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PLASTIC BALL AND SOCKET JOINTS AND CONNECTING LINES

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ABSTRACT

This report describes the fabrication and evaluation of polyethylene plastic joints and connecting lines used in the assembly of contained and shielded radiochemical apparatus.

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INTRODUCTION

It is often necessary to use conventional glass apparatus while working with radioactive materials in contained or shielded facilities. On equipment which must be assembled or altered in place by remote manipulation, it is extremely difficult to make satisfactory glass seals and to disassemble joints that have been in extended service. A need for a joint designed specifically for this application was recognized. Such a joint should meet all the requirements of conventional joints and in addition should (1) be resistant to radiation, (2) be sufficiently flexible to allow for easy remote manipulation, (3) be leak-tight without the use of grease or other lubricants, and (4) be resistant to breakage.

Plastic joints and flexible connecting lines were developed that would meet these requirements and replace standard glass tubing, joints and stopcocks. Polyethylene was selected as the molding material because it best meets the requirements. Molds were made for forming the interchangeable joints on a laboratory scale. Techniques were devised for sealing the plastic to glass and to itself.

Ball joints molded with a guide, Figure 1, were made to facilitate their remote assembly. The guide on the joint acts as a temporary support while the joint clamp is manipulated into place. Capillary type ball joints molded without the guide can be used as valves and flow regulators by tipping the ball in the corresponding ungreased socket joint.

An evaluation of the plastic joints and connecting lines was made under typical conditions of a radiation laboratory. The results of this evaluation showed that plastic joints and lines could be substituted successfully for some of the fragile all-glass parts.

FABRICATION

Polyethylene ball and socket joints, Figures 1 and 2, were molded to fit standard ground glass joints. Molds of 2024 aluminum, Figures 3 and 4, were heated to 150° C, sufficient polyethylene to fill the mold was inserted at room temperature, and the assembly was compressed in a screw press. The molds were allowed to cool slowly to room temperature.

The technique of attaching the plastic joints to the polyethylene tubing consists of heating the two parts in intimate contact while being contained in a glass mold with a suitable mandrel to maintain the desired shape. When the plastic reaches the fusing temperature it becomes transparent. The same procedure is used when sealing polyethylene tubing to glass. Care must be taken that the plastic is formed over the glass so that on cooling the plastic will shrink on the glass part and become vacuum tight.

When the plastic tubing is attached to a joint in such a manner that the mold cannot be removed, as in a splice, then a whole or two part glass mold is used. The whole glass mold may be removed by crushing it in a bench vise.

In all molding operations a mold release[1] is used to facilitate removal of the molded part.

Compression molding was satisfactory for making joints on a laboratory scale but joints made by injection molding are inexpensive and can be made by various injection molding manufacturers.[2]

Figure 5 shows the arrangement of the joints and lines in a contained radiochemical experimental setup.

EVALUATION

The apparatus shown in the schematic diagram, Figure 6, was used to evaluate the leak rate of the polyethylene joints. The joints were put together dry and tested for leak rate in a static system at a pressure of 0.010 mm of mercury absolute. The plastic joints selected at random held without noticeable loss of vacuum during the 15-minute test period. As a comparison, dry glass-to-glass joints leaked at a rate of 24 mm per minute. The combinations tested are shown in Table I.

SUMMARY

Plastic polyethylene joints and their connecting lines were made and put into service in a chemistry facility where they were exposed to corrosive chemicals and intense radiation fields. They have been in use for over a year and have required little maintenance.

The combination of plastic joints and connecting lines is particularly useful in any laboratory setup requiring changes or modifications. Depending on their usage, these joints and connecting lines can be made of any plastic with properties similar to polyethylene.

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REFERENCES

1. Silicone Spray Mold Release, Injection Molders Supply Co.

2. American Agile Corporation, Pyramid Plastic Incorporated, Bel-Art Plastics Company

TABLE I

LEAK RATE OF JOINTS*

COMBINATION	PRESSURE CHANGE DURING 15-MINUTE PERIOD**
1. Plastic Ball (12/3) in Plastic Socket (12/3)	<0.1 mm (<0.1 mm in 16 hours)
2. Glass Ball (12/5) in Plastic Socket (12/3)	0.5 mm
3. Plastic Ball (12/3) in Glass Socket (12/5)	0.5 mm (2.5 mm in 1 hour)
4. Glass Ball (12/5) in Glass Socket (12/5)	358 mm

* All joints selected at random
** Static System

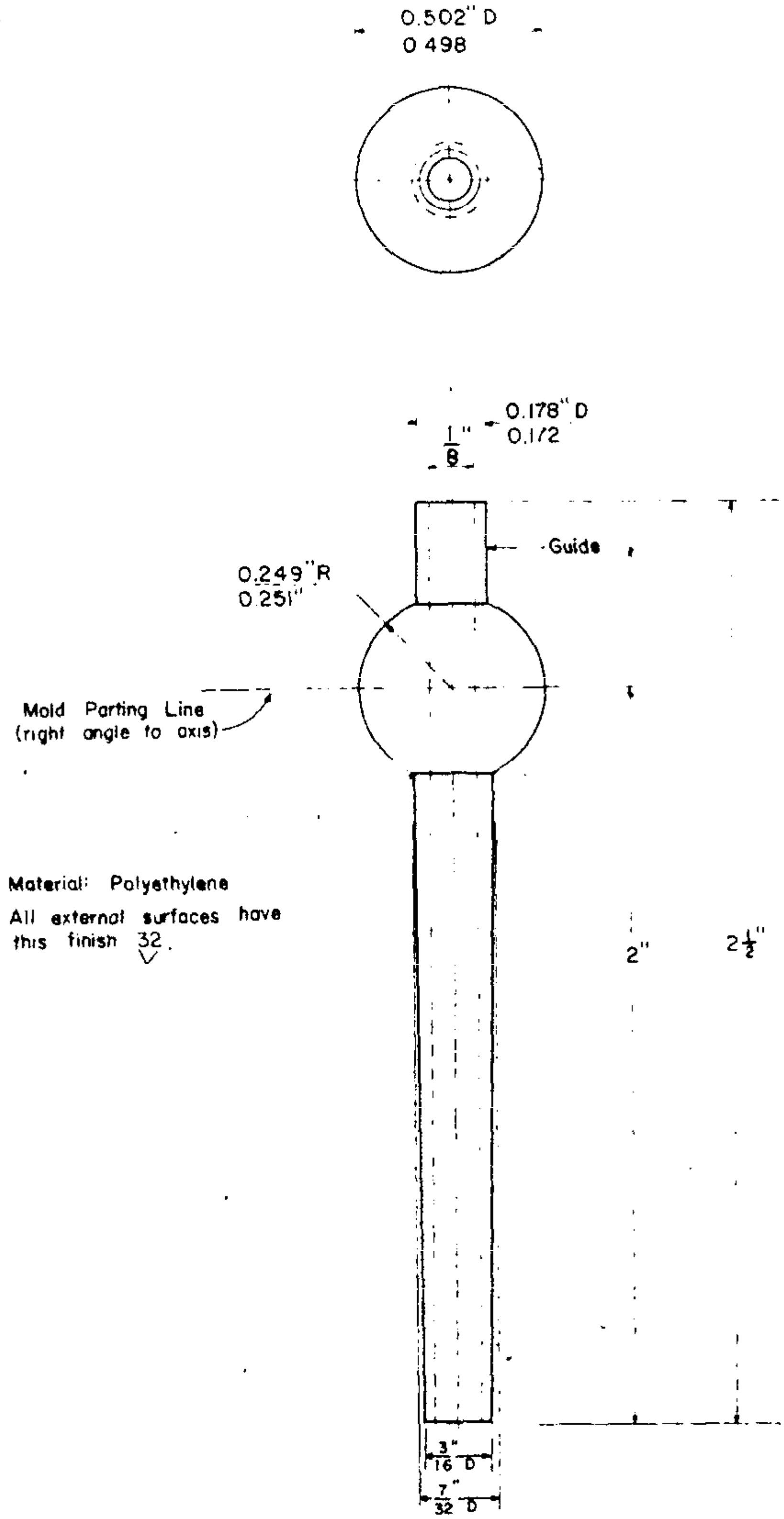

FIGURE 1 - 12/3 BALL JOINT

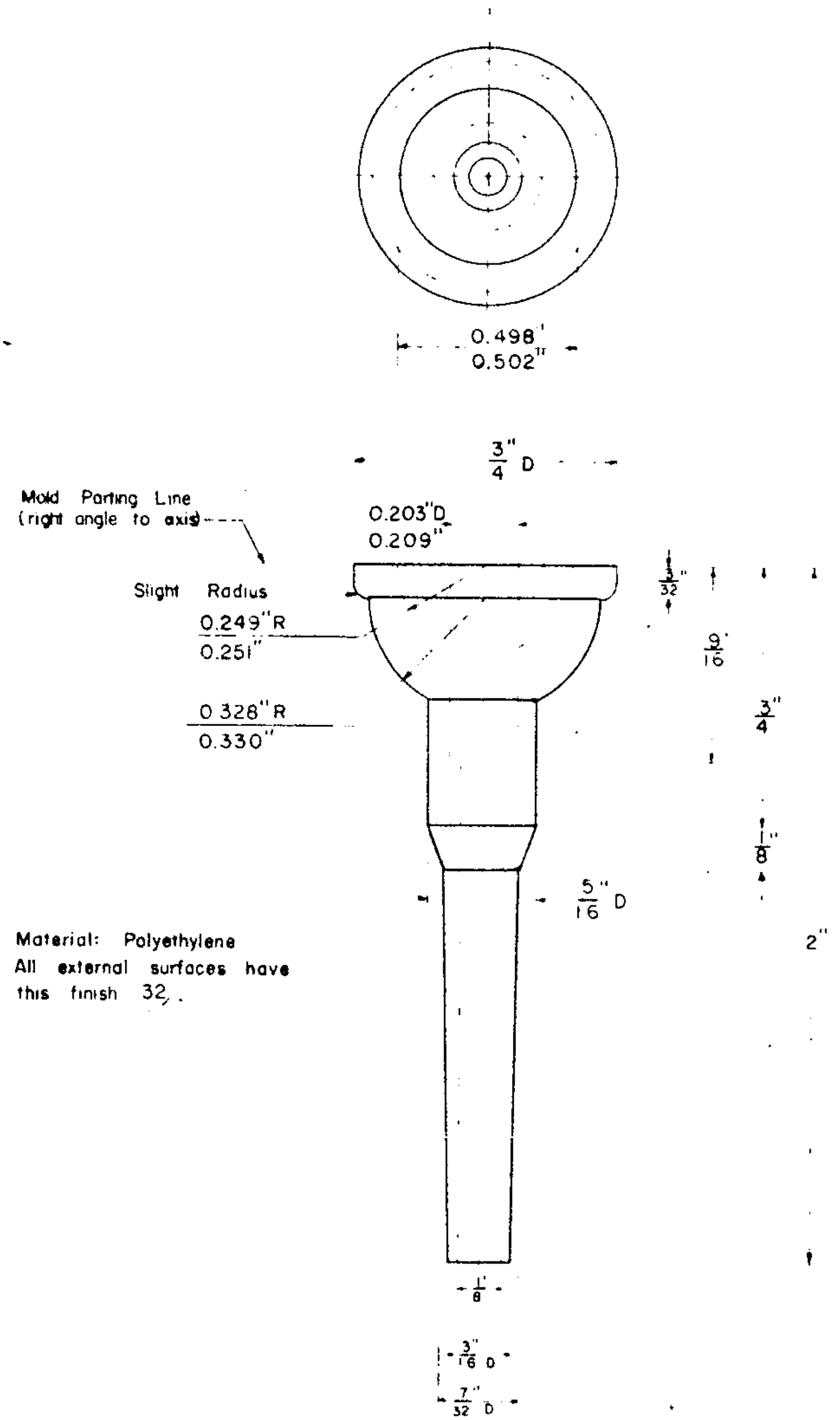

FIGURE 2 - 12/3 SOCKET JOINT

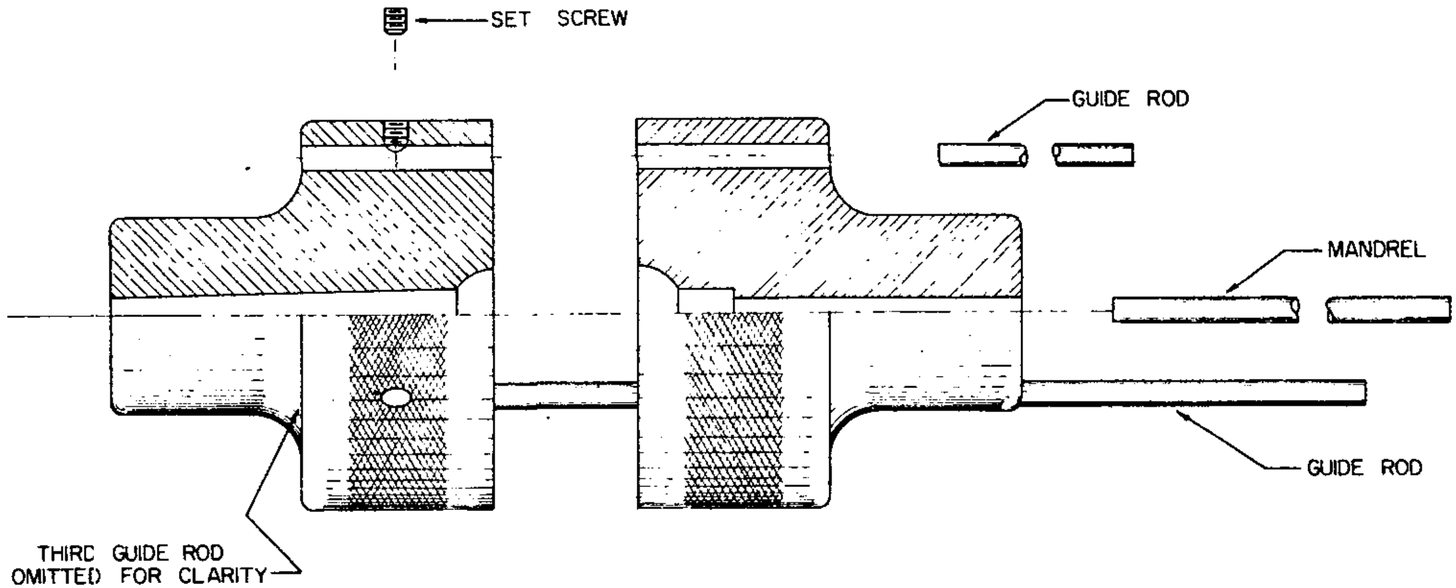

Figure 3 – Mold for 12/3 polyethylene ball

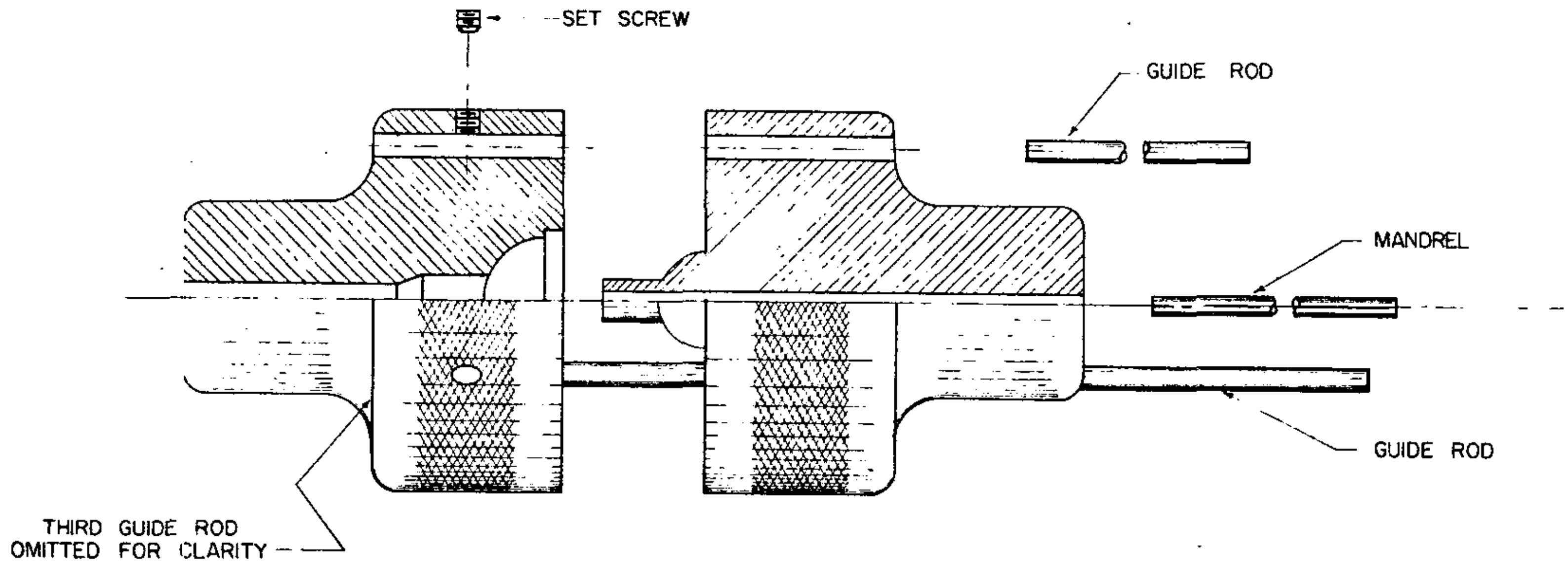

Figure 4 - Mold for 12/3 polyethylene socket

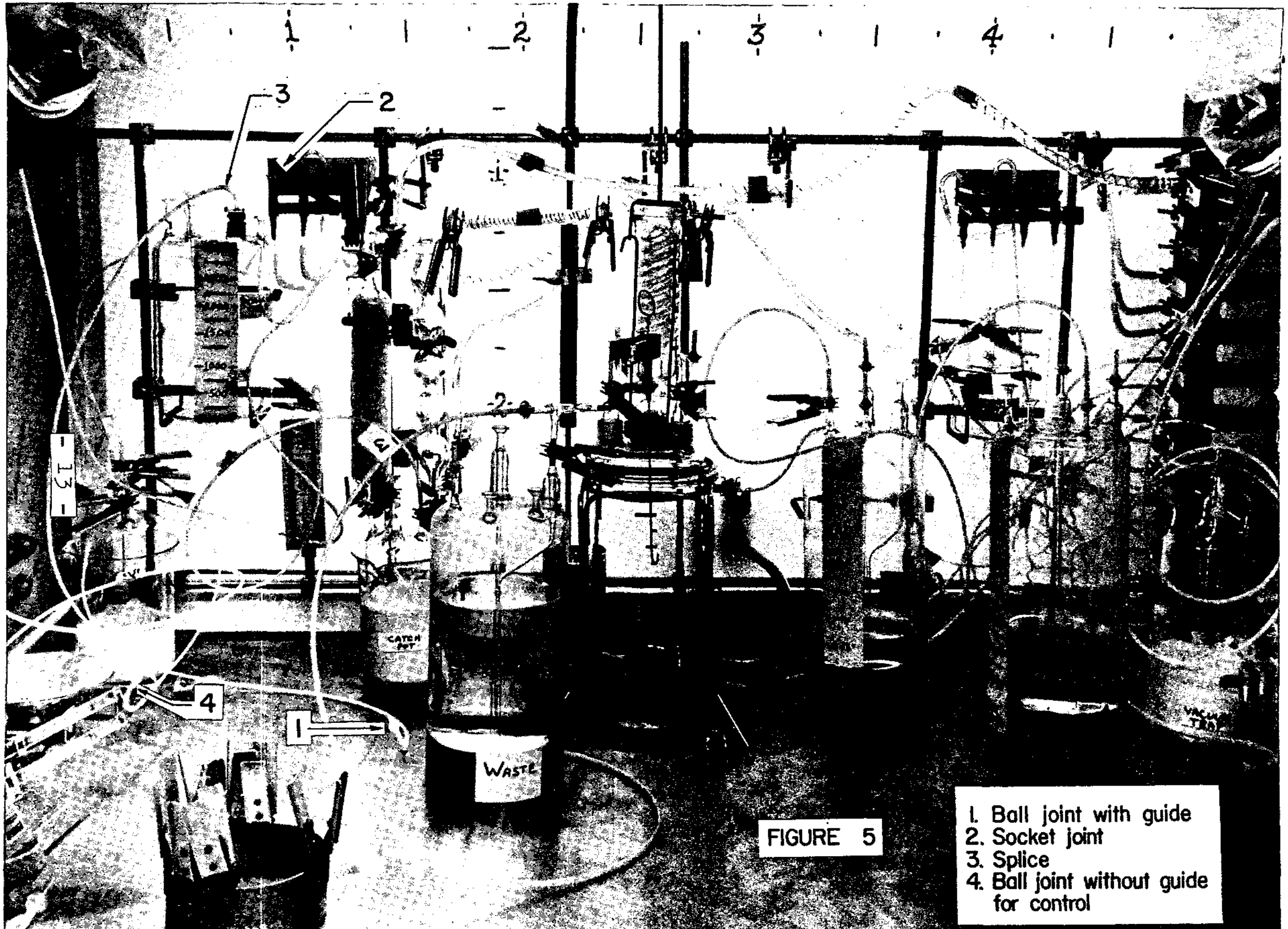

FIGURE 5

1. Ball joint with guide
2. Socket joint
3. Splice
4. Ball joint without guide for control

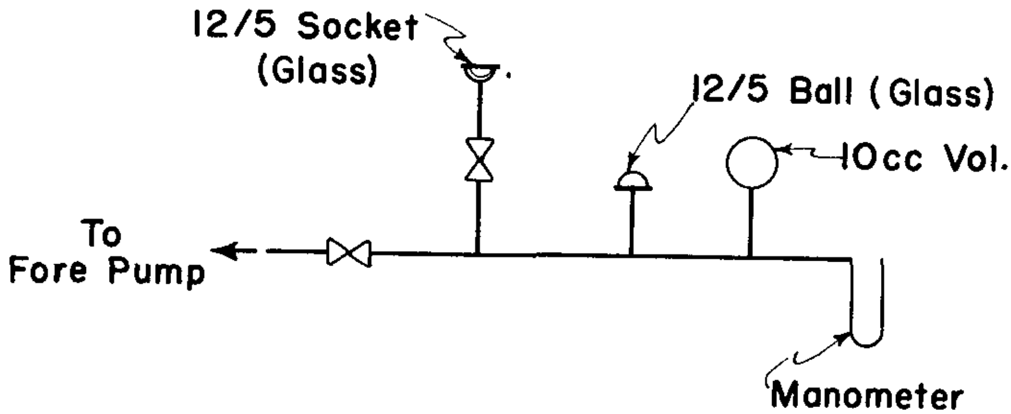

Figure 6 – Apparatus for Testing Plastic 12/3 Ball and Socket Joints