B. *Wide-range Controlling the Torque and Rotation Speed of the Torque Motor Simultaneously*

The torque speed characteristic (mechanical characteristic) of the general three-phase asynchronous motor is showing in Figure 5, nm means rotation speed with maximum torque, and it is also the boundary of the “steady part” and “unsteady part” of the motor mechanical characteristic. We can treat the nm~n0 section as steady operation part, and treat the 0~nm section as unsteady operation part. “Steady” means supposing that the motor was operating on point 1 of the “steady part”, if the motor torque is smaller than load torque when load torque MH increased to MH′ for some reason, the motor begins to slow down, but with decreasing of the rotation speed, the output torque of the motor begins to increase, the motor will operate on point 2 steadily until the torque keeping a balance with M_H' , the rotation speed is n_2 （$n_2 < n_1$）.

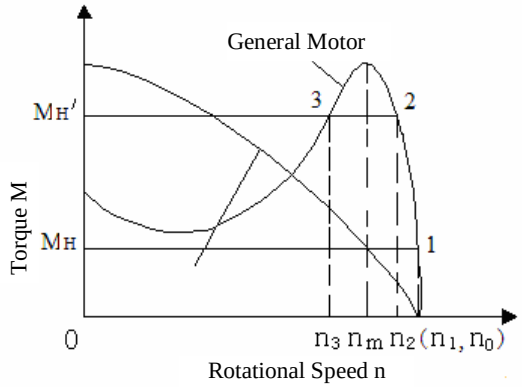

Figure 5. The Torque Speed Characteristic of the Three-phase Asynchronous Motor

Phase 0~n_m is unsteady operation area, that’s also means the crossing point 3 of mechanical characteristic and load torque in this phase are unsteady. Since the rotation speed on point 3 increases slightly which affected by some outside reasons, the torque will exceed load MH′ and increase the speed of the motor, finally it will operate with rotation speed n2 on point 2 of the steady phase. Otherwise, if the rotation speed on point 3 decreases slightly which affected by some outside reasons, the torque will be lower than load and the speed of the motor will be decreased to 0.

This proves that the speed of the motor can just change in the limited range between nm and n0, if needs to enlarge this range, we must shift the maximum torque point n0 left. Our torque motor was designed according to this principle, the maximum torque always appears near the locked-rotor, see Figure 6, the steady operation range is quite large, it can operate steadily from close synchronous speed to the near locked-rotor. So, it can satisfy the requirements of the test very well, even including the condition of working for 5 minutes under the locked-rotor situation continually with 4050N of tension, and it is an ideal supporting device for the test system.

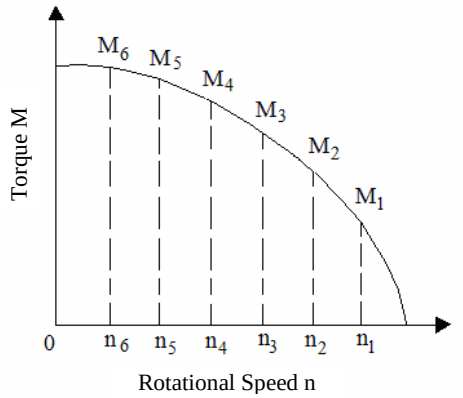

Figure 6. Torque-rotational Speed Characteristic of the Torque Motor

C. *Continuous adjustment of the Supplying Power of the Torque Motor*

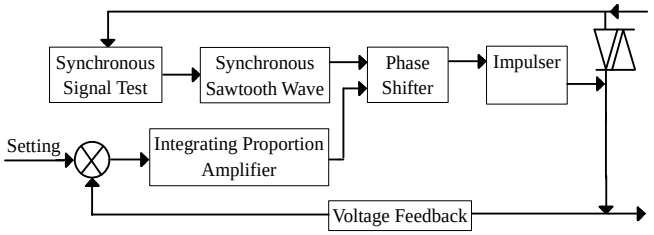

Figure 7. The Principle Diagram of Torque Motor Controller

The dedicated torque motor controller changes the conduction angle of the AC which flowing through the motor by bidirectional thyristor, and making the supplying power of the torque motor can be adjusted continuously. The controlling circuit can balance the three-phase output current automatically with tracking automatic control method through three-phase network phase synchronized control, and protect the motor voltage adjustment in operation from runaway effectively through output feedback control. At the same time, ensure the output three-phase voltage and current can be balanced automatically with three-phase voltage automatic synchronous phase-shifted control method, and making the power of torque motor becomes constant. The control principle diagram is shown in Figure 7, the voltage feedback in the diagram is real-time signals of torque and rotation speed which are acquired by torque-rotational speed sensor, and output 0~10V voltage controlled by the computer D/A, the voltage is in direct proportion to the output power of the motor. Adding this voltage to the voltage feedback port of the controller, it can realize constant-power control by the computer automatically.

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