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Manuscript received July 30, 1951.

Improved Artificial Respirator for Animal Experimentation[1]

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In studies of the electrical responses of the brain to auditory stimulation in the curarized cat, it was found that the noise of the usual motor-driven respirator interfered with the experiments. Accordingly, a new respirator has been designed which, in addition to being essentially noiseless, offers other advantages:

1) The respirator adds only a small dead air space to the respiratory system.

2) There are no valves to offer resistance to air flow during passive expiration.

3) The device can be adjusted to operate at 5–40 respiratory c/min and also to shorten or extend the inspiratory phase with respect to the respiratory phase. At any given setting, the frequency of cycling and the phase relationships between inspiration and expiration are stable for long periods of operation. Frequency is not subject to change with changes of line voltage, as in the case of motor-driven devices of this kind.

4) The frequency and phase relationships can be altered during the experiment without shutting down the apparatus.

5) Electrical sparking is not involved, as with the commutator and brushes of a motor, thus making the apparatus safe for use with ether anesthesia.

6) The apparatus does not induce electrical artifacts in electroencephalographic recording.

The operating principles of the mechanical parts of the respirator are shown in Fig. 1. The mechanical parts consist of a brass cylinder with a .500-in. bore, a double-ended filleted piston machined of drill rod to give a sliding fit to the bore of the cylinder, and 2 electromagnets wound at each end of the cylinder and using the cylinder as their cores (Fig. 2). The electromagnets are alternately energized with direct current, thus drawing the piston to and fro in the cylinder. Fig. 1 shows, for the inspiratory phase, the piston drawn to the extreme of one of its excursions,

[1] Reviewed in the Veterans Administration and published with the approval of the chief medical director. The statements and conclusions published by the author are a result of his own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

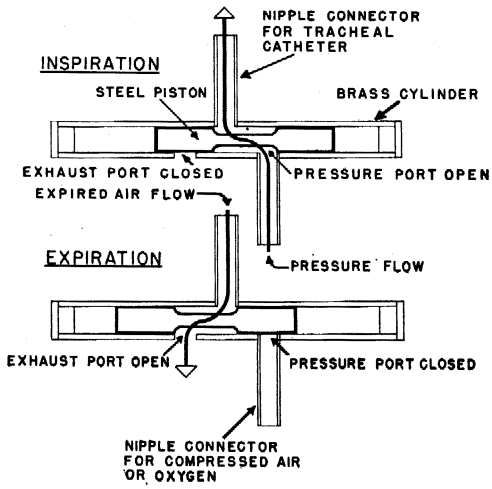

FIG. 1. Double solenoid-driven steel piston which gives free access to expired air without requiring animal's respiration to force open a valve.

allowing the compressed air or oxygen to flow through the opened pressure port, and to the animal through the tracheal connector. During this phase the expiratory port is closed. During the expiratory phase the piston is pulled to the opposite end of the cylinder, allowing free passage from the tracheal connection through the opened exhaust port, the pressure port being closed during this phase.

The cycling of the piston in the cylinder is controlled by the electronic circuit shown in Fig. 3. The electronic system is built into a small cabinet, used outside the area to which the EEG is sensitive, and is connected to the solenoids via two lines from the relay contacts and ground. These three lines may be of any length.

The functioning of the electronic system is as follows: The cycling and phasing of the system are established by the free-running multivibrator incorporating a twin-triode 6N7. Ganged potentiometers control the operating frequency. The frequency of oscillation is stabilized with the 0D3 voltage regulator. A 6J5 triode is used to operate the relay in its

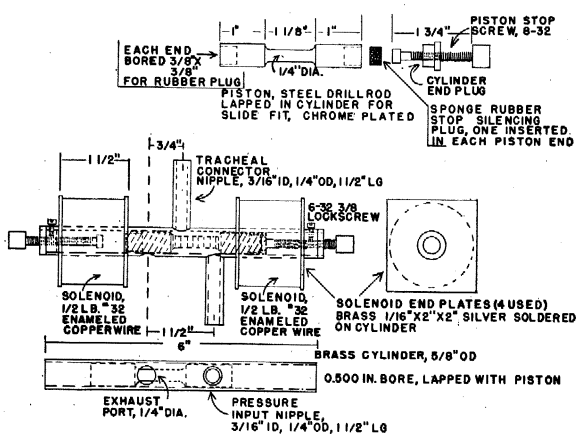

FIG. 2. Dimensions and specifications for double solenoid respirator.

plate circuit. The plate circuit of the 6N7 is directly coupled to the grid of the relay tube by means of a simple NE51 glow tube.[2] When the section of the 6N7 twin triode connected to the grid circuit of the 6J5 is conducting, the large voltage drop across the 100K resistor in the plate load circuit makes a reduced voltage drop across the neon tube and its load resistor. During this phase, the neon bulb is unionized and, hence, has almost infinite resistance. The voltage across its load resistor, which is also the grid input resistor to the 6J5 is, therefore, 0. The 6J5 is at cutoff during this phase owing to the voltage across its 2.5K cathode resistor induced by the current flow through the 25K 10W resistor connected between B+ and the 6J5 cathode. The relay is de-energized because of reduced plate current passage.

When the triode section connected to the 6J5 grid is at cutoff, the reduced voltage drop across the plate load resistor in this section allows a large voltage drop to appear across the neon tube and its load resistor, thus ionizing the neon tube and allowing passage of current and causing a voltage drop across the resistor

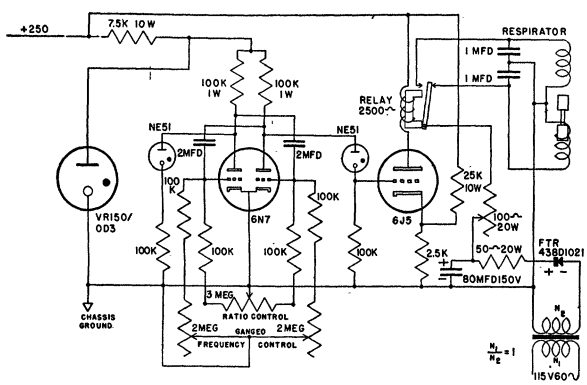

FIG. 3. Schematic circuit diagram of solenoid-driven artificial respirator.

in the grid circuit of the 6J5. The voltage drop across the neon load resistor/grid input resistor overcomes the cathode cutoff bias on the 6J5, causing it to pass plate current and energize the relay for the duration of the cutoff phase of the multivibrator. A second NE51 neon bulb is connected from plate to ground of the opposite section of the 6N7 to preserve the symmetry of the multivibrator and to provide operation indicators for the control. The two tubes are installed in standard pilot-lamp panel-mounting sockets on the unit.

The power supply for operation of the solenoids is provided with a unity ratio 30-w power transformer to isolate the system from powerline ground. Half-wave rectification is provided by a Federal Radio and Telegraph selenium rectifier 438D1021.

The electronic control system, as a separate unit, may serve other useful purposes in the laboratory. It has been used in our laboratory to operate an optical shutter in the application of photic stimulation.

The respirator has been used successfully with cats and dogs. It may be used with the usual laboratory compressed air source or compressed air or oxygen cylinder. The needle valves with which gas is ordinarily dispensed from these cylinders provide a convenient and reliable means of adjusting the rate of flow to the respirator. When the respirator is used on a 20-lb laboratory airline, a suitable regulating valve is required.

Manuscript received July 25, 1951.

[2] A suggested modification of the electronic control would eliminate the use of a relay, substituting two 6L6 tubes with the respirator solenoids in the plate circuits of these tubes, each tube being grid-controlled by the plate circuits of the 6N7 multivibrator.

Influence of Thyroid Status on Spermatogenesis

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Maqsood and Reineke (*1*) reported that the administration of thyroprotein (thyroactive iodinated casein) in physiological doses for short periods stimulated spermatogenesis in the testes of the young male mouse, kept at environmental temperatures of 24° and 30° C, whereas thiouracil treatment arrested the process of spermatogenesis, and the seminiferous tubules showed varying degrees of atrophic and degenerative changes. In view of these observations it was decided to study the effects of the administration of thyroxine and thiouracil for long periods on the process of spermatogenesis and the development of the interstitial cells of the testes in the rabbit and the ram, under natural environmental conditions. Libido and semen qualities of the control and treated animals were also estimated with a view to examining the possibilities of the practical application of thyroxine therapy in the field of reproduction.

Administration of L-thyroxine, in physiological doses, to 4 week-old-male rabbits for a period of 40 weeks stimulated the process of spermatogenesis and the development of the interstitial cells when compared with the control group (Fig. 1). A majority of the seminiferous tubules contained masses of maturing sperma attached to the Sertoli cells. A comparative increase in the number of rows of the spermatogenic cells was observed in a number of the seminiferous tubules, and the spermatogenic cells appeared in a stage of activity. The interstitial cells were numerous and well developed. The treated animals showed considerable increase in libido and improvement in semen qualities when compared with those of the control group. Feeding of thiouracil as 0.1% of the ration to 4-week-old male rabbits for a period of 40 weeks resulted in marked atrophic and degenerative changes in the seminiferous tubules of

[1] I am thankful to J. Hammond, F.R.S., and A. Walton for their help during the course of this work.