

Oct. 12, 1943.

H. ALBERTINE

2,331,284

VISCOSIMETER

Filed July 16, 1941

2 Sheets-Sheet 1

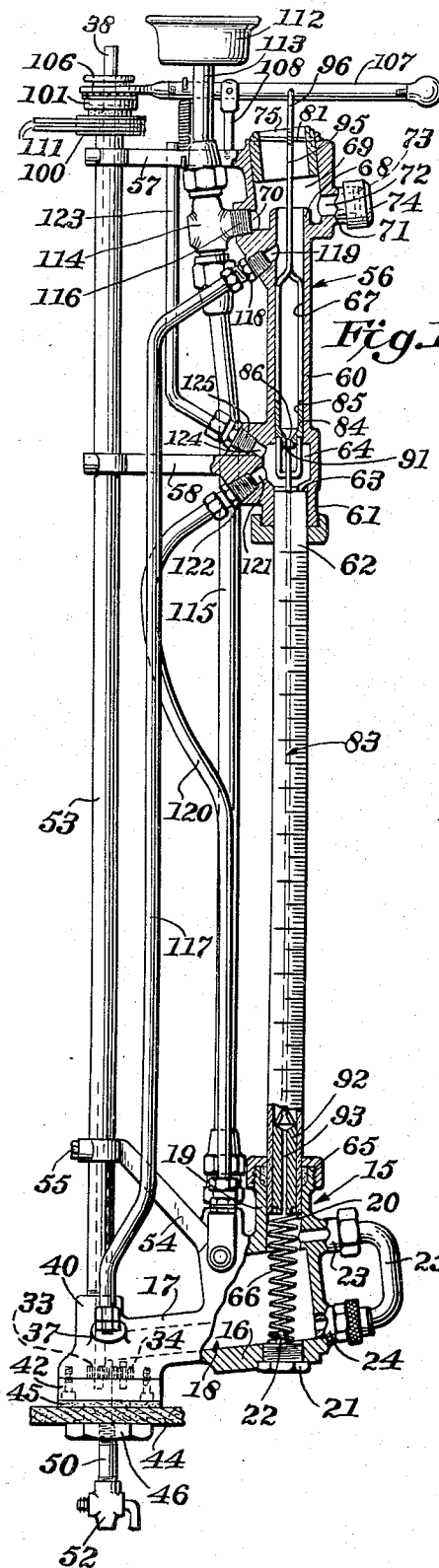


Fig. 1.

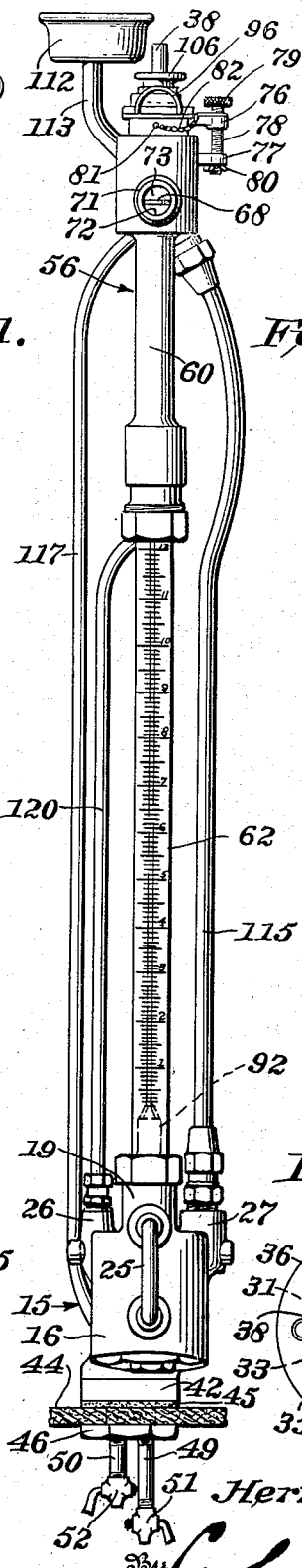


Fig. 2.

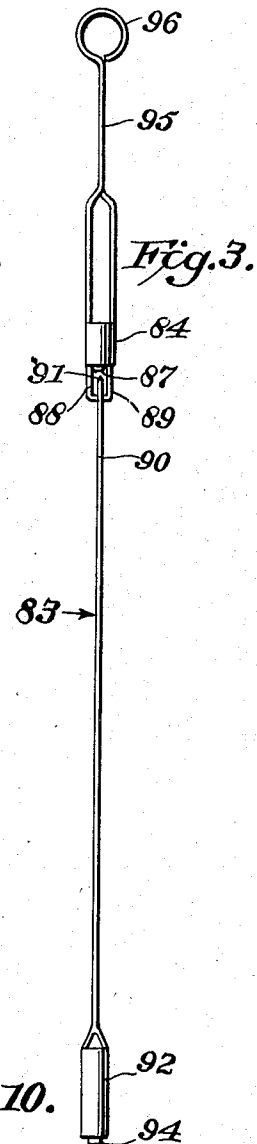
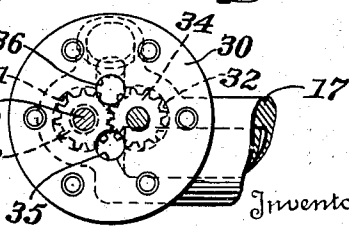


Fig. 3.

Fig. 10.



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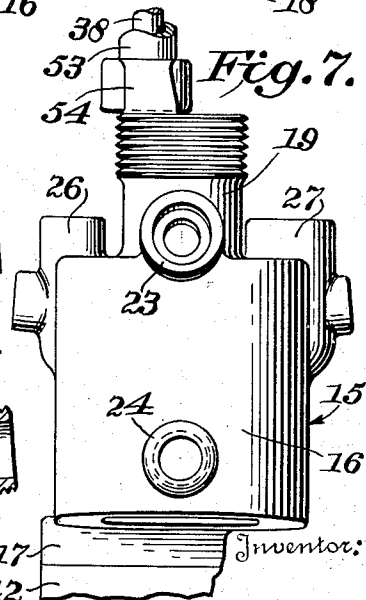
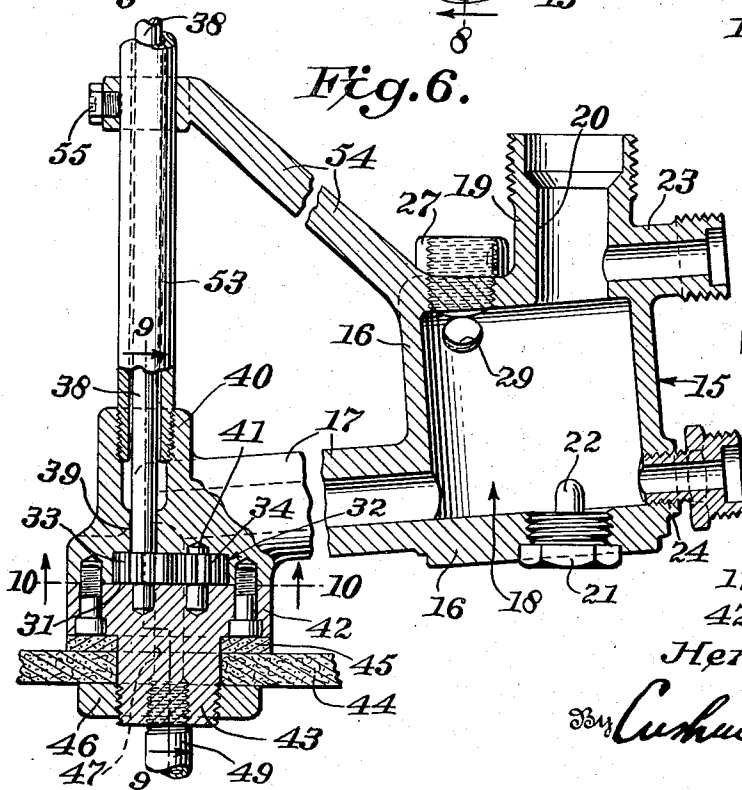
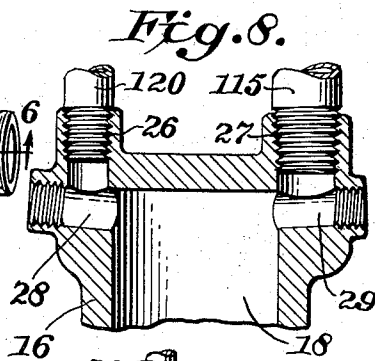
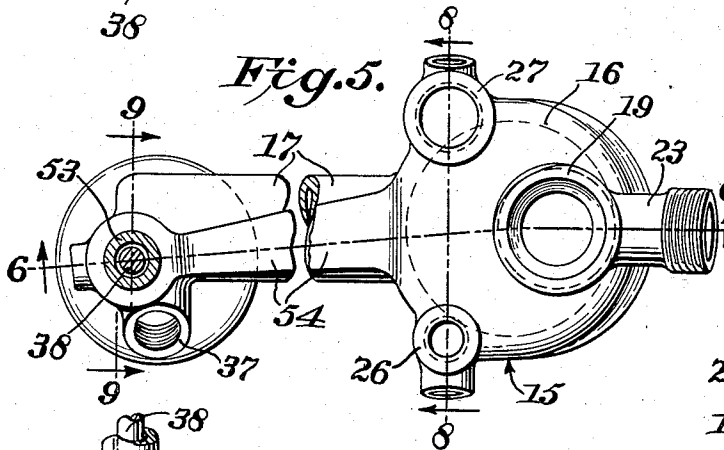
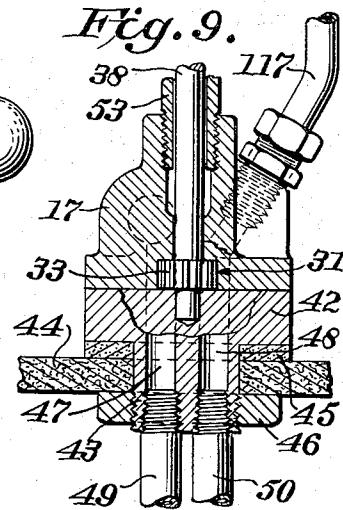
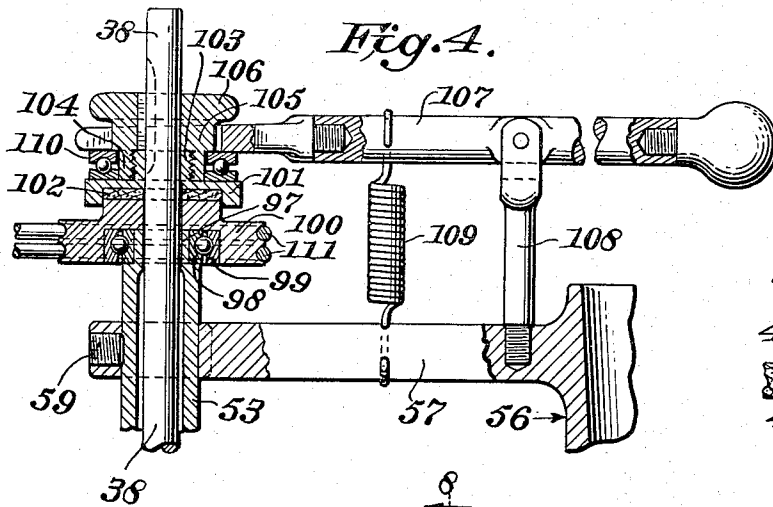
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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VISCOSIMETER

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14 Claims. (Cl. 265—11)

This invention relates to apparatus for measuring the viscosity of liquids such as, for example, lubricating oil. An object of the invention is to provide apparatus of this nature from which a reading may be readily taken. Another object is to provide apparatus which may be readily and thoroughly drained and cleaned after each operation and in this connection an object of the invention is to provide a capillary assembly or unit which may be readily removed and replaced. A further object is to provide a capillary assembly which may be adjusted longitudinally of the measuring tube in which it is disposed with the parts of the assembly always in predetermined relation. A further object is to provide for proper flow-guidance of the liquid in the measuring tube in a manner to prevent turbulence and air entrainment. Still another object is to provide a simple and compact unitary structure designed throughout for the attainment of quick and accurate readings in use. How these and other objects are attained will be described with reference to the accompanying drawings in which:

Figure 1 is a side elevation, partly in vertical section, of an illustrative, and at present preferred, embodiment of the invention.

Figure 2 is a front elevation of the apparatus of Figure 1.

Figure 3 is an elevation of a capillary unit which appears also in Figure 1 and is visible in part in Figure 2.

Figure 4 is a vertical section, on an enlarged scale, of certain drive and control instrumentalities which appear in elevation at the upper left of Figure 1.

Figure 5 is a plan view, with parts in section and with other parts removed, of a base portion which appears at the bottom of Figure 1.

Figure 6 is a section on line 6—6 of Figure 5.

Figure 7 is a front elevation of the base portion shown in Figure 5.

Figure 8 is a section substantially on line 8—8 of Figure 5.

Figure 9 is a section substantially on line 9—9 of Figure 5, and

Figure 10 is a section substantially on line 10—10 of Figure 6.

Referring to the drawings, reference numeral 15 designates generally the base portion of the apparatus, this including a hollow body portion 16 and a hollow foot portion 17 which constitute together a reservoir 18. The body portion 16 has a vertical neck portion 19 provided with a vertical cylindrical bore 20 which runs into the reser-

voir 18. In a bore in the bottom wall of body portion 16 and coaxial with bore 20, is threaded a plug 21, the inner end of this plug, except for a spring centering boss 22, being flush with the inner surface of the bottom wall of the reservoir, this surface being inclined throughout downwardly and to the left, Figure 1. The front wall of the body portion has upper and lower projections 23 and 24 provided with parallel bores sloped as the bottom wall of the reservoir 18 and connected, through coupling nuts, with a U-shaped transparent tube 25 whose arms are inclined as the bores with which they are flushly joined.

Projecting upwardly from the body portion 16 are hollow necks 26 and 27 which through inwardly and downwardly sloped counterbores 28 and 29, Figure 8, are in connection with the reservoir 18, these being plugged in use.

The foot portion 17 of the base casting has a flat horizontal circular bottom surface 30 in which are formed intersecting bores 31 and 32 for the reception of pump gears 33 and 34. A bore 35, which appears most clearly in Figure 10, connects with the hollow interior of the foot portion and constitutes the pump inlet. A pump outlet 36 leads to a hollow protuberance 37 at the top and at one side of the foot portion.

Gear 33 is fixed to a vertical shaft 38 which is journaled in a coaxial bore 39 just above the gear and extends upwardly through a hollow internally threaded neck 40, as most clearly shown in Figure 6. A coaxial bore above gear 34 provides a bearing for the axle pin 41 of the gear. Secured and sealed against the bottom surface 30 is a bottom cap 42 provided with bores which receive and journal a lower extension of shaft 38 and the lower portion of pin 41. The cap 42 has a reduced neck 43 which as here shown is passed through an opening in a horizontal wall 44 so that the base is supported on the latter through a gasket 45 and is secured by means of a nut 46 threaded on the extremity of the neck 43 against the bottom wall. Cap 42 is provided with vertical bores 47 and 48, most clearly shown in Figure 9, communicating with the inlet and outlet sides of the pump respectively, tubing sections 49 and 50 being threaded flushly into the bores and equipped at their lower ends with petcocks 51 and 52, respectively, for drainage purposes.

Threaded into the neck 40 is a rigid vertical tube 53 which constitutes a housing for shaft 38, the tube extending through an opening in an arm 54 which projects from the body portion 16 and being secured therein by a set screw 55.

Reference numeral 56 designates generally a head having parallel arms 57 and 58 through openings in the ends of which the upper portion of tube 53 extends to be rigidly fixed by set screws as at 59, Figure 4. Head 56 includes a tubular portion 60 aligned with the bore 20 of the base portion 16. The lower end 61 of the tubular portion 60 is constituted as a stuffing box in which is engaged the upper end of a transparent graduated measuring tube 62, the upper extremity of the tube bearing against a shoulder 63 which forms the annular bottom boundary of an enlargement 64, the upper surface of this boundary being sloped downwardly throughout and flushly overlying the end of the tube.

The lower end of tube 62 is received in the bore 20 and engaged in a stuffing box 65. To prevent the tube from jarring downwardly, its lower end is engaged by a compression spring 66 whose lower end rests on plug 21 and is centered by boss 22. Both the tube 62 and the spring 66 are insertable through the opening which plug 21 closes, or they may be inserted in the base prior to securing the head on housing 53.

Above enlargement 64 tubular portion 60 has a bore 67 having a diameter at least as large as the internal diameter of tube 62. The bore is continued through an annular extension 68 which projects upwardly into a cylindrical enlargement 69, the upper end of the extension being outwardly beveled. The bottom wall of the enlargement is sloped throughout toward an outlet port 70 which is similarly sloped. A neck 71 opposite the outlet 70 has a bore 72 sloped as the latter, the outer end of the bore being closed by a transparent disc 73 which is retained by an annular nut 74.

Slidable in the upper end of enlargement 69 is a ring 75 which has a laterally projecting ear 76 overlying an ear 77 on the head 56, Figure 2. Threaded in ear 76 is a screw 78 which for manipulation has a knurled head 79, the lower end of the screw being cylindrically reduced and having thrust and journal support in a bore in ear 77, the screw being retained by a cotter pin 80 below the latter. It will be evident that by turning screw 78 ring 75 will be threaded upwardly or downwardly thereon. The ring is provided with aligned horizontal bores in a fore and aft axial plane, these bores removably receiving a pin 81 which may be secured at one end to a flexible retainer 82 whose other end is fastened to the ring.

The capillary unit hereinbefore referred to is generally indicated by the reference numeral 83. It comprises an upper cylindrical plug 84 having a diameter affording a close sliding and sealing fit in bore 67 of the head. The plug 84 has an upper central bore 85 countersunk to a bottom central restricted orifice 86 below which is a short nozzle-like extension 87. Rod portions 88 and 89 secured in the lower end of plug 84 have lower portions bent toward each other and welded or otherwise fixed to a rod 90 which is coaxial with bore 86 and has a pointed end 91 slightly below the formation 87.

The lower end of rod 90 is forked into and secured to the top of a cylindrical plug 92 dimensioned for a close sliding and sealing fit in tube 62. The plug 92 has a countersunk top surface and is provided with an axial bore 93 which is continued through a bottom nozzle-like extension 94, the bore being coaxial with rod 90. The rod rigidly maintains a predetermined spacing between plug 84 which defines the flow orifice 86

and plug 92 which defines the flow-retarding passage 93.

A manipulating rod 95 has a lower bifurcated end secured to the top of plug 84 and at its upper end is formed as a ring 96 of such diameter that it can engage the top edge of ring 75 at opposite points for the support of the capillary unit. When thus supported, pin 81 can be inserted in ring 75 to the position shown in Figure 1 to engage the inner bottom of ring 96 and thus hold down the capillary assembly. Under these conditions the capillary assembly will be caused to follow ring 75 as adjusted by screw 78, or upon removal of pin 81, the assembly can be easily withdrawn upwardly for cleaning or replacement.

Referring to Figures 1 and 4, the upper end of housing 53 is restricted to provide a bearing portion 97 for the upper end of shaft 38 and also to provide a shoulder 98 on which is supported the inner race of a ball bearing assembly 99 received in a cylindrical cavity of a pulley 100 which is freely rotatable with respect to shaft 38, the pulley having thrust support on the upper end of the bearing portion 97. Pulley 100 constitutes the driving member of a clutch whose driven portion comprises a cup 101 which carries a friction disc 102 cooperable with a top cylindrical boss portion of the pulley. Cup 101 has an upwardly projecting neck 103 threaded into a collar portion 104 of a member 105 which has an upper circumferential flange 106 under which is engaged the forked end of a shipper 107 pivoted on a stud 108 rising from arm 57 and pulled downwardly by a tension spring 109 connected between the shipper and the arm. A ball bearing assembly 110 is interposed between the forked end of the shipper and the top of cup 101. The driven portion of the clutch, constituted by cup 101 and member 105 is splined on shaft 38.

With the parts in the relation shown in Figure 4 and drive to the pulley 100 being transmitted from any suitable source through belts 111, shaft 38 will be driven, since the clutch is closed by spring 109 which causes the shipper to bear downwardly on the ball bearing assembly 110 and thus press the friction disc 102 against pulley 100. If it is desired to interrupt the drive, shipper 107 is swung and through engagement with flange 106 lifts the driven member of the clutch to open the latter. Rotation of shaft 38, of course, causes the operation of the pump gears 33 and 34.

A bowl 112, Figures 1 and 2, is connected by a pipe 113 into a fitting 114 and therethrough to a pipe 115 which is connected into the neck 27 of body portion 16. Fitting 114 is branched flushly into outlet port 70 through a nipple 116 whose passage is inclined as the port. The inner bottom wall of the bowl is sloped throughout and flushly to the pipe 113.

A pipe 117 is connected into protuberance 37, being thus in communication with the outlet side of the pump, and extends upwardly to be connected flushly through a fitting 118 into an inclined port 119 which debouches upwardly and inwardly into bore 67 of the head 56, the passage of the fitting being inclined as the port. A pipe 120 leads upwardly from the hollow neck 26 of the body 16 and has its upper end flushly connected into a port 121 through a fitting 122, the port being downwardly and outwardly inclined from enlargement 64 and the passage of the fitting being similarly inclined. Finally, an upwardly extending pipe 123 is flush-

ly connected into a bore 124 through a fitting 125, the bore being downwardly inclined into the head enlargement 64 above bore 121, and the passage of fitting 125 being inclined as bore 124.

It is herein assumed that the described apparatus is mounted on the bottom 44 of a tank which for the purpose of temperature control may contain, for example, distilled water whose temperature is regulated in any suitable manner, the level of the liquid being, of course, below any open portions of the apparatus. With the apparatus at rest, a suitable amount of the liquid to be tested is run into the pan 112 and thence flows through pipes 113 and 115 and fitting 114 to the reservoir 18 in the required amount which may be observed through gauge 25. It is important that a fairly certain amount of liquid be introduced into the reservoir. It should not be up to the lower end of plug 93, nor should it be so small with respect to the capacity of the pump that air will be entrained.

With the proper amount of liquid in the reservoir, drive to the pump is started and fluid from the reservoir is consequently delivered through pipe 117 and port 119 to the bore 67 above plug 84. The liquid delivery is in amount greater than that which can escape through flow orifice 86 and consequently there is an overflow at the top of extension 68 and through port 70, fitting 114, and pipe 115 back to the reservoir. A constant head, which may be observed through the transparent disc 73, is thus maintained above orifice 86. Liquid escaping through orifice 86 meets the pointed upper end of rod 90 and flows down the rod to the plug 93, the rod being so much smaller than the internal diameter of tube 62, that the liquid is guided downwardly entirely out of contact with the tube walls. The provision of this flow guiding means is of great importance in preventing turbulence, air entrainment etc., and it has been found that if the liquid is permitted to run down the walls of the tube, errors in reading will result.

The flow retarding passage 93 of plug 92 is of such diameter and length as to have a definite flow retarding value with respect to the capacity of orifice 86. With this relationship established, the liquid will back up above plug 92, in accordance with its viscosity, until at some point in the tube a substantially constant head is maintained, this head being visible through the walls of the tube with reference to suitable calibrations on the latter, to give a reading determinative of the relative viscosity.

It sometimes happens that the liquids being tested form a scum on the inside of the tube 62 or perhaps some foreign matter may be injected, lodging in the orifices and thus affecting accuracy. In such case it is a simple matter to withdraw the complete capillary unit, thoroughly clean it and return it with the assurance that it will be returned in toto to its original disposition relative to tube 62. Also, in testing liquids greatly outside of the ordinary range, appropriately modified assemblies may be substituted.

The measuring tube 62 vents to atmosphere through pipe 123 as does also the reservoir 18 through the intermediary of pipe 120. Bore 67 and pipe 113 are upwardly open.

It will be noted from the drawings and from the description that all liquid conduits, air vents, etc. are directed downwardly throughout to the drainage cocks 51 and 52, and all joints are flush. Consequently, upon opening the cocks at the

completion of a testing operation, the apparatus may be thoroughly drained and flushed out with the use of only a small quantity of circulated cleaning fluid. There is no place for the fluid to hang when the drainage cocks are opened. The importance of this feature will be understood when it is recognized that only a few drops of liquid varying in viscosity from the liquid being tested will seriously affect the accuracy of the test.

Base 16 and head 56 can be conveniently cast in metal or moulded in plastic. These parts and the measuring tube should have the same coefficient of expansion, in order to prevent undue strain and consequent inaccuracies under temperature changes.

While, as hereinbefore stated, the invention has been shown in an embodiment at present preferred, I do not necessarily limit myself to the form and arrangement of parts shown. Variations in these respects are contemplated in the claims which follow.

I claim:

1. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, and flow-guiding means below said orifice receiving the flow from the latter and guiding it downwardly out of contact with the inner walls of said tubular means.

2. Apparatus according to claim 1 wherein the flow guiding means is constituted by a rod disposed between said defining means in said tubular means and spaced throughout from the inner walls of the latter sufficiently so that liquid flowing down the rod will not contact said inner walls.

3. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, and means directly connecting the orifice defining means and passage-defining means to maintain a predetermined spacing between the two, the said defining means and connecting means constituting a unit removable lengthwise from said tubular means, said unit including a portion above said orifice by means of which the unit is manipulable.

4. Apparatus according to claim 3 wherein the connecting means is constituted by a rod substantially aligned with the orifice and passage and serving as flow-guiding means, said rod being spaced throughout from the inner walls of the tubular means sufficiently so that liquid flowing down the rod will not contact said inner walls.

5. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, means directly connecting the orifice defining means and passage-defining means to

maintain a predetermined spacing between the two, the said defining means and connecting means constituting a unit adjustable lengthwise of said tubular means, and means for maintaining said unit in adjusted position.

6. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, means directly connecting the orifice defining means and passage-defining means to maintain a predetermined spacing between the two, the said defining means and connecting means constituting a unit removable lengthwise from said tubular means, and a rod projecting upwardly beyond the upper end of said tubular means so as to be accessible for the manipulation of said unit.

7. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, means directly connecting the orifice defining means and passage-defining means to maintain a predetermined spacing between the two, the said defining means and connecting means constituting a unit removable lengthwise from said tubular means, a rod projecting upwardly beyond the upper end of said tubular means so as to be accessible for the manipulation of said unit, and means engaging the last-named rod for maintaining said unit in certain longitudinal relationship to said tubular means.

8. A viscosimeter comprising vertically disposed tubular means, means defining a restricted flow orifice at the upper portion of said tubular means, means defining a flow retarding passage below said orifice, means for maintaining above said orifice a constant head of the liquid whose viscosity is to be determined, the head attained above said passage indicating the viscosity of the liquid, means directly connecting the orifice defining means and passage-defining means to maintain a predetermined spacing between the two, the said defining means and connecting means constituting a unit removable lengthwise from said tubular means, a rod projecting upwardly beyond the upper end of said tubular means so as to be accessible for the manipulation of said unit, and means adjustable longitudinally of said tubular means engaging the last-named rod for maintaining said unit in certain longitudinal relationship to said tubular means.

9. For use in a viscosimeter having vertical tubular means which includes a measuring chamber, a unit comprising plug portions insertable in said tubular means and means connecting said plug portions to maintain a predeter-

mined spacing between the two, one of said plug portions being provided with an orifice for inflow into the measuring chamber and the other of said plug portions being provided with a flow-retarding passage for the outflow from said chamber.

10. A unit according to claim 9 wherein a manipulating rod is secured to the inflow plug, said rod projecting oppositely from the outflow plug.

11. A viscosimeter comprising a hollow base, a measuring tube extending vertically upwardly from the base and communicating with the interior of the latter, a tubular head on said tube in communication therewith, means in said head above said tube defining a flow orifice, means in the lower portion of said tube defining a flow-retarding passage, means for delivering liquid from said base to the interior of said head above said orifice in amount greater than the flow capacity of said orifice, an overflow outlet in said head establishing a constant head of liquid above said orifice, a pipe connecting said outlet with the interior of said base, and a filling tube in connection with said pipe.

12. A viscosimeter comprising a hollow base, a measuring tube extending vertically upwardly from the base and communicating with the interior of the latter, a tubular head on said tube in communication therewith, means in said head above said tube defining a flow orifice, means in the lower portion of said tube defining a flow-retarding passage, a pump in said base with its inlet side communicating with the interior of the latter, a pipe connecting the outlet side of the pump with the interior of said head above said orifice, the pump having a delivery capacity greater than the flow capacity of said orifice, an overflow outlet in said head establishing a constant head of liquid above said orifice, and a pipe connecting said outlet with the interior of said base.

13. Apparatus according to claim 12 wherein a drive shaft for the pump extends vertically therefrom, wherein a rigid tubular housing secured to the base is provided for said shaft, and wherein said tubular head is secured to said housing.

14. A viscosimeter comprising a hollow base, a measuring tube extending vertically upwardly from the base and communicating with the interior of the latter, a tubular head on said tube in communication therewith, means in said head above said tube defining a flow orifice, means in the lower portion of said tube defining a flow-retarding passage, means for delivering liquid from said base to the interior of said head above said orifice in amount greater than the flow capacity of said orifice, an overflow outlet in said head establishing a constant head of liquid above said orifice, a pipe connecting said outlet with the interior of said base, and venting means including a tube connecting the interior of the base with the head below said orifice and including a tube extending upwardly from said head from below said orifice.

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