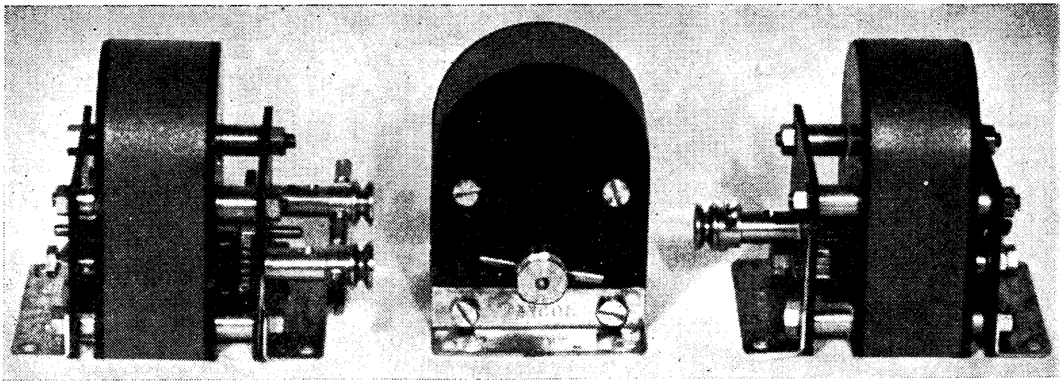


MODEL MAKER MOTOR TESTS
By R. H. WARRING & E. J. HOOK

Taycol Comet Series

THE *Taycol Comet* is a low-priced permanent magnet type motor which is produced in three forms—with straight drive, with a 4:1 reduction gear drive, and with a 4:1 reduction with twin counter-rotating shafts. In each case the motor is essentially the same unit, magnet and armature assembly being identical. All three variants were available for test and were tried with the geared motors driving the eddy-current dynamometer at low speeds, whilst spindle torque was also measured on the "plain" *Comet* and on the single-drive reduction version with gear train disconnected.

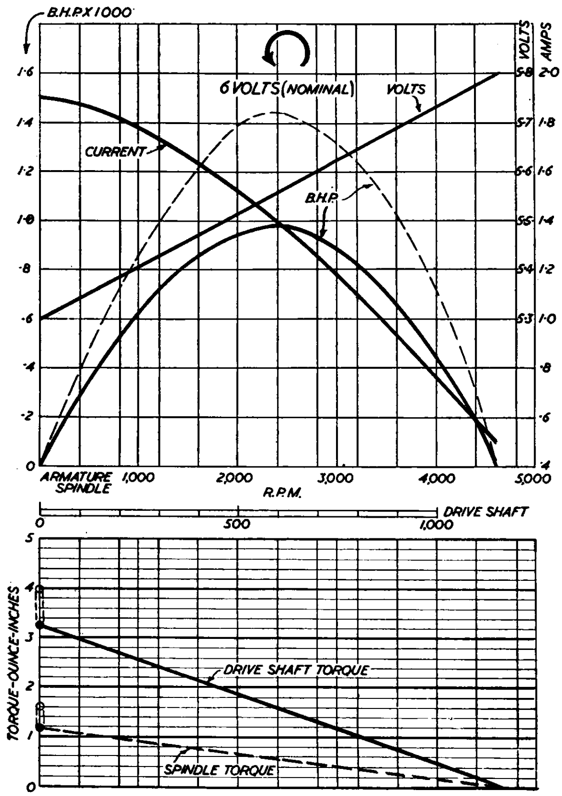
All three motors suffered, to different degrees, from poor commutation. This would appear to be due both to brush pressure bordering on, or being below, a critical value and also to the distorted magnetic field which inevitably results from the use of a horseshoe type permanent magnet without shaped pole pieces. This failing shows up as an inability to hold a constant speed, with current drawn consequently varying under the same steady load. Also, with the worst example, the speed of the motor could be changed over a very wide range by altering its attitude—e.g., turning it on its side. The single-geared *Comet* proved the most consistent of the three and it was from this motor that the majority of the test data was drawn.

The makers specify a current consumption of approximately .4 amps and a running speed of 1,200 to 1,500 r.p.m. for the drive shaft(s) on the geared version(s). Speed for the "straight" *Comet* is quoted as 4,800-6,000 r.p.m. These figures obviously refer to free running (i.e., no load on the motor) and were fairly consistent with measured results. An armature spindle speed of 5,200 r.p.m. was obtained with the "straight" *Comet*, drawing approximately .5 amps, although rather dependent on motor attitude. The single-geared *Comet* ran free at 4,600 r.p.m. spindle speed (1,150 drive shaft r.p.m.) drawing .54 amps; and the twin-geared *Comet* achieved an almost identical speed, drawing a slightly higher current.

Under increasing load (decreasing r.p.m.) the current curve is substantially linear until well down the speed scale, when heating is quite noticeable and the current falls off rather more sharply due to the increased resistance of the hot windings. Stall current is of the order of 2 amps on 6 volts nominal supply. Operating voltage is specified as 4.5 to 6 volts, the storage battery used for the tests giving rather less than 6 volts, the actual applied voltage at any particular speed being given by the voltage curve on the graph.

Torque output was also linear, the full line representing the torque as measured at drive shaft speed on the single-geared *Comet* and the dotted line a somewhat averaged curve of armature spindle torque derived from all three motors. The "straight" *Comet* was not consistent enough for this curve to be measured directly from it with good accuracy and so spot tests were also made on the geared *Comet* with gears disconnected as a check. The dotted curves must, therefore, be regarded as somewhat tentative.

Maximum B.H.P. achieved on test, through gears, was almost exactly 1/1,000th H.P. at 600 r.p.m. (drive shaft) or at roughly half-way along the speed curve. Compared with the B.H.P. curve for the "straight" drive, the



gears would therefore appear to account for a loss of power of the order of 50 per cent. The overall efficiency is quite low—which is only to be expected with a motor of this type, reaching a maximum for the single-geared version of 10 per cent. at 750 r.p.m. (drive shaft). The dotted overall efficiency curve on the graph corresponds to gears disconnected.

The "braking" effect of the gears is also shown by the mechanical efficiency curve, which achieves a maximum of about 22 per cent. at 500-600 r.p.m. (drive shaft). Both these efficiency curves are, however, quite flat, and so the motor is capable of being operated over a considerable speed range without appreciable reduction in efficiency. The electrical efficiency is good.

The middle speed range would appear about the ideal for operating the *Comet*—e.g., 2-3,000 r.p.m. armature speed—when current consumption is 1.1 to 1.5 amps. Something like one and a half ounce-inches of torque is then available from the drive shaft. Operating at a higher speed will reduce the current drawn, but substantially reduce the efficiency and the power capacity of the unit.

The gearing system employed in the single- and twin-geared *Comet* utilises 10-tooth $\frac{1}{4}$ in. diameter pinions and 20-tooth 15/32 in. gears, in brass, "paired" to give an exact 4:1 reduction between armature spindle and drive shaft. In the case of the twin-geared *Comet* an idler gear is incorporated in one of the side shaft drives to reverse the direction of rotation, the particular system in this case having nine gears in all.

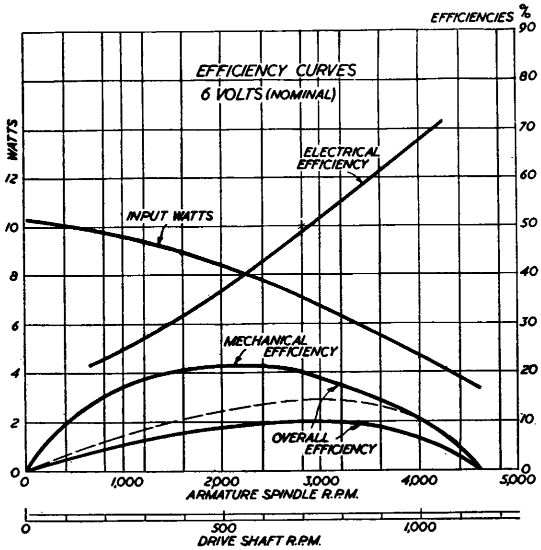
The electrical side of the motor is based around a horseshoe permanent magnet of cobalt steel with plain poles. The armature is of the conventional three-pole type, wound with enamelled copper wire connecting to a disc-type commutator with three segments, these segments being of phosphor bronze. The .095 in. diameter armature spindle is carried in holes drilled in 1/16 in. Paxolin end plates shaped to the contour of the permanent magnet and held in place by 4 BA brass studding and nuts. The brushes are carried on a separate 1/16 in. Paxolin sheet separated $\frac{1}{8}$ in. from one of the end plates by brass spacers.

The brushes themselves are stamped from phosphor bronze of generous thickness, dimpled to form the actual rubbing surface. These are set at a rather odd angle, necessitating the commutator to be similarly aligned with respect to the armature. Thus on superficial examination the motor appears to have been assembled with "lead", although this is not actually the case. Performance in either direction of rotation is similar, although on two of the motors tested there was a slight, but definite preference for anti-clockwise rotation (viewed from the driving end). This may have been due to an accidental incorporation of slight "lead", or purely coincidence. Motor reversal is obtained by reversing the battery leads.

Overhanging bearings for the gears and drive shafts are made from brass, turned down, pushed through the Paxolin plates and swaged over onto a brass washer. Such mounting is very well done and extremely rigid. The carriers for the drive shaft(s) are also drilled with oil-holes for lubrication purposes.

Regarding the question of lubrication, we were surprised to see that the makers recommend keeping "gears, bearings and commutator well lubricated". Whilst the mechanical system will undoubtedly benefit from generous oiling, we cannot see that lubricating the commutator will do anything but harm, and would probably make the motor fail to run in any case. Being of relatively open construction, too, an oil film on the commutator and brushes will attract dust and dirt, still further increasing contact resistance. Our own ideas on the subject would be to keep oil well away from this end of the motor.

Construction-wise, all the *Comet* motors are extremely robust and should give long service in this respect. Performance, too, we consider quite good for this type of design, which is probably due in no small part to the relatively large diameter armature which is employed. The addition of gears imposes a performance penalty, although we are all in favour of a reduction drive off such motors, especially for marine applications, and advantages of this nature must always be paid for. A rather simpler gear system would, however, probably have shown an advantage in this respect although the present design is no doubt dictated by a complete standardisation of parts employed throughout the range. This, we feel, has been a little bit overdone in producing the twin-geared model. As general-purpose motors for non-critical modelling applications (particularly where bulk is of relative unimportance), the *Comet* series would appear to fit the bill—and the pocket—quite well. Also, they should have an extremely long life without the necessity of " spares ". The design is of a type which is passing out of favour for miniature motor production and within its inherent limitations it is a good one. Our major criticism is with regard to the commutation, particularly as it shows inconsistencies from motor to motor.



Messrs. Taycol Ltd., the Manufacturers comment:—

We thank you for your letter of the 28th inst., and report etc. of our Comet Motor.

We regret that the samples tested suffered from defective commutation, and have taken steps to ensure that brush pressure will be consistent in future.

With regard to lubrication, as it is virtually impossible to keep oil from commutators in these small, low-priced motors, we are employing materials which we have proved work through a film of thin oil without adverse effect on contact. It is, in fact, improved. Excess oil is immediately thrown off by centrifugal force. Normally the brushes and commutators have a long life and, as you have said, a very low resistance.