

T Y P I C A L  
W I R I N G  
D I A G R A M S

F o r

Full Voltage  
STARTING  
SWITCHES



A L L E N - B R A D L E Y



## i n t r o d u c t i o n

This booklet has been prepared as a guide to some of the useful ways Allen-Bradley manual and magnetic across-the-line starters may be applied. It will also serve as a useful aid where simple wiring systems are to be studied.

When applying these diagrams, it is well to remember that the features described in several diagrams may be combined into one to produce another useful way of applying Allen-Bradley equipment. As you become familiar with the diagrams, most such changes will prove simple. Exercises of this kind will be extremely beneficial to a student's better understanding of motor control wiring diagrams.

The Allen-Bradley Company is very much interested in helping engineers, electricians and students to a better understanding of motor control equipment. We hope this booklet furthers this purpose.



# c o n t e n t s

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## Key to Symbols

Shown here are the symbols most often used in this book. Although the explanations accompanying the diagrams describe the devices used, familiarity with the various symbols will lead to a quicker understanding of each circuit.

The symbols, device designations, and abbreviations in this book are taken from the American Standard for Graphical Symbols for Electrical Diagrams, Publication No. Y32.2-1954, and have been approved as Nema Standard.

## Wiring Diagram Symbols

| Device     |                        | Symbol             | Device    |                                 | Symbol  |
|------------|------------------------|--------------------|-----------|---------------------------------|---|
| Coils      | Relay and Switch Coils | <br>Single Winding | Fuse      | General                         |   |
|            |                        | <br>Tapped         |           |                                 |   |
| Contacts   | Normally Closed (NC)   | <br>Main           | Motors    | General                         | <br>A - Amber<br>B - Blue<br>C - Clear<br>G - Green<br>R - Red<br>W - White |
|            | Normally Open (NO)     | <br>Main           |           | Indicating Lights               |   |
|            | Time Closing           | <br>T. C.          |           | 3 Phase Squirrel Cage Induction |   |
|            | Time Opening           | <br>T. O.          |           | Single Phase                    |   |
| Contactors | AC Solenoid Type       |                    | Rectifier | 2 Phase 4 Wire                  |   |
|            | Manually Operated      |                    |           | Full Wave with Color Code       |   |



| Device      |                             | Symbol  | Device                         |   | Symbol   |            |            |            |   |  |   |   |   |   |  |  |
|-------------|-----------------------------|---|--------------------------------|---|--|------------|------------|------------|---|--|---|---|---|---|--|--|
| Relays      | Control Type BR             |   | Switches                       | Limit Switches  | <div>Normally Open</div> <div>Normally Closed</div> <div>Held Closed</div> <div>Held Open</div>                                |            |            |            |   |  |   |   |   |   |  |  |
|             | Control Type B              | <p>Single Deck</p>  |                                | Pressure and Temperature  | <p>When this symbol is used on a drawing the symbol should be identified as a "pressure switch" or a "temperature switch".</p> |            |            |            |   |  |   |   |   |   |  |  |
|             | Thermal Overload            | <p>Bulletin 815</p> <p>Left Right</p>   |                                | Push Button Standard  | <p>NC NO</p>   |            |            |            |   |  |   |   |   |   |  |  |
|             | Timing (Pneumatic) ON-DELAY | <p>Style AX</p>   |                                | Push Button Heavy Duty, Oiltight  | <p>Mushroom Head</p>   |            |            |            |   |  |   |   |   |   |  |  |
|             | 3-Wire Thermostat Type BA   | <p>2 Position 3 Position</p>  |                                | Push Button and Jog Attachment  | <p>Run Jog</p>   |            |            |            |   |  |   |   |   |   |  |  |
|             | Float Switch                | <p>When this symbol is used on a drawing the symbol should be identified as a "float switch".</p> |                                | Standard Duty Selector Switch   | <p>2 Position 3 Position</p>   |            |            |            |   |  |   |   |   |   |  |  |
| Switches    | Float Switch                | <p>When this symbol is used on a drawing the symbol should be identified as a "float switch".</p> | Heavy Duty Selector 2-Position | <table><tr><th>Letter Sym.</th><th>Position 1</th><th>Position 2</th></tr><tr><td>C</td><td>X</td><td></td></tr><tr><td>D</td><td></td><td>X</td></tr></table>                                      | Letter Sym.  | Position 1 | Position 2 | C          | X |  | D |   | X |   |  |  |
|             | Letter Sym.                 | Position 1  | Position 2                     |   |  |            |            |            |   |  |   |   |   |   |  |  |
| C           | X                           |   |                                |   |  |            |            |            |   |  |   |   |   |   |  |  |
| D           |                             | X   |                                |   |  |            |            |            |   |  |   |   |   |   |  |  |
|             |                             |   | Heavy Duty Selector 3-Position | <table><tr><th>Letter Sym.</th><th>Position 1</th><th>Position 2</th><th>Position 3</th></tr><tr><td>C</td><td></td><td></td><td>X</td></tr><tr><td>D</td><td>X</td><td></td><td></td></tr></table> | Letter Sym.  | Position 1 | Position 2 | Position 3 | C |  |   | X | D | X |  |  |
| Letter Sym. | Position 1                  | Position 2  | Position 3                     |   |  |            |            |            |   |  |   |   |   |   |  |  |
| C           |                             |   | X                              |   |  |            |            |            |   |  |   |   |   |   |  |  |
| D           | X                           |   |                                |   |  |            |            |            |   |  |   |   |   |   |  |  |
|             |                             |   | Transformer                    | Potential   |  |            |            |            |   |  |   |   |   |   |  |  |
|             |                             |   |                                | Current   |  |            |            |            |   |  |   |   |   |   |  |  |

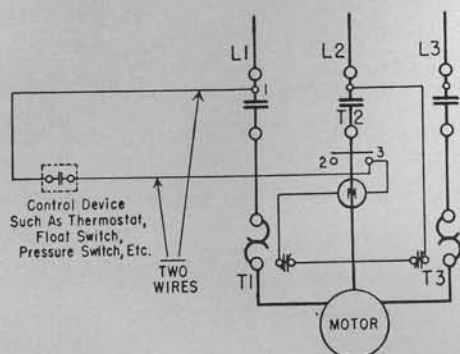
## SOME COMMON and IMPORTANT TERMS

In this booklet, and wherever motor control is discussed, there are several terms which are used repeatedly but whose meanings are often not completely understood by the reader. These terms represent things which are actually quite simple and everyone should become familiar with them as standard "motor control jargon."

### NO-VOLTAGE RELEASE

Also Called: Low-Voltage Release  
**Two-Wire Control**

These terms mean that the starter will drop out when there is a voltage failure and will pick up again as soon as voltage returns. Reference to the diagram below will show how this occurs. The pilot device is unaffected by the loss of voltage and its contact remains closed, ready to carry current as soon as line voltage returns to normal.

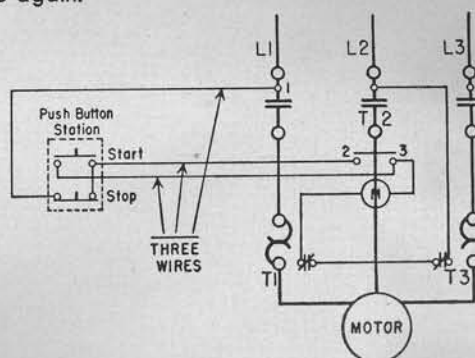


Two wires lead from the pilot device to the starter. "No-voltage release" and "two-wire control" should bring to mind an automatic pilot device such as a limit switch or float switch whose function is opening and closing the control circuit by means of a single contact.

### NO-VOLTAGE PROTECTION

Also Called: Low-Voltage Protection  
**Three-Wire Control**

These terms mean that the starter will drop out when there is a voltage failure but will not pick up automatically when voltage returns. The control circuit is completed through the "Stop" button and also through a "holding" contact (2-3) on the starter. When the starter drops out, this contact opens, breaking the control circuit until the "Start" button is pressed once again.



Three wires lead from the pilot device to the starter. "No-voltage protection" and "three-wire" control should bring to mind a "Start-Stop" push button station which is the most common means of providing this type of control.

The main distinction between the above two types of control is that with **no-voltage release** the coil circuit is maintained through the pilot switch contact, and with **no-voltage protection** it is maintained through a "stop" contact on the push button station and also an auxiliary contact on the starter. The designations "two-wire" and "three-wire" are used only because they describe the simplest applications of the two types. Actually, in other systems, there might be more wires leading from pilot device to starter but the principle of "two-wire" or "three-wire" control would still be present.

## "WIRING DIAGRAMS" vs "LINE DIAGRAMS"

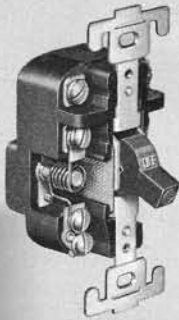
Most of the diagrams in this book are shown in two ways. There is a "wiring diagram" and adjacent to it a "line diagram." Line diagrams are included because their use is becoming more widespread and we believe it is advantageous to learn to use them.

Wiring diagrams include all of the devices in the system and show their physical relation to each other. All poles, terminals, coils, etc. are shown in their proper place on each device. These diagrams are helpful in wiring-up systems, because connections can be made exactly as they are shown on the diagram. In following the electrical sequence of any circuit, however, the wiring diagram does not show the connections in a manner that can be easily followed. For this reason a rearrangement of the circuit elements to form a line diagram is desirable.

The line diagram (sometimes referred to as an elementary diagram or a schematic diagram) is a repre-

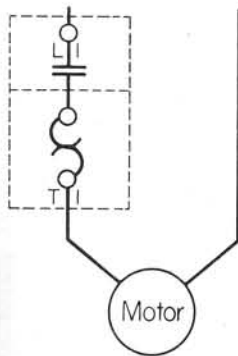
sentation of the system showing everything in the simplest way. No attempt is made to show the various devices in their actual relative positions. All control devices are shown between vertical lines which represent the source of control power, and circuits are shown connected as directly as possible from one of these lines to the other. All connections are made in such a way that the functioning of the various devices can be easily traced.

A **wiring diagram** gives the necessary information for actually wiring-up a group of control devices or for physically tracing wires when trouble-shooting is necessary. A **line diagram** gives the necessary information for easily following the operation of the various devices in the circuit. It is a great aid in trouble-shooting as it shows, in a simple way, the effect that opening or closing various contacts has on other devices in the circuit.



Bulletin 600 manual starting switches are designed for starting and protecting small AC and DC motors rated at 1 HP or less. They are operated by a toggle lever mounted on the front of the switch. Wiring diagrams do not show the operating mechanism since it is not electrically controlled.

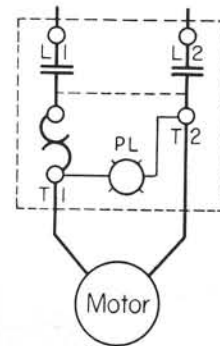
These motor starters consist of an "On-Off" snap switch combined with a thermal overload device operating on the soldered ratchet principle. Terminal markings corresponding to those shown on the diagrams will be found on each switch.



**Catalog No. 600TAX4**

Single pole switches can be used wherever the electrical requirements permit only one motor line to be broken.

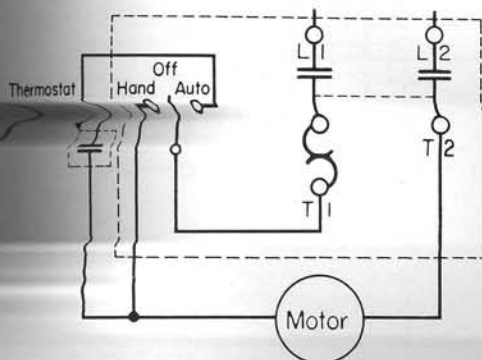
1.



**Catalog No. 600TAX109**

Double pole switch with built-in Neon pilot light to indicate when switch is on.

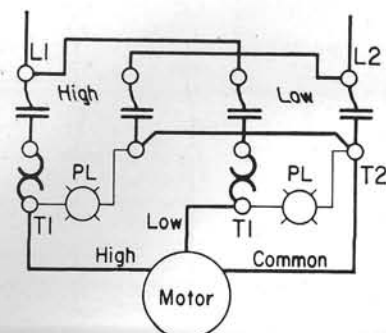
2.



**Catalog No. 600TAX9**

For use with automatic pilot devices such as thermostats, and float switches. A selector switch is mounted in the same enclosure to allow manual operation of the automatically controlled equipment.

3.



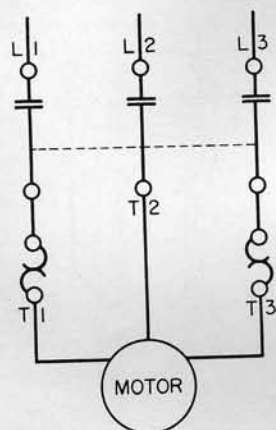
**Catalog No. 600TKX293**

Two speed manual motor starter is designed for starting and protecting small, single phase, two-speed AC fan motors. Consists of two mechanically interlocked switches.

4.



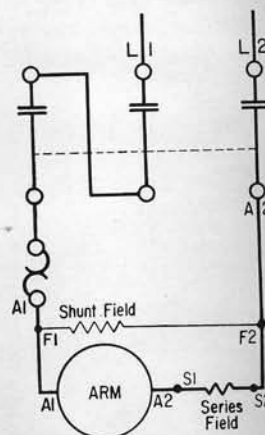
Bulletin 609 manual starters are operated by "Start-Stop" push buttons mounted on the front of the starter. Wiring diagrams do not show the operating mechanism since it is not electrically controlled. Pushing the "Start" button mechanically closes the contacts, connecting the motor to the line. The contacts can be opened by pressing the "Stop" button or by tripping of one of the solder ratchet overload relays. Terminal markings corresponding to those shown on the diagrams will be found on each switch.



**Sizes 0 & 1**

3 Phase or 2 Phase, 3 Wire  
(For 2 Phase, 3 Wire, L2 and T2 are common)

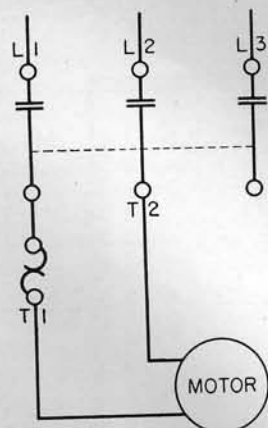
5.



**Sizes 0 & 1**

Direct Current

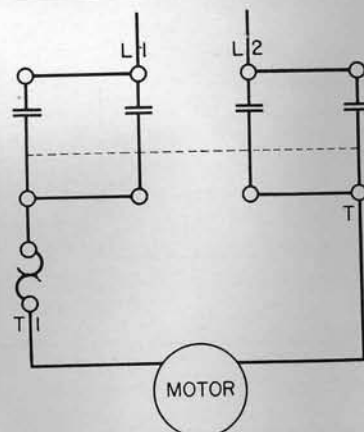
6.



**Sizes 0 & 1**

Single Phase

7.



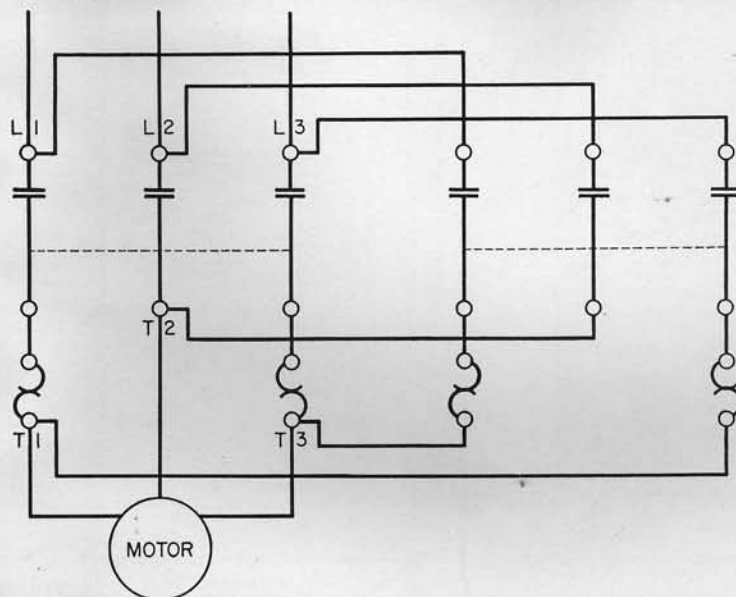
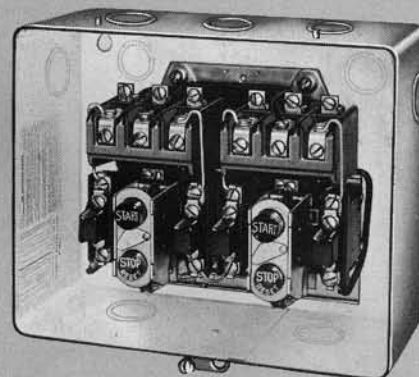
**Size 1P**

Single Phase

8.



The Bulletin 609RS manual reversing starters and the Bulletin 609TS manual two-speed starters consist of two standard Bulletin 609 starters mounted in a single enclosure. Internal wiring of these starters provides the necessary connections for interchanging two motor connections in the case of the 609RS or switching to another winding in the case of the 609TS. Bulletin 609TS is for two-speed separate winding motors only. Terminal markings corresponding to those shown on the diagrams will be found on each switch.

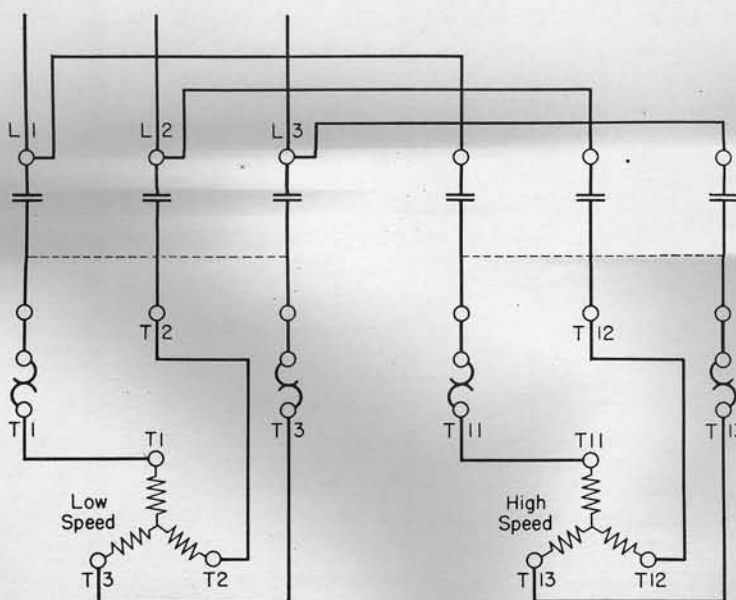


**Reversing  
Starter**

**Bulletin  
609RS**

**Sizes 0 & 1**  
3 Phase  
2 Phase, 3 Wire

**9.**



**Two-Speed  
Starter**

**Bulletin  
609TS**

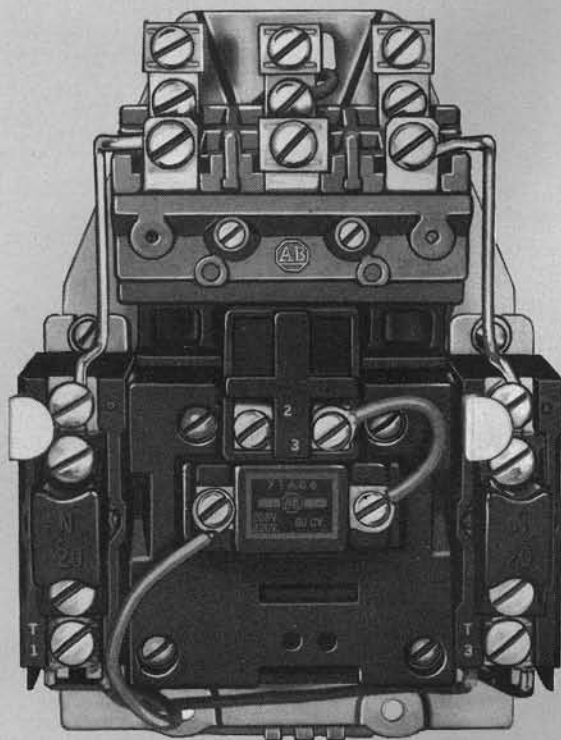
**Sizes 0 & 1**  
3 Phase  
2 Phase, 3 Wire

(For separate  
winding motors  
only)

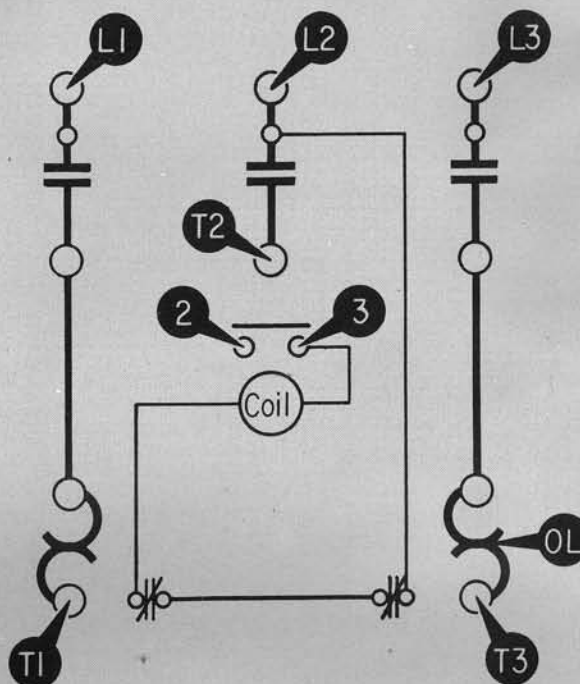
**10.**



## THE BULLETIN 709 AS REPRESENTED BY A WIRING DIAGRAM



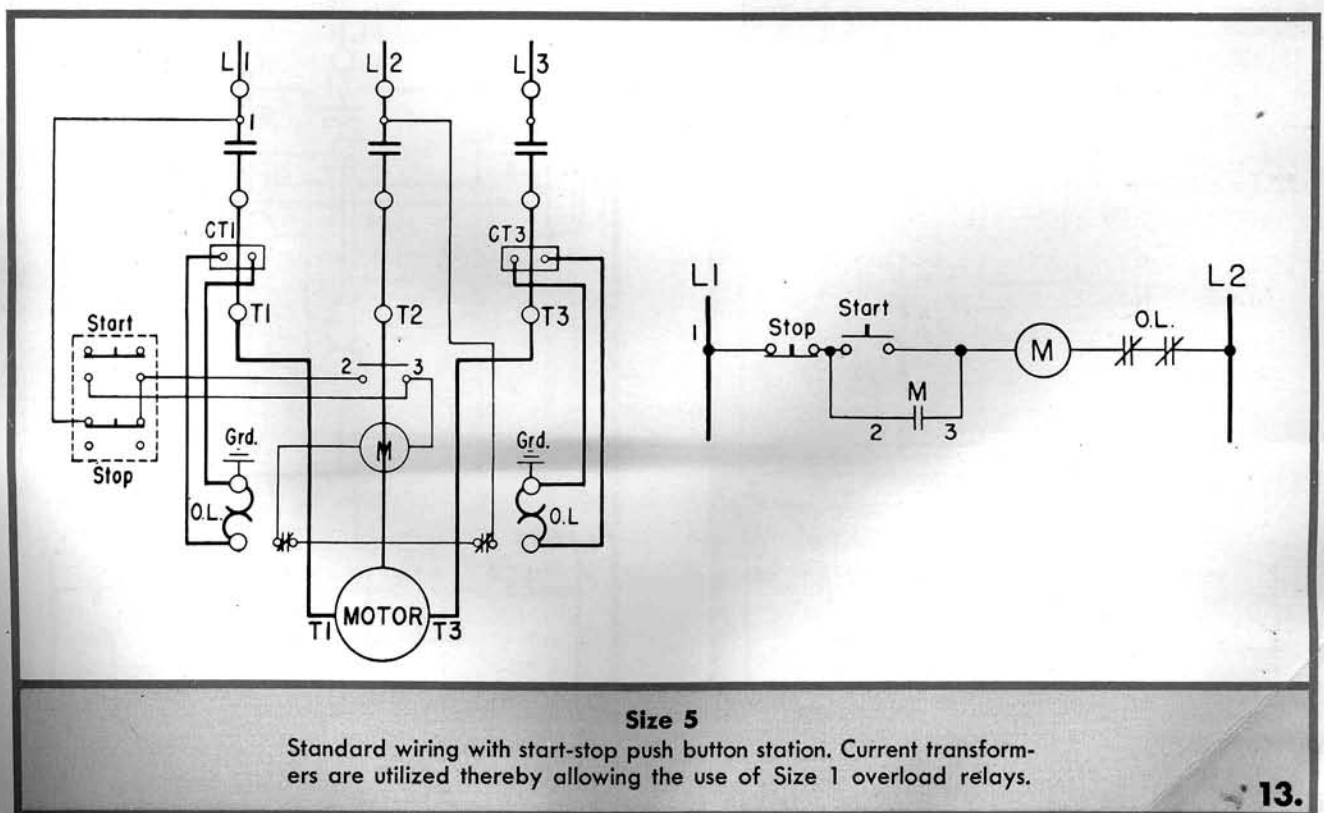
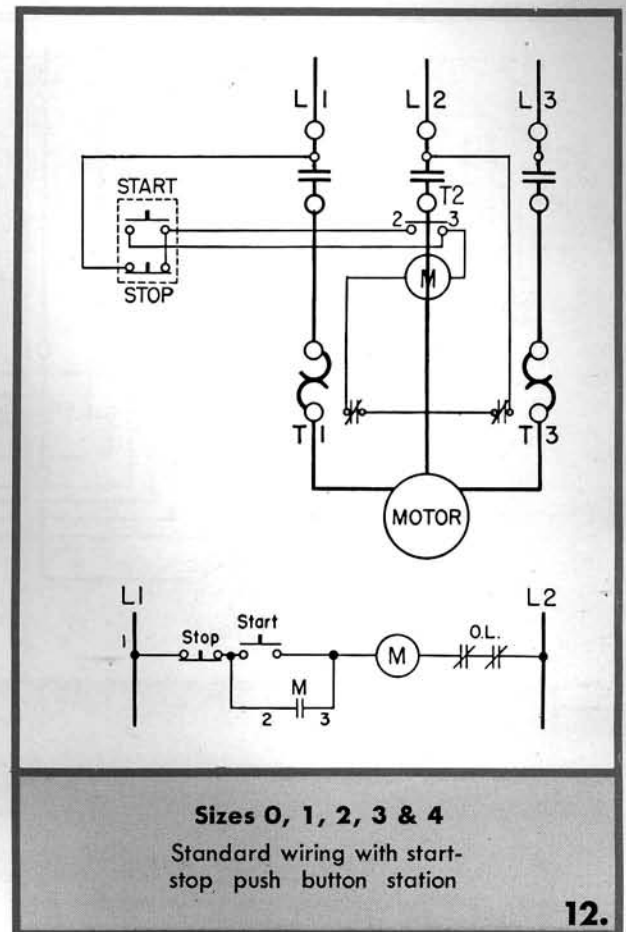
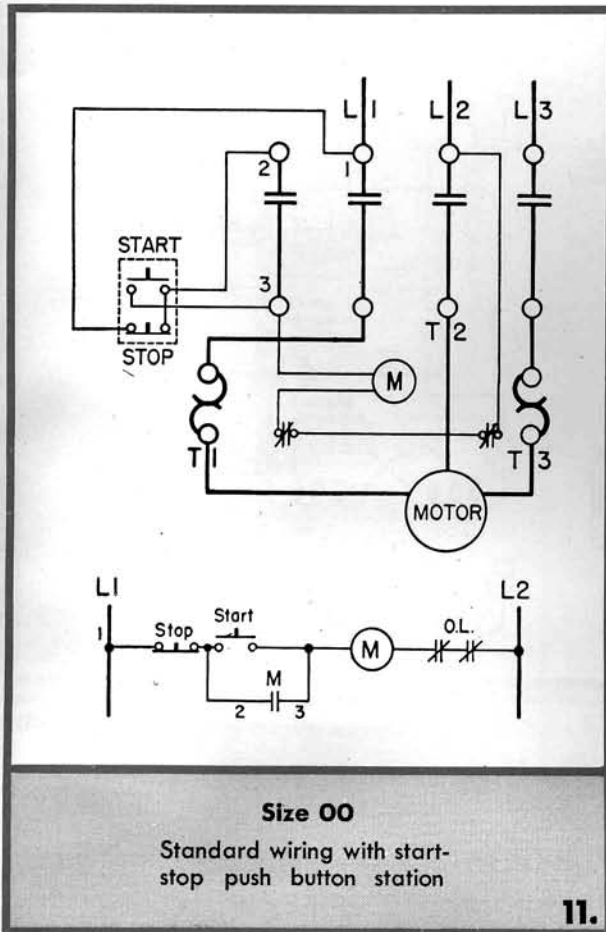
Bulletin 709 Starter, Size 1, Form 2

Wiring Diagram For  
Bulletin 709 Starter, Size 1, Form 2

Comparison of the picture and drawing shown above should help the reader become familiar with the Allen-Bradley Bulletin 709 starter as it is represented in wiring diagram form. Principal corresponding parts are labeled so that the wiring diagram can be compared with the actual starter. This should aid in visualizing the starter when studying a wiring diagram and will help in making connections when it is actually wired up. Note that the wiring diagram shows as many parts as possible in their proper relative positions. It is not necessary to show the armature and crossbar or the overload reset mechanism in the wiring diagram since these parts need not be considered from the wiring standpoint.

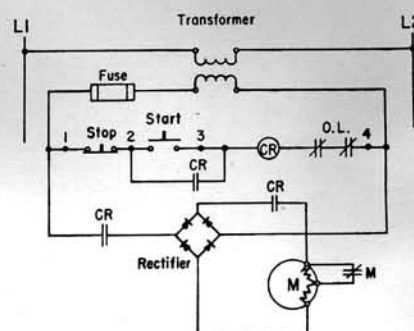
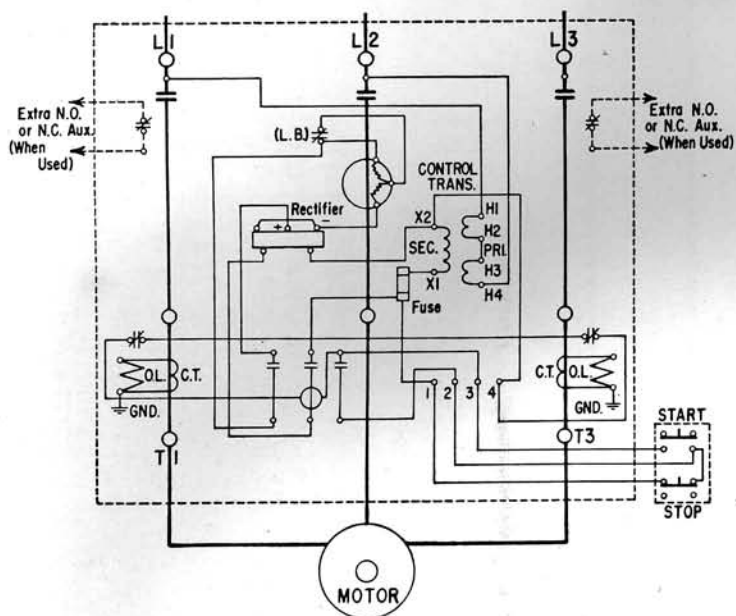
The Size 1 starter is shown here because all of the special wiring diagrams in this booklet use Size 1 starters as examples. The other sizes of starters have a similar appearance as the Size 1 and their principle of operation is the same. Wiring of the other sizes of starters is the same as for Size 1 although some of the connections are not physically located in the same places as on the Size 1.

### 3 Phase Starters





## 3 Phase Starter

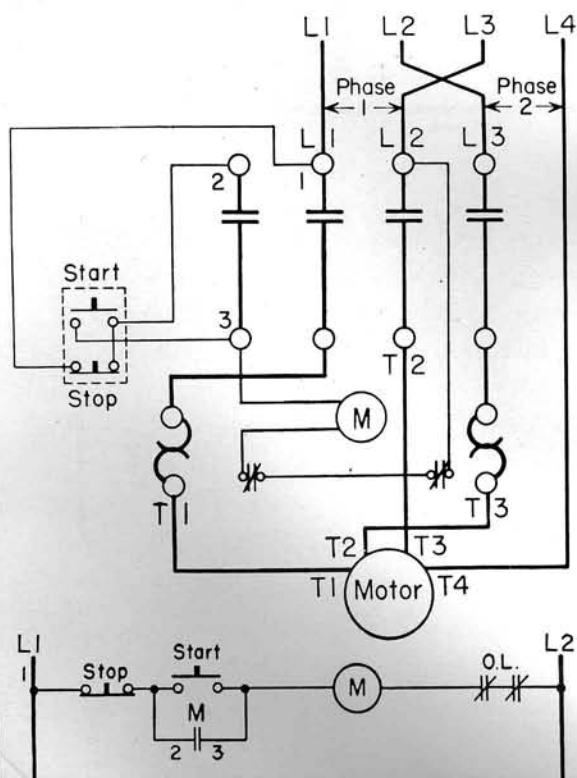


## Sizes 6 &amp; 7

Standard wiring with start-stop push button station.

14.

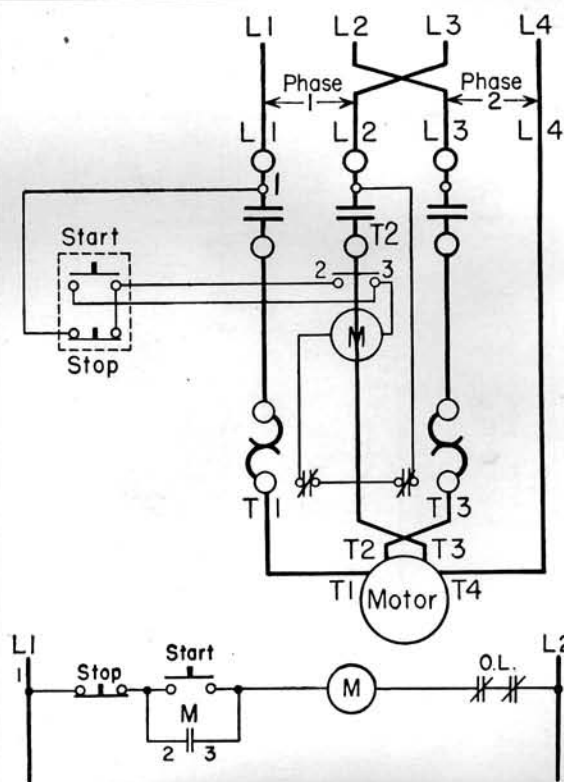
## 2 Phase, 4 Wire Using Standard 3 Phase Starters



## Size 00

Standard wiring with start-stop push button station.

15.



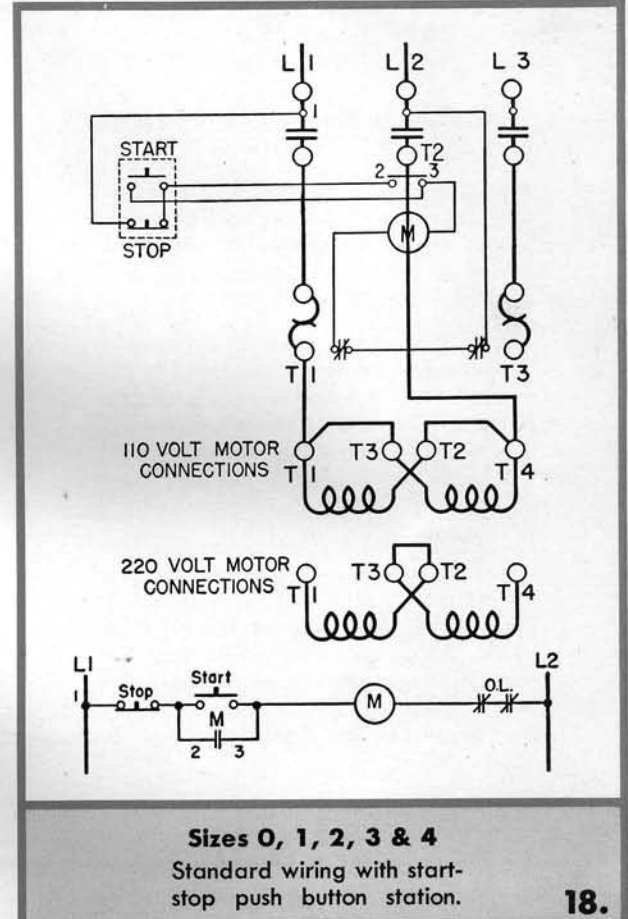
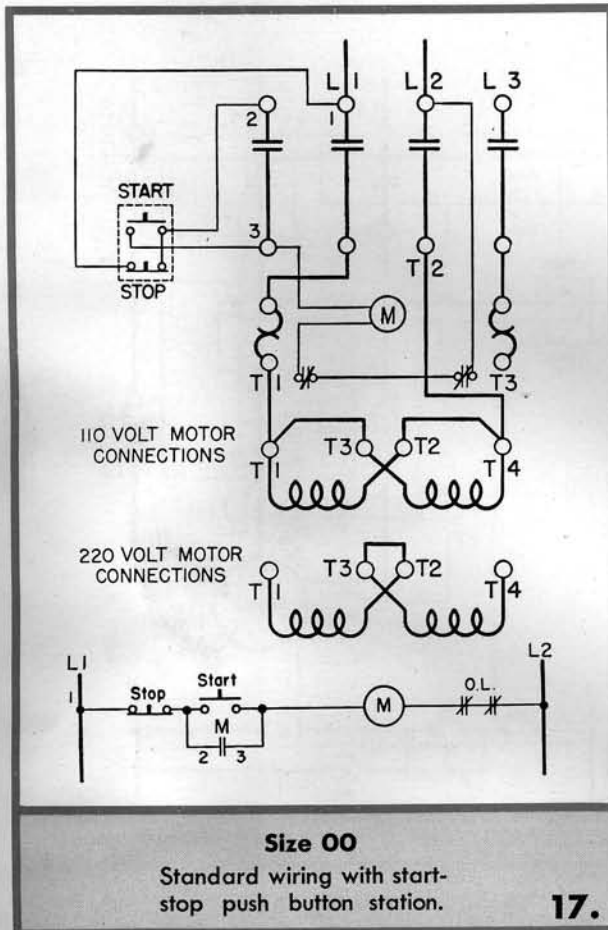
## Sizes 0, 1, 2, 3 &amp; 4

Standard wiring with start-stop push button station.

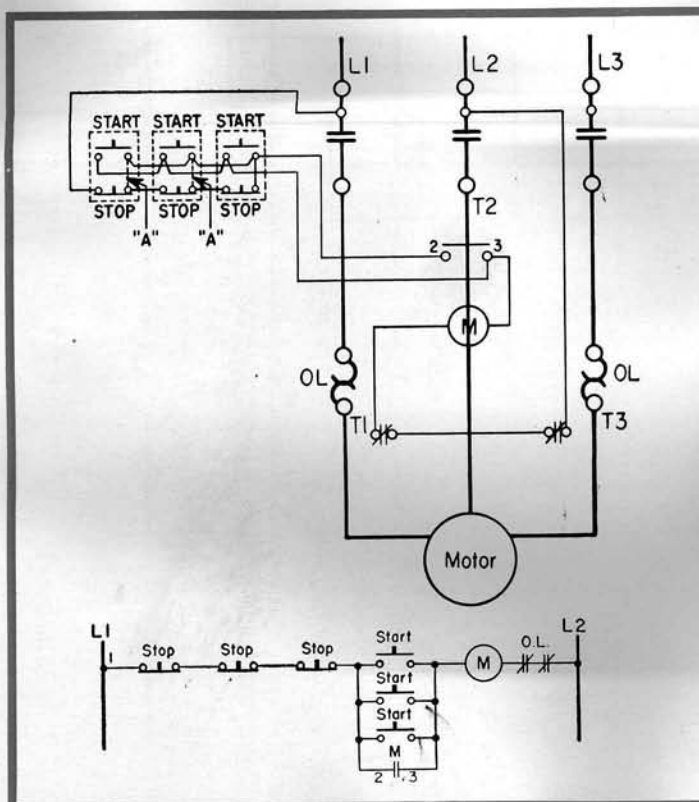
16.



## Single Phase Using Standard 3-Phase Starters



## Variations With Start-Stop Stations



## More Than One Start-Stop Station Used to Control a Single Starter

This is a useful arrangement when a motor must be started and stopped from any of several widely separated locations.

Notice that it would also be possible to use only one "Start-Stop" station and have several "Stop" buttons at different locations to serve as emergency stops.

Standard duty "Start-Stop" stations are provided with the connections "A" shown in the adjacent diagram. This connection must be removed from all but one of the "Start-Stop" stations used.

Heavy duty and oiltight push button stations can also be used but they do not have the wiring connection "A", so it must be added to one of the stations.



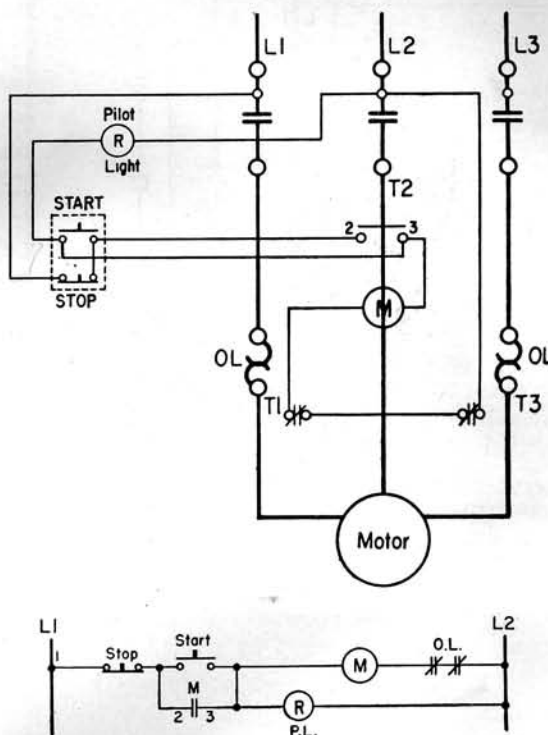
### Variations With Start-Stop Stations

#### Start-Stop Station with Pilot Light to Indicate When Motor is Running

A pilot light is to be used with a three-wire "Start-Stop" station, so that it will be on when the starter is energized and thus show that the motor is running.

The light is shown here as separately mounted, but it can be combined in the same enclosure with the start and stop buttons. Heavy duty stations combining all three are Bulletin 800, Type 2HAP (250 volts max.) and Bulletin 800, Type 2HAY (480 volts max.).

For oiltight stations which combine all three, use Bulletin 800T, Type 2TAR (110 volts max.), Type 2TAP (250 volts max.), Type 2TAY (480 volts max.), or Type 2TAV (550 volts max.). Note that the pilot light can also be operated by a NO Bulletin 1495 auxiliary switch in the manner of the following diagram.



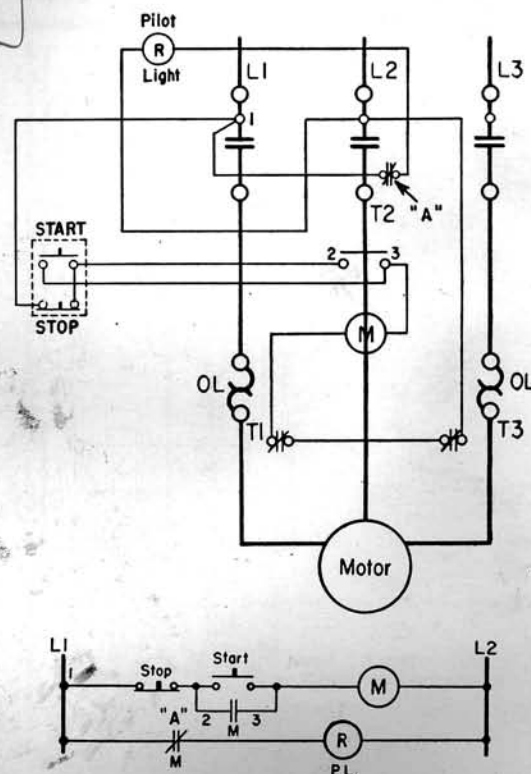
20.

#### Station with Pilot Light to Indicate When Motor is Not Running

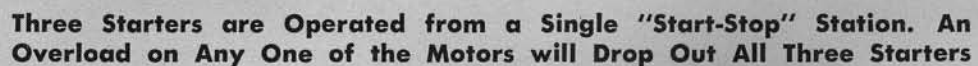
It is necessary for a pilot light to show when the starter is de-energized and the motor is not running.

This requirement is most easily fulfilled by attaching a normally closed **Bulletin 1495 auxiliary contact** to the starter and connecting it between L1 and L2 in series with the pilot light. "A" represents the Bulletin 1495 auxiliary contact which can be added to any Allen-Bradley starter, sizes 0 through 5.

If the pilot light is to be included in the same enclosure with the start and stop buttons, any of the push button stations listed with drawing No. 20 can be used. The Bulletin 1495 auxiliary contact has many other uses besides the ones shown here. It can also be used to operate other devices, interlock starters, etc.

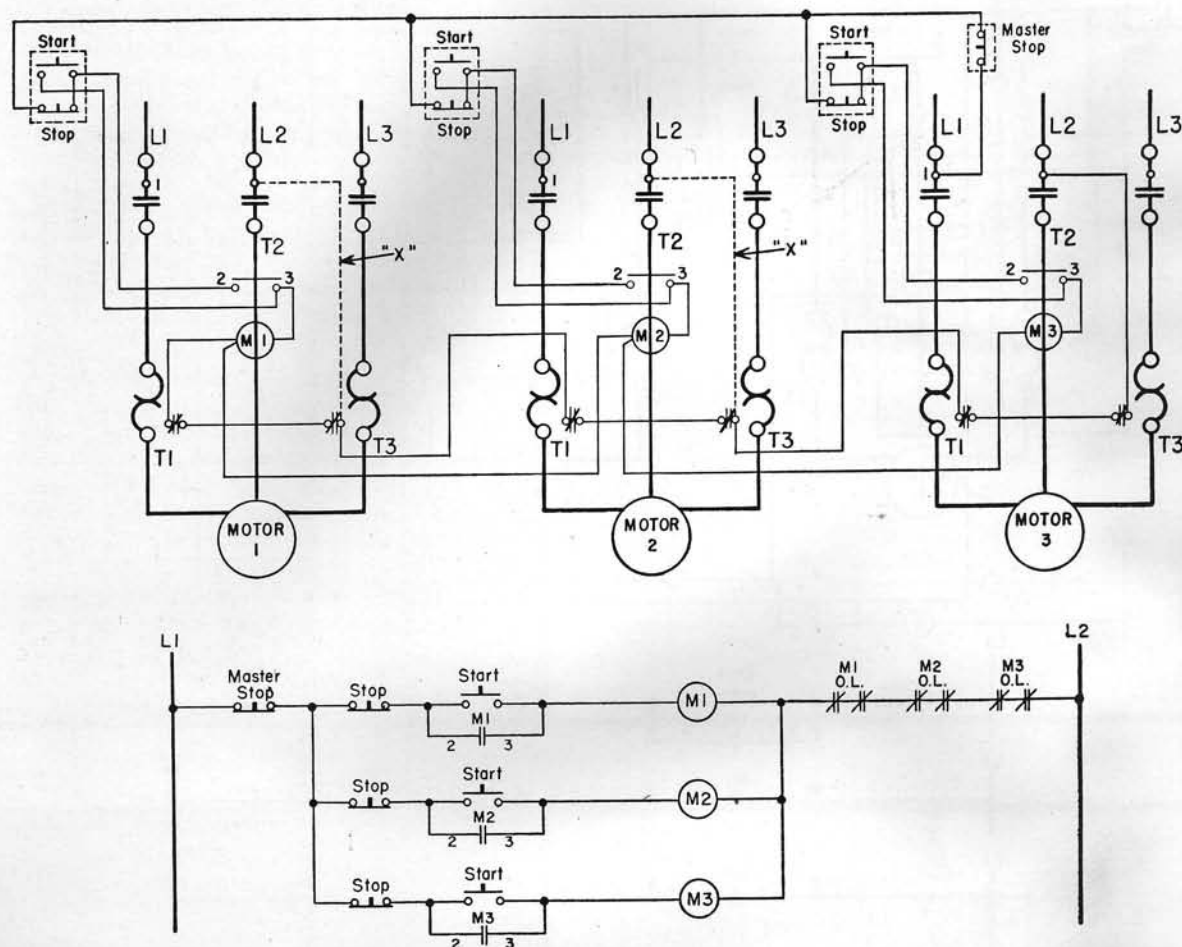


21.



Assuming that standard Bulletin 709, Form 2 starters are to be used, then in order to obtain the desired operation, the wiring connection "Y" must be removed from each starter. The control circuits of the several starters are interconnected. It is therefore necessary to break the power to the line terminals of all the starters to completely disconnect the equipment from line voltage.

## Variations With Start-Stop Stations



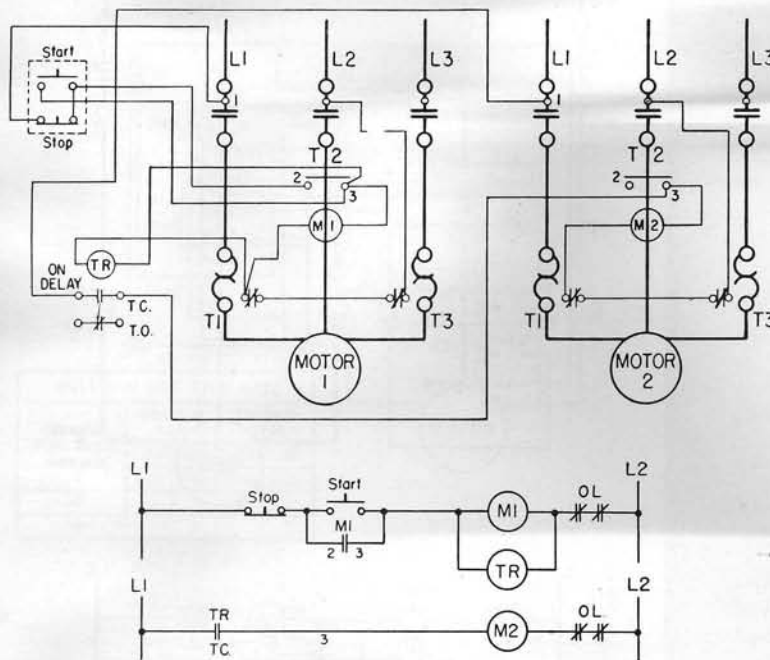
### Each Starter is Operated by Its Own "Start-Stop" Station. Overload on One Drops Out All Starters. A Master "Stop" Station Can Be Provided

Several starters (3 used in diagram) are to be wired so that each starter is operated from its own "Start-Stop" push button station. However, a maintained overload, tripping a relay on any one of the starters, will automatically drop out all of the starters. A master "Stop" station wired into the circuit as illustrated will trip out all starters when pushed.

To obtain the desired operation using standard Bulletin 709 Form 2 starters, wire "X" must be removed from all but one of the starters. Where the starters are used with disconnect switches, either as separate units or as "combination" starters, all disconnects must be in the "off" position in order to completely disconnect the equipment from line voltage.



# Variations With Start-Stop Stations



## Two Starters are to Be Operated from a Single Station, But a Short Delay Must Prevent Them from Being Energized Together

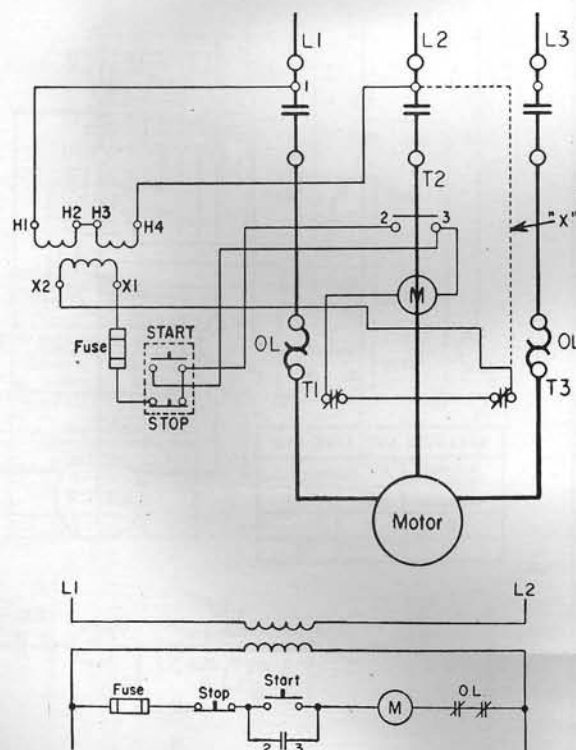
In some cases, the power distribution system *does not* have sufficient capacity to start several motors simultaneously. If several motors are to be started from the same push button station under these conditions a time delay can be provided between the operation of the motor starters.

When the start button is pushed, the first starter is energized along with a timing relay. When the timing relay times out, it operates a contact which closes the control circuit of the second starter. (The timer can be a Bulletin 849.)

If more than two starters are to be used, additional timers will have to be added in the same way as the one shown connected to M1 here.

24.

# Step-Down Transformer in Control Circuit



## Step-Down Transformer Provides Low Voltage for Control Circuit Wired for Three-Wire Control

The starter coil is to be operated on a voltage lower than line voltage. (Usually done for safety reasons.) This requires the use of a step-down transformer in the pilot circuit. The starter is operated from a "Start-Stop" push button station, either standard duty, heavy duty or oiltight.

When a control circuit step-down transformer is used with a standard Bulletin 709 starter, the wiring connection "X" must be removed. Note that a fuse is added to the transformer secondary.

25.



## Jogging

**Jogging, Safety Provided By Relay**

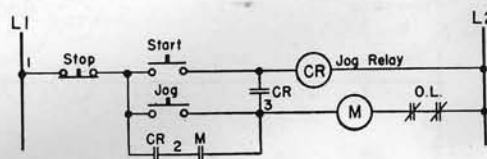
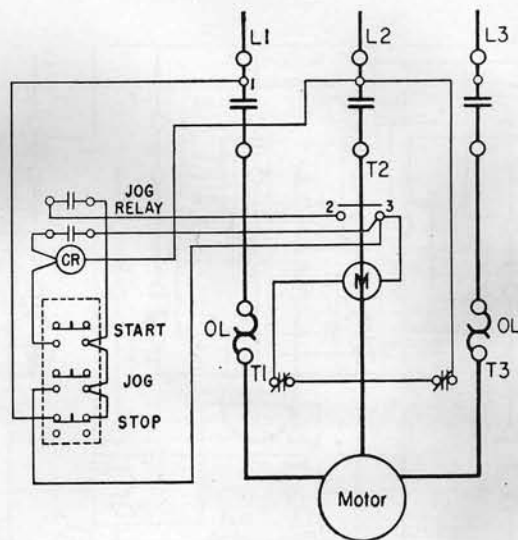
The Bulletin 709 starter is to be operated by a "Start-Jog-Stop" push button station.

The purpose of jogging is to have the motor operate only as long as the "jog" button is held down. The starter must have no chance to "lock in" during jogging, and for this reason the "jog relay" is used.

Pushing the "start" button operates both the motor starter and the jog relay, causing the starter to lock in through one of the relay contacts. When the "jog" button is pressed, the starter operates, but this time the relay is not energized and thus the starter cannot lock in.

CR represents the "jog relay," a Bulletin 700 Type C-20.

For a surface mounted heavy duty "Start-Jog-Stop" station, specify Bulletin 800 Type 3HG. A Bulletin 800T can also be used.

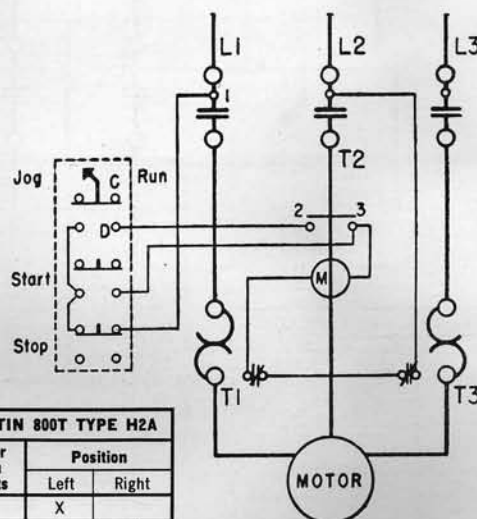


26.

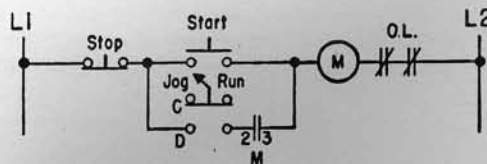
**Jogging With a Selector Switch**

Here, a three-unit Bulletin 800T Station including a catalog A1A START, a B6A STOP and a H2A JOG-RUN selector switch are used. A Bulletin 800H heavy duty station could also be utilized.

The circuit to the hold-in contact "M" is broken when the selector is in the "JOG" position. The "START" button is used to "JOG" or "RUN" the motor, depending on the position of the selector switch.

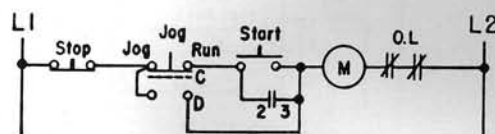
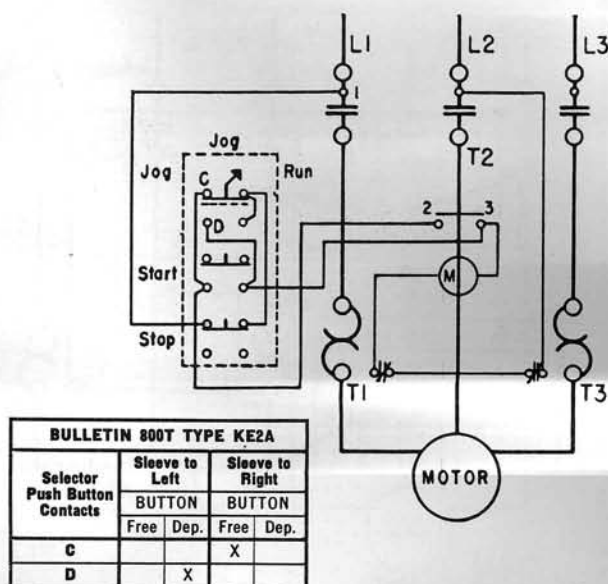


| BULLETIN 800T TYPE H2A   |          |       |
|--------------------------|----------|-------|
| Selector Switch Contacts | Position |       |
|                          | Left     | Right |
| C                        | X        |       |
| D                        |          | X     |



27.

## Jogging



## Jogging With Selector Push Button

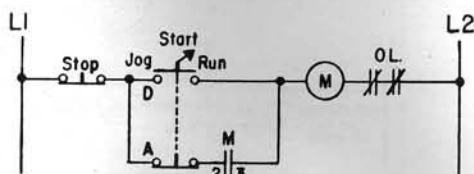
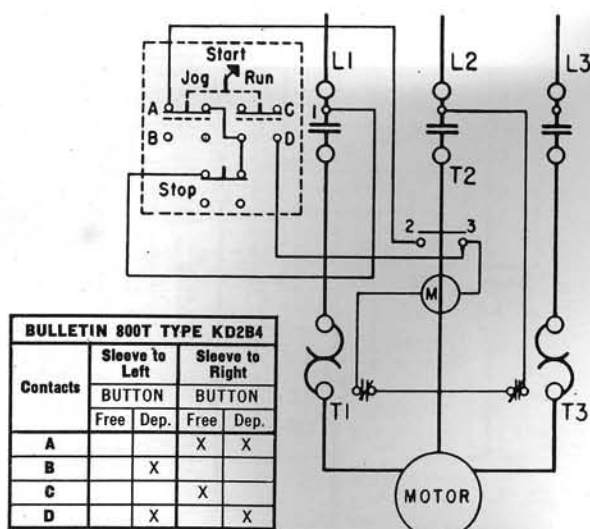
This is one of the safest and most desirable types of circuits available for jogging or inching service.

When the sleeve of the selector push button is turned clockwise to the "RUN" position the "START" and "STOP" buttons function according to the principle of the simplest "three-wire" control device.

With the sleeve in the "JOG" position the circuit to the "START" button and the hold-in contact "M" is broken. The motor will run only as long as the "JOG" button is held down.

A three unit Bulletin 800T station including a catalog A1A START, B6A STOP, and KE2A selector push button with an appropriate nameplate are shown. A Bulletin 800H, heavy duty, station may also be used.

28.



## Jogging With Selector Push Button Start Unit

A combination of the functions of the START and JOG buttons is provided in one unit. Only two of the four circuits provided by the selector push button are required, but a double block contact unit is necessary to obtain the proper contact operation. The "START" button is used to "JOG" or "RUN" depending upon the position of the selector ring.

This is a two-unit Bulletin 800T including catalog number B6A STOP and KD2B4 selector push button marked JOG-START-RUN. A Bulletin 800H, heavy duty, push button may also be used.

29.



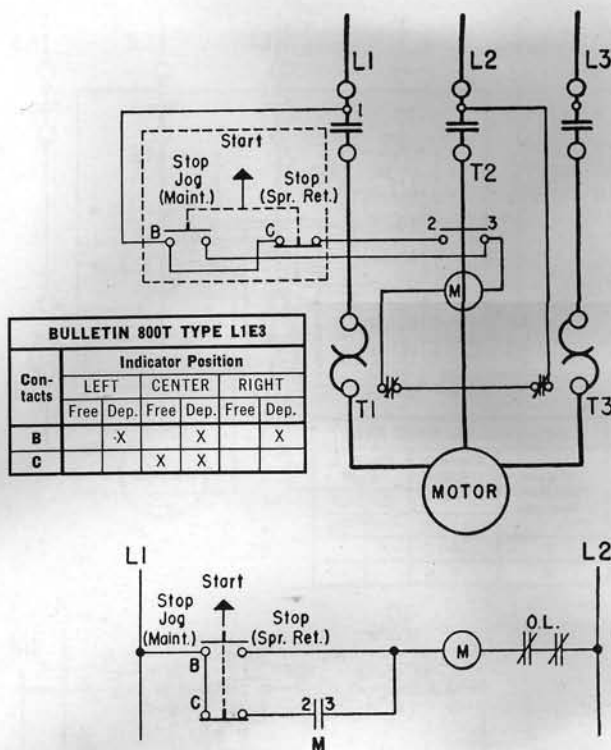
## Jogging

### Jogging With Wing Lever Push Button

For special applications where it is desirable to have all the functions of the "START", "JOG" and "STOP" buttons in one unit a Bulletin 800T catalog number L1E3 can be used. Catalog L1E3 with an appropriate nameplate may be either panel mounted or placed into a Bulletin 800T, oiltight, one unit enclosure.

The wing lever whether turned clockwise or counterclockwise opens the circuit to the hold-in contact and stops the motor. From the "STOP" position the wing lever is spring return.

To "JOG", the wing lever must be turned counter-clockwise. It is maintained in this position and contact "C" is held open, preventing any circuit through the hold-in contact "M". The motor is then jogged by pressing the "START" button.



**30.**

## Two-Wire Control Circuits

**Starter Operated by Pressure Switch or Thermostat with Manual Control Provided by a Selector Switch. High Pressure Cut-Out Switch Can Be Added**

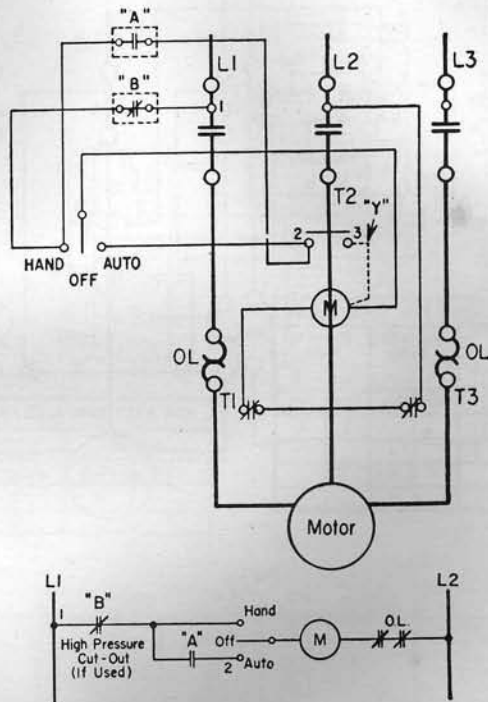
The selector switch makes it possible to operate the starter manually for testing or in case of failure of the automatic pilot control. When a standard Bulletin 709, Form 2, across-the-line starter is used, connection "Y" is removed and the wiring follows the solid lines of the diagram.

The selector switch feature can be obtained in a more convenient manner if the Form 3 starter is used. Form 3 has the selector switch built-in as part of the starter.

If a "high pressure" cut-out switch is added, it should be inserted in the line leading from L1 to the "Hand" terminal of the selector switch.

"A" represents the thermostat or "low pressure" switch and "B" represents the "high pressure" cut-out or "safety" switch.

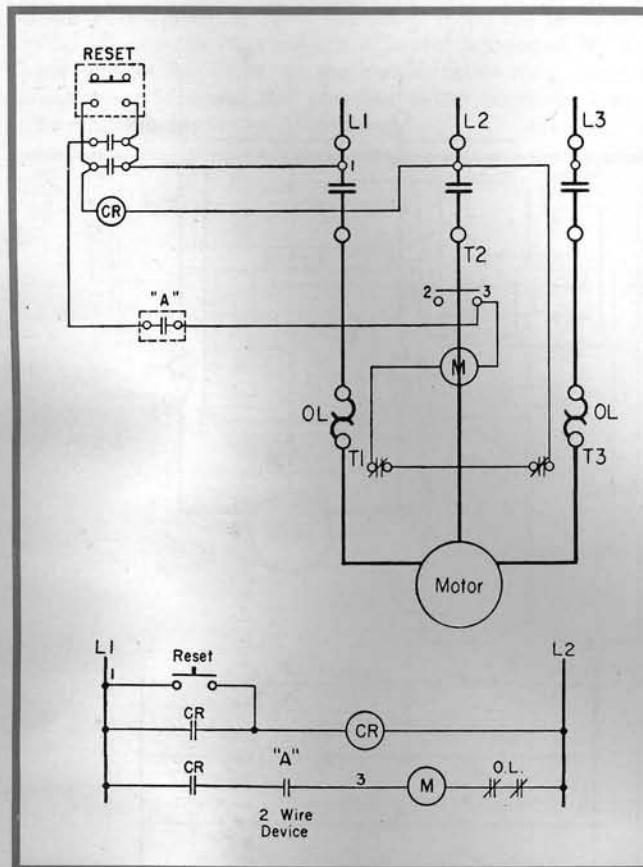
For the "Hand-Off-Auto" selector switch, either a Bulletin 800 Type R3SX (standard duty), a Type R3HA (heavy duty), or a Bulletin 800T R3TA (oiltight) can be used.



**31.**



## Two-Wire Control Circuits

**Two-Wire Control with Control Relay Added to Provide No-Voltage Protection**

No-voltage protection is often necessary when two-wire control is used in a location where line disturbances are frequent. Since the two-wire pilot device is not affected by loss of voltage, its contact will remain closed even though there is no power on the line. This means that without the feature of no-voltage protection, repeated voltage dips would cause the starter to "chatter" and welding of contacts might result.

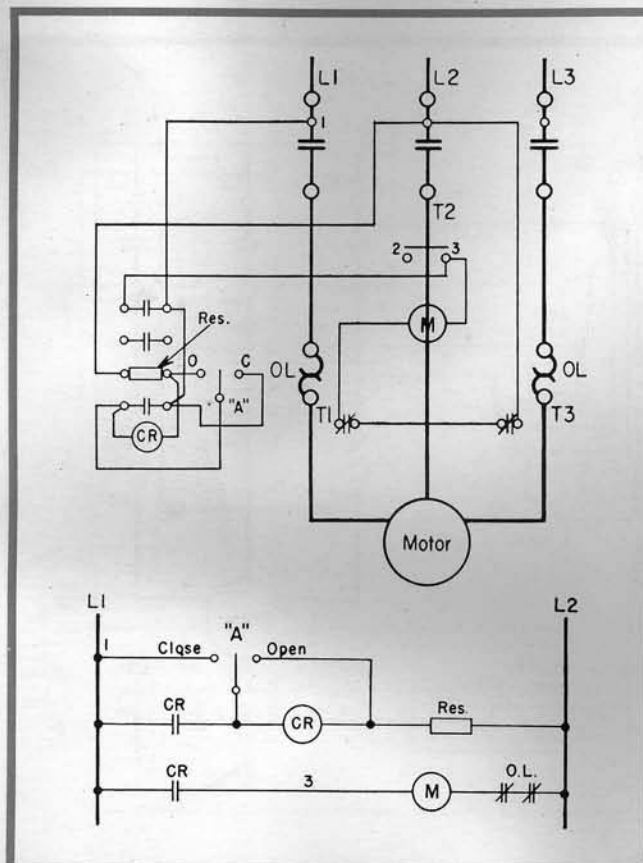
If a voltage failure relay is added, it will open the pilot circuit at a bad voltage dip and will not permit the starter to close again until the relay has been reset.

"A" represents the two-wire pilot device.

The reset button, can be a Bulletin 800 Type 1HG (heavy duty) or a Bulletin 800T Type 1TG (oiltight).

CR represents the voltage failure relay. A Bulletin 700 Type C-20 relay can be used.

32.

**Starter is Controlled by a Gauge-Type Thermostat**

Since the contacts of a thermostat of this type usually cannot handle the current to a starter coil, a "thermostat relay" must be used as an intermediate step between thermostat and starter. The relay is energized when the "close" contact is made and de-energized when the "open" contact is made. The "open" contact by-passes the relay coil to de-energize it. A resistor, built into the relay, prevents a short circuit when this is done.

The thermostat contacts must not overlap or be adjusted too close to one another, since this may burn out the resistance unit. It is also advisable to check the inrush current of the relay against the current rating of the thermostat. This scheme can also be used with pressure controls.

"A" represents the three-wire gauge type temperature control device.

CR represents the thermostat relay. A Bulletin 700 Type BA-20A can be used here.

33.



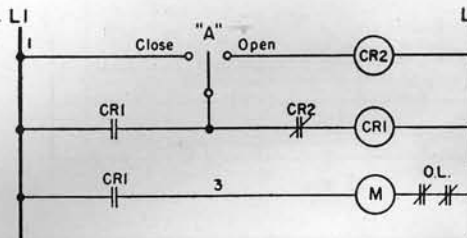
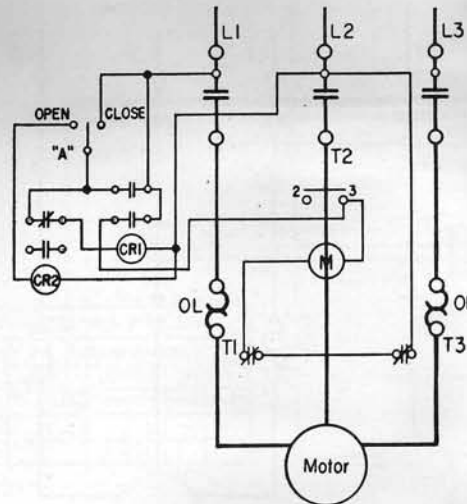
## Two-Wire Control Circuits

**Starter is Controlled by a Gauge-Type Thermostat Whose Contacts Can Switch Only a Small Amount of Current**

Here is another method of protecting thermostat contacts from high current. This scheme, however, is for use with a thermostat whose contacts can handle even less current than the ones in the previous example.

In a case like this, it is advisable to use relays having coils which operate at a very small value of volt-amperes. This will reduce the burden on the thermostat contacts and is especially advisable where frequent operation is required. "A" represents the three-wire sensitive gauge type control.

CR1 and CR2 represent low coil current relays, Bulletin 700, Types CL-20 and CL-11, respectively.



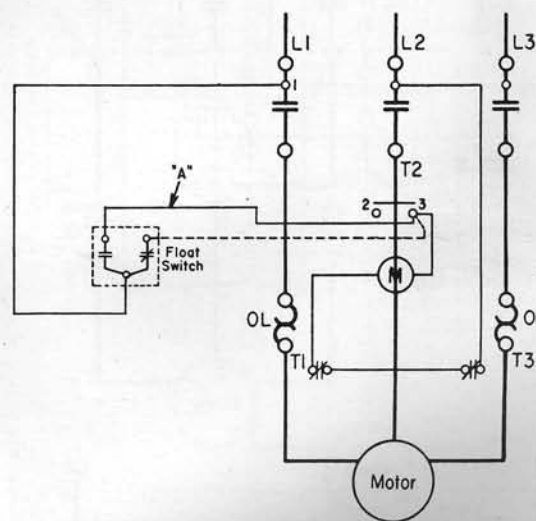
34.

**Float Switch Controls Starter**

The diagram shows a float switch intended for tank operation. When the water reaches "low" level the float switch closes. Pumping action will continue until the water reaches "high" level.

For sump pumping remove wire "A" and connect as per the dotted line. At "low" level the float switch operates and stops the pumping action. Sump pumping action will not commence until the water reaches "high" level.

A Bulletin 840 Float Switch with an appropriate float switch accessory may be used for this application.

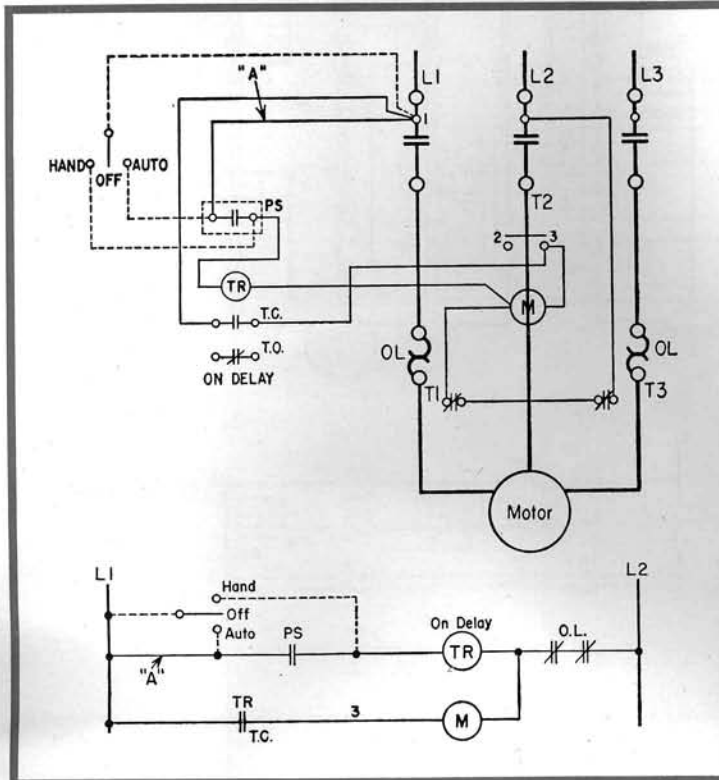


35.

## Pump Operation

**Surge Protection** is often necessary when the pump is turned off and the long column of water is stopped by a check valve. The force of the sudden stop may cause surges which operate the pressure switch contacts, thus subjecting the starter to "chattering."

**"Backspin"** is the name given to the backward turning of a centrifugal pump when a head of water runs back through the pump just after it has been turned off. Obviously starting the pump during backspin might damage the pump or motor.

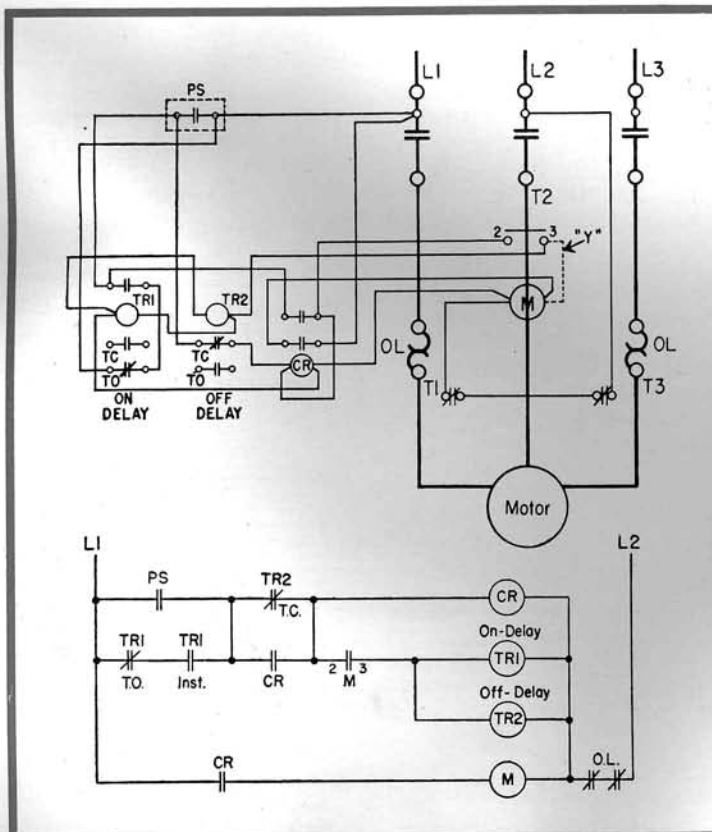


### System Provides Backspin Protection and Surge Protection on Stopping. — Time Delay Between Pressure Switch Closing and Motor Starting

The pressure switch energizes the timer (TR), but the motor cannot start until the time delay contact has closed. The timer can thus be set for a time long enough to allow all surges and backspin to stop.

The dotted lines show how a selector switch can be added to by-pass the pressure switch if necessary. This is often used for motor testing purposes. It does not eliminate the time delay however. If the selector switch is added, the wire "A" must be removed.

36.



### System Provides Surge Protection on Both Starting and Stopping. Backspin Protection Automatically Included

Two timing relays are used here, one to provide surge protection on starting and one to provide surge protection on stopping and backspin protection. TR1 is an "on-delay" timer used for surge protection on starting. When the pressure switch contact closes, relay CR, the starter and the two timers are energized. The instantaneous contact on TR1 closes, by-passing the pressure switch contact and preventing the pump motor starter from dropping out even though starting surges open the pressure contact. After the timing period, the time delay contact of TR1 opens the by-pass and PS can then stop the pump at the proper pressure. TR2 is an "off-delay" timer for surge protection on stopping and backspin protection. Once turned off, the system cannot be operated again until timer TR2 has timed out and its normally closed contact is closed.

When a standard Bulletin 709, Form 2 starter is used, connection "Y" must be removed.

37.

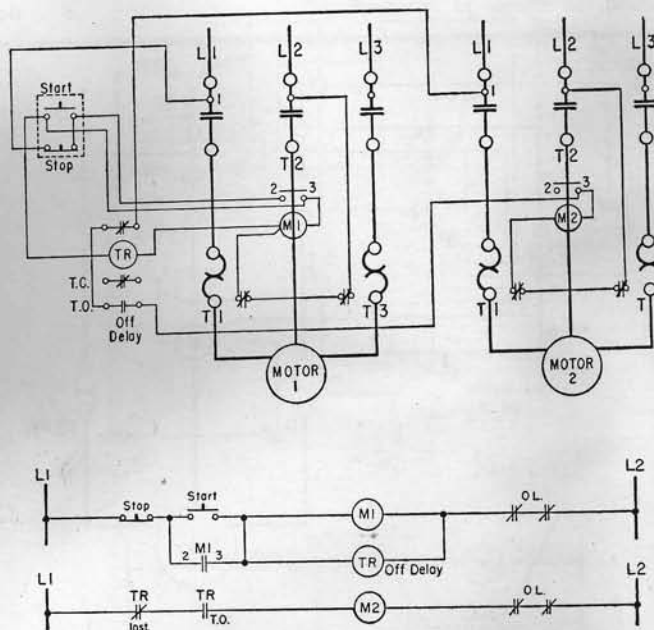


### Sequence Control

#### Sequence Control of Two Motors — One to Start and Run for a Short Time After the Other Stops

In this system it is desired to have a second motor started automatically when the first is stopped. The second motor is to run only for a given length of time. Such an application might be found where the second motor is needed to run a cooling fan or a pump.

To accomplish this an off-delay timer (TR) is used. When the start button is pressed, it energizes both M1 and TR. The operation of TR closes its time delay contact but the circuit to M2 is kept open by the opening of the instantaneous contact. As soon as the stop button is pressed, both M1 and TR are dropped out. This closes the instantaneous contact on TR and starts M2. M2 will continue to run until TR times out and the time delay contact opens.



38.

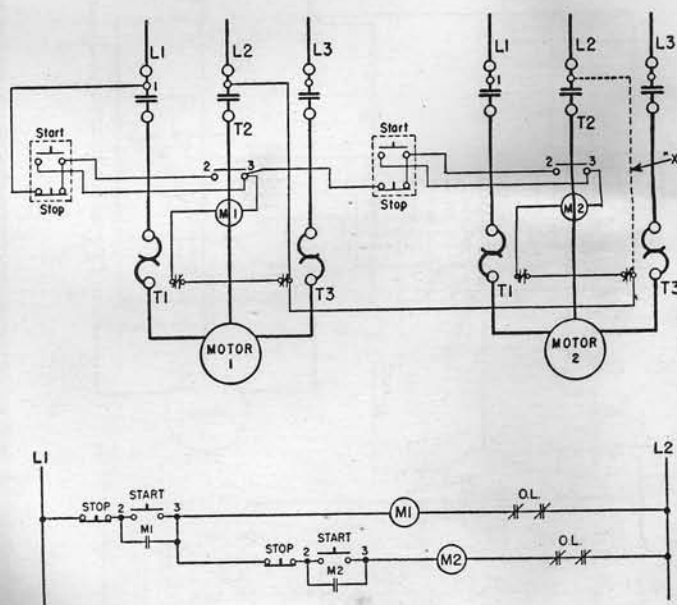
#### Starters Arranged for Sequence Control of a Conveyor System

The two starters are wired so that M2 cannot be started until M1 is running. This is necessary if M1 is driving a conveyor fed by another conveyor driven by M2. Material from the M2 conveyor would pile up if the M1 conveyor could not move and carry it away.

If a series of conveyors is involved, the control circuits of the additional starters can be interlocked in the same way. That is, M3 would be connected to M2 in the same "step" arrangement that M2 is now connected to M1, and so on.

The M1 stop button or an overload on M1 will stop both conveyors. The M2 stop button or an overload on M2 will stop only M2.

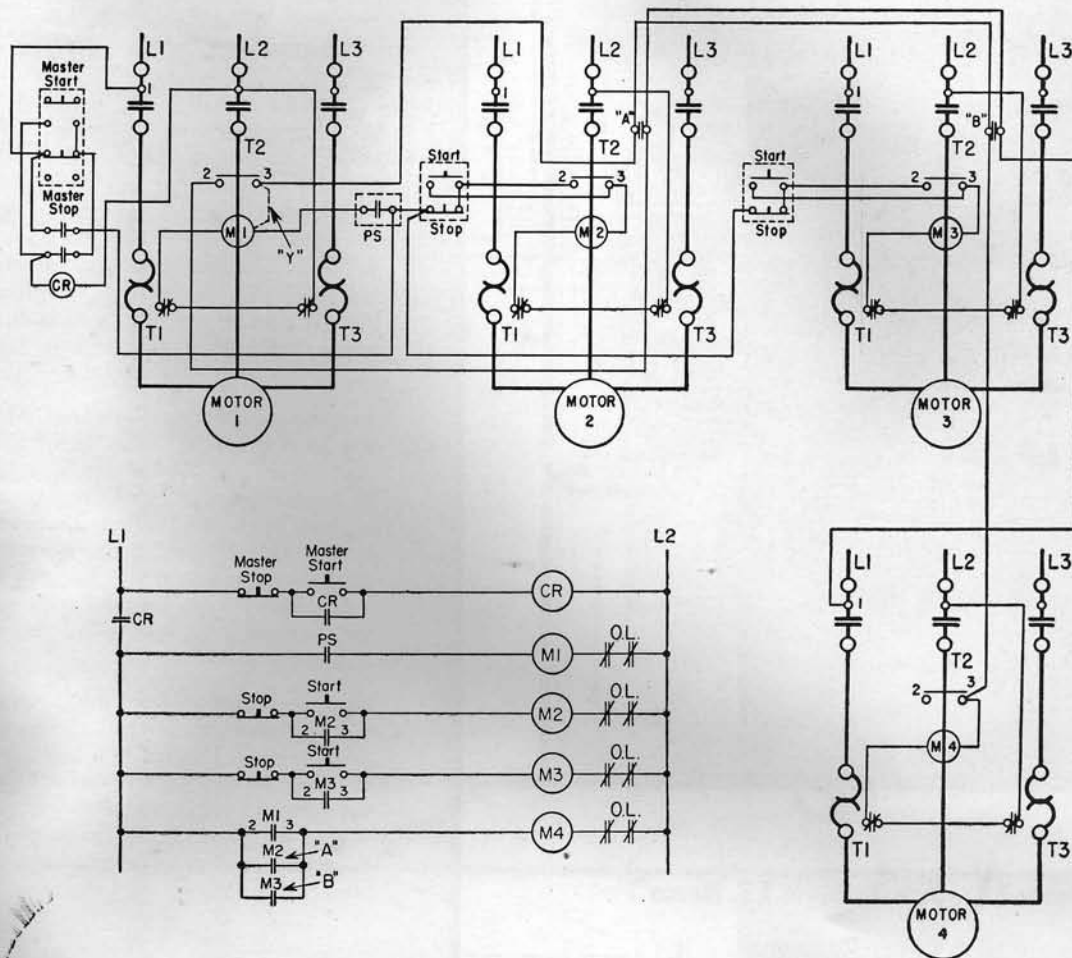
If standard Bul. 709 starters are used, wire "X" must be removed from M2.



39.



## Sequence Control



## Operation of Any One of Several Starters Causes a Pump or Fan Motor to Start

Several motors are to be run independent of each other, with some of the starters actuated by two-wire and some by three-wire pilot devices. Whenever any one of these motors is running, a pump or fan motor must also run.

A master start and stop push button station with a control relay is used to shut down the entire system in an emergency. Control relay (CR) provides "three-wire control" for M1 which is controlled by a two wire control device such as a pressure switch. Motors M2 and M3 are controlled by standard duty start-stop push button stations.

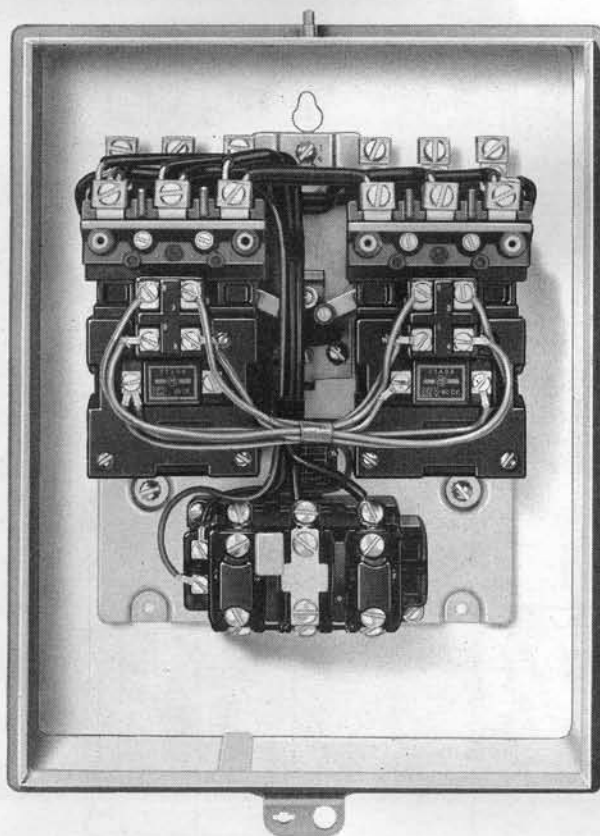
Auxiliary contacts on M1, M2, and M3 control M4. These auxiliary contacts are all wired in parallel so that any one of them may start M4. Bulletin 1495 auxiliary contacts have been added to M2 and M3 for this purpose. The standard "hold-in" contact on M1 may be used as an auxiliary if wire "Y" is removed. "Hold-in" contacts are not required when a two-wire control device is used.

The Bulletin 1495 auxiliary contacts are designated as "A" and "B" on the wiring diagram. These contacts are easily added to any Allen-Bradley starter sizes 0 through 5.

When this system is used, the phase connections on all of the starters must be the same. That is, L1 of each starter must be connected to the same incoming phase line, L2 and L3 of each starter must be similarly phased out.



## The Bulletin 705 Full Voltage Reversing Starter



**Bulletin 705, Size 1, Style RT, Nema 1  
with Cover Removed**

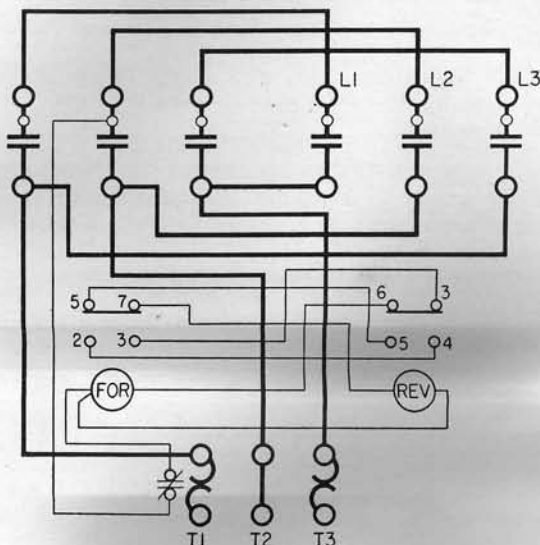
### THE BULLETIN 705 AS REPRESENTED BY A WIRING DIAGRAM

A photograph and a wiring diagram of an Allen-Bradley Bulletin 705 reversing starter are shown on this page. The two can be compared as was done with the Bulletin 709. This should help make the meaning of the wiring diagram clearer and should be quite useful when making connections to an actual starter.

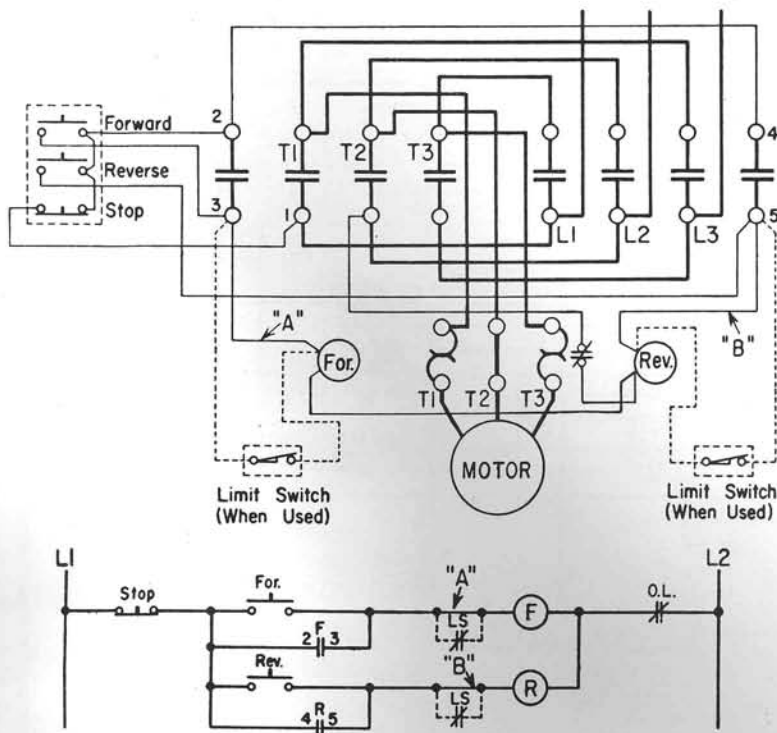
Because of the more involved wiring of the Bulletin 705, all of the connections cannot be clearly seen in the photograph. However, comparison with the wiring diagram should assist in tracing any wire on the photograph. Only the wires most likely to be worked with on the standard starter have been labeled.

Each reversing starter is equipped with a mechanical interlock. However, the mechanical interlock, armature, crossbar and overload reset mechanism are not shown in the wiring diagram since these parts need not be considered from a wiring standpoint.

**Wiring Diagram of  
Bulletin 705, Size 1, Style RT  
with Block Overload Relays**



## 3 Phase Starters



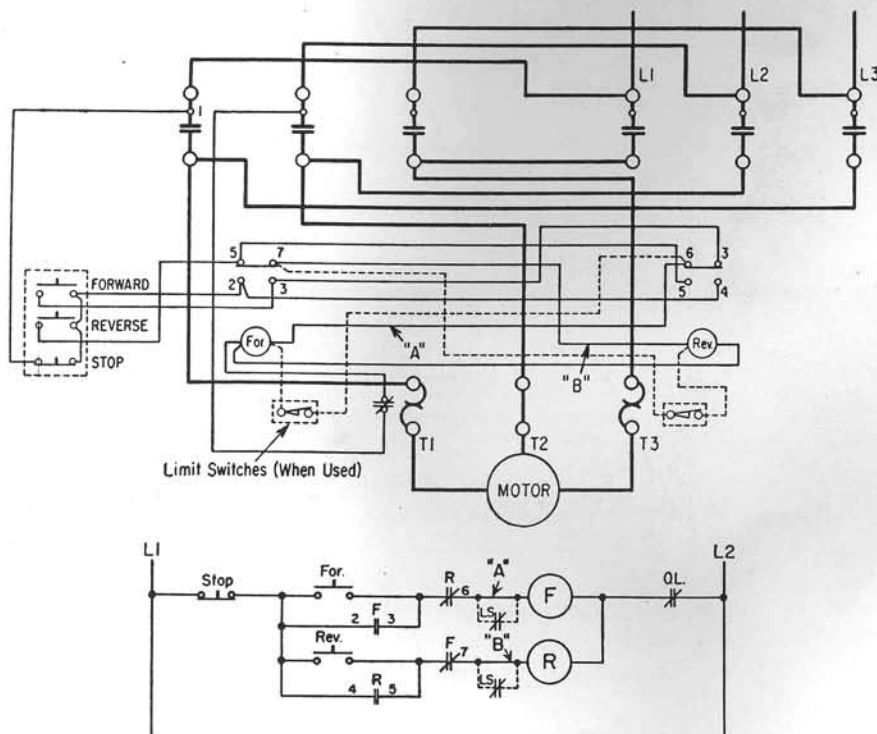
## Size 00

Standard wiring with "Forward-Reverse-Stop" push button station. The "STOP" button must be depressed before changing directions.

A mechanical interlock is provided, however electrical interlocks are not furnished on size 00 reversing starters.

Limit switches can be added to stop the motor at a certain point in either direction. Connections "A" and "B" must be removed when limit switches are used.

41.



## Sizes 0, 1, 2, 3 and 4

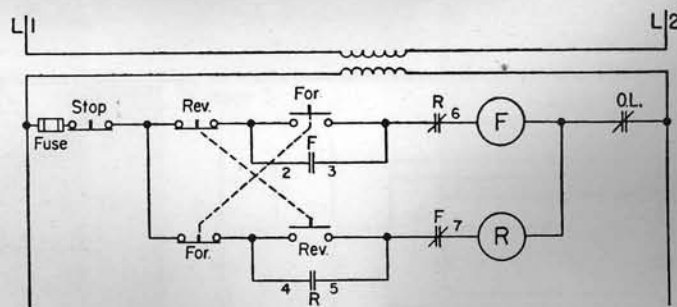
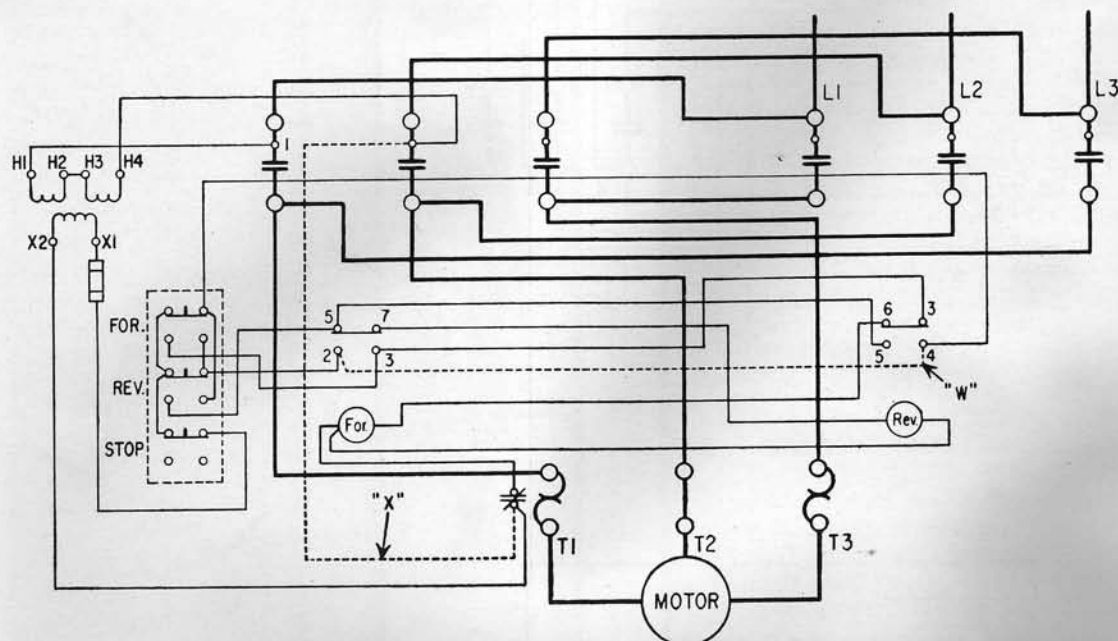
Standard wiring with "Forward-Reverse-Stop" push button station. The "STOP" button must be depressed before changing directions.

A mechanical interlock and electrical interlocks are supplied as standard on all reversing starters size 0 and larger.

Limit switches can be added to stop the motor at a certain point in either direction. Connections "A" and "B" must be removed when limit switches are used.

42.

# **Push Button Station Variations**



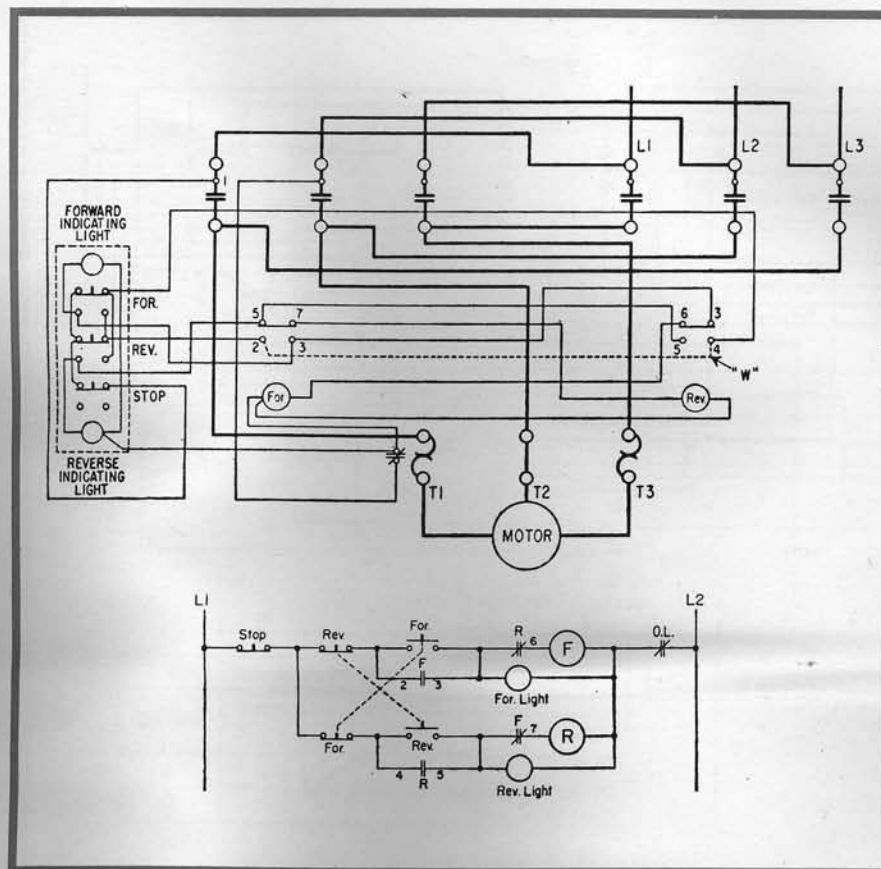
## **Push Button Wired so Starter Can Be Switched from One Direction to the Other Without Pushing Stop Button**

This scheme allows immediate reversal of the motor when it is running in either direction. It is not necessary to depress the "Stop" button when changing direction. A standard Bulletin 705 reversing switch can be used if wire "W" is removed.

The diagram shows the control circuit set up for reduced voltage control, although this may not be necessary in many cases. Notice that wire "X" must be removed when reduced voltage control is used. The push button station can be a Bulletin 800, Type 3SA (standard duty), Type 3HA (heavy duty) or a Bulletin 800T, Type 3TA (oiltight).



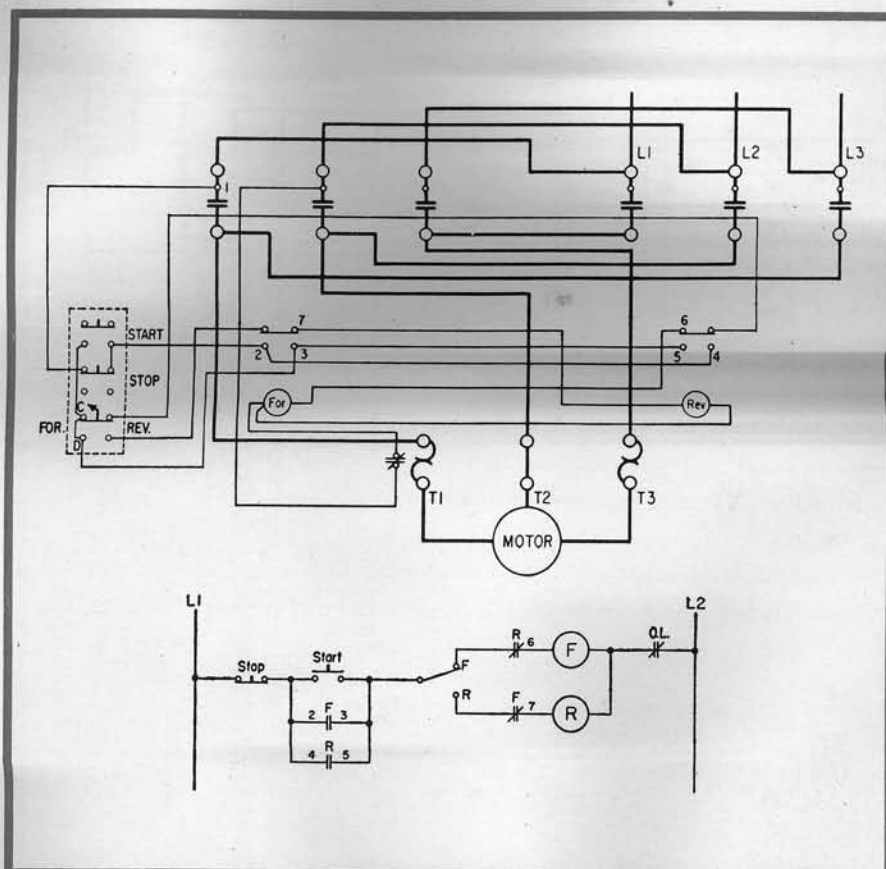
## Push Button Station Variations



### Starting and Stopping in Both Directions. Lights Indicate Direction in Which Motor is Operating

This setup provides exactly the same operation as shown in the previous diagram, except that pilot lights have been added to show which way the motor is running. Once again, standard Bulletin 705 reversing switch can be used if wire "W" is removed. The pilot lights can either be separately mounted or mounted in the push button station. If they are to be mounted in the station a Bulletin 800, Type 3HA2P can be used.

44.



### The Motor Runs in a Pre-selected Direction Which is Determined by The Setting of a Selector Switch

The motor can be run in either direction, but the desired direction must be set on a selector switch before starting. The motor is then operated from a "Start-Stop" station as a single direction motor.

The wiring of the standard Bulletin 705 reversing starter must be modified slightly to fill this requirement. Note that the connections which normally lead from the electrical interlock contacts to points 3 and 5 have been removed and that different connections have been made to the electrical interlocks and points 3 and 5.

It is usually most convenient to include the selector switch as part of the push button station. This can be done with either a Bulletin 800 heavy duty station or a Bulletin 800T oiltight station.

45.

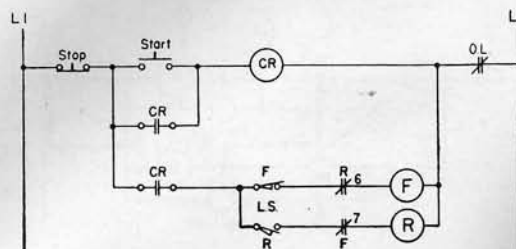
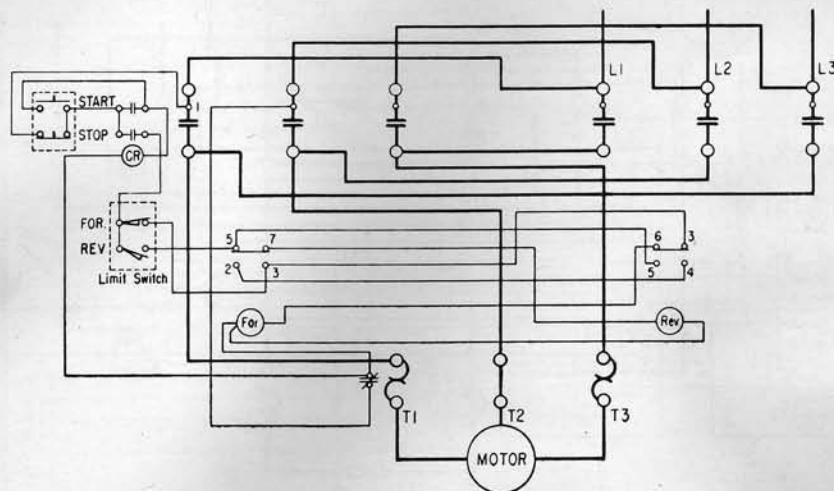


### Push Button Station Variations

#### Limit Switch Controls Reversing

Here the direction of the motor is determined by the position of a limit switch. A start-stop push button station is used to energize the system and the motor will start according to the position of the limit switch. The wiring of the standard Bulletin 705 need not be modified for this type of operation. Limit switch connections are made directly to the electrical interlocks.

It is necessary to use a control relay in this system and this relay is a Bulletin 700, Type C-20. The limit switch can be any of several in the Bulletin 802T line having one NO and one NC contact.



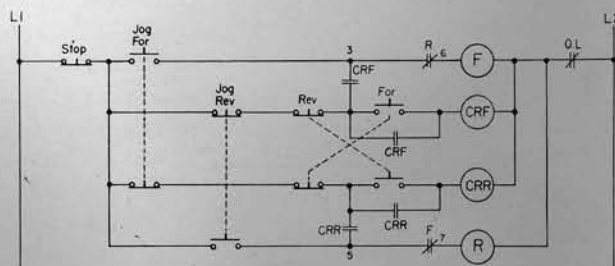
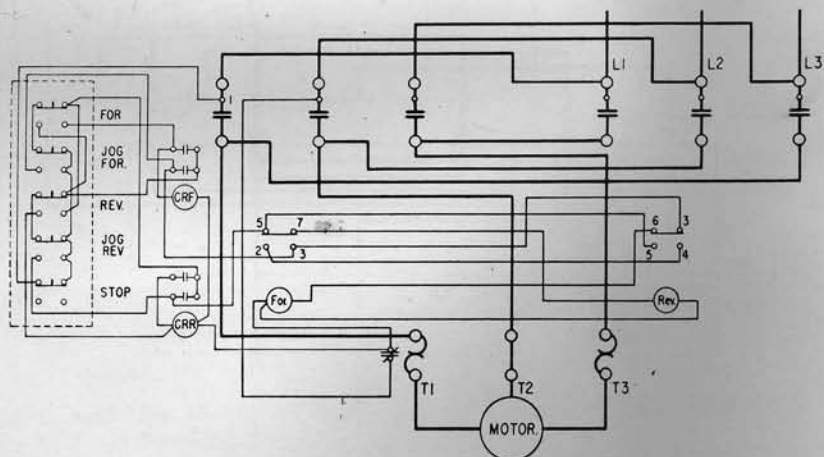
46.

### Jogging

#### Jogging With Relays

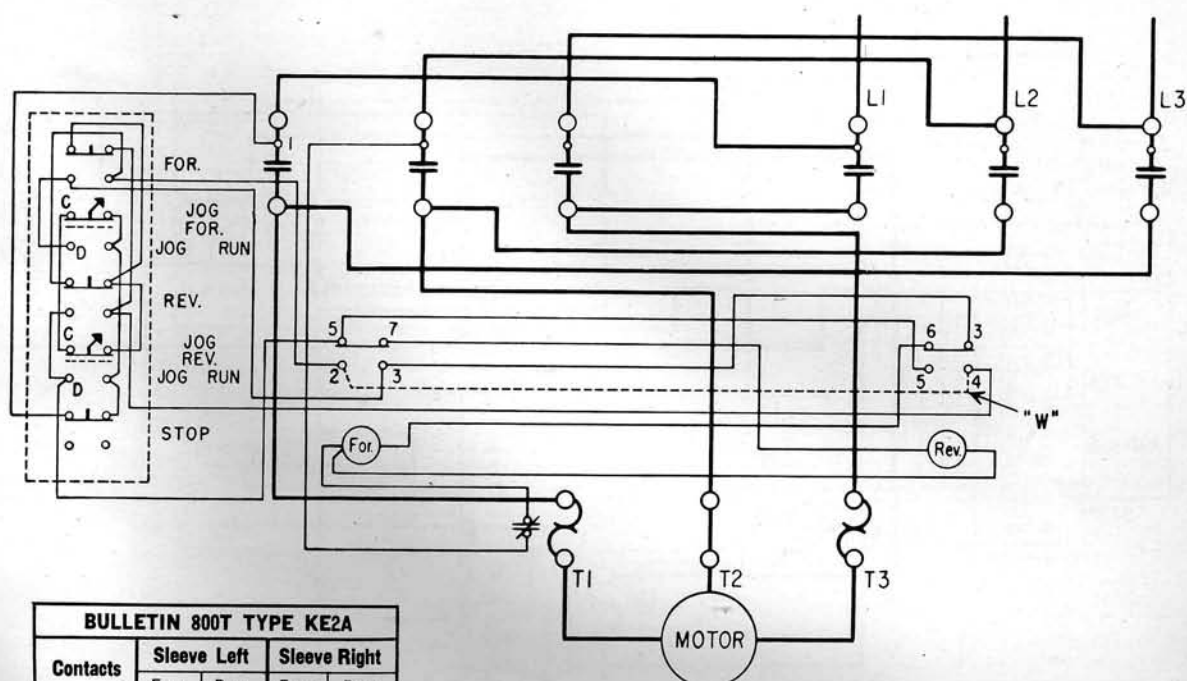
In this arrangement for jogging and running in either direction "jogging relays" are used to insure safe jogging. These relays prevent either the forward or reverse contactor from locking in during jogging.

The push button station can be a Bulletin 800, heavy duty, or a Bulletin 800T oiltight. Bulletin 700, Type C-20 relays may be used.

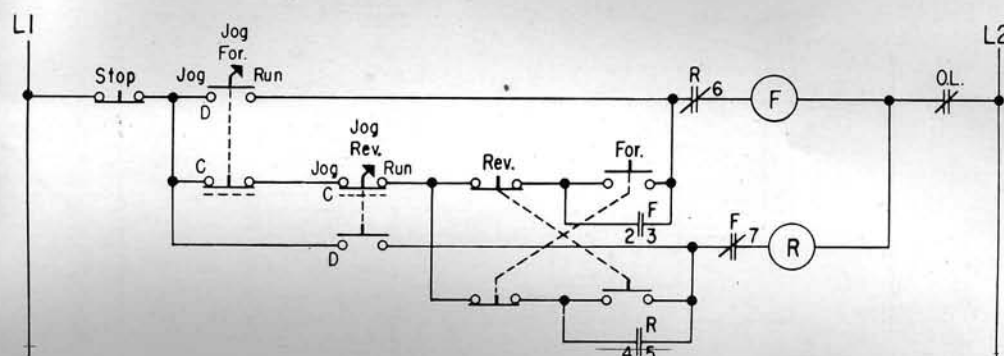


47.

## Jogging



| BULLETIN 800T TYPE KE2A |             |      |              |      |
|-------------------------|-------------|------|--------------|------|
| Contacts                | Sleeve Left |      | Sleeve Right |      |
|                         | Free        | Dep. | Free         | Dep. |
| C                       |             |      | X            |      |
| D                       |             | X    |              |      |



## Starting, Stopping and Jogging in Either Direction

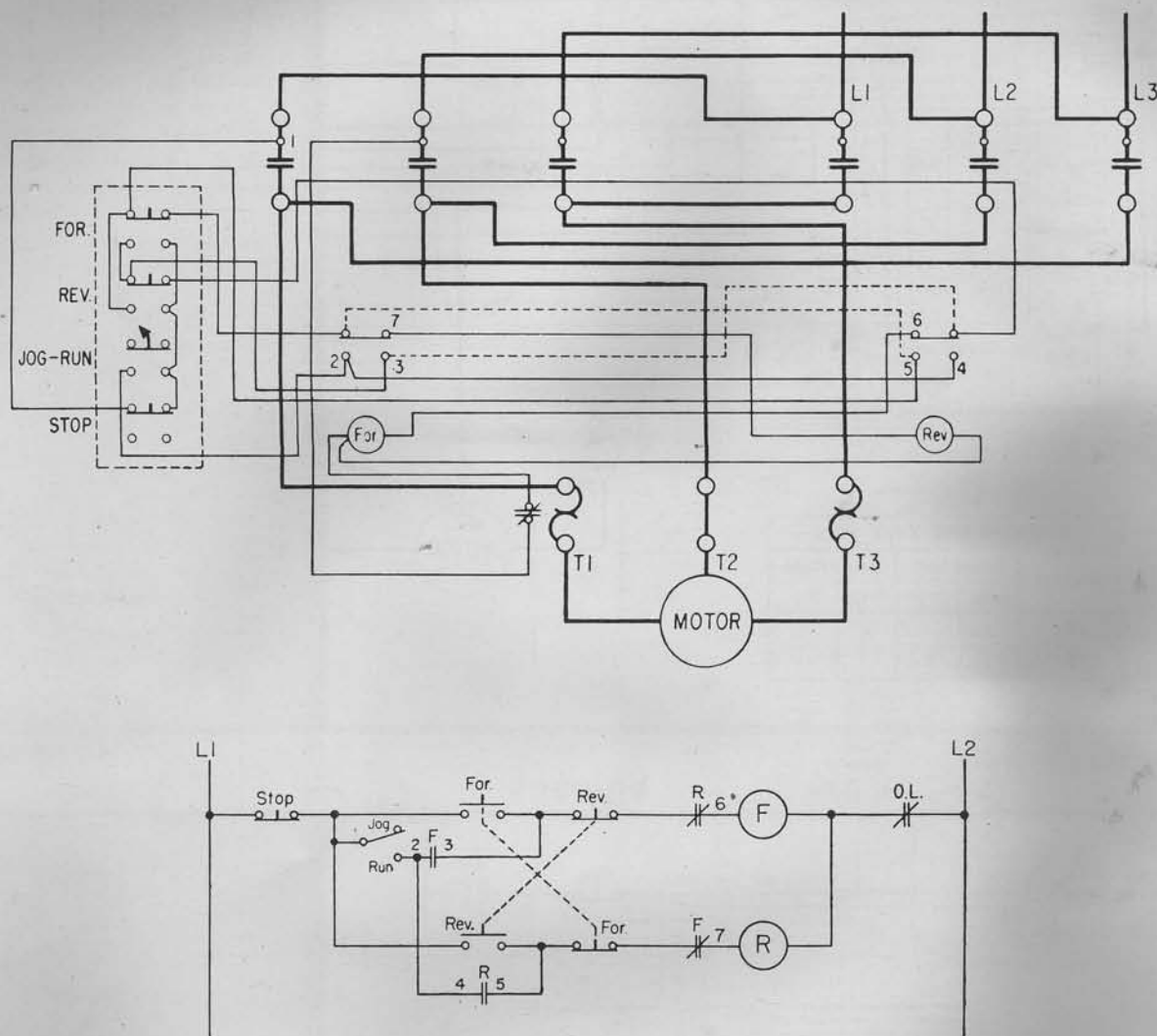
This is one of the safest and most desirable methods of jogging a reversing starter. The motor will run steadily in either direction and also can be jogged in either direction.

Bulletin 800T Type KE2A jogging units in an oiltight enclosure are shown in the diagram. If desired, a Bulletin 800H, heavy duty, push button station could also be utilized.

To jog, the jogging ring must be turned to the "JOG" position. The NC contact of the jogging unit is held open thus insuring safe action by preventing either contactor from locking in during jogging.



## Jogging



### Starting, Stopping and Jogging in Either Direction. Jogging Controlled Through a Jogging Selector Switch

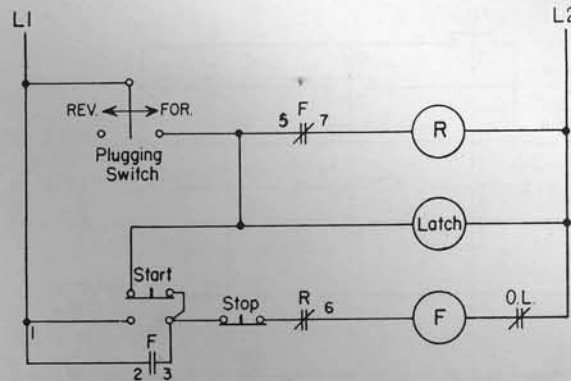
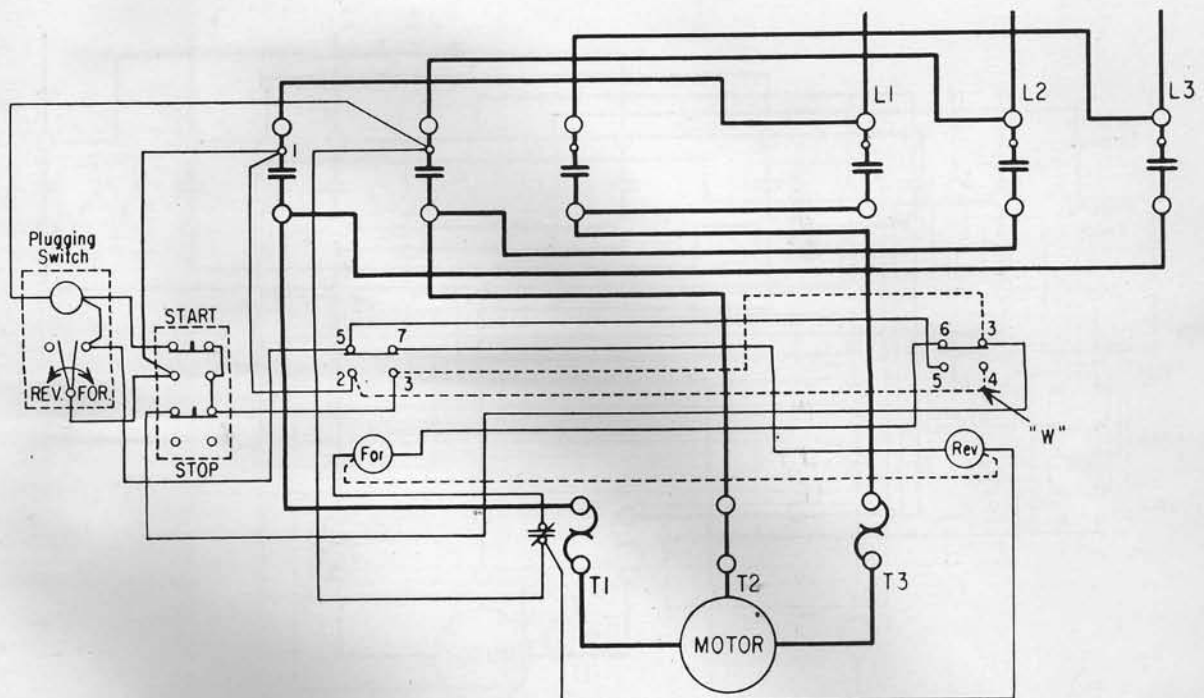
Here, the motor can run normally in either direction or can be jogged in either direction. With the selector in the "run" position, the motor can be started in either direction and will stop when the stop button is pressed. It is not necessary to press the stop button before changing from forward to reverse.

With the selector in the "jog" position, the "forward" and "reverse" buttons act as jogging buttons. The motor will run in the indicated direction when one of them is pressed but will stop as soon as the button is released.

The wiring of the standard Bulletin 705 must be modified for this type of operation. Note that the wires shown with dotted lines must be removed from the standard starter. The push button station can be either a Bulletin 800, heavy duty, or a Bulletin 800T, oiltight.



## Plugging



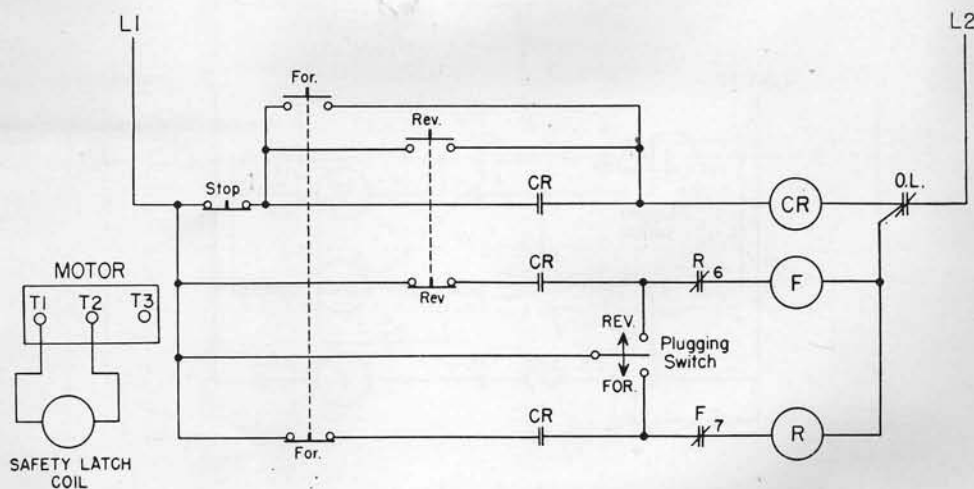
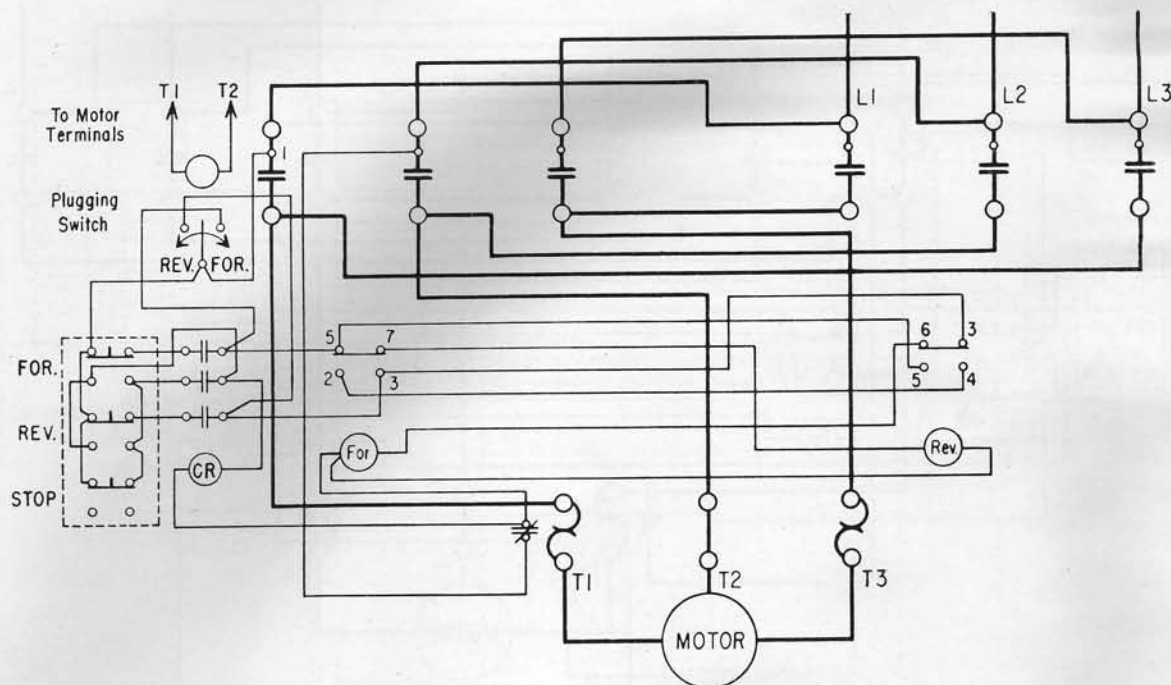
### Plugging a Motor to a Stop from One Direction. — Safety Latch Provided

This system is for a motor that is to run in one direction only and must come to an immediate stop when the stop button is pressed. The reverse contactor of the Bulletin 705 reversing switch is used only for plug-stopping and not for running in reverse. When a standard Bulletin 705 is used, wire "W" and all wires represented by dotted lines should be removed.

The safety latch is built into the Bulletin 808 Zero Speed Plugging Switch and its function is to prevent an accidental turn of the motor shaft from closing the plugging switch contacts and starting the motor. This protective feature is optional and the plugging switch can be furnished without safety latch if desired.

The push button station is a Bulletin 800, Type 2HA or a Bulletin 800T, Type 2TA.

## Plugging



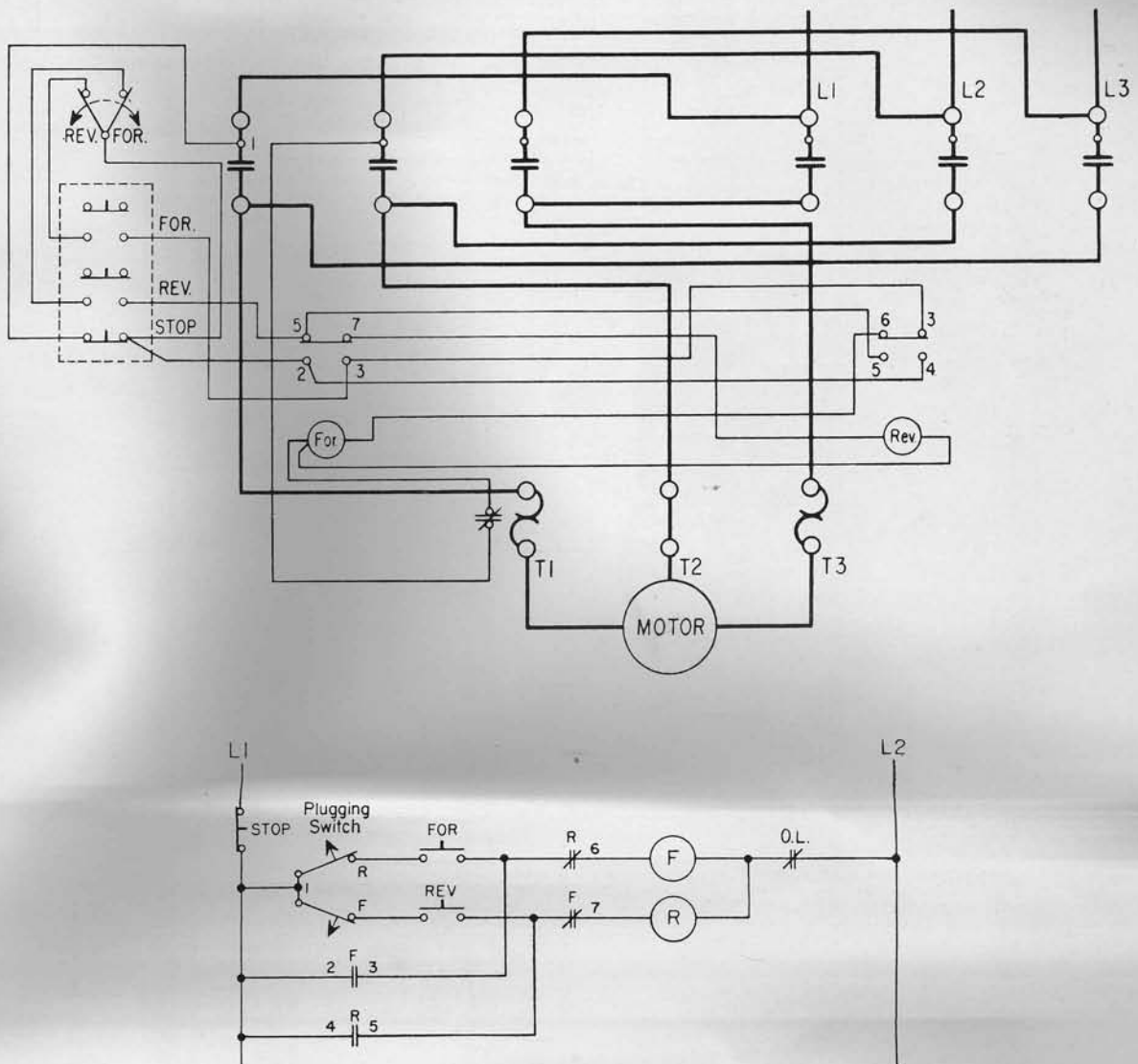
### Plugging a Motor to a Stop from Either Direction. — Safety Latch Provided

With the system wired as shown, the motor can be started in either direction by pressing the proper button. Pressing the stop button will plug the motor to a stop from either direction. A standard Bulletin 705 reversing switch is used for this application.

The safety latch is a built-in part of the Bulletin 808 Zero Speed Plugging Switch and it prevents an accidental turn of the motor shaft from closing the plugging switch contacts and starting the motor. This protective feature is optional and the plugging switch can be furnished without safety latch if desired.

The control relay necessary with this system is a Bulletin 700, Type B-30 and the push button station can be a Bulletin 800, Type 3HA, or a Bulletin 800T, Type 3TA.

# "Anti-Plugging"



## "Anti-Plugging" — Motor Is to Be Reversed, but it Must Not Be Plugged

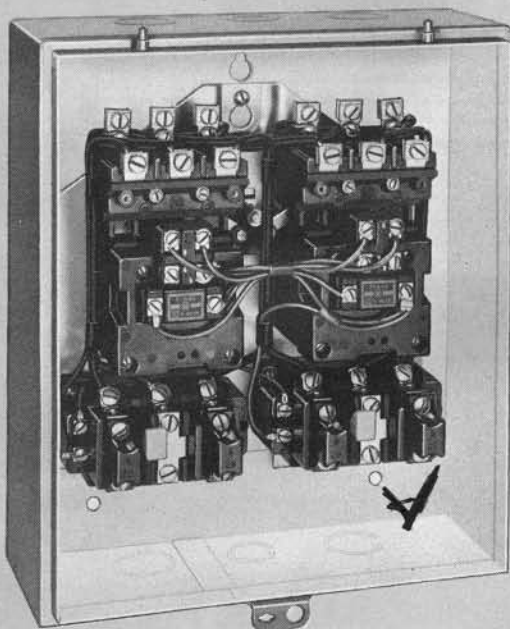
A Bulletin 808 Zero Speed Plugging Switch with normally closed contacts is used to prevent plugging. The schematic diagram shows that with the motor operating in one direction, a contact on the Zero Speed Switch opens the control circuit of the starter used for the opposite direction. The open contact will not close until the motor has slowed down, and thus, the reversing switch cannot be energized to change the direction of the motor until the motor is moving slowly.

A standard Bulletin 705 reversing switch can be used with this application. The push button station can be a Bulletin 800, Type 3SA, or 3HA, or a Bulletin 800T, Type 3TA.



## BULLETIN 715 MULTI-SPEED MOTOR STARTERS

Shown below are Bulletin 715 multi-speed starters of the types used in the diagrams on the following pages. Wiring of these starters can be compared to the diagrams in the same manner as was done for the Bulletin 709 on page 10 and the Bulletin 705 on page 26. Size 1 starters are used in the illustrations and diagrams, but the operating principle and wiring is similar for other sizes.

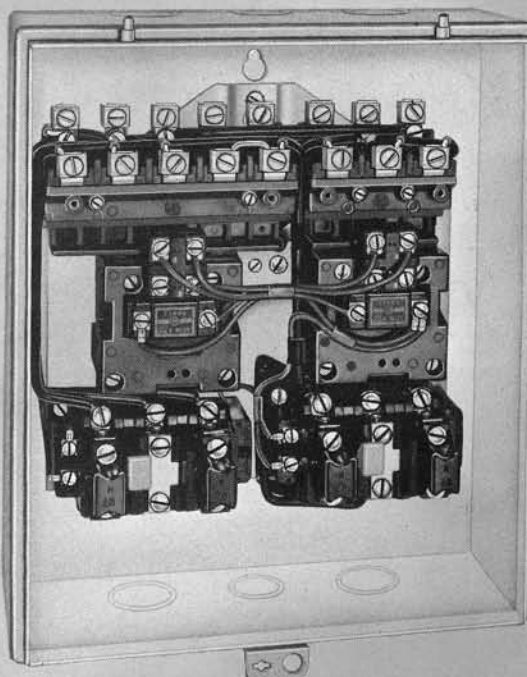


For  
Separate Winding  
Motors

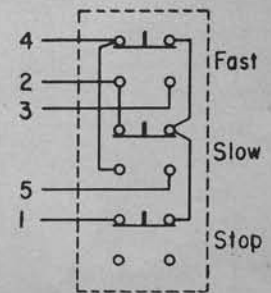
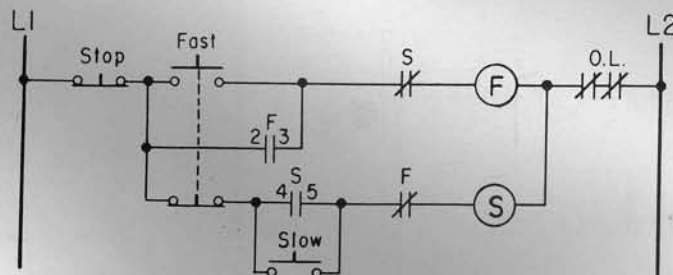
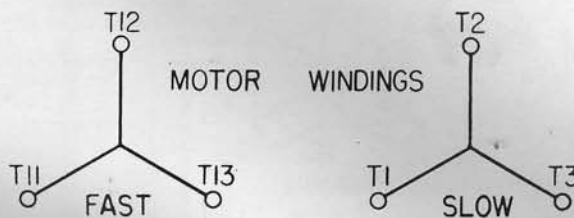
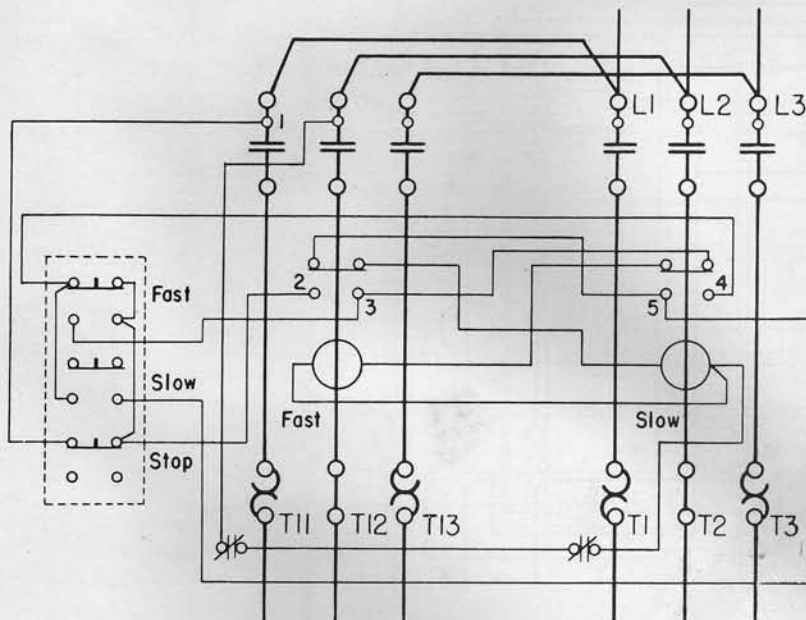
For  
Consequent Pole Motors,  
Constant Torque or  
Variable Torque

— OR —

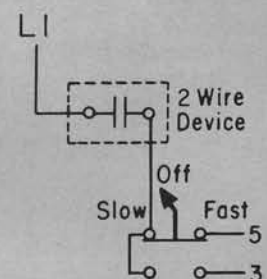
For  
Consequent Pole Motors,  
Constant Horsepower



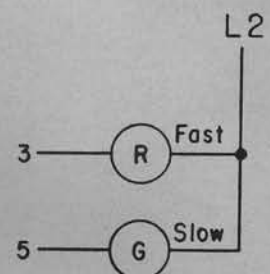




Push button connections to allow starting in either speed and changing from one speed to another without first pressing the "stop" button.



Control by an automatic "two-wire" device. A selector switch is used to determine speed.

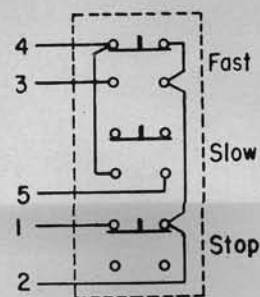
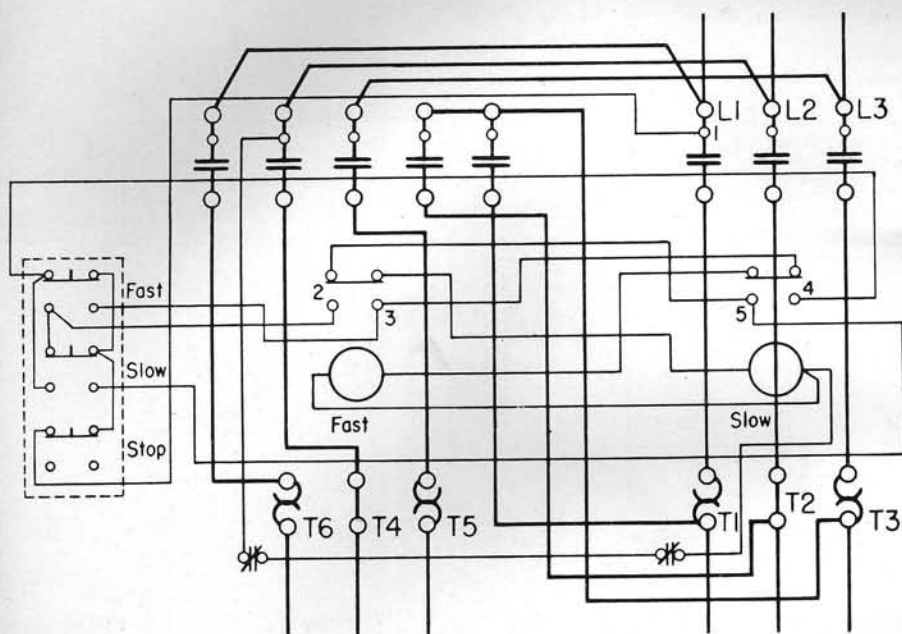


Connections for speed-indicating pilot lights. Can be added to any of the control schemes shown on this page.

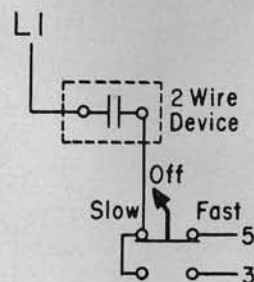
### For Separate Winding Motors

A standard connection for a Bulletin 715 used with a two speed separate winding motor is shown above. The wiring diagram and line diagram in the above panel illustrate connections for the following method of operation: Motor can be started in either "Fast" or "Slow" speed. The change from Slow to Fast can be made without first pressing stop button. When changing from Fast to Slow the stop button must be pressed between speeds.

The pilot device diagrams shown in the right side panel illustrate other connections that can be made to obtain different sequences and methods of operation.

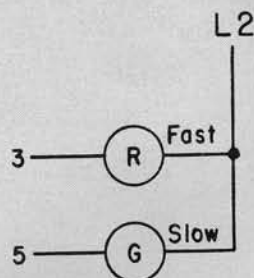
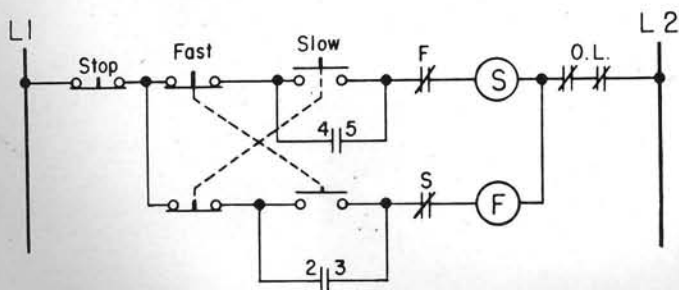
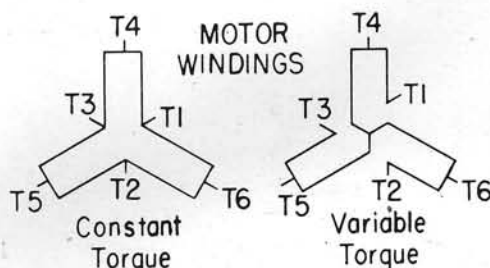


Connections above allow speed change from "low" to "high" only without using "stop." Start in either speed.



Control by an automatic "two-wire" device. A selector switch is used to determine speed.

| SYNOPSIS OF MOTOR CONNECTIONS |              |    |      |          |          |
|-------------------------------|--------------|----|------|----------|----------|
| Speed                         | Supply Lines |    | Open | Together |          |
|                               | L1           | L2 | L3   |          |          |
| Slow                          | T1           | T2 | T3   | T4, 5, 6 | None     |
| Fast                          | T6           | T4 | T5   | None     | T1, 2, 3 |

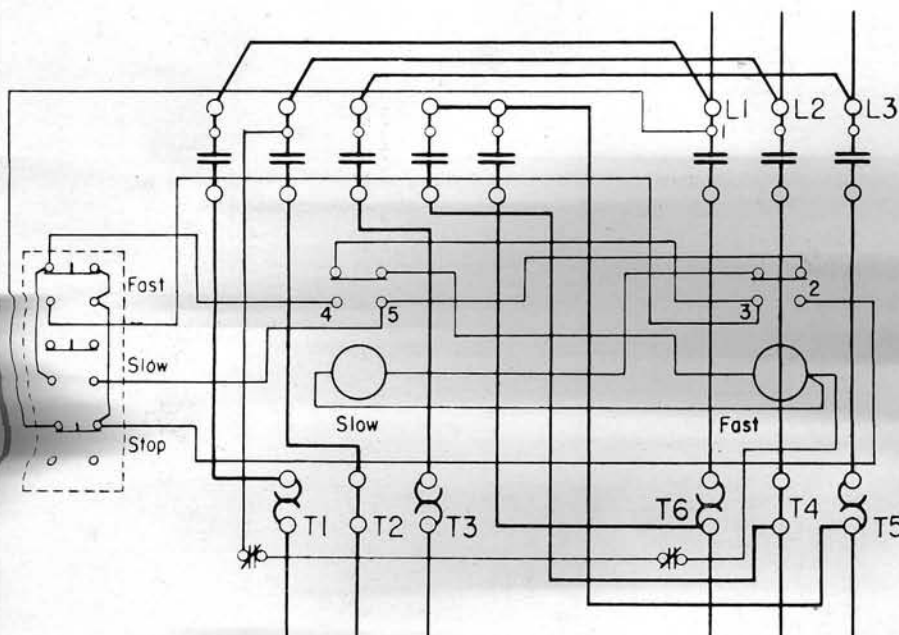


Connections for speed-indicating pilot lights. Can be added to any of the control schemes shown on this page.

### For Consequent Pole Motors — Constant Torque or Variable Torque

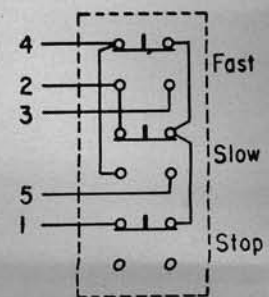
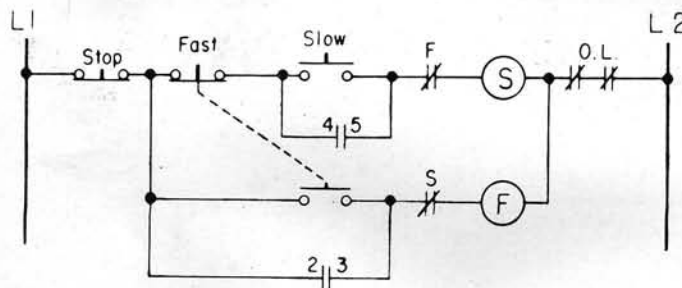
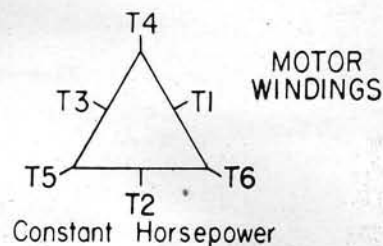
A standard connection for a Bulletin 715 used with a consequent pole, constant or variable torque motor is shown above. The wiring diagram and line diagram in the above panel illustrate connections for the following method of operation: Motor can be started in either "Fast" or "Slow" speed. The change from Slow to Fast or from Fast to Slow can be made without first pressing stop button.

The pilot device diagrams shown in the side panel illustrate other connections that can be made to obtain different sequences and methods of operation.

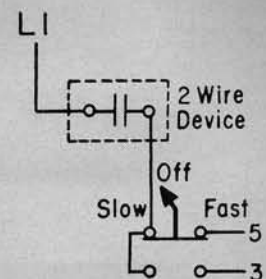


SYNOPSIS OF MOTOR CONNECTIONS

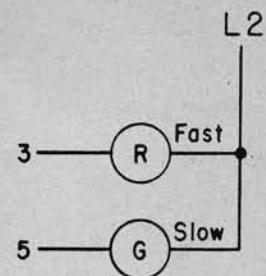
| Speed | Supply Lines<br>L1 L2 L3 | Open     | Together |
|-------|--------------------------|----------|----------|
| Slow  | T1 T2 T3                 | None     | T4, 5, 6 |
| Fast  | T6 T4 T5                 | T1, 2, 3 | None     |



Push button connections to allow starting in either speed and changing from one speed to another without first pressing the "stop" button.



Control by an automatic "two-wire" device. A selector switch is used to determine speed.



Connections for speed-indicating pilot lights. Can be added to any of the control schemes shown on this page.

### For Consequent Pole Motors — Constant Horsepower

A standard connection for a Bulletin 715 used with a consequent pole, constant horsepower motor is shown above. The wiring diagram and line diagram in the above panel illustrate connections for the following method of operation: Motor can be started in either "Fast" or "Slow" speed. The change from Slow to Fast can be made without first pressing stop button. When changing from Fast to Slow the stop button must be pressed between speeds.

The pilot device diagrams shown in the side panel illustrate other connections that can be made to obtain different sequences and methods of operation.

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