrupting capacity rating current limit. Current-limiting fuses for motor-starting service are designed to carry low overload currents for long time periods to permit repetitive motor starting or jogging. This type of fuse must be used in conjunction with a control contactor, or similar device, which will interrupt currents that would require over 100 seconds to melt the fuse. If this is not done, the entire fuse unit could become so overheated that it could not interrupt the current when the fuse finally melted. See Table I for minimum interrupting ratings of Type FM fuses.

Figure 5 is an osciliogram showing the let-through current, melting and clearing times for a typical interruption. The interrupting ability of FM fuses has been tested in accordance with AIEE and NEMA standards. The tests range from currents near the minimum flowing current to available currents up to 80,000 rms amperes, all with maximum design voltage. If the fuse had not been in the circuit to interrupt the fault, the current would have reached 80 ka rms (and approximately 100-ka crest value) in the first loop of current.

Fuse time-current operating characteristics are given in terms of the melting time for a given value of current. Unfortunately, this method has not been universally accepted. Standards do not specify whether they should be plotted on the basis of short-time, minimum melting, maximum melting, or total clearing time. On the other hand, time-current characteristics of the Type FM fuses can be derived from given characteristics by adding or subtracting allowances to curves shown in Figs. 6 and 7. Figure 6 shows total clearing time curves and Fig. 7 shows mimimum melting curves.

The current-limiting characteristics of the Type FM fuse is shown in Fig. 8. This curve shows the maximum instantaneous current peaks permitted by each fuse current designation for various available currents.

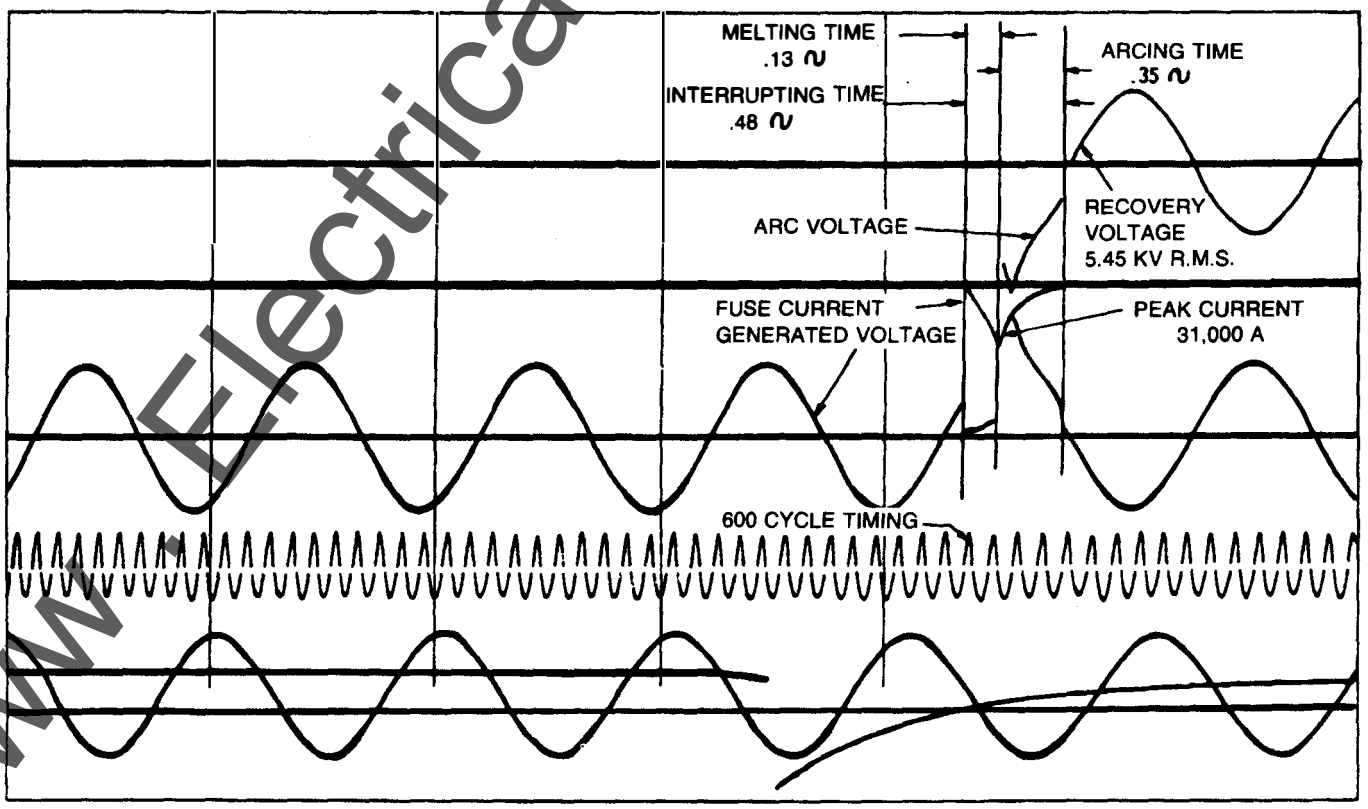

Fig. 5—Let-through current, melting and clearing times for typical interruption.

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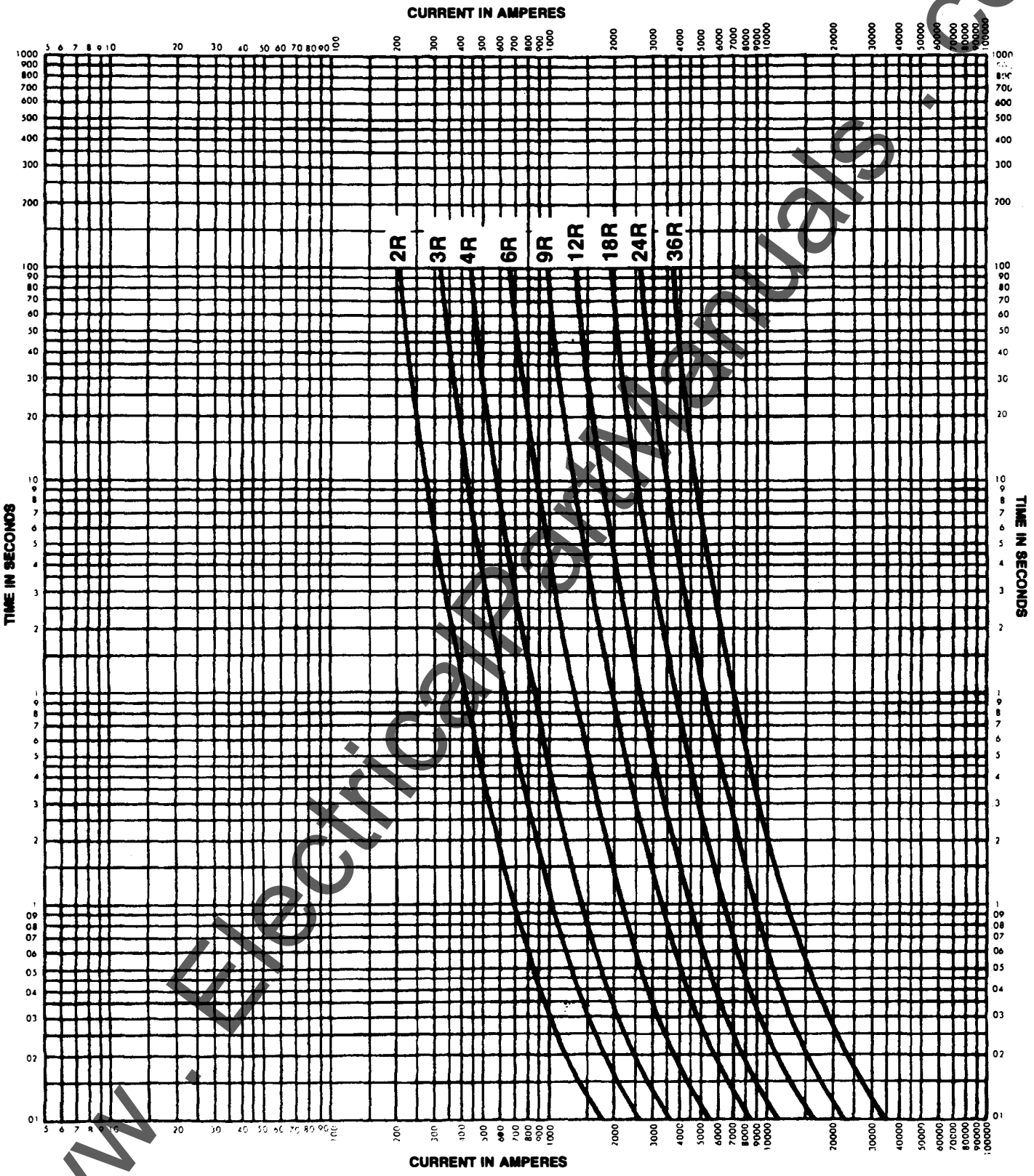


Fig. 6 — Clearing Time.

Basis for data:

1. Tests are made at 5500 volts ac at low pf, starting at 25C with no initial load.
2. Curves are plotted to minimum test points.

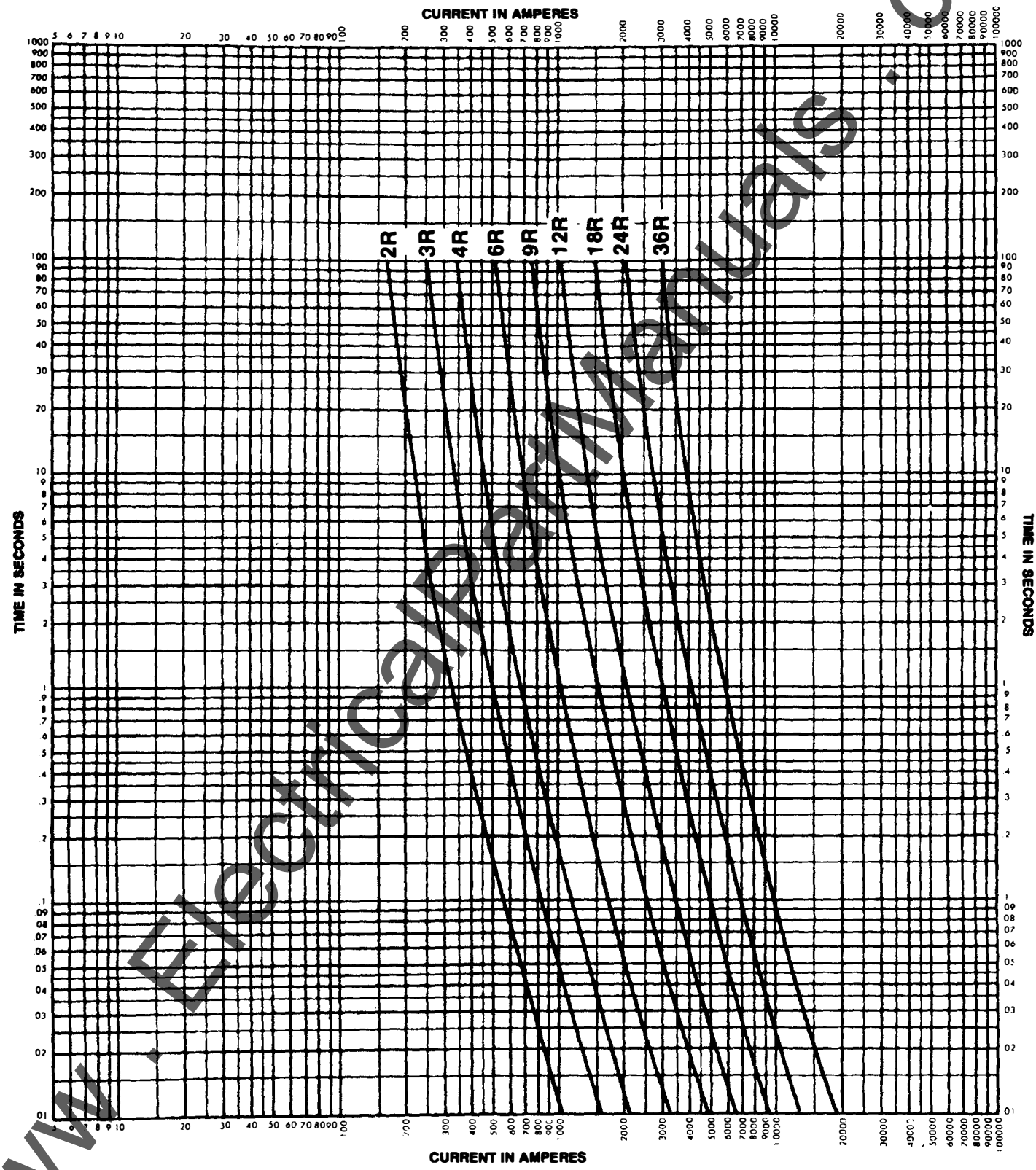
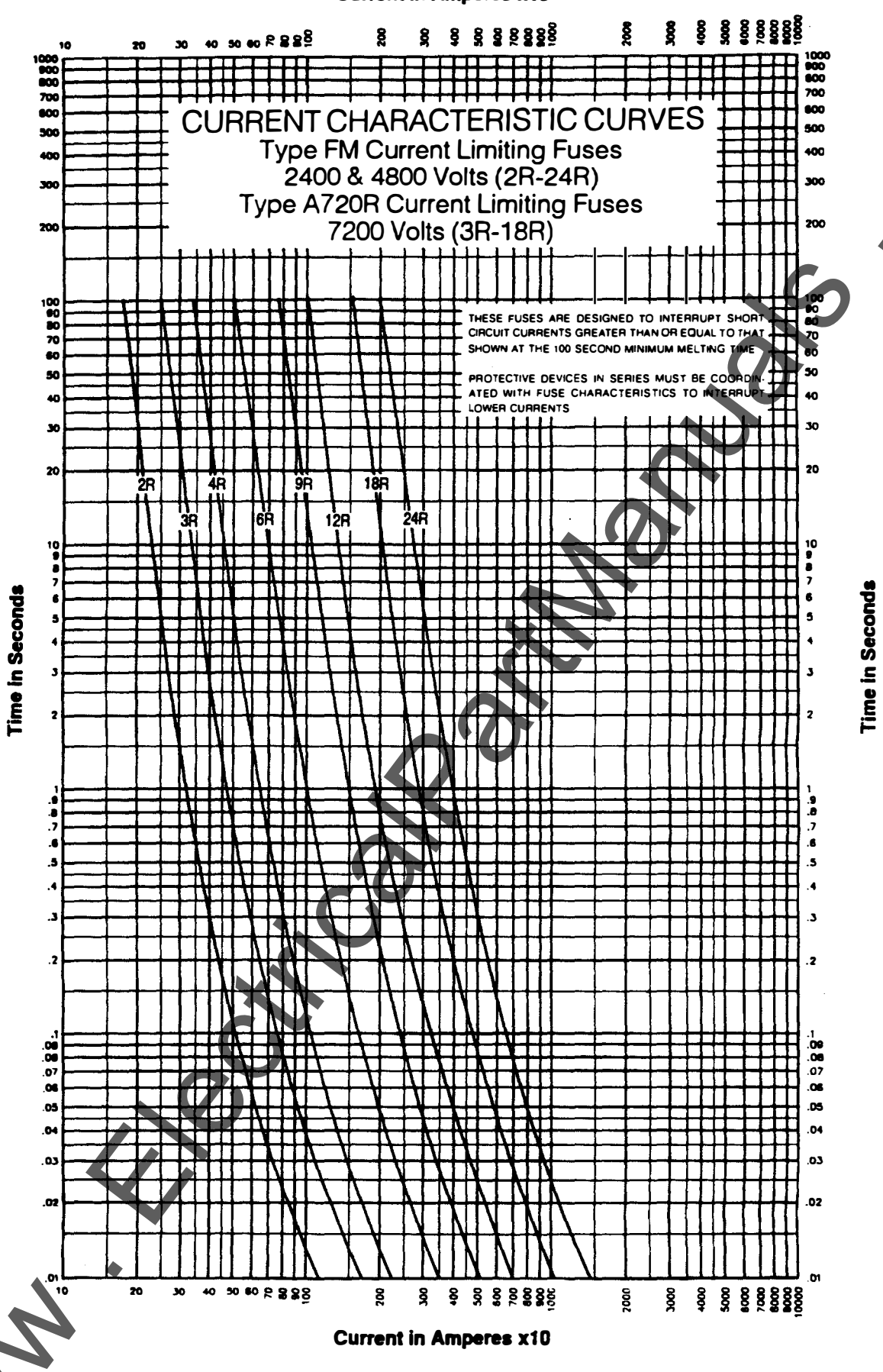


Fig. 7 — Minimum melting.

Basis for data:

1. Tests are made at 5500 volts ac at low pf, starting at 25C with no initial load.
2. Curves are plotted to minimum test points.



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Current Characteristic Curves—Minimum Melting