in 4 strains of mice studied. It is possible that genetic factors influence the capacity to develop obesity after injection of gold thioglucose.

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Apparatus for Continuous Infusion of Microvolumes of Solution into Organs and Tissues.* (21105)

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An apparatus has been devised for continuous infusion of microvolumes of solutions over long periods of time directly into tissues. It has been used successfully to infuse chemical substances into small regenerating limbs of salamanders(1-4), but it could be adapted for use in fields of study other than that for which it was designed. In comparison to other devices for perfusion into blood vessels (5-7), the apparatus has the advantages of non-interrupted flow, of delivering volumes of the order of 0.001 cc or less per hour, and of simplicity in construction, operation and performance. It utilizes the principle of the hand-driven micrometer screws that are employed in microchemical analyses(8,9).

Three models demonstrate the essential mechanism which may be modified for specific needs. In each, the rotary movement of a clock motor (Telechron) is translated into the forward movement of a screw device which advances, directly or indirectly, the plunger of a small hypodermic syringe. The syringe in turn delivers solution into fine polyethylene tubing and thence into a glass capillary needle which is inserted into the tissue. In experiments on the salamander, clocks with a speed of one revolution in 4 hours are most useful. In the simplest model (Fig. 1) a mounted micrometer caliper, in which a screw clamp is substituted for the anvil to accommodate the syringe, serves as the advancing mechanism. The mechanism to couple the clock and micrometer consists of a metal tube attached to the shaft of the clock and slit along its length to engage the pins of an extension shaft connected to the barrel of the micrometer. The motor, revolving counter-clockwise, is supported by an angle plate mounted between 2 rails of the stand so that the clock and micrometer can be engaged or disengaged. A thumb screw passing through a slit in the plate locks the plate in a selected position. The coupling constitutes an automatic shut-off device since, with forward movement of the

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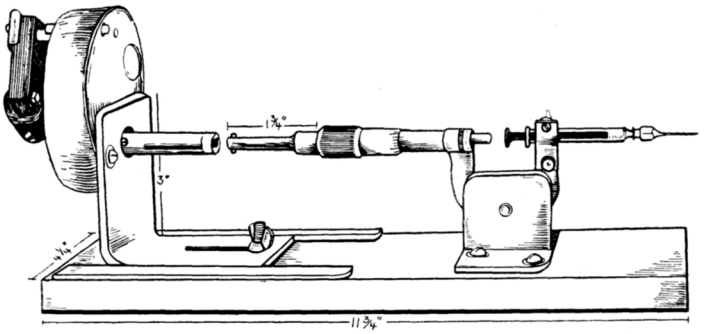

FIG. 1. Single-channel microinfusion apparatus.

caliper shaft, the coupling eventually disengages. The rate of forward movement is determined by the speed of rotation of the clock motor and the pitch of the caliper screw. The volume of solution delivered per hour may be determined by recording the forward movement of the plunger of the syringe over a long period of time.

A unit carrying a number of syringes is shown in Fig. 2. It incorporates the same principles of the simpler model except that a machined screw (stainless steel, ½ inch diameter, 40 threads per inch) is substituted for the micrometer caliper. The screw advances a horizontal plate attached to it by a bearing mechanism. The plate slides along parallel rods fastened to the upright members of the frame. One member carries the lead screw and the other is slotted to accommodate the syringes. The syringes are locked in place by swivel-mounted plastic plates. The advancing plate carries 4 adjustment screws arranged to contact the plungers of the syringes.

In the third model (Fig. 3) the screw (stainless steel, ½ inch diameter, 40 threads per inch—right hand) has no forward motion but is permanently mounted on ball-bearings to both frames. A sylphon bellows fixed to the end of the clock shaft engages the pins on the extension of the screw shaft by means of 2 slots. The coupling may be disengaged by compressing the bellows. The bellows permits immovable attachment of the clock support to the base but the advantage of the automatic release device of the previous coupling is lost. The advancing bar which bears the adjustment screws for contact with the plungers of the syringes carries an attached arm with clasp which rides firmly along a shaft between the 2 supporting members and insures that movement of the bar is in one plane. To preserve forward movement, a clockwise direction of rotation is required. The counter-clockwise direction of rotation of electric clock motors may be easily reversed by removing the coil from the armature, and

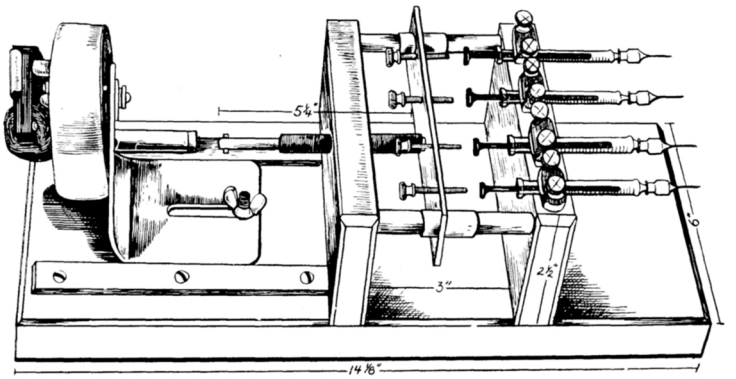

FIG. 2. Multiple-channel microinfusion apparatus with adjustable motor mount.

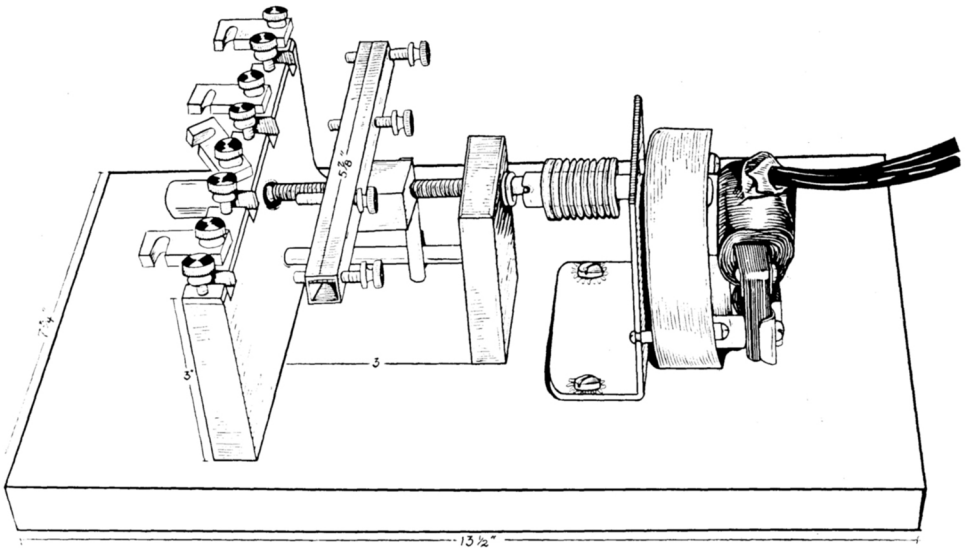

FIG. 3. Multiple-channel microinfusion apparatus with fixed motor mount.

replacing it in a reversed position.

There are a number of ways in which the mechanism can be further altered. Additional syringes can be driven by the same motor. The apparatus can be wired to feed discontinuously or to shut off following a prescribed time. By attaching the plungers of the syringes to the adjustment screws and reversing the motor it is possible to draw samples of tissue fluid into the syringes. A variable speed motor can be used instead of one with a fixed speed. Finally, syringes of any size may be employed.

Polyethylene tubing serves as leads from the needles of the hypodermic syringes. We have used ¼ cc tuberculin syringes, No. 26 syringe needles (½ inch) and tubing of inside diameter 0.015 inch. The tubing is sealed by heat to the needle and to the glass capillary tube at the other end, the glass having been previously drawn to a desired taper. Colored glass is of value in following the course of insertion in animal tissues. The plunger and mouth of the syringe are coated with silicone or fluorocarbon grease to avoid seepage.

Summary. An apparatus is described for infusion of small volumes of test solutions directly into tissues and organs. In more than 3000 successful infusions of the early regenerating limb of salamanders, volumes of 0.001 cc per hour have been introduced for periods of 5 or more hours. The apparatus consists of an advancing bar which is driven forward by a screw shaft attached to a clock motor. The advancing bar presses against the plungers of small syringes forcing fluid into fine polyethylene tubing and thence through a glass capillary needle into the tissues.

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