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ABSTRACT

This system presents a method for remote pipetting that features precision and excellence of control. The operator and Pipetter Controller are generally separated from the box-enclosed mobile Pipetter Head by shielding that may be up to several feet in thickness. In our 6-foot Water-Cave Neutron Facility a Kollmorgen periscope is used in conjunction with one pipetter for the taking of samples in the range of 1λ to 10λ. Pipettes can be replaced remotely in the Pipetter Head by the box manipulators. We have pipetter units of capacity 1λ to 1 ml and 1λ to 5 ml, and also macro units up to 30 ml.

INTRODUCTION

The pipetting of liquids, either for precise volumetric measuring or for purposes of transferring liquids from one container to another, is a well-established practice in the chemistry laboratory.[1] When one needs to take accurate assays or make critical dilutions, the micropipette is a very useful tool to the chemist.

In ordinary laboratory pipetting a syringe is coupled directly to a pipette, and the syringe is controlled by hand.

If the chemist operator needs to put distance between the pipette and the controller (syringe) because of shielding or box containment of the pipette, then the conventional coupling of the controller and the pipette becomes impossible. One can, of course, simply add tubing between the controller and the pipette and operate the unit in this manner. The latter method works reasonably well so long as critical control and precise measurement are not prerequisites. The air "leg" between controller and pipette acts as a spongy buffer because of the compressibility of air, which results in poor control and slow, uncertain response at the pipette.

In the Lawrence Radiation Laboratory at Berkeley, where radiochemistry is performed in box enclosures and with shielding up to 6 feet thick, the reader can see the need for a means of pipetting with remote control.

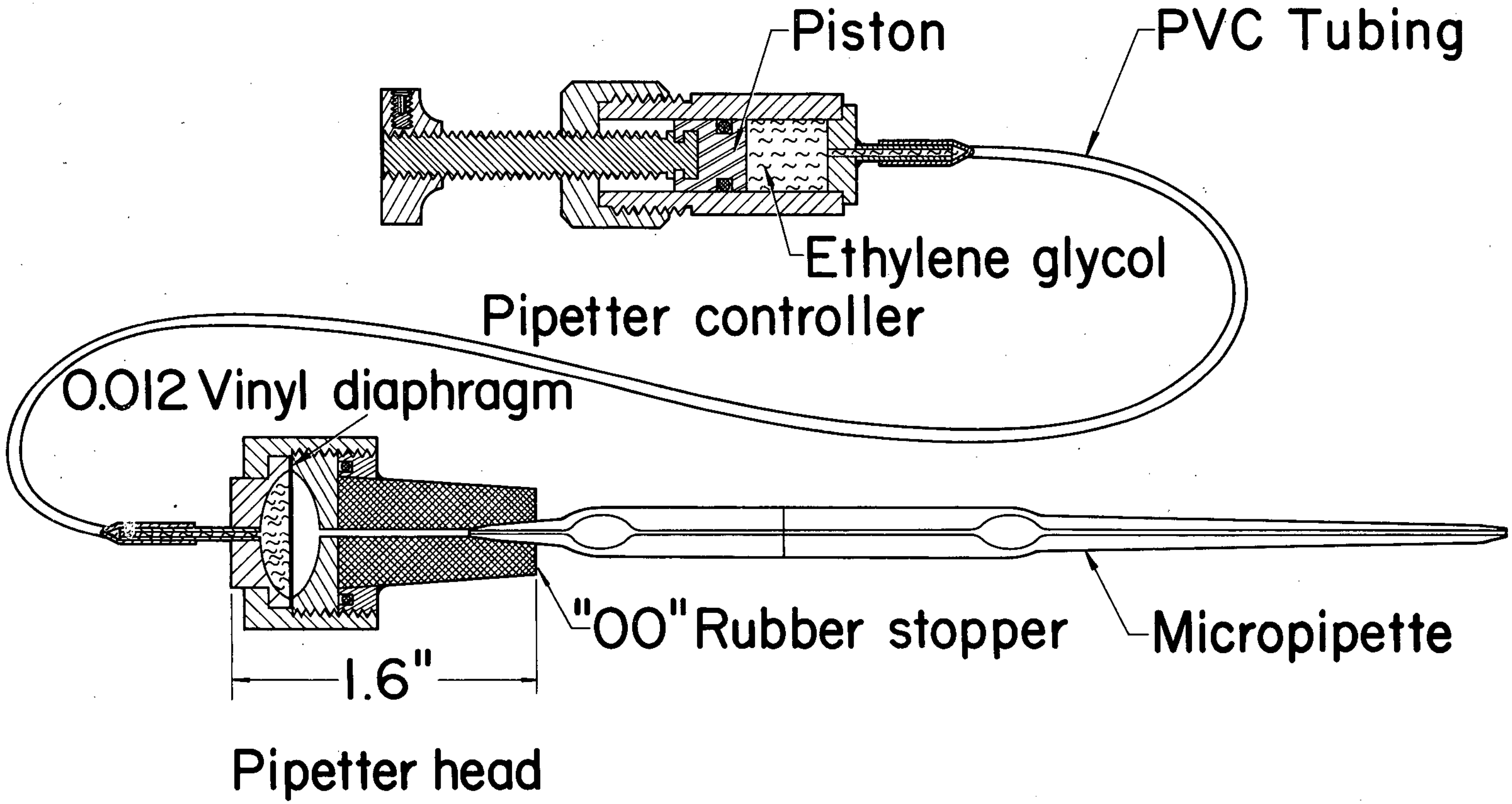
METHOD AND APPARATUS

At first it appeared that one might simply include the controller and the pipette within the box enclosure and operate the controller by use of the tong manipulators on the box. This method offers objectionable limitations.

1. It means that both box manipulators would be required to hold and to operate the pipetter, and this would not allow freedom of the manipulators for related operations.

2. The fine technique required to operate the controller with box manipulators is most difficult to achieve, and with micropipetting it is too tedious as well.

The system we evolved permits maximum flexibility of the operation and requires minimal technique. We use a system filled with liquid (ethylene glycol), which eliminates the spongy lag characteristic of an air-filled system. An O-ring-fitted piston in the control cylinder is coupled by flexible plastic tubing to the Pipetter Head, which has a confined diaphragm (Fig. 1). Motion of the piston is transmitted by the liquid to the confined diaphragm within the Pipetter Head and changes the volume of the cavity that, in turn, controls the level of the liquid in the pipette. The diaphragm also serves as contamination barrier.



Hydraulic micropipetter

MUB-2506

Fig. 1

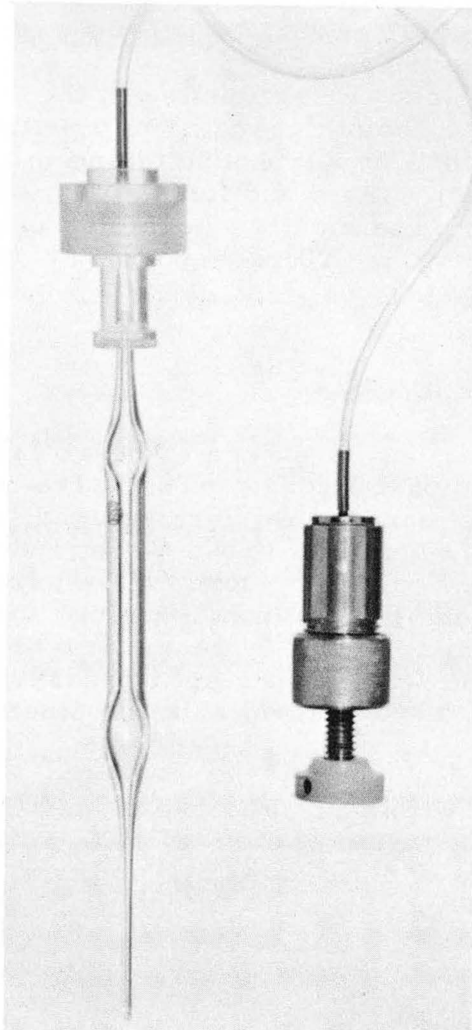
At the operating end precise control is accomplished by the screw and nut; this screw is linked to the piston in such a way that rotation of the piston is avoided. In the 15-ml unit a rack and pinion serve to drive the piston (Fig. 4).

Several methods have been devised for securing pipettes in the Pipetter Head, all of which lend themselves to remote changing of pipettes. One method is based on the friction-interference fit of the pipette end in polyvinyl chloride (PVC) tubing; another employs male and female glass-ball joints and a ball-joint clamp (Figs. 2 and 4). The most successful way yet developed for micropipettes is with the use of a size 00 rubber stopper affixed to the pipetting head (Fig. 3).

APPLICATION AND RESULTS

The Hydraulic Pipetters herein described have been standard laboratory equipment at LRL, Berkeley, for the past 4 years. They have been used in unshielded Berkeley Boxes as well as in Berkeley Boxes placed in a 2-inch lead shield, and show their real merit when used in the 4-foot and 6-foot Water-Neutron Caves.[2] With use of these pipetting units in the water caves, we have found it necessary to use "hard lines" (metal tubing) for most of the run from Controller to Pipetter Head. This is necessary because the flexible plastic (PVC) tubing does expand slightly upon pressurization and in lines 8 feet to 16 feet long does so to the degree that the pipetter response becomes slow and uncertain.

In the standard box enclosure, used within the Water-Shielded Cave Facility (Lawrence Radiation Laboratory, Berkeley), four remote pipetters are employed. There are two micropipetters of 1 ml capacity and two macropipetters of capacity 15 ml and 30 ml (Fig. 5).



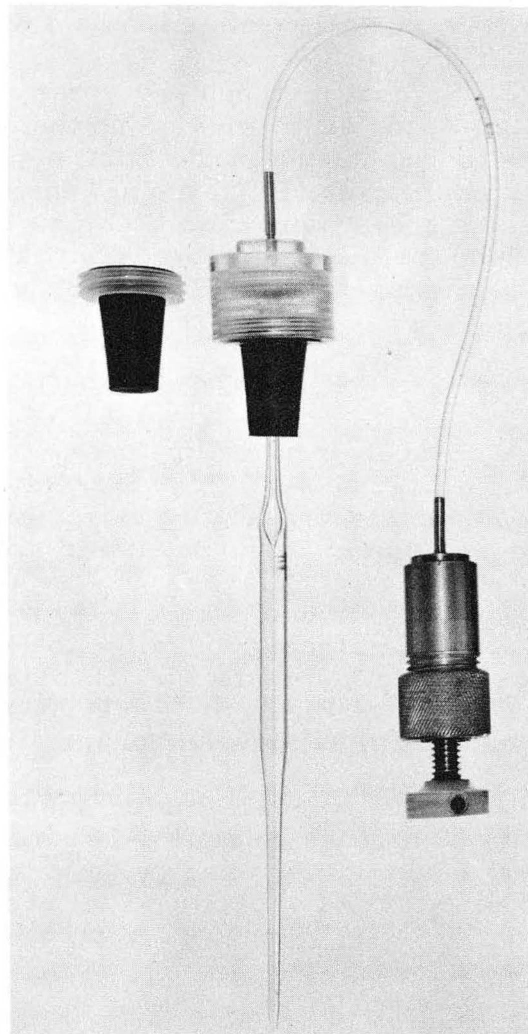


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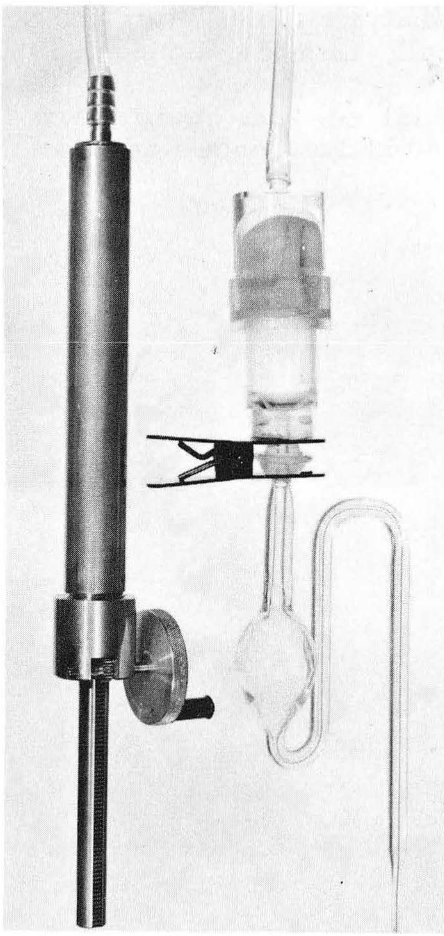
Fig. 2. In this model PVC tubing is used in the socket for securing the pipette.

Fig. 3. In this model a size 00 rubber stopper serves as a replaceable pipette socket.



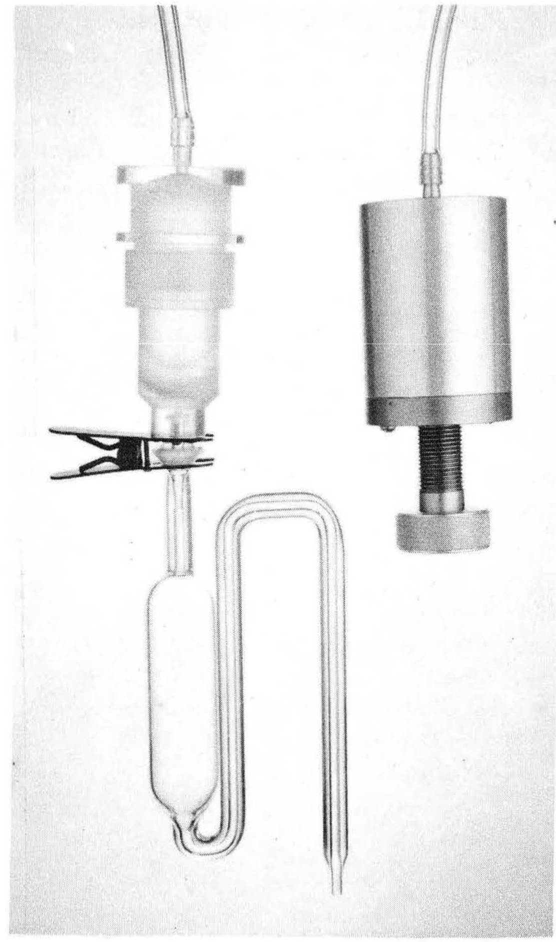


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Fig. 4. The 15-ml pipetter features a rack and pinion for propelling the control piston.

Fig. 5. The 30-ml pipette employs a screw and nut for propelling the control piston.

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