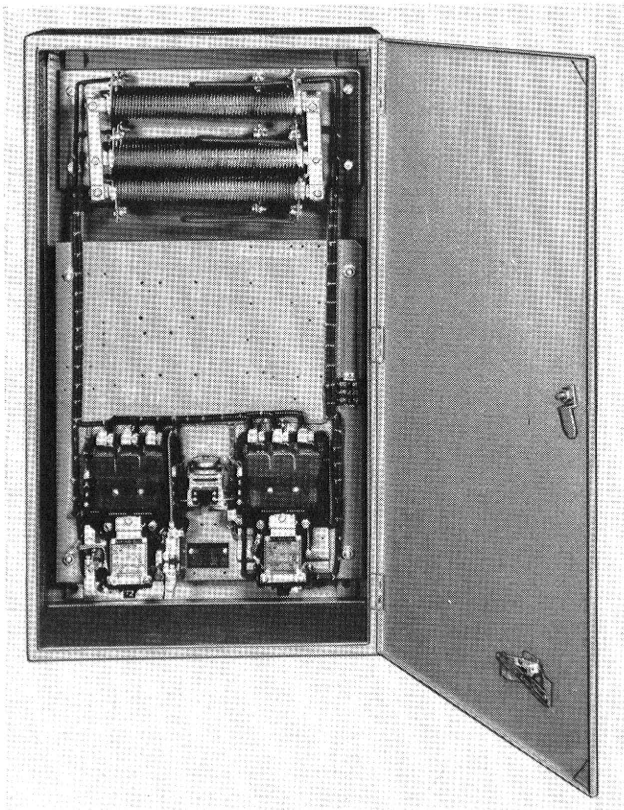
INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

Life-Line* CONTROL

MAGNETIC REDUCED VOLTAGE STARTER

Primary Resistance Type **Time Limit Acceleration**



MAGNETIC REDUCED VOLTAGE STARTERS to which this leaflet applies are listed with their basic class numbers in Table 1.

This leaflet has been prepared for guidance in installation, adjustment, operation, and maintenance of standard Magnetic Reduced Voltage Primary Resistance Type Starters. The standard Class 11-400 starter is used as an illustration. The information in this leaflet may also be used to advantage for special and non-standard designs which differ from the standard only in minor electrical or mechanical modifications.

This leaflet, the specific diagram of connections, and the general and specific device leaflets shipped with the starter should all be carefully studied before attempting to install, adjust, operate, or service the equipment and its devices. See reference column of Table No. 3 for list of instruction leaflets.

Use of primary resistance for reduced voltage starting provides an accelerating torque which gradually increases as the motor comes up to speed, gives a closed transition to running connection, but requires more line current per unit of motor accelerating torque than the autotransformer type starter.

Resistor assemblies for standard starters are designed for use with standard general purpose motors of modern design and have the following detail design objectives:

1. Produce 70 to 85% of line voltage at the motor terminals at the instant of starting.

2. Allow maximum resistor unit rise of 375 deg. C on repeated duty cycle of five seconds on at three times motor rated full load current followed by 75 seconds off with 40 deg. C. ambient free air ventilation.

3. Whenever practicable, to provide taps for minor adjustment of motor accelerating torque at installation. This also allows dual horsepower ratings in some instances.

Table No. 1

BASIC CLASS NO.†	DESCRIPTION
11-400	Non-reversing 2-point Standard
11-403	Class 11-400 with built-in non-fusible De-ion® switch
11-404	Class 11-400 with built-in fusible De-ion switch
11-406	Class 11-400 with built-in De-ion circuit breaker
11-410	Reversing (Non-plugging) 2-point Standard
11-413	Class 11-410 with built-in non-fusible De-ion switch
11-414	Class 11-410 with built-in fusible De-ion switch
11-416	Class 11-410 with built-in De-ion circuit breaker
11-420	Multi-step (Not Network)
11-421	Reversing (Non-plugging) Multi-step (Not Network).
11-440	Network (Increment)
11-441	Reversing (Non-plugging) Network (Increment)

† For elaboration of class number code, see page 3 of Westinghouse Price List 11-020.

SUPERSEDES I.L. 11-400-1

* Trade Mark

APRIL, 1956

When used on the full rated repetitive duty cycle, the equivalent continuous heat rate will be 50 to 70 watts per horsepower of motor rating, so ventilation will require particular attention if this full duty cycle is required. This type of starter is therefore seldom practicable in an application requiring a tight enclosure unless resistors can be remotely located in a ventilated enclosure. Where application requires a tight enclosure, the autotransformer type reduced voltage starter is recommended.

Raceway or conduit wiring to remotely mounted resistor assemblies may be selected for standard starters (resistor Class 116) by multiplying the motor full load current by 0.7 and using this value as motor full load current in the National Electric Code Table 20, making the usual allowances for more than three conductors in raceway, ambient, etc., as for any other motor or controller external wiring. Termination of this wiring at the resistor units requires some attention to avoid subsequent damage to the wiring insulation by heat from the resistor units. Arrangement of these terminations with the wire approaching resistor terminals from below and at right angles to the units, and stripping the insulation back from the termination should avoid difficulty from heat damage to insulation.

If the distance from starter to remote resistor assembly is large it may be necessary to reduce the resistor assembly resistance by approximately the value of the wiring resistance in order to produce satisfactory accelerating torque.

If it is desired to apply the standard starter design to duty cycles other than standard the following generalizations should be considered:

1. For on times less than about 5 seconds, the maximum resistor rise will be approximately standard if the total *on* plus *off* time is not less than the values given in Table No. 2 below:

Table No. 2

Equivalent Duty Cycles to give same resistor temperature rise as standard duty.

ON time seconds	5	4	3	2.5	2	1.5	1
Minimum ON plus OFF time seconds	80	64	48	40	32	24	16

2. For *on* times greater than 5 seconds the direct ratio relationship of Table II for equal temperature rise does not apply because the resistor thermal capacity limits the maximum *on* time quite severely. For standard starters rated 20 HP and lower at 440 V or 25 HP or lower at 550 V an *on* time of more than approximately 6 to 7 seconds will produce greater than the standard rise regardless of how long an *on* plus *off* time is allowed. For standard starters rated 220 volts, above 20 HP 440 V and above 25 HP 550 volts, the *on* time may be increased to about 10 seconds without excessive temperature rise provided the *on* plus *off* time is increased to 45 to 60 minutes. If starters are to be used for such extended starting times, care to avoid damage to resistor units during installation and subsequent testing will be necessary.

A rough test of resistor temperature for the gray metal edge wound ribbon type resistor units is to observe the resistor ribbons while starting for radiant energy color. In general, if the resistor ribbon begins to show a dark red color in subdued lighting, its *standard* temperature rating has already been exceeded and it is approaching its maximum continuous temperature limit of 600 deg. C. An occasional display of dark color in subdued lighting should cause no particular concern, but frequent operation with color visible in daylight will probably reduce the useful life of the resistor materially.

The cast iron type of resistor which may be used on the larger horsepower ratings should not be operated on a duty so severe as to cause them to show radiant energy color as their life will be shortened materially at temperatures lower than the threshold of radiant energy.

Network Starters. Network or increment type starters are designed for use on network distributing systems where starting current limitations are such that standard starters will not give small enough increment of starting current.

Resistor assemblies for network starters are different from standard starters and have the following detail design objectives:

1. Resistance values are chosen to produce increments of starting current approximately equal to the full voltage locked rotor current of the motor divided by the number of starting points (number of starting steps plus one).

2. The resistor capacity is chosen to allow a maximum resistor unit rise not to exceed 375 degrees C. on a repeated duty cycle of one start about every two minutes with 40 degree C. ambient free air ventilation when used with the motor for which the resistor assembly was designed. The resistor on time is standardized as three seconds for two point starters and two seconds per step for multistep starters.

It is the current *increment* which is of importance to the network regulators and the starter will ordinarily meet network requirements even though

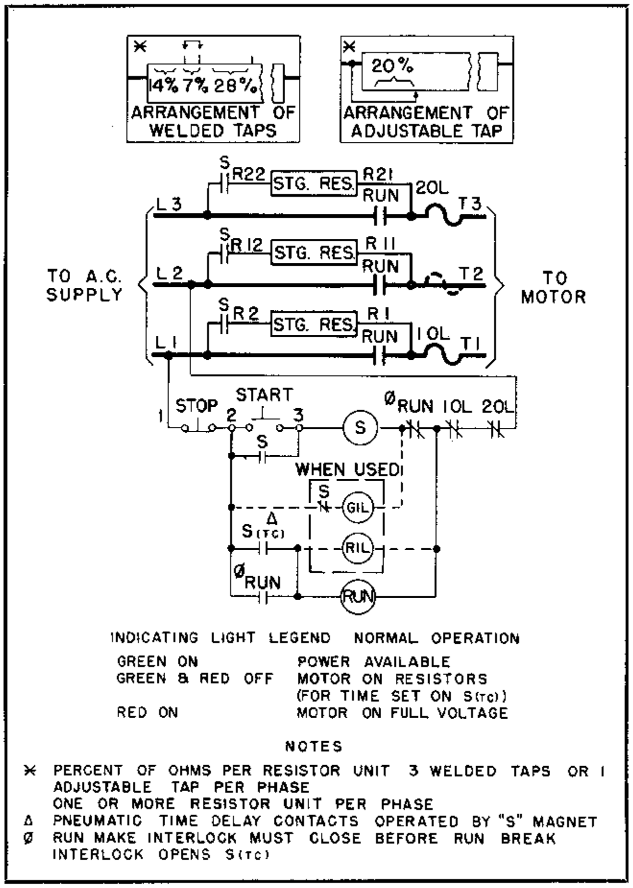


FIG. 1. Typical Elementary Diagram

the motor may not accelerate at all until all resistance has been cut out by the starter.

Resistor assemblies for network starters are therefore designed and supplied for a particular motor's characteristics and may not be suitable for use on other motors of the same horsepower, voltage, speed, and frequency rating which have different values of locked full voltage line current and power factor.

Multi-point starters other than the network type have various resistor designs to suit the particular circumstances of motor and load characteristics and local power supply limitations.

DESCRIPTION AND INSTALLATION

The standard basic three-phase starter includes a three-pole starting contactor, a three-pole running contactor, suitable interposing relays to handle the contactor coil current when required, a set of overload relays, a timing relay, a resistor assembly, and necessary connection, wiring, and terminal details as required. Interposing relays are not supplied on the standard Size 1, 2, 3, and 4 starters. See Fig. 1 for typical elementary diagram.

The starting contactor applies reduced voltage to the motor through the resistor assembly when the pilot device first operates to start the motor and timing relay. After the time set on the timing relay has elapsed, the timing relay energizes the running contactor which connects the motor to the line at full voltage.

Short Circuit Protection. Unless the starter is provided with built-in line fuses or circuit breaker, the user should protect the starter against short circuits by one of the following methods:

1. Fuses rated at not more than four times rated motor current.

2. Time Limit circuit breaker set at not more than four times rated motor current.

Overload Protection. Overload protection is provided by inverse time limit thermal overload relays which are connected in the motor circuit during starting as well as running conditions. Before putting the starter in service check the overload heater markings against the heater table per Table No. 3.

If the overload relay has optional reset feature, select type of reset action desired and adjust relay accordingly. For details on mounting heaters and optional reset adjustment see specific overload relay leaflet (Ref. column, Table No. 3).

Connections. See specific controller and motor diagrams for connection details. Typical elementary diagram is shown in Fig. 1. When making connections insert the bared cable or wire end into the connector so it is squeezed between the back of the tang and the collar when the fastener is tightened.

Figure 2 shows some optional master element (pilot device) connections. The inching connection shown in Fig. 2 is a simple low cost scheme that should be applied with caution as it is not a fool-proof inching arrangement. Should fool-proof inching be required for safety or other operational considerations, do not use this scheme. Starters with inching relays are recommended for fool-proof inching.

Inching with the scheme of Fig. 2 is accomplished by latching the stop-button open to set the starter up for inching and operation will depend upon whether latch depresses stop button fully or only partially. (Both arrangements are in use and available). Should the latch only depress the stop button partially, then the stop and start buttons must both be manually depressed for inching intervals longer than the setting of the timing relay. If start button only is used for inching and it is held down longer than the setting of the timing relay, the starter will be unable to transfer to run and will continue to repeat starting cycles. Such operation may damage resistors if it exceeds their *on* time rating without adequate cooling time.

Should the latch depress the stop button fully, then inch operations using start button only will be normal with starter transfer to run occuring automatically at the end of the starting period.

Electrical Interlocks. Additional electrical interlocks for customer sequence interlocking may often be added. See specific controller diagram and device leaflets for details. Note that the type AMB relay used on Size 2, 3, and 4 starters prevents addition of the left hand outboard interlock on the start contactor and the right hand outboard interlock on the *run* contactor for these three starter sizes.

TESTS AND ADJUSTMENTS

Make a careful check of the controller with all motor leads disconnected to insure that the equipment is in good operating condition. In particular, check the following:

a. Does controller go through complete sequence properly?

b. Trip overload relay contacts open manually.

Caution. Do not bend bimetal. Relay calibration may be destroyed if bimetal is forced. Type MW relay contacts may be opened manually by depressing reset fully.

Does relay drop out contactors?

c. Does the timing relay operate properly to energize the run contactor after a definite preset time? Factory setting for this relay will be found in Table No. 3.

d. Does the pushbutton station (or other master switch) operate to control the equipment as expected?

After tests as above, make temporary motor connections and make further tests and adjustments as follows:

e. Check direction of rotation of motor and correct if necessary.

f. Observe motor acceleration time and adjust timing relay setting to apply full voltage as soon as the motor rate of acceleration becomes noticeably reduced. If the starting load on the motor is variable, this adjustment should be made with the larger values of load. Some compromise

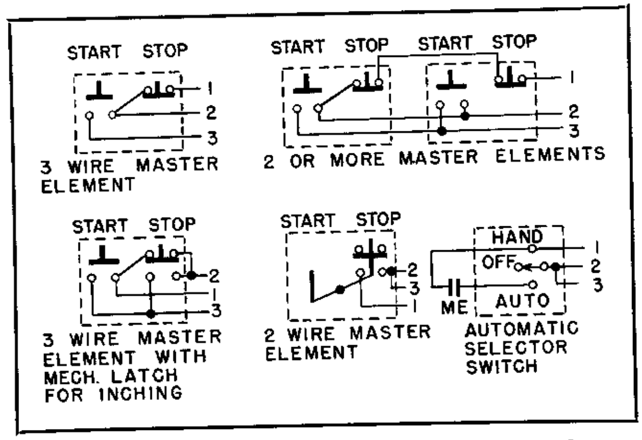


FIG. 2. Optional Connections to Master Switches

setting may be desirable if the larger values of load seldom occur.

It may be desirable to change the resistor tap adjustment if the load and motor characteristics are such that the factory tap setting is not suitable. To obtain more accelerating torque and shorter accelerating time, adjust the resistors to reduce the resistance (increase the portion which is shorted out). To obtain lower starting current, it will be necessary to reduce the accelerating torque and lengthen the accelerating time by increasing the resistance (reduce the portion which is shorted out).

The duty cycle limitations of starter rating are substantially the same for minor changes in resistance. If large changes in resistance must be made then the duty cycle must be reduced accordingly. This should be kept in mind while making changes in resistor tap settings and checked by observing resistor radiant energy color while starting. It may be necessary to reduce the timing relay setting to avoid overheating the resistor units. See specific device leaflet for instructions for adjusting the timing relay.

Caution. Do not exceed the resistor assembly duty rating while adjusting timing relay and resistor taps. Resistor damage or burnout may occur due to failure to allow adequate resistor cooling time while testing. Relay settings longer than 5 seconds on standard starters require increased cooling times and settings longer than 10 seconds will usually cause damage to standard starters. See resistor limitations, pages 1 and 2.

g. Observe overload relay operation. Relay should not trip starter off at rated motor load.

After above tests and adjustments are completed, motor leads may be permanently connected and insulated if necessary.

Table No. 3

Application, Heater Selection, and Instruction Literature Guide

APPLICATION						HEATER SELECTION			REFERENCE
3-PHASE, 60-CYCLE 2-POLE, APPROXIMATE MAXIMUM MOTOR HORSEPOWER* AT VOLTAGE				CONTACTOR AND RELAY ENCLOSED 8-HOUR RATING*	STANDARD STARTER NEMA I ENCLOSED	SELECT OL RELAY HTRS. FROM		FACTORY SETTING TIMING RELAY UNLESS SPECIFIED OTHERWISE	INSTRUCTION LITERATURE†
220	380	440	550	Amps.	Class	Table	Instructions	Seconds	Individual Device Instructions
15	25	25	25	45	11-400NS2	25.3	I.S. 10701	2	NR Contactor.......I.L. 10711 AMB Relay.........I.L. 15-827-15 MW Relay.........I.L. 10707
30	50	50	50	90	11-400NS3	26.3	I.S. 10702	3	
50	75	100	100	135	11-400NS4	26.4	I.S. 10705	4	
100	150	200	200	270	11-400NS5	26.5	I.S. 10799	5	NF Contactor.......I.L. 15-825-5 NR Contactor.......I.L. 10711 AMB Relay.........I.L. 15-827-15 N Contactor........I.L. 10449 MW51 Relay........I.L. 15-827-10

* Application must always be such that contactor and relay continuous currents will not exceed the enclosed 8 hr. rating.

† For general instructions covering unpacking, handling, storing, installation and maintenance, see I.L. 1477-D, I.L. 4330, I.L. 7000-2, I.L. 4332, I.L. 7000-1 and MB 1781-G

Starters designed for 220 volts will operate on 208 V network systems. For isolated 208 V. systems contact nearest Westinghouse Sales office and state minimum operating voltage.

MAINTENANCE

In operating, servicing, and adjusting the equipment, the attendant should consult the specific diagram and the general and specific device instruction leaflets and particularly remember the following points:

1. Warning. All circuits should be de-energized and disconnecting devices locked open when working on equipment.

2. The equipment should be kept clean at all times.

3. Periodic inspection should be made of all equipment to insure that all apparatus is kept in working condition.

4. Contacts becoming badly worn should be replaced before they cause a serious failure. Proper spring pressure should be maintained at all times.

5. Do not oil contactor bearings.

6. Do not use emery paper around electrical apparatus. Sandpaper or file only when absolutely necessary and use care to avoid embedding metal particles in insulating materials.

7. Keep all connections tight. Particular attention should be given to thermal overload relay heater connections to keep them clean and tight.

In Case of Trouble.

a. *If control fuses blow* check carefully for shorted or damaged coils or wires; repair equipment and replace fuse.

b. *If motor fails to accelerate properly*

1. Check AC line for low voltage or single phase condition.
2. Check load and motor for overload, excessive friction, or blocking.
3. Check load at starting. Is it too great for motor torque? If necessary, short out more of the starting resistor.

Note: Resistor assembly duty rating of 5-seconds on out of 80 seconds is only for factory tap setting of resistor, so some compensation of duty cycle may be required if tap setting is changed appreciably at installation. *See Tests and Adjustments, page 4(f).*

c. *If overload relay trips*

1. Check AC line for low voltage or single phase condition.
2. Check motor and load for overload, excessive friction, or blocking.
3. Check condition of heater connections. Clean and tighten if necessary.
4. Check ambient temperature at relay

when relay trips. Heaters may have been selected for a lower ambient than actually exists. See heater table and overload relay instruction leaflet (Table No. 3 reference).

5. Inspect carefully relay, control, motor, and load for any abnormal condition. Correct such condition.

6. Reset relay and attempt new start, observing carefully operation of equipment, motor and load. If accelerating time is long, higher torque or horsepower may be required.

d. If starter fails to go through starting sequence completely, check interlock contacts, connections, and operation of devices. Check particularly, the controller diagram for any interlock sequence information such as note ∅ Fig. 1 and see that the proper sequence is being obtained.

If any major repairs become necessary, we recommend that the nearest Westinghouse Sales office be asked for their recommendations.

Each equipment is designed and supplied for a particular voltage, frequency, horsepower, and number of phases, as marked on nameplate, based on standard general purpose motors of modern design. Before applying starter on other voltage, frequency, motor type, or horsepower rating, the nearest Westinghouse Sales office should be consulted.

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