The Swashplate

A Meccano Demonstration of a Novel Mechanical Movement

By H. F. Lane

Last month Mr. Lane explained the principles involved in the mechanism known as the " swashplate," and described certain of its practical uses. In the following article he deals with the Meccano demonstration model, which not only illustrates the operation of the swashplate very clearly but also forms an extremely interesting working model.

As was pointed out in last month's article, the swashplate is used extensively in hydraulic installations on shipboard. It is also put to a novel use in the transmission system of a certain make of motor car, but in this case the movement of the swashplate is transmitted by purely mechanical means instead of hydraulic power.

A device of this character holds several distinct advantages over the usual form of motor car gearbox and clutch unit, for it is simple in operation and robust in construction, and will stand up to considerably greater ill-treatment in the hands of an unskilful driver than the more familiar type. Added to these advantages is the fact that it is infinitely variable as regards the range of gear ratios obtainable. With the ordinary type of gear box only three or four fixed ratios may be obtained. On these grounds it is calculated that the swashplate transmission should appeal particularly to those motorists who experience difficulties in mastering the art of changing gear.

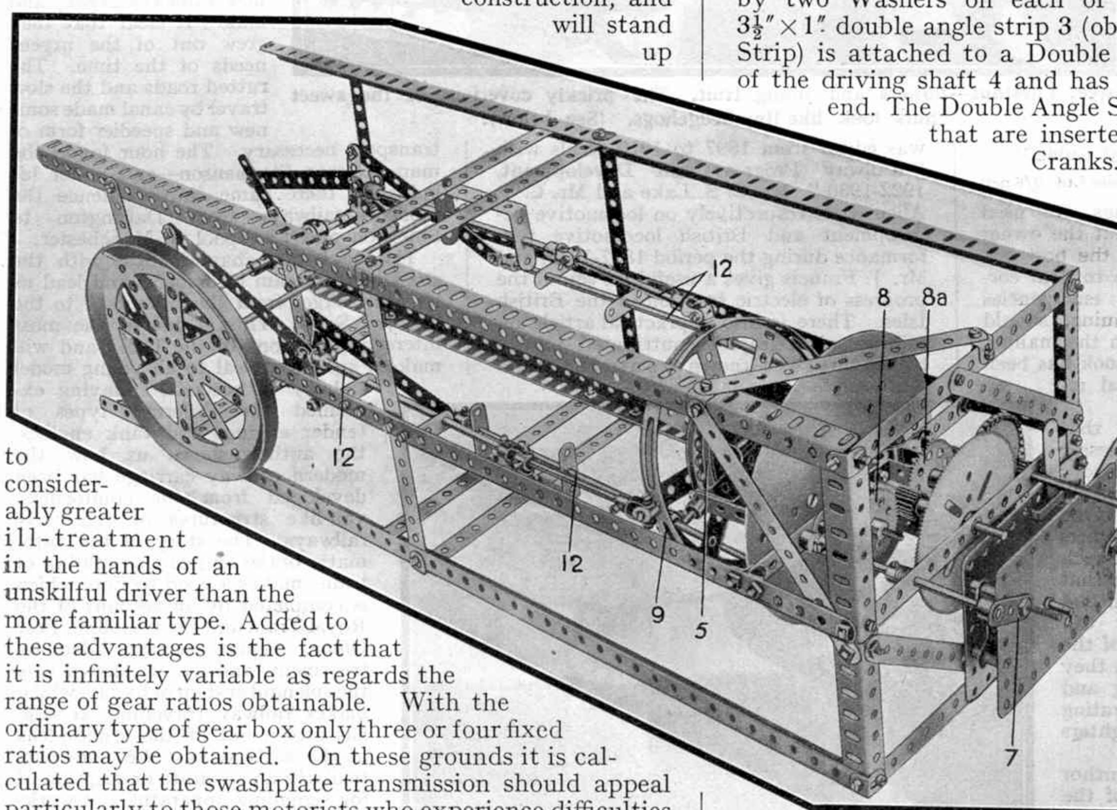

Fig. 1

The system by which the movement of the swashplate is transmitted by mechanical means, as in the experimental car gear box, is reproduced in the Meccano model described in this article. Incidentally, the model should form an interesting contrast to another novel variable-speed mechanism—the Constantinesco Torque Converter—which formed the subject of a Meccano model that appeared on page 426 of the May 1927 "*M.M.*" In the case of the torque converter the speed ratio varies automatically to suit the load, whereas in the swashplate model it is necessary to alter the tilt of the swashplate by means of a suitable lever or hand-wheel in order to vary the speed of the driven shaft.

Construction of the Meccano Model

The starting point of the construction of the model should be the containing framework and after this is completed attention may be paid to the swashplate unit. This is shown in detail in Fig. 2, from which it may be gathered that the swashplate itself comprises a 3" Pulley 1 to which a 3½"×½" Double Angle Strip 2 is bolted. The latter is spaced away from the face of the Pulley by two Washers on each of the securing bolts. A 3½"×1" double angle strip 3 (obtained by bending a 5½" Strip) is attached to a Double Arm Crank on the end of the driving shaft 4 and has a Crank bolted to each end. The Double Angle Strip 2 pivots on 1" Rods that are inserted in the bosses of the Cranks. Hence the Pulley 1 (the swashplate) rotates with the driving shaft and at the same time is free to turn about the axis formed by the 1" Rods.

A 3" Pulley 5 is mounted freely on the shaft 4 and is connected to the swashplate by a pair of 1½" Strips, which are mounted on 1" Rods that are held in Handrail Supports secured to both Pulleys. A Compression Spring, placed on the shaft 4 between the Pulley 5 and the boss of the Double Arm Crank, serves normally to retain the swashplate at right angles to the shaft. In order to take the twisting strain off the 1½" Strips when the swashplate is turning, a 1" Rod 6, attached by a Double Arm Crank to the double angle strip 3, enters one of the holes of the Pulley 5, thus allowing the latter to slide longitudinally on the shaft, and at the same time to rotate bodily with the swashplate.

A Circular Plate and a 3" Pulley are now bolted together, and the unit so formed is threaded on the shaft 4, on which it is free to rotate, its purpose being to transmit the thrust of the screw tilting gear to the Pulley 5.

The Screw Tilting Gear

The operating handle 7 (Fig. 1) is secured to a Rod that is journalled in suitable bearings in the frame and carries a $\frac{1}{2}''$ diam. $\frac{1}{2}''$ wide Pinion, which is in mesh with a 57-teeth Gear Wheel 8. The latter is in mesh with a second $\frac{1}{2}''$ diam. $\frac{1}{2}''$ wide Pinion, which is loose on the shaft 4 and also engages with a second 57-teeth Gear 8a. The Gears 8 and 8a are secured by nuts on 2″ Screwed Rods that work in the tapped bores of Strip Couplings (the slot of each Strip Coupling is passed over the edge of the transverse Strip on which it is mounted so that the tapped hole in the jaw of the Coupling coincides with one of the holes in the Strip). The inner ends of the Screwed Rods just enter the appropriate holes in the Circular Plate and are maintained in that position by two nuts locked together on each Rod about $\frac{1}{8}''$ from the end. By turning the handle 7, both Screwed Rods are advanced in their bearings by an equal amount, thus pushing the Pulley 5 along the Rod and tilting the swashplate.

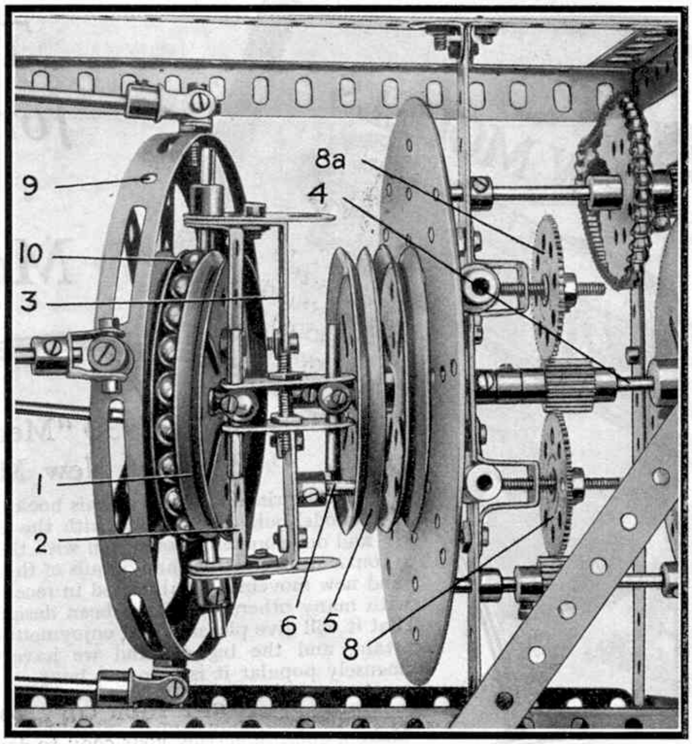

Fig. 2

The Hub Disc 9 has secured to it a 3″ Pulley 10, which forms one member of a built-up ball bearing (see Standard Mechanism No. 134), a Wheel Flange being bolted to the centre of the 3″ Pulley to form the "race" in which the Meccano Steel Balls are placed. The other portion of the bearing is formed by the back of the swashplate, the two portions being held on the Balls by a short Rod that passes through the bosses of the Pulleys and is retained by a Collar on each end.

When the shaft 4 revolves, the swashplate revolves also, but the Hub Disc 9 does not rotate but performs a sort of wobbling motion, so that a point on its circumference will move backwards and forwards in a straight line. This motion may be varied by altering the tilt of the swashplate through the medium of the handle 7, a large tilt giving a large but weak "wobble," and a small tilt (with the swashplate nearly at right-angles to its axis) a small, powerful one. This reciprocating movement is converted into rotary motion in the following manner.

Arrangement of the Final Drive

Four Swivel Bearings are attached loosely by Pivot Bolts to equidistant points on the circumference of the Hub Disc, and are connected by jointed Rods and Strips 12 to the levers 11a, 11b, 11c, 11d (Fig. 3). Each of these levers, with the exception of 11c, consists of a Boss Bell Crank, to one arm of which is bolted a 2″ Strip that is connected pivotally by lock-nutted bolts to the ends of the connecting links 12. The other arm of each Bell Crank carries a Pawl that is mounted freely on a Pivot Bolt.

The lever 11c is composed of a Crank, and the motion of one of the links is transmitted to it via the medium of the bell crank lever 13, which is secured on a Rod journalled in a Channel Bearing. The four levers are mounted freely on a Rod and the Pawls engage with Ratchet Wheels that are secured thereto. The Rod carries also a $3\frac{1}{2}''$ Gear Wheel that is in mesh with a $\frac{1}{2}''$ Pinion on the final driven shaft, to which is attached the 6″ Pulley forming the flywheel.

It will be seen that the driven shaft is rotated by means of a series of impulses received through the Pawl and Ratchet mechanisms, which receive their motion in turn from the wobble of the swashplate. A large tilt of the latter will impart a high speed to the driven shaft, while a small degree of tilt will result in the shaft rotating at a considerably slower rate with a correspondingly greater increase in power. Owing to the manner in which the swashplate is tilted, the degree of variation is infinite between the limits of maximum and minimum angles of tilt. When the swashplate is exactly at right angles to the shaft 4, no movement is imparted to the driven shaft.

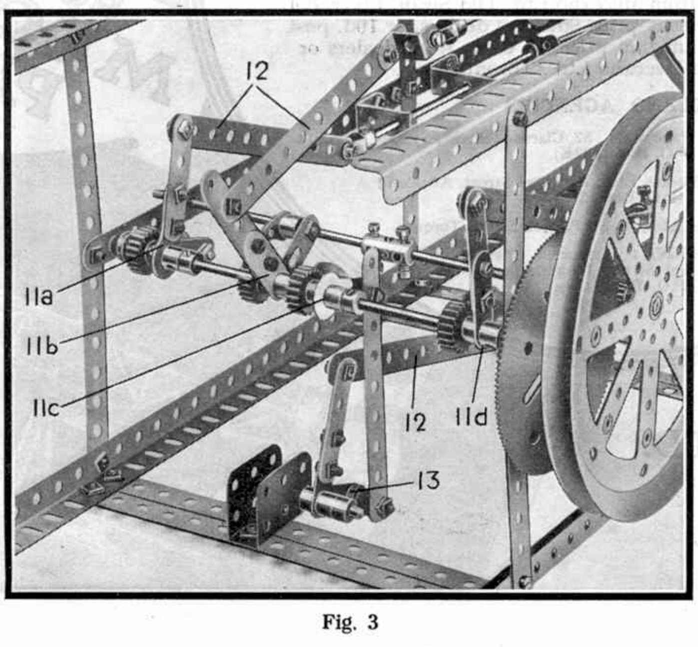

Fig. 3

The drive from the Clockwork Motor to the shaft 4 is conveyed by a Sprocket Chain drive to a Rod on which is a $\frac{1}{2}''$ Pinion that is in mesh with the $3\frac{1}{2}''$ Gear Wheel on the shaft 4.

The effectiveness of the device may be illustrated by setting the swashplate at the maximum angle and starting the Clockwork Motor. The Motor soon commences to slow down and eventually stops, but on diminishing the angle of the swashplate it recommences to work. This shows that, although the Motor may be too weak to drive the model with the swashplate at its maximum angle, it can be made to do so by diminishing the angle.