PHONE: 212 392-4010

AEP FANS MOTORS BLOWERS

ASHLAND ELECTRIC PRODUCTS, INC.

32-02 QUEENS BOULEVARD • LONG ISLAND CITY, N. Y. 11101

Audio Engineering Society Tape Recording Seminar Oct. 6, 1971

To be assured of optimum performance of motors and transports, we firmly recommend collaboration between the Engineer designing the tape transport and the motor manufacturer. The motor can be designed in the least uncompromising manner regarding performance, if the motor Engineer has a transport available to him. We urge the approach particularly with regard to capstan motors.

Properly specifying A.C. motors to drive tape transports is easier having facts and handy formulae available.

Within the magnetic saturation limit the locked rotor torque of a motor varies as

$$\left(\frac{E_1}{E}\right)^2 \times T = T_1$$

E= Original Design Voltage
E_1= Altered Voltage Level
T = Torque At Original Design Volts
T_1 = Resultant Torque On Altered Voltage

Applying a torque motor of known characteristics to a transport, tape tension can be varied to the desired level and the motor torque immediately determined.

Is the motor safe to operate continuously at the torque and tension desired?

The temperature rise is determined by the change in winding resistance.

$$\frac{RH}{RC}\,(234.5 + T) - (234.5 + T_1) = \text{Deg Centigrade}$$

RH = Resistance after operating at least 1½ hrs

RC = Resistance stablized at ambient temperature

T = Ambient at which RC was taken, in Deg Centigrade

T_1 = Ambient at which RH was taken, in Deg Centigrade

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The allowable total temperature for continuous duty is 105^{o} (Rise plus Ambient).

Because the input power is not changed when operating at 20, 100 or zero RPM it's convenient to restrain the motor shaft, and conduct the temperature rise test.

When required to rewind at full voltage but at a slower speed the motor RPM is governed by:

$$RPM = \frac{F \times T}{1/2\ P}$$

Where F = Frequency in CPS

T = Time in seconds

P = Number of poles

The maximum number of poles in a 24 slot stator for example would be 12 for a 2 phase motor. Actually the more slots per pole the better the motor, but also more expensive. For a 3 phase motor the maximum number of poles would be 8 in the same stator.

When the poles are changed ideally another rotor lamination would provide more optimum characteristics. It is for this reason multispeed asynchronous induction motors are not common. See attached print for example.

The H.P. developed is determined by:

$$H.P. = RPM \times torque\ (oz\text{-}in) \times 10^{-6}$$

The output in watts is determined by:

$$Watts\ out = \frac{RPM \times torque\ (oz\text{-}in)}{1350}$$

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Reluctance synchronous motors are not practical in multispeed designs. The rotor is very similar to a rotor for an asynchronous machine, except that reluctance paths have either been punched in as a lamination or machined in on the assembled rotor core.

Synchronous motors of the hysteresis type are not effected by the rotor & stator slot combination because the rotor has no slots. Multipseed motors are practical.

In selecting a hysteresis motor usually reference is made to one driving a similar transport, for a starting point.

The motors must have sufficient torque to:

1. Override any torque perturbations in the transport.

2. Prevent any fly wheel from oscillating or hunting due to load or line voltage transients.

The minimum torque that can be used to provide the performance in transport is the ideal approach. When one is concerned with maintaining accurately a series of concentric parts as a motor is, any distortion due to temperature is fatal. Capstan diameters for a direct drive @ 3 3/4 I.P.S. should be held to .0001" run out and .0002" in tolerance. High temperature operation could cause the run out to change far beyond specifications. A typical direct drive capstan motor will have a temperature rise of approximately one degree centigrade per watt @ 3 3/4 I.P.S. Maintaining a low operating temperature assures long life of the bearings and insulation. Tests show 13,200 hrs at an average of 10 lb radial load without periodic lubrication. Even at 2 times the normal capstan puck pressure.

The synchronous torque of a well designed hysteresis motor will vary as the square of the input voltage change. This is true of single speed motors, but not of multispeed motors because the relative magnetic saturation of one rotor energized by two or three pole grouping for two or three speeds is completely different. In practice the rotor is designed so that the minimum cross section of cobalt is used to achieve the desired torque resulting in minimum input power.

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Obviously if 6.oz-in is required at 600 RPM, then the same rotor could not satisfy the requirements for 6.oz-in at 3600 RPM, and a compromise is sought. For this reason we suggest you request from the motor manufacturer torque test data over at least a plus or minus 10% voltage range.

Ideally we prefer to design the motor "on" the transport in our lab.

Using an indirect drive allows the use of 1800 or 3600 RPM motors even for 3 3/4 - 7½ I.P.S. decks. Due to the belt and pulley drive the motor shaft configuration is not as critical. Ten times the HP is practical for indirect drive transports should it be required, as compared to the direct drive.

Lubrication for porus bronze bearing should be applied once every 3-6 months depending on usage. We suggest SAE # 20 non detergent motor oil. Shafts operating in bronze bearings should be hardened to not less than 45 Rockwell C.

Ball bearings used are selected for minimum noise. The higher the ABEC grade of the bearing does not necessarily mean the quieter it is. This should apply to bearings in the transport as well, as the motor.

To be certain of the proper selection of motors for your transport, we suggest you solicit the advice of the motor manufacturer and collaborate on the testing of the equipment.

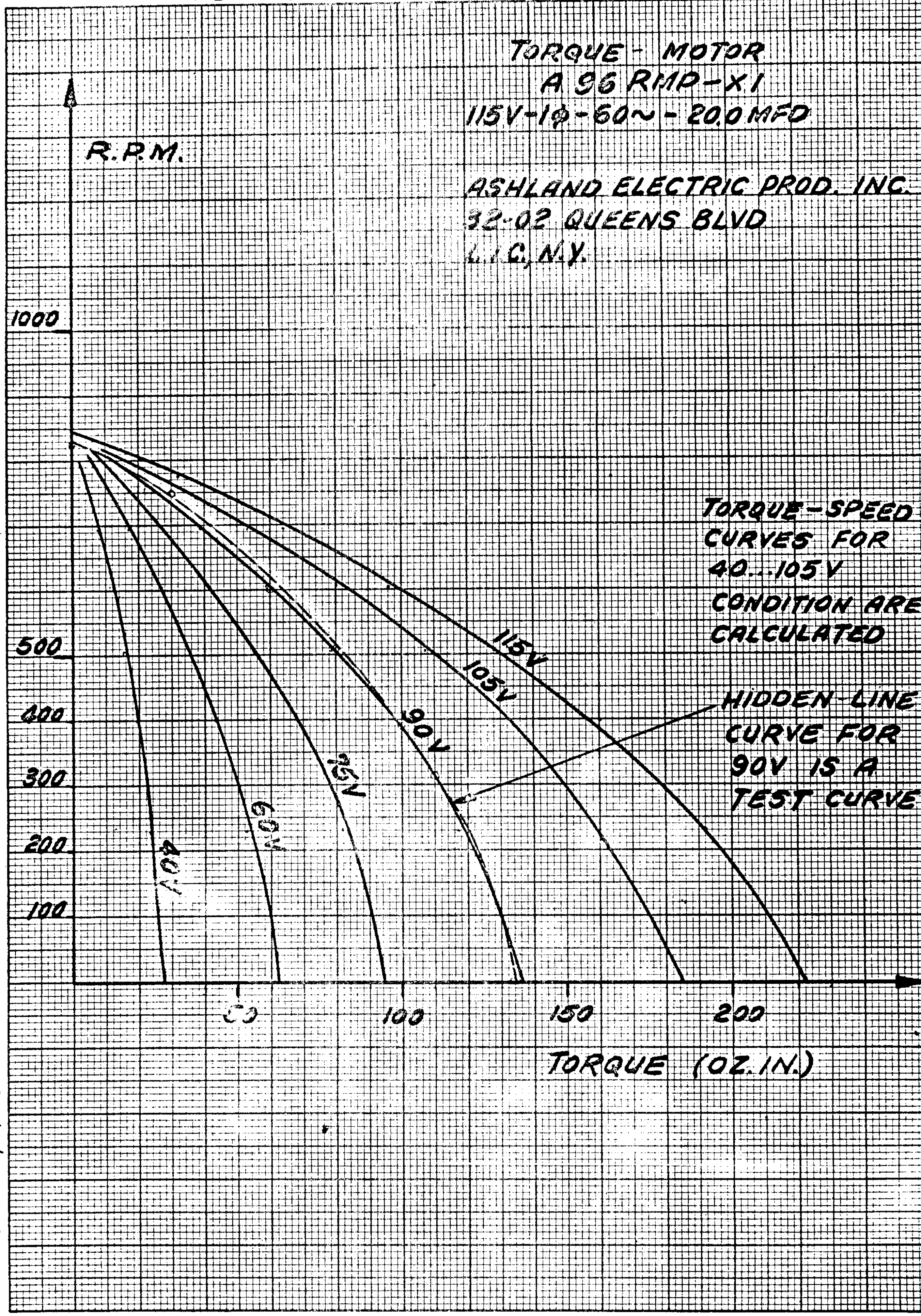
Carl Berntsen

Carl Berntsen
Chief Engineer

Enclosures:

1. EC 140: Torque/Speed VS Voltage Curves (A96RMP-X1)
2. EC 113: Torque/Speed VS Input (A70KKP-1)
3. Various Lamination Configurations.

PERFORMANCE CHARACTERISTICS



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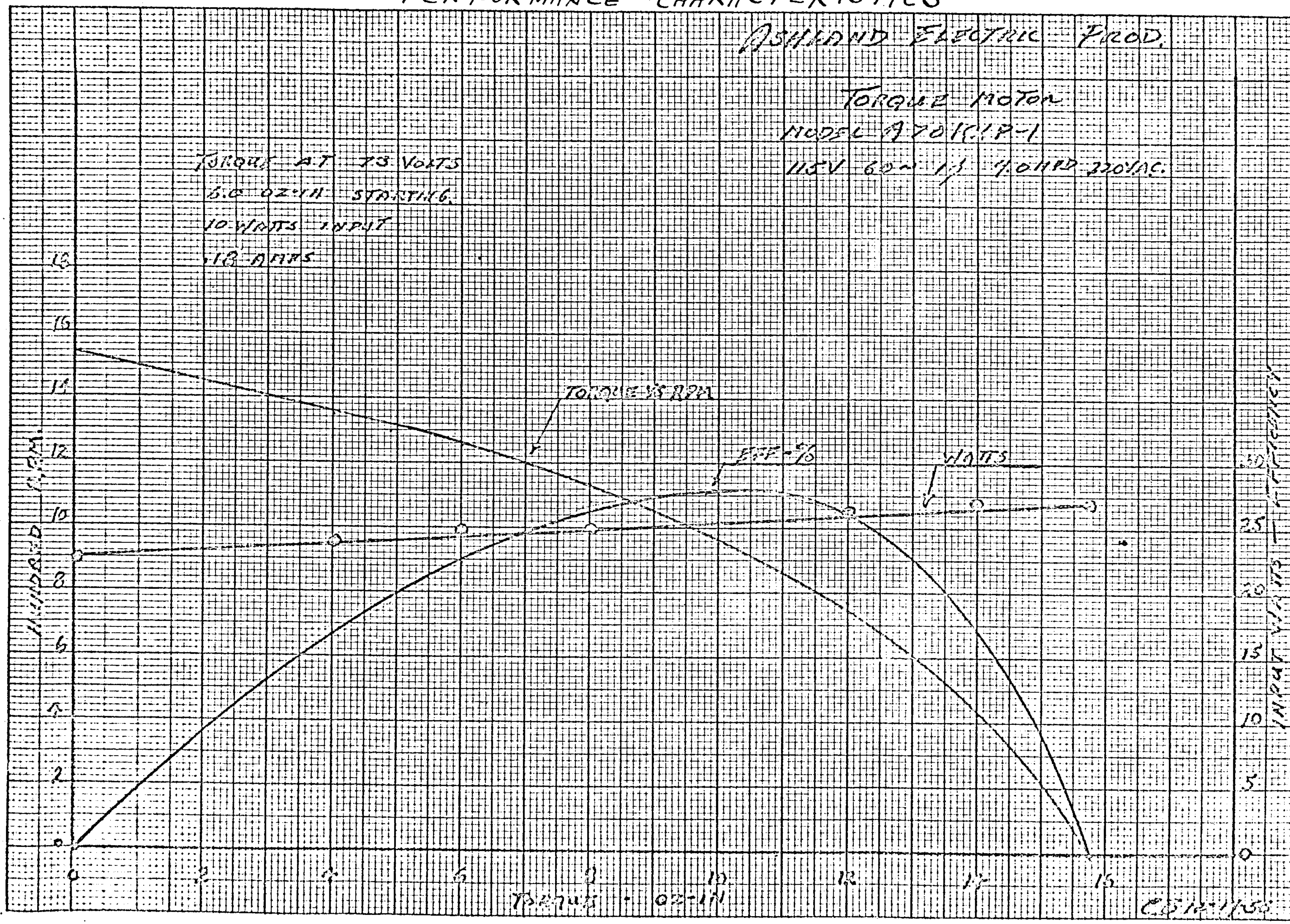
E.C. #140

E.C. #140

#EC-113

PERFORMANCE CHARACTERISTICS



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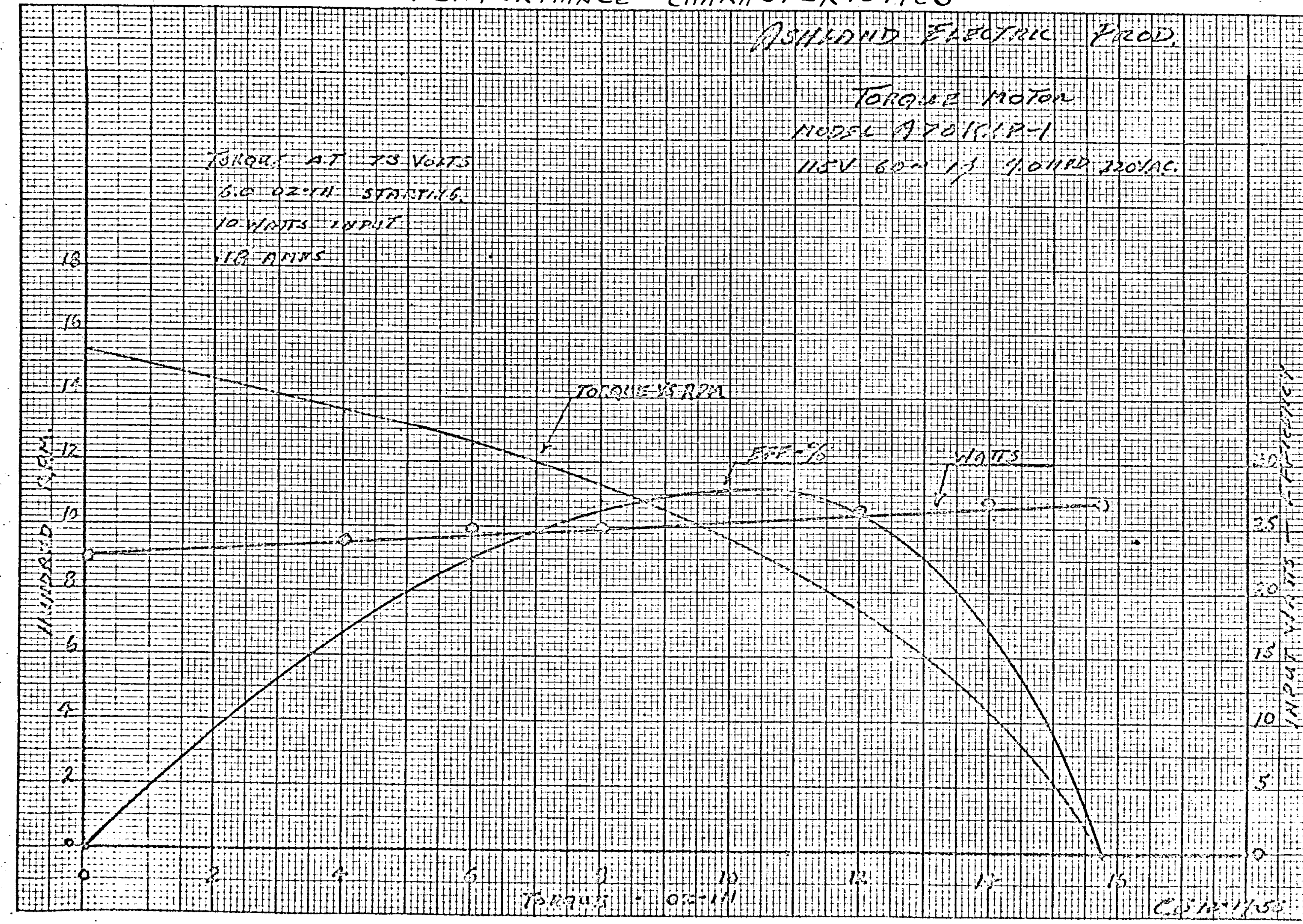

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