

MOTOR UNITS

DESCRIPTION AND PRINCIPLES OF OPERATION

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1. GENERAL

1.01 This section is reissued to include additional synchronous motor information, and to revise the section number appearing on each page. With the exception of the section number, which changed on every page, all other changes and/or additions are indicated by marginal arrows, or by arrows placed within the illustration or table.

1.02 The motor units that provide electro-mechanical 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 and 2) 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 I and II.

1.04 The series (governed) type motor units (Figure 3) 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 Table III.

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 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-cycle units) and 3000 rpm (50-cycle units) operation; an external fuse instead of the thermostatic cutout switch; single or dual air ducts to improve

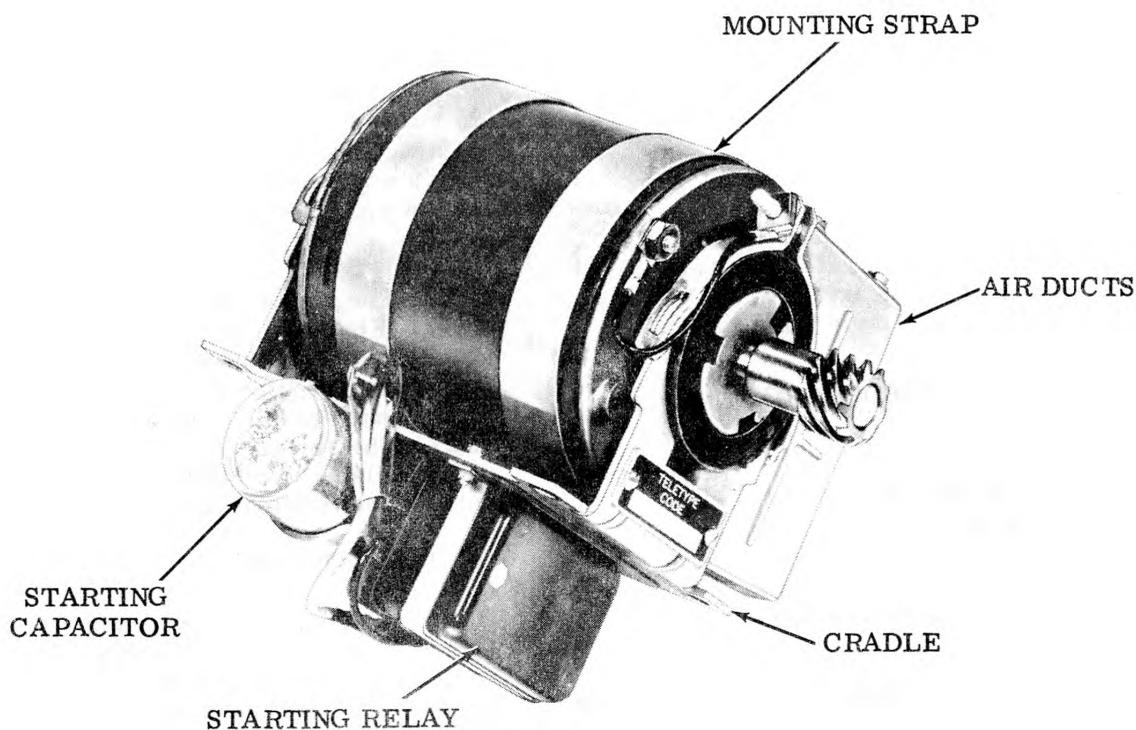


Figure 1 - Typical Miniature Synchronous Motor Unit

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 (Figure 2)

2.04 The standard and heavy duty synchronous motor units consist of a two pole wound stator and two end shields that support a ball bearing rotor. A combination hand wheel and fan 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 windings

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 cycle units) and 3000 rpm (50 cycle 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 requirements as in the Multiple KSR and RO Set where the control parts are mounted in a compartment at the rear of the fan.

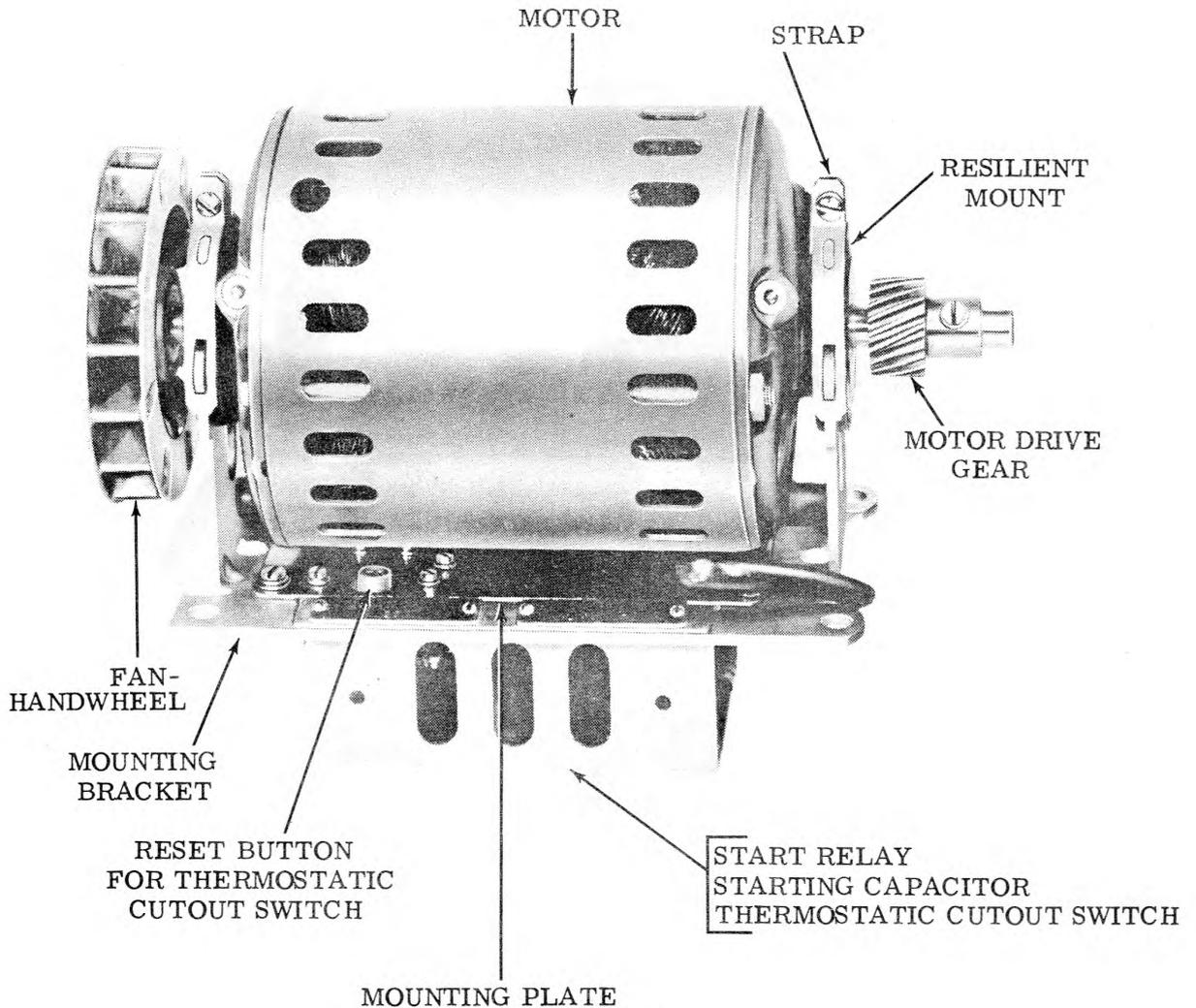


Figure 2 - Typical Standard or Heavy Duty Synchronous Motor Unit

SERIES (GOVERNED) MOTOR UNITS (Fig. 3)

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)

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 resilient mounts at each end shield that are fastened to the mounting bracket by straps.

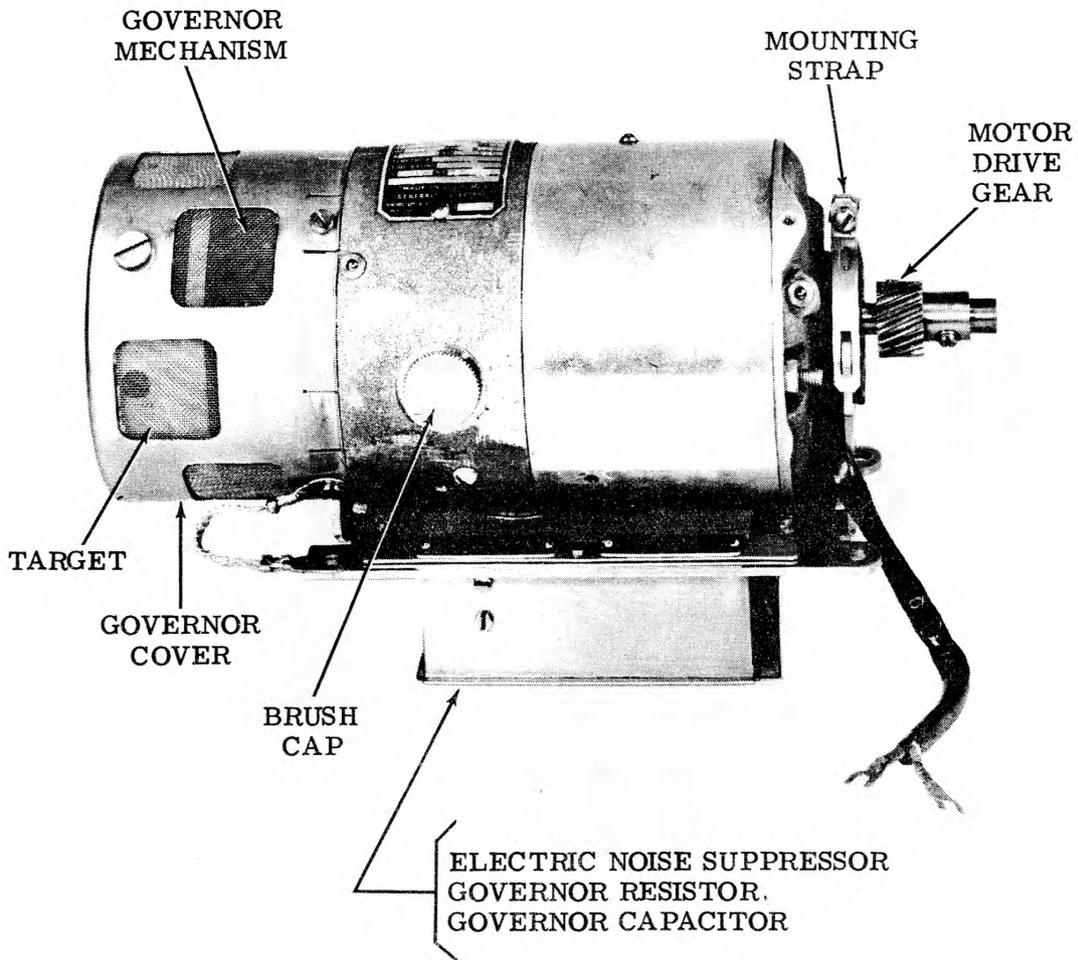


Figure 3 - Typical Series (Governed) Motor Unit

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

B. 1/15 Horsepower Motor Units (AC/DC)

2.09 These motor units are similar to the units described in 2.07, but are equipped with electrostatic shielding and radio frequency

noise suppression. The higher horsepower rating accommodates, for example, the requirements of the Automatic Send-Receive Set.

C. 1/15 Horsepower Motor Units (DC)

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

TABLE 1. TECHNICAL CHARACTERISTICS OF MINIATURE SYNCHRONOUS MOTOR UNITS

CHARACTERISTICS	LMU19, LMU20, LMU24, LMU26, LMU31, LMU45, MU43 (Bell 28F)	LMU35, LMU40
Rated Horsepower	25 Millihorsepower	25 Millihorsepower
Input Voltage	115 ±10% AC	115 ±10% AC
Phase	Single	Single
Frequency	60 Cycles, ±0.75%	50 Cycles, ±1%
Input Current (Full Load - Amperes) Starting Running	4.0-5.0 1.25	3.0 0.47
Power Factor (Full Load)		89%
Watts Input (Full Load)		50
Start Capacitor	88-108UF (130-156UF, MU43 (Bell 28F))	64-77
Run Capacitor	-	7.0
Speed	3600 RPM	3000 RPM
Rotation	Clockwise viewed from pinion end	Clockwise viewed from pinion end
Mounting	Upright	Upright
Other Distinguishing Characteristics	<p>LMU19 - Relay, capacitor, and thermostatic cutout switch mounted on motor bracket.</p> <p>LMU20, LMU26 - Relay, capacitor, and thermostatic cutout switch mounted on motor bracket. LMU20 has single ventilator, LMU26 none.</p> <p>LMU24 - Twin exhaust ducts. Relay and capacitor mounted on motor bracket. No thermostatic cutout switch. Fused externally. Latest design have double shaft.</p> <p>LMU31 - Capacitor and thermostatic cutout switch mounted on motor bracket. Relay mounted on bracket assembly.</p> <p>LMU45, MU43 (Bell 28F) - Relay, thermostatic cutout switch mounted on motor bracket. Capacitor mounted on motor shield. Wiring for external start switch noise suppressor (LMU45 only).</p>	<p>LMU35, LMU40 - Contain no thermostatic cutout device. Fused (0.8A) externally. Relay and capacitors mounted on motor mounting bracket. Equipped with an air shield.</p>

TABLE 2. TECHNICAL CHARACTERISTICS OF STANDARD AND HEAVY DUTY SYNCHRONOUS MOTOR UNITS

CHARACTERISTICS	LMU3 (Bell 28A), LMU15 (Bell 35A), LMU21 (Bell 28LA), LMU30, LMU37, LMU42, LMU46	LMU33, LMU36, LMU38, LMU51, LMU52	LMU11, LMU12 (Bell 28C), YMU-1	LMU50
Rated Horsepower	1/20	1/20	1/12	1/12
Input Voltage	115 \pm 10%, AC	115 \pm 10%, AC	115 \pm 10%, AC	115 \pm 10%, AC
Phase	Single	Single	Single	Single
Frequency	60 Cycles, \pm 0.75%	50 Cycles, \pm 0.75%	60 Cycles, \pm 0.75%	50 Cycles, \pm 0.75%
Input Current (Amperes)				
Starting	9.0	9.0	12.25	14.5
Running	1.85	2.4	2.8	2.8
Power Factor (Full Load)	30%	35%	44.75%	46.8%
Watts Input (Full Load)	65	107	132.9	150
Heat Dissipation (Watts)	50	70	70.6	63.38
Start Capacitor Rating	43-48 UF	43-48 UF	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 LMU27 and LMU30 which are inverted.	All upright except LMU36 which is inverted.	LMU11 - Inverted LMU12 (Bell 28C) - Upright	Upright
Other Distinguishing Characteristics	LMU3 (Bell 28A) - Control parts in compartment under motor. Fan cooled. Thermostatic cut-out switch. Latest design have more compact control parts arrangement.	LMU33 - Similar to LMU3 (Bell 28A). No fan. LMU36 - Similar to LMU3 (Bell 28A) except for inverted mounting with control parts above motor.	LMU11 - Control parts located above motor for inverted mounting. Fan cooled. Thermostatic cut-out switch.	Similar to LMU11 but with control parts in motor mounting cradle. Starting relay is voltage sensitive type.

TABLE 2. TECHNICAL CHARACTERISTICS OF STANDARD AND HEAVY DUTY SYNCHRONOUS MOTOR UNITS - Continued

CHARACTERISTICS	LMU3 (Bell 28A), LMU15 (Bell 35A), LMU21 (Bell 28LA), LMU30, LMU37, LMU42, LMU46	LMU33, LMU36, LMU38, LMU51, LMU52	LMU11, LMU12 (Bell 28C), YMU-1	LMU50
Other Distinguishing Characteristics - Continued	<p>LMU15 (Bell 35A) - Same as LMU3 (Bell 28A) except no fan. Pinion on short shaft end.</p> <p>LMU21 (Bell 28LA) - Same as LMU3 (Bell 28A) except control parts at rear of fan.</p> <p>LMU30 - Same as LMU3 (Bell 28A) except for inverted mounting with control parts above motor.</p> <p>LMU37 - Same as LMU3 (Bell 28A) except for more compact cradle and mounting arrangement. Control parts on side of motor.</p> <p>LMU42 - Same as LMU3 (Bell 28A) except cradle and mounting arrangement is more compact and control parts are in a bracket on side of motor.</p> <p>LMU46 - Same as LMU3 (Bell 28A) except for wiring for motor start relay arc suppressor.</p> <p>LMU49 - Same as LMU3 (Bell 28A) but with speed sensing device.</p>	<p>LMU38 - Differs from LMU3 (Bell 28A) only in power frequency.</p> <p>LMU51 - Similar to LMU3 (Bell 28A) except for more compact cradle and mounting arrangement. Fan reversed (solid side adjacent to end bell).</p> <p>LMU52 - Similar to LMU3 except control parts mounted at rear of fan.</p>	<p>LMU12 (Bell 28C) - Same as LMU11 but with control parts located in motor mounting cradle and end shields rotated 180° for upright mounting.</p> <p>YMU-1 - Control parts are located in a compartment of the motor mounting cradle.</p>	

TABLE 3. TECHNICAL CHARACTERISTICS OF SERIES (GOVERNED) MOTOR UNITS

CHARACTERISTICS	LMU6 (Bell 28B), LMU28, LMU41				LMU13, LMU32, LMU39				LMU23, LMU29 (Bell 28E)
	Cycles				Cycles				
	<u>25</u>	<u>50</u>	<u>60</u>	<u>DC</u>	<u>25</u>	<u>50</u>	<u>60</u>	<u>DC</u>	
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 cycles, or DC				25, 50, or 60 cycles, or DC				-
Input Current (Full Load - Amperes)	Cycles				Cycles				
- Starting	2.4	2.7	1.9	1.8	4.5	4.0	2.8	3.4	13.5
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, LMU32 - Inverted LMU39 - Upright				LMU23 - Inverted LMU29 - Upright
RF Shielding	LMU28, LMU41				LMU32, LMU39				LMU29 (Bell 28E)
RF Suppression	LMU28, LMU41				LMU32, LMU39				LMU29 (Bell 28E)
Other Distinguishing Characteristics	Control parts com- partment rectangular on LMU6 (Bell 28B) and LMU28 and LMU41 governor resistor mounted on heat sink.				LMU39 governor resistor mounted on a heat sink. LMU13, LMU32 cradle com- partments are rectangular.				No screened governor cover on LMU29 (Bell 28E)

3. PRINCIPLES OF OPERATION

SYNCHRONOUS MOTOR UNITS (Figs. 1, 2, and 4)

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.

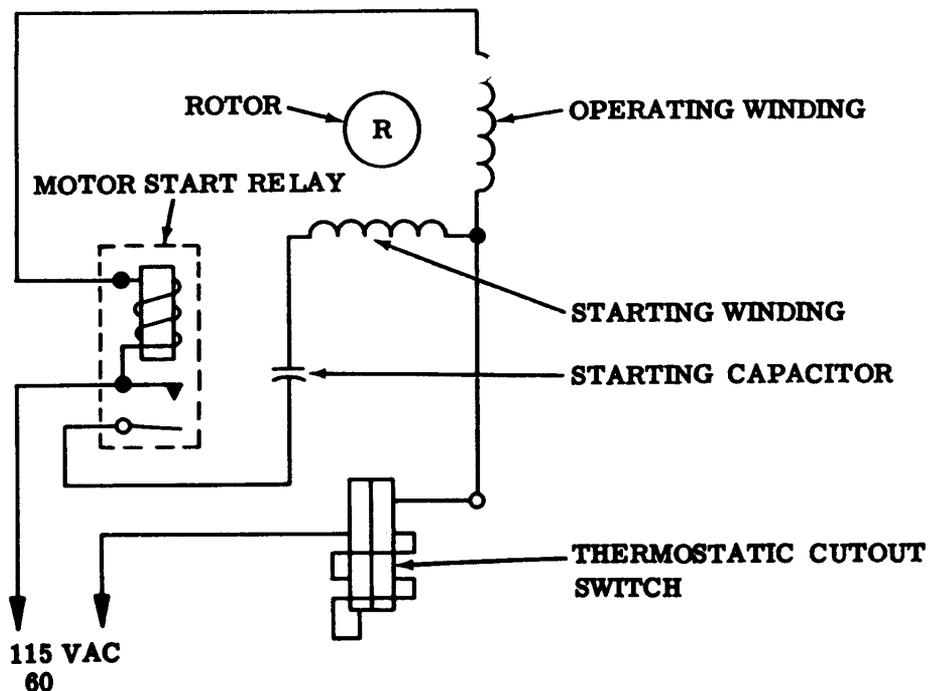


Figure 4 - Typical Synchronous Motor Unit Schematic Diagram

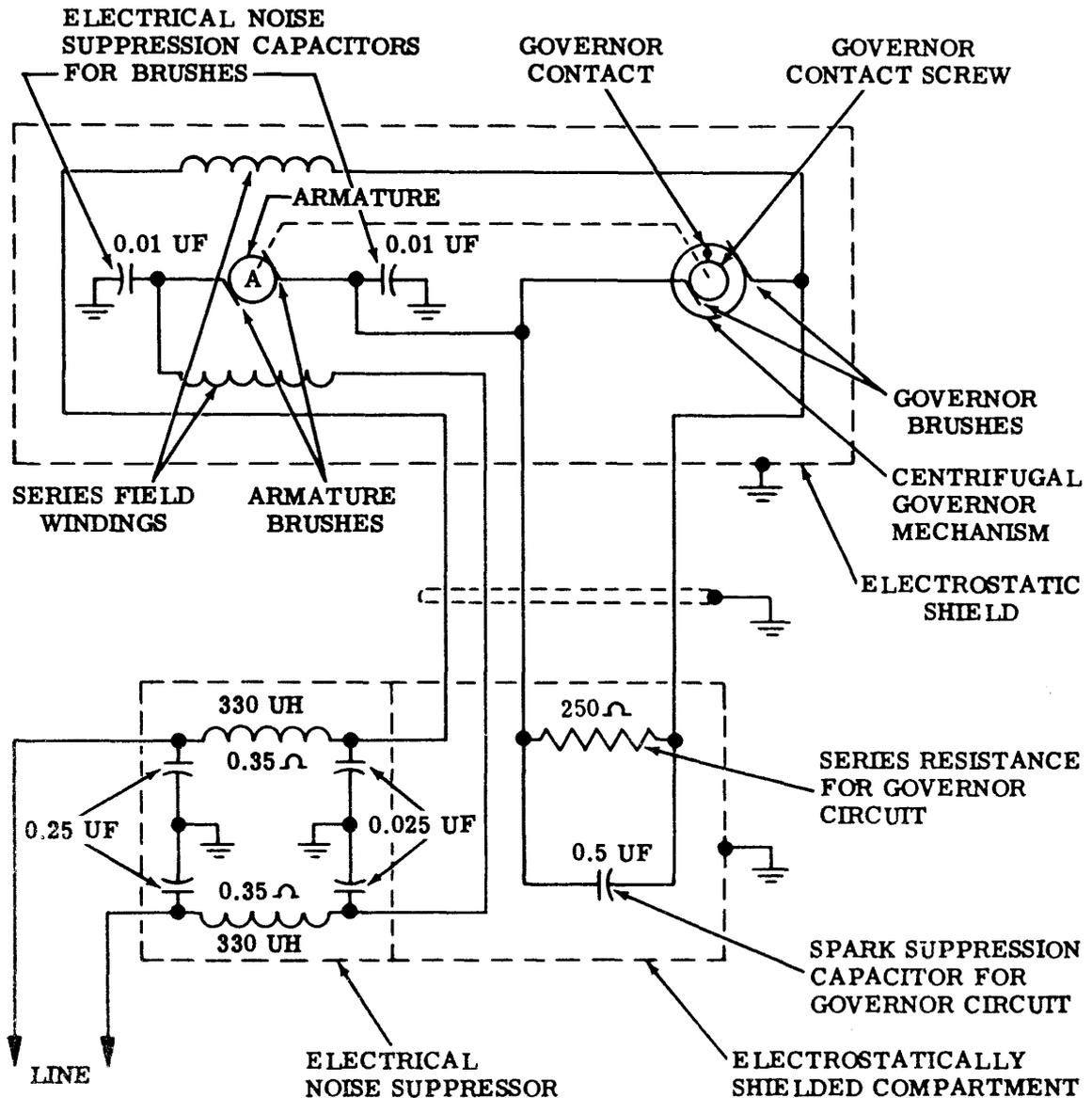


Figure 5 - Typical Series (Governed) Motor Unit Schematic Diagram

SERIES (GOVERNED) MOTOR UNITS (Figs. 3 and 5)

3.04 The following description of operation is applicable to all series (governed) motor units.

3.05 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.

3.06 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 per-second tuning fork. The six spot and thirty-five spot rows serve as targets when using an 87.6 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.