MOTOR UNITS

DESCRIPTION AND PRINCIPLES OF OPERATION

CONTENTS

		PAGE
1.	GENERAL	1
2.	DESCRIPTION	1
	SYNCHRONOUS MOTOR UNITS	1
	A. Miniature Synchronous Motor Units	1
	B. Standard and Heavy Duty Synchronous Motor Units	2
	SERIES GOVERNED MOTOR UNITS	3
	A. 1/20 Horsepower Motor Units (AC/DC and AC Only)	3
	B. 1/20 Horsepower Motor Units Variable Speed (AC/DC and AC Only)	4
	C. 1/15 Horsepower Motor Units (AC/DC and AC Only)	5
	D. 1/15 Horsepower Motor Units (DC)	5
3.	PRINCIPLES OF OPERATION	13
	SYNCHRONOUS MOTOR UNITS	13
	SERIES GOVERNED MOTOR UNITS	15
	SERIES GOVERNED MOTOR UNITS VARIABLE SPEED	17

1. GENERAL

1.01 This section provides description and principles of operation for motor units. It is reissued to include additional information on synchronous, series governed , and series governed variable speed motor units. Since it is a general revision, marginal arrows that indicate changes and additions have been omitted.

1.02 The motor units that provide electromechanical rotating motion for operating various teletypewriter apparatus are of two basic types: synchronous and series governed . Both types are self-contained motor units, with characteristics adaptable for use with standard power sources.

1.03 The synchronous type motor units (Figures 1, 2, and 3) are available in miniature (25 millihorsepower), standard, and heavy duty ratings. These motor units must be operated from a standard, single-phase, regulated power source with specifications as listed in Tables A and B.

1.04 The series governed type motor units (Figure 4) are available in standard and heavy duty horsepower ratings and may be operated from regulated or unregulated, standard, single-phase power sources, or dc (direct current). The series governed type motor unit is also available for operation with 48 volts dc only. Specifications are given in Tables C, D, and E.

2. DESCRIPTION

2.01 In general, the synchronous motor units consist of a motor and mounting arrangement, and the required starting and protective devices. Variations of this type are described below.

SYNCHRONOUS MOTOR UNITS

A. Miniature Synchronous Motor Units (Figure 1)

2.02 The 25 millihorsepower miniature synchronous motor units consist of a two-pole wound stator and two end shields that support a squirrel cage type rotor. The motor is secured to its bracket-type cradle by means of resilient mounts at each end, which tend to reduce the transmission of vibrations from the motor to the driven apparatus. A starting relay, capacitor and thermostatic cutout switch are mounted under the cradle. The thermostatic

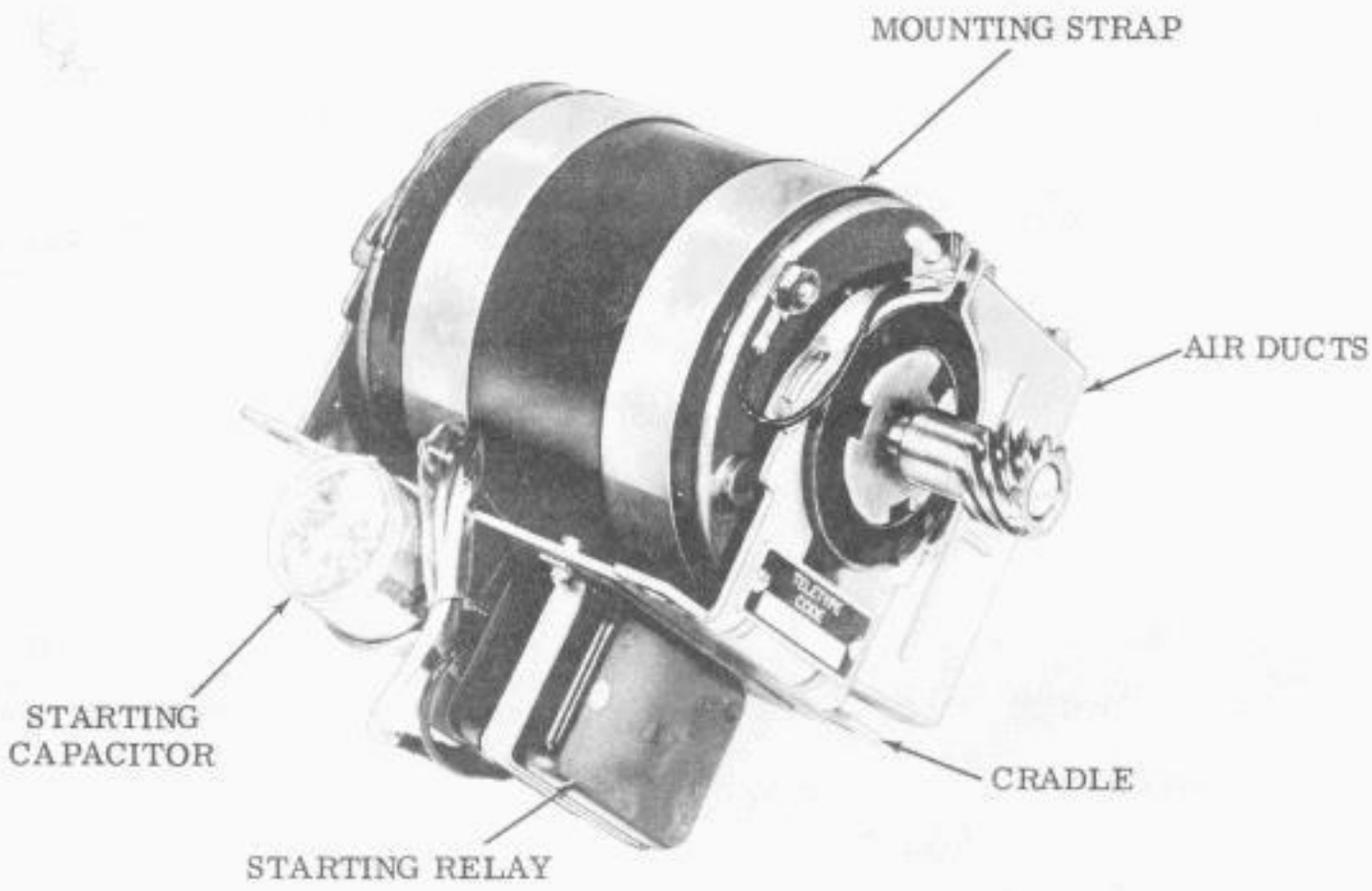

Figure 1 - Typical Miniature Synchronous Motor Unit

cutout switch protects the motor windings from excessive current drawn by the motor. It can be reset manually.

2.03 The variations of the miniature synchronous include 3600 rpm (60 hertz units) and 3000 rpm (50 hertz units) operation; an external fuse instead of the thermostatic cutout switch; single or dual air ducts to improve ventilation, or an air shield to isolate the incoming cool air from the outgoing heated air; and mounting of control parts on the side of the motor instead of under the cradle.

B. Standard and Heavy Duty Synchronous Motor Units

2.04 The standard and heavy duty synchronous motor units (Figure 2) consists of a two-pole wound stator and two end shields that support a ball bearing rotor. A combination handwheel and fan (new-style handwheel and fan is made of plastic — Figure 3) is mounted on the motor shaft, and two fans are mounted at each end of the rotor within the end shields. The opposite end of the shaft contains a tapped hole for mounting the driving gear. A motor starting relay, starting capacitor, and thermostatic cutout switch are mounted in a compartment of the motor mounting bracket. The thermostatic cutout switch, which is reset manually, protects the motor winding from excessive current drawn by the motor. The motor is supported by resilient mounts which are part of the end shields and which are held in place by straps attached to the mounting bracket. The resilient mounts tend to reduce the transmission of vibration from the motor to the driven associated apparatus.

2.05 Variations of the standard and heavy duty synchronous motor units include: 3600 rpm (60 hertz units) and 3000 rpm (50 hertz units) operation; 1/20 and 1/12 horsepower ratings; replacement of the fan with a gear to reverse the direction of rotation for such applications as the high speed punch unit; inverted mounting for installation in the Wall Mounted Page Printer Set, for example; re-location of control parts to meet varying installation re-

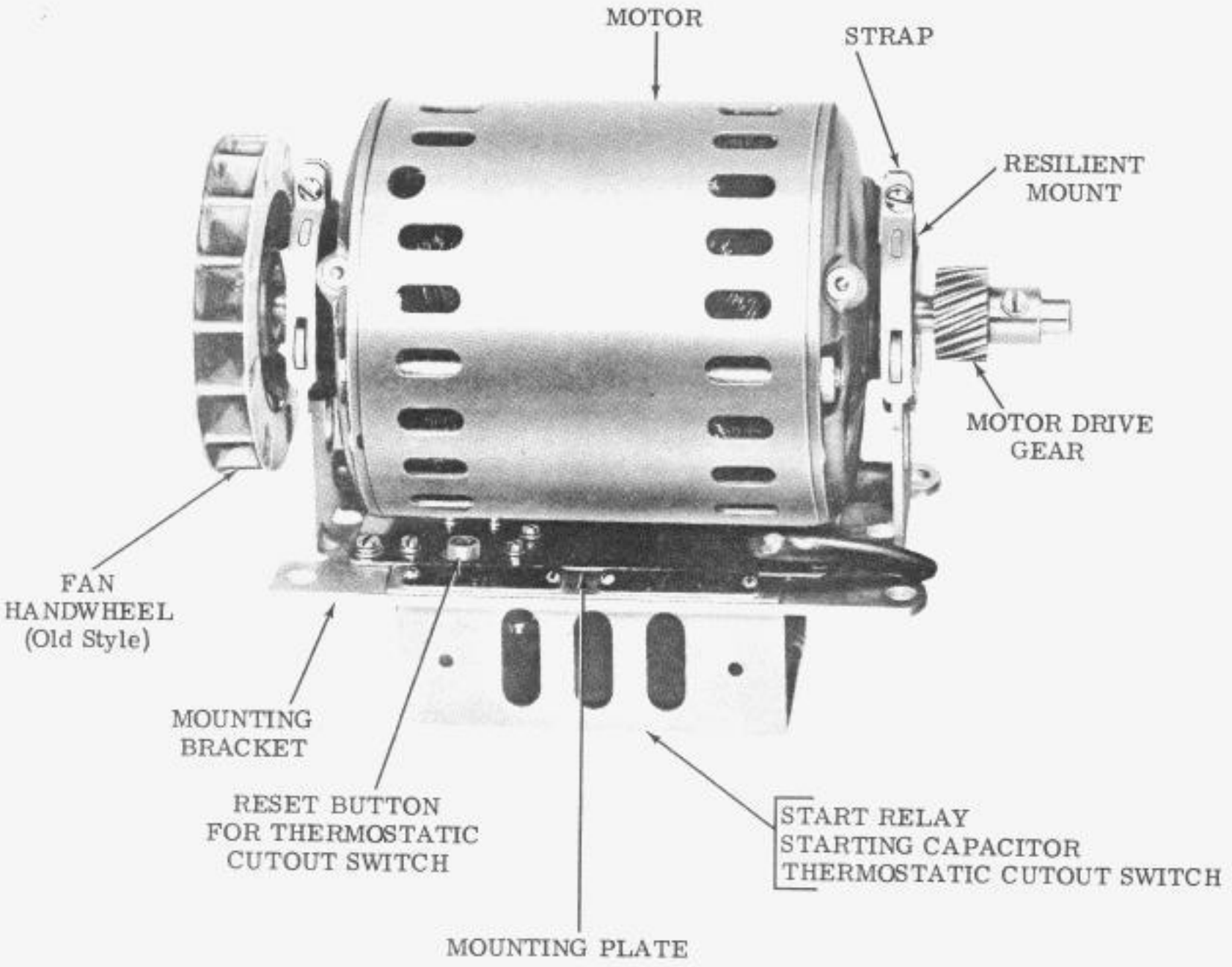

Figure 2 - Typical Standard or Heavy Duty Synchronous Motor Unit

quirements as in the Multiple KSR and RO Set where the control parts are mounted in a compartment at the rear of the fan. Some standard and heavy duty synchronous motor units have the start relay and start capacitor held in position with springs by hooking the ends of the springs through the projections in the sides of the mounting bracket.

SERIES GOVERNED MOTOR UNITS (Figure 4)

2.06 The series governed motor units typically consist of a motor, speed regulator (governor), protective and control devices, and a mounting. Variations of this type are described below.

A. 1/20 Horsepower Motor Units (AC/DC and AC Only)

2.07 The 1/20 hp series governed motor unit consists of a series type motor, speed governor, motor mounting bracket, and a housing for the governor resistors and spark suppression capacitor. The governor is mounted on an extension of the armature shaft and includes a fan that circulates air through the motor. The opposite end of the shaft contains a tapped hole for mounting the driving gear. Targets for speed checking purposes are provided on the governor cover. The motor is mounted by means of resili-

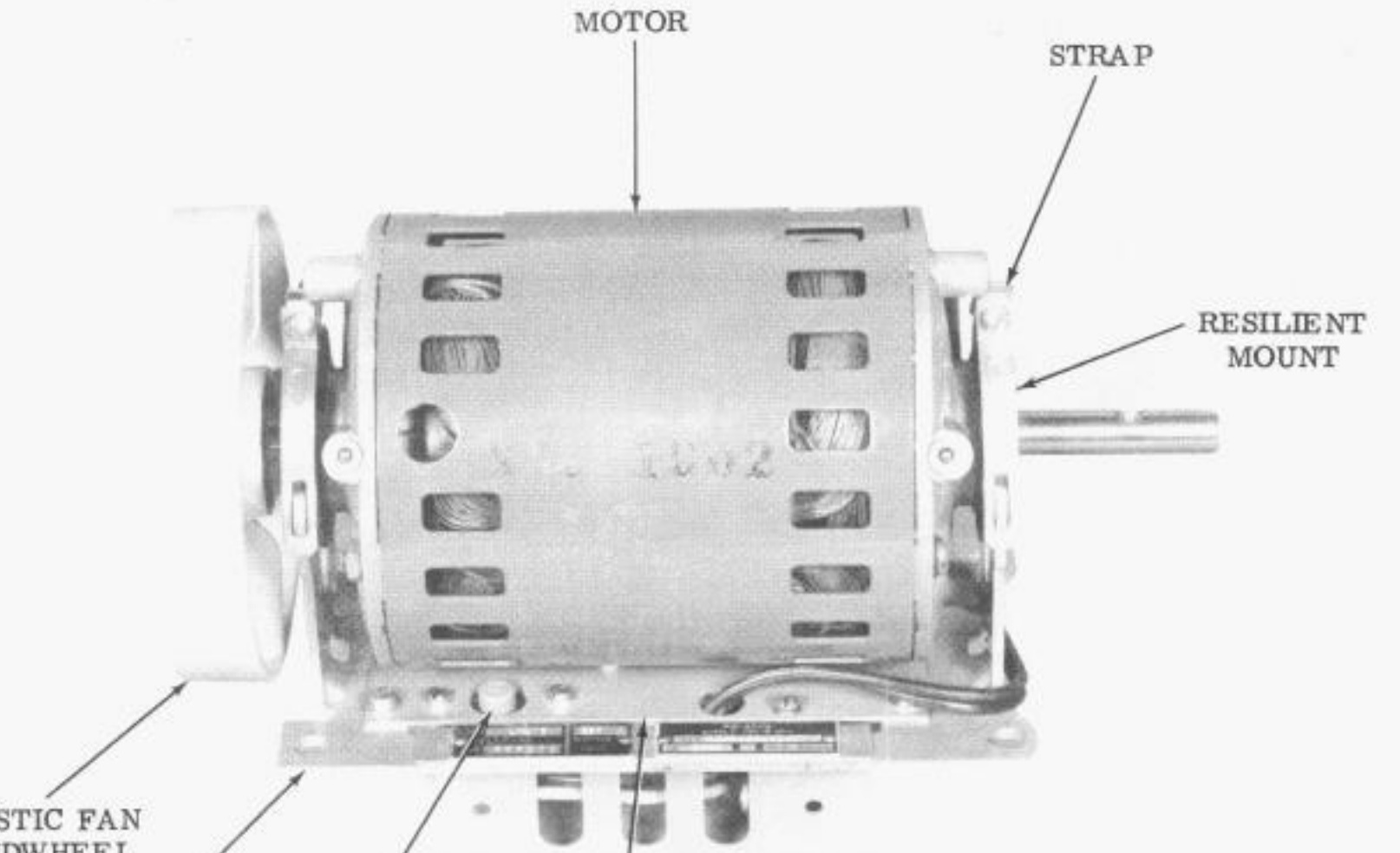

Figure 3 - Typical Standard or Heavy Duty Synchronous Motor Unit With New-Style Plastic Handwheel

ent mounts at each end shield that are fastened to the mounting bracket by straps. The ac only motor unit is furnished with a bidirectional switch controlled governor.

2.08 A variation of the motor unit described in 2.07 is available with electrostatic shielding and radio frequency noise suppression.

B. 1/20 Horsepower Motor Units Variable Speed (AC/DC and AC Only)

2.09 These motor units are similar to the units described in 2.07 and 2.08 but have a gear arrangement permitting changing the motor speed manually while the motor is in operation. The ac only motor unit is furnished with a bi-directional switch controlled governor.

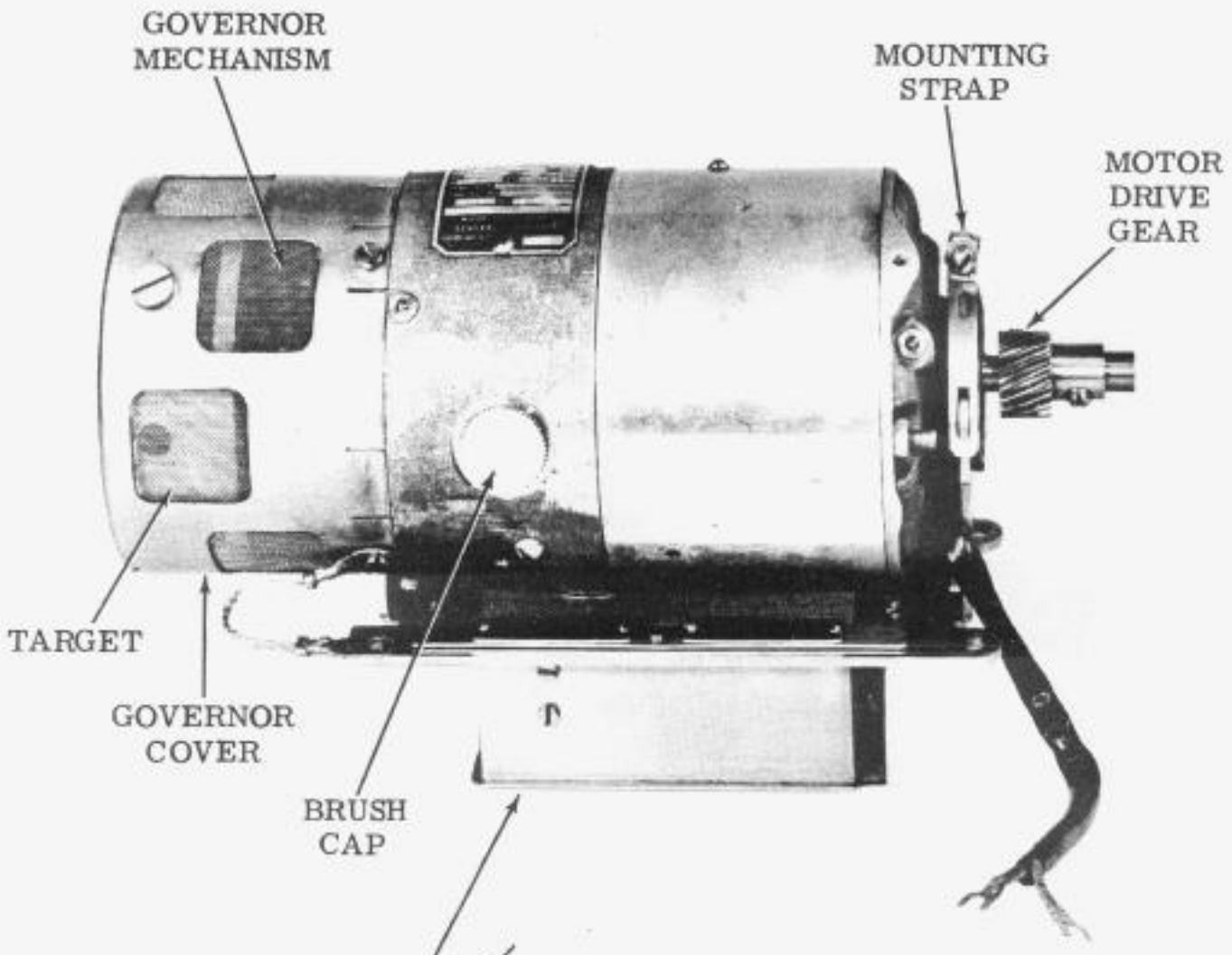

Figure 4 - Typical Series (Governed) Motor Unit

C. 1/15 Horsepower Motor Units (AC/DC and AC Only)

2.10 These motor units are similar to the units described in 2.07, but are equipped with electrostatic shielding and radio frequency noise suppression. The ac only motor unit is furnished with a bidirectional switch controlled governor. The higher horsepower rating accommodates, for example, the requirements of the Automatic Send-Receive Set.

D. 1/15 Horsepower Motor Units (DC)

2.11 These motor units are designed to operate with 48 volts dc only and are equipped with electrostatic shielding and radio frequency noise suppression.

TABLE A
TECHNICAL CHARACTERISTICS OF MINIATURE SYNCHRONOUS MOTOR UNITS

CHARACTERISTICS	LMU19, LMU20, LMU24, LMU26, LMU31, LMU45, MU43, LMU56	LMU35
Rated Horsepower	25 Millihorsepower	25 Millihorsepower
Input Voltage	115 ±10% AC	115 ±10% AC
Phase	Single	Single
Frequency	60 hertz, ±0.75%	50 hertz, ±1%
Input Current (Full Load - Amperes)		
Starting	5.0	3.0
Running	1.25	0.47
Power Factor (Full Load)	56%	89%
Watts Input (Full Load)	76	50
Start Capacitor	88-108 UF	64-77 UF
Run Capacitor	-	7.0 UF
Speed	3600 RPM	3000 RPM
Rotation	Clockwise viewed from pinion end	Clockwise viewed from pinion end
Mounting	Upright	Upright
Other Distinguishing Characteristics	LMU19 - Relay, capacitor, and thermostatic cutout switch mounted on motor bracket. LMU20, LMU26 - Relay, capacitor, and thermostatic cutout switch mounted on motor bracket. LMU20 has a ventilator bracket, LMU26 none. LMU24 - Twin exhaust ducts. Relay and capacitor mounted on motor bracket. No thermostatic cutout switch. Fused externally. Latest design have double shaft. LMU31 - Capacitor and thermostatic cutout switch mounted on motor bracket. Relay mounted on bracket assembly. LMU45, MU43 - Relay, thermostatic cutout switch mounted on motor bracket. Capacitor mounted on motor shield. Wiring for external start switch noise suppressor (LMU45 only). LMU56 - Has double shaft. Similar to LMU24 except no ventilator brackets.	LMU35 - Contains no thermostatic cutout device. Fused (0.8A) externally. Relay and capacitors mounted on motor mounting bracket. Equipped with a ventilator bracket and bidirectional switch.

TABLE B
TECHNICAL CHARACTERISTICS OF STANDARD AND HEAVY DUTY SYNCHRONOUS MOTOR UNITS

CHARACTERISTICS	LMU3, LMU15, LMU21, LMU30, LMU37, LMU42, LMU46, LMU49, YMU2, YMU4	LMU33, LMU36, LMU38, LMU51, LMU52, LMU55, YMU3	LMU11, LMU12	LMU50
Rated Horsepower	1/20	1/20	1/12	1/12
Input Voltage	115 ±10%, AC	115 ± 10% AC (230 ± 10% AC, LMU55)	115 ±10%, AC	115 ±10%, AC
Phase	Single	Single	Single	Single
Frequency	60 hertz, ±0.75%	50 hertz, ±0.75%	60 hertz, ±0.75%	50 hertz, ±0.75%
Input Current (Amperes)				
Starting	9.0, (7.0, YMU2)	8.3, (4.3, LMU55), (8.0, YMU3)	12.25	14.5
Running	1.85	2.4, (1.25, LMU55)	2.8	2.68
Power Factor (Full Load)	30%	35%	44.75%	34.4%
Watts Input (Full Load)	65, (90, YMU2), (90, YMU4)	107, (105, LMU55)	132.9	148
Heat Dissipation (Watts)	50	70	70.6	62
Start Capacitor Rating	43-52 UF	43-52 UF (15-18 UF, LMU55)	170-226 UF	161-193 UF
Speed	3600 RPM	3000 RPM	3600 RPM	3000 RPM
Rotation	LMU42 *CW, others *CCW viewed from fan or short shaft end.	CCW viewed from fan or short shaft end.	CCW viewed from fan end.	CCW viewed from fan end.
Mounting	All upright except LMU30 which is inverted.	All upright except LMU36 which is inverted.	LMU11 - Inverted LMU12 - Upright	Upright
Other Distinguishing Characteristics	LMU3 - Control parts in compartment under motor. Fan cooled. Thermostatic cutout switch.	LMU33 - Similar to LMU3. No fan. LMU36 - Similar to LMU3 except for inverted mounting with control parts above motor.	LMU11 - Control parts located above motor for inverted mounting. Fan cooled. Thermostatic cutout switch.	Similar to LMU11 but with control parts in motor mounting cradle. Starting relay is voltage sensitive type mounted on bracket externally and attached to side of mounting cradle.

*CW - Clockwise *CCW - Counterclockwise

TABLE B
TECHNICAL CHARACTERISTICS OF STANDARD AND HEAVY DUTY SYNCHRONOUS MOTOR UNITS (Continued)

CHARACTERISTICS	LMU3, LMU15, LMU21, LMU30, LMU37, LMU42, LMU46, LMU49, YMU2, YMU4	LMU33, LMU36, LMU38, LMU51, LMU52, LMU55, YMU3	LMU11, LMU12	LMU50
Other Distinguishing Characteristics (continued)	LMU15 - Same as LMU3 except no fan. Pinion on short shaft end. LMU21 - Same as LMU3 except control parts at rear of fan. LMU30 - Same as LMU3 except for inverted mounting with control parts above motor. LMU37 - Same as LMU3 except for cradle and mounting arrangement. Control parts on side of motor. LMU42 - Same as LMU3 except cradle and mounting arrangement and control parts are in a bracket on side of motor and has CW rotation. LMU46 - Same as LMU3 except for external wiring for motor start relay arc suppressor. LMU49 - Same as LMU3 but with speed sensing device.	LMU38 - Differs from LMU3 only in power frequency. LMU51 - Similar to LMU3 except for more compact cradle and mounting arrangement. Fan reversed (solid side adjacent to end bell). LMU52 - Similar to LMU3 except control parts mounted at rear of fan. LMU55 - Similar to LMU3 except has 230 v input. YMU3 - Same as YMU2 except thermostatic cutout switch for 50 hertz.	LMU12 - Same as LMU11 but with control parts located in motor mounting cradle and end shields rotated 180^{o} for upright mounting.	

TABLE B
TECHNICAL CHARACTERISTICS OF STANDARD AND HEAVY DUTY SYNCHRONOUS MOTOR UNITS (Continued)

CHARACTERISTICS	LMU3, LMU15, LMU21, LMU30, LMU37, LMU42, LMU46, LMU49, YMU2, YMU4	LMU33, LMU36, LMU38, LMU51, LMU52, LMU55, YMU3	LMU11, LMU12	LMU50
Other Distinguishing Characteristics (continued)	YMU2 - Similar to LMU3 except has control parts mounted at rear of fan. Has suppressor network. YMU4 - Similar to LMU3 except network assembly mounted on side of mounting bracket.			

TABLE C
TECHNICAL CHARACTERISTICS OF SERIES GOVERNED MOTOR UNITS FOR
LMU6, 13, 28, 29, 39, 41

CHARACTERISTICS	LMU6, LMU28, LMU41				LMU13, LMU39				LMU29
Rated Horsepower	1/20				1/15				1/15
Input Voltage	115 ±10%, AC/DC				115 ±10%, AC/DC				48 ±10%, DC
Phase	Single				Single				-
Frequency	25, 50, or 60 hertz, or DC				25, 50, or 60 hertz, or DC				-
Input Current (Full Load - Amperes)	Hertz				Hertz				
	25	50	60	DC	25	50	60	DC	
Starting	2.4	2.7	1.9	1.8	4.5	4.0	2.8	3.4	13
Running	1.18	1.34	1.12	0.93	2.1	2.3	1.8	1.7	2.5
Power Input (Watts)	123	114	92	1.07	235	200	190	195	120
Power Factor (Full Load)	90%	74%	71%	-	96.8%	87%	79%	-	-
Heat Dissipation (Watts)	86	87	55	70	130	97.2	94.2	111	66
Series Resistor (Ohms)	25	-	-	50	12	-	-	20	-
Target Indicator	4, 6, and 35 Spot				4, 6, and 35 Spot				4, 6, and 35 Spot
Governed Speed	3600 RPM				3600 RPM				3600 RPM
Rotation	CCW viewed from commutator end				CCW viewed from commutator end				CCW viewed from governor end
Mounting	Upright				LMU13 - Inverted LMU39 - Upright				LMU29 - Upright
RF Shielding	LMU28, LMU41				LMU39				LMU29
RF Suppression	LMU28, LMU41				LMU39				LMU29
Other Distinguishing Characteristics	Control parts compartment rectangular on LMU6, LMU28, and LMU41 governor resistor mounted on heat sink in stepped compartment.				LMU39 governor resistor mounted on a heat sink in stepped compartment. LMU13 cradle compartment is rectangular.				No screened governor cover on LMU29 with stepped compartment.

TABLE D
TECHNICAL CHARACTERISTICS OF SERIES GOVERNED MOTOR UNITS FOR
LMU57, 61, 63, 64, YMU5

CHARACTERISTICS	LMU61, YMU5			LMU57, LMU63, LMU64		
Rated Horsepower	1/15			1/20		
Input Voltage	115 ±10%, AC only			115 ±10%, AC only		
Phase	Single			Single		
Frequency	25, 50, 60 hertz			25, 50, 60 hertz		
Input Current (Full Load Amperes)	Hertz			Hertz		
	25	50	60	25	50	60
Starting	4.5	5.0	3.8	2.8	3.1	2.2
Running	2.5	2.3	2.4	1.2	1.3	1.2
Power Input (Watts)	135	130	133	82	61	63
Power Factor (Full Load)	45%	48%	54%	67%	43%	52%
Heat Dissipation (Watts)	72	72	75	53	34	36
Series Resistor (Ohms)	12	—	—	25	—	—
Target Indicator	4, 6, and 35 spot			4, 6, and 35 spot		
Governor Speed	3600 RPM			3600 RPM		
Rotation	CCW viewed from commutator end			CCW viewed from commutator end		
Mounting	Upright			Upright		
RF Shielding	LMU61, YMU5 Motor Only			LMU63, LMU64		
RF Suppression	LMU61			LMU63, LMU64		
Other Distinguishing Characteristics	LMU61 control parts mounted within end shield. Has bidirectional switch. YMU5 control parts mounted within end shield. Has bidirectional switch.			LMU57, LMU63, and LMU64 have control parts mounted within end shield. LMU63 noise suppressor mounted in square container. LMU64 noise suppressor mounted in rectangular container. LMU57, 63, and 64 have bidirectional switch.		

TABLE E
TECHNICAL CHARACTERISTICS OF SERIES GOVERNED MOTOR UNITS FOR LMU47, 60

CHARACTERISTICS	LMU47				LMU60		
Rated Horsepower	1/20				1/20		
Input Voltage	115 ±10%, AC/DC				115 ±10%, AC only		
Phase	Single				Single		
Frequency	25, 50, 60 hertz, DC				25, 50, 60 hertz		
Input Current (Full Load Amperes)	Hertz				Hertz		
	25	50	60	DC	25	50	60
Starting	2.4	2.7	1.9	1.8	2.4	2.8	2.1
Running	1.18	1.34	1.12	0.93	1.2	1.3	1.2
Power Input (Watts)	123	114	92	107	70	70	65
Power Factor (Full Load)	90%	74%	71%	—	90%	74%	71%
Heat Dissipation (Watts)	86	87	55	70	86	87	55
Series Resistor (Ohms)	25	—	—	50	25	—	—
Target Indicator	—				—		
Governor Speed	3600 RPM				3600 RPM		
Rotation	CCW viewed from commutator end				CCW viewed from commutator end		
Mounting	Upright				Upright		
RF Shielding	LMU47				LMU60		
RF Suppression	LMU47				LMU60		
Other Distinguishing Characteristics	Variable speed control parts mounted in stepped compartment.				Variable speed control parts mounted within end shield. Noise suppressor mounted in rectangular cradle compartment. Has bidirectional switch.		

3. PRINCIPLES OF OPERATION

SYNCHRONOUS MOTOR UNITS (Figures 1, 2, and 5)

3.01 The following description of operation applies to the miniaturized, standard, and heavy duty synchronous motor units.

3.02 The stator of the synchronous motor has two windings: a starting winding and an operating (or run) winding. The starting winding, starting capacitor and the normally-open contacts of the starting relay are connected in series. The coil of the current-operated starting relay is connected in series with the operating winding. When power is applied, the initial current through the operating winding (and also the starting relay coil) energizes the relay, and its contacts close the circuit to the starting winding. As the speed of the rotor increases, the current in the operating winding decreases and, when the current has decreased to a predetermined magnitude, the starting relay de-energizes. Its contacts open and remove the starting winding from the operating circuit. The rotor continues to accelerate until it reaches the synchronous operating speed. Rotation is in the counterclockwise direction, as viewed from the fan or short-shaft end of the motor.

3.03 The thermostatic cutout switch is connected in series with both stator windings. This temperature operated device opens the circuit to these windings whenever excessive current is drawn, such as may occur if the motor is stalled, thereby preventing overheating and damage to the motor and control parts. The switch may be reset after the unit has cooled by depressing a pushbutton.

3.04 In some motor units a suppression network is wired in parallel with the starting winding to suppress arcing of the relay contacts (Figure 5).

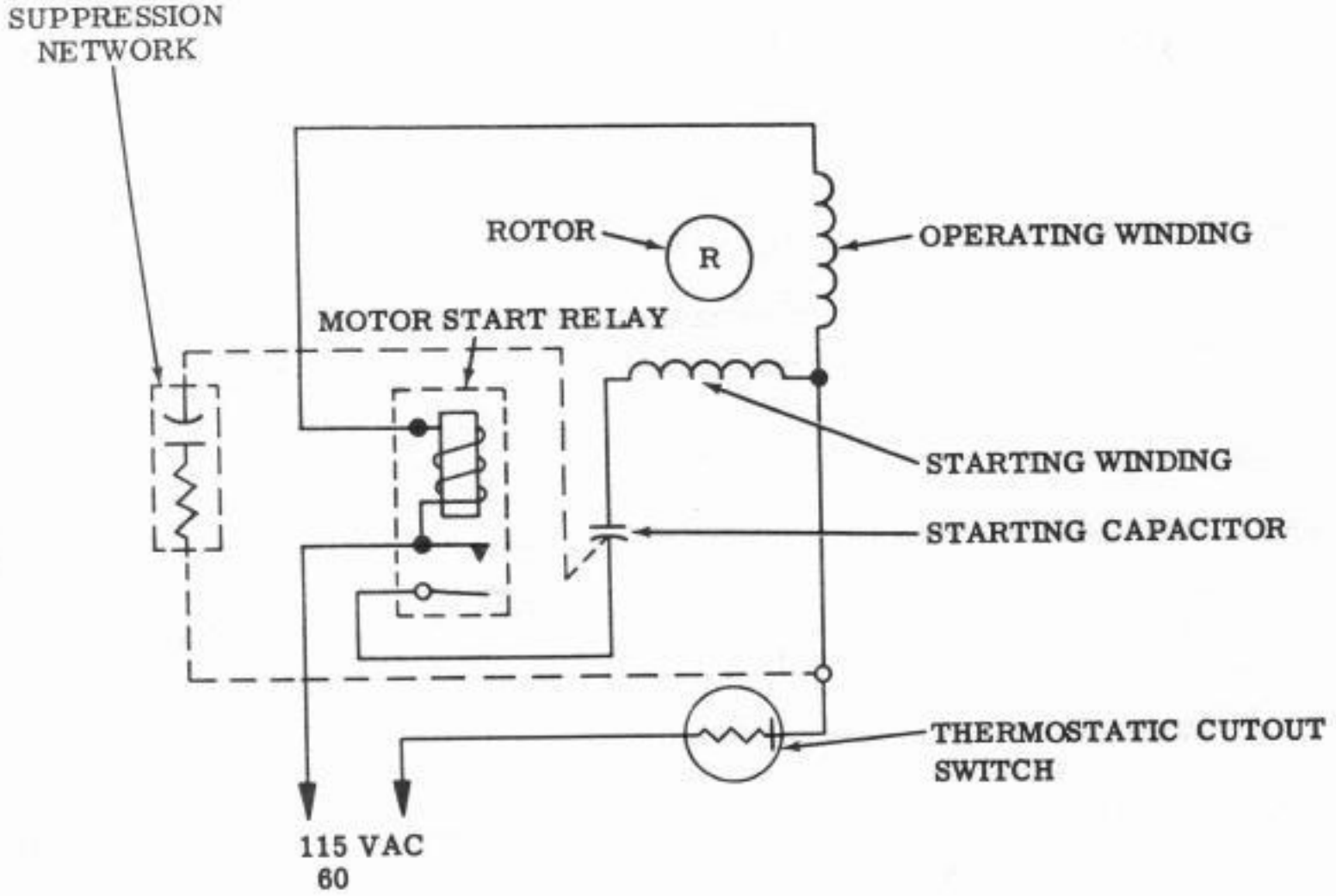

Figure 5 - Typical Synchronous Motor Unit Schematic Diagram

3.05 The following description of operation applies to synchronous motors with a bidirectional switch (Figure 6).

3.06 The stator of the synchronous motor has two windings: a starting winding and an operating (or run) winding. When power is applied to the motor terminals, the initial current through the relay coil, in series with the operating (or run) winding, energizes the relay. Its contacts close applying current to the gate of the bidirectional switch through a resistor, thus applying power to the start capacitor. As the speed of the rotor increases, current through the operating winding decreases and, when the current has decreased to a predetermined magnitude, the starting relay de-energizes. The contacts then open, breaking the flow of current supplied to the gate of the bidirectional switch, and disconnect the starting winding and start capacitor from the line. The rotor continues to accelerate until it reaches the synchronous operating speed. Rotation is in the counterclockwise direction, as viewed from the leads end of the motor.

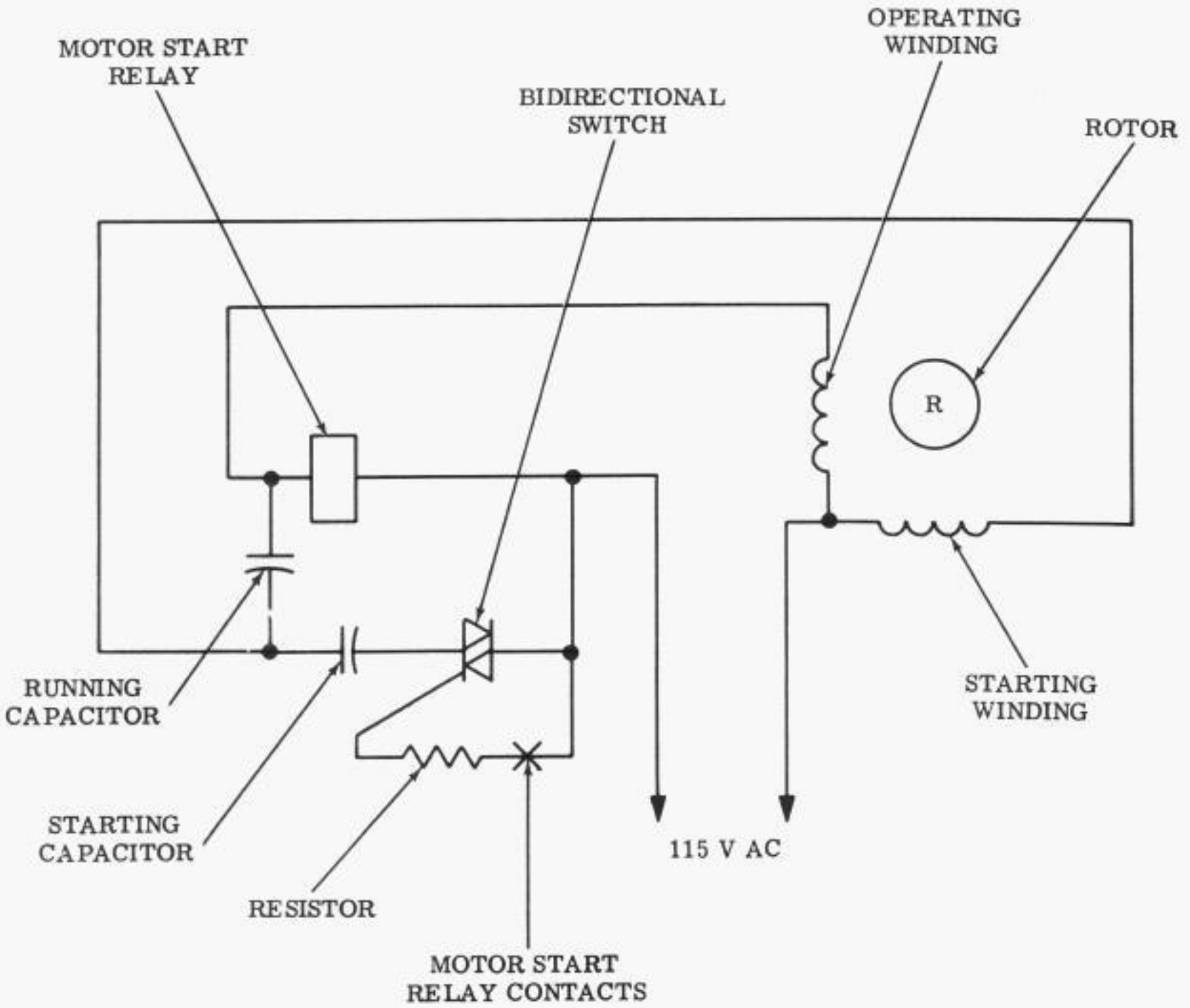

Figure 6 - Typical Synchronous Motor Unit Schematic Diagram With Bidirectional Switch

SERIES GOVERNED MOTOR UNITS

3.07 The following description of operation is applicable to ac/dc series governed motor units Figures 3 and 7.

3.08 The series wound motor utilizes an electro-mechanical governor for speed regulation. The governor regulates the speed at 3600 rpm, ±1 percent, by alternately increasing and decreasing the current in the series connected field windings and armature, which are also in series with a governor contact. A resistor (high-wattage) and capacitor are connected in parallel with the governor contact. The contact is held closed under the tension of a spring which is adjusted to maintain this condition during speeds up to a predetermined rate. With the contact closed, the resistors are shorted out. When the speed of the motor exceeds the predetermined rate, the centrifugal force acting upon the contact momentarily overcomes the spring tension and the contact is opened. This removes the short from the resistors and they then appear in series with the field windings and armature, reducing their current, and consequently reducing the speed of the motor.

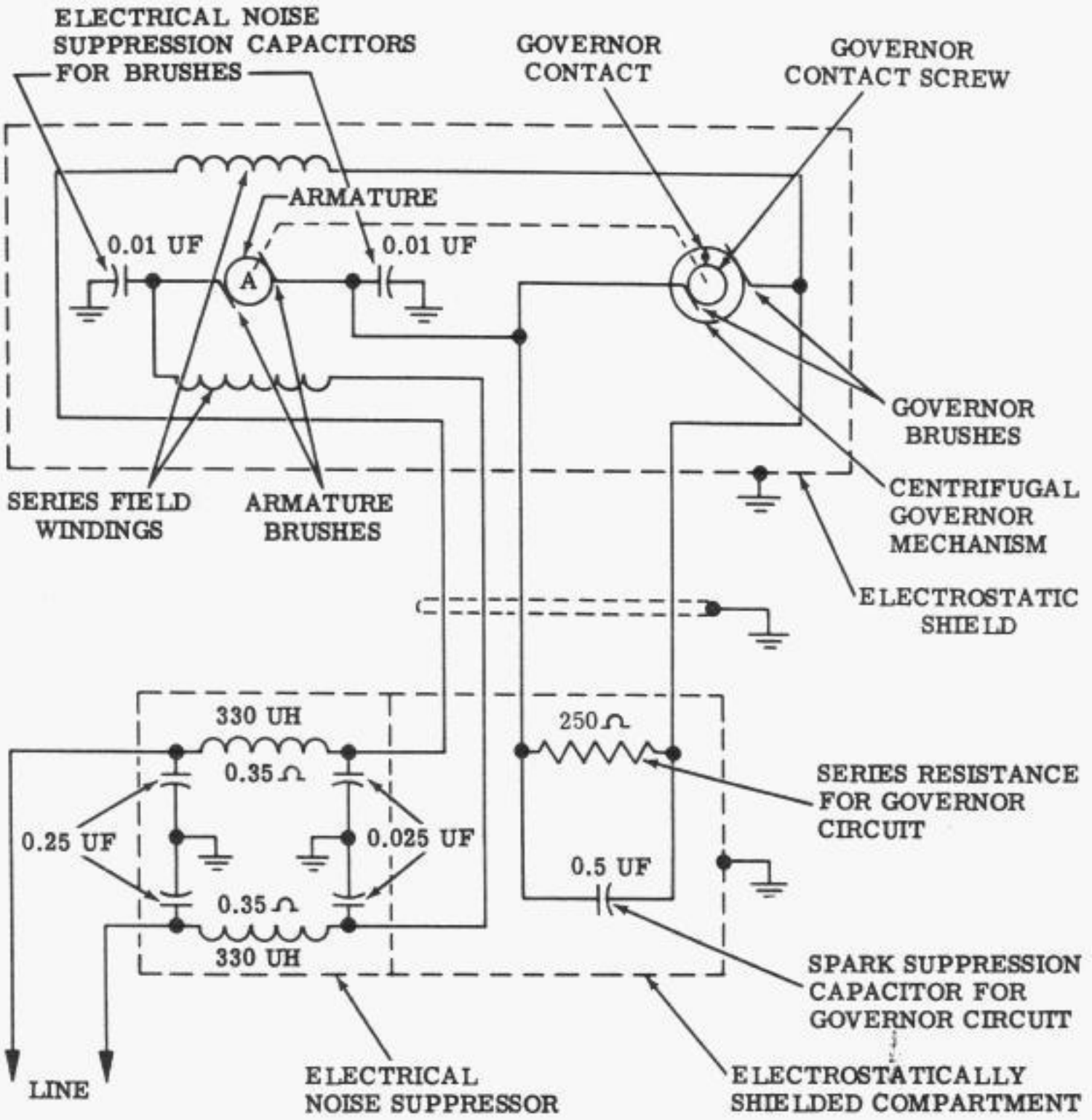

Figure 7 - Typical AC/DC Series Governed Motor Unit Schematic Diagram

3.09 The tension on the contact spring is adjustable to maintain the motor speed at 3600 rpm. To make this adjustment, a target is provided to compare the motor speed with a standard. The outside surface of the governor cover is finished in white with three rows of black spots equally spaced about its periphery. The outer, center, and inner rows contain four, six, and thirty-five spots, respectively. The four spot row is a target which should remain essentially stable at 3600 rpm, when viewed through the moving shutter of a 120 vibrations

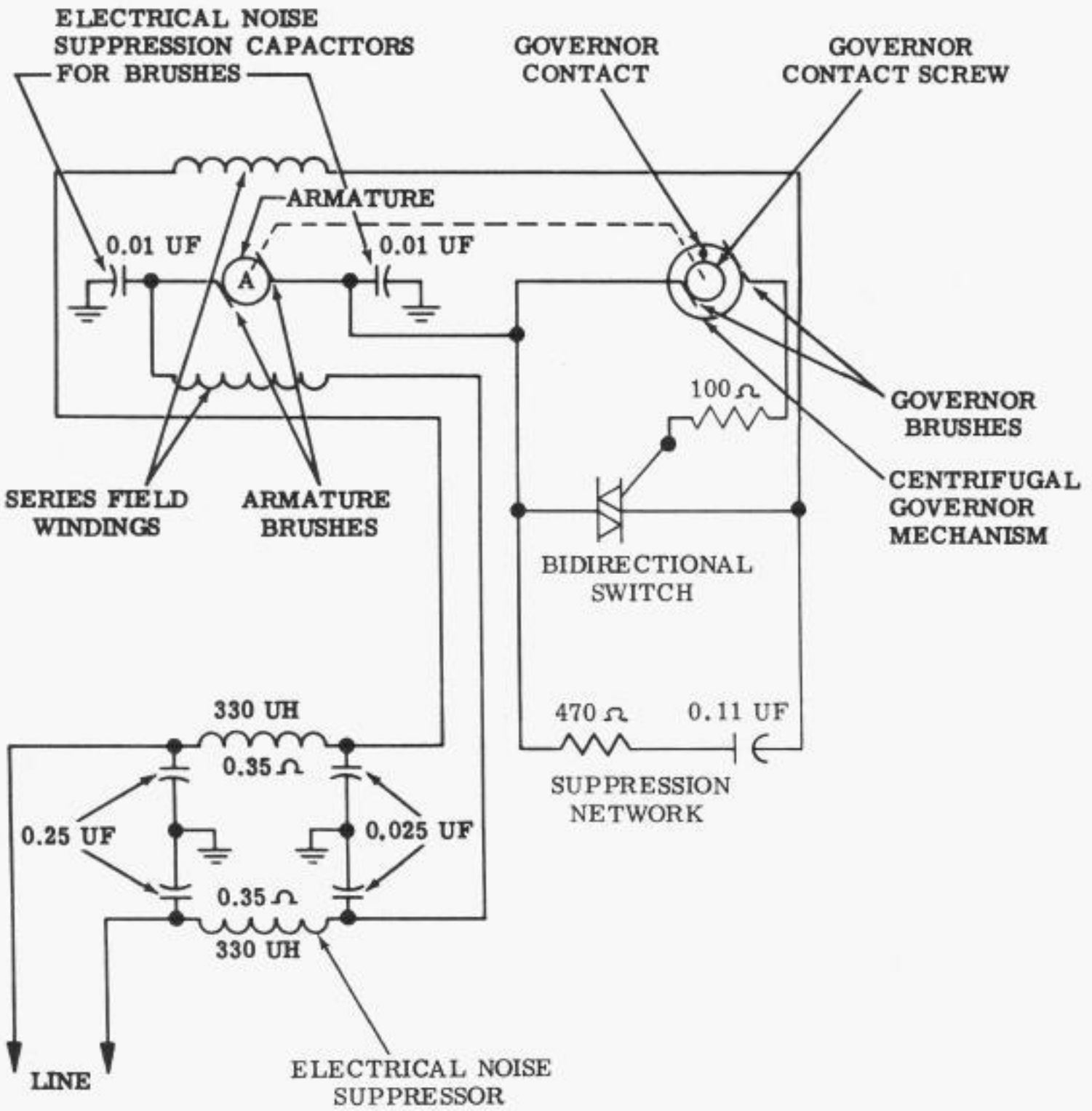

Figure 8 - Typical AC Only Governed Motor Unit Schematic Diagram With Bidirectional Switch

per-second tuning fork. The six spot and thirty-five spot rows serve as targets when using an 87.5 vibration-per-second tuning fork. The six spot row is used to approach an on-speed setting and the thirty-five spot row is used to arrive at an accurate setting of 3600 rpm.

3.10 The following description of operation is applicable to ac series governed motor units furnished with a bidirectional switch (Figure 8).

3.11 The series wound motor utilizes an electromechanical governor for speed regulation. The governor regulates the speed 3600 rpm ±1 percent by alternately increasing and decreasing the current in the series connected field windings and armature, which are also in series with a bidirectional switch controlled by the governor contacts. Normally the governor contact spring holds the governor contact against the contact screw. When the speed of the motor exceeds a predetermined rate, the centrifugal force developed on the governor contact overcomes the pull of the governor spring, and the governor contact opens, removing the trigger of the bidirectional switch, and therefore, decreasing the speed of the motor. The switch will then go into and remain in the blocking or nonconducting state when the alternating current crosses the zero reference point. Therefore, no power is applied to the motor until such time that the contacts again close and gate triggers the switch back into the conducting state. This will occur for either polarity of applied voltage. For motor speed adjustments see 3.09.

SERIES GOVERNED MOTOR UNITS VARIABLE SPEED

3.12 The variable speed motor units are not equipped with governor control linkage, tachometer, or gears. The parts are supplied in modification kit TP173518.

3.13 The variable speed motor has a range of 1800 to 4150 rpm and can be adjusted to within ±1 percent of a specific speed while the motor is running. In this externally controlled governor, the adjusting screw is turned by a gear train actuated by the rotation of the motor. The gear train at its driven end is divided into two branches with an odd number of gears (three) in one branch and an even number of gears (four) in the other. This provides for turning the adjusting screw in either direction to increase or decrease the tension of the governor spring. The pinion of each branch of the gear train is located on the same center as the motor shaft. The pinions are part of the brake disc assembly; an assembly which is free to idle on the stud to which it is mounted. When the speed is not being changed the gears do not rotate but merely revolve with the governor on which they are mounted. However, if a brake shoe is moved against either brake disc, by operating the lever SLOW or FAST that brake disc and its associated pinion turn the spring tension and adjusting screw. Changing of the spring tension causes the motor speed to change. For governor operation for ac/dc motor units refer to 3.08. For motor units operating on ac (with bidirectional switch) refer to 3.09.