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# Porosity Tester

Hugh M. Brown

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H. M. BROWN

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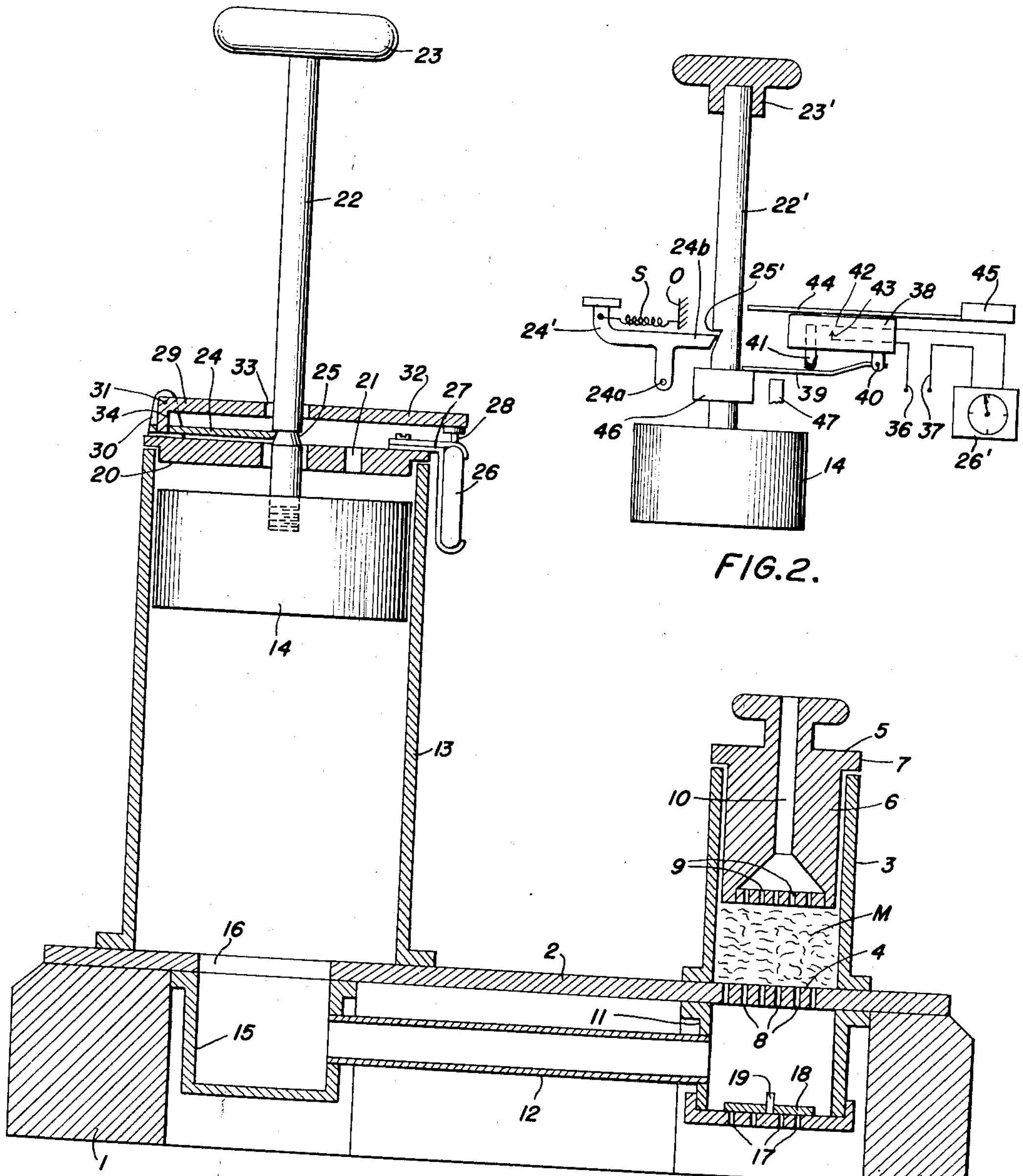


FIG. 1.



FIG. 2.


INVENTOR
HUGH M. BROWN

BY Ralph B. Stewart
ATTORNEY

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## POROSITY TESTER

Hugh M. Brown, Clemson, S. C., assignor to Clemson Agricultural College of South Carolina, Clemson, S. C., a corporation of South Carolina

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2 Claims. (Cl. 161—18)

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This invention relates to a porosity tester such as may be used in testing the relative porosities of various materials.

In such porosity testing, it has heretofore been proposed to pump a fluid through a sample of the material to be tested, using a single stroke of an expansible chamber fluid pump and timing said stroke in order to obtain a measure of the rate at which the fluid passes through or into said material, and hence an index of its porosity.

Important objects of the present invention are: to provide an improved means for automatically timing the pump stroke; and to provide such means which includes a latch mechanism for maintaining the movable pump element in a predetermined raised position prior to the beginning of the pump stroke, together with means operatively connecting said latch mechanism to the timer to place the latter in operation simultaneously with the release of the latch mechanism and inception of the pump stroke.

Further objects, in accordance with the preferred embodiment of the invention are: to provide means for automatically utilizing a usual mechanical stop watch for the timing function; to provide a novel coordinating means between the stop watch and a latch mechanism, whereby actuation of said coordinating means will simultaneously place the stop watch in operation and release said latch mechanism to permit commencement of the pump stroke; and to provide means cooperating with said coordinating means at the end of the stroke to discontinue the operation of the stop watch.

A still further object in accordance with a modification of the invention resides in the provision of a novel electrically actuated stroke timing mechanism for the pump, including a single timer switch actuated at the beginning and end of the pump stroke respectively to close and open an electrical circuit through the timer.

A still further object consists in the provision of a sample chamber embodying means for compressing samples of fibrous or other compressible material therein to a standard volume and thickness.

In this application I show and describe only the preferred modification of my invention, and one modification thereof, simply by way of illustration of the practice of my invention. However,

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I recognize that my invention is capable of other and different embodiments and that the several details thereof may be modified in various ways, all without departing from my invention. Accordingly, the drawings and description herein are to be considered as merely illustrative and not as exclusive.

In the accompanying drawings:

Figure 1 represents a vertical sectional view through apparatus embodying the preferred form of the invention; and,

Figure 2, a diagrammatic view illustrating a modified form of automatic timing means which may be employed with apparatus such as more fully illustrated in Figure 1.

Referring now in detail to the accompanying drawings, and first considering the apparatus illustrated in Figure 1, it will be seen that said apparatus embodies a hollow base **1** adapted to rest on a horizontal surface and having a cover plate **2**.

Disposed on the base is a sample receiving chamber which is defined in part by a cylindrical sleeve **3** resting on the plate **2** and having its lower end secured in air-tight manner thereto, whereby the bottom wall of said chamber will be defined at **4** by the plate **2**.

The upper end of the cylinder or sleeve **3** is closed by a removable weighted lid **5** having a cylindrical plunger portion **6** depending into the sleeve to define the top wall of the sample chamber. The lid **5** is provided with means which may assume the form of a radially projecting flange **7** to support the lower end of the plunger portion **6** at a predetermined height above the chamber bottom **4**. Thus, there is defined a chamber of fixed volume, in which a given weight or amount of porous or fibrous material M, when placed in said chamber, will be compressed into a space equal to the volume of the chamber by the plunger portion **6** of the lid, and will be of uniform depth or thickness between the relatively parallel surfaces of the plunger portion **6** and the chamber bottom **4**.

In order that air or other fluid might be caused to pass completely through such thickness of material M for the purpose of measuring its porosity, the chamber bottom **4** is provided with a plurality of uniformly distributed air or fluid inlet ports **8**, and the lid **5** similarly is provided with a plurality of evenly distributed discharge ports or perforations 9 opening through its lower end face and communicating with a central discharge passage 10 which opens into the atmosphere.

Air or other fluid may be supplied to the sample chamber by means of an air inlet manifold 11 secured in air-tight manner against the lower face of the chamber bottom 4 in communication with the several ports or perforations 8, the manifold in turn being placed in communication with a source of fluid supply through a conduit or tube 12.

Air or other fluid is supplied through the tube 12 from an expansible chamber fluid pump of the type wherein one end wall of the expansible chamber descends by gravity to expel fluid under constant pressure from the chamber. Such a pump in the preferred embodiment comprises a cylinder 13 fixedly mounted on the upper surface of the plate 2 with its axis disposed vertically, and a gravity actuated piston 14 loosely fitted into the cylinder 13 for axial movement. In order that the connections between this pump and the intake manifold 11 of the sample chamber may be disposed in an out-of-the-way position beneath plate 2, I provide a small fluid reservoir 15 secured to plate 2 beneath cylinder 13 and in communication with said cylinder through an opening 16 in the plate 2, this reservoir 15 being in communication with the air supply conduit 12, as shown.

In order to facilitate the flow of air into cylinder 13 during the upstroke of the piston 14, as the piston is reset, I provide an inlet port or ports 17 which in the present instance are disposed in the bottom of the manifold 11, these being controlled by a disc check valve 18 which is upwardly displaceable on a vertical guide stem 19 to permit an influx of air, but which seats against the manifold bottom to close the ports 17 against the escape of air from the manifold on the down stroke of the piston.

Extending across the upper end of the air supply cylinder 13 is a centrally apertured lid or cross-head 20 which may be provided with a port 21 therethrough to place the interior of the cylinder, above the piston 14, in communication with the atmosphere. A piston rod 22 carried by the piston 14 is freely movable through the central aperture of the lid 20 and is provided at its upper end with a radially projecting handle 23 by which the piston may be manually raised from the bottom of the cylinder and reset in the position illustrated in Figure 1, following its downward stroke.

As mentioned earlier, the fluid pump includes a timer and means for automatically initiating the actuation of the timer simultaneously with the start of the downward movement of the piston 14, and for automatically shutting off the timer or timing mechanism at the end of the downward movement or stroke.

In the embodiment illustrated in Figure 1, the timing means includes a latch 24 which is slidable radially across the top of cylinder 13 (and guided between a pair of brackets 30) to and from latching engagement in a notch 25 in the piston rod 22. The timer in this instance consists of a usual mechanical stop watch 26 which is supported by a bracket 27 adjacent the upper end of the cylinder 13 at a location diametrically opposed to the latch 24. The watch 26 has the usual upwardly spring projected controlling stem 28 which is actuated by downward pressure in known manner both to initiate and to terminate its timing function. In other words alternate downward pressures on this stem 28 will respectively initiate and terminate the operation of the watch.



The actuation of the watch 26 is coordinated with that of the latch 24 by means of a bell crank lever 29 which is pivotally mounted between brackets 30 on the cylinder lid for swinging movement about the axis of the pivotal connection 31. The longer arm 32 of said lever extends diametrically across the upper end of the cylinder 13 and has its free end normally resting on the control stem 28 of stop watch 26, whereby downward movement of said free end will depress the control stem. Normally the resilient upward spring pressure of the stem 28 will maintain the lever arm 32 in the raised position shown.

It will be noted that rod 22 passes through aperture 33 in the longer lever arm 32, and aperture 33 is enlarged to permit a limited swinging movement of the lever and free vertical movement of the piston rod 22.

The short depending arm 34 of the lever 29 is suitably connected to the latch 24, as by being received in a recess formed in the rear end of latch 24, so that downward swinging movement of the longer lever arm 32, with consequent depression of the watch stem 28 and initiation of the stop watch timing operation, will simultaneously cause both the short lever arm 34 and latch 24 to be retracted away from the piston rod 22, thus allowing the piston 14 to descend by gravity in cylinder 13.

It will be noted that the longer arm 32 of the lever is disposed in the path of descent of the radially projecting knob 23 on the piston rod, so that at the termination of the downward piston stroke this knob or handle will engage lever arm 32 and push it downwardly, again depressing stop watch stem 28 and terminating the operation of the stop watch. Thus it will be seen that the actuation of the stop watch will be accurately coordinated with the movement of the piston 14 to automatically time the duration of the downward piston stroke.

Following completion of a downward stroke, the piston 14 may be raised by grasping and lifting the handle 23, whereupon the latch 24 will be reset to maintain it in raised position preparatory to another timed downward stroke.

Prior to actual use of the invention in testing the relative porosity of various materials, the piston 14 is first allowed to descend while the sample chamber is sealed in any known manner against the passage of air therethrough. This will necessitate that all air expelled from the cylinder 13 escape upwardly past the loose fitting piston 14. The time required for the downward piston stroke, as ascertained by the stop watch 26 in the manner aforementioned, provides data which when considered in conjunction with the total volume of air displaced by the piston during its stroke, will permit ready ascertainment of the rate of leakage of air past the piston. Due to the loose fit of the piston 14 in its cylinder, there will be little wear on the piston and cylinder walls, and accordingly this particular rate of air leakage, once having been ascertained, will remain constant over long periods and need only be re-ascertained at rare intervals, if ever.

After once ascertaining the rate of leakage, as aforementioned, the sample chamber is unsealed, and when it is desired to test the porosity of any material, a given standard amount or weight of the material is placed in the sample chamber, the weighted lid 5 of the chamber serving to compress this material to a predetermined volume.

Following this, the piston 14 is again raised and allowed to descend, its downward stroke being again timed. The downward stroke of the piston will cause part of the air from the cylinder 13 to be forced through the sample material M at a constant pressure. Obviously, the difference in the time of fall of the piston when the sample chamber is sealed, and when the sample is disposed therein, provides a measure of the rate at which air flows through the porous sample M and thus an index of porosity of the material being tested.

In Figure 2 of the drawings I have shown a modified form of timing mechanism which may be employed with the air pump of Figure 1 in place of the timing mechanism shown in said figure. According to this modification, the timer 26′ is of the electrically actuated clock type adapted to receive electric current through supply wires 36 and 37.

Interposed in one of the supply wires is a normally closed micro-switch 38 which is disposed for cooperation with the piston 14 to energize the timer circuit simultaneously with the start of the downward piston stroke and to interrupt the timer circuit at the termination of such stroke.

The switch 38 has a control member in the form of a lever 39 pivoted to the switch housing as at 40 for vertical swinging movement. It will be seen that the lever 39 is operable to raise a vertically reciprocable plunger 41 in the switch housing. This plunger 41 carries a movable switch blade 42 which normally is in contact with the stationary switch blade 43 when the switch is free or unoperated. However upward movement of the control lever 39 is transmitted through the plunger 41 to the movable blade 42 to open the switch.

The switch is supported in any suitable manner for resilient vertical bodily deflection, as by a spring arm 44 having one end thereof secured to a fixed support 45, the control lever 39 of the switch projecting above and into the path of upward movement of a collar or projection 46 carried by the piston rod, to be raised thereby and maintain the switch open in the raised position of the piston as illustrated in Figure 2. A stop 47 is fixedly positioned below the control lever 39 to limit its downward movement and to open the switch responsive to bodily downward movement or deflection thereof. In order to open the switch coincidentally with the termination of the downward piston stroke, I provide means for deflecting the switch downwardly, as exemplified by the free end of the spring arm 44 projecting below and into the path of downward movement of the piston rod handle or radial projection 23′.

The latch 24′ of this embodiment is swingable on a stationary pivot *24a* to and from operative engagement with the piston rod 22, and is provided with a detent *24b* swingable into a recess or notch 25′ in the piston rod to maintain the piston in raised position, all as shown in Figure 2. If desired, the latch 24′ may be resiliently urged toward the piston rod by means such as a coil spring S placed under tension between the free end portion of said latch and a stationary part O.

Thus, as the latch 24′ is manually retracted from the piston rod, this will release the piston 14 for its downward stroke. The initiation of the downward stroke, with consequent downward movement of the collar 46, will permit the switch lever 39 to swing downwardly and close the energizing circuit through the timer 26′. As the piston 14 reaches the lower end of its stroke, the handle or projection 23′ thereof will engage the spring arm 44 to deflect same downwardly. This downward deflection of the spring arm 44 and the switch 38 carried thereby will cause the control lever 39 to engage the stop 47, and further downward movement of the switch will open the contacts and thereby interrupt the timer circuit.

In order to reset the piston for another automatically timed stroke, it is necessary simply to grasp the handle 23′ of the piston rod and raise the piston until the latch 24′ resiliently seats in its recess 25′ to maintain the piston in raised position.

On the upward movement of the piston, as soon as the weight of the piston is removed from the end of spring arm 44 switch 38 returns to normal position, but when the piston is in latched position, the collar 46 pushes the arm 39 upwardly to hold the switch open.

Except for the obvious slight differences incidental to the different types of timing mechanisms employed, the use of the testing apparatus embodying this modified form of electricaly actuated timing apparatus will be similar to that heretofore described in connection with the apparatus shown in Figure 1.

It will be obvious that the size of the sample chamber may be varied by changing the length or size of cylinder 3 or by changing the length of the plunger or plug 6. Also, the amount of compression normally applied to the material being tested may be varied by varying the weight of the plunger 6 as by using plungers of different lengths or of different materials such as lead, iron or aluminum.

I claim:

1. In a fluid pump of the type wherein a piston descends by gravity in a cylinder, the combination with said pump of means for automatically timing the downward stroke of said piston comprising a piston rod secured to said piston and being movable through the upper end of said cylinder, relatively vertically spaced lateral projections carried by said rod, an electrically actuated timer, and control means for initiating and terminating the energization of said timer simultaneously with the beginning and end of the downward piston stroke respectively, said control means comprising a normally closed micro-switch in the energizing circuit of the timer, said switch having a control member movable upwardly relative thereto to open said switch, and means supporting said switch for resilient vertical bodily deflection, the control member of said switch being disposed above and in the path of movement of the lowermost of said projections to be raised thereby and maintain the switch open in the raised position of the piston, a stop being fixedly positioned below said control member for engagement thereby responsive to bodily downward movement of the switch, and into the path of downward movement of the uppermost of said projections to be engaged thereby and open the switch at the termination of downward piston stroke.

2. In a fluid pump of the type wherein a piston descends by gravity in a cylinder, the combination with said pump of a piston rod carried by said piston, relatively vertically spaced lateral projections carried by said rod, a manually operable latch for maintaining the piston in a predetermined raised position, a normally closed timer switch and means supporting same for resilient

vertical deflection adjacent said rod, a control member vertically movable on said switch and projecting into the path of movement of the lowermost of said projections to open the switch as said member is moved upwardly by engagement with said projection, a stop being fixedly positioned below said control member for engagement thereby responsive to downward deflection of the switch, and means movable with the switch projecting into the path of downward movement of the uppermost of said projections to be engaged thereby and to open the switch at the termination of the downward piston stroke.

HUGH M. BROWN.




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