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Straight and Chopped DC Performance Data for a General Electric 5BT 2366C10 Motor and an EV-1 Controller

Paul C. Edie
Eaton Corporation
Engineering & Research Center

January 1981

Prepared for
National Aeronautics and Space Administration
Lewis Research Center
Under Contract DEN 3-123

for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
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NOTICE

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SUMMARY

This report is intended to supply the electric vehicle manufacturer with performance data on the General Electric 5BT 2366C10 series wound DC motor and EV-1 Chopper Controller. Data is provided for both straight and chopped DC input to the motor, at 2 motor temperature levels. Testing was done at 6 voltage increments to the motor, and 2 voltage increments to the controller. Data results are presented in both tabular and graphical forms. Tabular information includes motor voltage and current input data, motor speed and torque output data, power data and temperature data. Graphical information includes torque-speed, motor power output-speed, torque-current, and efficiency-speed plots under the various operating conditions.

The data resulting from this testing shows the speed-torque plots to have the most variance with operating temperature. The maximum motor efficiency is between 86% and 87%, regardless of temperature or mode of operation. When the chopper is utilized, maximum motor efficiency occurs when the chopper duty cycle approaches 100%. At low duty cycles the motor efficiency may be considerably less than the efficiency for straight DC. Chopper efficiency may be assummed to be 95% under all operating conditions. For equal speeds at a given voltage level, the motor operated in the chopped mode develops slightly more torque than it does in the straight DC mode. System block diagrams are included, along with test setup and procedure information.

INTRODUCTION

Today about one-half of the petroleum consumed in the United States is used for transportation. The introduction of electric vehicles could significantly shift the transportation energy base to other sources such as coal, nuclear, and solar.

In 1976 the Electric and Hybrid Vehicle Program was initiated within the Energy Research and Development Administration (ERDA), now the Department of Energy (DOE). In September of that same year, the Congress passed the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976 (Public Law 94-413). This Act is intended to accelerate the integration of electric and hybrid vehicles into our transportation system and to stimulate growth in the electric vehicle industry.

Part of the Electric and Hybrid Vehicle Program is focused upon assisting electric vehicle manufacturers with general technical problems relating to the design of near-term vehicles. For the most part, these manufacturers are small companies which often lack resources for testing, research, or development.

This report is intended to provide these manufacturers with performance data on an electric motor and chopper controller which may be used on this type of vehicle.

Due to the limited power and energy capability of batteries, high efficiency is a very desirable attribute of motors and controllers used in electric vehicles.

Although there is a great deal of electric motor and controller developmental work ongoing in both private industry and government research centers, the data supplied by the manufacturers of motors usually consists of limited information for straight DC operation only, and does not cover the motor's performance when used in conjunction with a chopper/controller.

The testing done under this contract and the resulting data formats were specified by the NASA Lewis Research Center. This report summarizes data on a General Electric model 5BT 2366C10 series wound motor and a General Electric model EV-1 controller. Other motor/controller combinations have also been tested, and appear as separate reports under the same contract number. To assure consistent test results under severe load, the batteries used for these tests had much higher capacity than those typically available in an electric vehicle. If smaller, more portable power sources are used, the resulting motor torque and speed would be limited by the output capacity of the source.

All tests were made at two motor operating temperatures, as outlined in the "Test Procedure" section. The data from these tests should characterize the motor performance under typical "hot" and "cold" conditions. It should be noted that these are only representative temperature levels.

The data contained in these results is all of a steady-state nature, and does not show motor or controller efficiency during acceleration, deceleration or regenerative operation. To provide a complete range of data, motor nameplate ratings were exceeded in some instances for short periods of time. At no time were the motors exposed to severe abuse, physical shock or contaminated environments.

The test data presented here is not intended to represent the absolute maximum power available from any motor or controller. Under certain conditions, the motor or controller may be capable of exceeding the input and output power levels shown in the data and still remain undamaged. However, since this represents the extreme conditions of motor/controller operation and is useful only in limited circumstances, such data is not presented here.

Data is presented in graphical and tabular forms. Tests were run as detailed in the section titled "Test Procedure." Tabular data represents the arithmetic average of all test runs, and is intended to reduce data scatter as well as the volume of total data recorded. Tabular data will supply the user with performance information at a specific desired test point.

Graphical data presents the averaged results plotted and extrapolated, such that information for any given point within the testing range may be found.

EQUIPMENT TESTED

Description of Motor

The motor tested in this report is a General Electric model 5BT 2366C10 series wound DC motor. This motor is shown in Figure 1, with a print detailing critical dimensions in Figure 2. Weight of this motor is 108.0 Kg (238.6 lbs.) with all mounting hardware attached. The following nameplate data appears on the motor:

Model Number	5BT 2366C10
Horsepower	32
Winding	Series
Volts	165
Amperes	175
RPM	5925
Encl.	BV
CL.F Duty - 1 hr.	140°C

During inspection, prior to testing, no signs of abuse or wear were noted.

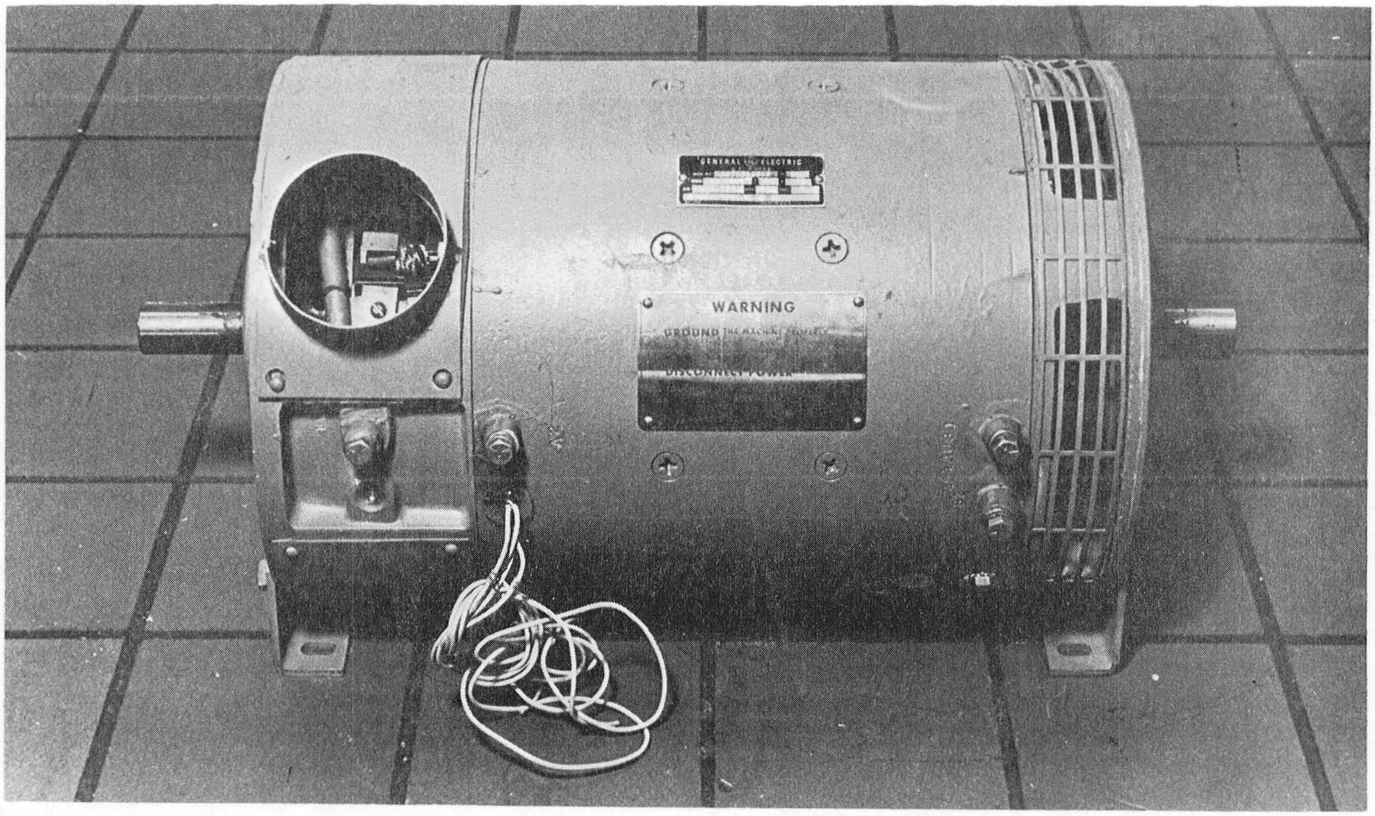

Figure 1 General Electric 5BT2366C10 Motor

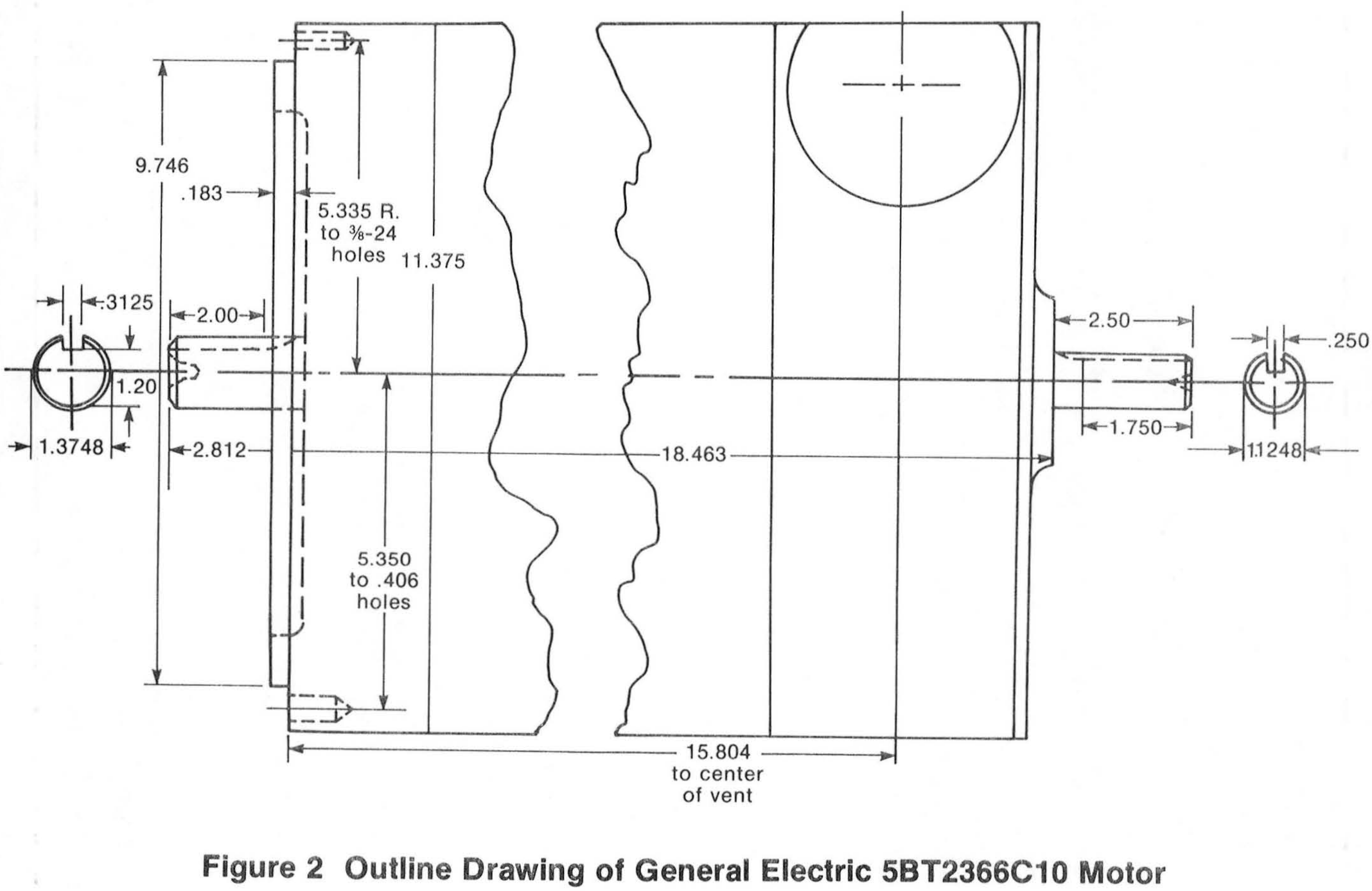

Figure 2 Outline Drawing of General Electric 5BT2366C10 Motor

Description of Controller

The chopper/controller testing in conjunction with the General Electric motor was a General Electric model EV-1. This unit is a conventional SCR controller. The controller is shown in Figure 3, with a print detailing critical mounting dimensions in Figure 4. Weight of the controller is 24.3 Kg (53.7 lbs.). The only nameplate data on the controller is a 144 volt DC rating. During inspection, prior to testing, it was found that the plastic mounts holding the oscillator card to the base were cracked, probably caused by mishandling when the unit was shipped. Several wires had been pulled off the card, apparently due to the shipping abuse. Once these were repaired, the unit functioned properly.

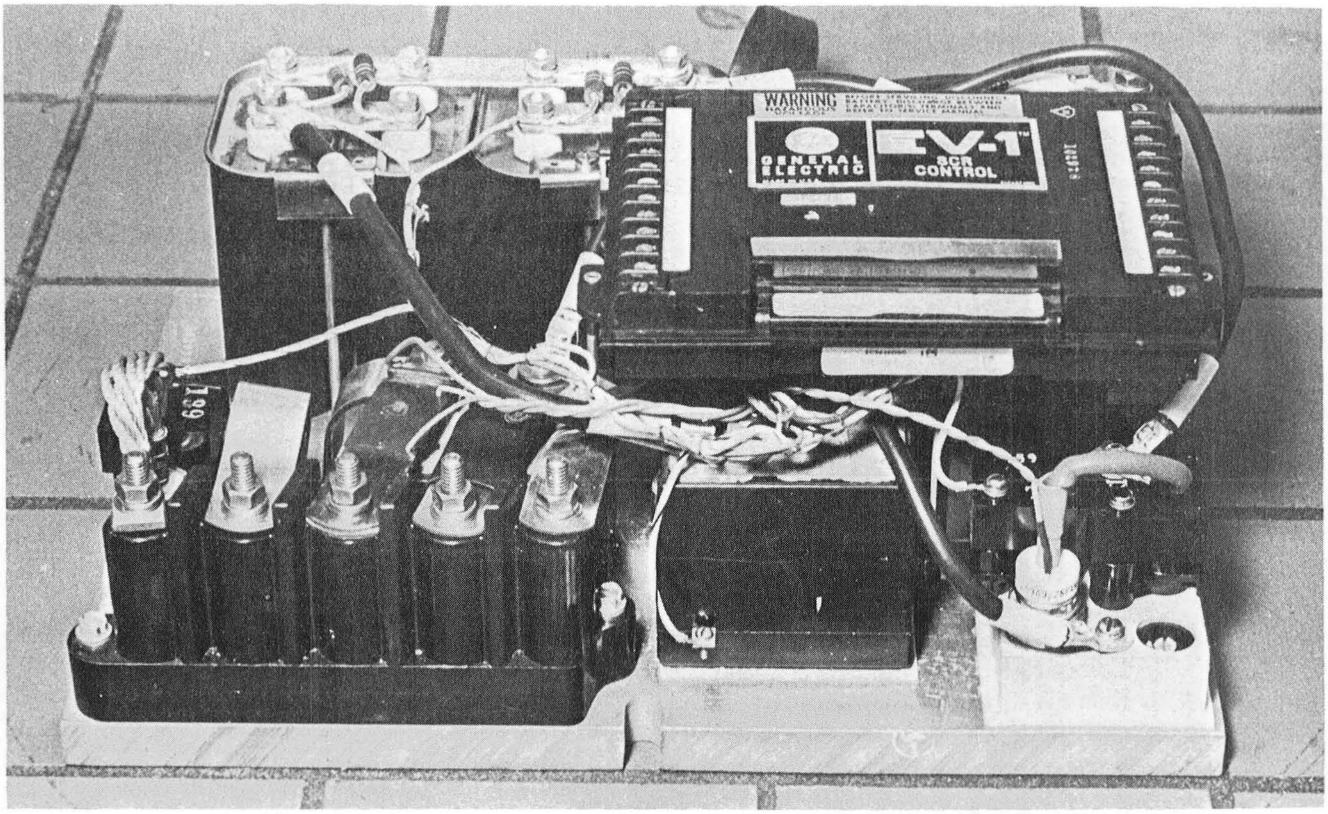

Figure 3 General Electric Model EV-1 Controller

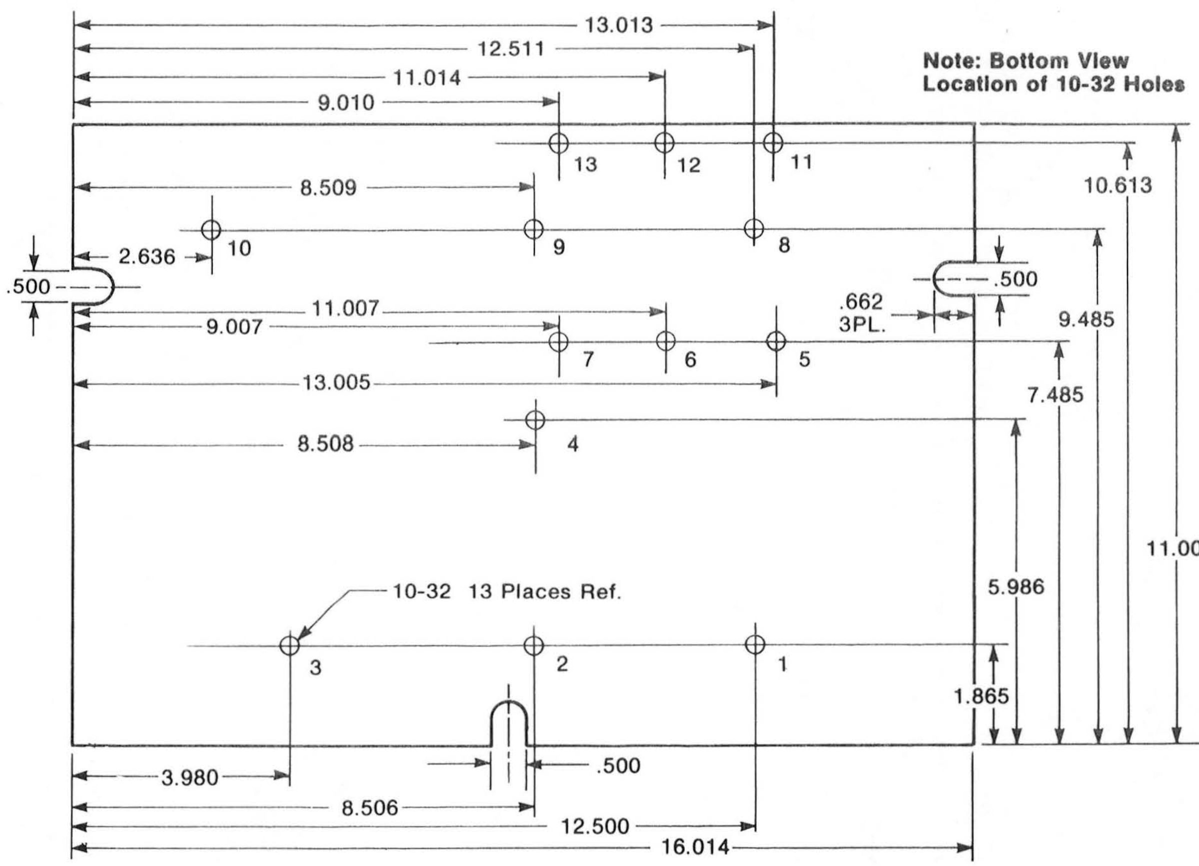

Figure 4 Drawing of General Electric EV-1 Controller Base Plate

TEST FACILITY

1. Dynamometer

The motor controller combination was mounted as shown in Figures 5-6. A conventional T-slot bedplate served as the mounting base. To absorb the motor output power, a General Electric DC dynamometer rated at 100 hp @ 6000 rpm was used. The dynamometer used a motor generator set as its source of DC power, and was controlled by a console located outside the test cell (Figure 7). The control console consisted of necessary dynamometer power and speed controls, along with a safety annunciator system to shut down the entire test cell should an overspeed, overcurrent or overtemperature condition occur. An automatic halogen fire extinguishing system was used to protect the entire testing area.

2. Power Source

To power the motor and controller, lead acid type batteries were used (Figure 8). Four 36 volt, 1100 amp hour batteries were wired in series using 4/0 copper stranded wire. Taps were wired at 6 volts increments from 0 to 144 volts. The batteries were charged using a Barrett current regulated industrial charger, rated at a capacity of 300 amps. Room air and hydrogen from the batteries were exhausted directly to the outside via overhead blowers.

3. Motor & Controller Installation

Figure 9 shows the motor mounting and transducer configuration. The motor was mounted directly on a small I-beam, which was in turn mounted on the bedplate. The motor was coupled to the telemetry transmitter (which is discussed in the Instrumentation section) by special machined slip fit couplings, held by a keyway. The transmitter assembly was coupled to the torque speed transducer (also discussed in the Instrumentation section) with Waldron Flex-Align couplings, which compensate for small alignment or balance errors. The opposite end of the torque/speed transducer was coupled to the dynamometer using another Waldron coupling.

All alignments between shafts were held to within 0.20 mm (0.008 in.) during setup.

The controller was mounted on a bench located directly over the motor to keep wire lengths as short as possible. All power wiring was accomplished using rubber insulated 4/0 stranded copper welding cable. Connections were made to the motor and controller via copper crimp type lugs.

The motor was cooled, when necessary to maintain temperature within the specified limits, by a squirrel cage blower motor forcing air through the motor's cooling duct. Room air was

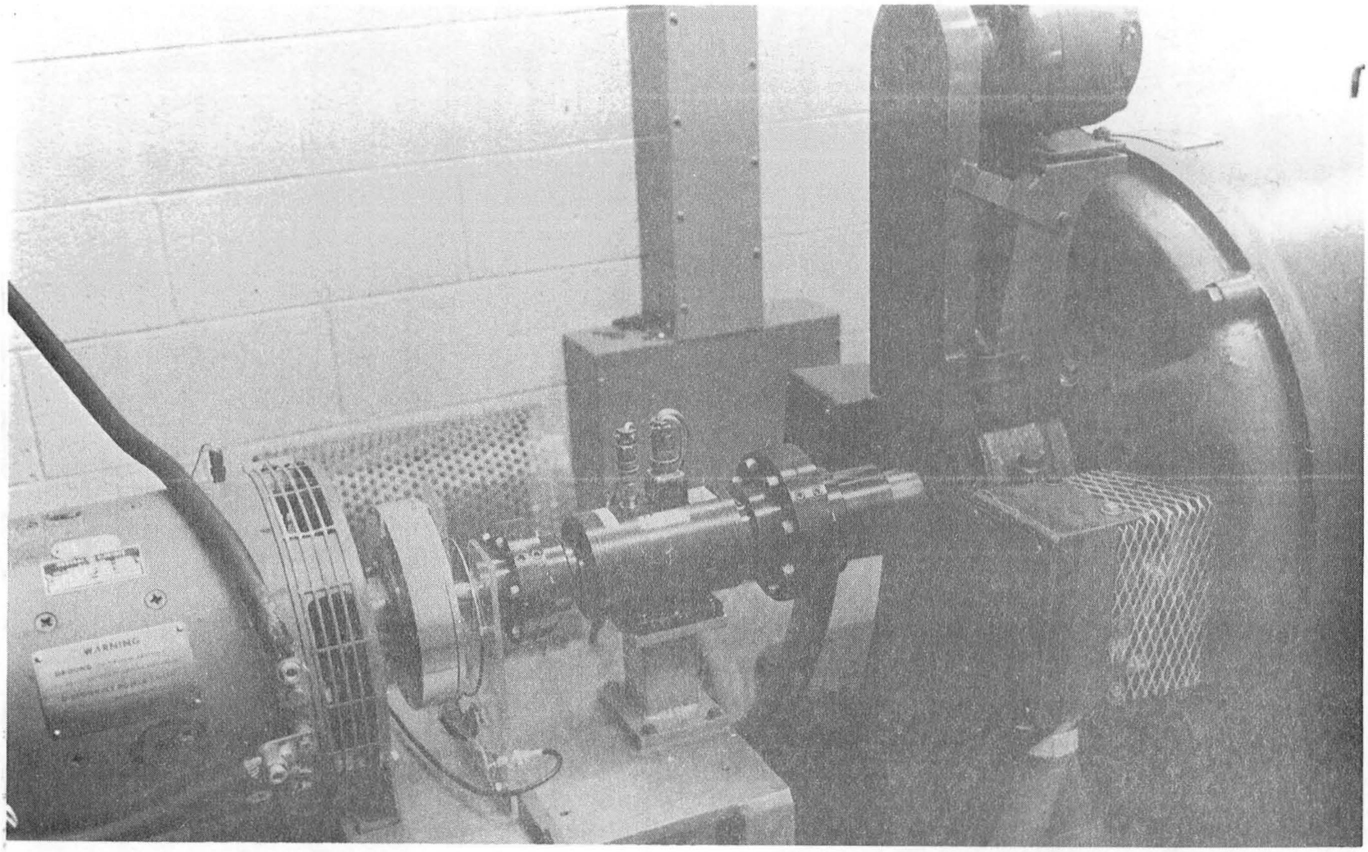

Figure 5 Mounting of Motor and Torque Transducer

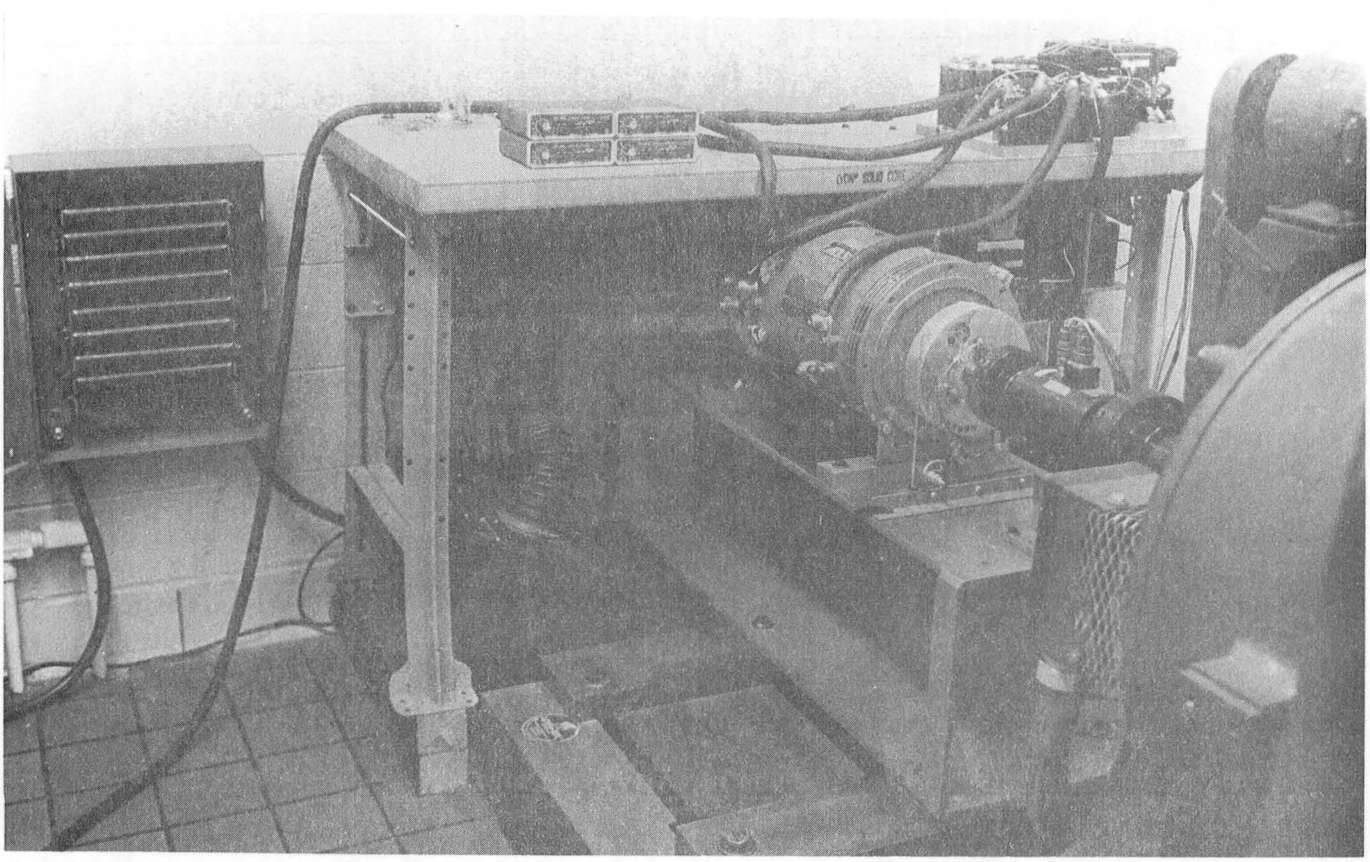

Figure 6 Mounting of Motor and Controller

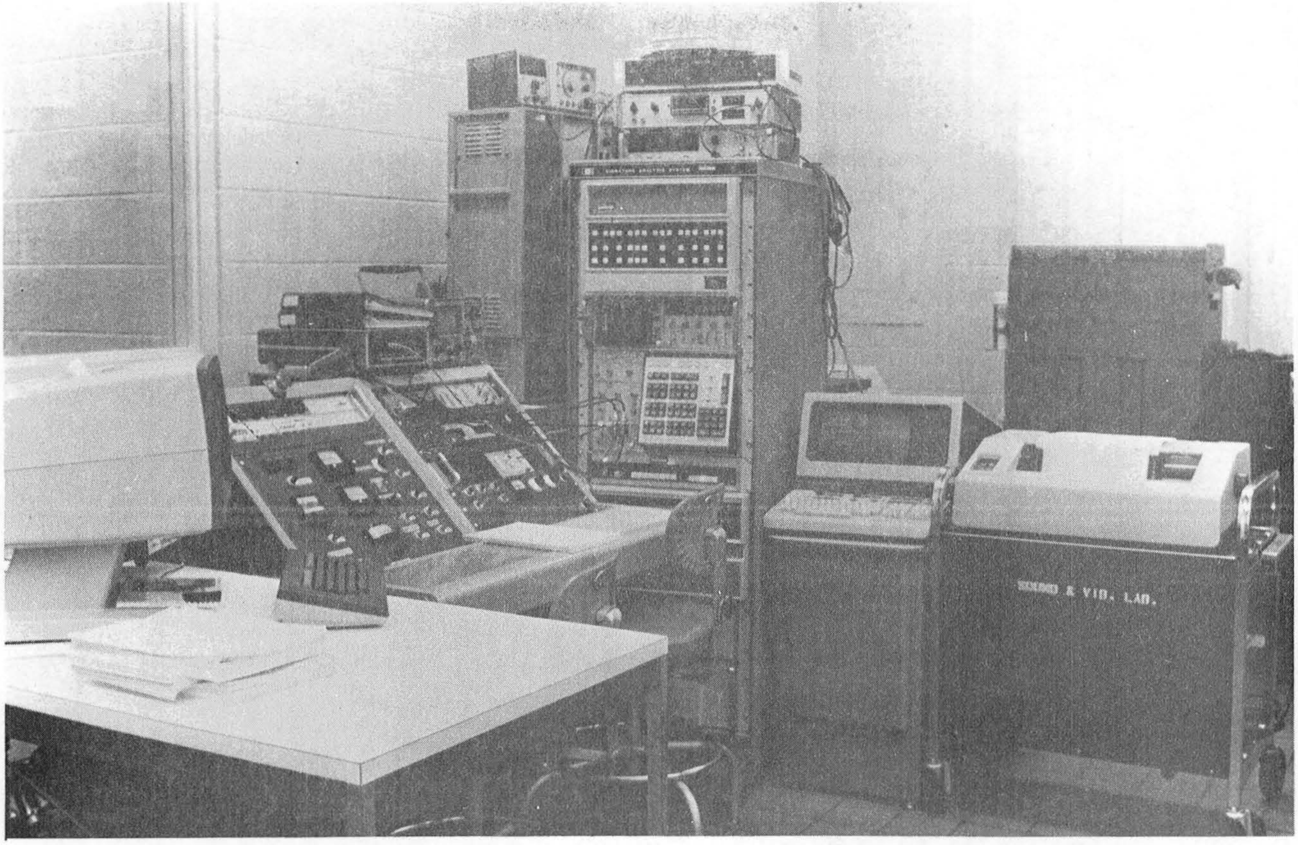

Figure 7 Control and Instrumentation Consoles

Figure 8 Battery Power Supply

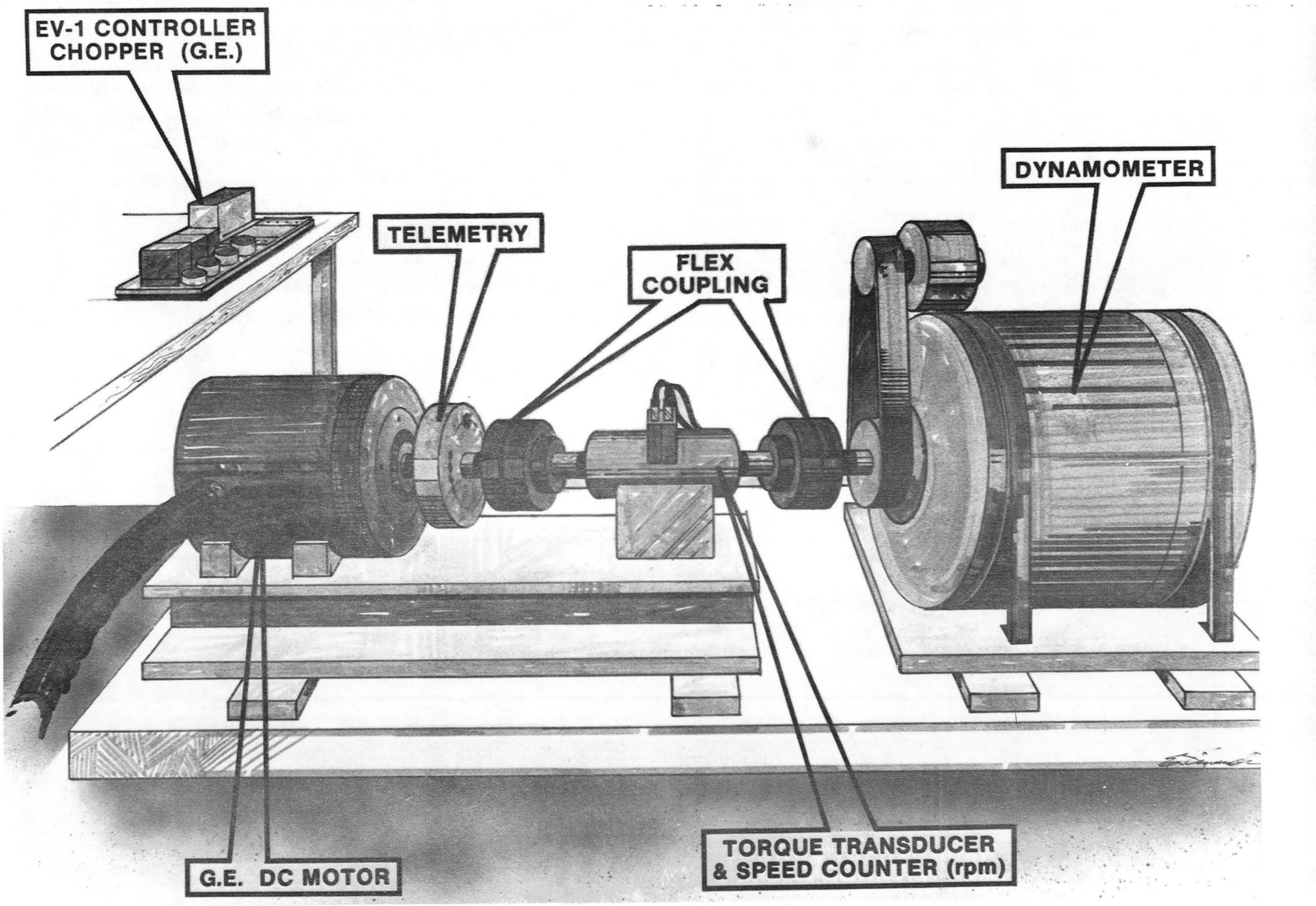

Figure 9 Motor Mounting and Transducer Configuration

also forced over the motor housing using a conventional fan. Motor and controller operator controls were located on the dynamometer console. These included motor power and controller power switches and controller acceleration potentiometer. Safety systems for the dynamometer also served to shut off the motor/controller in event of an unsafe condition. A 300 amp DC contactor, controlled at the console, switched battery power to the motor. When data was taken for chopped DC operation, power was routed through a resistive load in series with the battery to simulate a more realistic source impedance, as would be found in a typical electric vehicle. This resistance had a value of 0.059 OHM, and was capable of dissipating approximately 5200 watts.

4. Instrumentation

Connection between the motor and dynamometer was made via a Lebow type 1604-2K torque-speed transducer. The torque transducer was of the rotary transformer type; the speed transducer was of the magnetic pickup type. Full-scale ranges were 225 N-m (2000 in-lbs) for the torque and 15,000 rpm for the speed pickup.

Also coupled directly to the motor was an Inmet Model 201A temperature telemeter. Two type T thermocouples were mounted on the motor armature laminations, 180 degrees apart. Thermocouple wire was run underneath the motor bearings, through the shaft keyway (which was extended for this purpose) and directly to the telemeter module. The module and its 9 volt power source were mounted in an aluminum disc 19.0 cm (7.5 inches) in diameter and rotationally balanced to 6000 rpm. A loop antenna was mounted on the small support I-beam to receive the FM transmission. A receiver was located on the control console and calibrated to readout directly in degrees centigrade.

Other temperature measurements were made directly on the field windings, with type K thermocouples. Thermocouple wire was run directly to the control console for readout.

Torque, speed and temperature readout were accomplished using a Daytronics 9000 series modular signal conditioning rack. Readout was directly in SI units. A readout was also provided to calculate motor output horsepower from the speed and torque signals.

Current measurements were made using T&M Research Type F coaxial shunts located on the bench, directly over the motor. These shunts were rated for a 100 mV drop at 200 amps and frequency response of over 0.5 MHz at rated current. Voltage measurements were taken directly from the motor and controller terminals via coaxial cable.

For the straight DC tests, current and voltage measurements were made directly on Fluke Model 8350A digital voltmeters.

For the chopped tests, both the current and voltage signals were fed into Phillips type PM-8940 optical isolators. These units have a frequency response of DC to 1.5 MHz ± 3 dB, with a phase shift of less than 2 degrees at 15 kHz. The isolators serve to amplify (for current measurements) or attenuate (for voltage measurements) the input signal as well as to "float" the inputs, allowing the output signal "commons" to be tied together. The isolator's "front end" is battery powered, completely eliminating any chance for ground loops to be created on the signal lines.

Since it was necessary to measure average and RMS voltages and currents, as well as average wideband power for the chopped DC tests, a Hewlett-Packard 5451B Signature Analysis System was utilized.

Output signals from the isolators were fed directly into the Hewlett Packard system. Analog-to-digital converters sampled the data at 20,000 points/sec., and digitally performed the calculations for average, RMS and power measurements.

The analyzer was programmed to print out all data required for each test point automatically. To assure waveform integrity, data from each channel was constantly monitored on an oscilloscope while being input to the analyzer.

TEST PROCEDURES

1. Test Sequence

A typical test run consisted of initially assuring the motor to be at the correct test temperature. Two temperature ranges were tested, 25°-45°C and 130°-150°C. For the high temperature runs, this was accomplished by wrapping the frame with layers of fiberglass insulation. Once the desired temperature range had been reached, the motor was driven to its maximum rated speed by the dynamometer. When speed had stabilized, the motor was powered at a specific input voltage and data was recorded. Once completed, the dynamometer speed was reduced 600 RPM for a second data point. This procedure continued until the torque transducer limit was reached. When the motor heated above its testing temperature range, forced air blowers were turned on, allowing it to cool. Once the maximum torque point had been taken, the motor was brought back to maximum speed at 600 RPM increments to record motor hysteresis. When completed, the next voltage tap was selected, and tested as before. Six motor input voltage levels were selected: 24, 48, 72, 96, 120, and 144 volts. When all required input voltages were tested, the entire procedure was repeated a total of 3 times. The procedure was followed for both ripple-free and chopped testing, the only difference being that for the chopped data, motor input voltage was controlled by adjusting the chopper acceleration potentiometer to achieve the proper level. Chopped data was taken at 120 and 144 volt input levels to the chopper, and the above test sequences were followed for both chopper input voltages. Battery condition was constantly monitored to assure that excessive "droop" was not occurring due to lack of charge level. For the resulting data, "droop" in input voltage level is primarily due to interconnecting cable IR drop, inter-battery connection IR drop, and for chopped data only, the IR drop due to the series 0.059 OHM added resistance.

2. Data Acquisition

Data which was directly read from instruments and the Hewlett Packard analyzer printout was typed into a portable CRT screen located on the control console. The CRT was tied into the Eaton VAX 11/780 computer, pre-programmed with a "form" format, so that all data was typed under correct headings. This allowed an orderly method of data acquisition, and made it possible to "call up" data from previous runs to compare data points for hysteresis and to assure that there was no substantial data shift from identical earlier tests.

Once in the VAX system, all data from the tests was averaged for each unique test point. This included all three test runs as well as hysteresis points. Averaging was done arithmetically, and was available on hard copy as final test results.

The following parameters have been measured for the motor at each test point:

1. Motor speed - measured at the motor shaft in units of revs./min. (Accuracy, ±1% of 6000 RPM full scale.)

2. Motor torque - measured at the motor shaft in units of Newton-meters. (Accuracy, ±1% of 225 Nm full scale.)

3. Motor temperatures - measured at various points internal to the motor (see section titled "Instrumentation" for details) in units of degrees centigrade. (Accuracy, ±0.4°C for field measurements, ±2°C for armature measurements.)

4. Motor input voltage - measured at the input terminals of the motor in units of volts. (Accuracy, ±0.01% of 199 volt full scale.)

5. Motor input current - measured at the input terminals of the motor in units of amperes. (Accuracy, ±0.50% of 400 ampere full scale.)

6. Controller input voltage - measured at the input terminals to the controller in units of volts. (Accuracy, ±1% of 200 volt full scale.)

7. Controller input current - measured at the input terminals to the controller in units of amperes. (Accuracy, ±1% of 400 ampere full scale.)

8. Controller input power - measured at the input terminals to the controller in units of watts. (Accuracy, ±2% of 80,000 watt full scale.)

9. Controller output voltage - measured at the output terminals of the controller in units of volts. (Accuracy, ±1% of 200 volt full scale.)

10. Controller output current - measured at the output terminals of the controller in units of amperes. (Accuracy, ±1% of 400 ampere full scale.)

11. Controller output power - measured at the output terminals of the controller in units of watts. (Accuracy, ±2% of 80,000 watt full scale.)

(Measurements #1-#3 were made for all tests, measurements #4 and #5 for straight DC tests, and measurements #6-#11 for chopped DC tests.)

TEST RESULTS

The test results are tabulated in Tables 1 through 6 and depicted graphically in Figures 10 through 41. As indicated in the "Test Procedures" Section of this report, three separate test runs were made at each test condition. Each run started at maximum speed. The motor was gradually loaded, and data was taken at the speeds indicated in the tables until maximum load was achieved. The load was then gradually removed, and data was again taken at the same speeds. Consequently, the original test data consists of six data points at each speed and each test condition. This data was averaged and reduced to decrease the data scatter and the volume of test data to be reported.

1. Data Reduction

The original intent of running three test points with speed decreasing and three test points with speed increasing was to show the effect of hysteresis on the motor performance. However, the hysteresis effects were found to be negligible, so all six data points were averaged together.

For tests of a motor that will be used with a specified power source, the input voltage is usually varied in accordance with the power supply characteristics. Where the power source is not specified, the input voltage is usually held constant.

For the straight DC tests, constant voltage data was desired. Since the input voltage varied somewhat, a correction factor was applied to the speed data. This compensation factor considered the internal copper $I_A R_A$ drop of the motor but did not include an allowance for brush drop. The following compensation equation was used:

$$\text{compensated speed} = \text{test speed} \left[\frac{V_{IDEAL} - R_A I_A}{V_{TEST} - R_A I_A} \right]$$

0.01168 ohms was used for the value of R_A. The new compensated speed was used in all subsequent calculations such as motor output, power, and efficiency. The curves were also plotted using the compensated speed or the compensated power output as a parameter.

For the chopped DC tests, it appeared to be more appropriate to try to simulate the voltage "droop" characteristics of presently available electric vehicle batteries. At each test point, the controller was adjusted to maintain a nearly constant value of average motor voltage; thus, speed conpensation is not necessary.

Once the data was averaged, a best fit plotting routine was utilized on the VAX to produce the following plots:

1. Torque - speed (for each voltage level)
2. Power - speed (for each voltage level)
3. Torque - current (for all voltage levels)

At this time, plots of efficiency-speed were derived by the following process: (for straight DC)

1. Lines of constant power were drawn on the power-speed curves.

2. From these lines, values of speed at each power level for every voltage were extrapolated.

3. Knowing speed and power, torque was calculated for every point.

4. Current was extrapolated for every torque value using the torque current curves.

5. Efficiency for each point was calculated as

   $$n = \frac{\text{power out}}{\text{VxI}} \quad .$$

6. For each line of constant power, the efficiency was plotted against speed using a best fit program.

For the chopped DC data a similar method was used with the following exceptions:

1. Once torque was known for each intersection point, input power to the motor was extrapolated using a torque vs. input power plot (derived for each voltage level from the averaged data).

2. Once derived, efficiency was calculated as

   $n = \frac{\text{power out}}{\text{power in}}$ and plotted against speed for each

   power level using a best fit program.

The final plot of chopper efficiency versus volts was derived using the following routine.

1. Equations were calculated for controller efficiency

   $\frac{\text{power out}}{\text{power in}}$ versus controller output power for each

   motor input voltage level using each averaged data point.

2. For fixed levels of controller output power, the value of controller efficiency and voltage were stored.

3. Plots were made of controller efficiency-controller output voltage for each power level.

4. Since these plots were overlapping within a very small range of efficiency (approximately 95%), plots were replaced with a band showing the maximum and minimum extremes of controller efficiency within the power levels indicated.

2. Straight DC Results

The straight DC data for two ranges of temperatures are presented in Tables 1 and 2. The voltage, current, torque, and speed variables are tabulated in the conventional manner. The compensated speed and the compensated power output were calculated as discussed in the Data Reduction Section of this report. The calculated efficiency is the ratio of the compensated power output to the product of the nominal voltage and current.

The temperature tabulations illustrate one of the difficulties in performing this type of testing. Not only does the temperature vary from one point to another in the machine, but the temperature difference also varies.

The tabulated data is depicted graphically in Figures 10 through 17. These curves all have the expected shape.

The data was recorded for two temperature ranges in order to allow an evaluation of temperature effects. The most discernable temperature effects appear in the torque-speed curves. The high temperature curves (Figure 14) are shifted downward or to the right of the corresponding low temperature curves (Figure 10).

The shift in the torque-speed curves is primarily due to the increase of armature resistance with increased temperature. Since the torque-current curves are in close agreement, a given torque will produce a greater $I_A R_A$ voltage drop at the higher temperature. Consequently, the counter electromotive force and the speed will decrease.

Temperature appears to have very little effect on motor efficiency. For both temperature ranges, the peak efficiencies are between 86 and 87%. These peak efficiencies all appear at moderate loads, reasonably high speeds and near maximum voltage. The efficiency drops below 75% only at light loads or low voltage.

3. Chopped DC Results

The chopped DC data are tabulated in four categories as follows:

Table 3	25-45°C	144 Volt Input
Table 4	25-45°C	120 Volt Input
Table 5	130-150°C	144 Volt Input
Table 6	130-150°C	120 Volt Input

This data is also depicted graphically in Figures 18 through 41.

The voltages refer to the nominal input voltages to the chopper. Two voltage ranges were used to allow an evaluation of the effects of the batteries' state of charge. The 144 volt tests were intended to represent a fully charged battery. The 120 volt tests were intended to represent a partially discharged battery.

Both the average and the root mean square (RMS) values of all the voltages and currents were recorded. Only the average values of the variables were used to generate the curves depicted in Figures 18 through 41. The RMS values were recorded to give an indication of the form factor of each variable and to aid in future modeling work. The duty cycle of the controller may roughly be considered to be the ratio of the average value of the chopper output voltage to the average value of the chopper input voltage.

A comparison of the chopper input power wattmeter reading with the product of the average input voltage and current value will indicate that sizeable errors may result by using the volt-amp product as a measure of power. For the low voltage tests, the product of the average values of voltage and current is greater than the wattmeter reading. However, at high values of test voltage the volt-amp product is less than the wattmeter reading. (The deviation at high test voltage is approximately 3%, and may be attributed to instrumentation error.) The same results are found when the product of the RMS values are compared to the wattmeter readings.

On the output side of the chopper a similar comparison may be made. Here the product of the average values of voltage and current are less than the wattmeter reading for low values of motor voltage and are higher than the wattmeter reading for high values of motor voltage. (Again, a 3% deviation is typical at high voltage, and may be attributed to instrumentation error.) These results are the opposite of those found on the input side of the chopper. The product of the RMS values of voltage and current are always greater than the wattmeter reading.

The maximum values of motor efficiency for the chopped DC case are approximately the same as the maximum values for the straight DC case. These maximum efficiency values all occur at or near maximum voltage and correspond to duty cycles near 100%. Consequently, they should be expected to approach the straight DC values. At low duty cycles the efficiency may be considerably less than the efficiency for straight DC.

The measured chopper efficiency is about 95% throughout the test range. Small errors in either chopper input or output power measurement result in variations in the calculated chopper efficiency. Consequently, the variations observed at individual test points are not significant.

A comparison of the chopped DC torque versus speed curves with the corresponding straight DC curves shows that the chopped DC curves are shifted slightly upward and to the right. For equal speeds, the additional torque produced in the chopped mode is due to the AC component in both the current and flux waves.

The torque-speed curves for the chopped mode of operation (Figures 18, 24, 30 and 36) show that the curve for maximum voltage coincides with the next lower voltage curve for high values of torque. This phenomenon is caused by the impedance of the power source. The corresponding tabulated data shows that for the highest voltage curve in each category, the chopper duty cycle is nearly 100% and that a constant voltage cannot be maintained at the chopper output terminals as torque is increased. In the region of coincidence, the chopper duty cycle is also 100% for the second highest voltage curve.

CONCLUSIONS

A fairly elaborate setup is required to perform the tests described in this report.

1. <u>Power Supply Requirements</u>

   Ideally the motor should be tested with the specific power supply with which it will be used. In the case of battery powered vehicles, the variations of battery characteristics and its limited energy capacity make actual vehicle batteries impractical. Some compromises must be made. In the straight DC mode of operation, a constant voltage source appears to be most desirable. In the chopped mode, the internal impedance of the source substantially affects wave shapes.

2. <u>Temperature Control</u>

   The temperature of the motor windings can change very rapidly. To expedite testing, the winding temperatures should be monitored and some method of heating and cooling the motor is desirable.

3. <u>Instrumentation</u>

   For the chopped mode of operation, the instrumentation must be carefully considered. Significant errors can result from using the product of voltage and current as an indicator of power. Suitable wattmeters must be used. Many readings will be a small fraction of full scale and accuracy may be less than expected.

4. <u>Test Results</u>

   a. The controller efficiency may be assumed to be about 95% throughout the test range.

   b. The maximum efficiency of the motor was between 86 and 87% regardless of the motor temperature or the mode of operation. However, at low chopper duty cycles the motor efficiency may be considerably less than it is on straight DC.

   c. Most of the variations caused by changing test conditions are discernable on conventional torque-speed curves. For equal torque, a motor at high temperature will run somewhat slower than the same motor at a lower temperature. For equal speeds, a motor operated in the chopped mode develops slightly more torque than it does in the straight DC mode.

   d. The hysteresis effects of the motor alone, as well as the motor-controller combination, are negligible and can be ignored.

TABLE 1

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC STRAIGHT DC TESTS, 25-45°C TEMPERATURE RANGE

BATTERY TAP (VOLTS)	MOTOR FIELD TEMP (°C) #1	MOTOR FIELD TEMP (°C) #2	MOTOR ARMATURE TEMP (°C)	INPUT VOLTAGE (VOLTS)	INPUT CURRENT (AMPS)	OUTPUT TORQUE (Nm)	OUTPUT SPEED (RPM)	COMPENSATED OUTPUT SPEED (RPM)	COMPENSATED OUTPUT POWER (WATTS)	EFFICIENCY (%)
24	31	30	43	25.4	25.6	0.0	3600	3403.7	0.0	0.0
	31	30	36	25.2	30.3	0.7	3000	2853.2	209.2	28.8
	31	30	38	25.1	37.6	1.7	2400	2297.6	409.2	45.3
	30	30	39	25.0	49.0	4.3	1800	1726.3	777.7	66.1
	29	30	41	24.7	71.7	10.5	1200	1165.6	1282.2	74.5
	29	29	39	23.9	156.9	42.0	600	603.2	2654.1	70.5
	28	28	36	22.5	321.3	113.1	300	324.0	3839.0	49.8
48	36	36	52	50.8	33.6	0.4	5925	5599.6	234.7	14.6
	37	36	47	50.6	34.2	1.0	5400	5118.6	536.2	32.7
	38	38	49	50.5	40.1	1.9	4800	4560.2	907.7	47.2
	38	38	51	50.4	45.5	3.0	4200	4000.5	1257.3	57.6
	42	41	57	50.2	53.2	4.7	3600	3437.9	1692.8	66.3
	42	42	60	49.9	63.3	7.3	3000	2882.1	2204.2	72.5
	41	41	63	49.8	79.7	12.4	2400	2314.0	3006.1	78.6
	41	41	68	49.1	112.6	24.2	1800	1758.6	4458.6	82.5
	40	39	62	47.6	215.8	64.0	1200	1210.2	8114.3	78.3
	40	39	70	45.7	343.4	116.8	900	948.9	11611.1	70.4
72	36	36	61	76.1	51.5	3.7	5925	5605.7	2172.9	58.6
	39	39	64	75.6	56.3	5.2	5400	5139.5	2799.9	69.1
	41	41	66	75.4	63.2	6.9	4800	4579.4	3310.3	72.7
	42	42	70	75.3	72.3	9.7	4200	4016.5	4081.6	78.4
	42	42	75	74.9	85.3	13.8	3600	3458.0	4999.4	81.4
	43	42	78	74.5	105.5	21.2	3000	2899.6	6439.9	84.8
	43	43	81	73.5	147.9	36.9	2400	2349.8	9083.8	85.3
	43	43	78	71.2	257.2	79.5	1800	1820.7	15164.1	81.9
	43	42	85	69.3	363.3	123.5	1500	1561.5	20203.2	77.2

TABLE 1 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

GENERAL ELECTRIC STRAIGHT DC TESTS, 25-45°C TEMPERATURE RANGE

BATTERY TAP (VOLTS)	MOTOR FIELD TEMP (°C) #1	MOTOR FIELD TEMP (°C) #2	MOTOR ARMATURE TEMP (°C)	INPUT VOLTAGE (VOLTS)	INPUT CURRENT (AMPS)	OUTPUT TORQUE (Nm)	OUTPUT SPEED (RPM)	COMPENSATED OUTPUT SPEED (RPM)	COMPENSATED OUTPUT POWER (WATTS)	EFFICIENCY (%)
96	38	38	67	100.9	69.9	8.2	5925	5633.0	4839.1	72.1
	41	41	67	100.5	76.1	10.3	5400	5156.9	5564.6	76.2
	43	42	72	100.2	87.1	13.8	4800	4598.3	6647.9	79.5
	44	44	75	99.8	101.8	19.2	4200	4039.5	8125.3	83.1
	44	44	78	99.1	125.8	28.2	3600	3487.5	10303.3	85.3
	44	44	75	97.6	176.0	46.7	3000	2948.7	14426.4	85.4
	44	44	83	94.9	283.5	88.9	2400	2429.7	22629.0	83.1
	45	45	91	92.5	376.9	126.0	2100	2184.3	28833.3	79.7
120	35	35	56	126.1	90.2	14.6	5925	5636.0	8620.6	79.6
	38	37	59	125.2	101.0	18.2	5400	5173.6	9864.5	81.4
	40	40	64	124.8	119.0	25.0	4800	4612.7	12081.1	84.6
	41	40	68	123.8	147.6	35.9	4200	4068.7	15302.5	86.4
	41	41	71	122.1	202.3	56.1	3600	3537.8	20792.5	85.7
	41	41	72	118.6	308.8	97.7	3000	3037.0	31085.0	83.9
	45	45	83	116.2	390.4	129.8	2700	2791.9	37965.2	81.0
144	38	37	59	150.2	114.5	23.3	5925	5678.2	13860.5	84.1
	43	42	65	149.5	132.0	29.7	5400	5201.0	16182.8	85.1
	44	44	76	148.1	163.7	41.5	4800	4664.3	20279.0	86.0
	41	41	77	146.2	216.6	61.8	4200	4135.7	26776.2	85.8
	40	40	75	142.1	322.4	101.3	3600	3650.3	38739.1	83.4
	45	45	90	139.1	401.2	130.3	3300	3419.5	46678.7	80.8

TABLE 2

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC STRAIGHT DC TESTS, 130-150°C TEMPERATURE RANGE

BATTERY TAP (VOLTS)	MOTOR FIELD TEMP (°C) #1	MOTOR FIELD TEMP (°C) #2	MOTOR ARMATURE TEMP (°C)	INPUT VOLTAGE (VOLTS)	INPUT CURRENT (AMPS)	OUTPUT TORQUE (Nm)	OUTPUT SPEED (RPM)	COMPENSATED OUTPUT SPEED (RPM)	COMPENSATED OUTPUT POWER (WATTS)	EFFICIENCY (%)
24	133	133	140	25.0	25.1	0.7	3600	3452.0	253.2	42.0
	134	134	143	25.0	29.9	1.3	3000	2884.1	392.8	54.7
	134	134	143	24.9	36.6	2.4	2400	2316.5	582.4	66.3
	135	135	144	24.7	48.0	4.6	1800	1745.4	841.1	73.0
	135	135	142	24.5	70.3	10.4	1200	1174.7	1279.9	75.9
	135	135	146	23.9	136.8	34.8	600	602.2	2189.2	66.7
	134	134	145	22.9	248.8	80.7	300	316.5	2675.8	44.8
48	130	130	143	50.4	31.3	1.2	5925	5640.8	709.1	47.2
	130	130	146	50.2	34.5	1.7	5400	5158.0	918.6	55.5
	130	130	145	50.2	38.5	2.5	4800	4590.8	1202.4	65.1
	131	131	146	50.0	43.8	3.5	4200	4028.9	1477.3	70.3
	131	131	146	49.9	51.1	5.2	3600	3461.3	1885.6	76.9
	132	132	146	49.8	60.8	7.7	3000	2891.0	2332.1	79.9
	132	132	148	49.5	75.6	12.2	2400	2328.3	2975.8	82.0
	132	132	148	49.0	104.8	22.2	1800	1763.6	4101.7	81.5
	132	132	148	47.7	189.0	54.4	1200	1209.2	6891.4	76.0
	132	132	142	46.2	284.3	93.6	900	937.1	9189.1	67.3
72	143	144	155	75.2	47.9	4.3	5925	5669.7	2554.1	74.1
	144	143	156	75.0	52.8	5.3	5400	5181.0	2876.7	75.7
	143	143	156	74.9	58.9	7.0	4800	4612.4	3382.5	79.8
	144	144	158	74.6	67.5	9.5	4200	4050.2	4030.9	82.9
	144	144	158	74.3	79.4	13.2	3600	3487.2	4822.4	84.4
	144	144	160	74.0	98.3	19.7	3000	2919.6	6025.6	85.1
	145	145	162	73.1	135.0	33.2	2400	2363.1	8219.2	84.6
	147	147	165	71.3	223.6	67.2	1800	1819.7	12810.9	79.6
	147	147	161	69.7	306.4	100.5	1500	1553.0	16351.2	74.1

TABLE 2 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

GENERAL ELECTRIC STRAIGHT DC TESTS, 130-150°C TEMPERATURE RANGE

BATTERY TAP (VOLTS)	MOTOR FIELD TEMP (°C) #1	MOTOR FIELD TEMP (°C) #2	MOTOR ARMATURE TEMP (°C)	INPUT VOLTAGE (VOLTS)	INPUT CURRENT (AMPS)	OUTPUT TORQUE (Nm)	OUTPUT SPEED (RPM)	COMPENSATED OUTPUT SPEED (RPM)	COMPENSATED OUTPUT POWER (WATTS)	EFFICIENCY (%)
96	142	142	171	99.9	64.8	8.4	5925	5691.0	5008.2	80.5
	142	142	173	99.7	71.7	10.5	5400	5200.5	5720.7	83.1
	142	142	177	99.4	81.6	13.6	4800	4636.6	6606.2	84.3
	143	143	181	98.9	93.7	18.2	4200	4074.1	7768.1	86.4
	144	145	183	98.3	117.5	26.4	3600	3515.8	9723.9	86.2
	149	149	186	96.8	160.5	42.2	3000	2973.2	13144.6	85.3
	150	150	188	94.5	249.2	77.0	2400	2438.4	19670.1	82.2
	150	150	165	92.8	325.3	107.2	2100	2174.7	24423.4	78.2
120	140	140	157	125.6	84.3	14.3	5925	5660.3	8479.8	83.8
	140	140	156	125.1	94.5	17.9	5400	5177.2	9708.7	85.6
	140	140	163	124.3	111.5	23.9	4800	4630.9	11595.1	86.7
	140	140	164	123.4	137.5	33.5	4200	4082.8	14328.9	86.8
	140	140	170	121.8	184.4	51.0	3600	3546.8	18950.4	85.6
	139	140	174	118.9	273.7	85.7	3000	3029.0	27195.1	82.8
	138	138	167	116.9	339.0	112.1	2700	2774.1	32579.1	80.1
144	146	147	180	149.2	107.0	22.0	5925	5715.5	13173.1	85.5
	148	147	184	148.5	123.5	28.1	5400	5234.2	15408.8	86.6
	147	147	188	147.3	152.4	38.8	4800	4691.1	19068.6	86.9
	147	147	194	145.3	203.0	57.5	4200	4160.8	25064.3	85.7
	147	146	198	141.9	289.9	91.3	3600	3653.7	34947.4	83.7
	147	146	198	139.8	350.1	116.0	3300	3401.3	41334.6	82.0

TABLE 3

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

GENERAL ELECTRIC CHOPPED DC TESTS, 25-45°C TEMPERATURE RANGE, 144 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	FIELD #2	ARMATURE	CHOPPER INPUT VOLTAGE AVG.	RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
24	42	41	46	147.2	149.2	15.4	43.3	2128.2	23.5	55.2	27.9	53.9	2048.2	3600	1.3	490.3	23.9
	42	42	46	146.8	148.8	16.9	46.1	2336.3	23.4	56.5	33.8	59.5	2214.1	3000	2.0	628.6	28.4
	43	43	47	146.4	148.6	18.2	48.4	2469.5	22.8	57.1	41.6	65.4	2327.8	2400	3.3	829.7	35.6
	43	43	48	146.4	148.4	21.1	54.0	2901.3	24.4	60.0	54.4	75.5	2758.6	1800	5.8	1093.7	39.6
	43	43	51	145.8	148.1	25.2	63.1	3455.6	24.2	59.9	77.3	94.7	3336.5	1200	12.4	1558.9	46.7
	43	43	55	143.9	146.8	46.7	108.4	5775.2	24.2	56.4	170.4	184.2	5508.7	600	48.1	3023.5	54.9
	45	45	56	138.9	144.3	94.5	195.0	10171.6	24.0	51.0	344.4	351.7	9586.5	300	122.0	3834.4	40.0
48	42	42	51	145.8	146.7	26.3	52.1	3707.7	46.8	76.8	34.4	56.9	3488.0	5925	1.8	1117.3	32.0
	44	44	53	145.3	146.5	28.3	54.8	3998.2	46.5	77.7	37.8	60.7	3754.7	5400	2.5	1414.3	37.7
	45	45	57	144.7	146.4	31.6	58.5	4386.5	47.1	79.7	43.0	65.3	4114.6	4800	3.4	1709.7	41.6
	45	45	58	144.6	145.8	34.5	62.6	4832.5	48.1	81.4	79.4	71.2	4542.1	4200	4.7	2068.0	45.5
	45	45	60	144.2	145.5	37.7	66.9	5175.3	47.6	82.2	57.1	77.5	4834.7	3600	6.5	2451.5	50.7
	45	45	65	143.4	145.1	41.8	73.4	5789.9	47.3	83.3	68.0	87.1	5435.1	3000	9.4	2954.3	54.4
	45	45	68	142.5	144.4	48.6	83.8	6551.6	47.0	82.2	85.5	102.2	6182.6	2400	14.9	3746.4	60.6
	45	45	72	141.6	144.3	64.8	108.8	8639.7	47.9	83.5	123.6	139.3	8154.8	1800	28.5	5374.4	65.9
	45	45	73	135.4	140.4	123.5	192.3	14508.3	47.3	76.7	249.4	261.0	13615.2	1200	79.1	9944.2	73.0
	45	45	75	124.1	133.7	239.6	332.1	23911.0	47.3	71.2	431.2	437.9	22559.6	900	156.3	14737.1	65.3
72	45	45	54	143.4	144.5	40.5	63.3	5734.4	69.9	97.5	50.4	68.7	5519.4	5925	4.8	2979.5	54.0
	45	45	57	143.3	144.3	43.9	67.1	6070.0	70.4	8.5	55.0	73.2	5844.4	5400	6.0	3394.3	58.1
	45	45	62	142.8	144.3	47.8	72.2	6630.9	70.6	99.6	62.2	79.7	6399.7	4800	7.8	3922.4	61.3
	45	45	64	142.2	143.9	52.9	78.5	7279.3	70.4	100.1	71.1	87.5	6999.1	4200	10.4	4576.1	65.4
	45	45	66	140.6	143.3	60.1	88.1	8166.9	70.4	100.4	84.2	99.2	7895.3	3600	14.4	5430.9	68.8
	45	45	66	139.3	141.7	72.0	103.6	9650.9	70.0	99.2	105.2	119.4	9303.1	3000	21.6	6788.7	73.0
	45	45	68	138.0	141.5	98.2	137.4	12937.3	71.1	99.8	148.5	162.1	12541.5	2400	37.8	9504.2	75.8
	42	42	66	129.9	135.0	179.8	233.8	21075.0	70.3	93.0	267.9	278.0	20232.1	1800	85.2	16066.6	79.4
	43	43	82	118.4	125.7	263.3	354.3	30516.7	70.4	87.7	403.5	414.0	29215.6	1500	142.3	22361.8	76.5

TABLE 3 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

GENERAL ELECTRIC CHOPPED DC TESTS, 25-45°C TEMPERATURE RANGE, 144 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	FIELD #2	ARMATURE	CHOPPER INPUT VOLTAGE AVG.	RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
96	45	45	55	141.6	142.4	58.5	65.3	8199.6	94.1	115.5	68.0	80.3	7843.6	5925	9.1	5648.6	72.0
	45	45	66	141.2	141.9	63.9	81.3	8894.9	94.7	115.9	75.4	87.7	8565.6	5400	11.3	6392.6	74.6
	45	45	69	139.9	141.7	72.1	90.4	9961.7	94.9	115.9	86.0	97.8	9623.7	4800	14.7	7392.1	76.8
	45	45	72	137.4	140.2	83.0	103.4	11446.6	93.9	115.1	101.4	112.2	10964.7	4200	20.0	8800.2	80.3
	45	45	74	135.9	139.0	101.4	124.6	13620.4	93.9	114.0	125.9	136.5	13045.1	3600	29.1	10975.1	84.1
	45	45	77	132.4	135.0	142.5	169.5	18393.6	94.3	111.7	177.1	186.6	17728.3	3000	47.9	15054.6	84.9
	45	45	80	130.8	124.7	259.8	290.2	30144.4	94.2	104.8	305.4	313.3	29096.6	2400	99.2	24942.2	85.7
	45	44	84	108.3	112.7	386.4	411.5	40858.5	93.7	100.7	422.4	430.1	38402.5	2100	146.9	32318.6	84.2
120	42	41	57	140.2	141.3	80.9	90.8	11387.9	116.6	129.5	86.7	93.7	10916.5	5925	12.1	7510.8	68.8
	43	42	62	139.7	140.5	87.2	97.7	12208.4	116.7	129.0	94.1	101.1	11624.0	5400	15.9	8995.0	77.3
	43	43	64	138.0	139.1	105.3	116.8	14522.4	116.7	128.1	114.7	121.3	14003.5	4800	21.9	11012.7	78.6
	44	44	70	134.0	137.0	133.0	144.9	18001.9	117.0	127.5	144.4	150.6	17422.1	4200	32.7	14388.3	82.6
	44	44	81	130.1	131.1	185.3	197.4	24069.8	117.1	123.9	197.9	103.9	23237.1	3600	53.0	19988.9	86.0
	44	44	86	118.6	119.4	303.6	310.5	36265.4	115.1	117.7	310.4	313.4	35174.6	3000	96.9	30454.8	86.6
	45	45	88	112.7	114.5	357.7	363.6	40978.7	109.5	112.3	362.4	363.6	39231.3	2700	117.2	33151.5	84.5
144	44	44	65	137.9	138.4	103.7	105.6	14805.5	136.4	139.4	106.9	108.3	14173.4	5925	18.7	11607.6	81.9
	45	45	67	137.2	137.5	116.8	119.2	16598.2	135.7	137.4	120.0	121.5	16046.8	5400	23.5	13294.5	82.8
	45	45	71	133.8	135.7	138.1	141.3	19161.5	133.6	134.7	142.2	142.6	18464.3	4800	31.5	15840.3	85.8
	45	45	78	130.4	131.6	172.3	175.0	22805.4	128.3	131.4	176.4	178.2	22041.1	4200	43.9	19316.4	87.6
	45	45	86	126.1	126.9	222.4	225.7	28375.2	124.3	125.3	228.0	229.7	27381.6	3600	64.0	24137.6	88.1
	45	45	92	118.9	120.1	302.8	307.9	36785.7	115.7	117.8	311.0	313.7	35341.0	3000	97.1	30517.7	86.4
	45	45	92	112.7	114.8	352.5	364.1	40767.0	109.2	111.3	358.3	361.6	39250.3	2700	116.2	32868.6	83.7

TABLE 4

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC CHOPPED DC TESTS, 25-45°C TEMPERATURE RANGE, 120 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	FIELD #2	ARMATURE	CHOPPER INPUT VOLTAGE AVG.	RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
24	35	34	71	123.6	124.2	16.0	39.8	1895.9	23.4	52.8	27.6	48.0	1729.4	3600	0.8	301.7	17.4
	34	34	67	123.3	124.0	18.0	42.6	2108.5	24.0	54.6	33.5	53.0	1898.5	3000	1.5	471.4	24.8
	35	35	68	123.0	123.8	19.4	45.2	2279.4	23.6	54.9	40.9	58.4	2054.0	2400	2.7	678.9	33.1
	35	35	70	122.2	123.4	22.4	50.3	2611.5	24.4	56.1	53.2	67.9	2273.6	1800	5.2	980.6	43.1
	35	35	74	121.3	123.1	27.9	61.0	3275.1	24.1	55.5	77.6	88.9	3871.0	1200	12.0	1508.6	52.5
	35	35	73	118.9	121.8	53.8	110.6	5203.3	23.8	53.0	172.0	181.1	4925.6	600	47.8	3004.6	61.0
	39	38	77	111.5	117.2	125.3	226.0	9743.6	23.7	48.9	365.6	371.5	9205.8	300	129.1	4057.5	44.1
48	43	43	63	122.0	122.9	28.7	48.7	3420.3	47.0	73.4	35.4	52.4	3048.9	5925	1.3	806.9	26.5
	44	43	66	122.1	122.9	30.0	50.6	3584.4	46.6	73.5	38.4	55.1	3159.1	5400	1.6	905.2	28.7
	44	44	70	121.5	122.6	32.8	54.2	3913.2	47.6	74.5	43.4	59.7	3474.6	4800	2.8	1408.0	40.5
	45	44	74	120.7	122.0	35.8	57.7	4193.2	47.1	75.9	49.0	64.4	3719.1	4200	4.0	1760.0	47.3
	45	45	77	120.4	121.8	38.9	62.2	4563.0	47.4	76.9	56.2	70.6	4011.9	3600	5.7	2149.8	53.6
	44	44	78	120.0	121.7	43.3	68.6	4905.0	47.4	77.2	67.4	80.2	4353.0	3000	8.6	2702.9	62.1
	40	40	79	118.3	121.0	49.6	78.3	5574.3	48.1	76.1	83.2	94.1	5297.2	2400	13.5	3394.3	64.1
	40	40	82	116.5	119.1	66.4	102.3	7292.8	48.0	74.3	117.9	112.7	7009.3	1800	25.8	4865.2	69.4
	40	40	81	110.1	114.7	131.0	187.0	12719.0	47.5	68.9	234.1	241.9	12259.7	1200	71.3	8963.6	73.1
	42	41	79	99.7	108.4	232.0	319.9	20162.8	46.9	63.3	391.6	397.3	19376.6	900	137.5	12964.5	66.9
72	44	43	56	118.3	120.0	43.7	59.0	5161.6	70.9	92.6	51.6	63.5	4981.2	5925	4.3	2669.1	53.6
	44	44	57	117.7	119.8	47.1	63.3	5503.0	70.6	93.1	56.3	67.3	5295.0	5400	5.5	3111.5	58.8
	45	44	63	117.2	119.2	51.5	68.5	6052.1	71.2	93.6	73.4	73.9	5807.1	4800	7.4	3721.2	64.1
	45	45	66	116.6	119.2	57.5	75.2	6689.1	70.9	93.8	79.9	82.2	6398.7	4200	10.0	4400.1	68.8
	44	44	69	116.2	118.1	66.8	86.2	7656.8	71.1	92.9	86.0	95.4	7343.0	3600	14.3	5393.2	73.4
	44	44	72	114.9	117.1	82.0	104.9	9380.8	71.4	93.4	108.1	116.4	8998.3	3000	21.8	6851.6	76.1
	42	42	75	111.7	113.8	116.2	143.0	12756.0	70.4	89.4	154.0	161.2	12085.6	2400	39.2	9856.2	81.6
	44	45	80	100.6	104.3	229.8	264.0	22132.8	70.6	83.6	287.4	290.7	21162.5	1800	91.7	17292.3	81.7
	45	44	80	88.1	93.5	365.6	392.8	30357.4	68.1	76.5	410.3	417.1	29095.1	1500	144.1	22644.7	77.8

TABLE 4 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC CHOPPED DC TESTS, 25-45°C TEMPERATURE RANGE, 120 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	FIELD #2	ARMATURE	CHOPPER INPUT VOLTAGE AVG.	RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
96	45	45	52	115.7	117.2	61.1	69.8	7163.7	94.2	106.7	67.5	73.3	6882.0	5925	6.4	3972.6	57.7
	45	45	54	114.9	117.0	67.2	76.5	7825.2	93.5	106.8	75.0	80.8	7591.9	5400	8.6	4865.2	64.1
	45	45	56	114.3	116.7	76.1	85.7	8804.8	93.5	106.1	85.5	90.9	8471.5	4800	12.0	6034.4	71.2
	45	45	59	113.5	115.3	89.5	99.5	10234.3	94.2	105.9	100.8	106.2	9749.4	4200	17.2	7568.1	77.6
	45	45	62	111.2	113.1	111.9	123.0	12513.8	93.9	104.0	125.2	129.8	12051.1	3600	26.4	9956.8	82.6
	45	45	67	106.4	108.5	160.5	171.8	17150.2	93.5	101.1	177.0	181.0	16586.3	3000	45.6	14331.7	86.4
	45	45	71	94.8	97.2	283.5	290.2	27559.0	92.0	94.9	290.9	294.7	26663.0	2400	91.3	22955.9	86.1
	45	45	75	90.6	91.8	335.5	341.8	30537.4	87.6	89.1	337.5	342.7	29985.9	2100	113.4	24948.5	83.2
120	43	42	56	116.9	117.0	81.5	83.0	9712.2	114.9	116.5	83.4	85.1	9349.9	5925	10.6	6579.7	70.4
	43	43	59	114.6	116.1	90.0	92.3	10621.4	112.1	115.3	92.7	94.5	10095.8	5400	13.8	7807.0	77.3
	43	43	66	112.2	114.2	103.5	105.4	11950.7	110.0	113.3	105.6	107.7	11474.2	4800	18.6	9353.3	81.5
	44	43	71	111.5	112.6	123.7	125.3	14031.4	109.3	111.8	126.3	128.1	13389.6	4200	26.0	11440.2	85.4
	43	43	77	109.1	110.2	153.8	157.0	17005.7	106.2	108.7	158.1	159.9	16454.1	3600	37.9	14294.0	86.9
	43	43	83	103.3	105.1	206.0	211.2	22013.7	100.1	103.2	211.2	214.0	21119.6	3000	58.7	18448.9	87.3
	42	42	84	95.9	98.2	292.4	296.9	28612.7	92.4	95.1	298.9	300.3	27752.5	2400	93.2	23433.6	84.4
	45	44	89	90.9	92.8	344.2	348.0	31698.1	87.3	89.1	348.8	354.9	30136.5	2100	115.5	25410.5	84.3

TABLE 5

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC CHOPPED DC TESTS, 130-150°C TEMPERATURE RANGE, 144 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE	TEMPERATURE °C			CHOPPER INPUT VOLTAGE		CHOPPER INPUT CURRENT (AMPS)		CHOPPER INPUT POWER	CHOPPER OUTPUT VOLTAGE		CHOPPER OUTPUT CURRENT (AMPS)		CHOPPER OUTPUT POWER	M O T O R O U T P U T			
NOMINAL	FIELD #1	FIELD #2	ARMATURE	AVG.	RMS	AVG.	RMS	(WATTS)	AVG.	RMS	AVG.	RMS	(WATTS)	SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
24	138	138	183	145.6	146.4	14.4	40.3	2041.7	23.2	56.5	25.7	49.0	1935.3	3600	1.5	565.7	29.2
	137	137	191	145.7	146.3	16.4	43.6	2316.5	24.4	59.6	32.3	55.2	2166.1	3000	2.4	754.3	34.8
	138	138	198	145.2	146.0	17.3	46.1	2524.6	23.8	59.6	38.7	60.4	2346.0	2400	3.5	880.0	37.5
	138	137	201	144.9	146.3	19.2	49.3	1647.2	23.6	60.5	50.3	68.4	2484.0	1800	5.6	1056.0	42.5
	138	138	207	145.0	145.8	23.0	57.0	3137.2	23.6	59.6	72.0	86.7	2933.3	1200	11.6	1458.3	49.7
	139	138	212	143.3	144.4	40.1	94.4	5131.5	23.7	58.1	148.7	161.9	4826.8	600	40.0	2514.3	52.1
	142	142	220	140.8	142.7	74.5	162.9	8380.7	24.0	56.6	280.0	288.1	8126.6	300	95.9	3014.1	37.1
48	137	136	186	144.2	145.0	24.5	50.1	3680.0	47.5	79.1	33.0	54.0	3502.4	5925	2.1	1303.5	37.2
	137	137	190	144.2	144.9	27.4	52.6	3861.3	47.2	81.5	36.6	56.9	3660.8	5400	2.6	1414.3	38.6
	139	138	195	143.8	144.8	28.5	55.0	4014.8	47.3	81.5	40.5	60.9	3839.0	4800	3.4	1709.7	44.5
	139	139	198	143.9	145.0	32.0	58.1	4405.6	47.9	83.8	46.4	66.2	4175.0	4200	4.5	1980.0	47.4
	137	137	203	143.4	144.0	35.6	64.0	4987.8	48.0	85.8	54.5	74.0	4746.6	3600	6.3	2376.0	50.0
	140	140	206	143.2	144.3	37.8	68.9	5320.4	48.5	85.4	64.8	81.7	5035.1	3000	9.0	2828.6	56.2
	140	140	210	141.9	143.1	44.5	77.2	5986.3	47.0	83.1	76.9	90.7	5702.8	2400	13.8	3469.7	60.8
	141	140	213	141.2	143.1	59.0	100.3	7919.8	47.9	85.6	115.6	128.9	7502.5	1800	25.6	4827.5	64.3
	139	139	216	135.7	138.5	106.1	171.1	13095.8	47.4	78.9	220.3	231.3	12147.5	1200	68.3	8586.4	70.7
	146	146	216	130.2	131.4	161.8	240.5	18197.4	48.1	78.1	319.2	325.8	16474.9	900	107.0	10088.8	61.2
72	139	139	191	142.6	143.7	41.8	63.0	5891.5	71.2	100.5	50.4	66.6	5625.3	5925	4.9	3041.6	54.1
	139	139	195	141.9	142.9	44.7	66.4	6283.5	71.1	101.3	55.5	71.1	6035.1	5400	6.1	3450.9	57.2
	139	139	198	141.6	143.1	48.8	71.6	6798.8	71.3	101.3	62.3	77.3	6568.2	4800	8.0	4022.9	61.2
	140	140	202	141.3	142.9	54.1	79.1	7582.9	71.7	104.0	72.1	86.6	7342.3	4200	10.6	4664.1	63.5
	141	140	206	139.9	142.0	61.4	88.0	8529.7	71.4	102.7	85.1	98.6	8201.4	3600	14.8	5581.8	68.1
	143	142	211	139.2	141.9	71.8	102.5	9854.3	72.1	104.3	103.2	116.6	9461.9	3000	20.8	6537.3	69.1
	143	142	217	135.5	137.7	97.8	136.3	12660.3	71.3	100.1	145.7	156.3	12182.7	2400	36.9	9277.9	76.2
	143	143	217	128.3	132.0	173.3	224.2	20731.2	70.8	95.8	254.8	266.3	19729.4	1800	80.0	15086.0	76.9
	146	145	225	119.1	123.9	263.9	325.4	28931.9	71.2	90.7	365.6	373.6	27099.9	1500	126.9	19941.8	73.5

TABLE 5 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

GENERAL ELECTRIC CHOPPED DC TESTS, 130-150°C TEMPERATURE RANGE, 144 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	FIELD #2	ARMATURE	CHOPPER INPUT VOLTAGE AVG.	RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
96	135	135	197	141.0	142.0	57.9	73.8	8146.1	94.2	116.8	66.1	77.4	7859.3	5925	8.8	5462.4	69.5
	137	136	198	140.8	141.8	62.2	78.0	8676.4	95.0	117.9	71.4	82.4	8301.4	5400	11.0	6223.0	75.0
	138	137	200	139.7	140.7	71.4	88.8	9866.4	94.7	117.0	83.9	93.8	9561.3	4800	14.5	7291.6	76.3
	139	138	201	137.9	140.6	82.5	101.7	11377.2	94.4	116.6	99.2	109.2	10898.7	4200	19.7	8668.2	79.5
	140	139	202	135.9	138.3	101.4	122.9	13711.2	94.7	116.4	123.5	133.1	13103.1	3600	28.7	10824.2	82.6
	140	140	207	131.6	133.8	142.9	168.3	18433.6	94.3	111.6	176.7	182.2	17732.9	3000	47.8	15023.1	84.7
	140	139	212	121.3	124.5	250.2	279.4	29708.3	94.4	108.3	291.6	297.4	28684.7	2400	94.9	23861.0	83.1
	147	147	219	110.3	113.4	363.9	384.1	39887.8	94.5	103.2	392.8	397.9	37414.4	2100	137.5	30250.6	80.8
	137	137	194	139.1	140.3	80.7	89.2	11376.8	119.1	130.0	86.0	91.9	10908.7	5925	12.9	8007.4	73.4
	139	139	196	138.5	139.5	89.7	99.3	12500.4	118.7	129.1	95.6	101.5	11994.9	5400	16.4	9277.9	77.3
	140	139	201	135.5	138.1	105.6	116.2	14540.0	118.9	129.3	113.4	119.2	13958.1	4800	22.7	11415.1	81.8
	141	141	204	132.3	134.4	135.4	144.6	18060.1	118.4	126.4	144.7	149.2	17355.1	4200	33.8	14872.3	85.7
	143	143	211	128.1	129.3	190.4	200.6	24751.2	118.8	123.5	199.5	204.3	23882.4	3600	55.1	20781.0	87.0
	142	142	220	118.9	120.0	290.3	295.8	34877.1	114.9	116.5	294.3	297.1	33513.1	3000	92.5	29072.0	86.7
	149	149	221	113.7	116.1	328.3	335.3	38082.9	108.7	111.9	332.1	336.9	36750.0	2700	108.5	30690.6	83.5
144	138	138	205	136.2	136.8	98.2	100.5	13595.7	134.8	136.0	100.0	102.2	13052.4	5925	16.8	10428.2	79.9
	139	139	207	134.5	136.0	110.9	112.9	15159.7	134.3	135.3	113.3	114.7	14583.4	5400	21.4	12106.5	83.0
	140	139	212	130.8	132.9	131.9	133.7	17650.0	129.4	133.8	133.3	135.9	16585.6	4800	28.8	14482.5	87.3
	140	139	214	129.6	131.4	161.1	146.2	21198.4	127.6	130.6	163.9	166.1	20406.3	4200	40.5	17820.3	87.3
	143	142	219	124.3	126.1	206.8	212.1	26330.2	123.3	124.6	211.1	214.2	25371.1	3600	59.1	22289.6	87.9
	146	146	224	118.6	119.3	278.9	283.9	34255.5	115.3	117.0	283.7	285.9	33027.5	3000	91.8	28851.9	87.4
	147	146	234	112.7	114.3	320.3	327.7	37271.2	109.9	112.9	325.0	327.7	35721.7	2700	107.6	30436.0	85.2

TABLE 6

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC CHOPPED DC TESTS, 130-150°C TEMPERATURE RANGE, 120 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE NOMINAL	TEMPERATURE °C FIELD #1	TEMPERATURE °C FIELD #2	TEMPERATURE °C ARMATURE	CHOPPER INPUT VOLTAGE AVG.	CHOPPER INPUT VOLTAGE RMS	CHOPPER INPUT CURRENT (AMPS) AVG.	CHOPPER INPUT CURRENT (AMPS) RMS	CHOPPER INPUT POWER (WATTS)	CHOPPER OUTPUT VOLTAGE AVG.	CHOPPER OUTPUT VOLTAGE RMS	CHOPPER OUTPUT CURRENT (AMPS) AVG.	CHOPPER OUTPUT CURRENT (AMPS) RMS	CHOPPER OUTPUT POWER (WATTS)	MOTOR OUTPUT SPEED (RPM)	MOTOR OUTPUT TORQUE (Nm)	MOTOR OUTPUT POWER (WATTS)	MOTOR OUTPUT EFFICIENCY (%)
24	137	137	192	119.7	121.7	15.3	37.0	1825.6	23.6	53.4	26.2	44.1	1713.7	3600	1.4	529.6	30.9
	138	136	196	119.5	121.3	16.8	39.5	1986.9	23.9	54.7	31.4	48.2	1845.1	3000	1.2	660.0	35.8
	137	137	198	119.3	121.5	18.2	42.2	2127.0	23.8	55.5	38.6	53.7	1998.1	2400	3.2	804.6	40.3
	137	137	199	119.0	121.1	20.8	47.0	2468.2	24.0	55.5	50.0	62.8	2218.1	1800	5.6	1056.0	47.6
	138	138	199	118.6	120.6	25.5	56.2	2867.5	23.5	54.5	72.5	82.1	2627.3	1200	11.8	1483.5	56.5
	138	137	201	116.6	119.4	48.1	99.2	4892.9	23.8	52.8	153.4	161.5	4661.7	600	41.8	2627.5	56.4
	144	143	213	111.5	115.8	97.1	180.8	8488.7	23.4	49.5	294.1	301.0	8106.9	300	101.0	3174.3	39.2
48	139	138	208	118.8	121.0	25.6	44.5	3025.6	46.9	75.9	32.5	48.0	2902.7	5925	1.7	1055.2	36.4
	139	139	213	118.7	120.6	26.8	46.6	3141.0	46.3	74.4	35.7	51.4	2962.8	5400	2.3	1301.2	43.9
	140	140	216	118.4	120.6	28.9	49.4	3435.3	47.1	75.7	39.8	54.4	3262.7	4800	3.1	1558.9	47.8
	138	138	221	118.0	120.4	31.2	52.2	3685.8	46.9	76.3	45.0	59.0	3485.1	4200	4.2	1848.0	53.0
	140	140	226	118.1	120.1	33.8	56.0	3930.9	47.3	77.0	51.3	64.1	3735.3	3600	5.6	2112.0	56.5
	140	140	228	117.7	119.8	38.1	62.1	4397.1	47.0	76.8	62.6	73.6	4230.3	3000	8.2	2572.2	61.0
	140	140	233	116.9	119.1	44.4	71.4	5085.1	46.4	75.8	76.9	86.8	4890.9	2400	12.9	3243.5	66.3
	141	140	236	115.5	118.0	58.9	92.4	6584.5	46.6	75.8	107.5	226.5	6397.7	1800	23.5	4431.5	69.3
	140	139	234	111.5	112.4	131.7	207.8	11034.1	46.7	72.0	201.4	210.6	10473.0	1200	60.1	7555.6	72.1
	146	146	240	102.9	109.6	183.9	250.3	16036.7	46.8	65.8	312.5	318.8	15468.6	900	105.7	9966.2	64.4
72	141	140	200	118.2	119.8	42.6	56.8	5096.1	69.9	92.1	49.6	60.4	4844.0	5925	4.5	2793.3	57.7
	141	140	203	117.5	119.2	45.0	59.9	5314.2	69.6	92.2	54.1	64.3	5041.9	5400	5.6	3168.1	62.8
	143	143	208	117.3	119.5	48.6	65.1	5858.3	70.0	93.3	60.1	69.7	5611.3	4800	7.3	3670.9	65.4
	143	142	211	116.5	118.7	54.2	71.3	6425.9	70.0	92.9	68.8	78.0	6163.2	4200	9.8	4312.1	70.0
	143	143	218	116.3	118.5	62.3	80.9	7286.7	70.3	92.8	81.1	89.1	7033.5	3600	13.6	5129.2	73.0
	142	142	223	114.8	117.1	76.3	97.5	8668.8	69.8	91.5	100.8	107.5	8255.6	3000	20.6	6474.4	78.4
	144	143	227	112.4	114.9	103.9	130.7	11610.9	69.9	90.0	140.3	147.2	11044.5	2400	35.1	8825.3	80.0
	145	145	235	105.1	108.4	185.2	220.3	18819.8	69.7	86.2	240.9	246.6	17544.3	1800	75.6	14256.3	81.3
	148	148	239	95.2	98.8	290.2	324.7	26500.3	70.4	82.1	345.6	356.3	24716.4	1500	118.4	18606.1	75.3

TABLE 6 CONT'D

GENERAL ELECTRIC MODEL 5BT 2366C10 DC MOTOR
GENERAL ELECTRIC EV-1 CONTROLLER

DEN3-123

GENERAL ELECTRIC CHOPPED DC TESTS, 130-150°C TEMPERATURE RANGE, 120 VOLTS CONTROLLER INPUT TAP

MOTOR INPUT VOLTAGE	TEMPERATURE °C			CHOPPER INPUT VOLTAGE		CHOPPER INPUT CURRENT (AMPS)		CHOPPER INPUT POWER	CHOPPER OUTPUT VOLTAGE		CHOPPER OUTPUT CURRENT (AMPS)		CHOPPER OUTPUT POWER	M O T O R O U T P U T			
NOMINAL	FIELD #1	FIELD #2	ARMATURE	AVG.	RMS	AVG.	RMS	(WATTS)	AVG.	RMS	AVG.	RMS	(WATTS)	SPEED (RPM)	TORQUE (Nm)	POWER (WATTS)	EFFICIENCY (%)
96	137	137	214	115.8	117.3	59.1	67.5	6945.5	93.0	106.3	65.4	70.0	6734.0	5925	6.4	3972.6	59.0
	138	138	220	115.0	116.9	64.5	73.5	7577.7	93.2	106.2	71.7	76.6	7308.4	5400	8.5	4808.7	65.8
	137	137	225	114.3	116.4	73.2	82.2	8469.4	94.0	106.9	81.6	85.9	8187.8	4800	11.6	5833.2	71.2
	139	139	229	113.3	115.3	84.6	94.6	9777.7	93.4	105.0	94.6	99.5	9488.8	4200	16.6	7304.1	77.0
	137	137	233	111.5	113.3	105.3	116.1	11935.0	93.4	103.9	117.5	122.0	11444.7	3600	24.9	9391.0	82.1
	139	139	237	106.9	109.0	150.6	164.0	16163.9	92.8	100.8	165.7	168.7	15717.2	3000	42.7	13420.2	85.4
	139	139	238	97.3	98.2	263.6	272.9	26124.3	92.1	95.5	269.9	274.5	25006.5	2400	86.4	21723.8	86.9
	147	147	246	90.7	91.8	330.4	335.1	29688.3	85.9	88.5	337.3	334.7	29146.8	2100	109.8	24156.4	82.9
120	138	137	218	112.6	114.5	77.8	79.1	8995.7	111.4	114.2	80.1	80.7	8774.2	5925	10.7	6641.8	75.7
	137	137	224	111.9	114.1	86.0	87.4	9930.6	110.2	113.7	88.1	88.7	9635.8	5400	13.5	7637.3	79.3
	136	136	229	111.4	113.2	97.1	99.5	11302.0	109.5	112.8	100.2	102.5	10858.2	4800	17.9	9001.3	82.9
	137	137	233	220.4	111.2	115.2	117.2	12977.2	108.5	110.7	117.7	119.8	12579.8	4200	24.4	10736.2	85.3
	138	138	240	108.6	108.5	145.0	147.5	15827.8	106.5	108.0	150.3	150.7	15407.4	3600	35.8	13502.0	87.6
	140	140	245	102.4	104.5	191.3	196.6	20082.5	100.5	103.3	196.4	199.1	19458.2	3000	54.4	17097.5	87.9
	142	142	249	96.8	98.1	267.3	273.4	26488.0	92.9	95.8	272.8	275.6	25657.7	2400	85.8	21573.0	84.1
	147	146	260	91.0	93.2	314.0	319.7	30494.0	89.1	92.3	322.2	321.6	29112.6	2100	109.6	24112.4	82.8

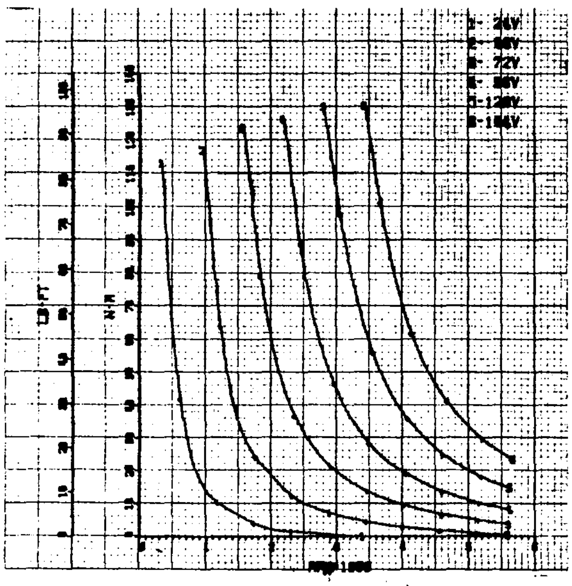

FIGURE 10 - SPEED-TORQUE CHARACTERISTICS

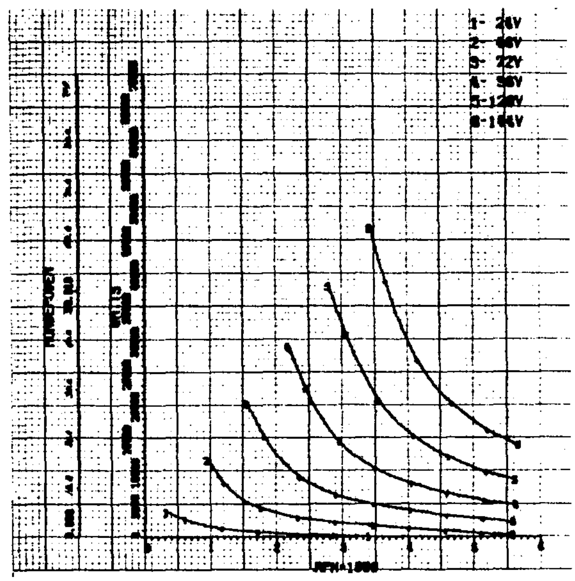

FIGURE 11 - OUTPUT POWER - SPEED CHARACTERISTICS

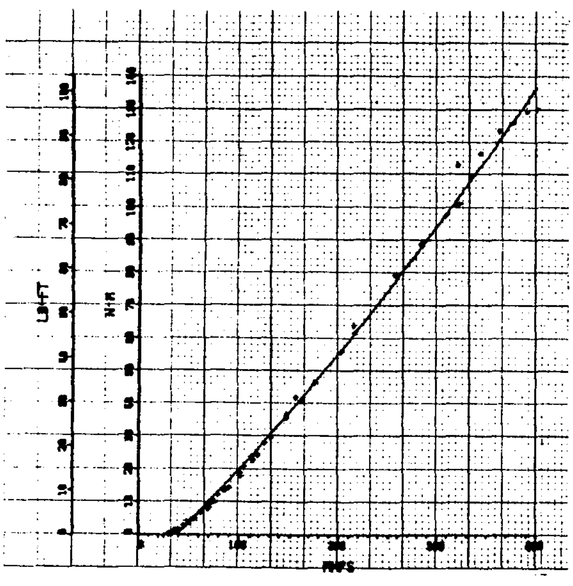

FIGURE 12 - TORQUE - CURRENT CHARACTERISTICS

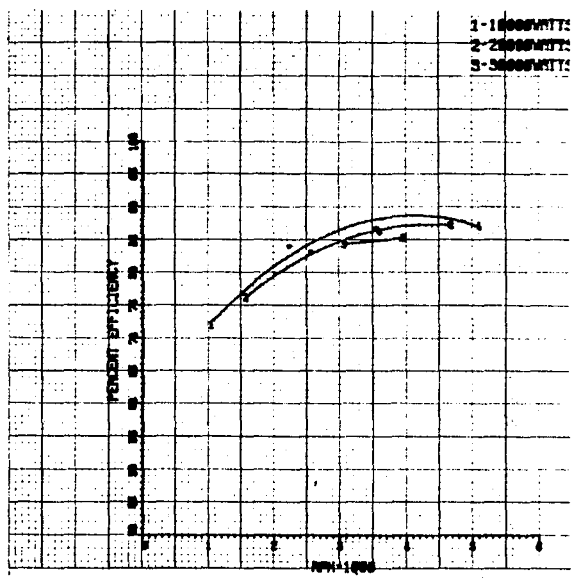

FIGURE 13. - MOTOR EFFICIENCY - SPEED - POWER RELATIONSHIPS

LOW TEMPERATURE - STRAIGHT DC

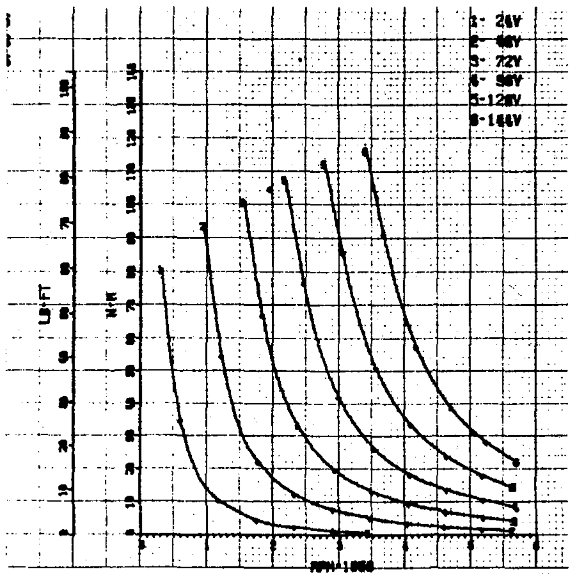

FIGURE 14. - SPEED-TORQUE CHARACTERISTICS

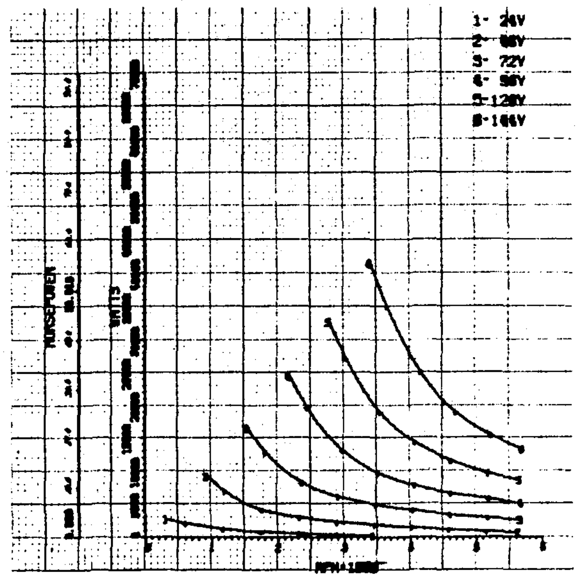

FIGURE 15. - OUTPUT POWER - SPEED CHARACTERISTICS

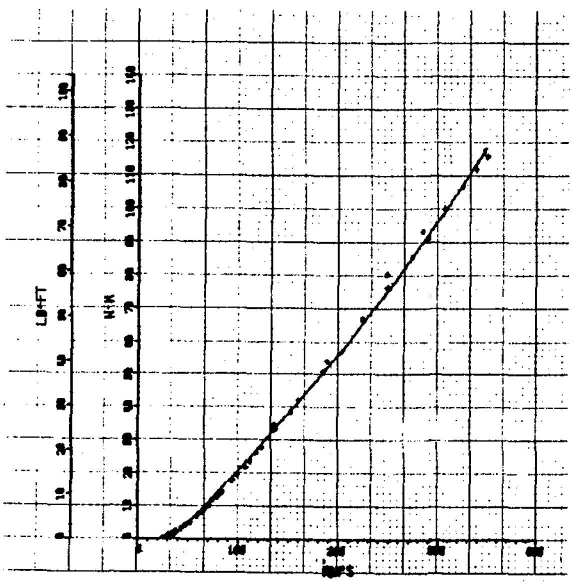

FIGURE 16. - TORQUE - CURRENT CHARACTERISTICS

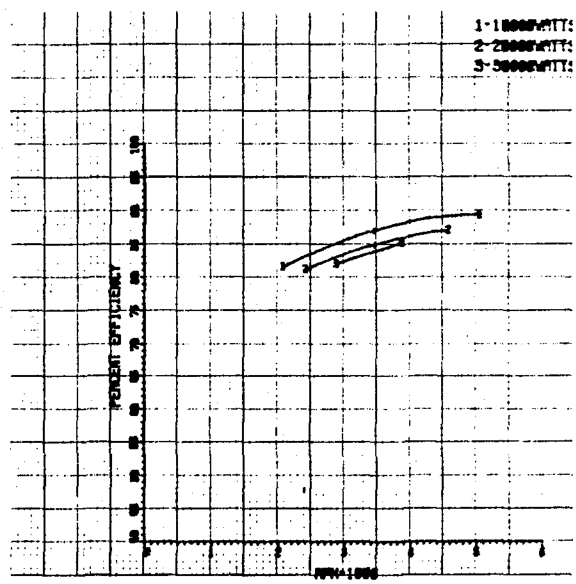

FIGURE 17. - EFFICIENCY-SPEED-POWER RELATIONSHIPS

HIGH TEMPERATURE - STRAIGHT DC

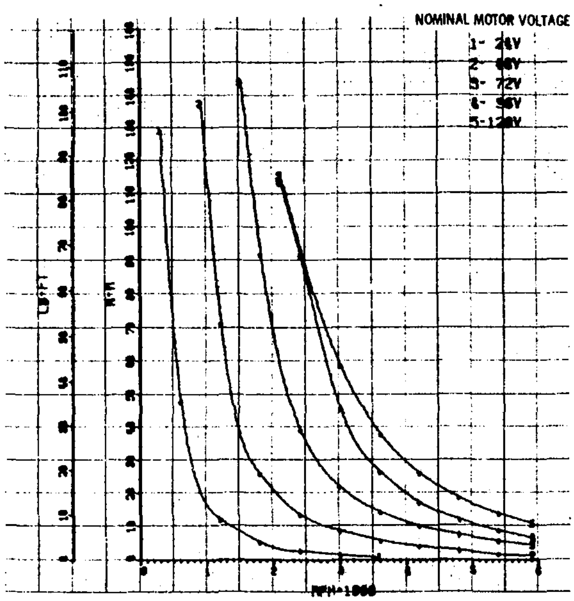

FIGURE 18. - SPEED-TORQUE CHARACTERISTICS

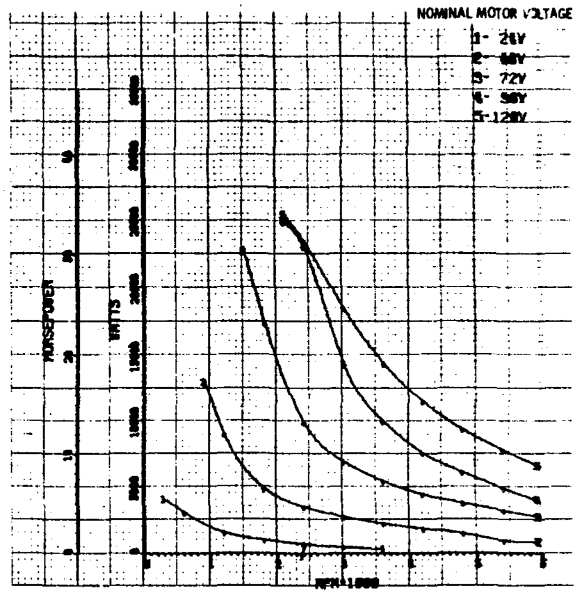

FIGURE 19. - OUTPUT POWER - SPEED CHARACTERISTICS

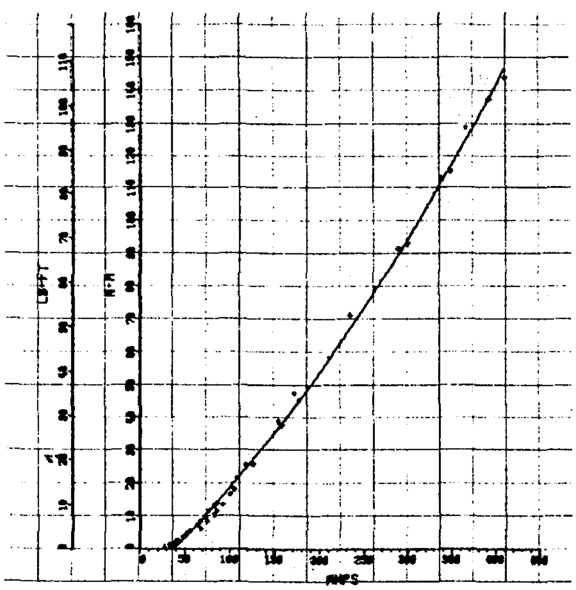

FIGURE 20. - TORQUE - CURRENT CHARACTERISTICS

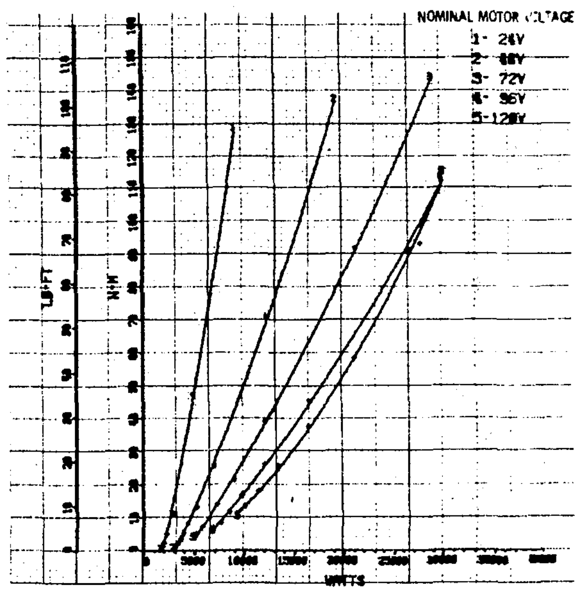

FIGURE 21. - TORQUE - POWER - VOLTAGE RELATIONSHIPS

LOW TEMPERATURE - CHOPPED DC - 120 VOLT INPUT

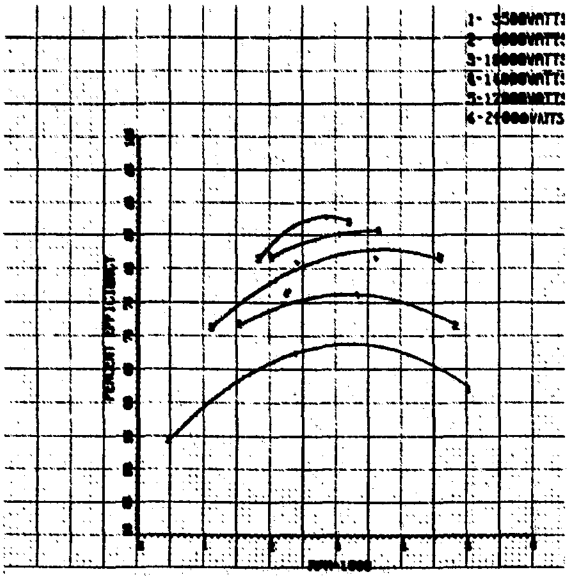

FIGURE 22. - MOTOR EFFICIENCY - SPEED - POWER RELATIONSHIPS

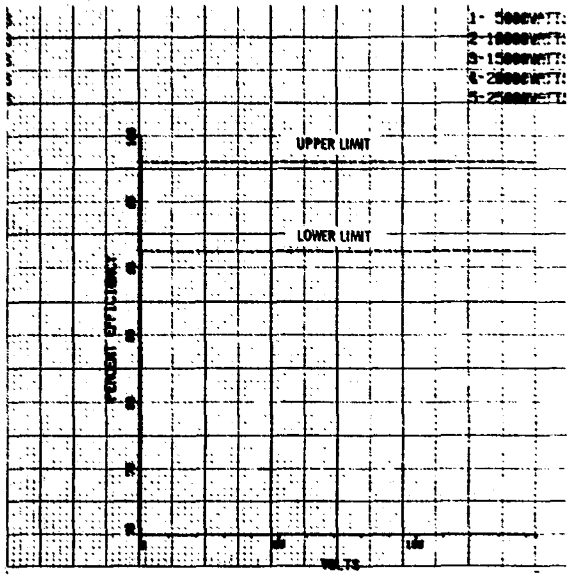

FIGURE 23. - CONTROLLER EFFICIENCY

LOW TEMPERATURE - CHOPPED DC - 120 VOLT INPUT

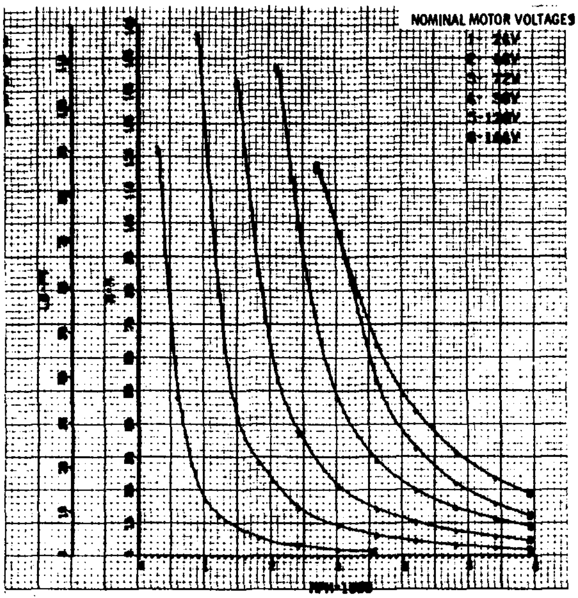

FIGURE 24. - SPEED - TORQUE CHARACTERISTICS

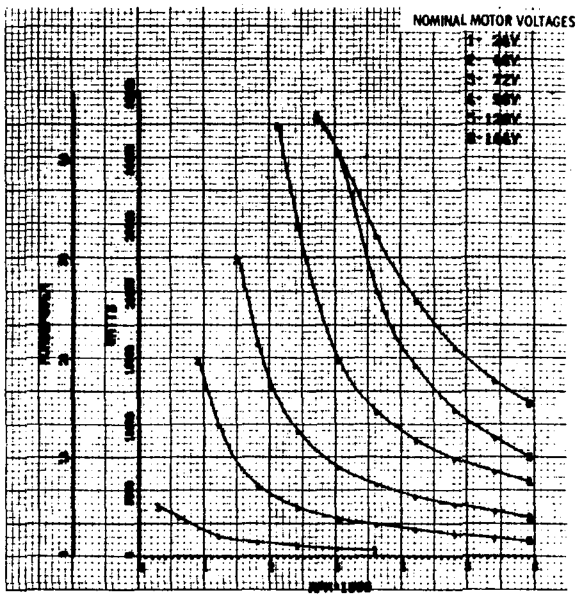

FIGURE 25. - OUTPUT POWER - SPEED CHARACTERISTICS

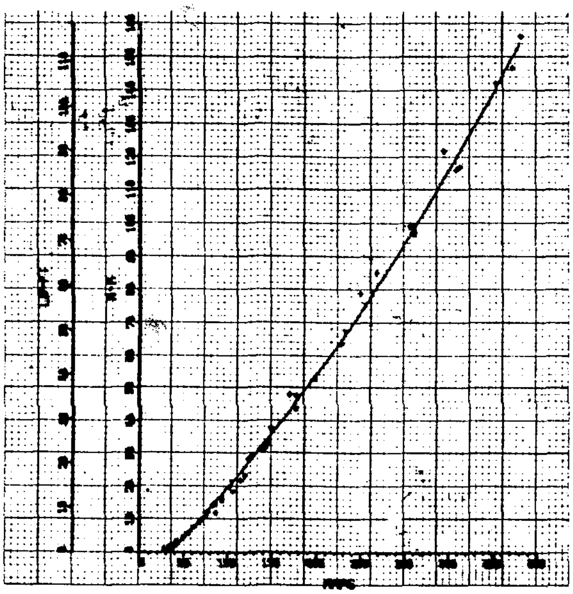

FIGURE 26. - TORQUE - CURRENT CHARACTERISTICS

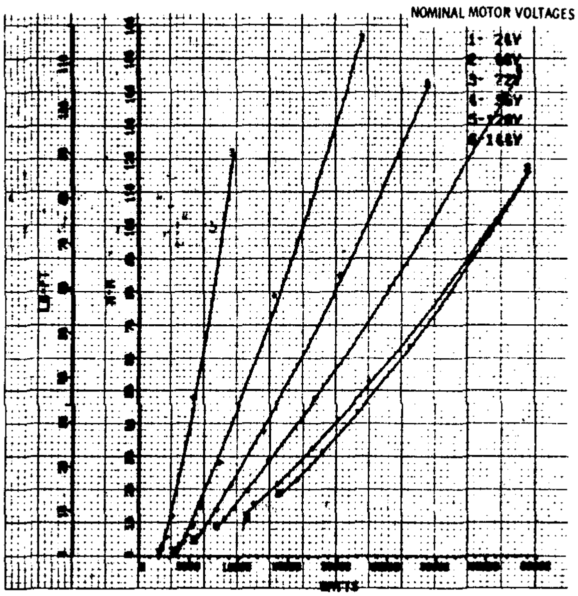

FIGURE 27. - TORQUE - POWER - VOLTAGE RELATIONSHIPS

LOW TEMPERATURE - CHOPPED DC - 144 VOLT INPUT

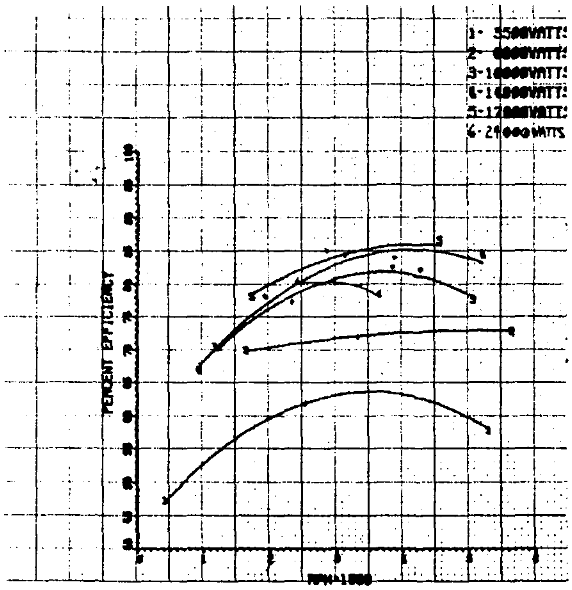

FIGURE 28. MOTOR EFFICIENCY - SPEED - POWER RELATIONSHIPS

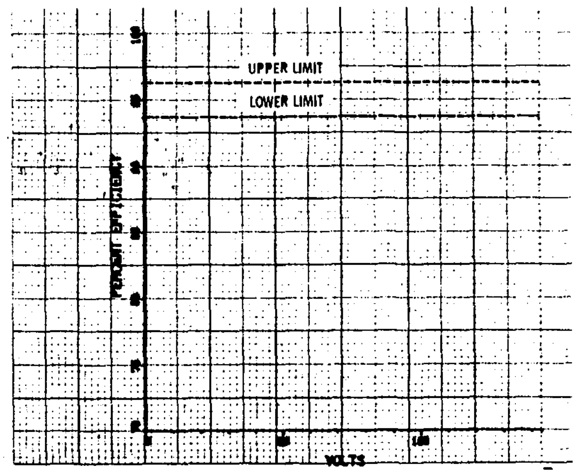

FIGURE 29. - CONTROLLER EFFICIENCY

LOW TEMPERATURE - CHOPPED DC - 144 VOLT INPUT

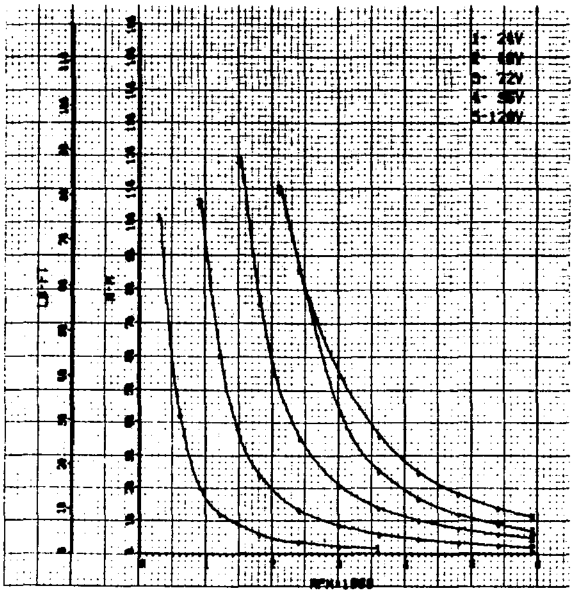

FIGURE 30. - SPEED - TORQUE CHARACTERISTICS

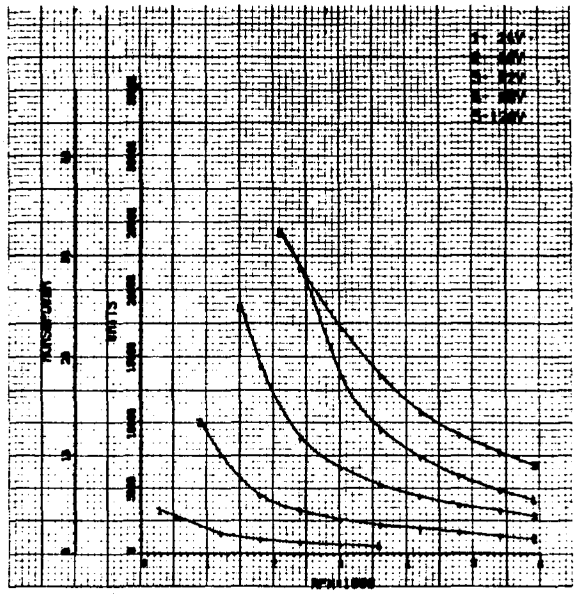

FIGURE 31. - OUTPUT POWER - SPEED CHARACTERISTICS

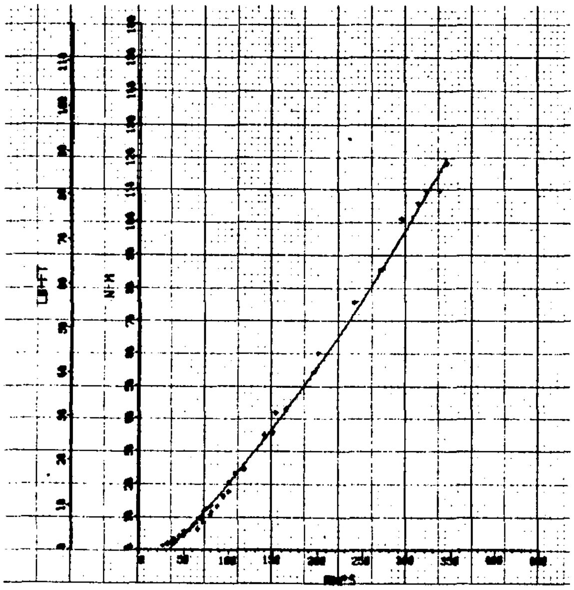

FIGURE 32. - TORQUE - CURRENT CHARACTERISTICS

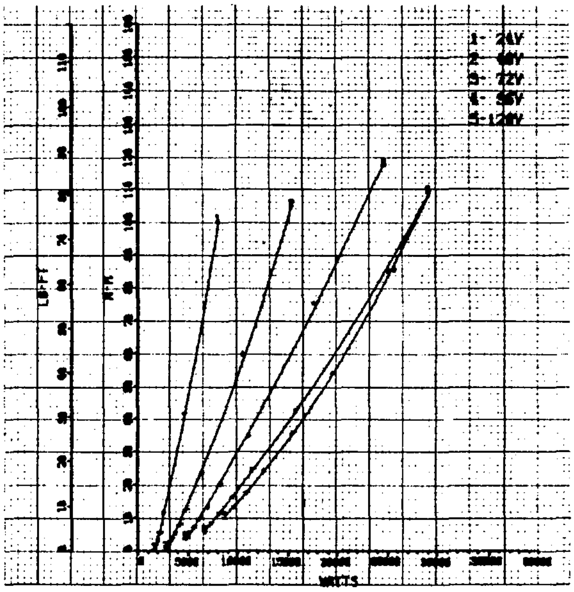

FIGURE 33. - TORQUE - POWER - VOLTAGE RELATIONSHIPS

HIGH TEMPERATURE - CHOPPED DC - 120 VOLT INPUT

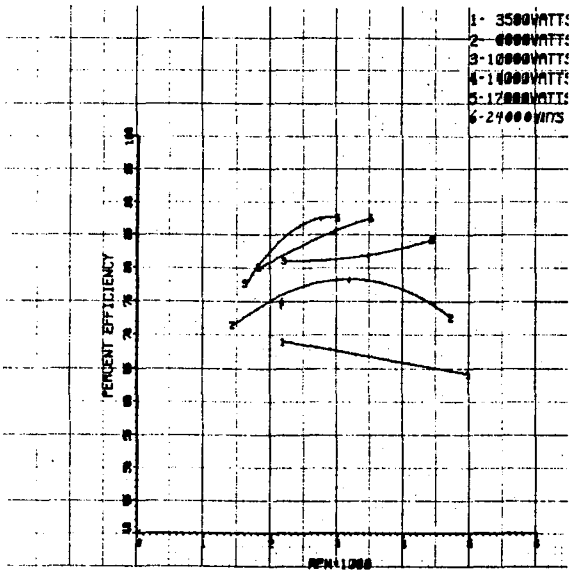

FIGURE 34. - MOTOR EFFICIENCY - SPEED - POWER RELATIONSHIPS

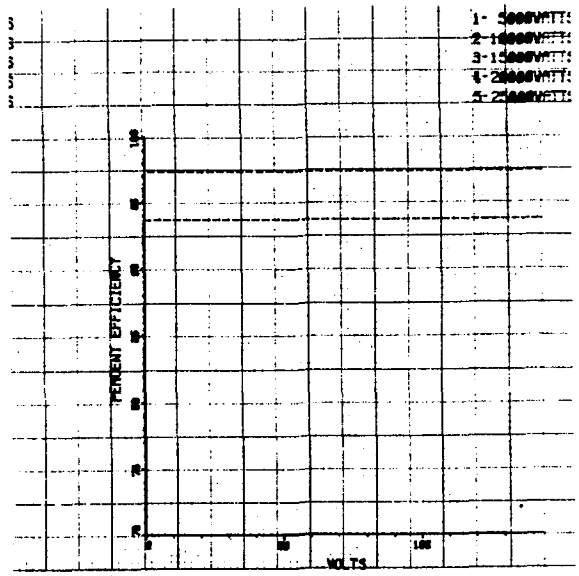

FIGURE 35. - CONTROLLER EFFICIENCY

HIGH TEMPERATURE - CHOPPED DC - 120 VOLT INPUT

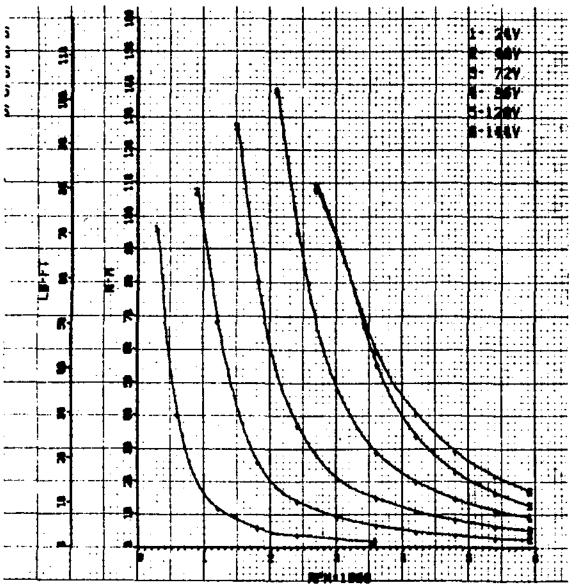

FIGURE 36. - SPEED - TORQUE CHARACTERISTICS

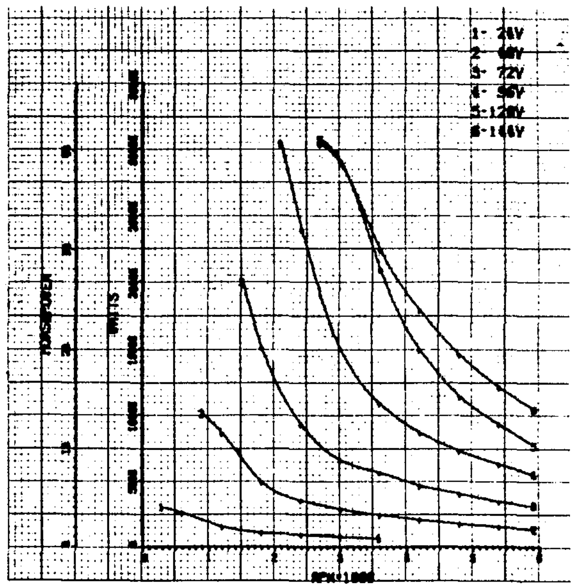

FIGURE 37. - OUTPUT POWER - SPEED CHARACTERISTICS

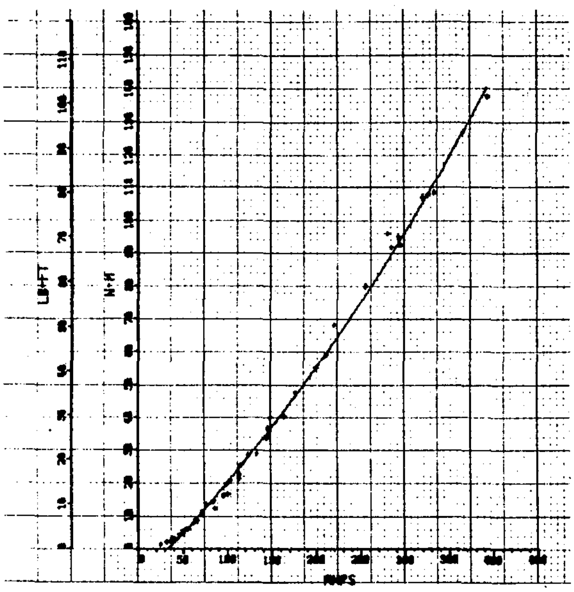

FIGURE 38. - TORQUE - CURRENT CHARACTERISTICS

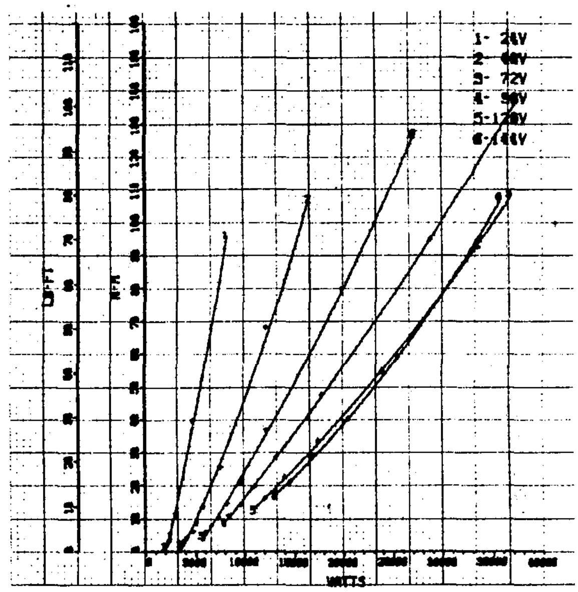

FIGURE 39. - TORQUE - POWER - VOLTAGE RELATIONSHIPS

HIGH TEMPERATURE - CHOPPED DC - 144 VOLT INPUT

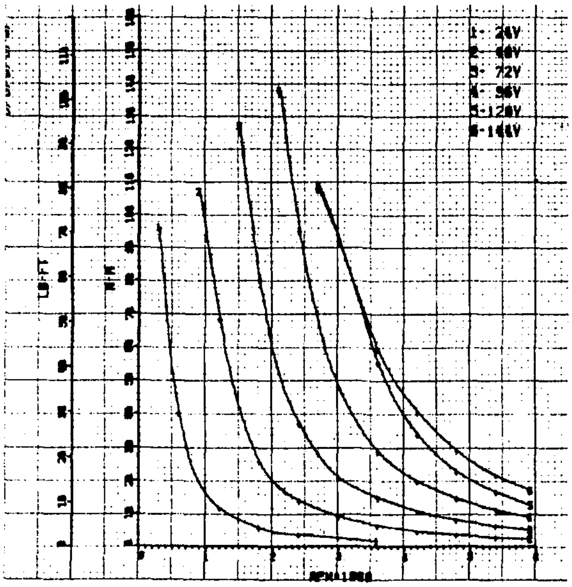

FIGURE 36. - SPEED - TORQUE CHARACTERISTICS

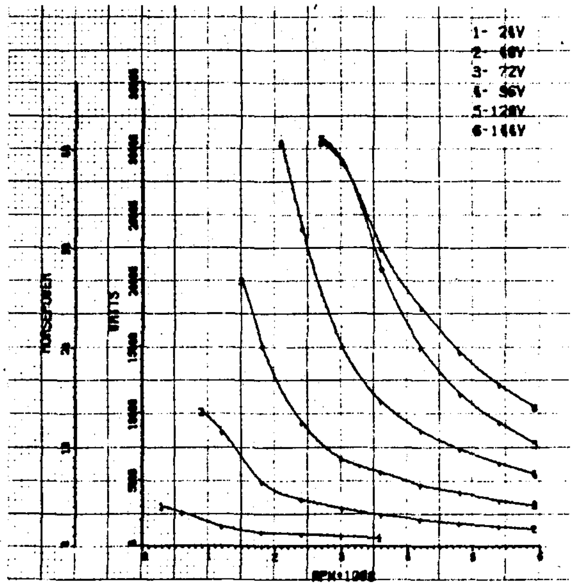

FIGURE 37. - OUTPUT POWER - SPEED CHARACTERISTICS

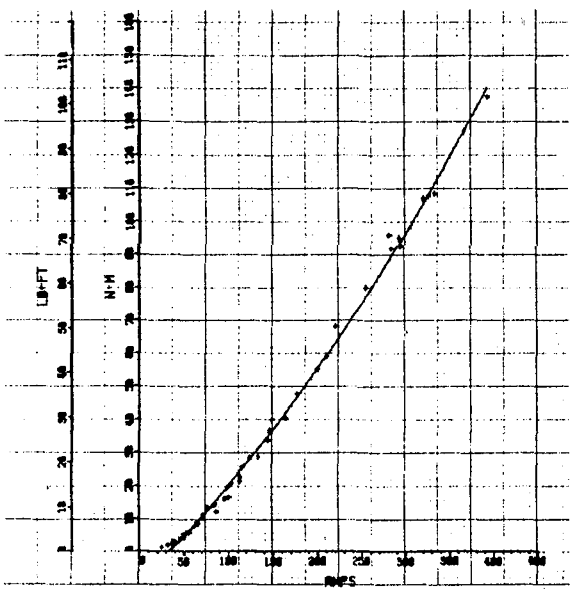

FIGURE 38. - TORQUE - CURRENT CHARACTERISTICS

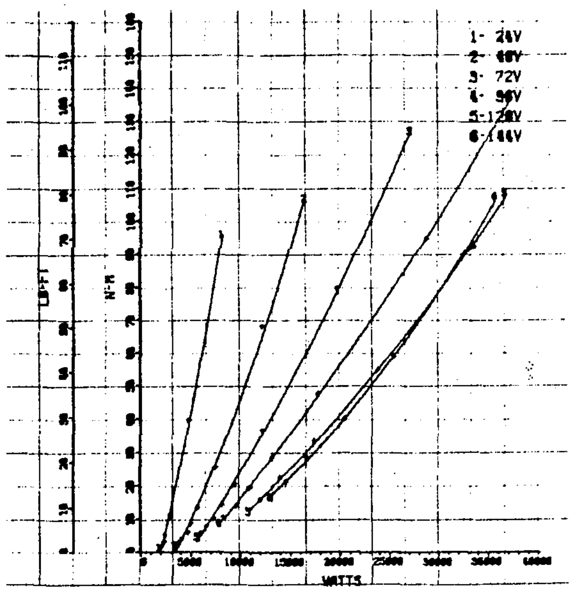

FIGURE 39. - TORQUE - POWER - VOLTAGE RELATIONSHIPS

HIGH TEMPERATURE - CHOPPED DC - 144 VOLT INPUT

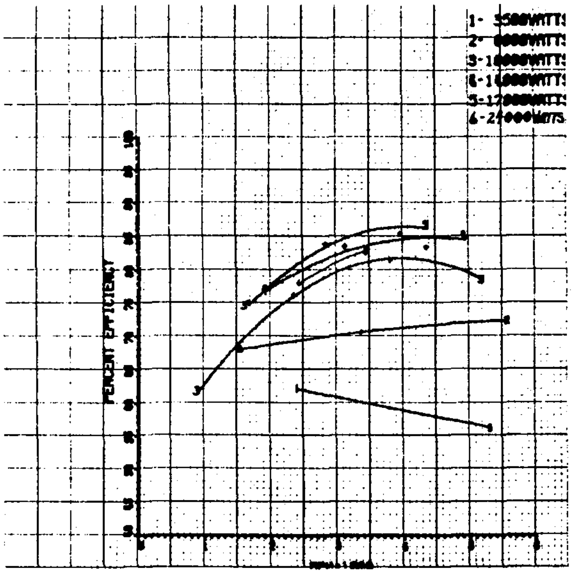

FIGURE 4Q - MOTOR EFFICIENCY - SPEED - POWER RELATIONSHIPS

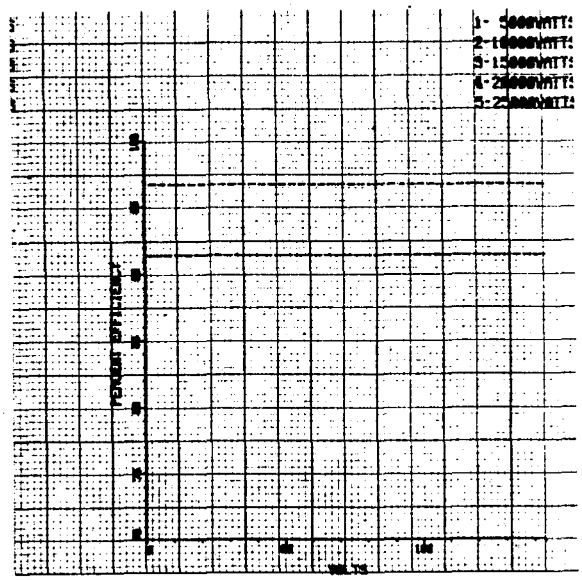

FIGURE 4L - CONTROLLER EFFICIENCY

HIGH TEMPERATURE - CHOPPED DC - 144 VOLT INPUT

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15. Supplementary Notes

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16. Abstract

Both straight and chopped DC motor performance data for a General Electric Model 5BT 2366C10 motor and an EV-1 controller is presented in tabular and graphical formats. Effects of motor temperature and operating voltage are also shown. The maximum motor efficiency is between 86% and 87%, regardless of temperature or mode of operation. Chopper efficiency can be assumed to be 95% under all operating conditions. For equal speeds, the motor operated in the chopped mode develops slightly more torque and draws more current than it does in the straight DC mode.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
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