Piston Based Ventilator Design

This virtues of the piston based ventilator design (see drawing) are the following:

Very accurate volume measurement and delivery
Very rugged. Can simply be wrapped to the bed.
Inexpensive to manufacture.
Reliable and durable design

A crude drawing is attached. Note that in the drawing, the longitudinal scale is different from the vertical scale.

The design starts with a piece of pvc pipe (or a plexiglass tube) about 20 inches long with a 4 inch inside diameter.

At the left end of the tube there is a piston with a displacement of about 7 inches. The piston can deliver a tidal volume of 1.44 liters. This would allow the ventilator to service two patients simultaneously. The tidal volume can easily be increased by lengthening the pipe.

A DC motor with encoder is bolted on the right end cap of the tube. The motor is coupled to an axial lead screw (or the lead screw is built into the motor). The lead screw drives the piston.

The pvc tube would very provide the basic mechanical structure for the ventilator without any need for an external frame.

The resulting system would be quite rugged.

One version of the design (shown in the sketch) has 4 cylindrical plates .

1) the Piston Head (which moves back and forth to generate the breaths)

2) the Guide Plate (fixed in the cylinder)

3) The Nut Plate (which moves back and forth with the nut on the lead screw)

4) The Motor Plate (fixed on the right of the cylinder)

For prototyping and perhaps for production, all of the plates could be manufactured by a 3-D printer.

A pressure transducer in the cylinder (or at the patient's mouth) would measure pressure.

Limit switches would be added at either end of motion..

And check valves are required where the air flows into and out of the piston. These check valves can be the same design as the check valves on a typical ambu bag.

The motor controller would servo the position and velocity of the piston. The control loop can control either the delivered pressure or control the delivered volume.

In the volume control mode, the servo control loop could be very simple. Basically, just run the motor at constant velocity until the correct volume has been delivered.

Contamination and cleanability might be a challenge, but I think it could be overcome with properly designed check valves and filters. Clearly when the community is talking about putting up to 4 patients on a single vent, then cleanability is a secondary concern.

A variation of the design uses a rolling diaphragm (Bellofram) instead of a simple piston. This would allow for a very cleanable design, but I do not think that the rolling diaphragms can be obtained in quantity in a short amount of time.

Your thoughts and ideas would be greatly appreciated!

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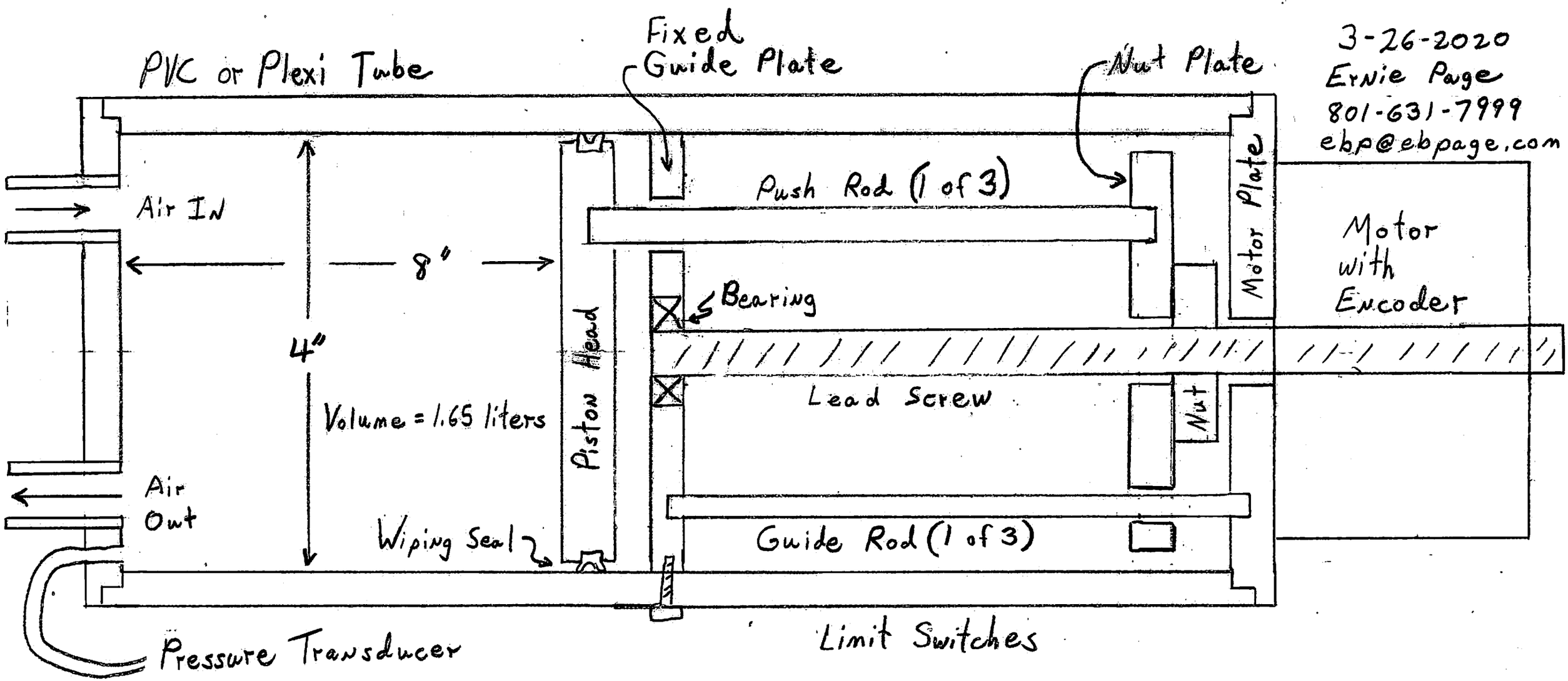

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