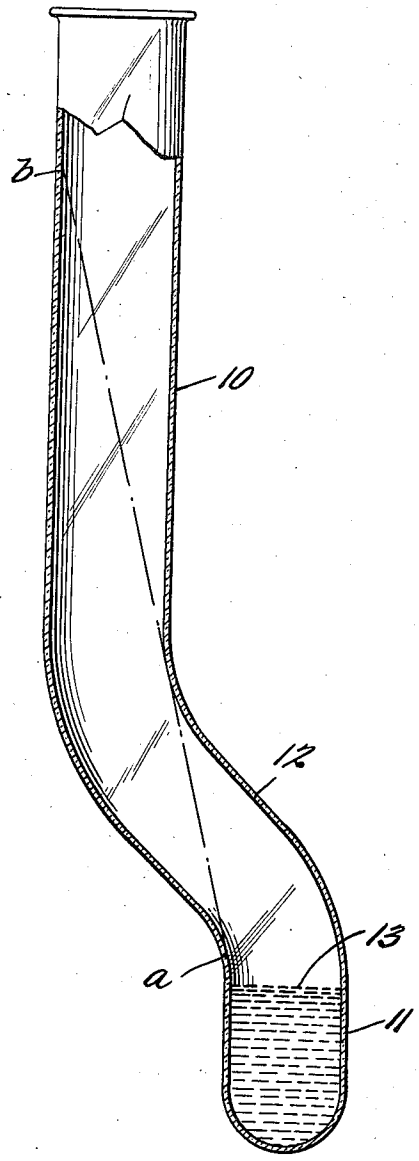
June 30, 1942. J. BENOTTI 2,288,065

DIGESTION TUBE

Filed April 10, 1941



Inventor

Joseph Benotti

By Watson, Cole, Grindle & Watson

Attorneys

Patented June 30, 1942 2,288,065

UNITED STATES PATENT OFFICE

2,288,065

DIGESTION TUBE

Joseph Benotti, Weston, Mass., assignor to Ethan Allan Brown, Boston, Mass.

Application April 10, 1941, Serial No. 387,951

3 Claims. (Cl. 23—292)

The present invention relates to chemical apparatus and particularly to the devices commonly designated digestion tubes and which are used daily in the determination of proteins by digestion and for heating or boiling small quantities of liquids.

The common digestion tube is a cylinder of glass, open at one end and closed at the other and being generally quite straight. Tubes of this kind may be conveniently kept in racks and may be most efficiently used for heating or boiling liquids, a small body of liquid being placed within it and the tube then held over a flame. The tube is of such length and diameter that its elongated upper portion comprises not only a handle by means of which it may be supported and manipulated, but likewise a charging and discharging tube and a spatter and vapor retaining guard which, in most cases, effectively prevents the escape of heated droplets of liquid from the mouth of the tube when a boiling operation is being conducted. Other types of vessels have been heretofore fabricated of glass or other materials, for special purposes, such apparatus, however, being clearly distinguishable from the digestion tube because of its complicated nature, and special and unusual shapes and purposes. The present invention is readily distinguishable, however, from all such prior special apparatus designed particularly for performing certain definite functions only in that it is capable of use for heating, boiling and digesting purposes generally. In accordance with the invention, a digestion tube is provided which is so constructed that spattering of liquid from the mouth of the tube during a liquid boiling operation is never possible, even when the boiling proceeds vigorously and the liquid being boiled is of viscous nature.

Those laboratory workers who boil small bodies of relatively viscous liquids in tubes are well aware of the difficulty and danger occasioned by the phenomenon known as "bumping." When a relatively viscous liquid is heated to the boiling point, all or a substantial portion of its upper strata or layer may be thrown upwardly at one time toward the mouth of the tube. Sometimes a very substantial amount of liquid will be thrown completely out of the tube due to the sudden development of gas or vapor pressure within the body of the liquid being heated, which gas cannot readily escape due to the viscosity of the liquid above it, and therefore lifts the upper layer of liquid suddenly. With the straight tube, the possibility of physical injury to the operator and to nearby apparatus due to bumping is always present when a relatively viscous liquid is being boiled or digested. And, more important, since the amount which has escaped cannot be measured with accuracy, quantitative estimations must necessarily be approximate, even with the most skillful technique.

In accordance with the present invention, a tube is provided which, while maintaining all of the virtues and convenience of the widely known and used straight tube, nevertheless is so formed that all possibility that the contained liquid or any part of it can be thrown directly from the mouth of the tube is obviated. To obtain this desirable result, the upper and lower portions of the tube are laterally offset; i. e., the lower or closed end of the tube is offset laterally a substantial distance from the axis of the upper or open ended portion of the tube and these two portions are connected by a reversely curved intermediate portion. The diameter of the tube is such, and the curved intermediate portion so designed, that no droplet of liquid thrown upwardly from the surface of the liquid being boiled in the bottom of the tube can pass directly through the mouth of the tube and thus escape. On the other hand, such a spattering drop of liquid must necessarily either impinge against the surface of the intermediate reversely curved portion of the tube or against the surface of the upper portion of the tube, flowing downwardly and returning to the body of liquid being boiled after being thus intercepted.

The reversely curved intermediate portion likewise wholly eliminates the possibility of liquid escape due to "bumping." Any portion of the body of liquid in the well which moves upwardly in the form of a substantial mass will strike against the inner surface of the intermediate reversely curved portion of the tube and will, after thus being intercepted, immediately fall downwardly into the liquid boiling or well portion of the tube. Under these conditions, it is, of course, possible for the operator or laboratory worker to boil, as rapidly as he wishes, any liquid introduced into the bottom of the tube and without danger of loss of such liquid due to its passage from the mouth of the tube in the form of small droplets or larger bodies. Since the tube can be graduated, and because no liquid is lost, quantitative estimations, especially protein digestion, and determination can be performed with a speed, convenience and accuracy not at present obtainable.

In the accompanying drawing, a tube of the improved character heretofore briefly described

is illustrated, this tube being shown partially in longitudinal axial section and partially in elevation. The upper portion of the tube is generally indicated at 10 and comprises a straight cylinder of glass, preferably with an external flange or bead at its upper end, the length of this portion 10 being preferably between four and five times its diameter, and this portion comprising a charging, discharging, and spatter and vapor retaining part. The lower end of the tube, indicated at 11, is a short cylinder having an end closure, the axis of this cylindrical portion being preferably parallel to the axis of the upper portion 10, but being laterally offset from that axis as shown. The depth of this portion of the tube may vary, but desirably may be somewhat greater than its diameter, at least having a cylindrical outer surface of such length that the tube may be supported in erect position by placing this lower end in the cylindrical tube receiving opening of a tube rack. The degree of offset may be varied within the import of the invention, but the intermediate portion 12 connecting the upper and lower portions 10 and 11 respectively should be smoothly curved so that this portion will function as a true continuation of the charging, discharging and spatter retaining portion 10, having the capacity to transmit smoothly liquids to or from the boiling well 11. The extent of lateral displacement of the liquid well 11 from the upper portion 10 of the tube will depend upon the length of the tube and its diameter, but in every instance, will be such that no portion of the area of a body of liquid in the well portion 11 of the tube can be seen by looking into the open upper end of the tube. In other words, the extent of offset is such that no droplet of liquid spattered from the surface of the body of liquid in the tube, which surface is indicated by the numeral 13, can pass directly out of the open end of the tube. The chain line *a, b* indicates the possible line of travel of a droplet of liquid which could most closely approach the mouth of the tube, but it will be seen that even if such droplet followed the dotted line *a, b*, it must nevertheless necessarily strike the side wall of the tube below the month and hence be intercepted. Thus, there is no possibility of direct spattering from the tube due to bumping or spattering. When bumping occurs, as, for instance, when a viscous liquid is being boiled, the body of rising liquid will strike directly against the surface of the intermediate connecting portion 12 of the tube and will immediately start to descend under the influence of gravity. It will promptly run down the inner surface of the curved portion of the tube and quickly rejoin the body of liquid being subjected to boiling.

The advantages of using a tube of this construction have been pointed out and it need only be said that the tube can be made at a cost comparable to the cost of a straight tube, may be handled almost as conveniently as a straight tube, while insuring against the loss of liquid during any certain operation, as well as adequately safeguarding the laboratory worker and nearby equipment.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A digestion tube having a closed end and an open end, the portion of the tube adjacent the end closure comprising, with such closure, a relatively shallow and wide well for retaining a body of liquid to be mixed, heated, dissolved, boiled or digested, and a length of said tube adjacent its open end comprising a relatively long charging, discharging and spatter intercepting portion, said portions being interconnected by an intermediate reversely curved portion through which liquid may freely flow but which will intercept boiling liquid thrown upwardly from a body of boiling liquid in the well portion.

2. A digestion tube having a closed end and an open end, the portion of the tube adjacent the end closure comprising, with such closure, a relatively shallow and wide well for retaining a body of liquid to be treated, and a length of said tube adjacent its open end comprising a relatively long charging, discharging and spatter intercepting portion, said portions being disposed in parallelism and being connected by a reversely curved portion through which liquid may freely flow but which will intercept boiling liquid thrown upwardly from a body of boiling liquid in the well portion.

3. The combination set forth in claim 1 in which the intermediate reversely curved portion of the tube is interposed at all times between the open mouth of the tube and all points on the surface of a body of boiling liquid in the well portion, to prevent direct spattering of liquid from the mouth of the tube.

JOSEPH BENOTTI.