



January, 1977
Supersedes DB 9250, pages 1-12,
dated September, 1973

Non-Reversing and Reversing
600 Volts Maximum,
NEMA Sizes 1-8

Mailed to: E, D, C/1806/DB

Ac Magnetic Reduced Voltage Starters



Application

Magnetic reduced voltage starters are designed for use with squirrel-cage induction motors, especially where local power companies restrict inrush current or increments of current drawn from the line. Ruggedly built for industrial applications, Westinghouse reduced voltage starters limit inrush current and reduce starting torque, thus cushioning power application to the load. They are ideally suited for starting squirrel-cage motors driving such equipment as motor-generator sets, mill machinery, compressors, conveyors, pumps, saws, fans, and blowers.

Although more than one type of reduced voltage starter may be used for a given application, only one will do the job at the lowest possible cost.

Advantages

Wide Selection: Westinghouse offers the largest selection of magnetic reduced voltage starters in the industry, with ratings ranging from 7.5 to 1500 horsepower. Five classes of starters are available in both non-reversing and combination types; reversing and multiple-point starter types and manual class auto-starters are also available.

Reliability: All Westinghouse reduced voltage starters have heavy-duty compo-

nents proven reliable in thousands of applications. Three-pole adjustable overload protection is standard on all types. Adjustable pneumatic relays ensure precise, accurate start-to-run transfer timing.

Flexibility: On all wall-mounted starters, enclosure panels are predrilled and pre-punched for quick, simple installation of control transformers, circuit breakers, and

other auxiliary control devices. Start-stop pushbuttons and external reset buttons may be easily added.

Appearance: Enclosures are handsome in appearance, with uncluttered, modern lines.

**Primary Resistor Starters
Class 11-400**

Application

Primary resistor type starters will reduce the motor torque and starting inrush current to produce a smooth, cushioned acceleration with closed transition. Since the motor is never disconnected from the line, there is no interruption of line current which could cause a second inrush during transition. Although not as efficient as other methods of reduced voltage starting, primary resistor type starters are ideally suited to applications such as conveyors, textile machines, or other delicate machinery where reduction of starting torque is of prime consideration. Starters size 5 and smaller will limit inrush to approximately 80% of locked rotor current and starting torque to approximately 64% of locked torque. Larger sizes are custom designed to the application.

Design Features

Contactors – (S) (Run)

A three pole contactor (S) which connects the motor in series with the starting resistor for reduced voltage start (see table below for size).

A three pole contactor (Run) which bypasses the starting resistors and connects the motor for full voltage across-the-line running (see table below for size).

Max. Hp	NEMA Size		S
	Starter	Contactors Run	

230 Volts, 60 Hz

	1	2	3	4	5
7½	1	2	3	4	5
15	2	3	4	5	6
30	3	4	5	6	
50	4	5	6		
100	5	6			
200	6				

460-575 Volts, 60 Hz

	1	2	3	4	5
10	1	2	3	4	5
25	2	3	4	5	
50	3	4	5		
100	4	5			
200	5				

Overload Relay – (OL)

A three pole adjustable type AN overload relay provides starting and running over-current protection.

Timing Relay – (TR)

An electrically operated pneumatic relay provides accurate, adjustable, start-to-run transfer timing.

Starting Resistor – (Stg. Res.)

Stainless steel resistor tubes limit the inrush current by reducing voltage during starting. NEMA class 116 resistors are standard for general starting duty where starting time is no more than five seconds out of 80 seconds. For applications that exceed this duty cycle, NEMA class 156 resistors, good for 15 seconds out of 60 seconds, are recommended.

Other Types

Class 11-400 primary resistor starters are also available in combination, reversing or multiple point acceleration types.

**Dimensions in Inches
Approximate Only**

Starter Class	Size	Dimensions			Maximum Shipping Wt., Lbs.
		H	W	D	
11-400	1-2	29	18	10	120
	3-4	35	24	12	400
	5	64	28	14	750
	6	90	28	28	1300
11-403	1	64	28	14	300
11-406	2	64	28	14	350
	3-4	64	28	14	800
	5	64	36	14	900
11-404	1	64	28	14	375
	2-3-4	64	28	14	475
	5	76	36	14	950

① 64, 76 and 90 inch high enclosures are floor mounted.

Operation (Refer to schematic diagram)

Closing the start button or other pilot device energizes the start contactor (S), closing the contacts (S), and connects the motor in series with the starting resistor for a reduced voltage start. The contactor (S) is now sealed in through its interlock (S_a). Timing relay (TR) is energized, and after a preset time interval its contacts (TR_{TC}) close energizing the run contactor (RUN) which seals through its interlock (RUN_a). The contacts (RUN) close, bypassing the starting resistors, and the motor is now

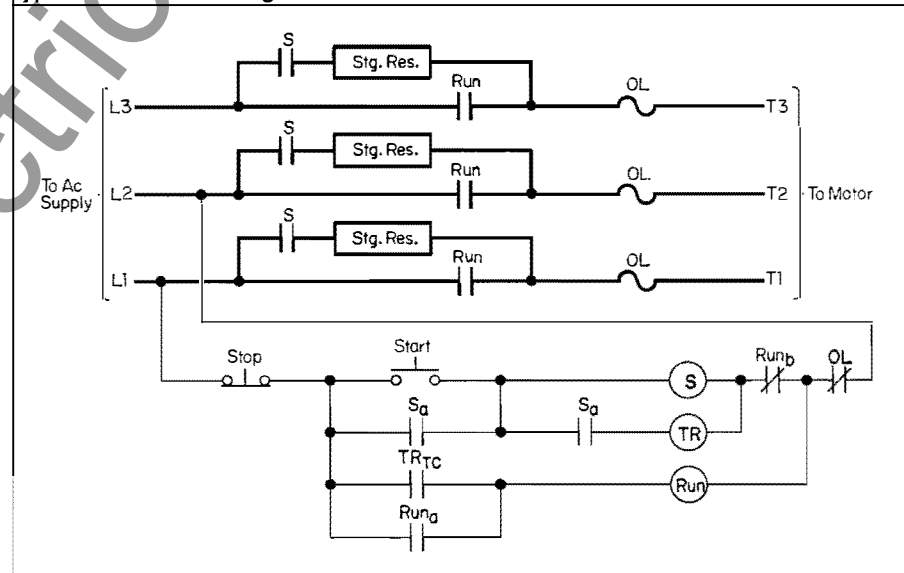
running at full voltage. The contactor (S) and timing relay (TR) are de-energized when the interlock (RUN_b) opens.

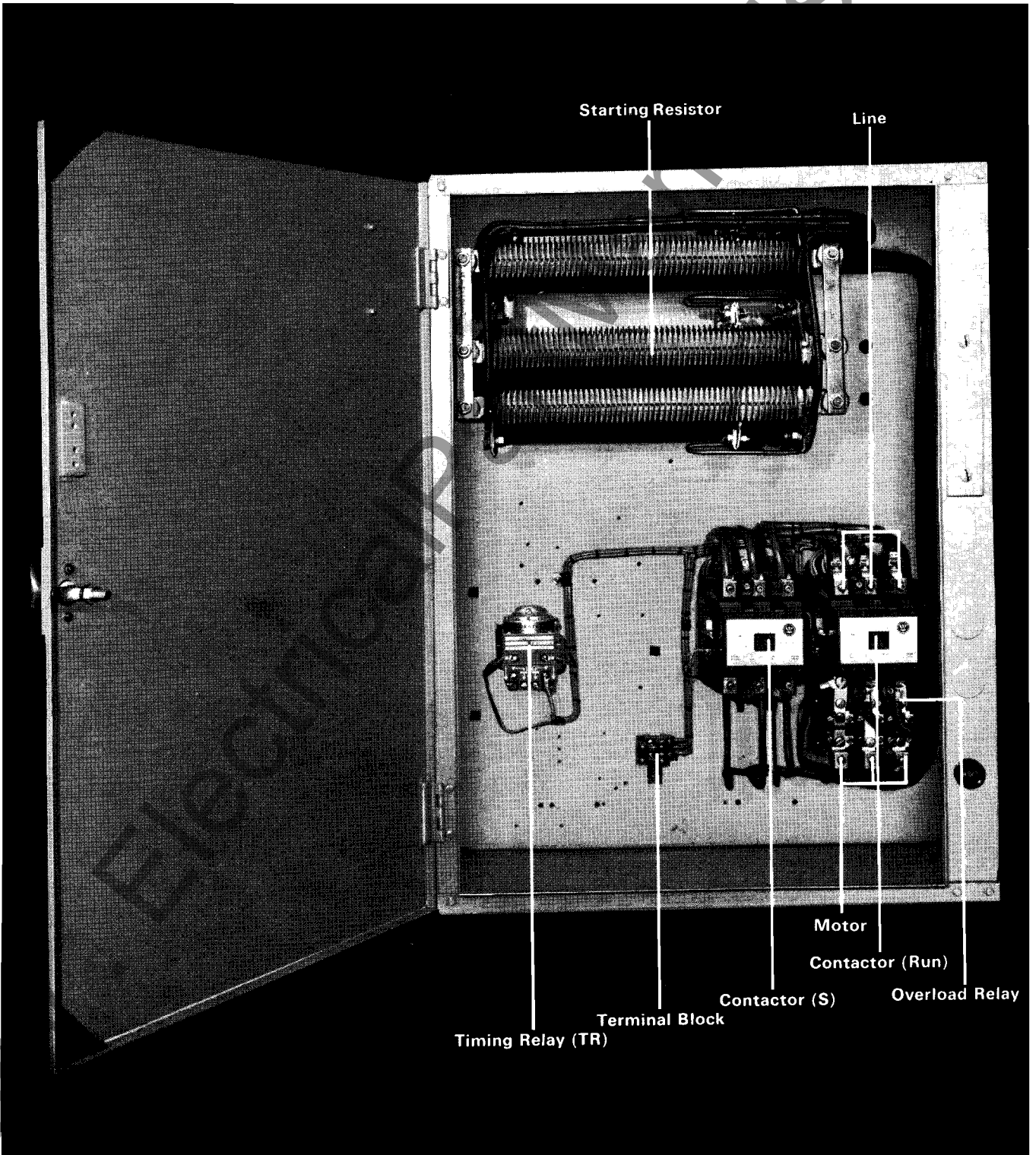
An overload, opening the stop button or other pilot device de-energizes the (RUN) contactor, removing the motor from the line.

Contactor Sequence

Contactor	Start	Transition	Run
S	●	●	
RUN		●	●

Typical Schematic Diagram





Starting Resistor

Line

Motor

Contactor (Run)

Contactor (S)

Overload Relay

Timing Relay (TR)

Terminal Block

Autotransformer Starters Class 11-600

Application

Autotransformer type starters are the most widely used reduced voltage starters because of their efficiency and flexibility. All power taken from the line, except transformer losses, is transmitted to the motor to accelerate the load. Taps on the transformer allow adjustment of the starting torque and inrush to meet the requirements of most applications. The following starting characteristics are produced by three voltage taps:

Tap	Starting Torque (Percent Locked Rotor Torque)	Line Inrush (Percent Locked Rotor Amperes)
50% ^①	25	28 ^②
65%	42	45 ^②
80%	64	67 ^②

- ① Provided only above 50 hp.
- ② Includes transformer magnetizing current.

Closed transition is standard on all sizes assuring a smooth transition from reduced to full voltage. Since the motor is never disconnected from the line, there is no interruption of line current which could cause a second inrush during transition.

Duty cycle of these starters is as follows:

Up to 200 hp, 15 seconds on each four minutes for one hour, repeated after two hours. Over 200 hp, three periods of 30 seconds on, 30 seconds off, repeated after one hour.

Design Features

Contactors – (1S) (2S) (Run)

A three pole (1S) ^① and a three pole contactor (2S) connect the motor to the autotransformer for reduced voltage starting (see table below for size).

A three pole contactor (Run) bypasses the autotransformer and connects the motor for full voltage across-the-line running (see table below for size).

Max. Hp	NEMA Size			
	Starter	Contactor Run	Starting (1S) (Three Pole)	(2S) (Three Pole)
230 Volts, 60 Hz				
15	2	2	2	2
30	3	3	3	3
50	4	4	4	4
100	5	5	5	5
200	6	6	5	5
300	7	7	6 ^①	6
450	8	8	7 ^①	7
460-575 Volts, 60 Hz				
25	2	2	2	2
50	3	3	3	3
100	4	4	4	4
200	5	5	5	5
400	6	6	5	5
600	7	7	6 ^①	6
900	8	8	7 ^①	7

① 1S is two pole on size 7 & 8.

Overload Relay – (OL)

A three pole adjustable type AN overload relay provides starting and running over-current protection.

Timing Relay – (TR)

An electrically operated pneumatic relay provides accurate, adjustable start-to-run transfer timing.

Autotransformer – (Auto Trans.)

A two winding open delta connected autotransformer limits the inrush current by reducing voltage during start.

Other Types

Class 11-600 autotransformer starters are also available in combination and reversing types and in manual class 10-600 auto-starters.

Dimensions in Inches Approximate Only

Starter Class	Size	Dimensions			Maximum Shipping Wt., Lbs.
		H ^①	W	D	
11-600	2-3-4	35	24	12	450
	5	64	28	14	750
	6	90	36	21	1250
	7-8	90	56	28	1400
11-603 } 11-606 }	2-3-4	35	24	12	500
	5	64	28	14	800
	6	90	36	21	1300
	7-8	90	56	28	1500
11-604	2-3-4	64	28	14	600
	5	64	36	14	850
	6	90	36	21	1450
	7-8	90	84	28	1750

① 64 and 90 inch high enclosures are floor mounted.

Operation (Refer to schematic diagram)

Closing the start button or other pilot device energizes the start contactor (1S). The interlock (1S_a) closes, energizing the timing relay (TR) and contactor (2S) which seal in through the interlock (2S_a). With the (1S) and (2S) contactor main contacts closed, the motor is connected through the autotransformer for reduced voltage start. After a preset time interval, the (TR_{TO}) contacts time open, de-energizing contactor (1S) and connecting the autotransformer as a reactor in series with the motor. Interlock (1S_b) immediately energizes the run contactor (RUN) which seals in through its interlock (RUN_a). The run contacts are now

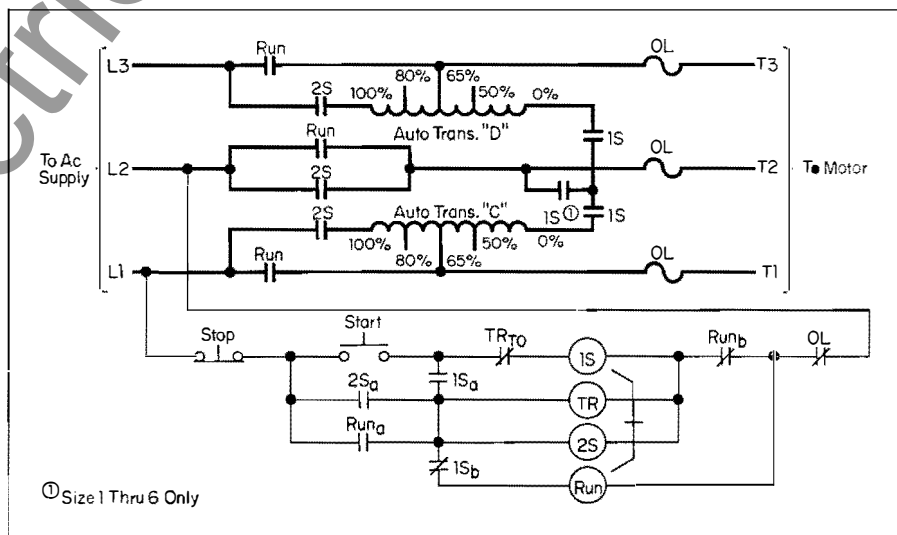
closed, and the motor is running at full voltage. Start contactor (2S) and relay (TR) are de-energized when interlock (RUN_b) opens.

An overload, opening the stop pushbutton or other pilot device de-energizes the (RUN) contactor, removing the motor from the line.

Contactor Sequence

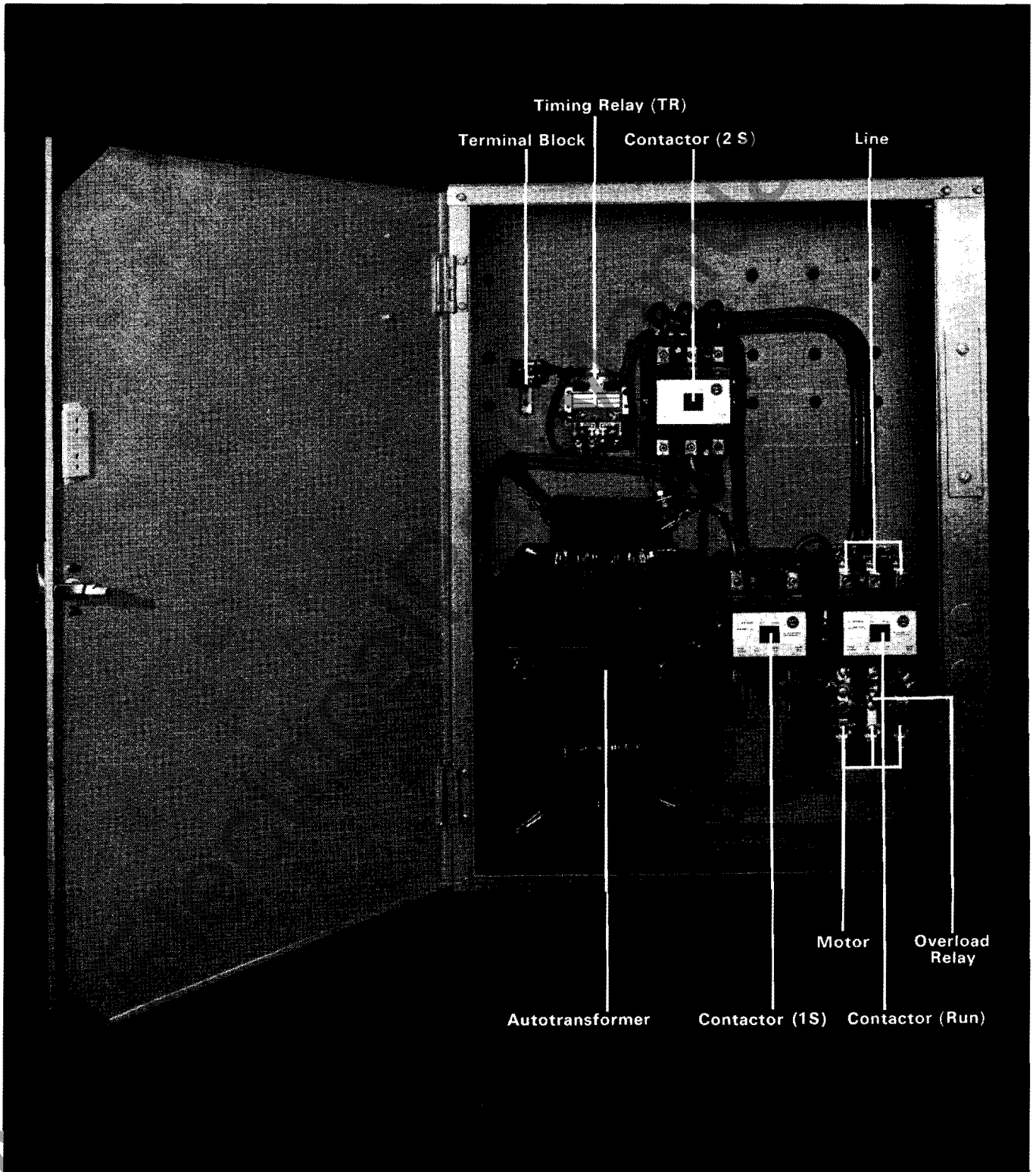
Contactor	Start	Transition	Run
1S	●	●	
2S		●	●
RUN			●

Typical Schematic Diagram





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**Part Winding Starters
Class 11-700
Application**

Part winding starters provide economical reduced current starting where the power company specifies a maximum inrush current or limits the increments of current drawn from the line. These starters can be used with standard dual-voltage motors on the lower voltage and with special part-winding motors designed for any voltage. When used with standard dual voltage motors, it should be established that the torque produced by the first half winding will accelerate the load sufficiently so as not to produce an undesirable inrush when the second half winding is connected to the line. Most motors will develop starting torque of 1/2 to 2/3 of NEMA standard values with half of the winding energized and draw 2/3 of normal line inrush current.

**Design Features
Contactors – (1M) (2M)**

A three-pole contactor (1M) which connects only the first half winding of the motor for reduced inrush current on starting (see table below for size). A three-pole contactor (2M) which connects the second half winding of the motor for running (see table below for size).

Max. Hp	NEMA Size	
	Starter	Contactor
		(1M) (2M)

230 Volts, 60 Hz			
10	1 PW	1	1
25	2 PW	2	2
50	3 PW	3	3
75	4 PW	4	4
150	5 PW	5	5
300	6 PW	6	6
450	7 PW	7	7

460-575 Volts, 60 Hz			
15	1 PW	1	1
40	2 PW	2	2
75	3 PW	3	3
150	4 PW	4	4
350	5 PW	5	5
600	6 PW	6	6
900	7 PW	7	7

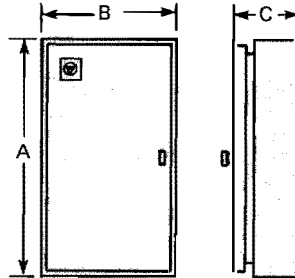
Overload Relay – (OL)
Two three-pole adjustable type AN overload relay provide starting and running over-current protection.

Timing Relay – (TR)
An electrically operated pneumatic relay provides accurate, adjustable start-to-run transfer timing.

Other Types
Part winding class 11-700 starters are also

available in combination, reversing, and three point (primary resistor) types.

**Dimensions in Inches
Approximate Only**



Starter Class	Size	Dimensions			Max. Shipping Wt., Lbs.
		A	B	C	
11-700	1-2 PW	21	14	7	100
	3-4 PW	29	18	10	160
	5 PW	40	24	13	100
	6 PW	64	28	21	600
	7 PW	77	56	21	1000
11-704	1-2-3 PW	35	24	12	200
	4-5 PW	64	28	14	550
	6 PW	90	28	21	700
	7 PW	90	56	21	1200
11-703	1-2-3-4 PW	35	24	12	200
11-706	5 PW	64	28	14	550
	6 PW	90	28	21	700
	7 PW	90	56	21	1200

① 64.76 and 90 inch high enclosures are floor mounted.

Operation (Refer to schematic diagram)

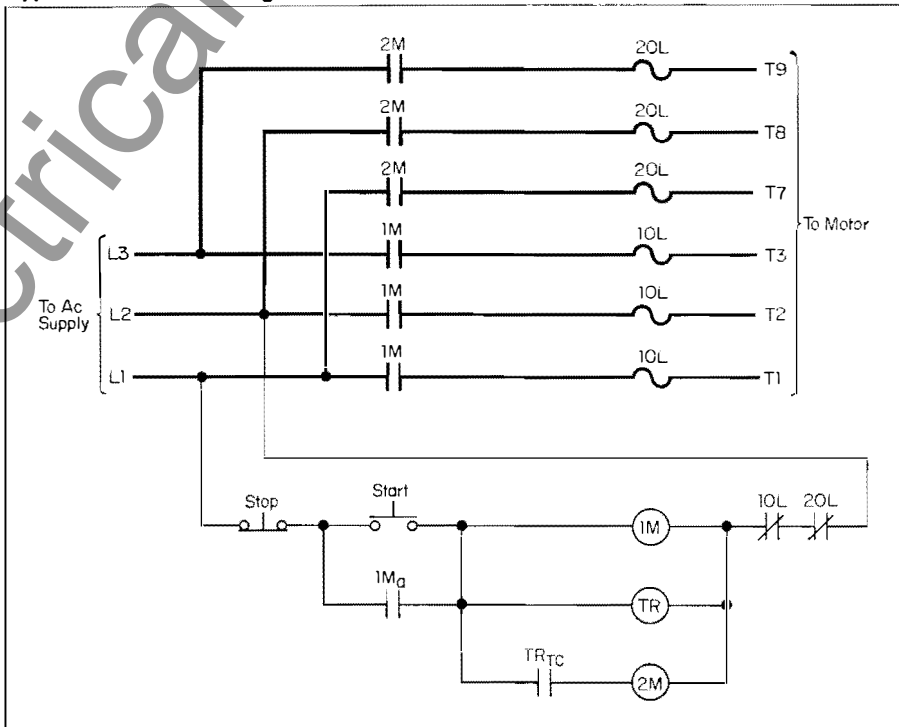
Closing the start button or other pilot device energizes the start contactor (1M) which seals in through its interlock (1M_a) and energizes the timer (TR). The (1M) contacts connect the first half-winding of the motor across the line. After a preset time interval, timer (TR_{TC}) contact closes energizing contactor (2M). The (2M) contacts connect the second half winding of the motor across the line.

An overload, opening the stop button or other pilot device de-energizes contactors (1M), (2M) and timer (TR), removing the motor from the line.

Contactor Sequence

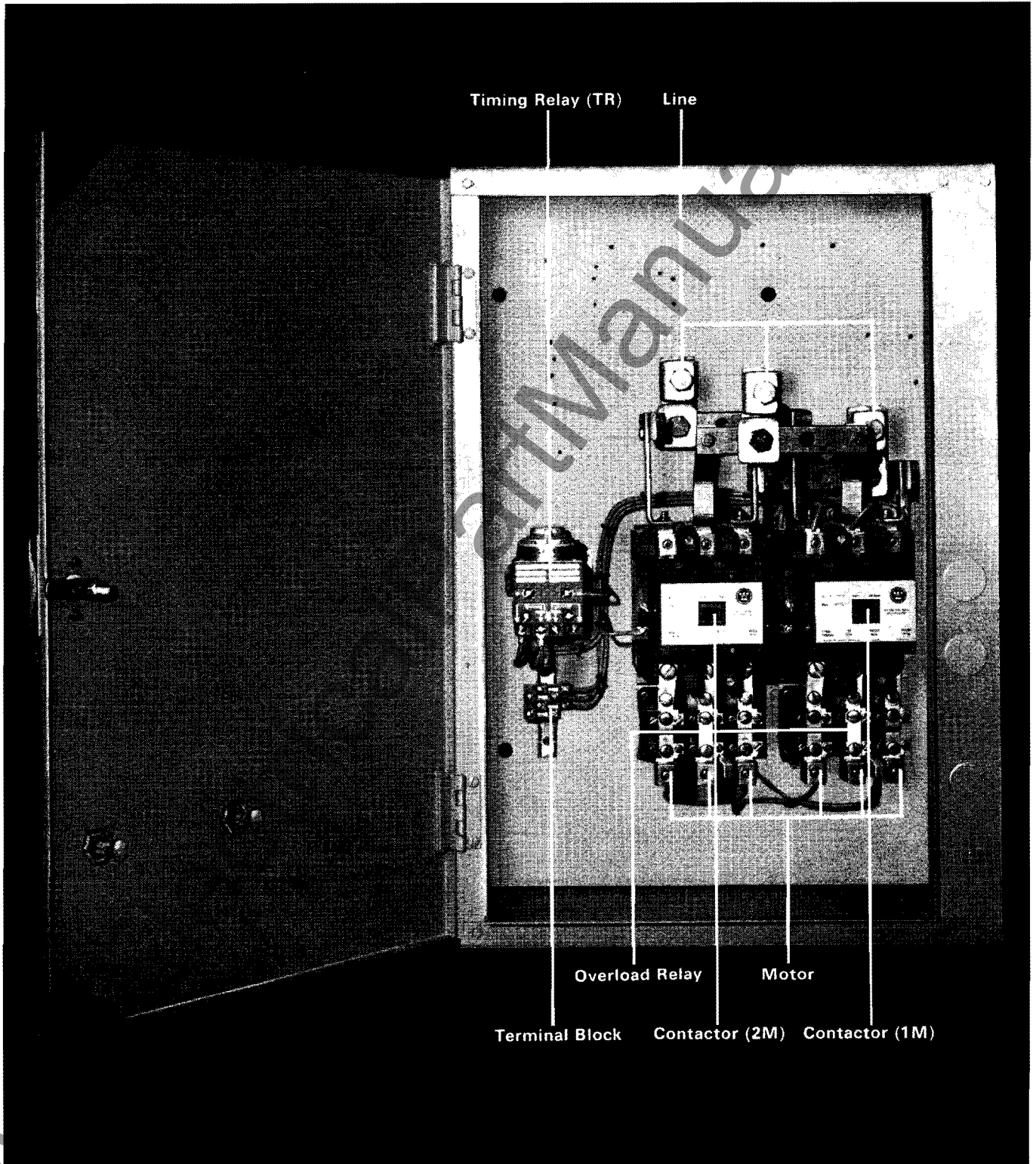
Contactor	Start	Run
1M	●	●
2M		●

Typical Schematic Diagram





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Star Delta Starters – Open Transition

Class 11-800 Application

Star Delta starters, also known as Wye-Delta Starters, are particularly applicable to starting motors driving high inertia loads with resulting long acceleration times. When six or twelve lead delta-connected motors are started star connected, approximately 58% of full line voltage is applied to each winding, and the motor develops 33% of full voltage starting torque and draws 33% of normal locked rotor current from the line. When the motor has accelerated, it is reconnected for normal delta operation.

Open transition star-delta starting, where the motor voltage is momentarily interrupted in going from start-to-run, is suitable where a very short duration (measured in cycles) current spike on the system is not objectionable.

Design Features

Contactors – (S) (1M) (2M)

A three-pole contactor (S) which shorts the motor leads T4-T5-T6 during starting to connect motor in star (see table below for size).

A three-pole contactor (1M) which energizes motor leads T1-T2-T3 for both star and delta connections (see table below for size).

A three-pole contactor (2M) which energizes motor leads T4-T5-T6 during running to connect the motor in delta (see table below for size).

Max. Hp	NEMA Size			
	Starter	Contactor (1M)	Contactor (2M)	Contactor (S)
230 Volts, 60 Hz				
10	1 YD	1	1	1
25	2 YD	2	2	2
50	3 YD	3	3	3
75	4 YD	4	4	4
150	5 YD	5	5	4
300	6 YD	6	6	5
500	7 YD	7	7	6⊙
800	8 YD	8	8	7⊙
460-575 Volts, 60 Hz				
15	1 YD	1	1	1
40	2 YD	2	2	2
75	3 YD	3	3	3
150	4 YD	4	4	4
300	5 YD	5	5	4
700	6 YD	6	6	5
1000	7 YD	7	7	6⊙
1500	8 YD	8	8	7⊙

⊙ S is two pole on size 7 & 8.

Overload Relay – (OL)

A three-pole, adjustable type AN overload relay provides overcurrent protection in star and delta motor connections.

Timing Relay – (TR)

An electrically operated pneumatic relay provides accurate, adjustable star to delta transfer timing.

Other Types

Star-delta class 11-800 open transition starters are also available in combination types.

Dimensions in Inches

Approximate Only

Starter Class	Size	Dimensions			Max. Ship. Wt., Lbs.
		H⊙	W	D	
11-800	1-2-3-4 YD	35	24	12	210
	5 YD	64	28	14	600
	6 YD	64	28	14	850

⊙ 64 inch high enclosures are floor mounted.

Operation (Refer to schematic diagram)

Closing the start button or other pilot device energizes contactor (S) whose contacts connect the motor in a star connection. Interlock (S_a) closes, energizing contactor (1M) and timer (TR). The contacts (1M) energize the motor winding in star. Contactor (1M) is now sealed in through interlock (1M_a). After a preset time interval, the timer (TR_{TO}) contact opens, de-energizing contactor (S) thereby opening the star connection. The motor is, at this moment, temporarily de-energized. Interlock (S_b) then closes, energizing contactor (2M). The (2M) contacts close, and the motor is re-

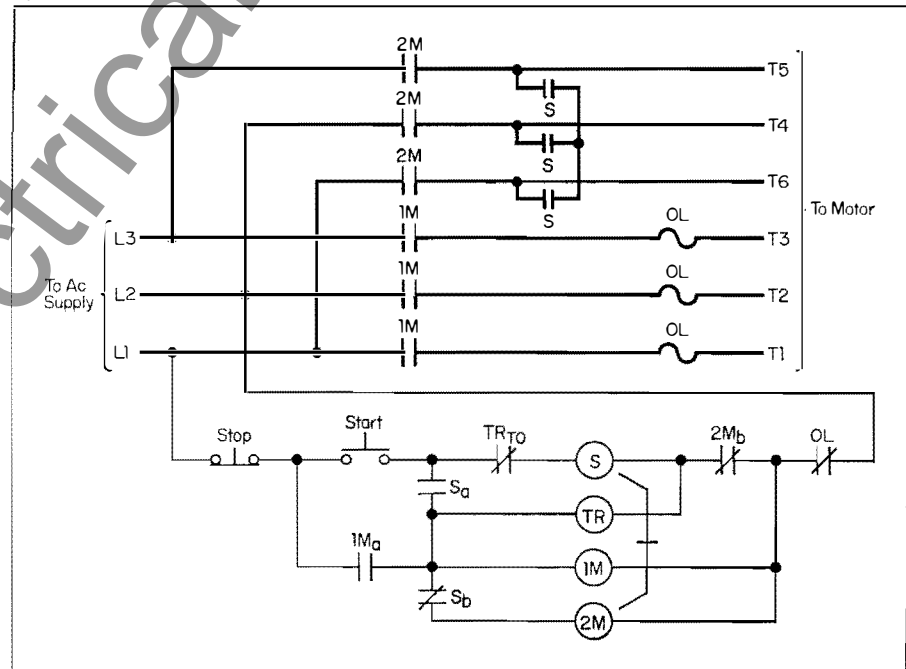
energized in delta. Interlock (2M_b) de-energizes timer (TR).

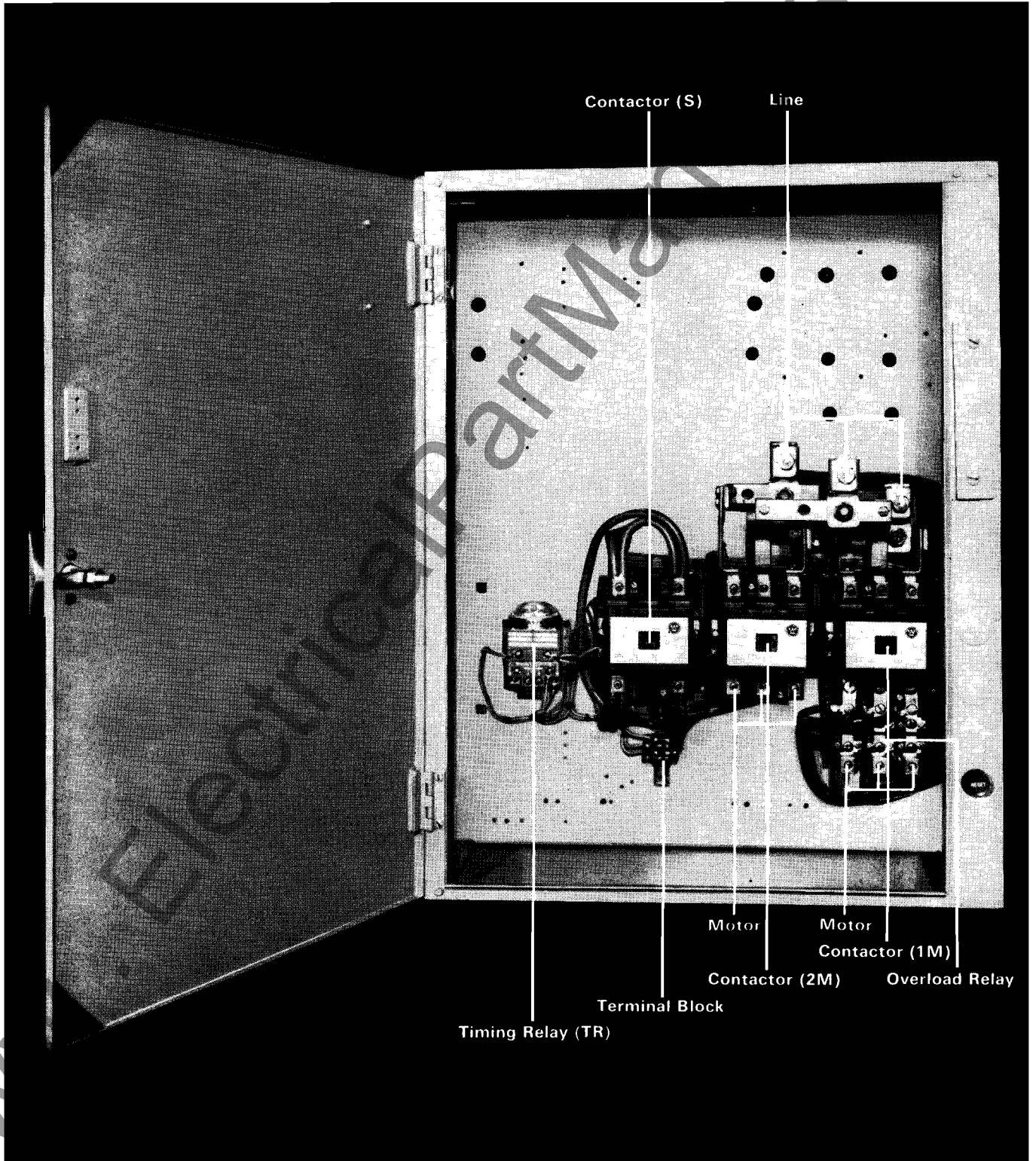
An overload, opening the stop button or other pilot device de-energizes contactors (1M) and (2M) removing the motor from the line.

Contactor Sequence

Contactor	Start	Transition	Run
S	●	●	
1M		●	●
2M			●

Typical Schematic Diagram





Star Delta Starters – Closed Transition

Class 11-890

Application

Star Delta starters, also known as Wye-Delta starters, are particularly applicable to starting motors driving high inertia loads with resulting long acceleration times. When six or twelve lead delta-connected motors are started star connected, approximately 58% of full line voltage is applied to each winding, and the motor develops 33% of full voltage starting torque and draws 33% of normal locked rotor current from the line. When the motor has accelerated, it is reconnected for normal delta operation.

Closed transition star delta starting is used where a short duration motor torque interruption caused by open transition starting cannot be tolerated.

Design Features

Contactors – (1S) (1M) (2S) (2M)

A three-pole contactor (1S) which shorts the motor leads T4-T5-T6 during starting to connect motor in star (see table below for size).

A three-pole contactor (1M) which energizes motor leads T1-T2-T3 for both star and delta connections (see table below for size).

A three-pole contactor (2S) which connects resistors in series with the motor windings during the start-to-run transition period (see table below for size).

A three-pole contactor (2M) which energizes the motor leads T4-T5-T6 during running to connect the motor in delta (see table below for size).

Max. NEMA Size

Hp	Starter			
	1M	2M	1S	2S

230 Volts, 60 Hz

Max. Hp	YD	1M	2M	1S	2S
10	1 YD	1	1	1	1
25	2 YD	2	2	2	1
50	3 YD	3	3	3	1
75	4 YD	4	4	4	2
150	5 YD	5	5	4	3
300	6 YD	6	6	5	4
500	7 YD	7	7	6⊕	5
800	8 YD	8	8	7⊕	6

460/575 Volts, 60 Hz

Max. Hp	YD	1M	2M	1S	2S
15	1 YD	1	1	1	1
40	2 YD	2	2	2	1
75	3 YD	3	3	3	1
150	4 YD	4	4	4	2
300	5 YD	5	5	4	3
700	6 YD	6	6	5	4
1000	7 YD	7	7	6⊕	5
1500	8 YD	8	8	7⊕	6

⊕ 1S is two pole on size 7 & 8.

Overload Relay – (OL)

A three-pole, adjustable type AN overload relay provides overcurrent protection in star and delta motor connections.

Timing Relay – (TR)

An electrically operated pneumatic relay provides accurate, adjustable star to delta transfer timing.

Resistors – (Res.)

Transition resistors allow motor to be continuously energized during transition from star to delta.

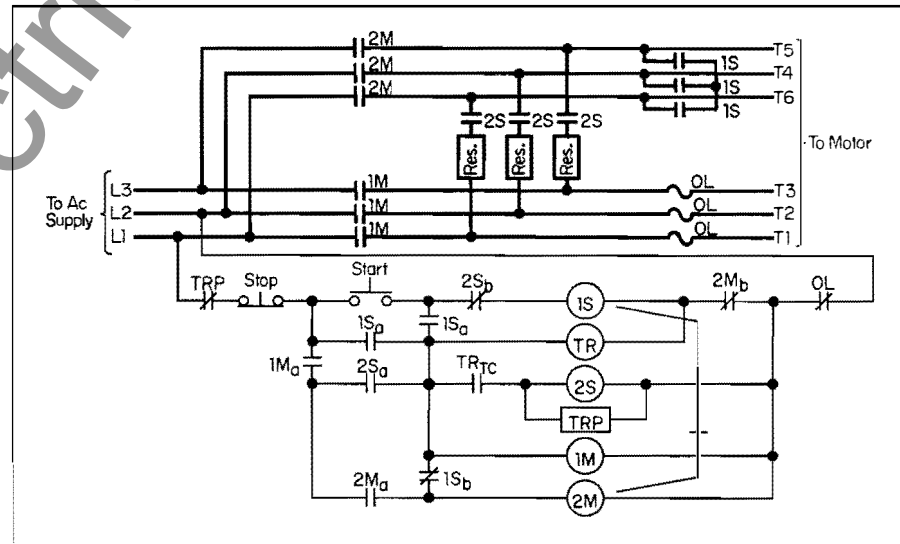
Transition Resistor Protector – (TRP)

Synchronous motor driven timer assures that the transition resistor duty cycle is not exceeded.

Operation (Refer to schematic diagram)

Closing the start button or other pilot device energizes contactor (1S) whose contacts connect the motor in a star connection. Interlock (1S_a) closes, energizing contactor (1M) and timer (TR). The (1M) contacts energize the motor windings in a star. After a preset time interval, timer (TR_{TC}) contact closes energizing contactor (2S). Interlock (2S_b) opens, dropping out contactor (1S). The motor is now energized in series with the resistors. Interlock (1S_b) closes, energizing contactor (2M), bypassing the resistors and energizing the delta connected motor at full voltage. Interlock (2M_b) opens, de-energizes the timer (TR) opening timer (TR_{TC}) thus energizing contactor (2S).

Typical Schematic Diagram



Other Types

Star-Delta class 11-890 closed transition starters are also available in combination types.

Dimensions in Inches

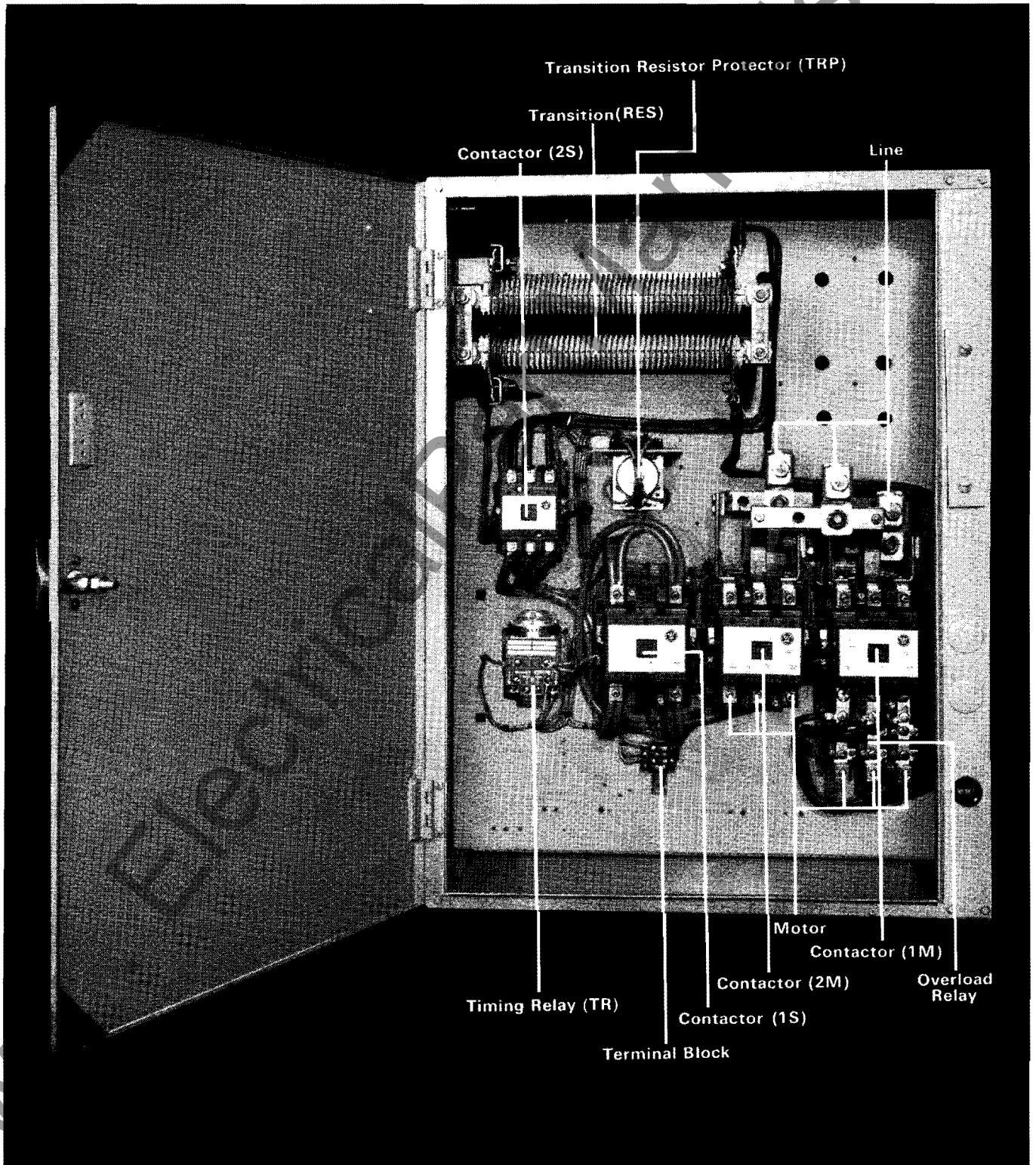
Approximate Only

Starter Class	Size	Dimensions			Max. Ship. Wt., Lbs.
		H⊕	W	D	
11-890	1-2-3-4 YD	35	24	12	400
	5 YD	76	28	14	900
	6 YD	90	28	21	1100

⊕ 76 and 90 inch high enclosures are floor mounted.

Contactor Sequence

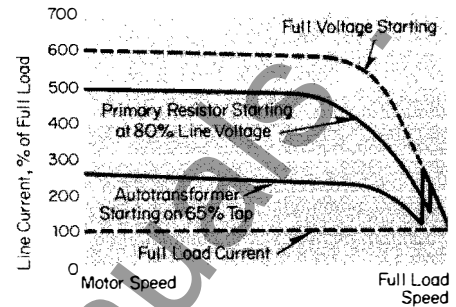
Contactor	Start	Transition	Run
1S	●	●	
1M		●	●
2S		●	●
2M			●



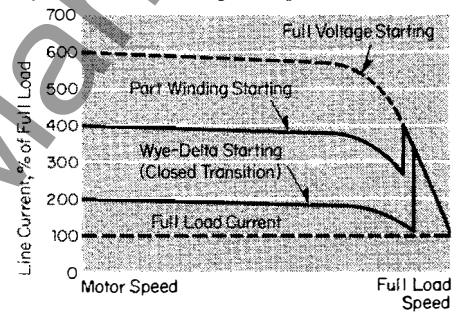


Type of Starter	Starting Characteristics in Percent of Full Voltage Values		
	Voltage at Motor	Line Current	Starting Torque
Full Voltage	100	100	100
Autotransformer	Taps		
	80	64	64
	65	42	42
50	25	25	
Primary Resistor	80	80	64
Part Winding	100	65	42
Wye-Delta	100	33%	33%

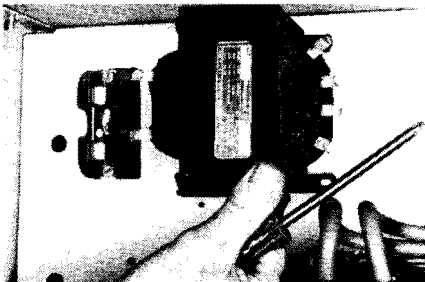
Primary Resistor or Autotransformer Starting



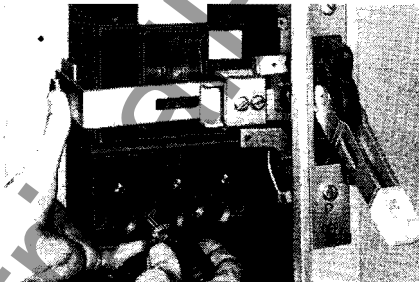
Wye-Delta or Part Winding Starting



Flexibility of Wall Mounted Starters



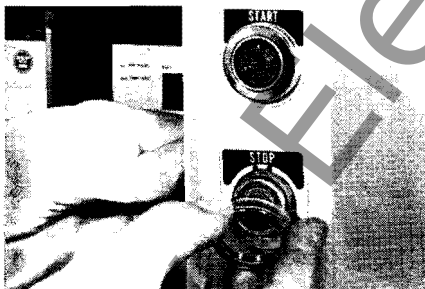
Panel predrilled for quick, simple installation of control transformer and secondary fuse.



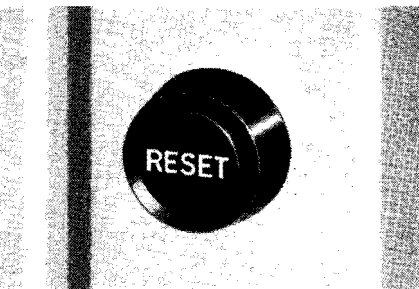
Predrilled for simple addition of molded case circuit breaker.



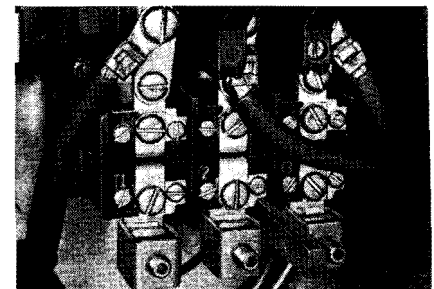
Prepunched for disconnect safety operating mechanism which is never separated from the disconnect . . . whether the door is open or closed.



Start-stop pushbuttons can be quickly and easily added.



External reset button can be easily installed in the prepunched opening.



Adjustable, block type, thermal overload relay. Three-pole protection is standard.

Further Information: Price List 9220