

March 15, 1966

J. H. JONES

3,240,053

VISCOSIMETER

Filed Dec. 6, 1963

2 Sheets-Sheet 1

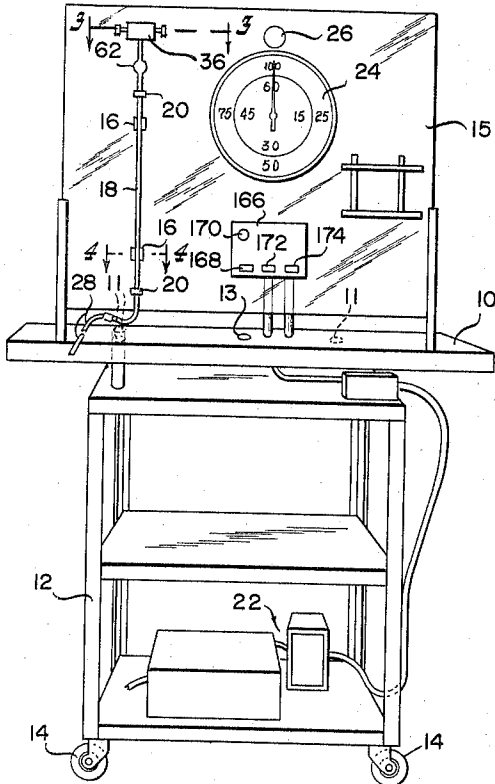


Fig. 1

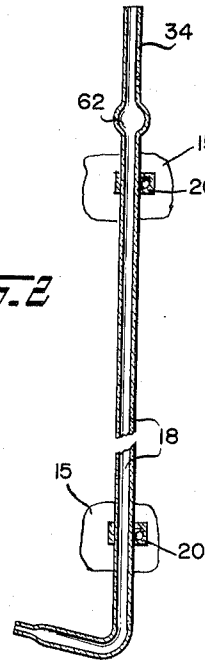


Fig. 2

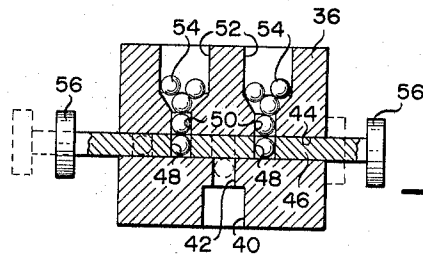


Fig. 3

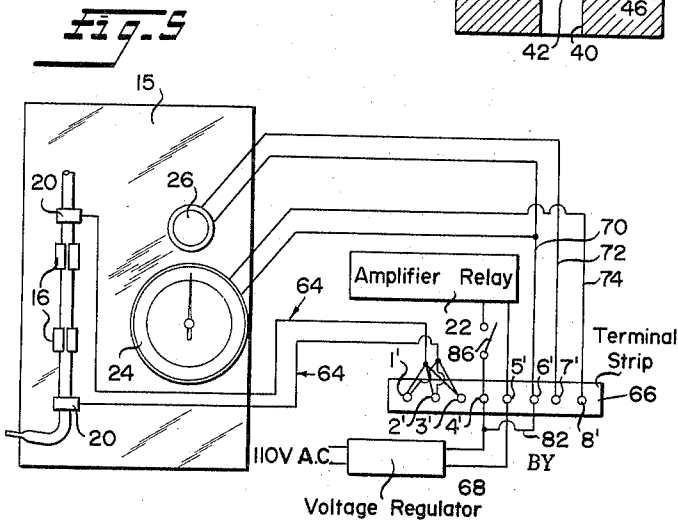


Fig. 4

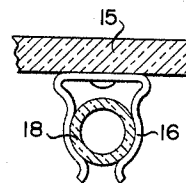


Fig. 5

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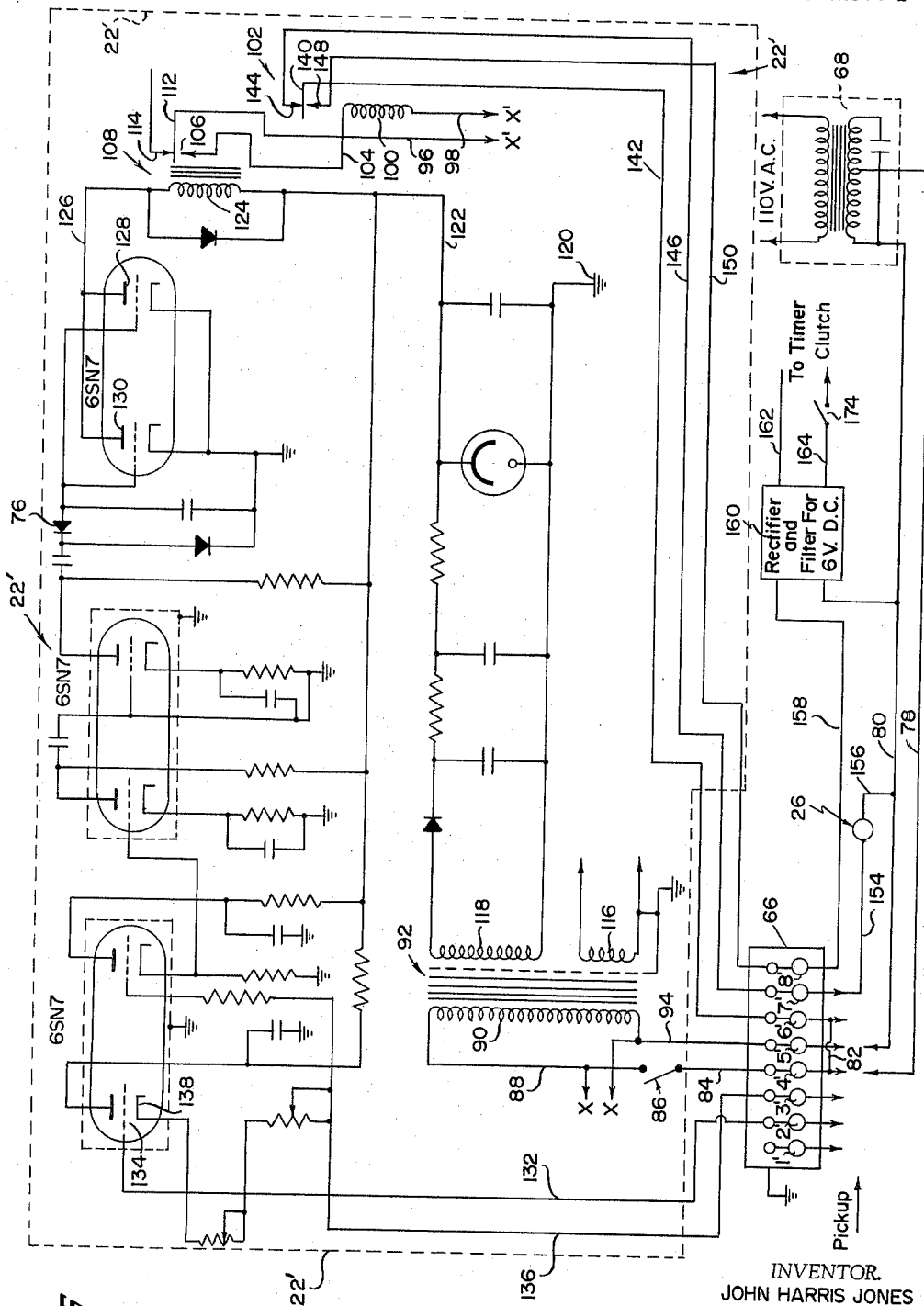
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VISCOSIMETER

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2 Sheets-Sheet 2



BY

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7-19-66

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3,240,053

VISCOSIMETER

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5 Claims. (Cl. 73-57)

The invention relates to devices or apparatus for measuring the viscosity of fluids and is particularly adaptable for measuring the internal fluid friction of blood emulsion.

It is a fact that in medical practice there is no satisfactory method of checking human blood viscosity and it is for this reason that American hospital laboratories do not make viscosity checks on blood specimens of hospital or clinical patients.

The importance of blood viscosity as a diagnostic procedure is pointed out by August Reis in his report on the "Kinetic Effect of Increased Viscosity of the Blood" (Zeitschrift fur innere Medizin 10, No. 14, 673-679, 1955). In his report in reference to such diseases as Addison's disease, thyreosis, cardiac ailments, depressive psychosis, he states that "it was found time and again that the improvement of the clinical picture went hand in hand with the drop in blood viscosity." He further states "only by creating new instruments for checking viscosity will one be placed in the position to correct pathological changes in energy metabolism, by acting directly upon the components of the chemical resistance or the viscosity."

In regard to viscosity, Cameron's Hydraulic Data states "With few exceptions viscosity is expressed as the number of seconds required for a definite volume of fluid under an arbitrary head to flow through a standardized aperture at constant temperature."

In "Viscosity and its Measurement," Institute of Physics and the Physical Society, Dinsdale & Moore, speak of the "rate of shear" and "shearing stress" as affecting viscosity and of "correcting for hydrostatic head," all of which calls for complicated mathematical formula.

Because of the difficulty of securing an exact constant head in present day viscometers, the time consumed in doing this precludes their use for checking blood viscosities that must be checked immediately the blood is withdrawn from the vein to be checked as close to an "in vivo" state as possible.

Human blood is an emulsion being produced by the body by what may be described as a continuous process. Many factors bear out the fact that blood is continuously varying in physical character. One of the characteristics of blood emulsion is that its viscosity, along with other factors, would vary, and this invention was designed to help measure blood viscosity with the object of aiding diagnostic procedure.

To be relatively sure that the physical character of a blood specimen, after being removed from the circulation, would be comparable to the physical character of the blood before it was removed from the circulation, it is important that there would be a minimum of exposure to air and a minimum of time lapse between the securing of the blood specimen and the viscosity test.

The provision of a device or apparatus for measuring the internal fluid friction of blood emulsion is the principal object of the invention. The provision of means for extracting a minimum amount of a blood specimen from the circulation and testing its viscosity with no or at

2

least minimal contact of air with the specimen between the extraction of the specimen and the test is another important object of the invention. By the use of my invention the test can be made within seconds after the withdrawal of the blood specimen from the circulatory system, and this is another important object of the invention, since blood emulsion undergoes rapid changes beginning from the moment it is withdrawn from the circulation and in direct proportion to its contact with ambient atmosphere. The viscosity is indicated by accurately measuring the elapsed time of the travel of a non-magnetic or austenitic stainless steel ball in the fluid between two sensing heads or proximity switches perpendicularly spaced, the time being indicated immediately in seconds and hundredths of seconds on an electronic elapsed time counter.

I have invented apparatus and combinations of apparatus that eliminate all the objections found in the use of standard viscometers when used for checking human blood viscosities. My invention makes it possible to check human blood viscosities in less than one and one-half seconds, accurate to one one-hundredth of second, plus or minus.

In standard viscometers, such as Ostwald, blood is introduced into the top of one leg of a U-tube up to a mark. The blood is then allowed to flow through a restricted aperture, the length of time being noted for the blood specimens to pass through this aperture, the time of flow being affected by "shearing stress," "rate of shear" and also continuous loss of "hydrostatic head." The apertures of Ostwald's U-tube viscosimeters vary and this makes it necessary to standardize each Ostwald with a solution of known viscosity.

In my invention, instead of passing the blood down through an aperture, I establish an aperture and pass this aperture through a column of blood. To accomplish this I use a specially constructed Pyrex glass tube of five mm. inside diameter and an inside area of 19,635 sq. mm. The aperture is established by introducing into the upper end of the Pyrex glass tube after it has been filled with human blood a non-magnetic stainless steel ball. The circumference of this ball encloses an area of 7,917 sq. mm. When the ball is introduced into the tube, it automatically establishes a doughnut-shaped aperture of 11,718 sq. mm.

As the aperture descends through the column of blood, it passes two accurately spaced (16") magnetic sensing heads. The ball which is maintained at the center of the aperture because of the exact perpendicularity of the viscosity tube, activates these sensing heads to start and stop a visual counting device.

Because of the restrictive or braking effect of the restricting aperture, the progress of the ball through the column of blood cannot be described as "free falling."

The exact size of the aperture is assured by the combination of the specific inside diameter of the tube, 5 mm., and the specific diameter of the ball, 3.175 mm., the ball being spherically accurate to .0001.

Viscosity tests were made with my invention using U.S. Bureau of Standards Oil D with 4 mm. I.D. and 5 mm. I.D. viscosity tubes. It will be noted that in the two viscosity tests of oil D, the oil being common to both tests and the ball or bob also being common to both tests, that the difference in the readings of the two tests was due solely to the difference in the two apertures.

3

In the 4 mm. I.D. tube the area of the aperture formed by the combination of ball and tube was 4.38 sq. mm. and in the 5 mm. I.D. tube the area of the aperture formed by the combination of ball and tube was 11.72 sq. mm. Results of the tests follow:

4 mm. I.D. tube (aperture 4.38 sq. mm.)	5 mm. I.D. tube (aperture 11.72 sq. mm.)
241 -----	99
241 -----	99
241 -----	99
241 -----	99
241 -----	100
	99

Both columns read in hundredths of a second.

As before stated, there does not appear to have been any satisfactory type of apparatus designed for clinical or hospital use in checking the blood viscosity of patients. While the importance of blood viscosity determination has been recognized as a diagnostic procedure, the lack of reliable apparatus for this purpose has severely limited this field of medicine. Therefore, it is an object of my invention to provide apparatus for measuring or testing human blood viscosity which can be used to quickly and accurately provide data for clinical studies.

It is another object of my invention to provide apparatus which can be operated by laboratory or hospital personnel after a relatively short period of training.

It is a further object of my invention to provide electrical control means in my apparatus whereby human errors in the test procedure are reduced to the minimum.

It is a still further object of the invention to provide apparatus for measuring or testing human blood viscosity which can be readily moved about in the facility where it is being used and conveniently plugged into outlets of the common 110 volt, 60 cycle, A.C. circuits.

In order to accomplish the above described objects, I provide a cart which can be easily wheeled about and which is designed to carry the viscosity measuring apparatus. At the top of the cart there is a vertically mounted panel which carries a viscosity tube that is designed to receive the sample of human blood and associated means, which will be described in detail later, for electrically timing the fall of a steel ball through the column of blood in the viscosity tube in order to measure the viscosity of the blood. On this panel there is also mounted an electric timer with a large face and dials which can be easily read by a technician conducting the test. Necessary electrical switch means for the operator's use are conveniently mounted on the panel and on the cart.

In general, my invention involves the use of an austenitic stainless steel ball release means disposed at the top of a perpendicularly mounted viscosity tube whereby the ball, that is machined to close tolerance, is allowed to fall under the influence of gravity through the column of blood in the viscosity tube and past two sensing heads forming part of an electrical sensing means. These heads are disposed in accurately determined, vertically spaced positions on the viscosity tube. The inside diameter of the viscosity tube is constant throughout the length of the tube so that as the steel ball falls through the blood, it, in effect, establishes an annular aperture for the relative flow of blood past the ball. As the stainless steel ball passes each sensing head, electrical signals are produced through the sensing means and these signals are amplified to actuate relay mean for starting and stopping an electric timer. The elapsed time interval is noted by the operator or technician and is used in computing or determining the viscosity of the blood sample.

Referring now to the accompanying drawings forming part of this application, and wherein like reference characters indicate like parts.

FIGURE 1 is a perspective view of the invention.

FIGURE 2 is an enlarged cross-sectional view of the preferred viscosity tube.

4

FIGURE 3 is an enlarged cross-sectional view of the ball applicator, taken on line 3—3 of FIGURE 1.

FIGURE 4 is a cross-sectional view somewhat enlarged on the line 4—4 of FIGURE 1.

FIGURE 5 is a partial wiring diagram of a portion of the electrical system.

FIGURE 6 shows a wiring diagram of the electrical system used in my invention.

Referring now more in detail to the drawing, it will be observed that I have provided a mobile table comprising a top 10 and a base section or cart 12 supported on caster wheels 14. Means are provided for leveling the top 10, so that by adjustment of the table top, the viscosity tube, to be described later, can be arranged in a perpendicular position for the test.

Leveling of the assembly on the cart 12 is accomplished by providing a tripod assembly of three adjustable jacks or supports 11 upon which the table top 10 rests. This top 10 is approximately 36" x 16" in size and has installed therein a round bubble level 13 at the geometric center of the top to assist the operator in leveling the top by adjustment of the jacks or supports 11.

A rectangular panel 15 about 20" x 30" in size is fixed in any acceptable manner upon a table top. This panel is constructed of lucite or other electrically nonconductive material. One of the edges is secured to the table top in a manner so that the panel will be maintained perpendicularly thereto. Spaced inwardly from one vertical edge of the panel a short distance is a pair of spring clips, indicated at 16. Clips 16 are vertically spaced in axial alignment and are provided as one simple means of removably holding the viscosity tube 18 to the panel. It is important that the tube be held perpendicularly to the table whenever my apparatus is being used to measure the viscosity of a sample of fluid.

The viscosity tube 18 is of Pyrex, 7 mm. outside diameter and 5 mm. inside diameter. The tube is provided at one end with an acute angled bend on a radius, the end of the tube being reduced in diameter to accommodate one end of a rubber tubing of 1/8" I.D. to be applied thereover providing an airtight connection. The other end of the rubber tubing is provided with a spring clip closure.

The other end of the viscosity tube 18, a short distance from the top thereof, is provided with a bulb-like enlargement 62. On the panel a bob or ball feeder is indicated at 36 into which the top of the tube fits. This ball feeder 36, as will be seen from the enlarged sectional view FIGURE 3, comprises a body portion with an axial hole 40 in one side thereof which is applied over the upper end of the portion 34 of the tube. The hole 40 is in diameter slightly larger than the outside diameter of the portion 34. Connecting with this hole 40 is another hole 42 of smaller diameter, which is equal to the inside diameter of the portion 34. At right angles to this hole 42 is a rectangular hole 44, laterally through the ball feeder, and this is of like depth to that of hole 42, but is of greater width. A slidable feeder bar 46 is applied in this hole or slot 44, which bar is provided with a pair of spaced holes 48—48. These holes 48—48 are registerable with other holes 50—50 of like diameter which communicate with larger hopper-like openings 52—52, each of which holds a plurality of the spherical balls 54 used in making the tests. The feeder bar 46 is slidable back and forth within the limits of the operating knobs 56 on each end thereof so that when the bar 46 is moved to the left, for example, the hole 48 would pass over the hole 42, during which movement one ball 54 would drop into the hole 42 and pass down through the viscosity tube. The balls are of austenitic nonmagnetic stainless steel insuring that their rate of travel through the field of the sensing heads is not retarded, and are of a diameter just less than the internal diameter of the viscosity tube 18.

5

When a ball 54 is dropped into the upper end of the tube 18, with the liquid to be tested filling the tube up to just about half way in the air release area 62, there would be a splash when the ball hit the fluid, which would cause any air bubble produced by the dropping of the ball to escape to the upper level of the fluid before the ball reached the field of the upper sensing head. If the ball had any air bubbles entrapped ahead of its descent, a true reading of viscosity could not be made.

When a test is to be made, the tube is filled with the fluid to be tested until the bulb 62 is half filled. One operating knob is then pushed so as to move the feeder bar 48 over hole 42 when a ball 54 would drop through openings 42 and 40 into the tube 18. Then as the ball drops in the tube, it passes through the field of the upper sensing head 20, and starts the timer or counter 24 operating in a manner to be described later. As the ball continues its descent in the tube and passes through the field of the lower sensing head 20, it stops the counter 24. The elapsed interval between the passing of the upper and lower sensing heads gives an indication of the viscosity of the fluid tested.

Referring to FIGURE 5, it can be seen that the cable leads, which are generally indicated at 64, from the sensing heads 20 of the sensing means are connected to terminals 1', 2' and 3' of a terminal strip 66. The complete wiring of the terminal strip 66 is shown in FIGURE 6 of the drawings but it is sufficient at this point to note that this terminal strip 66 also provides terminals for the 110 volt A.C. supply being furnished through voltage regulator 68, for an oscillator, amplifier and associated relay assembly forming part of the sensing means and generally indicated at 22, and for electrical connections generally indicated at 70, 72 and 74 to the electric timer 24 and indicating light 26. The complete connections to terminal strip 66 are shown in FIGURE 6 of the drawings.

The sensing means used with my invention is of the type which is commercially available, and for my purposes I have used two sensing heads 20 together with an associated electrical system, generally indicated at 22' and shown in FIGURE 6 as within the dash line box. This sensing means, which is also known commercially as a proximity switch, is produced by Electro Products Company, Inc., of Chicago, Illinois. The sensing means used in my invention is of the same general type as that disclosed in Reissue Patent No. 24,779, issued on February 9, 1960, to David L. Elam. It is not believed necessary to completely describe the feature of the sensing means used in my invention, and for a complete description of the mode of operation of this type of sensing means, reference is made to the above cited Reissue Patent No. 24,779.

In general, it can be stated that the heads 20 each includes a stainless steel shell within which there is a wound inductance of fine wire, and two leads from this inductance and a third lead attached to a metal clad cable 64 are carried to terminals 1', 2' and 3' on terminal strip 66. Each head 20 and cable 64 in combination provide an inductance and associated distributive capacity for a tuned circuit which is connected to the left half portion of the 6SN7 input tube of the electrical system shown at 22 to provide a triode oscillator. As viewed in FIGURE 6, this input tube is the left-hand tube within the dash line box, and the specific connections to this tube from the sensing heads 20 and cables 64 will be set forth later in this description.

As a general statement of the operation of the sensing heads 20 and associated electrical system 22' shown within the dash line box of FIGURE 6, it can be said that under normal conditions, that is, without a conductive object to be sensed near the heads 20, the oscillator circuit, which includes the portion of the input tube 6SN7 together with the associated wound inductance of sensing heads 20 and the distributive capacity cables 64, oscil-

6

lates continuously and the output thereof is amplified by the right-hand portion of the 6SN7 input tube and the second 6SN7 tube of the circuit. These amplified oscillations are rectified by the germanium diode shown at 76 to apply a sufficient negative bias potential to the grids of the 6SN7 output amplifier tube shown at the right-hand side of the dash line box of FIGURE 6. This negative bias is sufficient to cut off this stage. However, when a mass of conductive material, such as a steel ball, is introduced into the field of the inductance within the head 20, the eddy current losses occurring therein serve to dampen or squelch the oscillations of the circuit and thereby remove the bias from the output portion of the electrical system. This permits a substantial current flow there-through which can be utilized to operate desired means. In this case, the desired means include a relay arrangement which will be described in detail later.

Turning now to FIGURE 6, it can be seen that terminal strip 66 has eight terminal connections which, for convenience, I have labeled 1' to 8', inclusive, as viewed from left to right on the drawing. The output of the voltage regulator 68 is fed through line 78 to terminal 4' and through line 80 to terminal 5'. Terminal 4' is also connected to terminal 6' by line 82. From terminal 4', line 84 runs to a switch generally indicated at 86 that is also connected to line 88 running to one side of the primary coil 90 of transformer 92. Line 94 runs from terminal 5' to the other side of the primary coil 90. It will also be noted that leads X—X' from lines 88 and 94 are connected at X'—X' to leads 96 and 98. Lead 98 is connected to one side of coil 100 of the two-way contact relay generally indicated at 102. The other side of coil 100 is connected through line 104 to contact 106 of a latching relay generally indicated at 108. The lead 96 is connected to the movable contact arm 112 of latching relay 108 which rests against contact 114 of the relay when this relay is unenergized. There is no operative connection to this contact 114.

Turning now to the transformer 92, secondary coil 116 is a low voltage winding to provide filament voltage for the three tubes of the sensing means 22. The high voltage secondary coil 118 of transformer 92 is connected to a rectifier and filter circuit designed to deliver a high voltage D.C. supply to the sensing means 22 and relay 108. This circuit is conventional and will not be described in detail. One lead of the high voltage D.C. supply from the rectifier is grounded as at 120 while the other lead 122 is connected to one side of coil 124 in relay 108. The other side of coil 124 is connected by lead 126 to plates 128 and 130 of the output tube of the sensing circuit 22.

Terminal 1' of the terminal strip 66 receives the connection of the shielded cable and, as indicated, the connection is grounded. Terminals 3' and 2' receive the two leads from the inductance coils in each of the heads 20. As indicated in FIGURE 6, terminal 2' is connected by lead 132 to the grid 134 of the oscillator portion of the input tube 6SN7 shown at the left-hand portion of the dash line box. Terminal 3' is connected by lead 136 to the cathode 138 of the same oscillator tube.

Referring again to relay 102, it can be seen that the movable contact arm 140 is connected through lead 142 to terminal 6' on terminal strip 66, that contact 144 is connected through lead 146 to terminal 7' and that contact 148 is connected through lead 150 to terminal 8'. As shown in FIGURE 6, terminal 6' is connected through lead 82 to terminal 4' and to line 78 of the A.C. voltage supply. Terminal 7' is connected by lead 154 to indicating light 26 and the other side of the indicating light 26 is connected through lead 156 to the line 80 of the alternating current supply. Terminal 8' is connected through lead 158 to a rectifier circuit generally indicated at 160 which is designed to rectify and filter the 110 volt A.C. supply to a 6 volt D.C. supply. As also indicated in FIGURE 6, line 80 of the A.C. circuit is connected to this rectifier 160.

At this point mention should be made of the counter or timer shown at 24. This timer is commercially available, and for my use I have selected a timer known as the Model S-1 produced by the Standard Electric Time Company of Springfield, Massachusetts. However, any suitable timer can be used if desired and if operable within the scope of my invention. The timer 24 shown in the drawings is driven by an A.C. synchronous motor through a gear train to register elapsed time in seconds and one-hundredths of a second. There is a 6 volt D.C. clutch arrangement disposed between the motor and dials of the timer so that movement of the dial hands of the timer are initiated and stopped through the operation of this clutch. As shown in FIGURE 6 of the drawings, this clutch is connected through lines 162 and 164 to rectifier 160. In addition, it is desirable that the timing device as at 24 has a reset device so that the operator can reset to zero after each blood viscosity test.

At 166 in FIGURE 1, I have shown a small panel control board which is mounted on panel 15. On this control board electric switch 168 turns the synchronous motor of the timer 24 off and on. Directly above switch 168 there is a red light 170 so connected that, when switch 168 is in an on position and the synchronous motor of timer 24 is running, the red light 170 will be on. Switch 172 on the control board 166 is used to reset the timer to zero when desired. A third switch 174 is provided to connect and disconnect the 6 volt D.C. rectifier 160 with the timer clutch.

The sensing arrangement of my invention operates in the following manner. When a steel ball which is falling through the fluid passes the upper sensing head 20, the associated electrical system 22 functions in the manner previously discussed so that there is a current flow through the latching relay 108. When this occurs, movable contact arm 112 of latching relay 108 is snapped and held against contact 106 of the latching relay. At this time the circuit from the 110 volt A.C. supply at X'-X' is completed through lead 98, coil 100, line 104, contact 106, movable contact arm 112, and lead 96. As the coil 100 is energized, movable contact arm 140 is moved from contact 144 to contact 148. The position of the movable contact arm 140 against contact 144 is the normal or unenergized position of the arm when coil 100 is not energized. In this normal position it can be seen that one side of the A.C. circuit from terminal 6' is completed through lead 142, movable contact arm 140, contact 144, and lead 146 to terminal 7'. From terminal 7', lead 154 goes to one side of the indicating light 26 and the other side of the indicating light 26 is connected through lead 156 to line 80 or the other side of the alternating current circuit. Thus, in the normal position illustrated in FIGURE 6 of the drawings, the indicating light 26 will be energized and lit.

When the movable contact arm 140 is snapped to contact 148, one side of the alternating current from terminal 6' is now connected through lead 142, movable contact arm 140, contact 148 and lead 150 to terminal 8' on the terminal strip 66. From terminal 8' this side of the alternating current circuit continues through lead 158 to the 6 volt D.C. rectifier and filter supply generally indicated at 160. Line 80, the other side of the alternating current circuit, is also connected to this rectifier and filter 160.

Therefore, as the steel ball passes the upper sensing head 20, relays 108 and 102 operate so that the alternating current supply is shut off from indicating light 26 and is directed to the rectifier and filter arrangement to provide a 6 volt D.C. supply. As relay 108 is a latching relay, the current through coil 100 is maintained and a 6 volt D.C. supply is furnished to lines 162 and 164. If switch 174 on control board 166 has been closed by the operator, the 6 volt D.C. clutch on timer 24 will be energized and the hands on the timer 24 will start to move.

This condition prevails until the steel ball, which is falling through the column of blood, reaches the lower sensing head 20. At this time latching relay 108 will again be operated in the manner described above, and movable contact arm 112 will be snapped from contact 106 to contact 114. This interrupts the 110 volt A.C. supply to coil 100 of relay 102 so that movable contact arm 140 will be snapped from contact 148 to contact 144. At this instant the 6 volt D.C. supply will be interrupted to the timer clutch to stop the movement of the hands of the timer 24. At this instant also, the indicating light 26 will again be energized.

What I claim is:

1. Apparatus for measuring the viscosity of a fluid comprising in combination, a tube, means for supporting said tube in a perpendicularly disposed position, said tube being designed to receive the fluid to be measured, a ball feeder secured to and closing the upper end of said tube, said ball feeder having hopper-like openings therein for holding a plurality of metallic balls, manually operated means disposed in said ball feeder adjacent said hopper-like openings to selectively receive an individual ball from said hopper-like openings, said manually operated means being movable to a predetermined ball release position, said ball release position being over the central portion of the column of fluid in said tube so that as the ball is dropped into the fluid the relative flow of the fluid past the ball during the downward passage of the ball through the column of fluid will be through an annular aperture of substantially constant area as defined by the size of the ball and the inside dimension of the tube, electrical sensing heads mounted on said tube in vertically spaced relationship to detect the passage of a ball past the respective sensing heads, said electrical sensing heads being connected through amplifier means to relay means which are adapted to initiate and terminate the operation of timing means in response to signals produced by the passage of said ball past an adjacent pair of said electrical sensing heads.

2. Apparatus for measuring viscosity of a fluid comprising in combination, a tube having an opening at the bottom portion thereof through which the fluid to be measured can be inserted into the tube, means for closing said opening, a ball feeder mounted upon and closing the upper end of said tube and having hopper-like openings therein for holding a plurality of metallic balls, manually operated means disposed in said ball feeder adjacent said hopper-like openings to selectively receive an individual ball from said hopper-like openings, said manually operated means being movable to a predetermined position where said ball is dropped into the central portion of the column of fluid in said tube, means for mounting the tube in a perpendicular position on a supporting structure so that as the ball falls under the influence of gravity through the column of fluid the relative movement of said fluid past said ball is through an annular aperture of substantially uniform size, electrical sensing means mounted in vertically spaced relationship on said tube, means connected to said sensing means to receive electrical signals from the sensing means generated by the presence of said ball in the area adjacent the respective sensing means, electrical timing means connected to said signal receiving means, said electrical timing means being actuated and stopped in response to electrical signals from said electrical sensing means.

3. Apparatus as set forth in claim 2 wherein the viscosity tube has a bulb-like enlargement therein adjacent the top of the tube into which the top of the column of fluid will extend during the measuring operation.

4. Apparatus as in claim 2 wherein a portion of the bottom of said tube is turned upwardly at an acute angle to provide a trap for air bubbles so that as the fluid is inserted the perpendicular column of fluid will not contain air bubbles.

5. The combination set forth in claim 2, said tube being of definite inside diameter and said balls being of a diameter approximately 1.83 mm. less than the diameter of the tube.

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10 RICHARD C. QUEISSER, *Primary Examiner.*
DAVID SCHONBERG, *Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,240,053

March 15, 1966

John H. Jones

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, before line 7, insert the following paragraph:

This application is a continuation-in-part of my copending application Serial No. 168,936, filed January 26, 1962, now abandoned, for improvements in Viscosimeter.

column 2, line 28, for "specimens" read -- specimen --; column 3, line 7, after "11.72 sq. mm." insert a closing parenthesis; line 56, for "visciscity" read -- viscosity --; line 66, for "mean" read -- means --; column 6, line 24, for "lie" read -- line --.

Signed and sealed this 24th day of January 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents