A Meccano Rotoscope

Rapidly Moving Objects Made to Appear Still

UNTIL recently one of the many difficulties with which engineers were confronted was their limited knowledge concerning the peculiarities of high-speed machinery in motion. Some method of examining rapidly-moving objects was necessary in order to increase the reliability and safety of engines and machinery, particularly in the case of petrol engines and textile machines. It was not until the introduction of the Ashdown Rotoscope in 1926 that this difficulty was overcome.

The principle on which the Rotoscope operates will be understood best by carrying out a simple experiment. Look at a clock pendulum, but only open your eyes once for every second tick given by the clock. The pendulum will then appear to remain in the same position all the time. From this it will be seen that, if a wheel is rotated at high speed and a momentary glimpse of it is obtained once for every revolution it makes, the wheel will appear to remain stationary. By regulating the frequency of the glimpses the wheel may be made to appear to rotate slowly, so that any irregularities in its movement are readily seen.

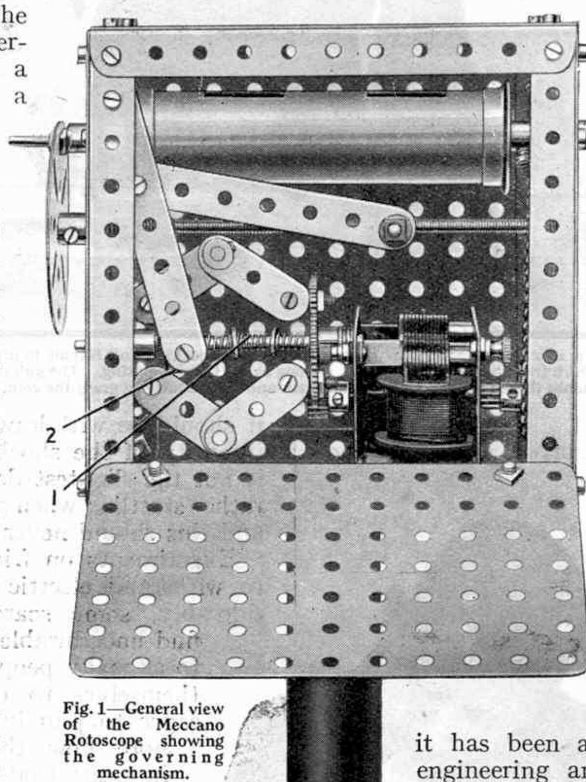


Fig. 1—General view of the Meccano Rotoscope showing the governing mechanism.

The first successful attempt to examine moving objects in this manner was made by Ferdinand Plateau in the early part of the 19th century. Plateau discovered that, by looking through a revolving disc having a number of slots, it was possible to make turning or vibrating movements appear stationary. He named his instrument the stroboscope, a term that is still applied to this form of instrument. Many subsequent forms of stroboscope were devised by different inventors, but it was not until the introduction of the Rotoscope by Mr. A. J. Ashdown that the method of observation became of more than scientific interest and was applied to practical mechanics.

The Ashdown Rotoscope is a remarkably compact instrument, easily portable, and capable of being used as an extremely accurate measuring machine. It consists of a box 5½ in. by 7 in. by 6 in., inside which is carried the clockwork mechanism for driving the shutter. The springs, of which there are two, and the governor, are similar to those employed in a gramophone, and a five-speed gear box is incorporated between the governor and the shutter. By careful adjustment a range of speeds between 500 and 20,000 r.p.m. may be obtained with a normal shutter, and by fitting special shutters a still wider range of from 50 to 250,000 r.p.m. is possible.

The shutter, which is of the rotary type, is a metal cylinder 4½ in. in length and 1 in. in diameter, pierced by two slots through which the observer looks. There are four different types of shutter available, known as "bladed," "heteroptic," "displaced," and "hybrid" respectively. The bladed shutter is fitted with a number of thin steel strips, and enables a very short period of vision to be obtained. It has the disadvantage of reducing the amount of light passing through the slot, however, and in order to overcome this defect the heteroptic shutter was introduced. This consists of two cylinders, one revolving inside the other. The slots in this case are not bladed, but rely for their quick opening and closing action on the two sets of slots working in opposite directions.

In the displaced type of shutter the two slots are set at an angle of 90 deg. to each other, the slots being bladed as in the normal type. With this shutter objects may be successfully examined that have twice the speed of those with which the bladed shutter can be used. The hybrid shutter is a combination of the bladed and heteroptic types, and is used for giving high-speed vision with the greatest possible definition.

The sphere of utility of the Rotoscope is enormous, and it has been applied to almost every branch of engineering and research where moving objects play a part. The examination of gas jets and their flames, the effect of pressure-fed oil on chains, the study of chains and gears under varying loads, and the inspection of gramophones, printing machines and automatic telephones, are among the duties of this remarkable instrument.

The Meccano model Rotoscope is, externally, a close replica of the instrument already described, but an E1 Electric Motor is used in place of clockwork mechanism because of its simplicity and its high speed. Speed control is effected in a similar manner to that employed in the original.

The case is constructed by first building a framework of 5½" and 3½" Angle Girders as shown in Fig. 1, two 5½" Angle Girders being fitted for an eyepiece, as illustrated in Fig. 2. The front and side 5½"×3½" Flat Plates are now fitted, the front plate being bolted in place immediately below the eyepiece. The back of the case is composed of a 5½"×3½" Flat Plate. This is attached to the model by means of two Hinges, and in this manner the motor and controls of the shutter are always easily accessible. A small catch, consisting of a Flat Bracket mounted on a lock-nutted Bolt, may be fitted if desired to one of the corner $5\frac{1}{2}''$ Angle Girders, in order to prevent the inspection cover from falling open.

The top and bottom of the case consist of $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flat Plates, the bottom Plate being fitted at its centre with a Bush Wheel. This Bush Wheel carries a 5" Rod in its boss on which is mounted a Wood Roller serving as a handle. A piece of rubber tubing slipped over this handle will add greatly to its appearance, and will also give the operator greater comfort and grip, points of considerable importance if long studies are to be made with it.

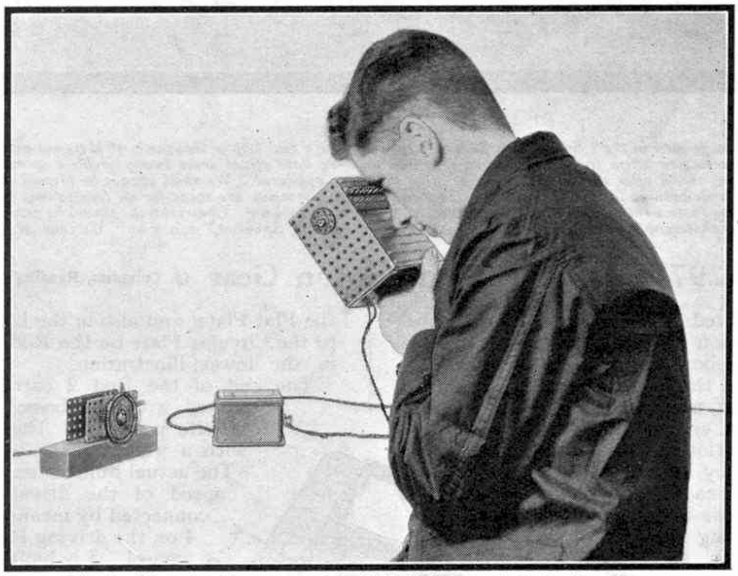
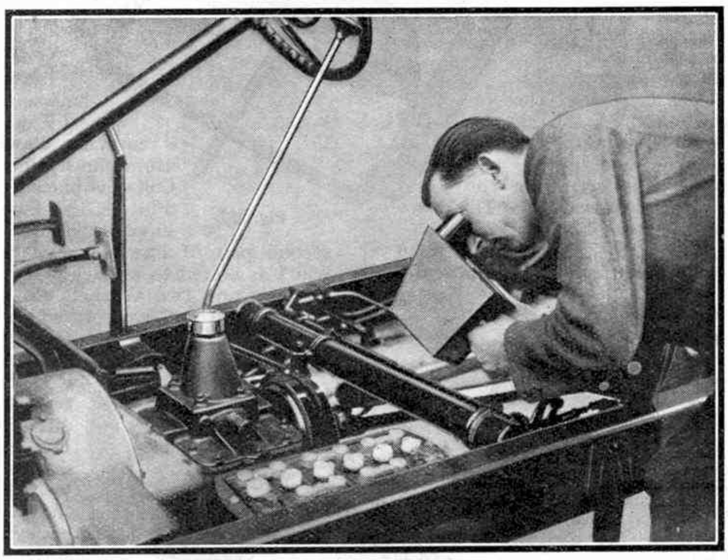


Fig. 2. How the Meccano model of the Rotoscope is held when in use.

The motive unit, which consists of an E1 Electric Motor, is bolted to the Flat Plate forming the base of the model. A $\frac{3}{4}''$ Sprocket Wheel is carried on one end of the armature shaft, the other end being fitted with a $\frac{1}{2}''$ Pinion. A $3\frac{1}{2}''$ Rod is journalled in a top hole of one of the motor side plates, and also in a hole in one of the Flat Plates forming the side of the case. This Rod carries a 57-teeth Gear that is spaced away from the motor side plate by means of four Washers. Two Handrail Supports are secured to this Gear in opposite holes, and they must be so arranged as to allow their plain holes to point towards the centre of the Gear.



The actual Rotoscope in use for the examination of motor car gear boxes.

Four Compression Springs and three Washers are now placed alternately on the Rod 1, the Washers being necessary in order to prevent the Springs from entwining. A Face Plate follows the Springs on to the Rod, and this is fitted with two Handrail Supports in a similar manner to those on the 57-teeth Gear Wheel. The Face Plate must be allowed to rotate freely on the Rod, and a Collar is placed between it and the side of the case.

The governor is now fitted, and this consists of eight $1\frac{1}{2}''$ Strips loosely attached to the Handrail Supports already mentioned. The connections are made by small screws taken from Universal Couplings, although Grub Screws will be suitable if others are not available. If Grub Screws are used, 1" Rods must be passed through the plain holes of the Handrail Supports in order to prevent the Strips from being gripped too firmly. The Strips are loosely connected together by 1" Rods and Collars at their end holes, Collars being placed between each set of Strips for spacing purposes.

When the Motor is run the Strips will fly outward, their movements being controlled by a $\frac{1}{2}'' \times \frac{1}{2}''$ Angle Bracket 2 attached to a $3\frac{1}{2}''$ Strip. This Strip is lock-nutted to the model at its upper end, and to a second $3\frac{1}{2}''$ Strip at its third hole from the top. The loose end of this Strip is pivotally attached to a Handrail Support carried on a 6" Threaded Rod. This is held in position by a Collar on the inner face of the side plate and by a Face Plate on the outer face, the latter also serving as a control handle, a Threaded Pin being fitted in one of its outer holes for the purpose.

The shutter now occupies our attention, and this is the most difficult part of the model. A piece of thin sheet iron or stiff cardboard is required, $4\frac{1}{4}'' \times 3\frac{5}{8}''$. Four slots, each $1'' \times \frac{3}{16}''$, are cut lengthways in the metal or cardboard, and so arranged that they are exactly opposite when the cylinder is formed. When these slots are cut the material is carefully bent to shape and a $1\frac{1}{8}''$ Flanged Wheel is passed over each end. These Wheels will be found to be a tight fit if the material has been measured correctly. The seam in the cylinder is now jointed by means of glue or solder according to the material used.

The complete shutter is carried on a $6\frac{1}{2}''$ Rod, journalled in the side plates of the model, on one side of which is mounted a $\frac{3}{4}''$ Sprocket Wheel. The drive from the Sprocket on the armature shaft is conveyed to this by a short length of Sprocket Chain. If required, the bearings carrying the shutter rod may be reinforced by the use of Bush Wheels.

When the model is completed all the bearings should be well oiled with fairly thin lubricating oil, and then be allowed to "run in." Better results will then be obtained owing to greater steadiness in the working parts.

The method of using the Meccano Rotoscope is shown clearly in Fig. 2. In order to carry out observations the motor should be first allowed to revolve at maximum speed, and then the control handle should be turned slowly in the retarding direction. In this manner the instrument is readily "tuned in" to the required frequency with the least possible variation in the speed of the shutter and motor.