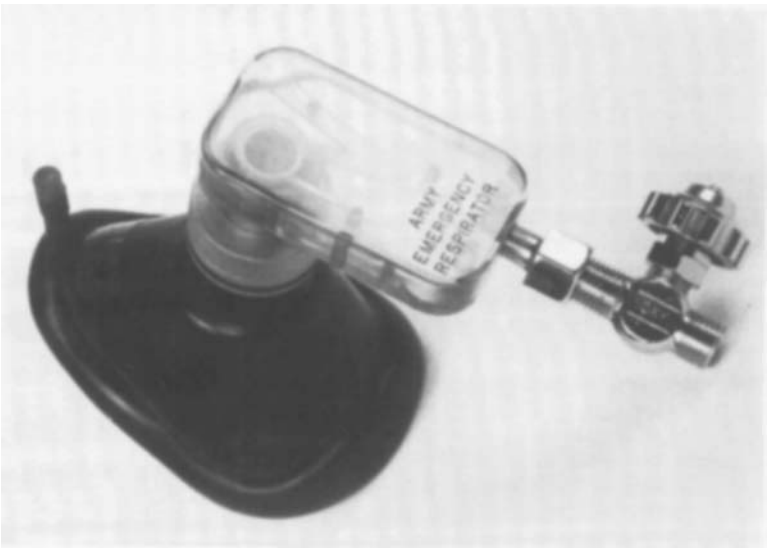


FIG. 5. Army emergency respirator.

level, and platelets, are in progress in the laboratory. Clinical studies, using this pump for left heart bypass in severe cardiac patients unable to survive anesthesia and surgery for noncirculatory conditions, such as in the acute abdomen, are also underway.

Development of Ventilators — The fluid amplifier is also being applied in the development of two ventilators. The first is designed primarily as a resuscitator[6] (fig. 5). It is a fluid amplifier molded in the center of a block of plastic, 2 x 3½ x ¾ inch. There are no moving parts other than a plastic disc in an exhalation valve (fig. 6). This device will ventilate a patient in either

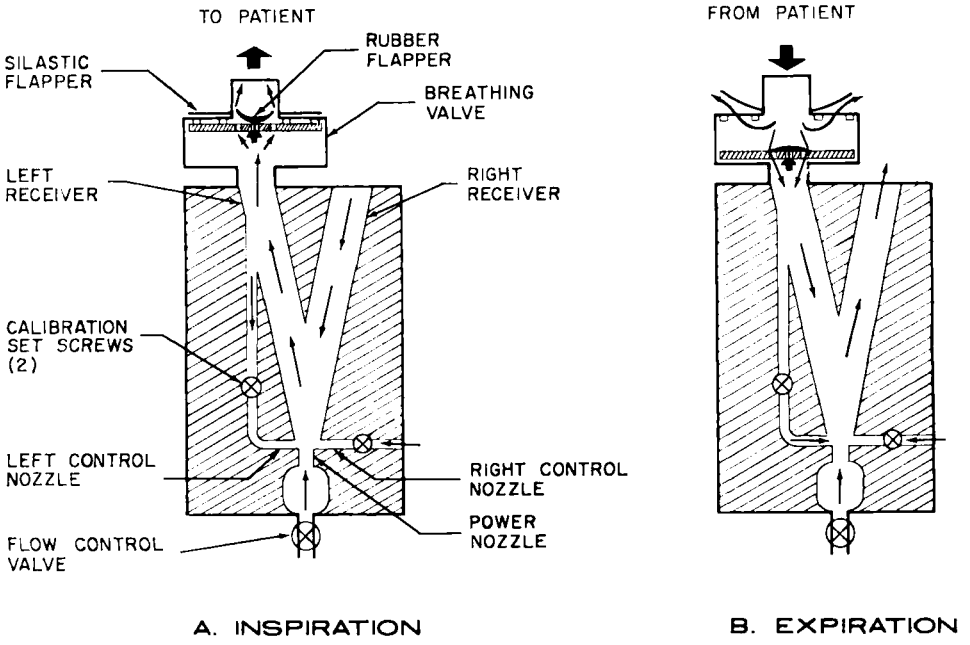


FIG. 6. Army emergency respirator schematic.

an assist or control mode. The unit automatically controls ventilation when there is no patient effort. An on-off valve controls the flow rate as well as the cycling pressures, which range from 12 cm. of water with an input pressure of 2 psig to 33 cm. of water at 5 pounds per square inch gauge.

The second unit is a volume-cycled ventilator (fig. 7) which also has the capability for pressure limit cycling. Two fluid amplifiers are utilized for the powering and control (fig. 8). A piston and bellows separate the driving gas from the breathing gas. This allows powering the respirator by an air supply not suitable for breathing. Oxygen from a demand valve or a bag reservoir, room air, or anesthetic gases can be delivered. The present model is for nonrebreathing only. Testing, both in animals and in humans, has proved the versatility of this design.

Another volume ventilator containing a small digital control circuit using only fluid amplifiers is under development. This unit will have only one moving part other than the exhalation valve. Subminiature flueric components will provide efficient operation from oxygen supplies.

A fluid amplifier oscillator has been used to control an external cardiac compressor (fig. 9). This bistable boundary fluid amplifier drives an oscillating valve which results in variable time cycling (fig. 10). The force applied to the chest is adjustable from

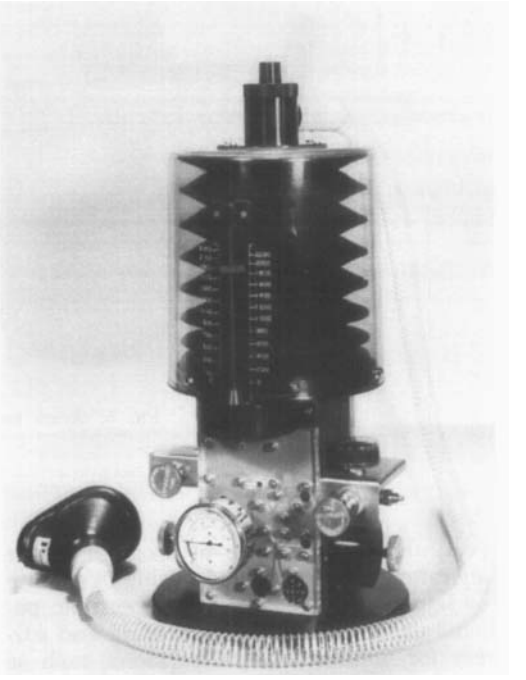
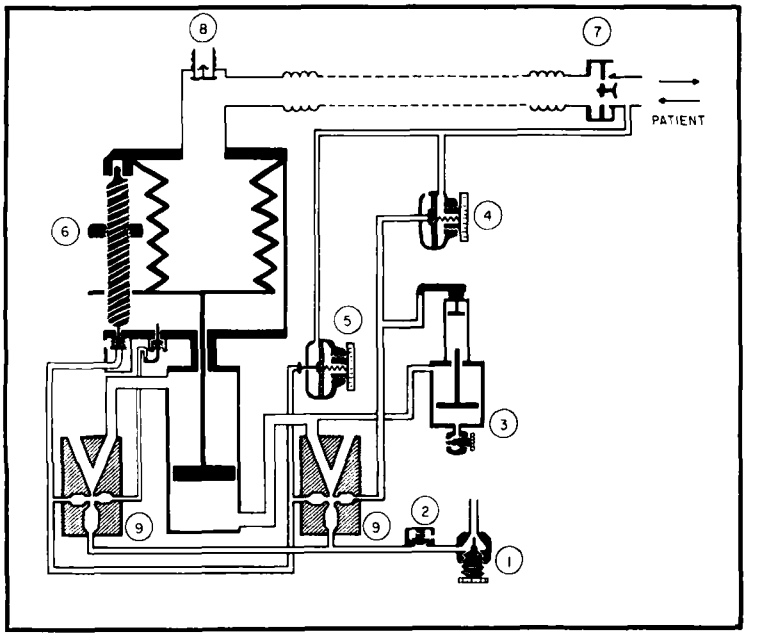


FIG. 7. Volume cycled ventilator.



① INSPIRATORY TIME CONTROL
② SAFETY RELIEF VALVE
③ EXPIRATORY TIME CONTROL
④ INSPIRATION INITIATION SENSITIVITY CONTROL
⑤ PRESSURE-CYCLE CONTROL
⑥ TIDAL VOLUME CONTROL
⑦ BREATHING VALVE
⑧ BREATHING GAS INTAKE
⑨ FLUID AMPLIFIER

FIG. 8. Volume cycled ventilator schematic.