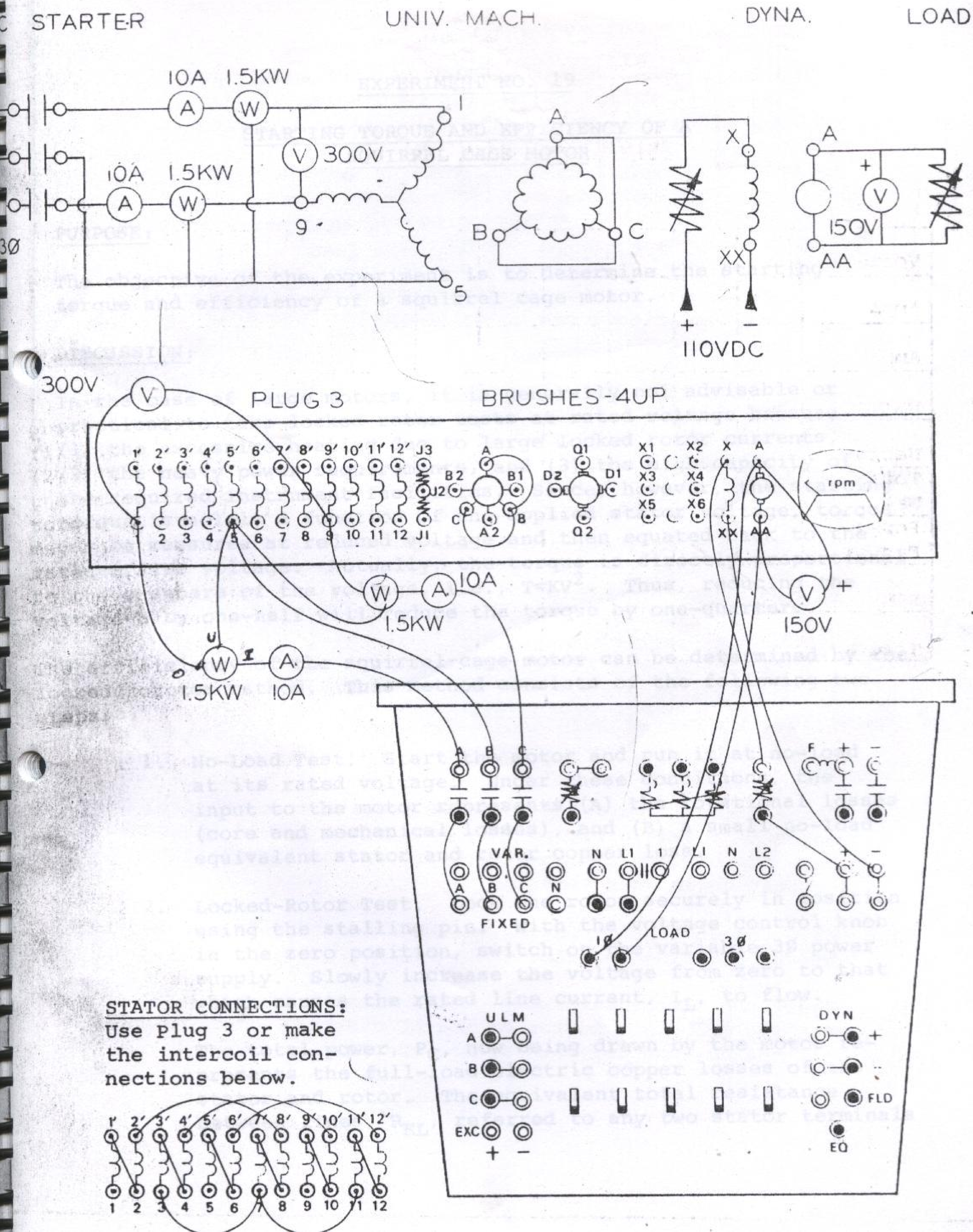

STARTER
UNIV. MACH.
DYNA.
LOAD
10A
1.5KW
300V
150V
110VDC
PLUG 3
BRUSHES-4UP
rpm
FIXED
VAR.
LOAD
ULM
EXC
DYN
FLD
EQ
STATOR CONNECTIONS:
Use Plug 3 or make
the intercoil con-
nections below.

EXPERIMENT NO. 19

STARTING TORQUE AND EFFICIENCY OF A SQUIRREL CAGE MOTOR

PURPOSE:

The objective of the experiment is to determine the starting torque and efficiency of a squirrel cage motor.

DISCUSSION:

In the case of large motors, it is generally not advisable or practical to take locked rotor tests at rated voltage because (1) the excessive heating due to large locked rotor currents, (2) the heavy power requirements, and (3) the high capacity of the required instrument facilities. Since, however, the starting torque is solely a function of the applied stator voltage, torque may be measured at reduced voltage and then equated back to the rated line voltage. Actually, the torque is directly proportional to the square of the voltage, i.e., $T=KV^2$. Thus, reducing the voltage by one-half will reduce the torque by one-quarter.

The efficiency of the squirrel cage motor can be determined by the locked rotor method. This method consists of the following two steps:

1. No-Load Test. Start the motor and run it at no-load at its rated voltage. Under these conditions, the input to the motor represents (A) the rotational losses (core and mechanical losses), and (B) a small no-load equivalent stator and rotor copper loss.

2. Locked-Rotor Test. Lock the rotor securely in position using the stalling pin. With the voltage control knob in the zero position, switch on the variable 3Ø power supply. Slowly increase the voltage from zero to that which causes the rated line current, I_L, to flow.

   The total power, P_C, now being drawn by the motor represents the full-load electric copper losses of the stator and rotor. The equivalent total resistance between lines, R_{EL}, referred to any two stator terminals can be computed from the following equation:

$$P_C = \frac{3}{2} I_L^2 R_{EL}$$

Using this equivalent resistence, the equivalent copper losses can be determined for each value of line current from no-load to full-load.

The rotational losses, P_R, can be determined by the following equation:

$$P_R = P_{no\ load} - \frac{3}{2} R_{EL} (I_{no\ load})^2$$

Knowing the losses for each individual value of motor load, efficiency can be determined by the following equation:

$$\%\ Efficiency = \frac{P_{total} - Losses}{P_{total}} \times 100\%$$

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI
1 ULM Console containing,
    208/120v-3Ø Source
    AC Starter
1 0-150/300 volt AC Voltmeter
2 0-10 amp AC Ammeters
2 0-.75/1.5kw AC Wattmeters

PROCEDURE:

1. Connect the Universal Machine to operate as a squirrel cage motor as shown in Figure 28. The meters should be connected into the circuit as shown with provisions for shorting their current coils when starting.

2. Have the instructor check your machine and meter connections before starting the ULM.

3. Start the ULM by switching on the main AC circuit breaker and pushing the start button of the AC starter. Take readings for the no-load test and record the data in Table 29.

4. Reconnect the ULM as shown in Figure 29 and perform the locked rotor test. The rotor may be locked in place using the stalling pin. This pin is not capable of withstanding the full starting torque. Therefore, the voltage control knob MUST be at zero position before switching on the supply. The current should be adjusted up to 7.0 amps. Record the readings including torque in Table 30.

5. If time permits, perform the locked rotor test for several other of the 36 stalling positions.

REPORT:

Prepare a formal report. Using your data from the previous experiment (No. 18), calculate the efficiency for each load point. On the same graph as you used for the previous experiment, plot an efficiency curve. Calculate the starting torque from the data in Table 30. Discuss the efficiency and the relationship between starting and running torque of a squirrel cage motor.

QUESTIONS:

1. What are the three causes of power loss in an induction motor?

2. What losses are measured by the no-load test?

3. What other method could have been used to determine efficiency? What is the procedure involved?

TABLE 29: NO-LOAD TEST

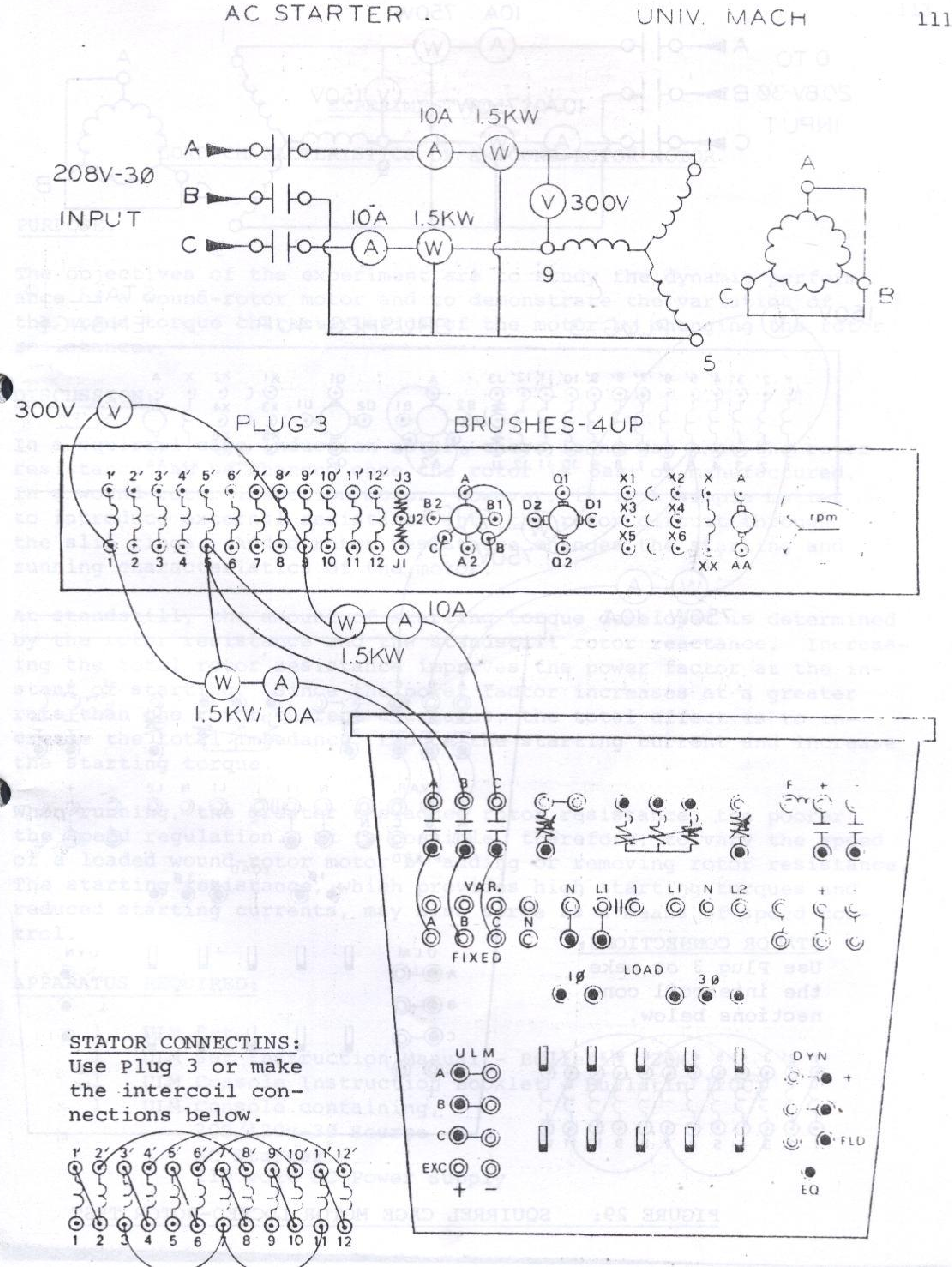
Volts	Amps	Amps	Watts	Watts	Total Watts

TABLE 30: LOCKED-ROTOR TEST

Volts	Amps	Amps	Watts	Watts	Total Watts	Torque

TABLE 31: EFFICIENCY CALCULATIONS

Volts	Amps	Total Watts	P_R	P_C	% Eff.


AC STARTER.
UNIV. MACH
208V-3Ø
INPUT
A
B
C
10A
1.5KW
300V
1
9
5
A
B
C
300V
PLUG 3
BRUSHES-4UP
1′ 2′ 3′ 4′ 5′ 6′ 7′ 8′ 9′ 10′ 11′ 12′ J3
1 2 3 4 5 6 7 8 9 10 11 12 J1
J2
B2
B1
A2
D2
D1
Q1
Q2
X1
X2
X3
X4
X5
X6
X
XX
AA
rpm
10A
1.5KW
1.5KW 10A
VAR.
FIXED
N
L1
L2
LOAD
1Ø
3Ø
F
+
ULM
EXC
+ −
DYN
FLD
EQ
STATOR CONNECTINS:
Use Plug 3 or make
the intercoil con-
nections below.
1′ 2′ 3′ 4′ 5′ 6′ 7′ 8′ 9′ 10′ 11′ 12′
1 2 3 4 5 6 7 8 9 10 11 12

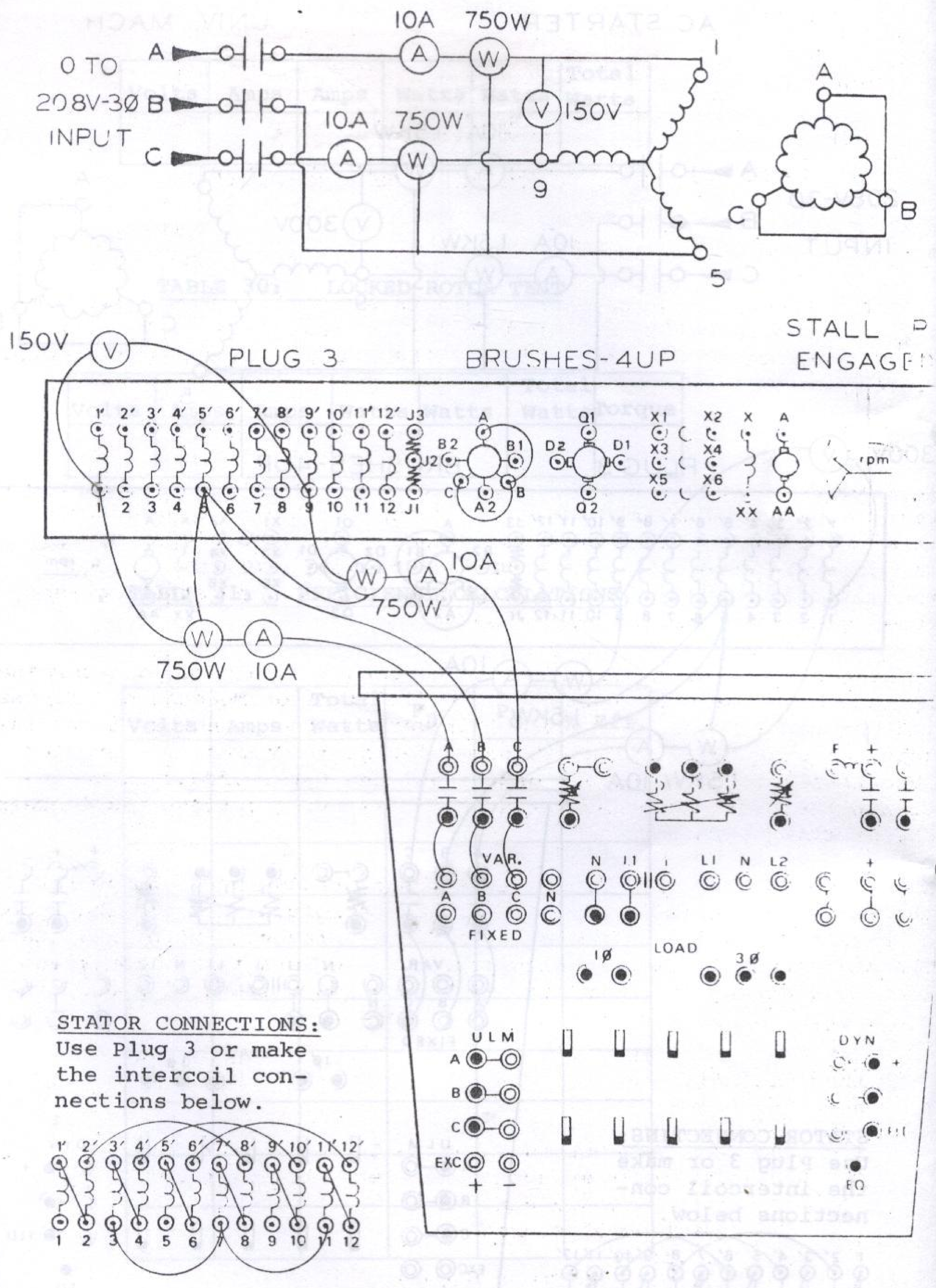


FIGURE 29: SQUIRREL CAGE MOTOR LOCKED-ROTOR TEST

EXPERIMENT NO. 20

LOAD CHARACTERISTICS OF A WOUND-ROTOR MOTOR

PURPOSE:

The objectives of the experiment are to study the dynamic performance of a wound-rotor motor and to demonstrate the variation of the speed-torque characteristics of the motor by changing the rotor resistance.

DISCUSSION:

In a squirrel cage induction motor, there is no way that the rotor resistance can be changed once the rotor is cast or manufactured. In a wound-rotor induction motor, however, it is a simple matter to introduce external resistance into the rotor circuit through the slip rings. Added rotor resistance changes the starting and running characteristics of the motor.

At standstill, the amount of starting torque developed is determined by the rotor resistance and the standstill rotor reactance. Increasing the total rotor resistance improves the power factor at the instant of starting. Since the power factor increases at a greater rate than the rotor current decreases, the total effect is to increase the total impedance, reduce the starting current and increase the starting torque.

When running, the greater the added rotor resistance, the poorer the speed regulation. It is possible, therefore, to vary the speed of a loaded wound-rotor motor by adding or removing rotor resistance. The starting resistance, which provides high starting torques and reduced starting currents, may also serve as a means of speed control.

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI
1 ULM Console containing,
  208/120v-3Ø Source
  AC Starter
  110 volt DC Power Supply

Dynamometer Field Rheostat (250Ω)
Resistance Load Bank
Wound Rotor Rheostat
1 0-300 volt AC Voltmeter
3 0-10 amp AC Ammeters
2 0-1.5 kw AC Wattmeters
1 0-150 volt DC Voltmeter

PROCEDURE:

1. Connect the Universal Machine to operate as a wound-rotor motor as shown in Figure 30. The current coils of the meters should be short-circuited when starting. Switch on the circuit breaker of the wound-rotor rheostat.

2. Connect the Dynamometer to operate as a shunt generator as shown in Figure 30. Adjust its field rheostat to the maximum resistance position.

3. Have the instructor check your machine and meter connections before starting the Universal Machine.

4. Start the motor with the rotor resistance at zero by switching on the main AC circuit breaker and pushing the start button of the AC starter. Record the volts, amps, watts, rotor amps, and speed of the motor and the torque of the Dynamometer from no-load to a load drawing 5.5 amps input to the motor. Calculate the power factor for each load point. Enter all data in Table 32.

5. Repeat Step 4 with the rotor rheostat in the mid-resistance position. Record the data in Table 33.

6. Repeat Step 4 with the rotor rheostat in the maximum resistance position. Record the data in Table 34.

REPORT:

Prepare a formal report. For each condition of rotor resistance, plot the volts, amps, RPM, rotor amps, and power factor as ordinate versus the load torque as abcissa. Compare the various curves, pointing out the different characteristics obtained. Plot a curve of the speed-load characteristics only for each load test. Discuss the relation of the results to speed control of a wound-rotor motor. Discuss the variation of rotor current with load and with rotor resistance.

QUESTIONS:

1. Why is the resistance added to each of the slip ring circuits?

2. How does the speed at a given torque vary with the rotor resistance?

3. For a given application not requiring speed control, is a wound rotor or squirrel cage more practical?

4. Why is a rotor variable resistance control not as effective as voltage control on the supply to the stator?

TABLE 32: MINIMUM ROTOR RESISTANCE

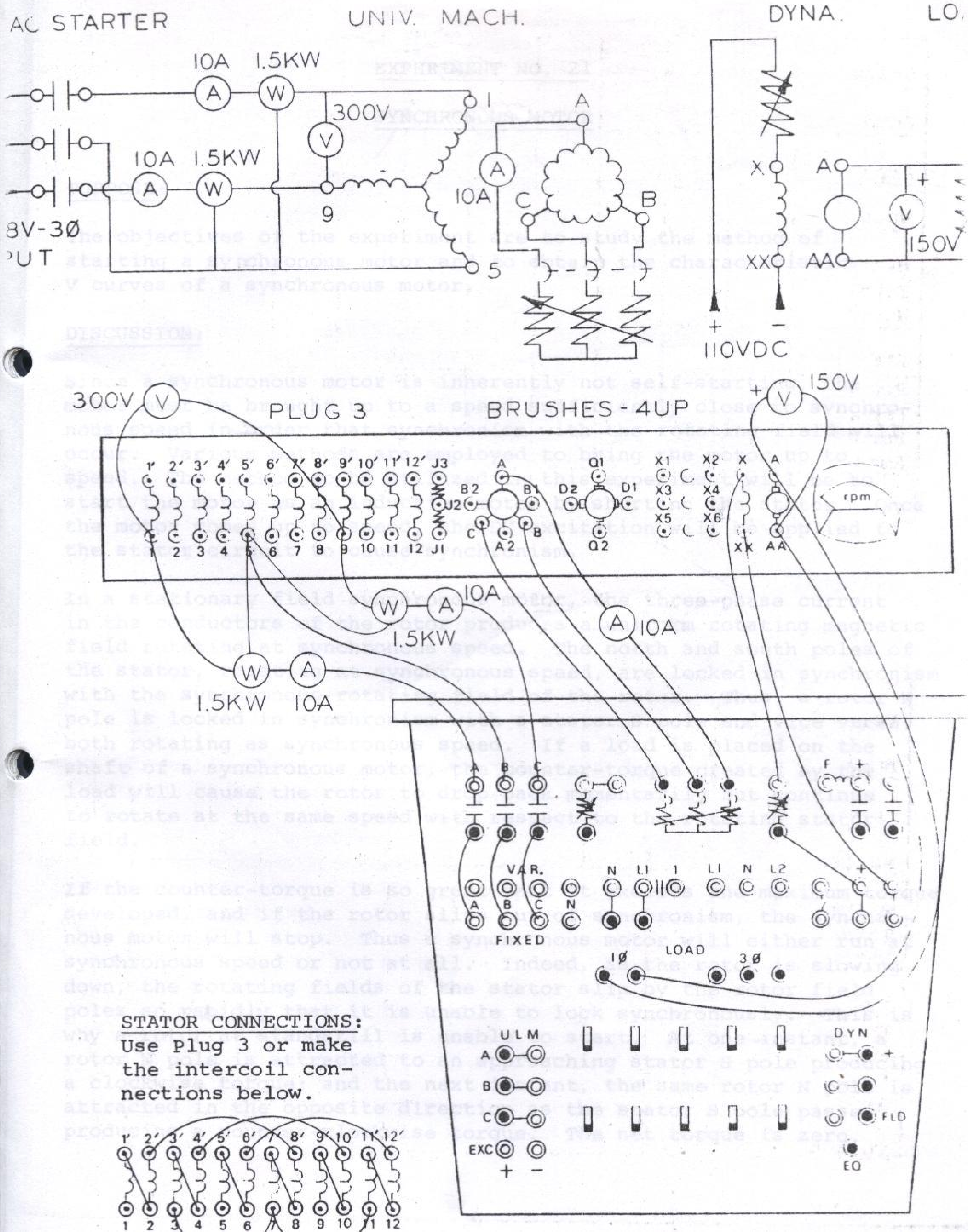
Volts										
Amps										
Amps										
Watts										
Watts										
Total Watts										
RPM										
Power Factor										
Rotor Amps										
Torque										

TABLE 33: HALF ROTOR RESISTANCE

Volts										
Amps										
Amps										
Watts										
Watts										
Total Watts										
RPM										
Power Factor										
Rotor Amps										
Torque										

TABLE 34: MAXIMUM ROTOR RESISTANCE

Volts										
Amps										
Amps										
Watts										
Watts										
Total Watts										
RPM										
Power Factor										
Rotor Amps										
Torque										


AC STARTER
UNIV. MACH.
DYNA.
LO.
10A
1.5KW
300V
10A
1.5KW
8V-3Ø
PUT
110VDC
150V
300V
PLUG 3
BRUSHES-4UP
150V
rpm
1.5KW
10A
1.5KW
10A
VAR.
FIXED
LOAD
1Ø
3Ø
ULM
DYN
EXC
FLD
EQ
STATOR CONNECTIONS:
Use Plug 3 or make the intercoil connections below.

EXPERIMENT NO. 21

SYNCHRONOUS MOTOR

PURPOSE:

The objectives of the experiment are to study the method of starting a synchronous motor and to obtain the characteristic V curves of a synchronous motor.

DISCUSSION:

Since a synchronous motor is inherently not self-starting, the motor must be brought up to a speed sufficiently close to synchronous speed in order that synchronism with the rotating field will occur. Various methods are employed to bring the motor up to speed. The method to be utilized in this experiment will be to start the motor as an induction motor by shorting the stator. Once the motor comes up to speed, the DC excitation will be applied to the stator circuit to cause synchronism.

In a stationary field synchronous motor, the three-phase current in the conductors of the rotor produces a uniform rotating magnetic field rotating at synchronous speed. The north and south poles of the stator, rotating at synchronous speed, are locked in synchronism with the synchronous rotating field of the rotor. Thus, a rotor N pole is locked in synchronism with a stator S pole and vice versa, both rotating as synchronous speed. If a load is placed on the shaft of a synchronous motor, the counter-torque created by the load will cause the rotor to drop back momentarily but continue to rotate at the same speed with respect to the rotating stator field.

If the counter-torque is so great that it exceeds the maximum torque developed, and if the rotor slips out of synchronism, the synchronous motor will stop. Thus a synchronous motor will either run at synchronous speed or not at all. Indeed, as the rotor is slowing down, the rotating fields of the stator slip by the rotor field poles so rapidly that it is unable to lock synchronously. This is why a rotor at standstill is unable to start. At one instant, a rotor N pole is attracted to an approaching stator S pole producing a clockwise torque; and the next instant, the same rotor N pole is attracted in the opposite direction as the stator S pole passes producing a counter-clockwise torque. The net torque is zero.

The operating characteristics of a synchronous motor are represented by a family of V-curves. These V-curves are obtained by applying a given constant load to the shaft of the synchronous motor and varying the field current from over excitation to under excitation, recording the rotor current at each step.

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI
1 ULM Console containing,
    110 volt DC Power Supply
    Dynamometer Field Rheostat (250Ω)
    Resistive Load Bank
    Universal Machine Field Rheostat (173Ω + 11Ω)
    208/120v-3Ø Variable Source
    AC Starter
    Synchronous Motor Switch
1 0-150 volt AC Voltmeter
2 0-20 amp AC Ammeters
2 0-1.5 kw AC Wattmeters
1 0-150 volt DC Voltmeter
1 0-10 amp DC Ammeter

PROCEDURE:

1. Connect the Universal Machine to operate as a synchronous motor as shown in Figure 31. The current coils of all meters should be SHORT-CIRCUITED WHEN STARTING. Switch on the main AC and 3Ø Variable Source circuit breakers and adjust the output of the Variable Source to 115v-3Ø.

2. Connect the Dynamometer to operate as a shunt generator as shown in Figure 31. Adjust its field rheostat to the maximum resistance (fully clockwise) position.

3. Have the instructor check your machine and meter connections before starting the ULM.

4. Switch on the DC supply circuit breaker and, with the switch in the "SYN. RUN" position, pre-adjust the DC field current to 7 amps. Change the switch to "IND. START" position and start the ULM using the AC starter. When the machine comes up to speed, change the switch to the "SYN. RUN" position,

causing the machine to pull into synchronism.

5. Obtain data for V-curves for field currents from 9 to 3 amps or pull out for loads on the generator of no-load, 110v-300w, 110v-600w, and 110v-900w. Record the data in Tables 35-38. If the machine drops out of synchronism, push the stop button and then restart as an induction motor at no-load.

REPORT:

Prepare a formal report. Using the data in Tables 35-38, plot the stator current as ordinate versus the field current as abcissa for the various values of load. Also plot curves of .8 lag, unity, .8 lead power factor as dotted lines versus the field current on the same set of axes. Discuss the performance of the ULM as a synchronous motor.

QUESTIONS:

1. Explain the method of bringing a synchronous motor up to speed.

2. What is a synchronous condenser? Why is it called this name? For what is it used?

3. What would be the effect of reducing the line voltage of the synchronous motor at a given value of load and field current? What would be the effect of increasing?

4. Explain why the load angle must change when the load is increased.

5. The ULM is capable of operating as both a rotating field and a stationary field synchronous motor. Explain the operation of both types. Which would be best suited for large horsepower motors?

TABLE 35: NO LOAD V-CURVE (PERFORM WITH NO EXCITATION ON DYNAMOMETER)

Field Amps	Volts	Amps	Amps	Watts	Watts	Total Watts	Power Factor

TABLE 36: 300W V-CURVE

Field Amps	Volts	Amps	Amps	Watts	Watts	Total Watts	Power Factor

TABLE 37: 600W V-CURVE

Field Amps	Volts	Amps	Amps	Watts	Watts	Total Watts	Power Factor

TABLE 38: 900W V-CURVE

Field Amps	Volts	Amps	Amps	Watts	Watts	Total Watts	Power Factor

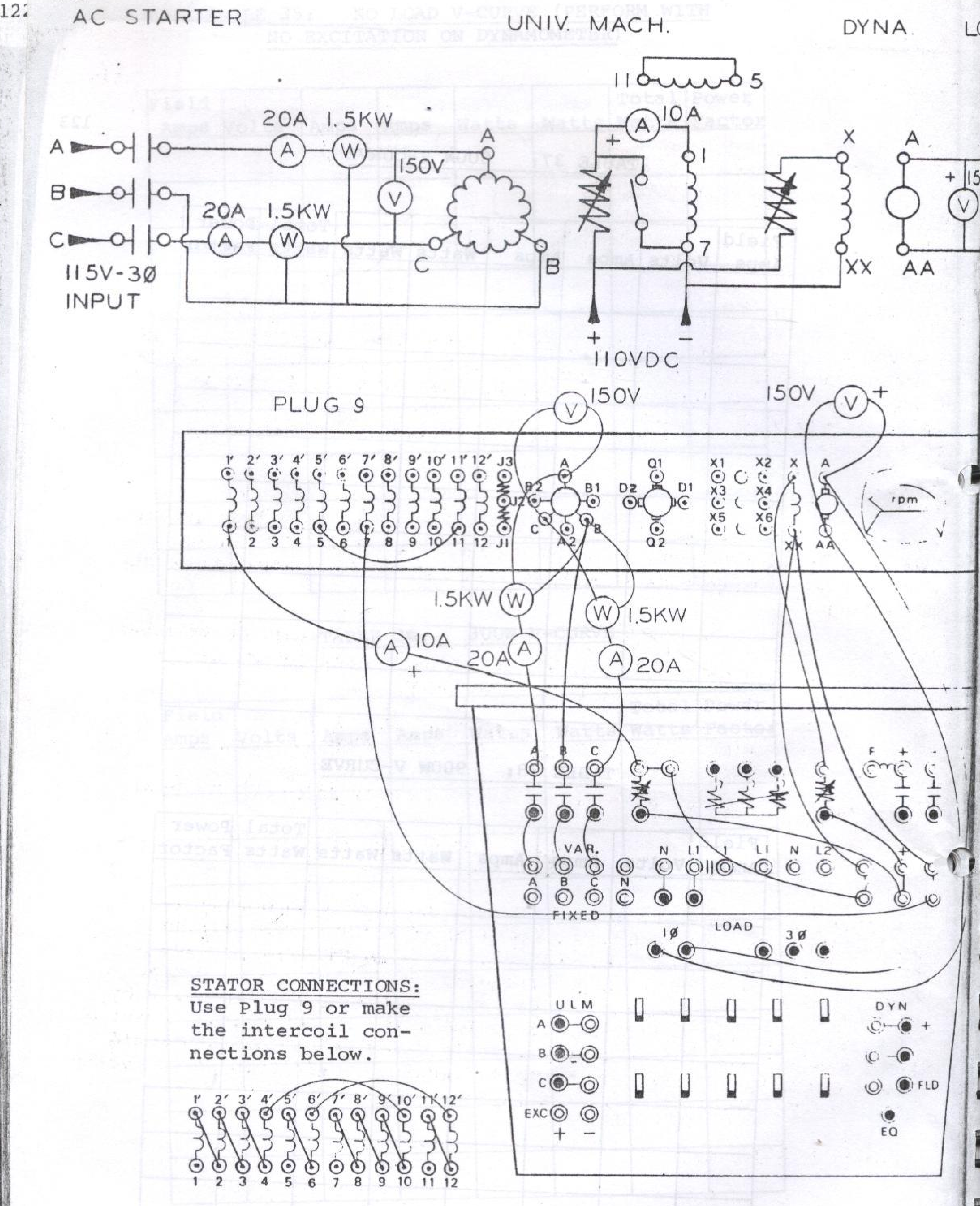


FIGURE 31: SYNCHRONOUS MOTOR V CURVES

EXPERIMENT NO. 22

FREQUENCY CHANGER

PURPOSE:

The objective of the experiment is to demonstrate the relationship between the slip, rotor frequency and rotor voltage of a frequency changer for speeds from zero to synchronous with (1) the rotor being driven with the revolving field of the stator and (2) the rotor being driven against the revolving field of the stator.

DISCUSSION:

A frequency changer or frequency converter is an electrical machine which converts frequency from one value to another. It may be either a single phase or a polyphase machine with a wound-rotor and slip rings.

In a frequency changer, the slip from synchronous speed establishes the output frequency; the synchronous speed being determined by the number of poles and the input frequency.

$$\text{Syn. Speed (RPM)} = \frac{60 \times \text{Freq. (C.P.S.)}}{\text{No. of Pairs of Poles}}$$

Any decrease in rotor speed increases the rotor slip and voltage.

$$\text{Slip (\%)} = \frac{\text{(Syn. Speed)} - \text{(Rotor Speed)}}{\text{(Syn. Speed)}} \times 100$$

For example, the Universal Machine is a 60 CPS, 2 pole machine. It therefore has a synchronous speed of 3600 RPM. Driving the rotor with synchronous field rotation at 1800 RPM will produce a slip of 50%. The rotor output frequency would then be 0.50 x 60 or 30 cycles. The output voltage would, assuming a 2:1 turns ratio between stator and rotor, be 0.50 x 208 volts or 104 volts. Driving the rotor against the synchronous field rotation at 1800 RPM would produce a slip of 150%. The output frequency would then be 90 cycles and the output voltage would be 312 volts.

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI

1 ULM Console containing,
  208/120V-3Ø Variable Source
  110 volt DC Power Supply
  DC Starter
  Dynamometer Field Rheostat (250Ω)
1 Oscilloscope
1 Calibrated Audio Signal Generator
2 0-150 volt AC Voltmeters

PROCEDURE:

1. Connect the Universal Machine to operate as a frequency changer as shown in Figure 32. Using this connection, the rotor will be driven with the synchronous field rotation.

2. Connect the Dynamometer to operate as a shunt motor as shown in Figure 32. Switch on all ten steps of the resistance load bank. The resistance load enables speeds below 2400 RPM to be obtained. Adjust the Dynamometer Field Rheostat to its minimum resistance position.

3. Connect the Oscilloscope and Signal Generator as shown in Figure 33 to enable the measurement of the output frequency. Frequency is determined by adjusting the horizontal and vertical gains of the oscilloscope and the frequency and amplitude of the output of the signal generator until a stationary lissajous pattern is obtained. The output frequency of the changer is then the same as indicated on the calibrated dial of the signal generator.

4. Have the instructor check your machine and meter connections before proceeding.

5. Start the Dynamometer by switching on the main AC, DC supply and DC Starter circuit breakers and pushing the start button of the DC starter. Adjust the speed to 3600 RPM.

6. Switch on the Variable 3Ø Supply and adjust the stator voltage up to 110v-3Ø.

7. Record in Table 39 the rotor volts and frequency for speeds from 3600 RPM to 0 RPM. The speed can be varied over this range by rotating the field rheostat to its minimum resistance position and then switching off the load bank steps.

8. Repeat Steps 5, 6, and 7 with the rotor being driven against

the synchronous field rotation. The rotating field is reversed by swapping any two of the stator leads (with the variable 3Ø supply deenergized). Record the data in Table 40.

REPORT:

Prepare a formal report. Using the data in Tables 39 and 40, plot the slip, output frequency, and output volts as ordinates versus the speed as abcissa on one set of axes. Analyze your curves, comparing them to the results that one would expect considering the theory involved. Explain any sources of error in the results. Your analysis should reveal your comprehension of the theory of operation of the frequency changer.

QUESTIONS:

1. Define slip.

2. How does the number of poles affect the speed of an AC machine? What effect does frequency have on speed?

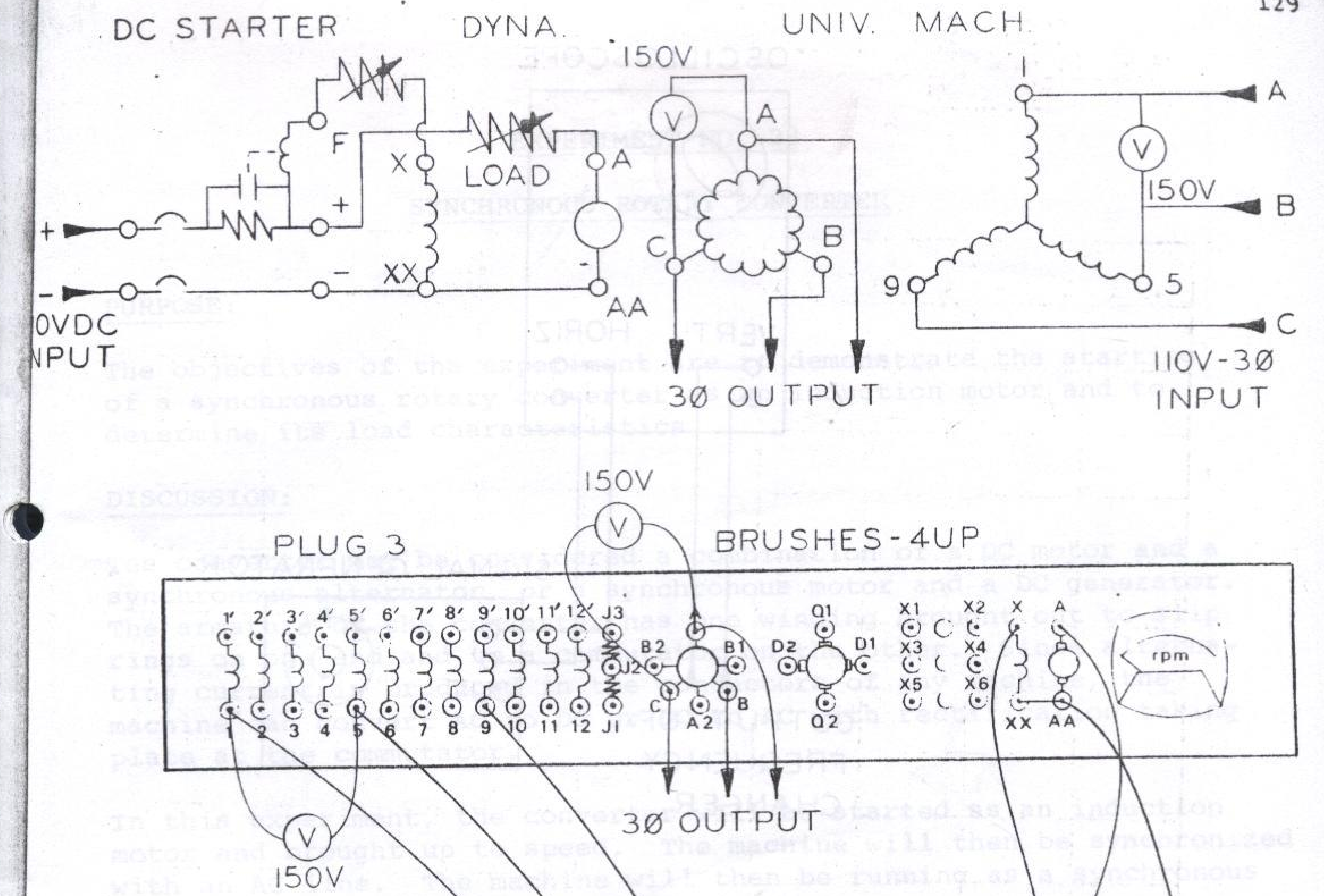
3. Name three applications for frequency changers.

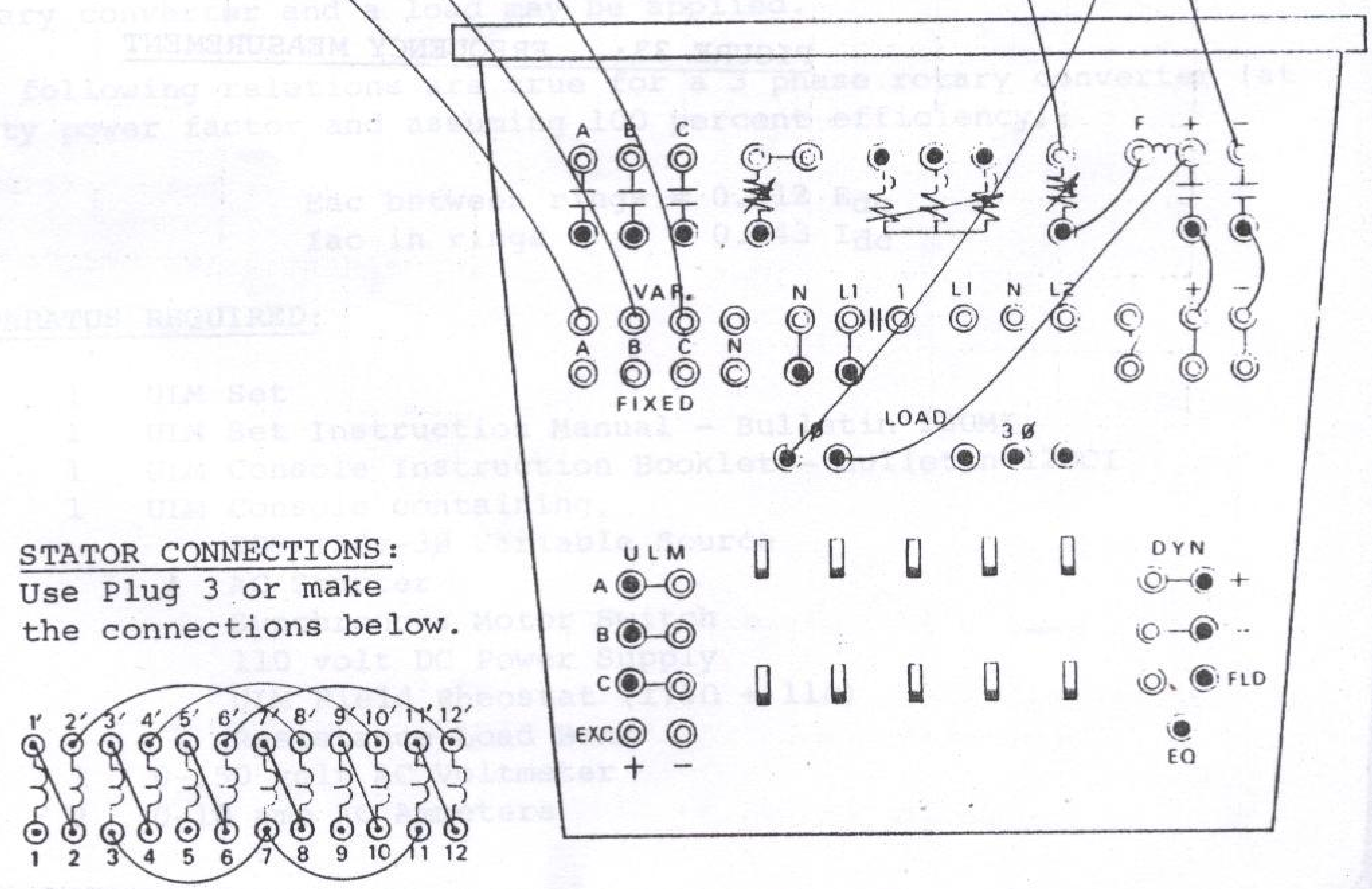
TABLE 39:
WITH SYNCHRONOUS FIELD ROTATION

RPM	Cycles	Volts	% Slip

TABLE 40:
AGAINST SYNCHRONOUS FIELD ROTATION

RPM	Cycles	Volts	% Slip


DC STARTER
DYNA.
UNIV. MACH.
150V
V
A
F
X
LOAD
+
-
XX
AA
C
B
+
-
110VDC
INPUT
30 OUTPUT
150V
V
A
B
C
9
5
110V-3Ø
INPUT
150V
V
PLUG 3
BRUSHES-4UP
1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12' J3
1 2 3 4 5 6 7 8 9 10 11 12 J1
B2 J2 B1 C A2 B
D2 D1 Q1 Q2
X1 X2 X3 X4 X5 X6
X A XX AA
rpm
3Ø OUTPUT
V
150V


A B C
F + -
VAR.
N L1 1 L1 N L2
+ -
A B C N
FIXED
LOAD
3 Ø
STATOR CONNECTIONS:
Use Plug 3 or make
the connections below.
ULM
A
B
C
EXC
+ -
DYN
+
-
FLD
EQ
1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12'
1 2 3 4 5 6 7 8 9 10 11 12

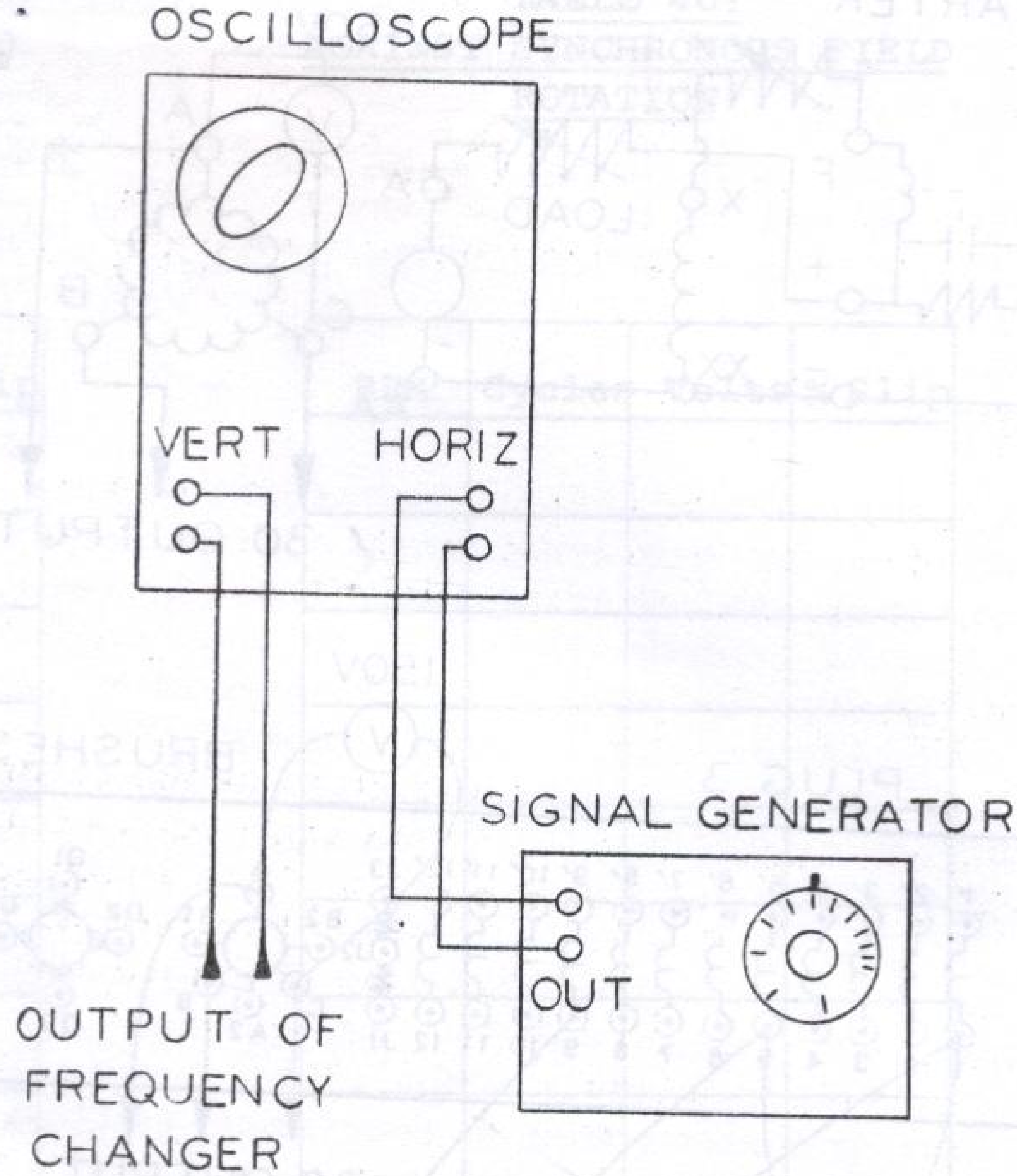


FIGURE 33: FREQUENCY MEASUREMENT

EXPERIMENT NO. 23

SYNCHRONOUS ROTARY CONVERTER

PURPOSE:

The objectives of the experiment are to demonstrate the starting of a synchronous rotary converter as an induction motor and to determine its load characteristics.

DISCUSSION:

The converter may be considered a combination of a DC motor and a synchronous alternator, or a synchronous motor and a DC generator. The armature of the converter has one winding brought out to slip rings on one end and to a commutator on the other. Since alternating current is produced in the conductors of any machine, the machine can convert AC to DC or DC to AC with rectification taking place at the commutator.

In this experiment, the converter will be started as an induction motor and brought up to speed. The machine will then be synchronized with an AC line. The machine will then be running as a synchronous rotary converter and a load may be applied.

The following relations are true for a 3 phase rotary converter (at unity power factor and assuming 100 percent efficiency):

$$E_{ac} \text{ between rings} = 0.612\ E_{dc}$$
$$I_{ac} \text{ in rings} = 0.943\ I_{dc}$$

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI
1 ULM Console containing,
  208/120v-3Ø Variable Source
  AC Starter
  Synchronous Motor Switch
  110 volt DC Power Supply
  ULM Field Rheostat (173Ω + 11Ω)
  Resistance Load Bank
1 0-150 volt AC Voltmeter
2 0-10 amp AC Ammeters

2 0-750 kw AC Wattmeters
1 0-150 volt DC Voltmeter
2 0-10 amp DC Ammeters

PROCEDURE:

1. Connect the Universal Machine to operate as a synchronous rotary converter as shown in Figure 34. Provisions should be made for short-circuiting the current coils of the AC meters during starting.

2. Have the instructor check your machine and meter connections before proceeding.

3. Switch on the main AC, Variable 3Ø, and DC supply circuit breakers. Adjust the output of the 3Ø supply to 115v-3Ø. With the Syn Motor Switch in the "SYN. RUN" position, adjust the DC field current to 7 amps. Change the switch to the "IND. START" position.

4. Start the machine using the AC starter. When the machine comes up to speed, change the switch to the "SYN. RUN" position, causing the machine to pull into synchronism.

5. Adjust the AC input voltage to 100v-3Ø. Adjust the field current to yield a DC output of 115 volts. Maintaining the AC input voltage and DC field current constant, perform a load test on the machine from no-load to a 7 amp DC load. Record the data in Table 41.

REPORT:

Prepare a formal report. Using the data in Table 41, plot a DC regulation curve for the converter. Compare the output values of current and voltage to the input values, discussing how they compar to the theoretical values. Discuss any difficulties encountered in starting and synchronizing the converter.

QUESTIONS:

1. Give several applications of a synchronous rotary converter.

2. What is the efficiency of the SRC at full-load?

3. What is the percentage speed regulation?

4. Draw a connection diagram using the machine as a DC to AC converter. What would the starting procedure be?

5. How could the SRC be used as a 3-wire DC system?

TABLE 41: SYNCHRONOUS ROTARY CONVERTER

DC OUTPUT			AC INPUT					
Volts	Amps	Watts	Volts	Amps	Amps	Watts	Watts	Total Watts

I_{fld} = ____________ A

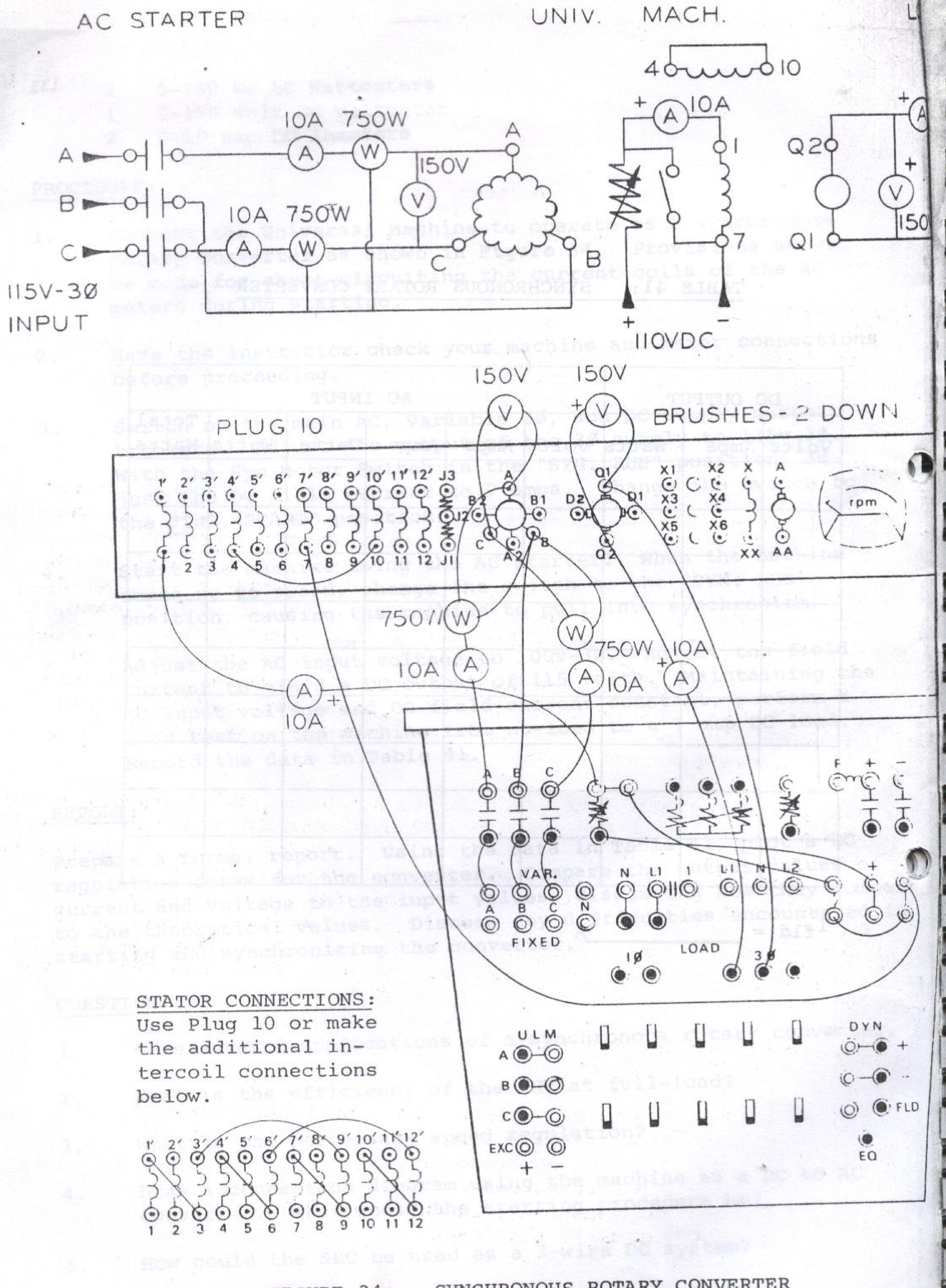


FIGURE 34: SYNCHRONOUS ROTARY CONVERTER

EXPERIMENT NO. 24

TWO-PHASE INDUCTION MOTOR

PURPOSE:

The objective of the experiment is to become familiar with the two-phase induction motor and its application as an AC servo motor and drag cup tachometer.

DISCUSSION:

The operation of a two-phase induction motor is quite similar to the other polyphase induction motors previously studied. At the present time, interest in the two-phase induction motor arises from its use as a reversible AC servo motor. In this application, a constant AC voltage is applied to one phase while a variable AC control voltage 90° phase shifted is applied to the other phase. The motor torque is then a function of the control voltage and the direction of rotation can be reversed by reversing the phase of the control voltage. Such motors have high resistance rotor circuits to give them drooping speed torque characteristics so that the motor will not tend to run up to synchronous speed once it has started to rotate.

The principle of the drag-cup tachometer, a related two-phase device, can also be demonstrated on the Universal Machine although the real drag-cup tachometer is a very much smaller machine. This tachometer has a high resistance rotor circuit and only one stator phase is energized from the supply. The voltage that appears across the second phase of the stator is closely proportional to the speed at which the rotor is driven and is of the same frequency and almost co-phasal with the supply voltage. As such it has been widely used as a source of velocity feedback in AC servo systems.

APPARATUS REQUIRED:

1 ULM Set
1 ULM Set Instruction Manual - Bulletin 120MI
1 ULM Console Instruction Booklet - Bulletin 120CI
1 ULM Console containing,
110 volt DC Power Supply
Dynamometer Field Rheostat (250Ω)
Resistive Load Bank

115v-2Ø Power Source
AC Starter

2 0-150 volt AC Voltmeters
2 0-20 amps AC Ammeters
2 0-1.5 kw AC Wattmeters
1 0-150 volt DC Voltmeter

PROCEDURE:

1. Connect the Universal Machine to operate as a two-phase motor as shown in Figure 35. The AC meters should be connected into the circuit as shown with provisions for shorting their current coils when starting.

2. Connect the Dynamometer to operate as a shunt generator as shown in Figure 35. Adjust its field rheostat to the maximum resistance (fully clockwise) position.

3. Have the instructor check your machine and meter connections before starting the ULM.

4. Start the motor by switching on the main AC, DC supply and 2Ø source circuit breakers and pushing the start button of the Ac starter. Perform a load test on the motor for 5 steps of resistance load on the dynamometer. Record the volts, amps, watts, speed, and torque in Table 42. Maintain the Dynamometer output at 110v DC by adjusting its field rheostat. Calculate t power factor for each load point.

REPORT:

Prepare a formal report. Using the data in Table 42, plot the motor's amps, RPM, power and power factor as ordinates versus the torque as abcissa on one set of axes. Analyze your curves, comparing them to the results you obtained in Experiment 18. Draw connection diagrams of the way you would connect the ULM to operate as a two-phase servo motor and a drag-cup tachometer.

TABLE 42: TWO-PHASE INDUCTION MOTOR

Volts										
Amps										
Watts										
Volts										
Amps										
Watts										
Total Watts										
Power Factor										
Torque										

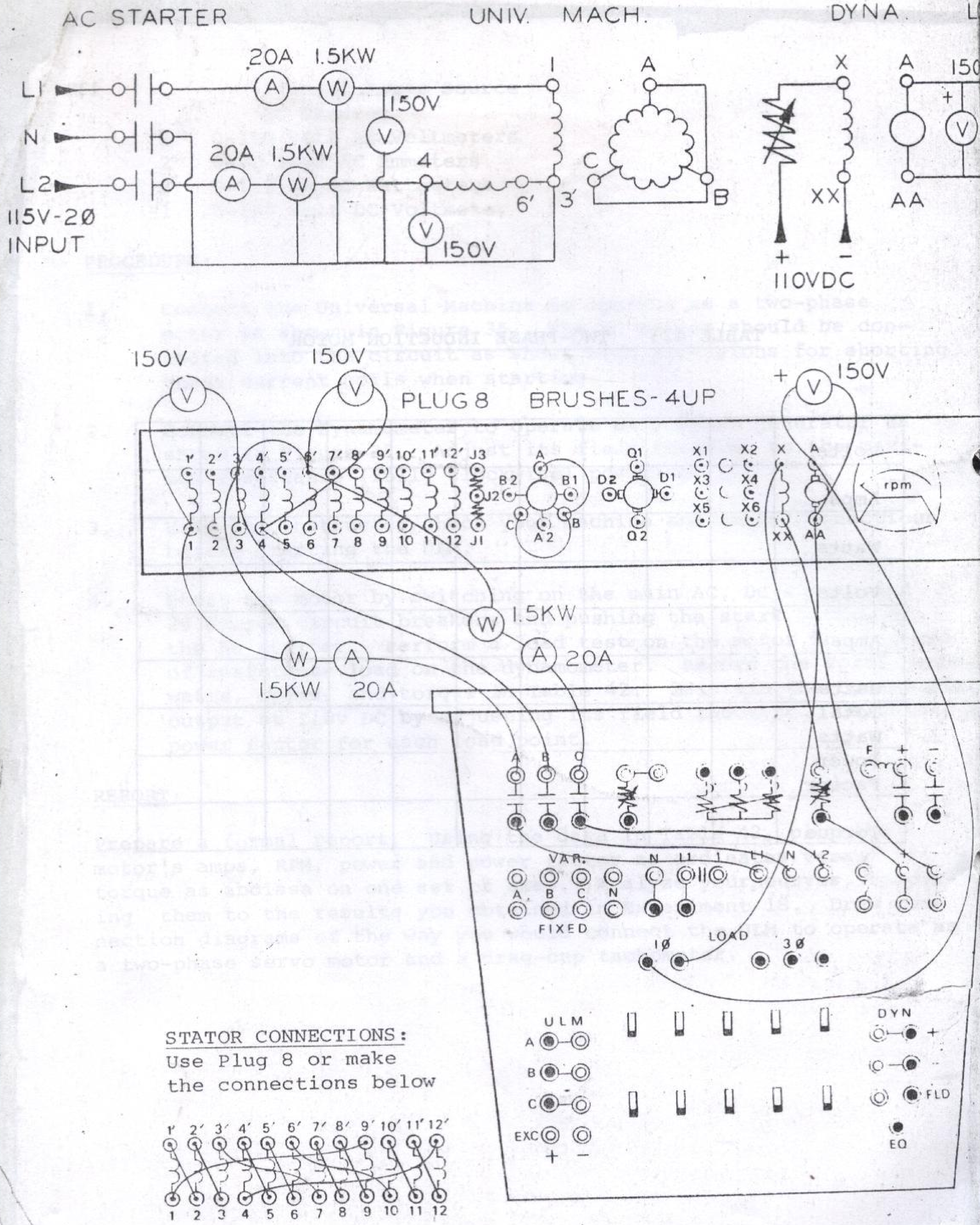


FIGURE 35: TWO PHASE INDUCTION MOTOR