the remaining summer months for the collection of other potential hosts and natural vectors.

It has been suggested that arachnids may serve as vectors in the dissemination of equine encephalomyelitis[2]. This suggestion has been substantiated experimentally. The tick used was *Dermacentor andersoni* (Stiles)[3]. A 250 gram guinea pig was inoculated intracerebrally with 0.12 cc. of brain tissue-equine encephalomyelitis virus suspension. Eleven nymphs were immediately placed on the guinea pig. Engorgement was completed in 48 hours. Thirty-four days later the resultant adult ticks, six females and five males, were placed on a "gopher." The "gopher" died five days later. Brain tissue suspensions, unfiltered, and as Berkefeld V and Berkefeld N filtrates, resulted in equine encephalomyelitis on passage to guinea pigs.

These preliminary observations indicate that ticks of the genus *Dermacentor* may act as vectors of equine encephalomyelitis, Western strain. As far as we are aware, this is the first time that a tick of the genus *Dermacentor* has been implicated in the transmission of a filterable virus disease. Further studies which include other ticks are now in progress. It is significant that the geographical distribution of the disease corresponds to that of this vector and of other ticks belonging to the same genus. The susceptibility to equine encephalomyelitis of the "gopher," *Citellus richardsonii* (Sabine), one member of a large group of closely related native rodents, many of them with a geographical distribution similar to that of the disease and the tick vector, has been reported.[2]

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE SPEED CONTROL FOR SMALL D. C. MOTORS

THE device described here furnishes a simple and flexible means of securing, on short notice and over a wide range of values, steady rotational speeds applicable to light loads. It has been employed for stirring baths, driving sector and siren disks, for stroboscopic determinations, producing and studying vibrations and waves, for lecture demonstrations and for a variety of uses such that it has come to be a tool for both research and instruction. The design is offered, therefore, in the hope that workers in various types of laboratory will be interested. In principle it makes use of well-known facts and, in construction, of parts that are cheap and easily obtained. The particular combination, as far as the author is aware, is not generally known. It has been given only a brief description in a local journal[1] and a demonstration before a public audience.[2]

Two units enter into its assembly: a D. C. shunt motor and a control board. The principle utilized consists in reducing the potential on the armature terminals without changing that on the field magnet when speeds slower than the designed normal speed are desired, while for speeds above normal the field magnet is weakened, while the potential on the armature is kept at full value. A potential divider is used to accomplish this. Series resistances could be employed to secure this type of regulation, but the potential divider has two advantages: first, its resistance is not critical; second, at the lower speeds, the power output is greater. Thus, at 1/3 normal speed for a certain $\frac{1}{8}$ H. P. motor, the output with the potential divider was 10 times that with series control.

Figure 1 shows the wiring diagram for the control board. The terminals of the field and armature are plugged in at F and A, respectively, using a standard receptacle to fit the base of an outworn radio tube with connecting flexible cable (three to four feet long for general purposes) of four stranded leads between motor and plug. The control board in turn is plugged through a lamp cord to the mains whose potential is applied across the potential divider as indicated. Of the two double pole double throw switches, R is for reversing the direction of rotation and the other, or "fast-slow" switch, is for running above or below normal, respectively. It will be observed that as the

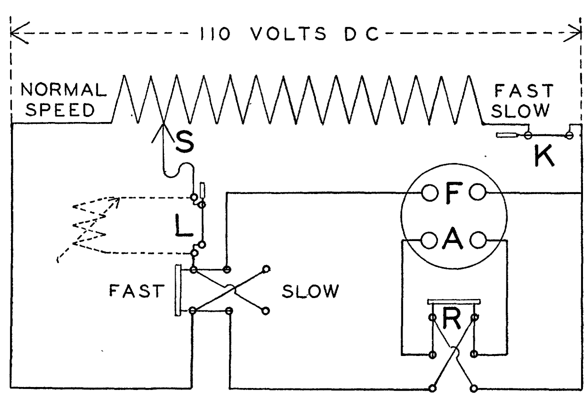

FIG. 1. Wiring diagram for control board.

[3] We are much indebted to Dr. C. B. Philip, U. S. Public Health Service, Hamilton, Montana, through whose courtesy we were able to obtain ticks.

[1] *University of Virginia Journal of Engineering*, 5: 77, 1924.

[2] *Proceedings*, Virginia Academy of Science, 1924–5, page 8.

slider S is moved to the right the speed will rise from normal; while, if the fast-slow switch is thrown on "Slow," the same sliding operation will cause the speed to drop continuously from normal to zero. To stop the motor this switch is opened and, to stop the current through the potential divider, K is opened.

Somewhat unusual conditions occur when continuous running at or close to normal speeds or when finer gradation in regulation is required. For the first case K may be left open to reduce waste in heat, while, in the second, L is opened and a low resistance rheostat is inserted as shown by the dotted lines.

Figure 2, drawn from a photograph, shows an ex-

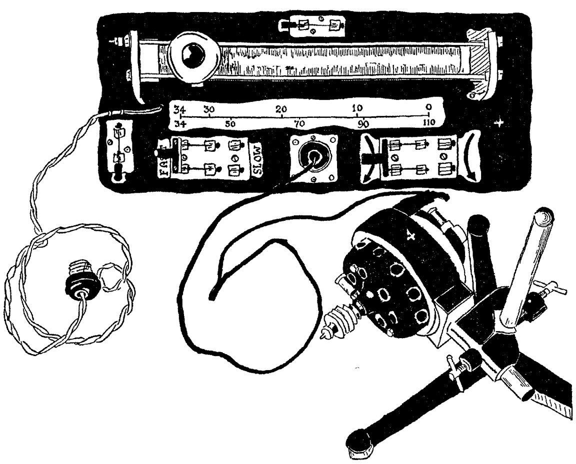

FIG. 2. Specimen assembly.

ample of a set-up where a ⅛ H.P. motor is adapted for mounting in a clamp stand in a number of positions. The switches at the top and the left of the diagram are the L and K switches of Fig. 1, respectively. The remainder is self-explanatory, except perhaps for the scale. This, while little used, shows the speeds corresponding to positions of the slider and brings out, incidentally, their approximately linear relationship. The normal speed in this motor is shown as 34 revolutions per second. The effective range in speeds is from about 1 or 2 r.p.s. to around 100 r.p.s., depending upon the load. The resistance of the potential divider may be anything from 50 to 200 ohms. Two hundred ohms wastes less in heat (about 50 watts) than 50 ohms (about 200 watts), but it is better not to go much over 200 ohms, for that would probably cut down the power output of the motor to an undesirable extent. The head shown on the shaft consists of a cone of small pulleys ended off with a washer and clamp screw for mounting disks, extra pulleys, drums and the like. On the tip is soldered a small wire loop for hanging objects to be spun vertically. Direct coupling to various apparatus is effected by short lengths of rubber tubing.

In equipping our laboratory with small motors, the same size of shaft (½ inch) has been adhered to for the sake of interchangeability. This is easily done from the lists of dealers in second-hand "rebuilt" electrical machinery. The control boards are also interchangeable, although that is of secondary importance. The method has been applied to the ½ H.P. size, but in the larger sizes one would have to consider the power loss. The ⅛ H.P. size is most frequently employed, although a number of ¼ H.P. motors are in use. A variant on the principle is to divide the potential at the source, say, in the case of storage batteries where the intermediate potentials may be tapped off or in a 3-wire system) where both 220 and 110 volts are available. There is an advantage to be gained (not shown in Fig. 2) in the employment of a rheostat provided with a slow motion drive for the slider.

Some of the disadvantages of this design are obviously its limitation to D. C. supply, reduction in the full power output and the heat loss in the potential divider, the last named being trifling for the small sizes. On the other hand, some of its advantages are flexibility, freedom from change-speed accessories, such as gears or intermediate pulleys, and its practically fool-proof characteristic. The main precaution is to avoid stalling the armature too long, especially in the high-speed ranges. Only one motor, however, has been burned out, and that was due to this cause, although these motors have been handled by hundreds of students and others over a period of more than twelve years. I am indebted to Mr. John C. Wyllie, of the University Library, for the sketch of Fig. 2.

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