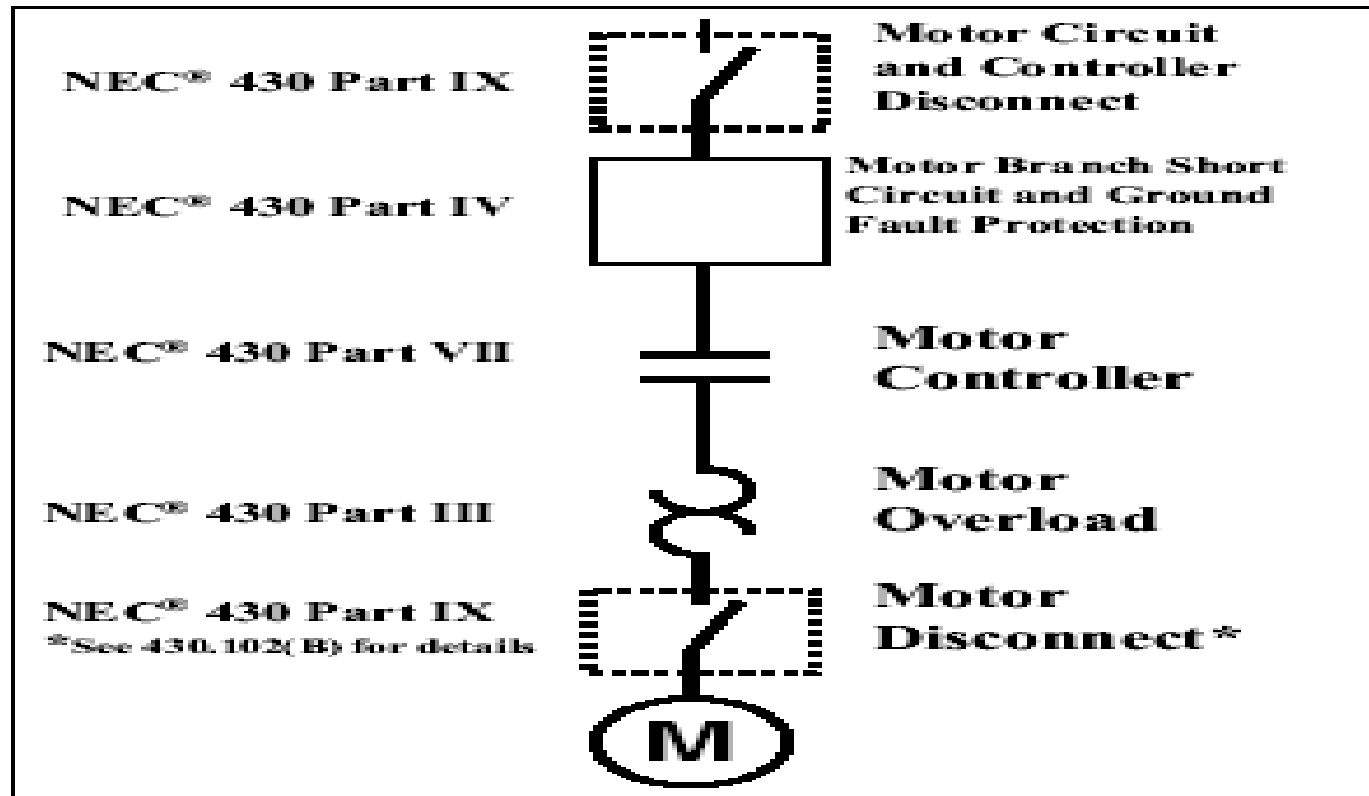


1ª cifra característica		2ª cifra característica	Letra adicional
Protección del material contra la penetración de cuerpos sólidos extraños		Protección del material contra la penetración de agua con efectos nocivos	Protección de las personas contra el acceso a las partes activas peligrosas con:
0	(no protegido)	0	(no protegido)
1	De diámetro $\geq 50\text{mm}$	1	Gotas de agua verticales
2	" " " 12,5mm	2	Gotas de agua ( $15^\circ$ de inclinación)
3	" " " 2,5mm	3	Lluvia ( $60^\circ$ de inclinación)
4	" " " 1,0mm	4	Proyección de agua
5	Protegido c/ el polvo	5	Proyección con lanza de agua
6	Estando al polvo	6	Proyección potente con lanza
		7	Inmersión temporal
		8	Inmersión prolongada

**Nota:** la letra final se coloca y significa que, el grado de protección contra el acceso a las partes peligrosas es mayor que la primer cifra (grado de protección contra la penetración de cuerpos sólidos extraños).

## OVERCURRENT PROTECTIVE DEVICES AND DISCONNECTING MEANS FOR MOTOR & MOTOR CIRCUIT PROTECTION



## Motor Circuit Devices

### Branch Circuit Fuses

As listed to UL/CSA/ANCE 248 series of standards.



Fuse Holders



### Instantaneous Trip Circuit Breakers (MCPs)

As recognized to UL 489



Thermal Magnetic (Inverse Time) Circuit Breakers  
As listed to UL 489



These are circuit breakers without overload (thermal) protection capability. They are intended to provide only branch circuit, short-circuit and ground protection for individual motor branch circuits.

**Manual Motor Controllers (Manual Motor Protectors)**  
**As listed to UL 508**

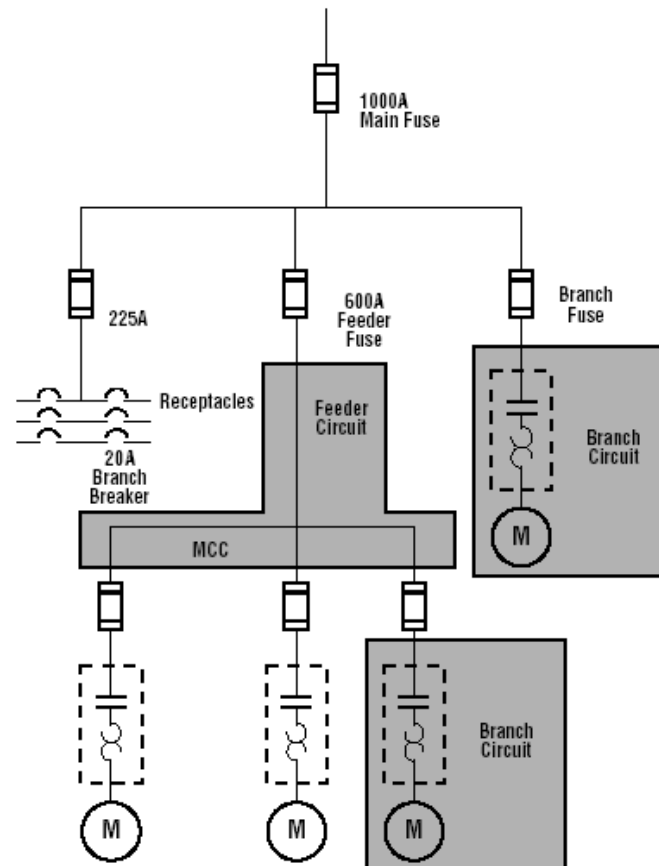


These manual motor starters, sometimes called MMPs, often combine a magnetic short-circuit trip and adjustable motor overload

# Motor Circuit Protection

Motor circuit protection describes the short-circuit protection of conductors supplying power to the motor, the motor controller, and motor control circuits/conductors.

NEC® Motor Circuit Protection Requirements



**Table 430.52. Maximum Rating or Setting of Motor Branch Circuit, Short-Circuit and Ground Fault Protective Devices**

Type of Motor	Percent of Full-Load Current			
	Non-Time-Delay Fuse**	Dual-Element (Time-Delay) Fuse**	Instantaneous Trip Breaker	Inverse Time Breaker*
Single-phase motors	300	175	800	250
AC polyphase motors other than wound-rotor				
Squirrel Cage:				
Other than Design E	300	175	800	250
Design E	300	175	1100	250
Synchronous†	300	175	800	250
Wound Rotor	150	150	800	150
Direct-current (constant voltage)	150	150	250	150

For certain exceptions to the values specified, see 430.52 through 430.54.

\* The values given in the last column also cover the ratings of non-adjustable inverse time types of circuit breakers that may be modified as in 430.52.

\*\* The values in the Non-Time-Delay Fuse Column apply to Time-Delay Class CC fuses.

† Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, etc., that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 percent of full-load current.

Table 430.52 lists the maximum sizes for Non-Time-Delay Fuses, Dual Element (Time-Delay) Fuses, Instantaneous Trip Circuit Breakers, and Inverse Time Circuit Breakers. Sizing is based on full load amp values shown in Table 430.147 through 430.150, not motor nameplate values.

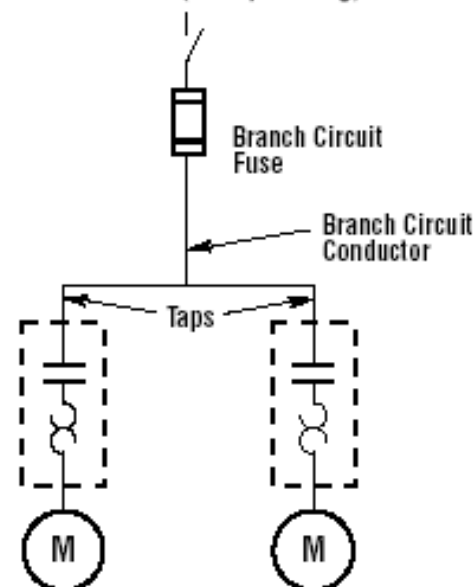
For example, the maximum time-delay fuse for a 10 HP, 460 volt, 3 phase motor with a nameplate FLA of 13 amps would be based on 175% of 14 amperes, not 175% of 13 amps.

### GROUP FUSING

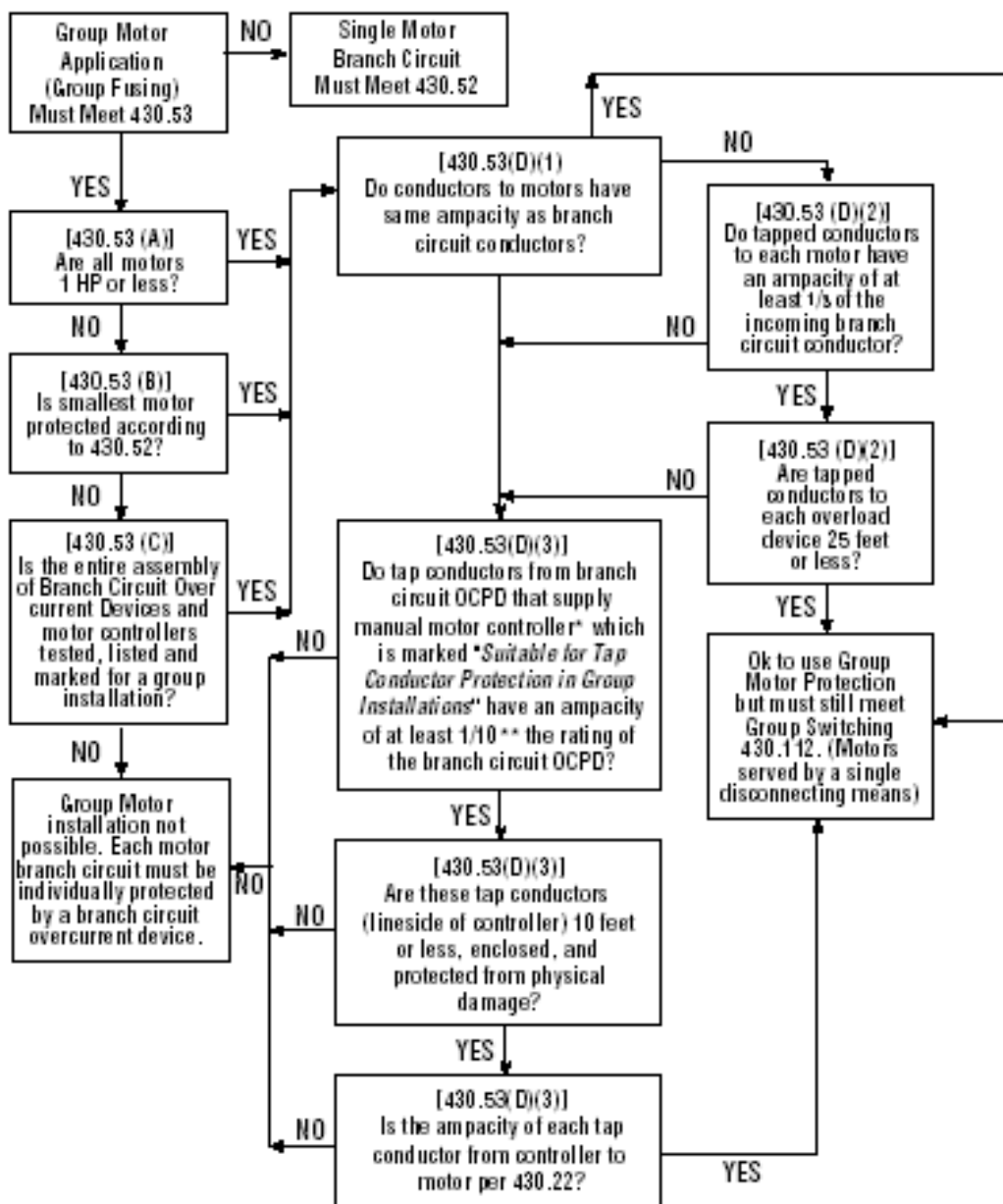
430.53 covers the requirements for group motor installations. Two or more motors, or one or more motors and other loads may be protected by the same **branch circuit overcurrent protective device** if:

- (A) all motors are 1 HP or less, protected at not over 20A at 120V or at 15A at 600V or less, the full load amp rating of each motor does not exceed 6 amperes, the device rating marked on the controller is not exceeded, and individual overload protection conforms to 430.32.
- or (B) the circuit for the smallest motor is protected per 430.52; i.e. the branch circuit overcurrent protective device protecting the group meets 430.52 for the circuit with the smallest motor.
- or (C) the complete assembly of properly sized branch circuit overcurrent protective device, controller, and overload devices is tested, listed, and marked for a group installation.

Group Motor Installation (Group Fusing) NEC® 430.53



## Group Motor Protection





## **CONDUCTORS FOR MOTOR BRANCH AND FEEDER CIRCUITS**

### **Motor Branch Circuit Conductors**

The ampacity of branch circuit conductors supplying a single motor must be at least 125% of the motor full-load current rating [430.22(A)].

**Exceptions:** For conductors supplying motors used for short-time, intermittent, periodic, or varying duty refer to 430.22(B).

Any motor application must be considered continuous duty unless the nature of the apparatus it drives is such that the motor will not operate continuously with load under any conditions of use.

## **FEEDER CIRCUITS FOR MOTORS**

### **Feeder Conductor Ampacity**

The ampacity of a conductor supplying two or more motors must be at least equal to the sum of (1) 125% of the largest motor (if there are two or more motors of the largest size, one of them is considered to be the largest), and (2) the total of the full-load ampere ratings for all other motors and other loads.

### **Feeder Fuse Size**

On normal installations, size FUSETRON® dual-element fuses or LOW-PEAK® YELLOW dual-element fuses equal to the combined ampere rating of (1) 150% to 175% F.L.A. of the largest AC motor (if there are two or more motors of the same size, one of them is considered to be the largest), and (2) the sum of all the F.L.A. for all other motors.

This dual-element fuse size should provide feeder protection without unnecessary fuse openings on heavy motor startings.

Where conditions are severe, as where a high percentage of motors connected must be started at one time, a larger size may be necessary. In that event, use the maximum size permitted by the Code as follows.

#### **The Maximum Motor Circuit Feeder Fuse (430.62)**

1. *For the one motor in the group with the highest starting current*—Find the largest fuse permitted for branch circuit protection using Table 430.52 or 440.22(A). The fuse capacity permitted for the motor with the heaviest starting current may be considered for only one motor. If two or more motors can each have a fuse of the same maximum size, only one of them can be considered. Then add:

2. *The Ampere Rating of All other Motors on that feeder.*

### Feeder Motor Schedule – Example

No. of Units	HP	Amps*	Multiplier†
1	3	4.8	1¾
1	5	7.6	1¾
1	15	21	1¾
1	40	52	1¾
1	75	96	1¾

\*Per Table 430.150.

†Per Table 430.52.

### Calculations:

*Maximum.*

1. Largest motor (~~96A~~  $\times 175\% = 168\text{A}$ ) (Round up to 175A)
2. F.L.A. all other motors (85.4A)
3. Total ( $175\text{A} + 85.4\text{A} = 260.4\text{A}$ ) (Round down to 250A)

Choose 250 ampere dual-element fuse.

**Feeder Circuit-Combination Motor, Power and Lighting Loads**

Where a feeder supplies motor load and power and/or lighting load, the permitted feeder fuse size calculation is the sum of that calculated for the motor load in accordance with 430.62, plus that calculated for the other loads in accordance with Articles 210 and 220 (430.63). The conductor ampacity supplying motors and other loads must be at least the sum of that calculated for the motor load in accordance with 430.22 and 430.24, plus that calculated for the other loads in accordance with Article 220 (430.25). (For exceptions see 430.25.)

**Example of Sizing of Dual-Element Fuses for Combination Load Feeder**

Motor Load (Use "Motor Schedule" in preceding example).

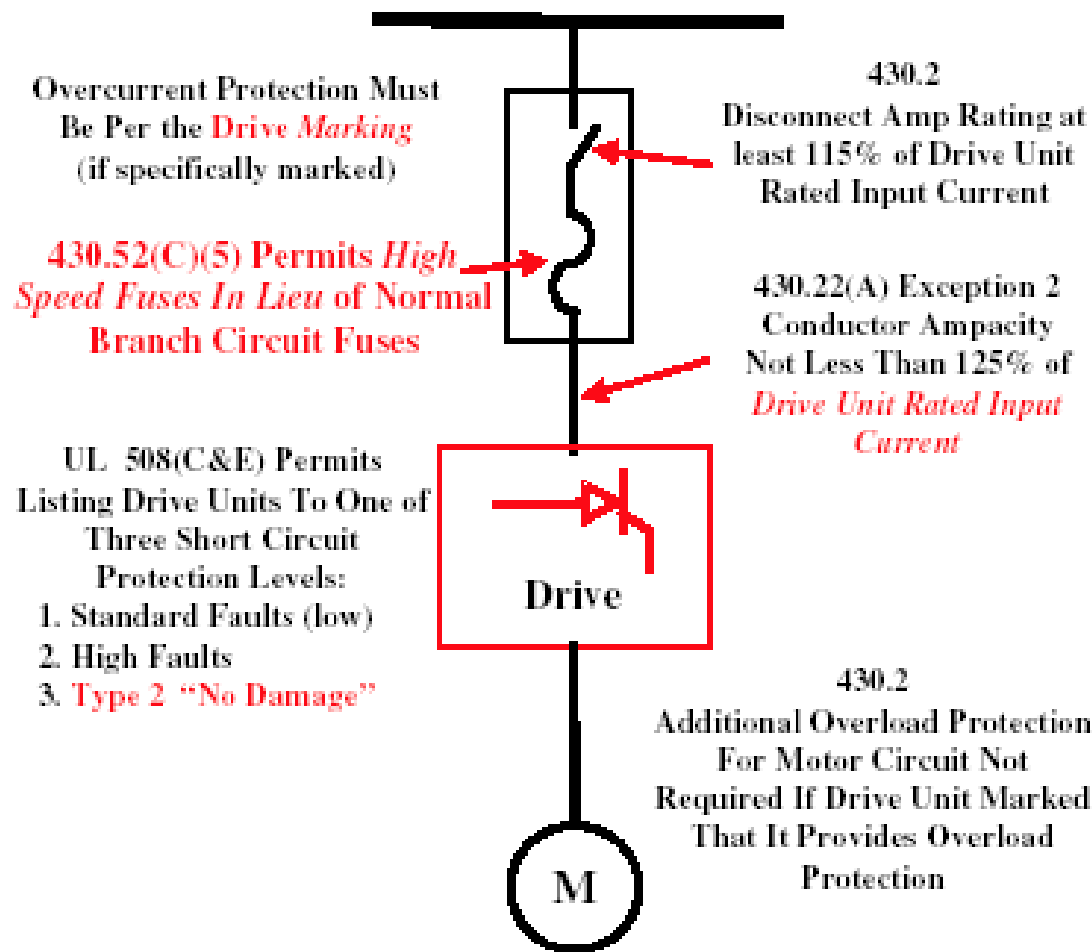
Continuous Heating and Lighting Load .....	135A
Non-Continuous Loads .....	110A

**Calculations:**

1. Motor Load: (Use calculation in preceding example) ....	260.4A
2. Continuous Non-Motor Load 135A x 125% .....	168.8A
3. Non-Continuous, Non-Motor Load .....	<u>110.0A</u>
	Total 539.2A
	(Round down to 500A)

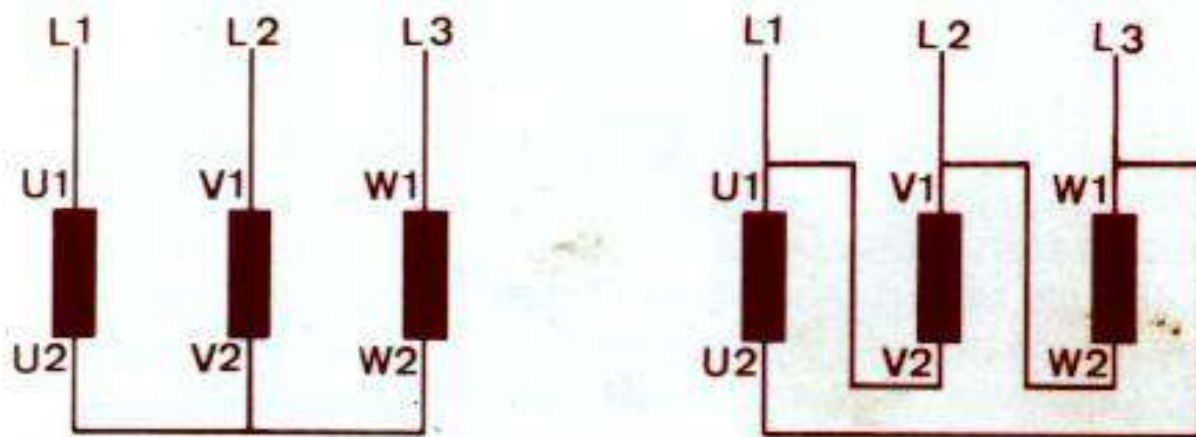
Choose 500 ampere dual-element fuse.

## Adjustable Speed Drive Systems



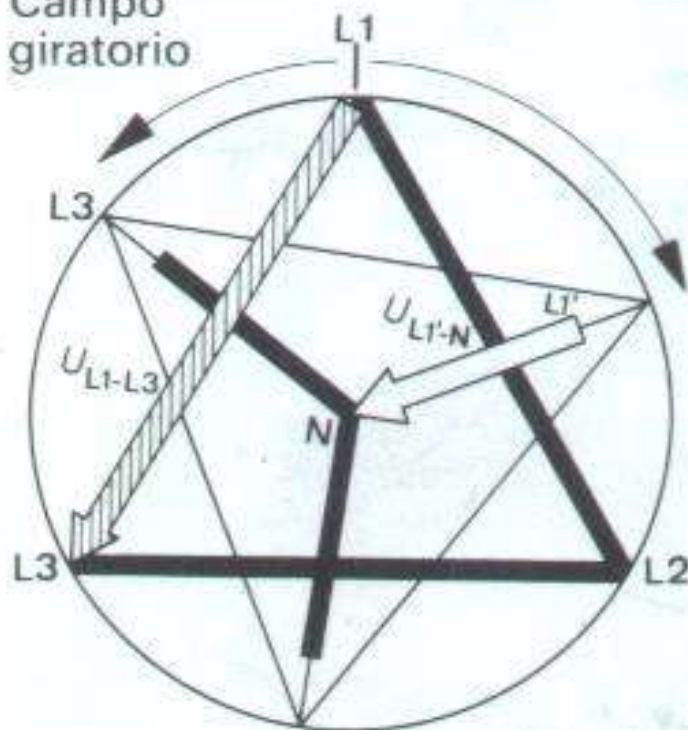
### 3.3.1.3 Conexionado para marcha a derechas y a izquierdas

Para que el impulso de la corriente de conmutación en el paso estrella a triángulo sea lo menor posible es necesario tener en cuenta un conexionado correcto de los bornes del motor.



*Fig. 3.19 Conexionado correcto de las fases del motor para marcha a derechas*

Campo  
giratorio



Retraso del rotor  
durante la pausa  
sin corriente

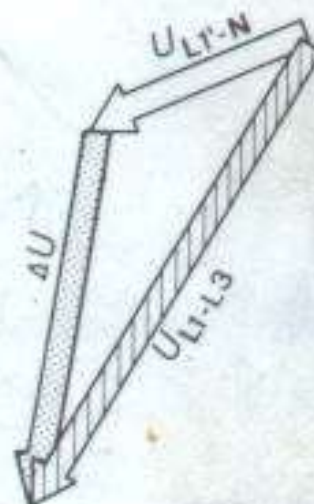
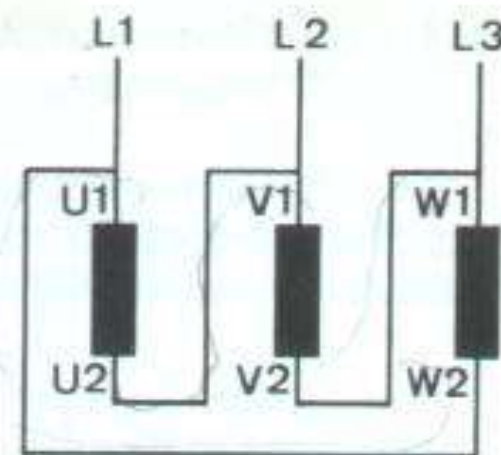


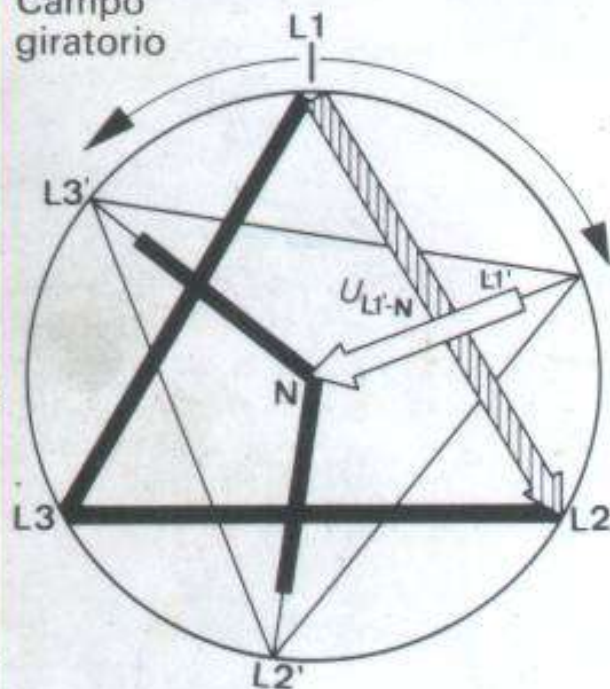
Fig. 3.20 Diagrama vectorial para la conmutación estrella-triángulo en marcha a derechas con conexión correcto de las fases del motor

*Fig. 3.21 Conexión errónea de las fases del motor que proporciona igualmente la marcha a derechas*





Campo  
giratorio



Retraso del rotor  
durante la pausa  
sin corriente

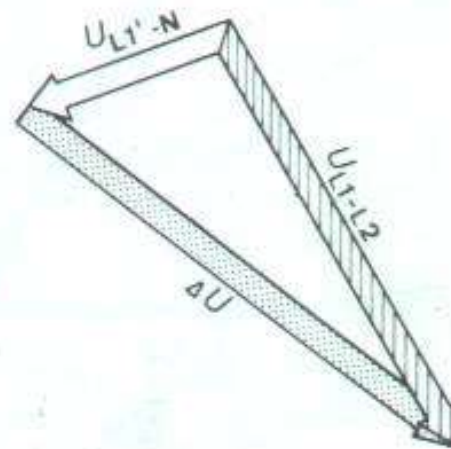
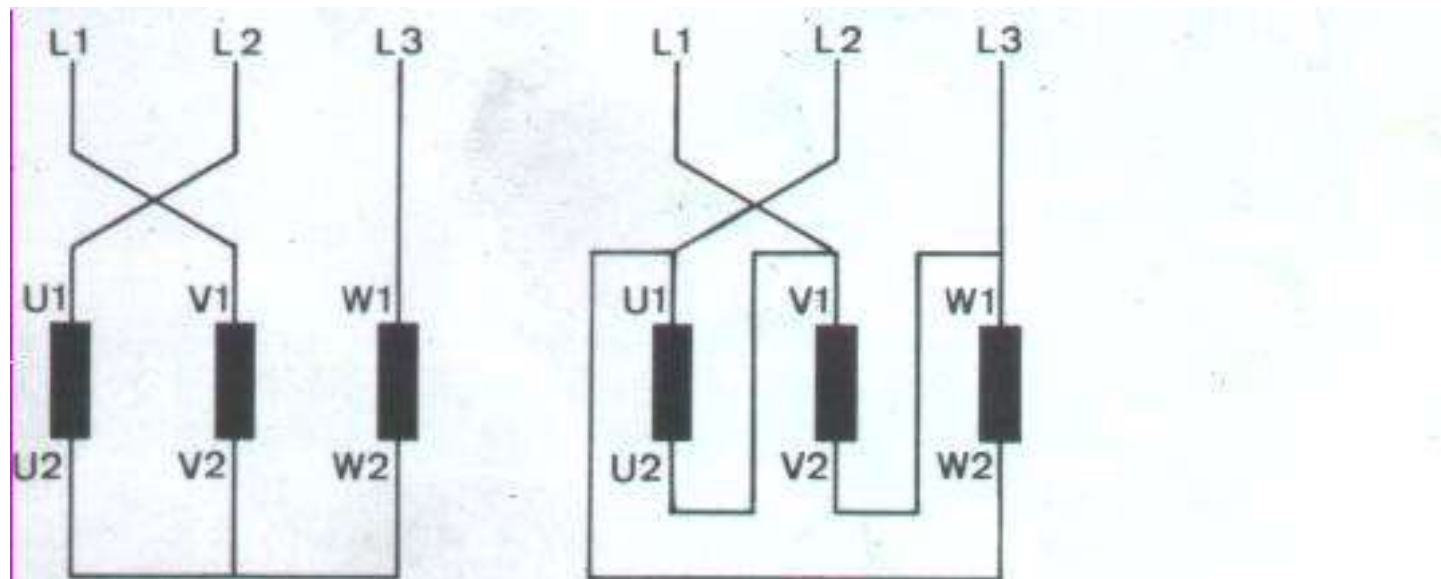


Fig.3.22 Diagrama vectorial para conexión del motor según la Fig.3.21; se produce un gran impulso de corriente de conmutación



*Fig.3.23 Conexionado correcto de las fases del motor para marcha a izquierdas*

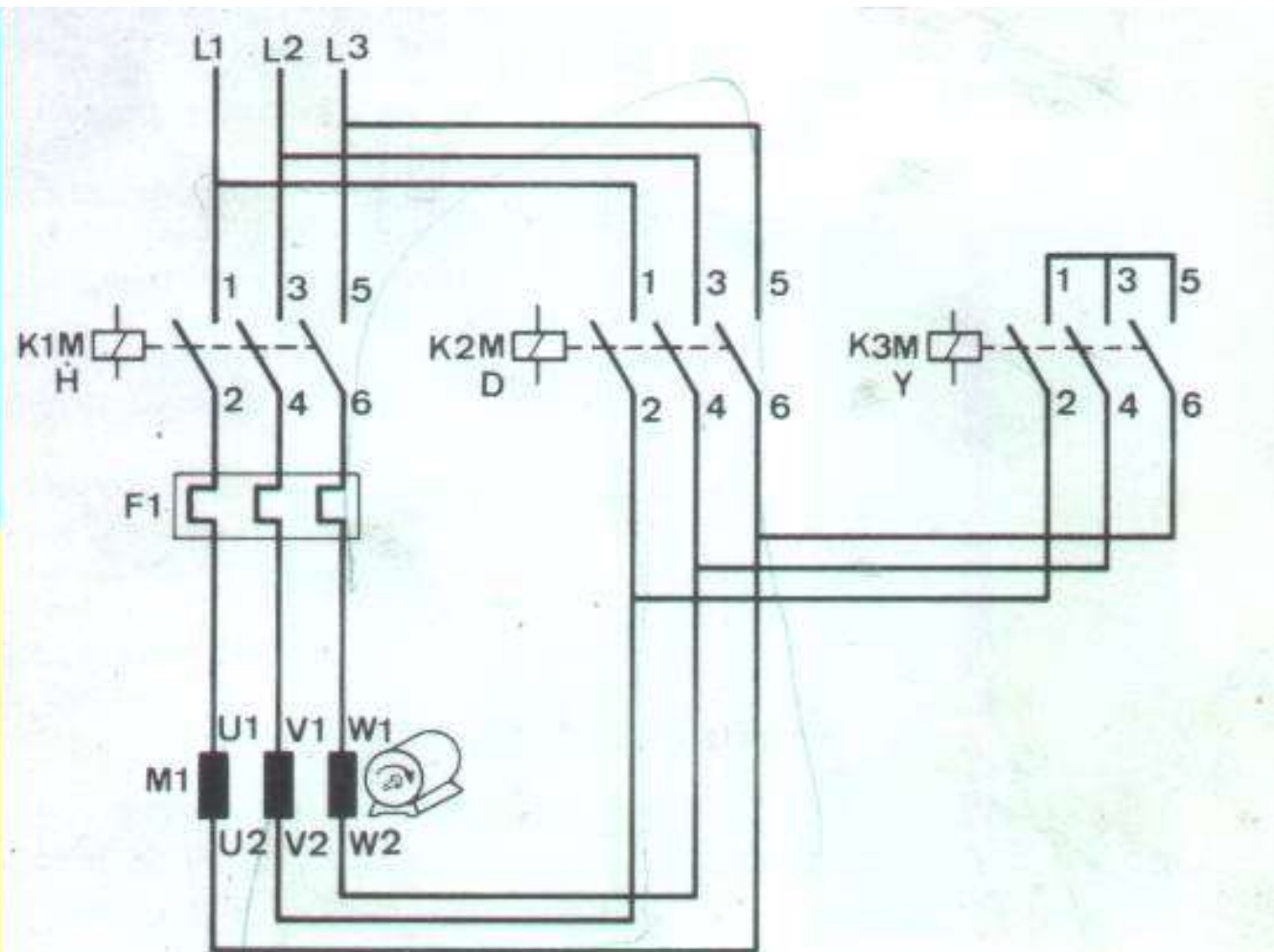


Fig.3,11 Arranque estrella-triángulo normal