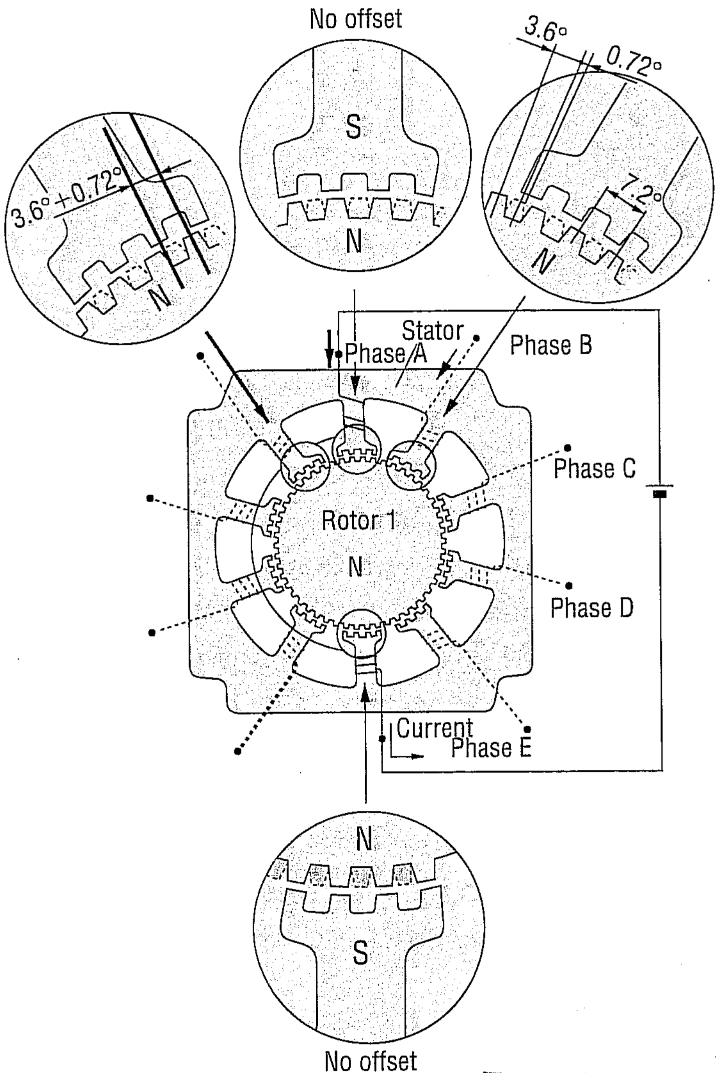
When Phase "A" Is Excited

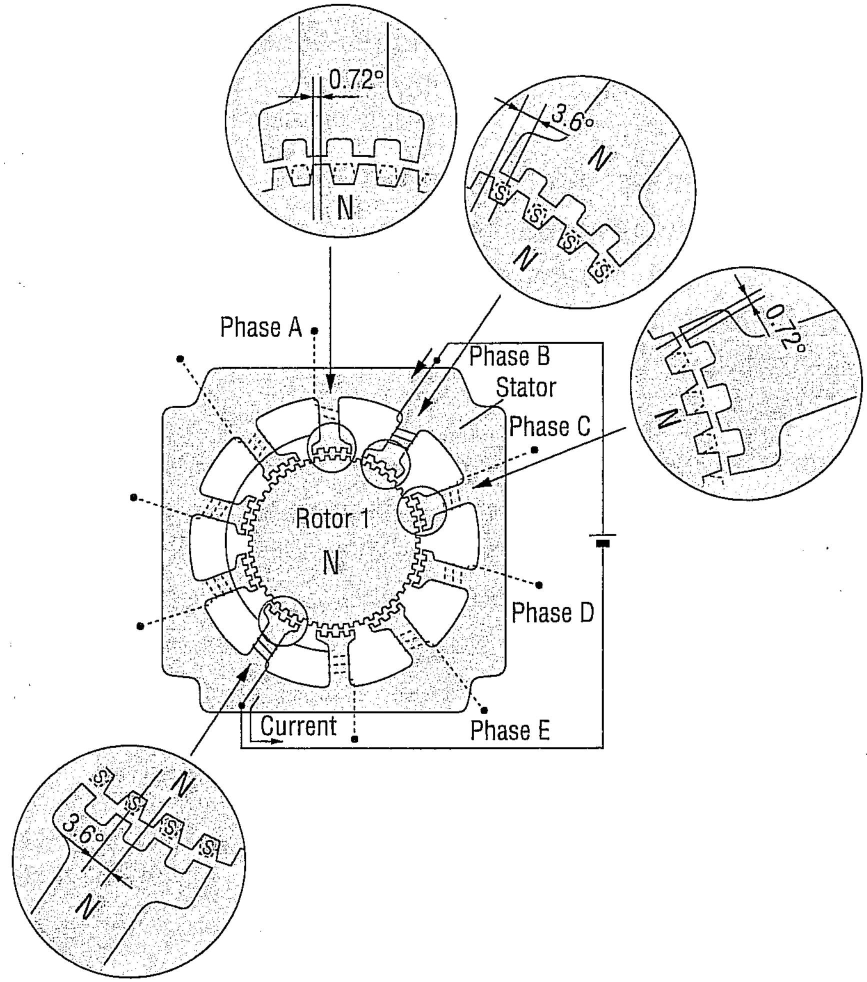
When phase A is excited, its poles are polarized south. This attracts the teeth of rotor cup 1, which are polarized north, while repelling the teeth of rotor cup 2, which are polarized south. Therefore, the forces on the entire unit in equilibrium hold the rotor stationary.

At this time, the teeth of the phase-B poles, which are not excited, are misaligned with the south-polarized teeth of rotor 2 so that they are offset 0.72°.



When Phase "B" Is Excited

When excitation switches from phase A to B, the phase B poles are polarized north, attracting the south polarity of rotor 2 and repelling the north polarity of rotor cup 1.



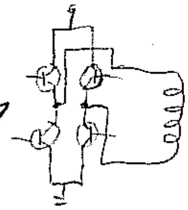
In other words, when excitation switches from phase A to B, the rotor rotates by 0.72°. As excitation shifts from phase A, to phases B, C, D and E, then back around to phase A, the stepping motor rotates precisely in 0.72° steps.

FROM ORIENTAL MOTOR GENERAL CATALOG 2003-2004

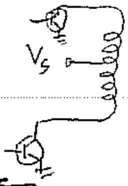
DRIVE CONSIDERATIONS

TWO TYPES BIPOLAR UNIPOLAR

BIPOLAR ⇒ NEED TO REVERSE WINDING POLARITY TO GENERATE STEP SEQUENCE

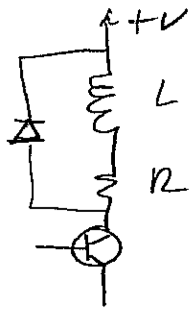


UNIPOLAR ⇒ HAS POWER SUPPLIED TO CENTER TAP OF EACH WINDING, DON'T HAVE TO REVERSE POLARITY



TO GET SAME NUMBER of TURNS per winding need SMALLER DIAMETER wire HIGHER R resistance and have less TORQUE at low speed

WINDING looks like

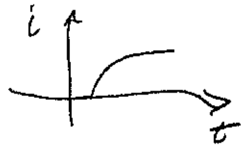


winding inductance is a KEY LIMITATION IN SPEED

$$L \frac{dI}{dT} + RI = V_S$$

$I(0^+) = 0$ close switch

$$I(t) = \frac{V_S}{R}\left[1 - e^{-t/\tau}\right]$$



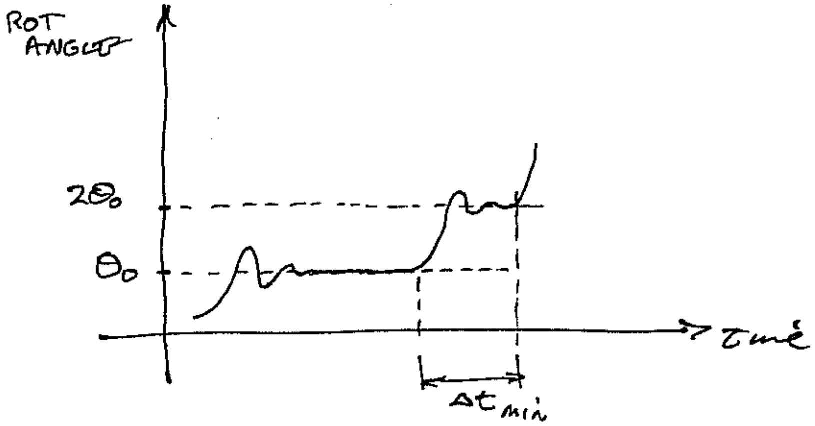
$\tau = L/R$

Reduce Time Constant by increasing R, usually a MULTIPLE of WINDING RESISTANCE [L/nR], But to get same current need nV_S !

STEPPER MOTOR DYNAMICS

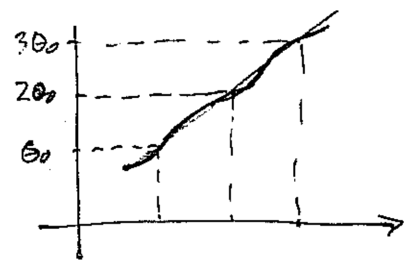
11-16-99

MOTOR DISPLACEMENT VS. TIME FOR SINGLE STEP



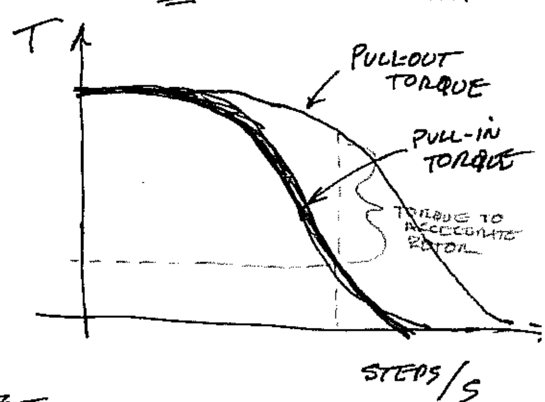
MAX STEP RATE FOR A SINGLE STEP $= \frac{1}{\Delta t_{min}}$

MOTOR DISPLACEMENT VS. TIME FOR CONTINUOUS ROTATION (SLEWING)



DYNAMIC TORQUE

MOTOR TORQUE SPEED DATA



PULL-IN TORQUE (OR "START WITHOUT ERROR TORQUE")
FOR A GIVEN STEP RATE, PIT IS THE LARGEST TORQUE THE MOTOR CAN DELIVER STARTING FROM REST WITHOUT MISSING A STEP. (NOTE INCLUDES ROTOR INERTIA FIND MAXIMUM STARTING RATE BY ENTERING CURVE WITH FRICTION TORQUE

PULL-OUT TORQUE (OR RUNNING TORQUE)
WHILE RUNNING AT
FOR A GIVEN STEP RATE (STEADY), IT IS THE MAXIMUM TORQUE THE MOTOR CAN DELIVER
(NOTE: EFFECT OF INERTIA DOES NOT COME INTO PLAY, BECAUSE WE ARE ROTATING AT CONSTANT SPEED)

NEED TO BE CAREFUL ACCELERATING MOTOR UP TO PULL-OUT T/S CURVE IN ORDER NOT TO MISS STEPS

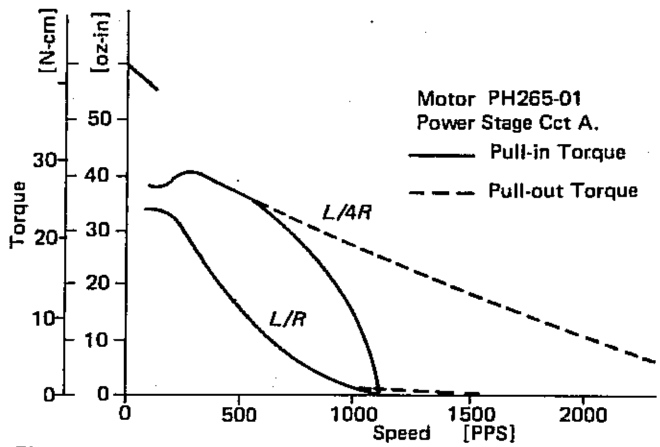


Figure 3—8 Torque-speed curves of Oriental Motor PH265-01 stepping motor

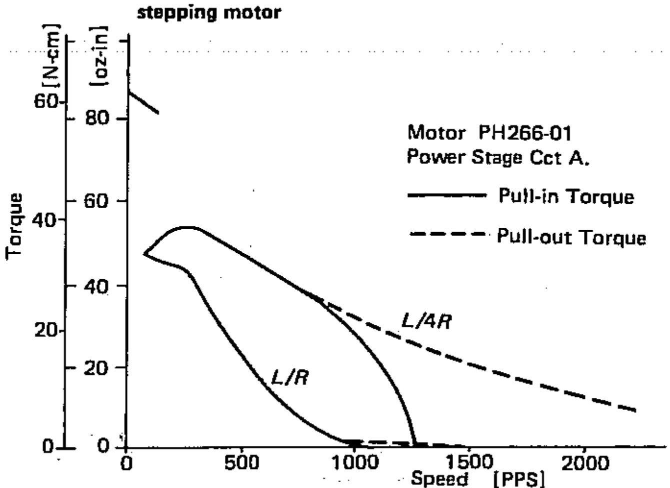


Figure 3—9 Torque-speed curves of Oriental Motor PH266-01 stepping motor

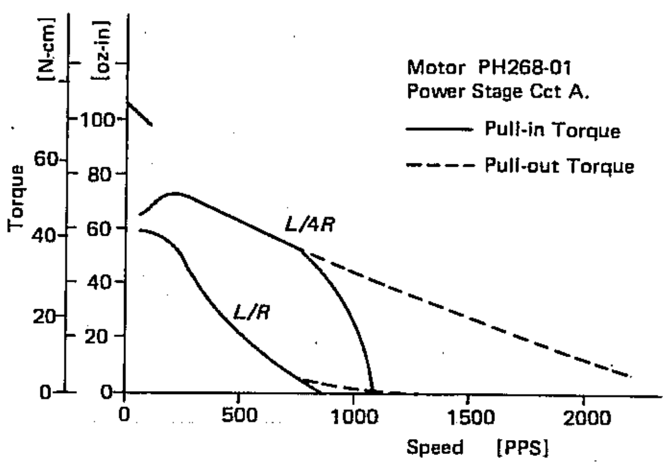


Figure 3—10 Torque-speed curves of Oriental Motor PH268-01 stepping motor

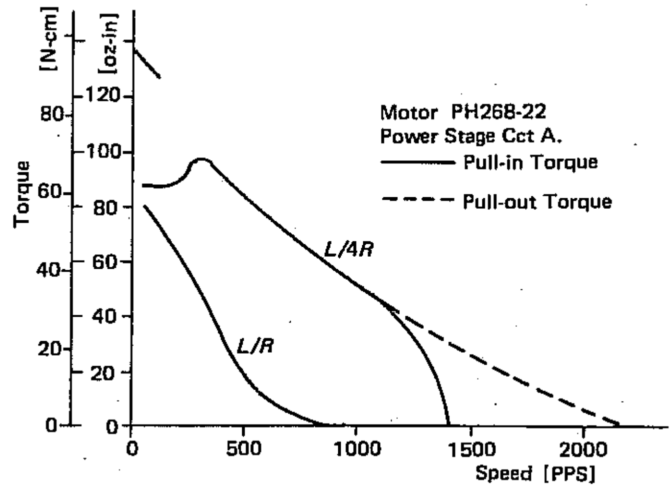


Figure 3—11 Torque-speed curves of Oriental Motor PH268-22 stepping motor

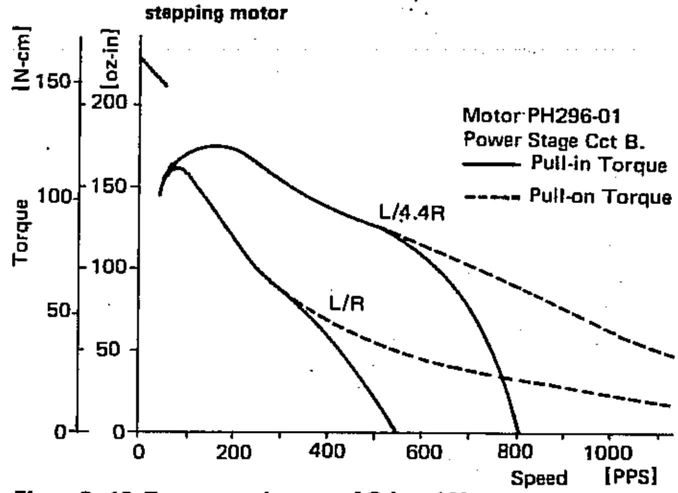


Figure 3—12 Torque-speed curves of Oriental Motor PH296-01 stepping motor

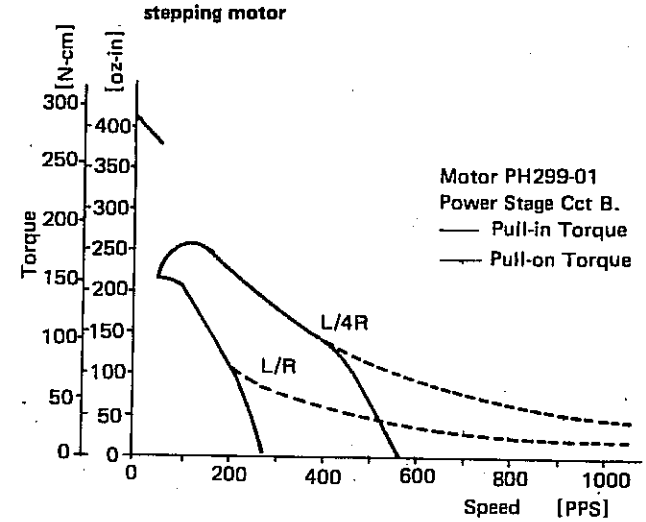


Figure 3—13 Torque-speed curves of Oriental Motor PH299-01 stepping motor