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A Simple, Inexpensive, Continuously-Variable Infusion Pump.* (23049)

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The instrument to be described was developed to fill the need for an infusion pump with which rate of delivery could be continuously varied over a wide range during injection. The present pump has met this need and has been employed for 9 months in experiments on small animals in which rate of injection has been critical.

Details of construction and mode of operation of this pump will be apparent from Fig. 1 and 2. The motor (Bodine Electric Co., Chicago, 1/50 H.P., 1725 rpm, with gear reduction to 11.5 rpm) turns the first drive cone (A). The 4 identical drive cones are knurled cast aluminum. The conical portion is 4" long and the large and small diameters are 3" and .95" respectively. Cone A drives cone B by means of rubber ring (¼" by 18" circumference) which provides contact between the 2 cones. The point of contact of the ring with the cones is adjustable by means of yoke K, rod L and setscrew M (Fig. 1). It can be seen that when the largest portion of cone A is driving B, B rotates 3.16 times as rapidly as A; conversely, when the smallest portion of A is driving B, A rotates at 3.16 times the speed of B. Thus, a 10-fold range of speed is achieved by the first pair of cones. Cone C is coupled to B and both turn at the same speed. Cone D, however, is driven by C through a mechanism identical to that linking cones A and B. Range of speed for the 2 pairs of drive cones is therefore 100-fold. To prevent slippage of the cones on the rubber rings it is necessary to have considerable tension on the 2 pairs of drive cones. This is achieved by means of the tension frame (N to P) which is clearly shown in Fig. 2. This frame carries cones B and C on supports N and N′ and holds them under tension against cones A and D by means of the 2 springs on rod O. The springs are turned in opposite directions, and tension on them can be varied by means of nut and setscrew P.

Cone D turns the threaded ½" shaft F through the sprocket and chain drive E (Fig. 1). The syringe plunger is driven by rider G which is carried along as shaft F turns. This rider is made of two brass bars ½" x 1" x 4" which are clamped together and drilled and threaded to receive shaft F. The 2 halves of the rider are then hinged at one end and closed with a pivoted pin at the other end so that they can be opened and moved on F. Also on this rider is bar I which can be set to contact switch J and stop the pump at any desired position. The syringe is held in place by the lucite block H. Two cylindrical lucite plugs attached to the holder project through holes in the pump mounting plate. The holder is removed by lifting vertically. It is convenient to make several holders with identical mounting plugs to accommodate several syringe sizes. About 10 seconds are required to remove the syringe, refill

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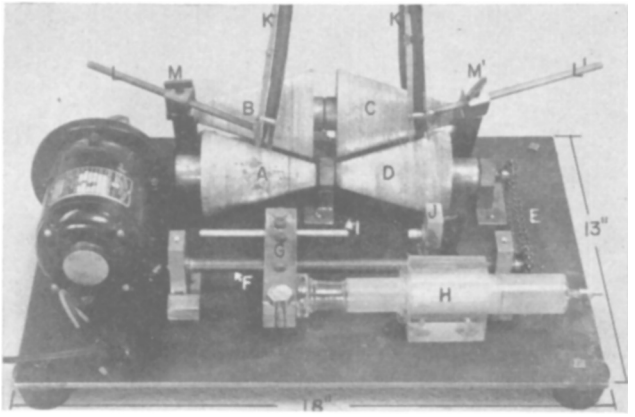

FIG. 1. Front view of infusion pump.

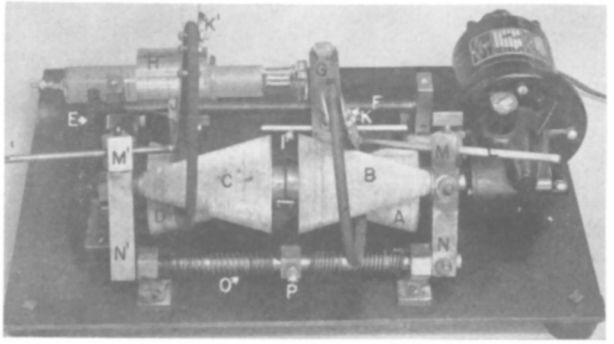

FIG. 2. Rear view of infusion pump.

it and begin the infusion again. The syringe drive can be easily modified to handle multiple syringes simultaneously.

Several factors influence the rate of delivery from the syringe: 1) speed of the gear drive from the motor; 2) relative sizes of the cones; 3) relative sizes of the sprockets in assembly E; 4) pitch of the threads on shaft F; and 5) volume delivered per unit of barrel length of the syringe. The present instrument has a motor drive speed of 11.5 rpm, 10-fold reduction or acceleration in the cone drives (100-fold total variation), 2-fold fixed reduction in the sprocket assembly, and 16 threads per inch on shaft F. Rate of delivery is therefore 0.50 to 50 ml per minute with a standard 50 ml syringe and 0.15 to 15 ml per minute with a 10 ml syringe. Rate of delivery for a given syringe can easily be calibrated by marks on rods L and L'. Constancy and reproducibility of infusion rate was checked by timing over 6 runs the delivery of 10 ml (10 ml syringe) at an arbitrary setting. With the setting unchanged, the range of times was 3.117 to 3.150 minutes. When rods L and L' were moved and returned to the setting the range was 3.107 to 3.177 minutes. With the setting unchanged the range was 3.193 to 3.206 when fluid was delivered against a pressure of 100 cm of water.

The materials for this infusion pump cost approximately $60. No intricate machining is required, nor are the adjustments critical. Furthermore, variations in speed, range of variation, total capacity, etc. can easily be made by certain obvious alterations in the instrument which has been described.

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