

UL-LISTED SRC SERIES AC MAGNETIC MOTOR STARTERS

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I. INTRODUCTION

The export of machine tools to the United States is increasing year by year and this has meant that electrical equipment for machine tools must conform to various American standards. The most common standards which must be met are those of the Underwriters' Laboratories. These standards will be considered in this article. Fuji Electric applied to the UL for tests and listing of its SRC series magnetic motor starters—main components of electrical equipment for machine tools.

The severe UL tests were fulfilled and an official File No. was allotted. This paper will be a good opportunity to introduce details concerning Fuji's UL-listed motor starters. We hope this paper will be a direct aid to engineers wishing to use our starters.

II. OUTLINE OF UL

UL is the abbreviation of Underwriters' Laboratories, Inc. It was established as a non profit organization in 1894 under the sponsorship of the American Insurance Association. The UL is engaged in testing for public safety, and maintains and operates laboratories for the examination and testing of devices, systems, and materials concerning their relation to life, fire and casualty hazards, and crime prevention. Thus, UL standards have been recognized widely in the United States as "standards for safety".

1. Makeup of UL Listings ^{(1) (2) (3)}

Every piece of equipment is classified in one of the following categories: Electrical Construction Materials, Electrical Appliance and Utilization Equipment, Hazardous Location Equipment, Fire Protection Equipment and so on. In addition, products which are incomplete in construction features or are restricted in performance capabilities so as not to warrant their acceptability as field-installed components are classified as "Recognized Components".

For instance, magnetic motor starters, knife switches, molded case branch circuit breakers, snap switches, etc. belong to "Electrical Construction Materials",

and air-conditioning equipment, washing machines, radios, television sets, record players, etc. to "Electrical Appliance and Utilization Equipment".

Another point which characterizes the UL-listing is the Follow-Up program. The Follow-Up program is designed as a formal check on the supervision which the manufacturer exercises in determining compliance of the product with the applicable requirements of UL. The Follow-Up service is briefly described below.

Reexamination Service: This service involves visits to the factory, one or more times yearly, by a member of the Laboratories' staff, for the selection, examination, and testing of representative samples of the most recent output of the listed product, together with the listing of such products in the published records of UL. Symbols called "Reexamination Service Markers" (Fig. 1) do not necessarily appear on all devices which are listed under the Reexamination Service. The use of the specified markings for reexamined products is the manufacturer's assertion that they are listed.

Label Service: Under Label Service the manufacturer attaches labels (Fig. 2) to such products as are found, by the specified examinations and tests conducted by him, to be in compliance with the applicable requirements. The UL representatives conduct frequent examinations at the factory in which the products are manufactured. In many cases, examinations and tests are conducted at UL on samples of labeled products purchased on the open market and serve as a counter-check on factory examinations. Products listed under the Label Service bear the Underwriters' Laboratories label incorporating the



Fig. 1 Reexamination marker



Fig. 2 Label service symbols

Label Service Symbol, together with the classification of the products involved, and each label bears a serial or issue number.

Special Services: UL will undertake the development of an appropriate follow-up program for a new class of product found acceptable for listing whenever one of the established forms of follow-up is not suitable.

For example, Fuji Electric motor starters belong to "Electrical Construction Materials" and are listed under the Reexamination Service. Molded case branch circuit breakers are to be listed under the Label Service.

2. Requirements for the Use of UL-Listed Products

It is reported that many states and cities in the United States request machine tool manufacturers to use UL-listed products on their machine tools which are exported into the United States. Although the actual number of such states and cities is comparatively small, it is important to note that they are located mainly on both the east and west coasts where there is the greatest concentration of industry.

III. UL STANDARDS FOR MAGNETIC MOTOR STARTERS⁽⁴⁾⁽⁵⁾

The applicable standards of the Underwriters' Laboratories are Industrial Control Equipment (UL508) and Wire Connectors and Soldering Lugs (UL486). Requirements specified under the above-mentioned standards are explained briefly below.

1. Industrial Control Equipment: UL508

(1) Enclosures

The enclosure of magnetic motor starters is specified with respect to panel thickness, overlap, flat surface surrounding a knockout, corrosion protection and so forth.

(2) Overload relays

Overload relays have to be calibrated in respect to tripping current. They also have to be calibrated so that, when tested at an ambient temperature of 40°C (20°C, 40°C and 50°C in case of ambient-compensated relays), they operate ultimately on 100 percent of the current element rating, in not more than eight minutes on 200 percent of the element rating, and in not more than thirty seconds on 600 percent of the element rating. Co-ordination between the overload relay and its series fuses is specified under the requirements for the short-circuit test.

(3) Terminals

Soldering lugs or solderless (pressure) wire connectors must be used as terminal parts for field-wiring connections.

However, for a No. 8 Awg or smaller wire, the parts may consist of clamps or binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position.

A wire binding screw for field-wiring connection must not be smaller than No. 8. However, a No. 6 screw may be used for a terminal to which No. 14 Awg wire would normally be connected.

Minimum thickness of terminal plate and minimum number of full threads in the plate and extruded tapped hole respectively are also specified.

(4) Spacings

Spacings for motor starters are specified as shown in *Table 1*.

The minimum thickness of an insulating barrier or liner which separates uninsulated live parts and grounded dead metal parts or uninsulated live parts of opposite polarity, and minimum thickness of the barrier or liner which is used in addition to an air space are also specified.

Table 1 Minimum Spacings

		51~ 150 v	151~ 300 v	301~ 600 v
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part	Through air	1/8	1/4	3/8
	Over surface	1/4	3/8	1/2
Between any uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable	Shortest distance	1/2	1/2	1/2

(Dimensions in inches)

(5) Temperature

Maximum temperature rises at specific points are specified as described below:

Field-wiring terminals: 50°C

Contacts: 65°C

Class A insulation: 85°C

(Resistance method)

(6) Operation

An ac electromagnet has to be capable of withstanding 110 percent of its rated voltage continuously without apparent injury and has to operate at 85 percent of its rated voltage. *Table 2* holds for devices having voltage ratings within one of the following voltage ranges: 110 to 120 v, 220 to 240 v, 440 to 480 v and 550 to 600 v.

(7) Overload

An ac starter has to perform acceptably when subjected to overload test consisting of making and breaking, for 50 cycles of operation, six times full-load motor current at power factors of 0.4 to 0.5 and at test voltages of 120, 240, 480 and 600 v, respectively.

Auxiliary contacts controlling contactor-operating-coils and magnetically-operated devices have to be capable of making and breaking acceptably

Table 2 Voltages for Operation Test

Test	Voltage Rating of Device and Corresponding Operating Test Potential in Volts			
	110~120	220~240	440~480	550~600
Overvoltage	132	264	528	660
Undervoltage	102	204	408	510

loads such as those given in *Table 3*.

The overload test of an overload relay is to be conducted on the control-circuit contacts of the relay using the largest contactor electromagnet with which the overload relay is intended to be used, or the manufacturer's assigned rating, whichever is greater.

The test cycle is to be one second ON and nine seconds OFF.

(8) Endurance

An ac starter has to perform acceptably when subjected to an endurance test consisting of making and breaking two times the full-load motor current for 6000 cycles of operation at power factors of 0.4 to 0.5 and at test potentials of 120, 240, 480 and 600 v, respectively. The test cycle is to be 1/2 second ON and 1/2 second OFF.

The number of test cycles for auxiliary contacts is 6000 cycles of operation, and the load is to be as described in *Table 3*.

Table 3 Standard Electromagnet Load for Push-Button Stations and Other Contactor-Operating Devices

Normal Potential in Volts	Standard Duty		Heavy Duty	
	Normal current	Current inrush	Normal current	Current inrush
110~120 ac	3.0	30	6.0	60
220~240 ac	1.5	15	3.0	30
440~480 ac	0.75	7.5	1.5	15
550~600 ac	0.6	6	1.2	12
115~125 dc	1.1	—	2.2	—
230~250 dc	0.55	—	1.1	—
550~600 dc	0.2	—	0.4	—

(9) Dielectric strength

An industrial control device has to withstand for one minute without breakdown the application of a potential of 1000 volts plus twice the maximum rated voltage:

- (a) Between uninsulated live metal parts and the enclosure with the contacts open and closed,
- (b) Between terminals of opposite polarity with the contact closed and
- (c) Between uninsulated live metal parts of different circuits.

(10) Short-circuit

Overload relay current elements connected in series with fuses are to be subjected to short-

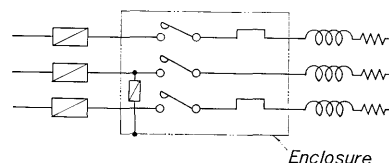


Fig. 3 Schema for short-circuit test

circuit tests at a short circuit current of 5000 amp (for starters rated at not more than 50 hp) or 10,000 amp (for starters rated at more than 50 hp). The fuse rating is to be four times the maximum motor current, and not less than 15 amperes. A relay may be tested with a fuse less than four times but not less than three times (15 amp minimum) the motor-nameplate current rating if the device is plainly marked to indicate this maximum limit of fuse protection. As shown in *Fig. 3*, the series fuses are to be connected to the pole judged most likely to strike to ground and a 30 amp fuse is to be connected between the enclosure and the live pole judged least likely to strike to ground.

2. Wire Connectors and Soldering Lugs: UL486

All of the field-wiring connectors have to be tested acceptably in accordance with these requirements, which are very severe tests for the connectors.

(1) Secureness test

As shown in *Fig. 4*, a connector is to be fastened to a length of wire, not less than three inches longer than the height distance given in *Table 4*, and secured rigidly. The free end of the wire is to be passed through a bushing of the size specified in *Table 4*. The bushing is to be driven at a rate of approximately 9 rpm and in such a manner that the center of the bushing is made to describe a circle having a diameter of three inches. A weight given in *Table 4* is to be suspended from the free end of the wire. The test is to be conducted for a period of one hour if the wire is a No. 18 or No. 16 Awg conductor

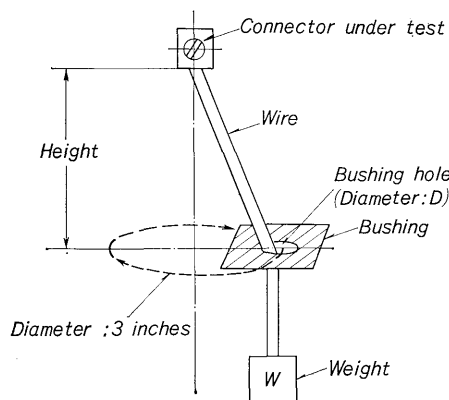


Fig. 4 Illustration for secureness test

Table 4 Secureness Test Specifications

Awg of Wire	Tightening* Torque (Pound-Inches)		Diameter of Bushing Hole (Inches)	Height (Inches)	Weight (Connector for Copper Wire) (Pounds)
	A	B			
18	20	50	1/4	10 1/4	2
16	20	50	1/4	10 1/4	2
14	20	75	3/8	11	3
12	20	75	3/8	11	5
10	20	75	3/8	11	5
8	20	75	3/8	11	8
6	35	100	1/2	11 3/4	18
4	35	100	1/2	11 3/4	30
2	50	125	9/16	12 1/2	30
0	50	150	5/8	13 1/2	50
000	—	200	3/4	14 1/2	60

* Column A : Screw-driver-tightening torques

Column B : Wrench-tightening torques for connectors other than split-bolt types

Table 5 Heating Test and Pull-Out Test Specifications

Awg of Wire	Current (Amp)	Maximum Temperature Rise (Degrees C)	Pull-Out Force (Connector for Copper Wire) (Pounds)
18	7	20	35
16	10	20	45
14	15	20	60
12	20	20	70
10	25	20	80
8	35	20	90
6	50	20	100
4	70	20	140
2	90	20	180
0	125	20	250
000	175	20	350

and for a period of two hours if the conductor is of larger size.

(2) Heating test

After the secureness test, the connector is to be subjected to the heating test described in Table 5.

(3) Pull-out test

After the heating test, the connector must not be separated from the wire when subjected for one minute to a direct pull of a value given in Table. 5.

IV. TECHNICAL SPECIFICATIONS OF UL-LISTED SRC SERIES AC MAGNETIC MOTOR STARTERS

1. Types

(1) Types of starters and contactors are as given in Table. 6.

(2) Types of accessories are as given in Table 7.

Table 6 Types of Starters and Contactors

Starter	Starter (w/o Enclosure)	Contactor	Overload Relay
SRC 3931-5-1UL	SRC 3931-5-1ULH	SRC 3631-5-1UL	RCa 3737-1UL
SRC 3931-2UL	SRC 3931-2ULH	SRC 3631-2UL	RC 3737-4UL
SRC 3931-4UL	SRC 3931-4ULH	SRC 3631-4UL	
SRC 3931-6UL	SRC 3931-6ULH	SRC 3631-6UL	RC 3737-10UL
SRC 3931-8UL	SRC 3931-8ULH	SRC 3631-8UL	

Table 7 Types of Accessories

Starter or Contactor *1)	Extra Auxiliary Interlock *2)	Push Button *3)	Selector Switch *3)	Lamp *4)
-5-1UL		RC 472-E	RC 472-P	RC 902
-2UL	RC491-2			
-4UL	RC491-4			
-6UL				
-8UL				

* 1) Basic types of starters and contactors with which the accessories are intended to be used.

* 2) Can be installed on the side of contactor.

* 3) Can be mounted on the front of enclosure cover.

* 4) Not UL-listed, but available.

Table 8 Starter Ratings

Starter Type	3-Phase Motor HP				Amps Open/Encl.	NEMA Size
	110 v	220 v	440 v	550 v		
SRC 3931-5-1UL	2	5	10	5	20/18	0
SRC 3931-2UL	3	10	20	10	30/27	1
SRC 3931-4UL	10	20	40	50	60/54	2
SRC 3931-6UL	15	30	60	75	100/90	3
SRC 3931-8UL	25	50	100	125	150/135	4

Table 9 Auxiliary Contact Ratings * (Standard Duty)

Volts	Amps	Making (amp)	Breaking (amp)
110~120 ac	10	30	3
220~240 ac	10	15	1.5
440~480 ac	10	7.5	0.75
550~600 ac	10	6	0.6

* At same polarity

2. Ratings and Specifications

- (1) Ratings of ac magnetic motor starters are as given in *Table 8*.
- (2) Ratings of auxiliary contacts are as given in *Table 9*.

Starters of size 1 and larger are constructed so that one or two extra auxiliary interlock units can be installed easily. Each unit is provided with 1NO or 1NC or, 1NO and 1NC contacts, the ratings of which are the same as those given in *Table 9*.

- (3) Contact ratings of push-button and selector switches

Since all of the relevant tests were conducted with respect to the SRC series starters with which these switches are intended to be used, the push-button and selector switch are for use only with the SRC series starters.

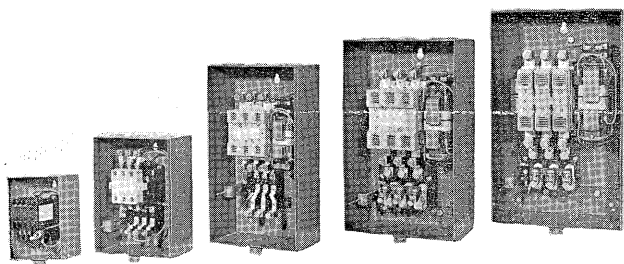


Fig. 5 UL-listed SRC series ac motor starters
(with cover removed)

- (4) Heater element ratings of overload relays
Overload relays are tripping-current-adjusted.

Table 10 Heater Ratings and Protection Fuse Ratings

Type of Overload Relay	Protection Fuse (amp)	Heater Rating (amp)	Type of Overload Relay	Protection Fuse (amp)	Heater Rating (amp)
RCa 3737-1UL	15	0.6~1.3	RC 3737-4UL	80	20~30
	15	1.2~2.5		100	30~40
	15	2.5~5		125	40~50
	25	5~10		150	50~60
RC 3737-4UL	50	10~20	RC 3737-10UL	175	60~70
	15	0.6~1.3		100	20~40
	15	1.2~2.5		150	40~60
	15	2.5~5		250	60~100
	25	5~10		350	100~140
	50	10~20		400	140~160

Table 11 Standard Coil Ratings

Types		Coil Rating
Starter	Contact	
SRC 3931-5-1UL, -5-1 ULH	SRC 3631-5-1UL	110, 220, 440, 550v, 60 Hz
SRC 3931-2UL -2ULH	SRC 3631-2UL	
SRC 3931-4UL, -4ULH	SRC 3631-4UL	
SRC 3931-6UL, -6ULH	SRC 3631-6UL	110/220, 220/440, 550v, 60 Hz
SRC 3931-8UL, -8ULH	SRC 3631-8UL	

Current rating ranges and protection fuse ratings are as given in *Table 10*.

- (5) Coil ratings

Standard operating-coil ratings are as given in *Table 11*.

- (6) Connector specifications

Copper wire sizes which can be accepted by the connectors used on these starters are as given in *Table 12*.

Table 12 Connector Specifications

Type		Awg (Copper Wire)
Starter	Contact	
SRC 3931-5-1UL, -5-1ULH	SRC 3631-5-1UL	No. 18—10
SRC 3931-2UL, -2ULH	SRC 3631-2UL	No. 14—8
SRC 3931-4UL, -4ULH	SRC 3631-4UL	No. 14—4
SRC 3931-6UL, -6ULH	SRC 3631-6UL	No. 12—0
SRC 3931-8UL, -8ULH	SRC 3631-8UL	No. 12—3/0

V. FACTORY TEST DATA

All tests performed at the factory prior to the tests at the Underwriters' Laboratories are introduced below :

1. Construction

Contactors, overload relays, enclosures and all other parts of these starters comply with every requirement regarding materials, through-air spacing, over-surface spacing and so on.

2. Temperature Test

The temperature test was performed with the main circuit subjected to the specified current and with the operating-coil circuit subjected to the specified voltage. An example of the test data is given in *Table 13*.

Table 13 Temperature Tests (with enclosure)

Type	Main Circuit Current (amp)	Operating Circuit		Temperature Rise (Degrees C)					
				Coil		Contact		Terminal	
		(v)	(Hz)	Thermo-couple method	Resistance method	Movable	Stationary	Line side	Load side
SRC 3931-5-1UL	18	240	60	55	57	49	45	40	43
SRC 3931-2UL	27	240	60	60	70	47	43	40	37
SRC 3931-4UL	54	240	60	40	51	33	31	27	28
SRC 3931-6UL	90	240	60	41	52	48	44	38	25
SRC 3931-8UL	135	240	60	53	65	53	47	41	40

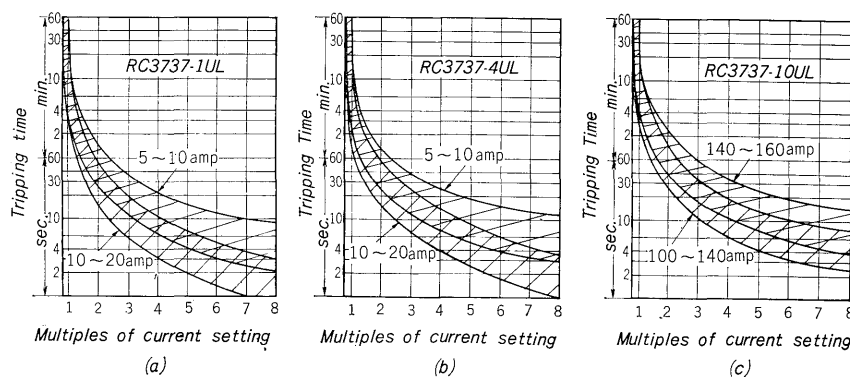


Fig. 6 Operating characteristics of overload relay

Table 14 Operation Test

Type	Cold		Hot	
	Pick-up voltage (v)	Drop-out voltage (v)	Pick-up voltage (v)	Drop-out voltage (v)
SRC 3931-5-1UL	176	127	185	135
SRC 3931-2UL	162	130	180	145
SRC 3931-4UL	166	125	170	128
SRC 3931-6UL	175	135	180	139
SRC 3931-8UL	156	129	160	132

Coil rating of tested sample is 220 v, 60 Hz

3 Operation Test

The operation test consisting of undervoltage and overvoltage operation was performed satisfactorily. The former was done immediately after a constant temperature had been reached in the coil and the later was carried out by applying the specified overvoltage to the coil, which withstood constant application of the voltage without burning-out. Pick-up and drop-out voltages before and after the temperature test are given in Table 14.

4. Calibration Test

Tripping characteristics of the overload relay are shown in Fig. 6.

5. Overload Test

These starters performed satisfactorily when subjected to an overload test consisting of making and breaking for 50 cycles of operation at six times the full load motor current. In addition, these starters were shown to be able to withstand making and breaking ten times the full load motor current as specified in NEMA and JIS.

6. Endurance Test

These starters were capable of making and breaking satisfactorily two times the full load motor current for more than 6000 cycles of operation. The UL-listed starters are based upon Fuji Electric S-series motor starters which have been well-received and

have captured more than 50% of the market in Japan. Therefore, they have a normal electrical life of more than two million (at 220 v ac) and a normal mechanical life of more than ten million operation cycles.

7. Dielectric Strength Test

These UL-listed starters withstood the application of a 60-cycle sinusoidal potential of 2200 v (=2E+1000) for one minute without any breakdown.

8. Short-Circuit Test

The short-circuit test is to check whether or not fuses, contactors and overload relays are properly co-ordinated. These starters were tested with non-renewable cartridge fuses as indicated in Table 15. Almost all of the contactor contacts and overload relay elements showed no change, and performed acceptably after the test; however, some of the contacts were fused and elements of 2.5 amp and less burned out. Since, according to UL508, fusing of contacts is not considered to be a failure and an overload relay current element for use with a motor rated at less than 3.75 amp may burn out, these starters actually showed excellent results. An oscillogram of a short-circuit test conducted on one of these starters is shown in Fig. 7.

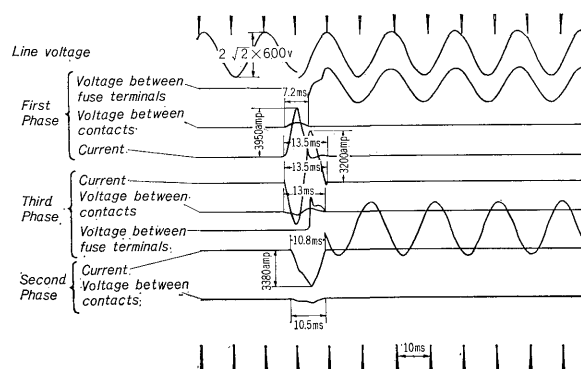


Fig. 7 An example of short-circuit test on SRC3931-4UL with 50 amp-series-fuse and overload relay with current element of 10~20 amp

Table 15 Short Circuit Test

Type	Heater Rating (amp)	Fuse Rating (amp)	Voltage (v)	Test Current (amp)	Type	Heater Rating (amp)	Fuse Rating (amp)	Voltage (v)	Test Current (amp)
SRC 3931-5-1UL	0.6~1.3	15	600	5000	SRC 3931-4UL	60~70	175	600	5000
	1.2~2.5	15	600	5000	SRC 3931-6UL	20~40	100	600	5000
	2.5~5	15	600	5000		20~40	100	600	10000
	5~10	25	600	5000		40~60	150	600	5000
	10~20	50	600	5000		40~60	150	600	10000
SRC 3931-2UL	0.6~1.3	15	600	5000		60~100	250	600	5000
	1.2~2.5	15	600	5000		60~100	250	600	10000
	2.5~5	15	600	5000	SRC 3931-8UL	20~40	100	600	5000
	5~10	25	600	5000		20~40	100	600	10000
	10~20	50	600	5000		40~60	150	600	5000
	20~30	80	600	5000		40~60	150	600	10000
	30~40	100	600	5000		60~100	250	600	5000
	10~20	50	600	5000		60~100	250	600	10000
	20~30	80	600	5000		100~140	350	600	5000
SRC 3931-4UL	30~40	100	600	5000		100~140	350	600	10000
	40~50	125	600	5000		140~160	400	600	5000
	50~60	150	600	5000		140~160	400	600	10000

9. Connectors

All connectors employed on these starters performed well, without any trouble, when subjected to the secureness, heating and pull-out tests specified in UL486.

VI. FEATURES

Many modifications have been employed in the standard models so as to meet UL requirements and also to insure marketability in the United States. Therefore, these UL-listed starters have many features which are considered to be of great advantage for electrically-equipped machine tools exported to the United States, even though they lack some of the interchangeability of the standard models. The modifications which give these features and also make the starters different from the standard products are briefly described below:

1. Terminal Parts

All connectors are constructed so that they comply with all requirements specified in UL486. Clamp-type connectors are provided for size 0 and auxiliary contact terminals on all sizes. The clamp terminal has a pair of small ribs which insure good connections. Though the aforementioned tests are to be carried out using solid wires of No. 14 to No. 8 Awg and stranded wires of No. 6 Awg and larger, tests were also conducted using stranded wires of

No. 14 to No. 8 Awg. It was found that the connectors insure extremely good connections even under rigorous conditions. Since almost all users in Japan prefer stranded wires to solid ones, the clamp type connectors provided on these starters are also useful for the home market. The connector was found to be able to be used with a crimp-on type wire connector, which is widely employed in Japan. Pressure type wire connectors are employed for starters of sizes 1, 2, 3 and 4. This insures good connections for wires of larger sizes.

2. Dual Voltage Molded Coil

Dual voltage (i.e. 110/220 v, 220/440 v) molded coils are provided on starters of sizes 2, 3 and 4.

3. Easy Installation of Push-Button and Selector Switches

The starter enclosure is constructed so that a push-button or a selector switch can be installed. The push-button consists of a START-STOP button unit and a switch element. The selector switch consists of an operator which works as a 2-position (ON-OFF) or 3-position (MAN-OFF-AUTO) operator, and the same switch element.

4. External Reset Mechanism

The starter is provided with an external reset mechanism for the overload relay. Simply pressing the RESET button on the enclosure cover resets the overload relay.

5. Extra Auxiliary Interlocks

Two kinds of extra auxiliary interlock units, each of which carries 1NO or 1NC or 1NO and 1NC contacts, are available. One is for the size 1 starter and another for starters of sizes 2 to 4. One or two extra auxiliary interlock units can be mounted on the side of the contactor, providing extra 1NO or 1NC to 2NO and 2NC contacts. Since the starter is provided originally with 2NO and 2NC contacts, the starter must have 4NO and 4NC contacts.

6. Terminal Marks

All terminal numbers and codes are marked in accordance with NEMA.

7. Unified Screw

All loose screws are of unified coarse types as specified in ASA standards. This greatly facilitates screw replacements in the United States.

8. Lead Holes

Double knockouts as specified in NEMA are provided in the starter enclosure.

9. Correspondence with NEMA Sizes

Corresponding NEMA sizes are given in *Table 16*. These starters have larger horsepower ratings than

Table 16 Correspondence with NEMA Sizes

Size	HP	110 v	220 v	440 v	550 v
SIZE 0	NEMA	2	3	5	5
	-5-1UL	2	5	10	5
SIZE 1	NEMA	3	7.5	10	10
	-2UL	3	10	20	10
SIZE 2	NEMA	—	15	25	25
	-4UL	10	20	40	50
SIZE 3	NEMA	—	30	50	50
	-6UL	15	30	60	75
SIZE 4	NEMA	—	50	100	100
	-8UL	25	50	100	125

specified by NEMA at certain voltages. Naturally, these starters save mounting space and can control motors in excess of requirements.

References

Underwriters' Laboratories, Inc.:

- (1) Elec. Construction Materials List—1968
- (2) Elec. Appliance and Utilization Equipment—1968
- (3) Recognized Component Index—1968
- (4) Industrial Control Equipment UL508, Tenth Edition, 1966
- (5) Wire Connectors and Soldering Lugs UL486, Third Edition, 1965

MAIN PRODUCTS OF FUJI ELECTRIC

HEAVY ELECTRICAL MACHINERY DIVISION

- a) Power Station Equipment
Water, Pump, Steam, Gas Turbines and Ac/Dc Generators.
- b) Transmission and Distribution Equipment
Transformers, Rotary Condensers, Static Condensers, Circuit Breakers, Switchboards, Disconnecting Switches. Voltage Regulators, Lightning Arresters.
- c) Rectifiers
Mercury-arc, Selenium and Silicon Rectifiers, Rotary Converters.
- d) Machinery
Diesel Engines & Generators, Winders, Cargo Winches, Fuji-Voith Schneider Propellers, Torque Converters. Electrical Equipment for Rolling Stock. Precipitators, Luft Filters, Induction Melting Furnaces, Deck Auxiliary Machines for Marine Use.
- e) Motors and Motor Applications
Synchronous Motors, Induction Motors, Commutator Motors, Generator Motors, Ac/Dc Motors.

STANDARD ELECTRICAL EQUIPMENT DIVISION

- a) Miniature & Medium Type Induction Motors
Standard Single- or Three-phase Induction Motors, Special Motors of All Types.
- b) High-Voltage Controls
High-Voltage Magnetic Contactors & Magnetic Switch Boxes, Oil Circuit Breakers.
- c) Low-Voltage Controls
Magnetic Motor Starters, Magnetic Contactors, Auxiliary Relays, Thermal Overload Relays, Push Buttons, Manual Starter Switches, Pole Change Switches, Limit Switches, Microswitches (snap action switches), Magnetic Switches, Motor Timers, SCR Timers, Low-voltage Fuses, Auto Breakers.
- d) Watt-hour Meters of All Types
- e) Relays
Protective Relays for Overcurrent, Undercurrent, Overvoltage, Undervoltage, Grounding and Counter Phase.
- f) Semiconductor Elements
Selenium Rectifier Elements, Silicon Rectifier Elements, Thyristor Elements.

MEASURING INSTRUMENTS DIVISION

- a) Automatic Controls
(TELEPERM-TELEPNEU System)
Transmitters (pressure, flow, level, temperature transmitters), Receivers (indicators, recorders, integrators), Controllers (setters, selectors), Automatic Combustion Controls, Others (transducers amplifiers, limiters, extractors, compensators).
- b) Industrial Measuring Instruments
Thermometers, Gas Analyzers, Flow Meters, Transmitters, Indicators, Miniature Recorders, KERS (multipurpose recorder), Temperature Controllers & Other Controllers, Motor Valves, Damper Drivers & Control Valves for Final Control.
- c) Electrical Measuring Instruments
Taut-Strip Suspension Type Portable Dc & Ac Ammeters, Voltmeters & Wattmeters, Galvanometers, Transistorized Automatic Insulation Testers, Switchboard Instruments, Remote Measuring & Remote Monitoring Instruments.
- d) Equipment
Data Processing System, Scanning Monitors, Digital Telemeters, Panels, Boiler ACC Instruments.

ATOMIC ENERGY DIVISION

Nuclear Reactors and Radiation Equipment

ELECTRIC HOUSEHOLD APPLIANCES DIVISION

Electric Washing Machines, Spin Dryers, Fans, Ventilators, Juice Extractors, Refrigerators, Air Conditioners, Air Purifiers, Vacuum Cleaners, Pumps for Home or Farm Use, Shavers, Blade Sharpeners, TV Sets, Transistor Radios, Tape Recorders, Stereo Equipment, Flashlights, Dry Cell Batteries, Irons, Hot Plates, Toasters, Heating Equipment, Illuminating Devices, Electric Ranges, etc.