Oct. 30, 1956 T. A. HEWSON 2,768,879

APPARATUS FOR PERFORMING CHEMICAL TESTS

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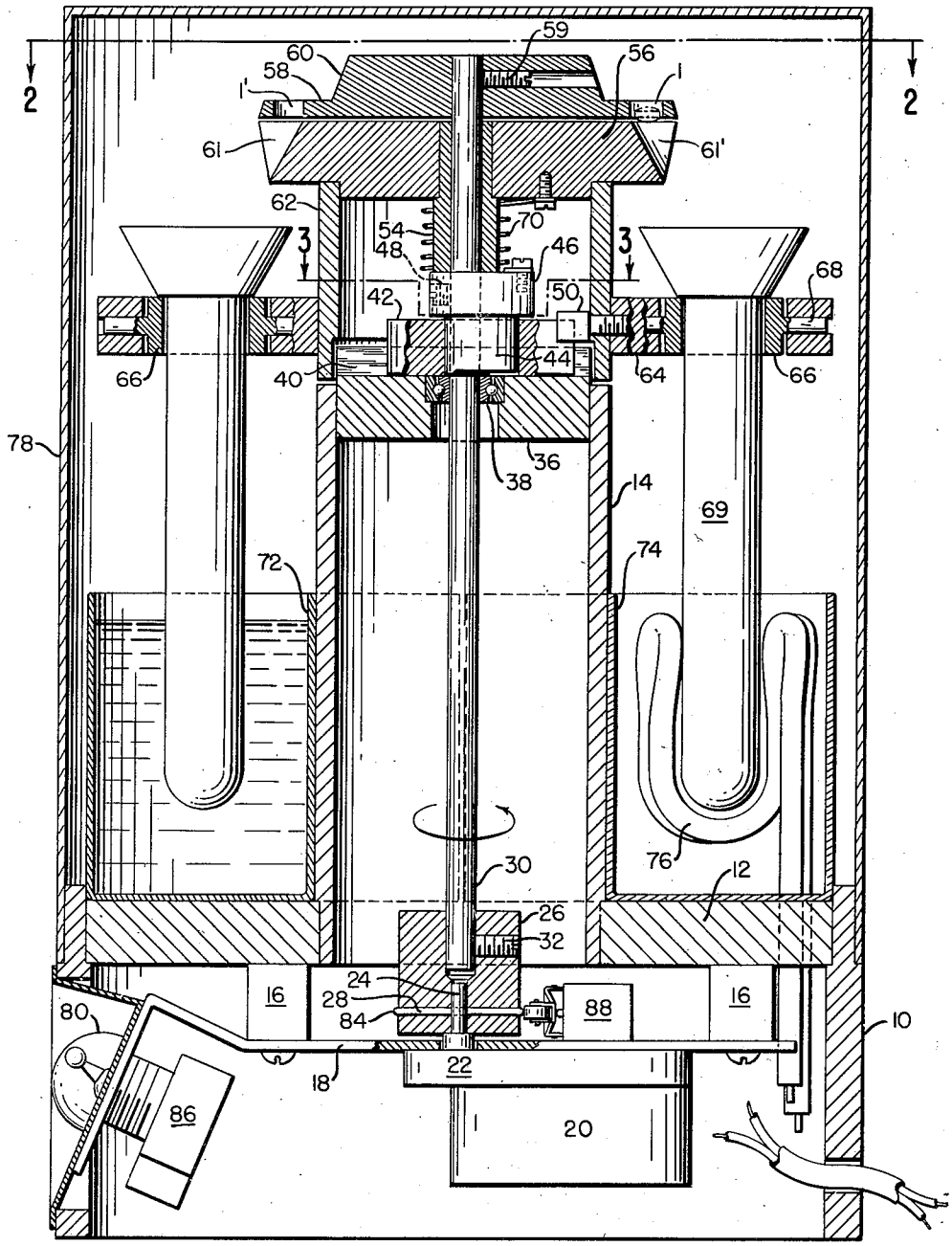


Fig. 1

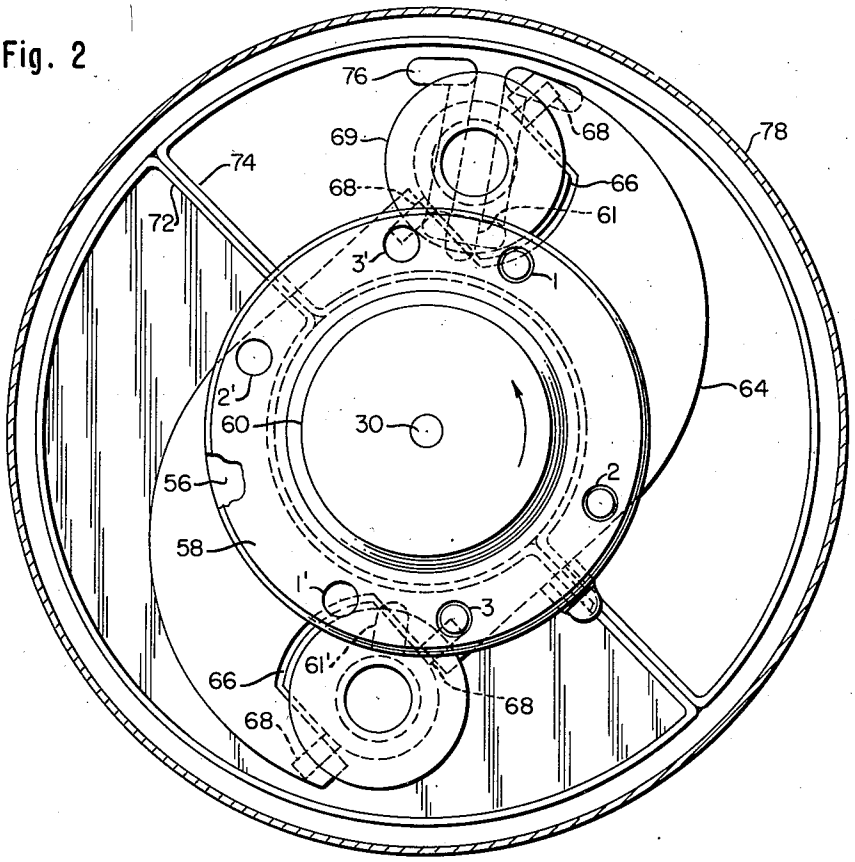
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Fig. 2



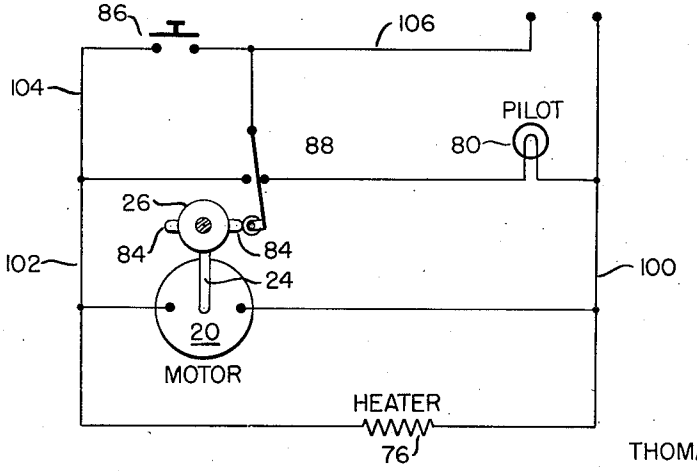


Fig. 6

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Fig. 3

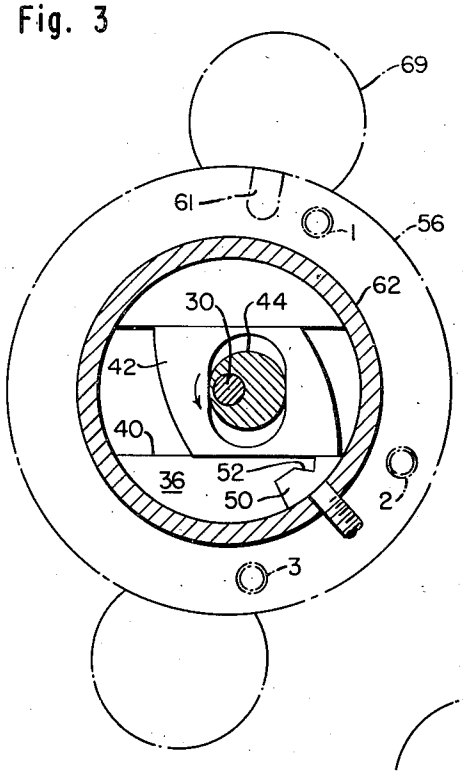


Fig. 5

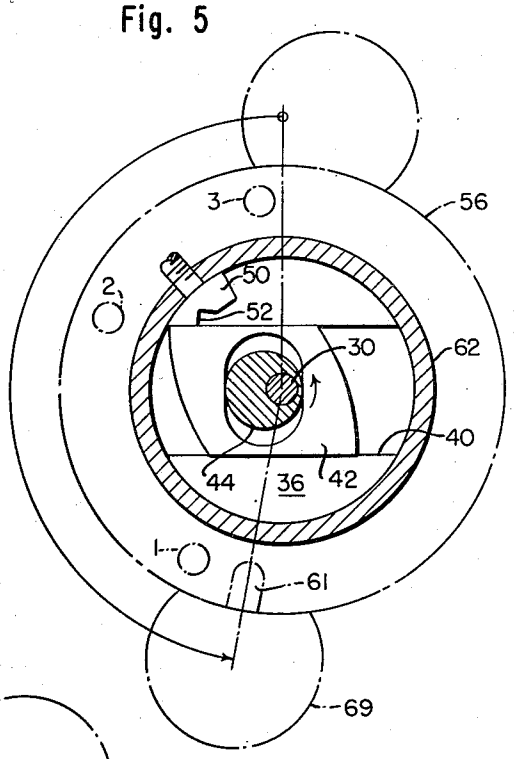
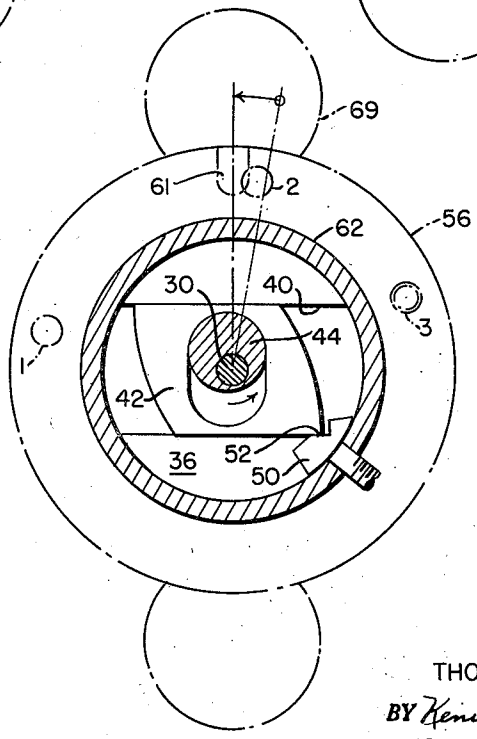


Fig. 4



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APPARATUS FOR PERFORMING CHEMICAL TESTS

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Application April 23, 1952, Serial No. 283,927

6 Claims. (Cl. 23—253)

My invention relates to apparatus for performing chemical tests automatically and comprises an improvement upon apparatus of the type disclosed in my prior United States Letters Patent Nos. 2,550,067 and 2,560,107.

The primary object of my present invention is to facilitate and make more efficient the construction and operation of apparatus for performing a series of operations on samples of material contained in test-tubes or the like.

Another object of the invention is to provide a relatively small and inexpensive chemical testing machine suitable for use in individual doctor's offices, small processing plants, and the like.

An important feature of the invention resides in a simple, compact machine incorporating a combination of elements for performing a sequence of steps such as adding reagents, heating, cooling, etc., and including a receptacle carrier suspended from a central column above a heater and fluid container and beneath a reagent dispenser, the movements of the carrier and dispenser being controlled by mechanism housed in the central column. The operating mechanism is thus securely protected from dirt and fluids, while the external elements are conveniently exposed for easy cleaning and observation.

These and other objects and features of the invention will be more readily understood and appreciated from the following detailed description of a preferred embodiment selected for purposes of illustration and shown in the accompanying drawings, in which:

Fig. 1 is a view in vertical cross-section through a machine constructed in accordance with one embodiment of the invention,

Fig. 2 is a view in cross-section taken along the line 2—2 of Fig. 1,

Fig. 3 is a view in cross-section taken along the line 3—3 of Fig. 1,

Fig. 4 is a view in cross-section as in Fig. 3 showing the relation of the elements at the end of the first motion of the carrier,

Fig. 5 is a view in cross-section as in Fig. 3, showing the relation of the elements at the completion of the cycle of the machine, and

Fig. 6 is a circuit diagram showing the control circuit for the machine.

The machine of my invention, as shown in the embodiment illustrated in the drawings, is organized about a heavy cylindrical casting forming a base 10 adjacent the upper surface of which is welded, or otherwise rigidly secured, an annular platform 12 serving as a base support for an upright cylindrical tube or column 14 mounted coaxially with the main base casting 10. Rigidly secured to the lower surface of the annular platform 12 is a pair of depending spacer bars 16 to which a metal mounting plate 18 is secured. A small motor 20 having an integral gear reduction system 22 is bolted to the lower surface of the mounting plate 18 and is provided with an upright shaft 24 which revolves at the rate of one turn in each ten mintes when the motor is supplied with alternating current

at about 110 volts and 60 cycles. The motor shaft 24 is received in a cylindrical coupling block 26 and secured against relative rotation therewith by means of a transverse pin 28 provided with rounded protruding heads 84 at each end.

Also received in the coupling block 26 is the lower end of the main drive shaft 30, extending vertically upward through the tubular column 14 and fixed in the block 26 by means of a set screw 32. At the top of the column 14 there is fixedly mounted a block 36 in which is secured a bearing 38 for an intermediate portion of the vertical shaft 30. In the top of the block 36 there is cut a broad transverse slot 40 in which slides a latch or slide member 42, best shown in Figs. 3, 4 and 5, and provided in turn with an ovoid center slot accommodating the lower portion of an eccentric 44 secured to the shaft 30. As the shaft 30 turns, the eccentric 44 turns with it and moves the latch 42 back and forth in the slot 40 in the top of the block 36.

The eccentric has an upper portion 46 upon the offset portion of which is secured one end of a torsion spring 70. A set screw 48 also passes through the upper portion of the eccentric and serves to lock the latter upon the shaft 30. Resting upon the upper surface of the eccentric is a bushing 54 which in turn supports a circular plate 56 mounted for free rotation upon the bushing 54 and providing support for a depending skirt or flange 62 extending downwardly to a plane just above the level of the top of the tubular column 14.

A circular dispensing plate 58 is integral with a knob 60 and secured to the upper end of the shaft 30 by means of a set screw 59. The plate 58 is provided with two sets of spaced, through-and-through holes, shown in Fig. 2 at 1, 2, 3 and 1', 2' and 3'. Corresponding holes in each set are located 180 degrees apart. Cut in the plate 56 are a pair of opposed discharge orifices or chutes 61 and 61', arranged to underlie the holes in the dispensing plate 58 as the two plates are rotated relative to each other. A unitary carrier plate 64 is secured to the skirt 62 and comprises essentially two opposed arm portions integral with a center hub. At the outer end of each arm of the carrier plate 64 there is disposed a test-tube holder 66 pivoted to the carrier as shown at 68.

The rotation of the shaft 30 at the rate of one revolution per ten minutes causes similar rotation of the dispenser plate 58. Tablets placed in the holes 1, 2, 3 or 1', 2' and 3' will be discharged through the chutes 61 or 61' and thence into a test-tube held in the appropriate one of the holders 66. But beneath the carrier 64 on one side of the platform 12 there is a semi-circular can or container 74 in which is mounted an electrical resistance heater 76, while on the other side of the platform there is mounted a similar can 72 in which a coolant liquid may be placed. In performing tests, such as the Wilkerson-Heftmann test for the sugar content of human blood, it is required that the blood be heated while three reagent tablets are introduced, the heat being reduced shortly after the introduction of the second tablet and then drastically reduced after the introduction of the third reagent tablet. Consequently the carrier is driven, by means now to be described, from a position in which the test tube 69 is directly opposite the heater 76 to a position slightly spaced from the heater and finally to a position in which its lower end dips into coolant liquid in the container 72.

As the shaft 30 turns the eccentric 46 it moves the lower end of the torsion spring 70 in counterclockwise direction thus exerting torque on the plate 56. However, the skirt 62 carries an inwardly projecting stop 50 having a notch or step 52 and disposed in line with the sliding latch member 42. The latch engages the stop 50 and holds the skirt 62, the plate 56 and the carrier 64 against rotation until such time as the eccentric 44 acts

to slide the latch inwardly so that the stop 50 rides up on the notch 52. Then the carrier moves a distance proportional to the length of the notch, and the carrier then comes to rest again as the notch 52 engages the latch 42. This short movement is effective to remove the test tube 69 from close proximity to the heater 76. Finally the eccentric 44 acts to disengage the latch 42 from the stop 50, and the spring 70 then acts to turn the plate 56, skirt 62, and carrier 64 through an angle of approximately 165 degrees, or until the stop 50 comes into engagement with the opposite corner of the latch 42. During this movement the test-tube 69 rides over the end of the container 74, over the end of the container 72 and then returns to vertical position with its lower end below the level of the cooling liquid in the latter container.

The cycle of operation of the apparatus can best be appreciated from a comparison of Figs. 3, 4 and 5. In Fig. 3 the elements are shown in position as the cycle starts. Hole 1 is just to the right of the chute 61 and the latch 42 is fully engaged with the stop 50. The eccentric 44 is in position forcing the latch to its extreme right hand position. Although not shown in the figure the test tube 69 is now close to the heater 76.

In Fig. 4 it will be seen that the plate 58 has been rotated through 90 degrees (2.5 minutes), during which movement the tablet from hole 1 has been discharged into the tube 69. Also, however, the latch 42 has been moved to the left by the 90 degree rotation of the eccentric 44 and has permitted the skirt 62 and stop 50 to move a few degrees counterclockwise, as shown by the arrow, to move the test tube away from the heater 76. The hole 2 has previously registered with the chute 61 and discharged the second tablet into the tube 69.

In Fig. 5 the full ten minute cycle has been completed. The dispenser plate 58 has rotated 180 degrees, discharging the second and third tablets into the tube 69. However, the eccentric 44 has now moved the latch 42 to its extreme left hand position, freeing the stop 50 and permitting the spring 70 to rotate the carrier 64 and tube 69 about 165 degrees, until the latch engages the stop once more but upon the corner diametrically opposite to that formerly engaging the stop 50. Consequently the tube 69 is 180 degrees opposite its starting position. Of course the holes 2 and 3 are so spaced upon the plate 56 that the third tablet is discharged just before the latch is disengaged. For the sake of clarity the holes 1', 2' and 3' have been omitted from Figs. 3, 4 and 5.

To provide control means for the mechanism just described there is provided in the base of the machine a pair of switches and a pilot light, wired as shown in the circuit diagram of Fig. 6. From one side of a supply line a lead 100 runs to a pilot light 30, the motor 20, and the heater 76. The other terminals of the motor and heater are connected by a line 102 to a two position switch 88 operated by the cam heads 84 on the ends of the pin 28 in the coupling block 26. When the elements are in the positions shown in Fig. 6, the circuit is open, since the only return path is through a lead 104 running through a spring push button switch 86 to the other side of the supply line, and the latter switch is normally open. When the switch 86 is closed manually, the motor 20 and heater 76 are energized, as well as the pilot light. When the motor has turned the appropriate cam head 84 to release the switch 88, the pilot light is disconnected from the circuit, and the normal operating circuit established through a lead 106 from the supply line to the second contact member of the switch 88.

In operating the apparatus herein described, the operator first removes a cylindrical casing 78 which fits over the apparatus, thereby exposing the interior of the machine. The necessary reagent tablets are placed in the appropriate holes in the plate 58, the can 72 filled with cold water or other liquid, the test tube placed in the receiver, and the switch 86 manually closed. The pilot

light immediately comes on, if the machine is properly synchronized; if not, the light will not come on until the cam head 84 operates the switch 88. When the pilot light goes out, it is an indication that the regular operating circuit is established and the cycle begun. At the end of the cycle, the other of the cam heads again lights the pilot light through the switch 88 and disconnects the motor and heater. The second lighting of the pilot light is an indication that the cycle has been completed and the tube ready for removal and observation. It also indicates that the machine is ready to undertake another cycle. The second test tube will then be in position to start through the cycle, and it is only necessary to place the reagent tablets in the proper holes in the plate 58, depress the switch 86 until the light goes out, and wait until the light comes on once more to indicate the end of another cycle.

Those skilled in the art will readily understand and appreciate that the embodiment herein described and illustrated is but exemplary of many possible variations. The number and timing of the dispensing operations depends upon the number and angular position of the holes in the plate 58. Other plates may be provided for performing various tests. Moreover, by varying the number of notches in the stop 50 it is possible to introduce several step movements of the carrier and test tubes. The distance the latch 42 must move in each notch determines the time before a movement of the carrier, while the length of each step or notch in the stop 50 determines the angular rotation effected by the carrier. Moreover the number of stops may be increased to any desired number to bring about an almost infinite variation in the timing and extent of the movements of the carrier. The cans or containers 72 and 74 may be varied also to provide any desired succession of heating and cooling steps or alternations of heating and cooling.

It is especially to be noted that the electrical control elements are all housed securely beneath the platform and mounting plate in the base where they cannot be damaged by liquids, reagent powders and the like. Similarly the mechanical trains are concealed and protected by the tubular column 14 and the skirt 62. The exposed portions may conveniently be made from stainless steel and are shaped and arranged to facilitate easy cleaning and inspection.

Perhaps the most important advantage offered by the apparatus of my invention is the fact that it provides completely automatic and extremely simple means by which totally unskilled personnel can accomplish complex chemical testing procedures.

Having thus disclosed my invention, what I claim as new and desire to secure by Letters Patent of the United States is;

1. Apparatus of the class described, comprising a base, a vertical shaft mounted on said base, means for turning said shaft, a perforated plate secured to said shaft, a receptacle carrier freely mounted on said shaft beneath said plate, a spring mechanically connected to said shaft and said carrier, a fixed support, a latch mounted on said support and normally preventing movement of said carrier, and means actuated by said shaft to disengage said latch and permit said spring to rotate said carrier, whereby said shaft turns said plate at a substantially constant rate while said carrier remains at rest until turned by said spring.

2. Apparatus of the class described, comprising a base, a shaft mounted vertically upon said base, means for driving said shaft at a substantially constant rate, a perforated plate mounted at the upper end of said shaft, a tubular column mounted on said base and surrounding the lower portion of said shaft, a carrier supported upon said column for rotation about said shaft, a receptacle receiver secured to said carrier, a torsion spring connected mechanically to said shaft and said carrier, a stop member secured to said carrier, and a latch actuated by rotation of the shaft and normally engaging said stop to hold said

carrier against rotation, disengagement of the latch and stop causing said spring to rotate the carrier.

3. Apparatus of the class described comprising a cylindrical base, a centrally located tubular column secured to said base, an arcuate heater-containing compartment and an arcuate fluid container resting on said base in nesting relation with said column, a receptacle carrier mounted on said column for rotation above said compartment and container, a tablet dispenser coaxial with said column and disposed above said carrier, a shaft disposed within said column and secured to said dispenser, means for turning said shaft at a substantially constant rate, and latch-controlled means actuated by the shaft including a torsion spring connected to the carrier and the shaft for causing intermittent rotation of the carrier.

4. Apparatus of the class described, comprising a vertically disposed shaft, a reagent dispenser fixed to the upper end of the shaft, a receptacle carrier mounted for rotation beneath said plate upon an axis concentric with said shaft, a spring coupling the carrier to the shaft, cam controlled mechanism operated by the shaft for alternately locking and unlocking the carrier against rotation, and means for turning the shaft at a constant rate.

5. Apparatus of the class described comprising a vertically disposed shaft, a reagent dispenser fixed to the upper end of the shaft, a receptacle carrier mounted for rotation beneath said plate upon an axis concentric with

said shaft, a spring coupling the carrier to the shaft, a cam fixed to said shaft, a sliding latch controlled by said cam, a stop fixed to said carrier in position to engage said latch, said cam being effective to move the latch in and out of engagement with the stop, and means for turning the shaft.

6. Apparatus of the class described comprising a vertically disposed shaft, a reagent dispenser fixed to the upper end of the shaft, a receptacle carrier mounted for rotation beneath said plate upon an axis concentric with said shaft, a spring coupling the carrier to the shaft, a cam fixed to said shaft, a sliding latch, a stop fixed to said carrier in position to engage said latch at two positions 180° apart, said cam being effective to move the latch from one position to the other, and means for turning the shaft.

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