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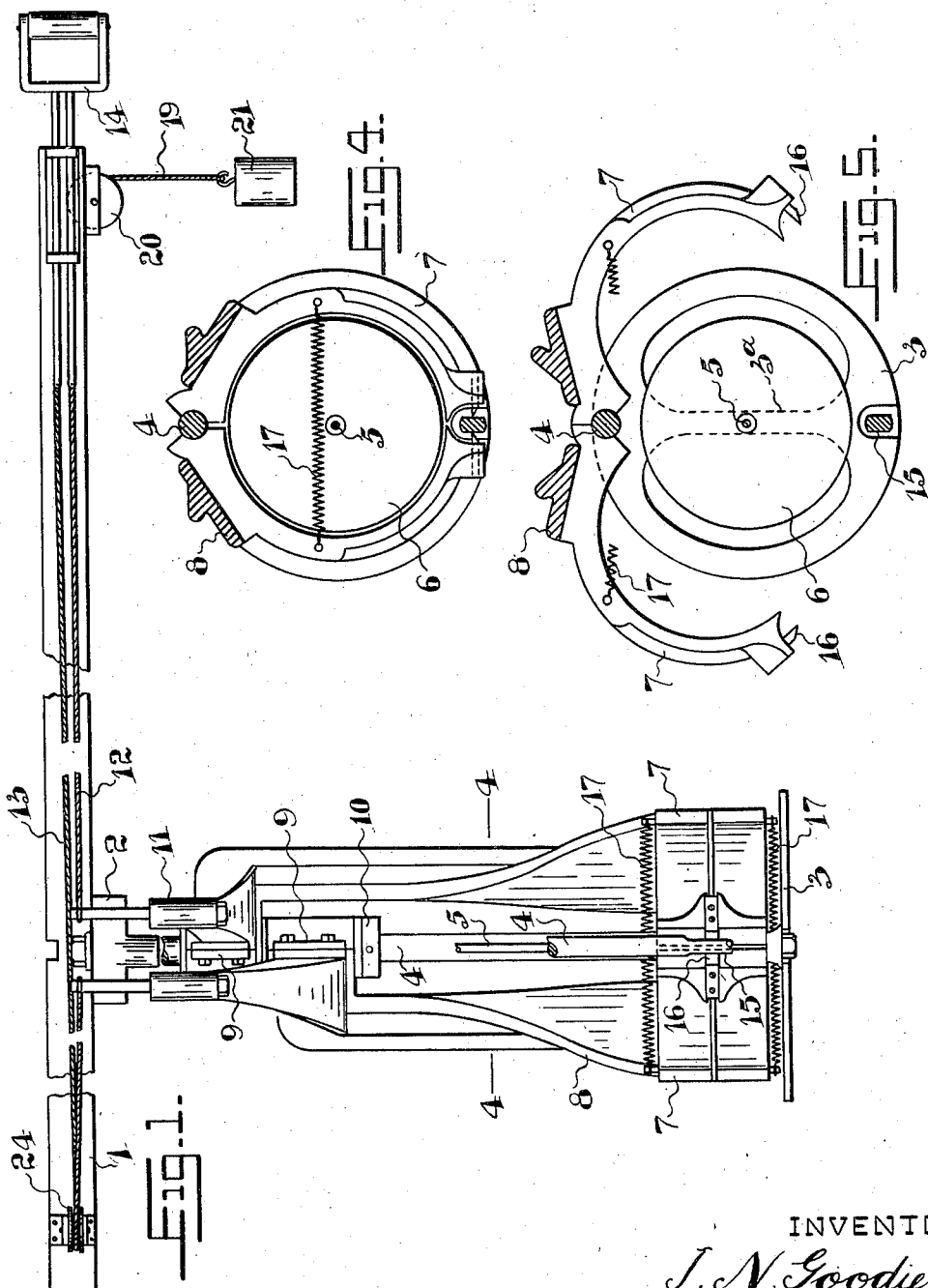
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2,074,175

VISCOSIMETER

Filed May 25, 1936

3 Sheets-Sheet 1



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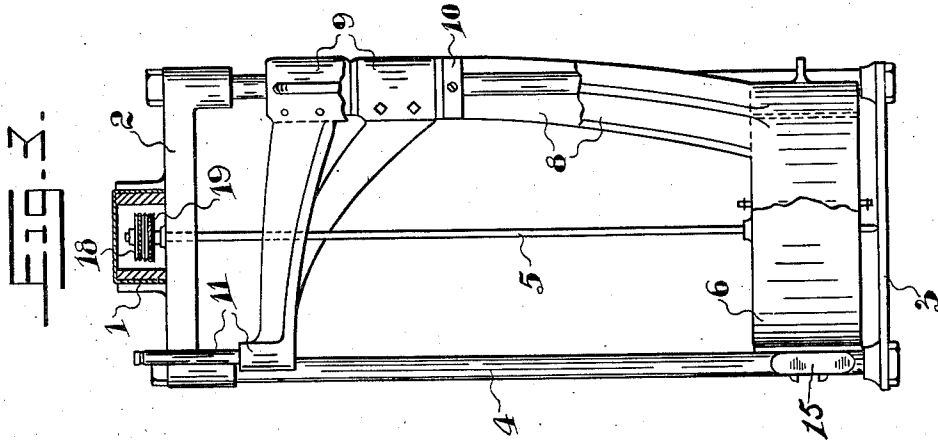
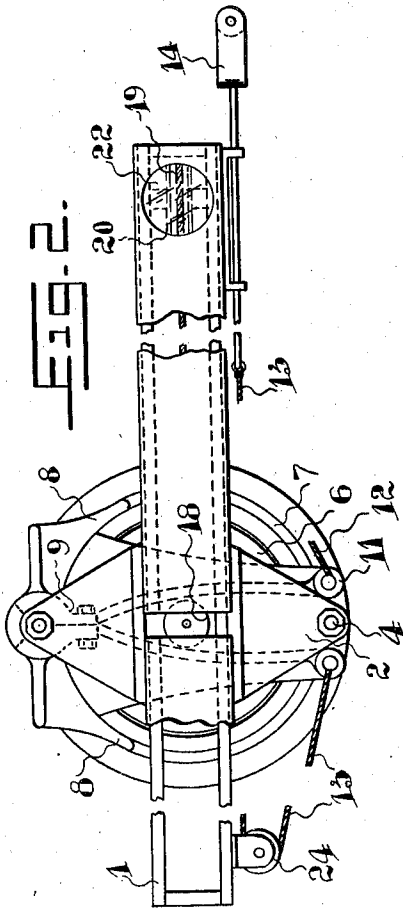
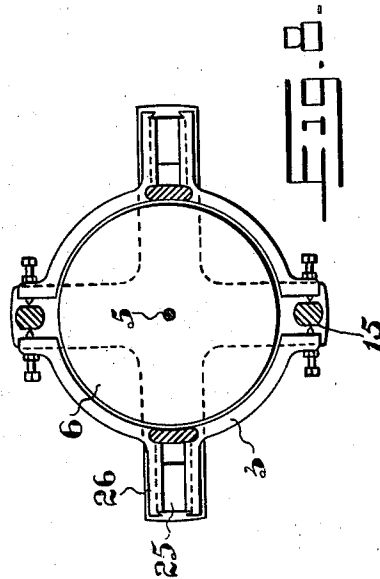
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3 Sheets-Sheet 2



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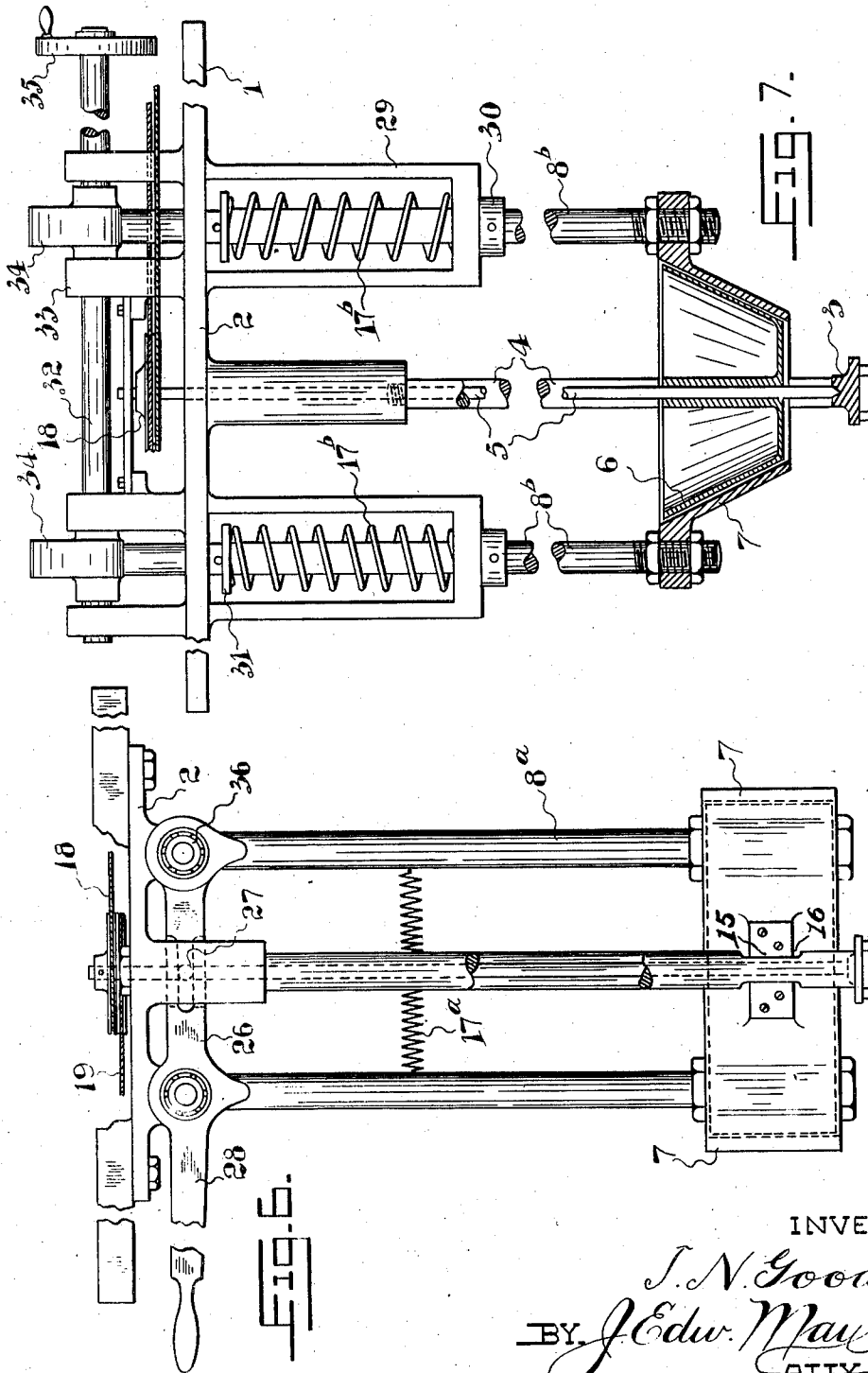
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VISCOSIMETER

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,074,175

VISCOSIMETER

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17 Claims. (Cl. 265—11)

This invention relates to a viscosimeter intended to be immersed in the liquid whose viscosity is to be tested, and my object is to provide a viscosimeter especially adapted for successive determinations of the viscosity of a liquid contained in a vessel and which is progressively changing in physical characteristics. It is known that viscosities can be determined by measuring the resistance to relative rotation of two concentric cylinders enclosing between them a thin annular film of the liquid but, as such devices are at present constructed, it is found that no amount of agitation of the liquid in the vessel will ensure the film changing with changes in the characteristics of the liquid in the vessel so that the film will at all times be truly representative of the liquid in the vessel.

My invention therefore consists in so constructing a viscosimeter of the aforesaid type that after a determination has been made the liquid surrounding the immersed parts of the instrument is agitated and a fresh film of liquid entrapped between the cylinders.

The invention may be briefly described as follows: Two concentric spaced cylinders, cones or other surfaces of revolution forming a stator and a rotor, are employed connected with a support by means of which they may be suspended in a tank containing the liquid to be tested. The space between the cylinders is open at both top and bottom and will vary widely in thickness for different liquids. For a patent leather daub a thickness of one-tenth of an inch has been found suitable. The inner cylinder is rotatably mounted while the outer is non-rotatable but is formed in parts displaceable from and replaceable to their position of co-operation with the inner cylinder while in the liquid to effect agitation of the liquid in which they are immersed and to enclose a fresh film of liquid on their return to their normal position. In a modification of the invention the rotor and stator are axially relatively displaceable and the latter is in one piece.

The invention is hereinafter more specifically described and is illustrated in the accompanying drawings in which

Fig. 1 is a front elevation of my improved viscosimeter;

Fig. 2 a plan view of the same;

Fig. 3 a side elevation, partly in section;

Fig. 4 a sectional plan on the line 4—4 in Fig. 1 with the parts of the outer cylinder in closed position;

Fig. 5 a view similar to Fig. 4 showing the parts of the outer cylinder in open position;

Fig. 6 a front elevation, partly broken away, showing a modified arrangement of the outer cylinder;

Fig. 7 a front elevation, partly in section, of another modification of the outer cylinder; and

Fig. 8 a plan view, partly in section, of a third modification.

In the drawings like numerals of reference indicate corresponding parts in the different figures.

Referring to the drawings, 1 is a suspension beam which is preferably formed as a tube. One of the functions of this beam is to rest on the rim of a vat in which it is desired to suspend the working parts of a viscosimeter. The frame of the viscosimeter includes a top frame 2 and a bottom frame 3 connected by the connecting bars 4. The bottom frame 3 is preferably annular with a cross bar 3^a in which the lower end of the rotor spindle 5 has a thrust bearing. The upper end of the rotor spindle 5 is journaled in the top frame 2 and extends into the interior of the hollow suspension beam 1 where it is provided with a pulley 18 by means of which it may be rotated. The rotor 6 is preferably formed as a hollow closed cylinder and is suitably connected to the lower end of the spindle 5. 7 is the stator which is, in the form of the invention shown in Figs. 1-5, formed in halves adapted to be moved to and from a position of co-operation with the rotor 6. While the spacing between the rotor and stator when they are in co-operative relationship may vary, a spacing of about one tenth of an inch will usually be found to be satisfactory for patent leather daub. Anyone skilled in the art can readily determine what spacing gives the best results for any particular purpose.

The parts of the stator are shown as connected to the depending arms 8 which are journaled on the rear connecting bar by means of the bearings 9 adjacent the top frame 2. The vertical position of these bearings is determined by the collar 10 secured to the rear connecting bar 4. The bearings are positioned, as shown, in order to keep them well above the surface of the liquid in which the working parts are to be immersed, thus avoiding gumming up of the bearings by the liquid. Adjacent the bottom frame 3 the halves of the stator preferably merely rest against the said rear connecting bar 4 as shown in Figs. 4 and 5 of the drawings.

In order that the halves of the stator may be moved to and from their co-operative position as shown in Figs. 4 and 5 of the drawings, rock arms 11 are secured to the depending arms 8 near

the top of the device. To these rock arms are connected the cables 12 and 13, the latter passing round the pulley 24 on the suspension beam. Both cords are carried along the suspension beam to the sliding handle 14 mounted on the beam. By operating this handle the halves of the stator may be readily swung to the position shown in Fig. 5. Springs 17 tend to close the parts of the stator to the position shown in Fig. 4, these springs being connected at their opposite ends to the halves of the stator.

Instead of having the ends of the parts of the stator merely abut one another when the stator and rotor are in co-operative relationship, it is important that the inward movement of each half of the stator be limited by a stop which is fixed in its relationship to each half of the stator. To form such a stop I provide the flat faces 15 on the sides of the front connecting bar 4. These flat faces are engageable by the knife edges 16 secured to the ends of the halves of the stator.

Wrapped on the pulley 18 secured to the upper end of the spindle 5 is a cable 19 which runs through the hollow suspension beam and passes over the pulley 20 journaled on the said beam. To the end of this cable is secured the weight 21 which serves through the medium of the cable to rotate the pulley 20 and thus the rotor 6. A peep hole 22 is formed in the upper side of the beam through which the pulley may be observed and its rate of rotation noted.

The operation of the apparatus so far described is substantially as follows: The device is suspended with the rotor and stator immersed in the fluid whose viscosity is to be determined and which will usually be in a heated condition. The halves of the stator are then opened and closed a few times, thus agitating the surrounding fluid and finally taking into the space between the two parts a representative sample. The parts of the stator are then closed and the resistance to rotation measured in any suitable manner, as, for example, as referred to above, by noting the time taken to effect a given number of revolutions of the pulley 20.

The time required for this measurement is so short say, 30 seconds, that the viscosity thus measured is representative of the viscosity of the whole fluid at the time the measurement is begun or ended. For each repetition of the measurement to follow the progress of the changes in the liquid, the parts of the stator are opened and closed before each measurement. The complete operation, agitation and measurement lasts only about one minute, which permits accurate control of such rapid changes as occur, for instance, in the final stages of the preparation of daub in the patent leather industry.

In the form of the invention previously described, while the movements of the two parts of the stator is substantially radial, it is not rectilinear. It is possible, however, to so mount the parts of the stator that their movement will be rectilinear. Such a construction is shown in Fig. 8 of the drawings, in which the parts of the stator have slides 26 formed thereon which are adapted to slide in dovetail grooves in the guides 25 supported by the frame 3.

In Fig. 6 I show yet another form of the invention in which the halves of the stator are carried by depending arms 8^a journaled on the frame 2 at 36. These depending arms 8^a have formed at their upper ends a rock arm 26 which engage each other with a pin-and-slot connection 27, thus the swinging of one of the depending arms 8^a

will also swing the other. An arm 28 is secured to one of the arms 8^a by which this movement may be imparted to the arms 8^a and then to the parts 7 of the stator. A spring 17^a connected to the arms 8^a serves normally to maintain the parts of the stator in co-operative relationship with the rotor as in the first construction described. The mode of operation will be substantially the same as in the form first described, though the movements of the two parts of the stator is more nearly rectilinear. Indeed, it is substantially so for all practical purposes.

In Fig. 7 I show another form of the invention in which the displacement of the stator is axial instead of radial. In this form the stator is in one piece and is carried by the plunger rods 8^b which slide in the yokes 29 secured to the top frame 2. Collars 30 limit the upward movement of the plunger rods 8^b by engaging the ends of the yokes 29, thus defining the co-operative position of the rotor and stator. The plunger rods are normally held up with the stop collars 30 in engagement with the yokes 29 by means of the springs 17^b which engage the yoke ends and the collars 31 on the plunger rods 8^b. The downward movement of the plunger rods 8^b to effect the separation of the rotor and stator is effected by means of the cams 34 which engage the upper ends of the plunger rods 8^b and are secured on the shaft 32 journaled in the bearings 33 on the top frame 2. A hand wheel 35 is secured on the shaft 32 by means of which the cam shaft may be operated when necessary to separate the rotor and stator to thus agitate the liquid in which the rotor and stator are immersed and to accumulate a fresh film of liquid between the two when they are brought to their co-operative position.

In all the forms described it will be noted that there is a relative movement of the rotor and stator by means of which the space between them may be widened and narrowed whenever desired. The movement of the one part relative to the other serves to agitate the liquid in which the device is immersed while the separation of the two parts enables the fresh film of liquid to be entrapped between the opposed surfaces of the rotor and stator.

What I claim as my invention is:

1. A viscosimeter comprising concentric rotor and stator members mounted with their adjacent surfaces normally slightly spaced a predetermined distance apart and shaped as surfaces of revolution; means for suspending the device with the concentric members immersed in the liquid in a vessel; and means for increasing the distance apart of the rotor and stator and then decreasing it to the normal predetermined distance apart while the device is in the liquid to agitate the liquid and admit fresh liquid to form a new film between the said members.

2. A viscosimeter comprising concentric rotor and stator members mounted with their adjacent surfaces normally slightly spaced a predetermined distance apart and shaped as surfaces of revolution, the stator member being formed in parts movable from and to their normal position to increase the spacing aforesaid and then decrease it to the normal predetermined distance apart while the device is in the liquid to agitate liquid in which the members are immersed and admit fresh liquid between said members.

3. A viscosimeter according to claim 2 in which the parts of the stator are each hinged on an

axis parallel to the axis of the rotor to swing to and from their normal operative position relative to said rotor.

4. A viscosimeter according to claim 2 in which the parts of the stator are hinged on a common axis parallel to the axis of the rotor to swing to and from their normal operative position relative to said rotor.

5. A viscosimeter according to claim 2 in which the parts of the stator are rectilinearly and radially movable to and from their normal operative position relative to said rotor.

6. A viscosimeter according to claim 2 in which the parts of the stator are each hinged on an axis at right angles to the axis of the rotor to swing to and from their normal operative position relative to said rotor.

7. A viscosimeter according to claim 2 in which the parts of the stator are each hinged on an axis parallel to the axis of the rotor to swing to and from their normal operative position relative to said rotor and a spring is provided tending to move the parts to their normal position.

8. A viscosimeter comprising concentric rotor and stator members mounted with their adjacent surfaces normally slightly spaced and shaped as surfaces of revolution, means for suspending the device with the concentric members immersed in the liquid in a vessel; and means for displacing and replacing the rotor and stator relative to one another in an axial direction while the device is in the liquid to change the film of liquid between the said members.

9. A viscosimeter comprising a bottom frame; a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; a rotor secured to the said shaft; and a stator formed in halves, each journaled at one end on the device on an axis parallel to the axis of the rotor to swing to or away from a normal position in which it is in co-operative relationship with the rotor to form a narrow space open at top and bottom.

10. A viscosimeter comprising a bottom frame; a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; a rotor secured to the said shaft; a stator formed in halves, each journaled at one end on the device on an axis parallel to the axis of the rotor to swing to or away from a normal position in which it is in co-operative relationship with the rotor to form a narrow space open at top and bottom; and a stop member on the bottom frame contactible by the free ends of the parts of the stator to define the normal position of the parts of the stator.

11. A viscosimeter according to claim 9 in which the bearing on which the parts of the stator swing are located above the upper ends of the rotor and stator so that the latter may be immersed in liquid without immersing the bearings.

12. A viscosimeter comprising a bottom frame;

a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; and a stator cylinder formed in halves, each journaled at one end on one of the connecting bars to swing to or away from a position in which it is in co-operative relationship with the rotor.

13. A viscosimeter comprising a bottom frame; a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; and a stator cylinder formed in halves, each journaled at one end on one of the connecting bars adjacent the upper frame to swing to or away from a position in which it is in co-operative relationship with the rotor.

14. A viscosimeter comprising a bottom frame; a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; and a stator cylinder formed in halves, each journaled at one end on one of the connecting bars to swing to or away from a position in which it is in co-operative relationship with the rotor, the other connecting bar forming a stop contactible by the free ends of the parts of the stator to define the normal position of the parts of the stator.

15. A viscosimeter comprising a bottom frame; a top frame; connecting bars connecting the said frames; a rotor shaft journaled on said frames; and a stator cylinder formed in halves, each journaled at one end on one of the connecting bars to swing to or away from a position in which it is in co-operative relationship with the rotor, the other connecting bar forming a stop contactible by the free ends of the parts of the stator to define the normal position of the parts of the rotor tending to move the parts to their normal position.

16. A viscosimeter comprising concentric rotor and stator members mounted with their adjacent surfaces normally slightly spaced and shaped as surfaces of revolution; means for suspending the device with the concentric members immersed in the liquid in a vessel; means for displacing the rotor and stator relative to one another in an axial direction to change the film of liquid between the said members; a stop limiting the movement of approach of the members; and a spring engaging the members to move them to their co-operative position.

17. A viscosimeter comprising concentric rotor and stator members mounted with their adjacent surfaces normally slightly spaced a predetermined distance apart and shaped as surfaces of revolution; means for suspending the device with the concentric members immersed in the liquid in a vessel; and means for displacing and replacing the rotor and stator relative to one another while the device is in the liquid to agitate the liquid and admit fresh liquid to form a new film between the said members.

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