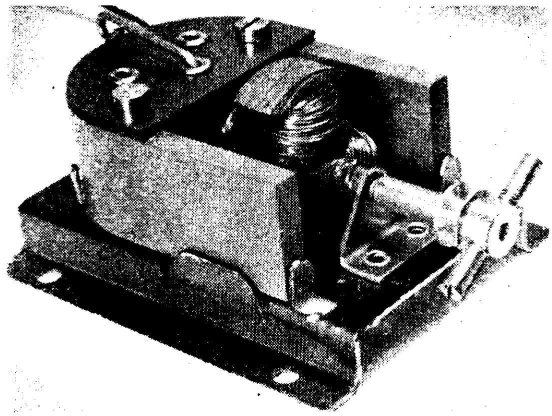
MODEL MAKER MOTOR TEST

Taycol Star



BY R. H. WARRING & E. J. HOOK

FOR what is essentially an elementary form of electric motor, drawing high current, the Taycol "Star" has a surprisingly high efficiency and is therefore no mean power producer. In many respects its main features are common with the companion "Comet" series —disc commutator, "dimpled" leaf spring brushes, alloy steel permanent magnet, etc. One particular feature is, however, unique—the combined speed control and reversing switch. By manipulation of this switch from one side to the other speed can be varied from a maximum down to dead slow, stop, then through slow to maximum speed in the opposite direction. The straight or central position is the normal "off" or stop.

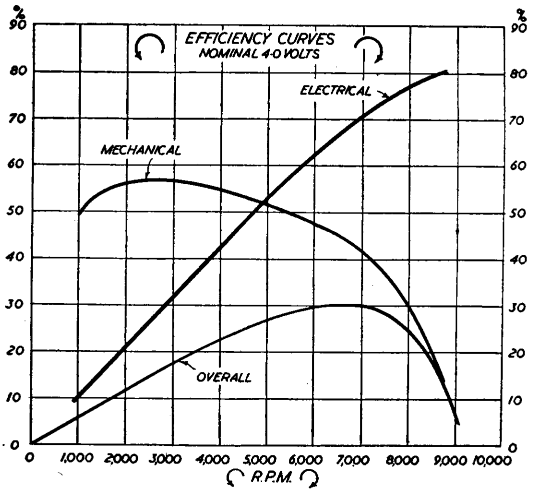
The switching device is an extremely simple gadget—just a pivoted bracket carrying two commoned brushes. Effectively, for running purposes, the motor has only one brush, the return circuit being completed through the shaft and bearing to the motor frame, i.e. one end of each armature coil is connected to a commutator segment and the other to the armature spindle—see sketch. The brush position is just above the centre of the commutator and the commutator disc is displaced, relative to the armature poles, to achieve the desired timing. With the switch arm pushed over to one side the brush on that side is made to contact the commutator disc on that same side, producing either repulsion or attraction in the one armature coil energised (depending on the polarity of the applied voltage) relative to the adjacent field pole. Thus the motor will start and run in a certain direction.

If the switch is moved back to the centre position the brush is pivoted away from the commutator, breaking the connection and thus the motor stops. Moving over to the other side the second brush now contacts the other side of the commutator disc and the respective armature coil now energised, with the same polarity as before, reacts with the *opposite* effect, so the motor starts and runs in the *opposite* direction. The "trick" really lies in the amount of displacement of the commutator segments from their respective armature coils and the operating level of the brushes.

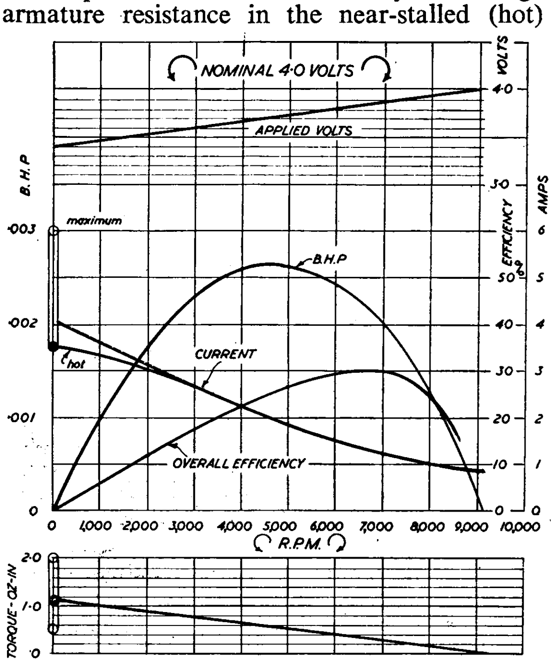
Speed control is achieved simply on the basis of varying contact pressure. With the switch full over to one side (limited by a stop), contact pressure is a maximum and brush resistance a minimum. Hence maximum current flows through the armature and speed is a maximum. Moving the switch arm back towards the central position has the effect of reducing the contact pressure and thus increasing contact resistance, so less current flows through the armature and the motor slows up. This slowing up effect is progressive until finally a position is reached where the brush actually breaks contact with the armature and so the motor is effectively switched off.

In practice, the speed control is produced both by varying brush contact resistance, as described, and the degree to which the brush will begin to bounce with decreasing pressure. The control available is quite real—from 9,000 r.p.m. running speed down to a matter of 600 r.p.m. or so—but is far from positive. Particularly at the lower speeds, the control will not hold anything like a constant setting. Frankly we would regard it as more of a novelty than a *useful* feature with the main function of the switch arm as an "on-off" and "reversing" control. But we particularly commend the delightful simplicity of the scheme.

The effective timing of the motor, as such, is symmetrical. That is, performance is identical



with either direction of rotation with a maximum speed on 4 volts of 9,100 r.p.m. (i.e. free running speed, no load). The makers actually specify that the operating voltage is 4.5 to 9 volts, but whereas our normal practice is to test at the *highest* design voltage, in this instance we adopted the lower figure in view of the extremely high current demand. The armature resistance is under 1 ohm and it is possible to get a resistance reading as low as .5 ohms in the stalled condition with the brush contacting two segments, which would mean a drain of 18 amps from a 9 volt battery! Average armature resistance in the near-stalled (hot) condition is about .9 ohms so that, very roughly, stall current will be about equal to the number of volts applied. The minimum current reading we achieved was .9 amps, free running, the speed-current curve being substantially linear. There was rather less fall off at low speeds due to heating up than might be expected from such a high current, but it was noticeable that the armature created quite a considerable draught which was undoubtedly effective as fan cooling.

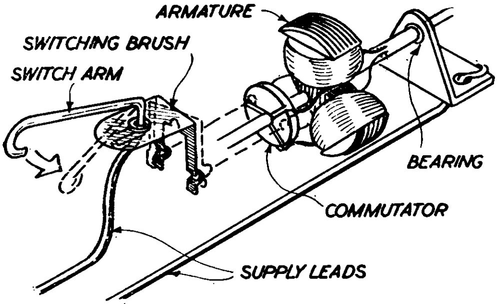


The measured torque plotted out as a straight line from the average stall torque to zero at free running speed. The resulting B.H.P. curve is symmetrical, peaking at 4,500 r.p.m. or the half-way point on the speed range, with the quite good maximum figure of .00265 B.H.P. Current consumption at this point is of the order of 2 amps and overall efficiency 25 per cent. Maximum overall efficiency is achieved at an appreciably higher speed, 7,000 r.p.m., and is 30 per cent. At maximum efficiency, current consumption is approximately 1.25 amps.

The main limiting feature of this motor is the high current demand at any speed, certainly of an order which would quickly flatten dry batteries. A lead-acid accumulator would appear to be the most practical source of supply voltage. The best operating speed would probably be between 4,500 and 7,000 r.p.m., depending on the torque demand. It would appear inadvisable to load the motor down below 4,000 r.p.m. and so for operating at lower speeds a geared drive would become essential. It must be appreciated, of course, that the normal load-speed characteristics of the motor refer to the brush switched to 'maximum speed' position and that the main effect of using the 'speed control' to adjust running speed under load is simply to promote erratic running.

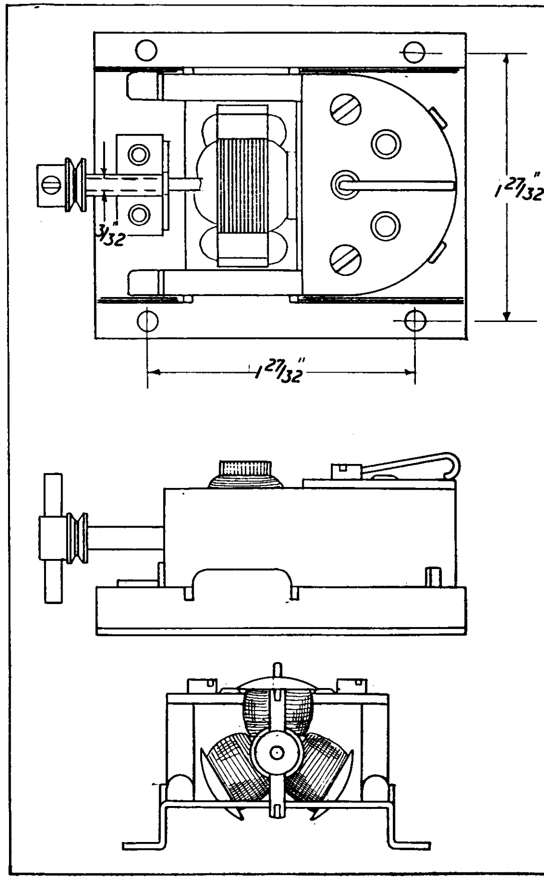
A very pleasing feature of the 'Star' was its smooth and consistent running under different load settings, with a marked absence of vibration at any speed, although the armature itself is assembled 'as made' and not balanced. Also the bearings are stout and well fitted, no doubt contributing to the good figure achieved for mechanical efficiency, although fall of the latter with speed is noticeable, due to friction and windage losses.

The horseshoe field magnet of alloy steel is comparatively weak. It is simply located on the aluminium base-plate by means of a series of turned up tabs and held down when the semi-circular Paxolin brush carrier is bolted



in place. The armature consists of only 9 laminations in a thickness of 5/16 in. together with fibre end plates and is mounted on a brass sleeve force-fitted to a steel shaft. One end of each armature coil is commoned by soldering off to this brass sleeve; the other ends to their respective commutator segments. The commutator itself consists of an insulated disc mounted on the shaft with thin copper segments held in place by bent-over tags.

The armature spindle is supported by two 18 gauge brass trunnions riveted to the baseplate. Fore and aft positioning is achieved by means of a brass sleeve piece fitted between the trunnion and standard drive coupling. The earth connection, e.g. one of the battery leads, is sandwiched between the baseplate and rear trunnion whilst the second lead is soldered directly to the pivoted brush assembly. In view of the high current drawn by this motor it is unfortunate that such thin wire has been used for these leads and, short as they are, there is undoubtedly a considerable voltage drop down them. Surprisingly enough the electrical resistance of the earth path via steel shaft to (oiled) brass trunnion appears to be very low and constant. Also brush contact resistance is low (switched full 'on'), there being only a matter of 0.1 to 0.15 ohms difference between measured (static) armature resistance and running resistance through the brush gear. In common with the other Taycol motors employing the same 'dimpled' form of brush, slight oiliness on the commutator



seems to have a beneficial, rather than an adverse, effect. One need not, therefore, hesitate to oil the bearings on the 'Star' and keep them fairly well oiled for consistent running.

Summarising: a motor which we put in the 'toy' class when we first saw it, but it made us change our minds when we tried it out. Its chief limitation is the high current drawn at any speed, which means that it automatically becomes an expensive power plant to operate off dry batteries. But apart from that it would appear to be a most useful little power plant in the lower price bracket.