[*May* 8, 1934]

The Bragg-Paul Pulsator

An Apparatus for Prolonged Artificial Respiration by Sir William Bragg's Method.

Designed and developed by R. W. PAUL, M.I.E.E., F.Inst.P.

AN outfit for adults or young persons comprises a pulsator which rhythmically inflates an air-bag (encircling the bony thorax of the patient below the armpits) to a definite air-pressure as indicated by a manometer. The pulsator is readily transportable, works quietly, and may be placed at any moderate distance from the patient, being connected to the air-bag by a flexible hose-pipe. The action is independent of the position or movements of the patient. Normally the pulsator can be operated on any electric supply circuit or, in special cases, from accumulators; it can also be modified so as to be worked by a hand lever. In a different model power is taken from the town water-supply.

Pulsator mechanism and manometer.—A stout rubber bellows, 22 cm. diameter, is attached at one end to a plate carried by pillars on the pulsator base, its lower end being attached to a pressure plate. Axial movement of the latter causes the air capacity of the bellows to change by about 1·5 litres, an amount which can be varied if necessary. The upper plate bears a large nozzle for the connecting hose, a smaller nozzle with non-return valve through which an initial supply of air can be introduced from a hand pump, a release cock, and an adjustable safety-valve. Another cock provides connexion to a manometer, mounted on the machine, but capable of detachment for use in any neighbouring position.

The manometer can be set by means of a ball joint to face in any direction. It has a bold dial graduated in mm. of mercury column, the range being usually to 70 mm.

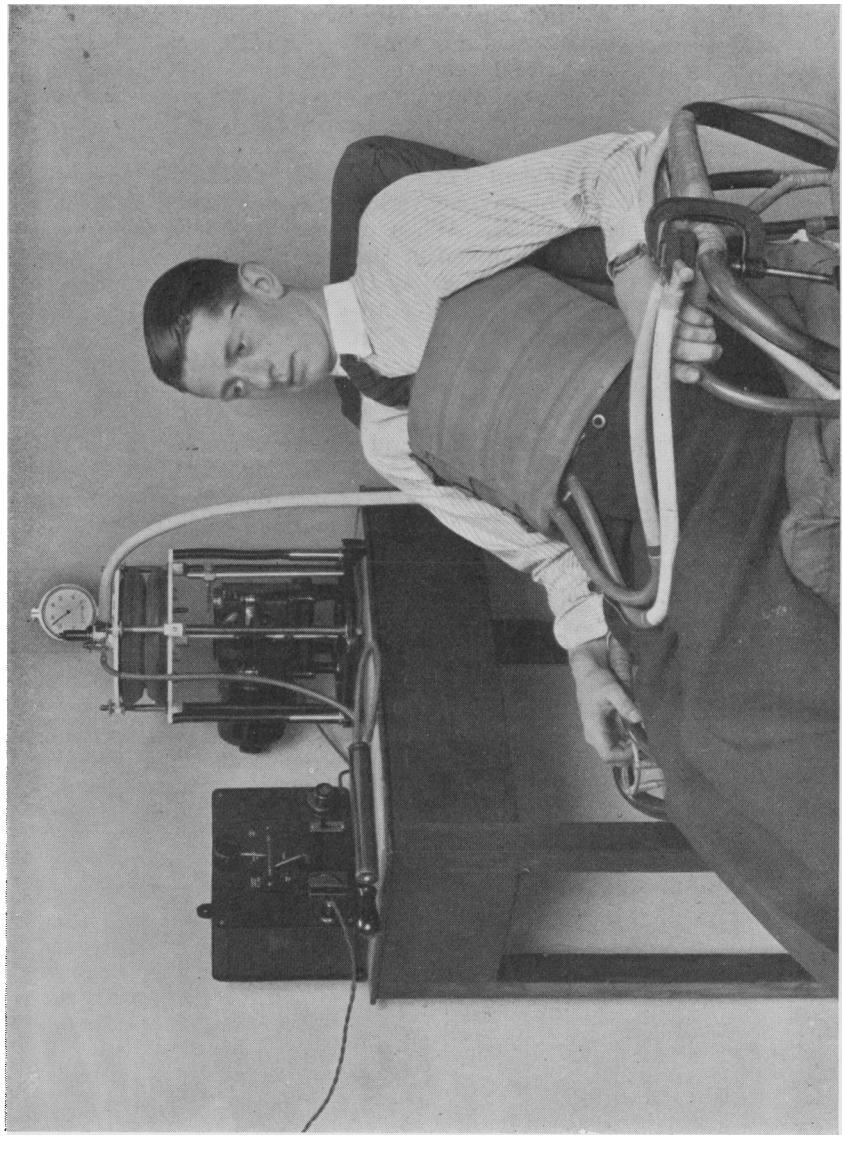
The air-bag having been adjusted on the patient and connected to the pulsator, the system is charged with air to an appropriate final pressure which, in the case of an adult, may be 30 or 40 mm. The pulsator is then started and conditions will remain constant for a long period.

Electrical drive and control box.—On the base of the pulsator is fixed a unit comprising a motor and gear-box, the output shaft being fitted with a crank. The latter carries a bearing-block sliding in a slotted yoke fixed to the pressure plate and running in vertical guides. The gear-box is grease-packed, and wick oilers are fitted to the other working parts. The motor is of the series universal type, to work on d.c. or a.c. circuits; as it takes only a fraction of one ampere, it may be connected to a lamp socket if desired.

Since there is no load on the motor during the down stroke of the pressure plate, compression springs are used to equalize the torque on the motor shaft.

The control-box enables the machine to be used on any voltage from 100 to 250, and the speed of the pulsator to be adjusted between 15 and 30 strokes per minute; a series resistance and an armature-shunt have dials by means of which they can be re-set to suit any pre-determined condition. All live parts are enclosed, plugs and lead being provided for the input and output connexions, with double-pole switch and fuse.

Hydraulic drive.—Where electricity is not available this model can be used on a water-supply at 50 to 150 lb. per square inch. The axial motion of the pressure plate is given by a piston about 5 cm. diameter, working in a cylinder of which the upper end is open. A fine-adjustment valve controls the water flow and the speed. The pressure plate carries tappets acting, at each end of the stroke, on a rocker which is spring-loaded so as to tip suddenly on passing its dead centre. This rocker controls a two-way balanced piston-valve sliding freely in a block



attached to the hydraulic cylinder. When the bellows is fully extended the valve trips and connects the cylinder to the water supply, the piston rising until the bellows is compressed. Reversal takes place, and long tension springs then cause the water to be expelled through a waste-pipe, and the bellows again to extend. The length of stroke can be varied, if necessary, by adjusting the tappets. The upper end of the valve is enclosed in a flexible chamber with drain to carry off any slight leakage of high-pressure water. Once in three days a little grease should be applied to the two nipples on the valve block; the other working surfaces are provided with greasing pads. Experience of continuous operation for many months indicates that the flow of water is about 700 gallons per twenty-four hours; this could be re-utilized for other purposes.

Air-bags.—Normally the air-bag is of stout rubber and has a flattened rectangular shape. Its outer surface has a canvas covering vulcanized on it and integral with straps fitted with prongless buckles. When in place it almost encircles the bony thorax below the armpits. At each end of the bag is a rubber tube, and a metal fitting provides means of connecting together these tubes and by a hose-pipe to the pulsator. The metal fitting can be clamped to a bed-rail. Several sizes of air-bag are available, ranging from, say, 38 in. by 10 in. for an adult to 11 in. by 3 in. for a newly born infant. No exact fitting is necessary. In case of injury to one side of the thorax, it has been found that a bag of half-length suffices to cause action by both lungs.

The above apparatus has been tested and approved at the London School of Hygiene and Tropical Medicine by Dr. P. M. T. Kerridge, who also suggested the form of the air-bag. The apparatus is being manufactured by Messrs. Siebe, Gorman and Co., Ltd., 187 Westminster Bridge Road, S.E. 1.

By the courtesy of Professor H. A. Harris, X-ray photographs have been taken in the Anatomy Department of University College, London. Antero-posterior and lateral views of the thorax of a normal subject were photographed, with and without the pulsator in action. With the apparatus working, the diaphragm was higher, the antero-posterior diameter of the lower part of the thorax was increased and the lateral diameter diminished. Thus the normal expiratory position was exaggerated, but not so much as might have been produced in voluntary forced expiration. The pressure in the air-bag was 47 mm. Hg when the photographs were taken. This was sufficient to increase the respiration of the subject without causing discomfort.