April 14, 1970 T. E. WEICHSELBAUM ET AL 3,506,164

AUTOMATIC PIPETTE

Filed May 31, 1968 3 Sheets-Sheet 1

Fig. 2

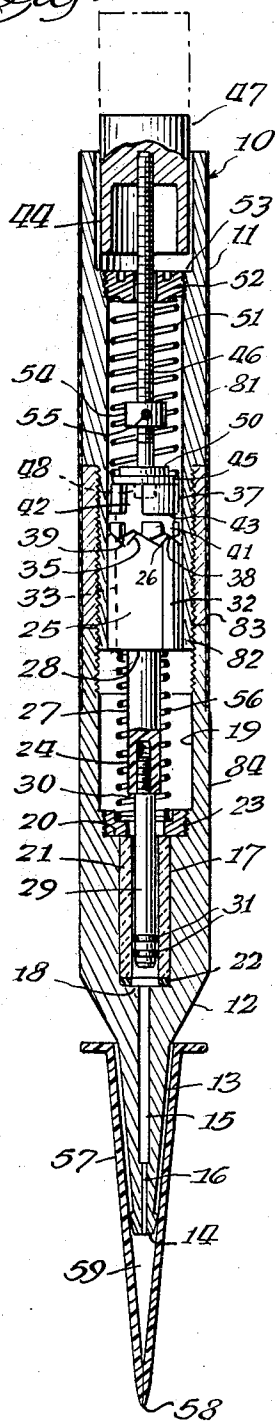


Fig. 1

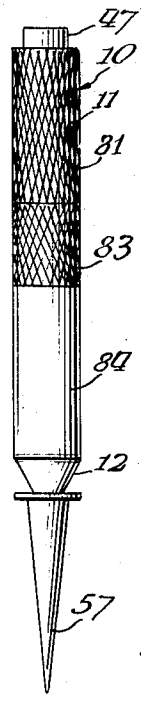


Fig. 10

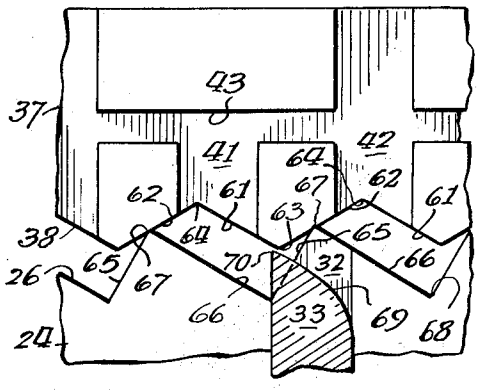


Fig. 11

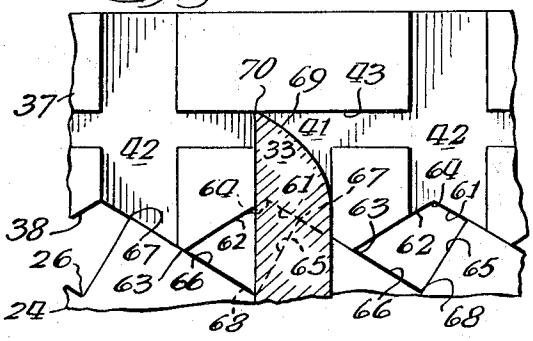


Fig. 12

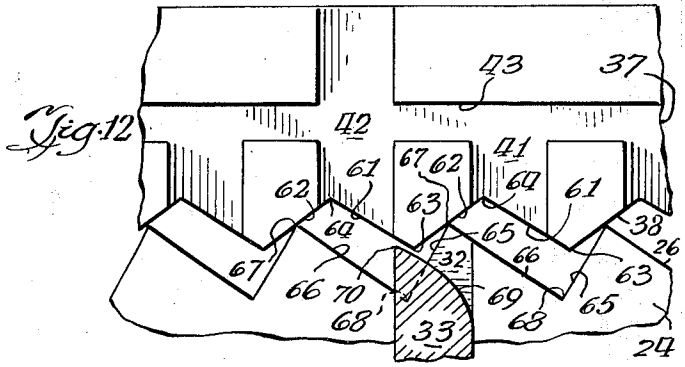
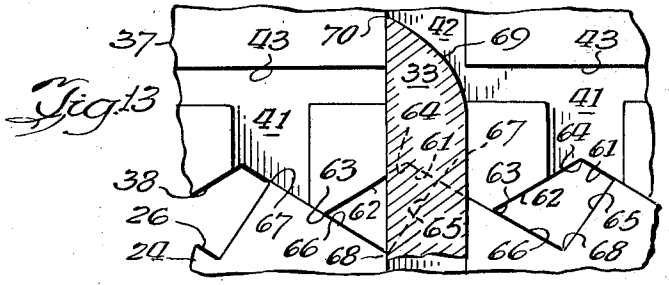


Fig. 13



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Fig. 3

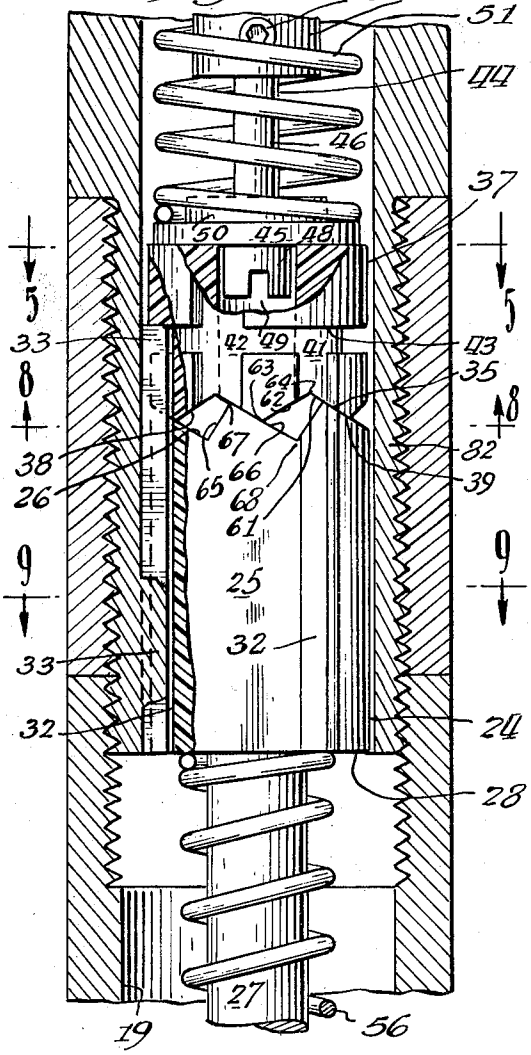
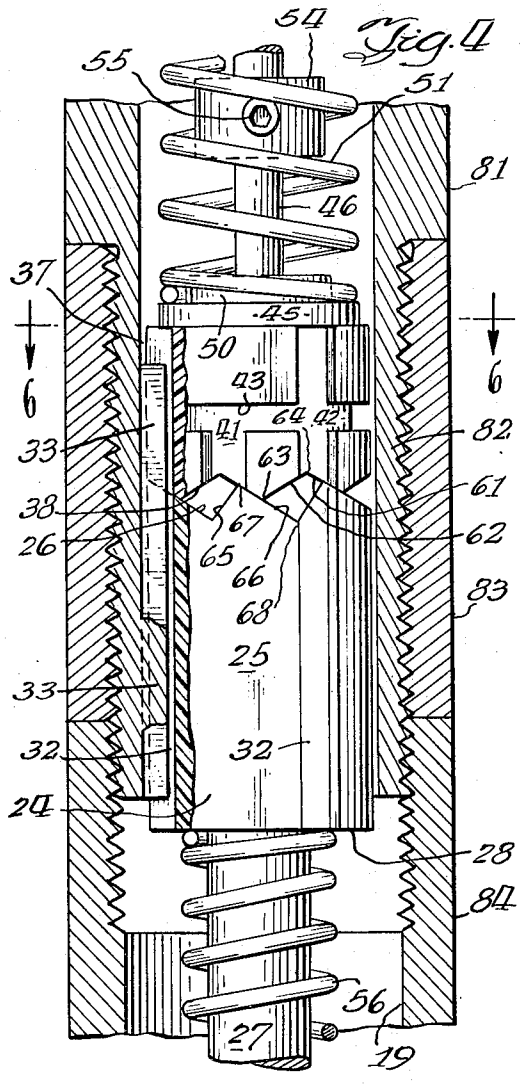


Fig. 4



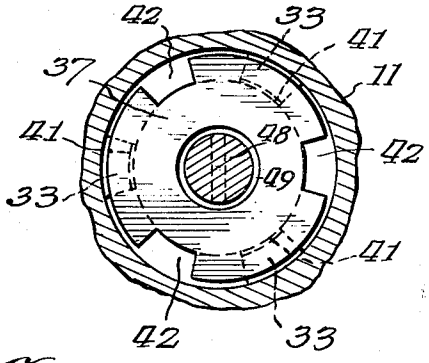


Fig. 5

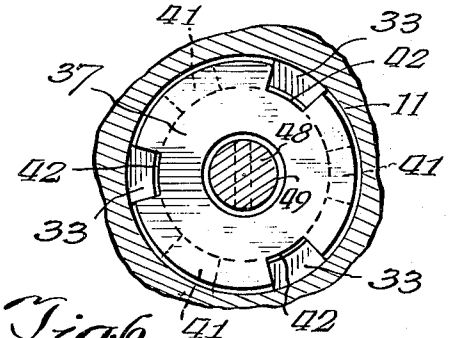


Fig. 6

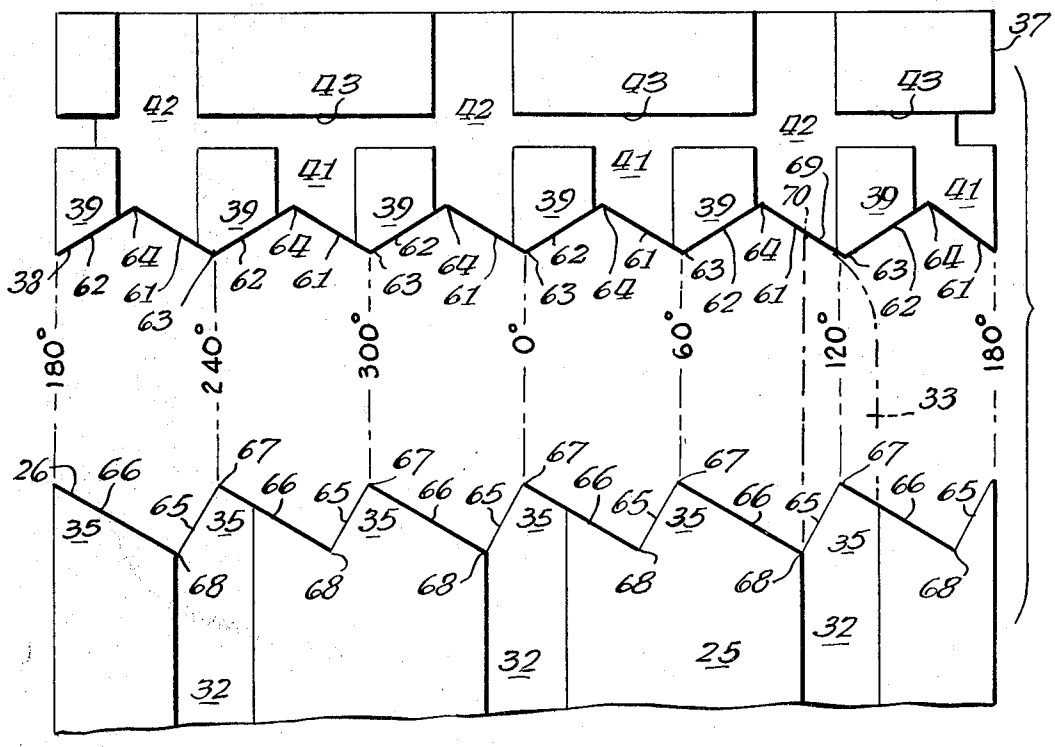
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ATTORNEY

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AUTOMATIC PIPETTE

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Fig. 7



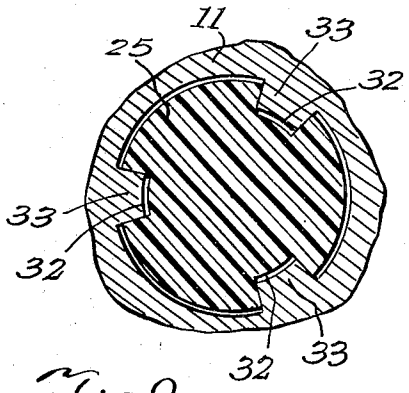


Fig. 9

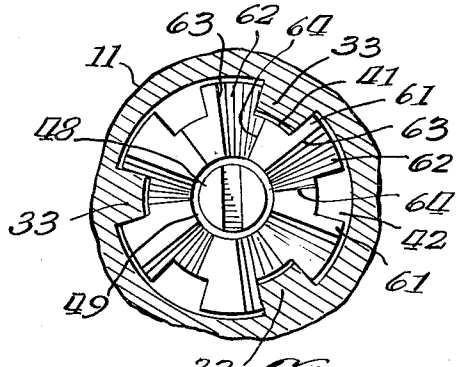


Fig. 8

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United States Patent Office 3,506,164 Patented Apr. 14, 1970

3,506,164

AUTOMATIC PIPETTE

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Filed May 31, 1968, Ser. No. 733,337
Int. Cl. B67d 5/42
U.S. Cl. 222—340 10 Claims

ABSTRACT OF THE DISCLOSURE

A pipette adapted to draw a variable predetermined volume of liquid into a reservoir and thereafter completely dispense all traces of said liquid. The pipette comprises a barrel, a piston reciprocal in the barrel, a plunger operable on the piston to cause axial displacement thereof, and automatically operating indexing means responsive to the stroke of the plunger and piston in the barrel providing a relatively shorter positive-stopped intake stroke and a relatively longer positive-stopped dispensing stroke so as to insure that all traces of the liquid drawn into the reservoir on the intake stroke are completely dispensed on the dispensing stroke.

This invention relates to liquid transferring devices and, more particularly, to pipettes adapted to receive and dispense predetermined volumes of liquid.

Various scientific, industrial and medical analytical procedures require quick and easy transfer of predetermined volumes of liquid from one receptacle to another. A form of device commonly used for this purpose is a pipette having a barrel and a piston reciprocal in the barrel, whereby upon a first intake stroke of the piston in the barrel, a predetermined volume of liquid is drawn into a reservoir, and upon a second dispensing stroke of the piston in the barrel, the liquid is dispensed therefrom. One major problem associated with this type of device is that of insuring that all of the liquid drawn in by the intake stroke is completely dispensed by the dispensing stroke. If the length of the dispensing stroke is the same as that of the intake stroke, trace amounts of the liquid will generally remain in the reservoir and fail to be dispensed, which, depending upon the sensitivity of the analytical test being run, may seriously affect the reliability of the test.

Various attempts have been made to overcome this problem by providing devices allowing an intake stroke somewhat shorter than the dispensing stroke. Heretofore, however, these attempts have not proven to be completely satisfactory for accomplishing the intended purpose for the reason that the stopping point for the intake stroke on such devices has not been a positive stop but rather a semi-stop, requiring caution on the part of the operator to avoid being overshot.

It is an object of this invention to provide a pipette of the barrel and reciprocating piston type which is adapted to drawn a predetermined volume of liquid into a reservoir and thereafter positively completely dispense all traces of said predetermined volume of liquid.

Another objects of this invention is to provide a pipette having the features of the foregoing object which is adapted to provide a dispensing stroke of the piston within the barrel longer than the intake stroke so as to insure that all traces of the liquid drawn into the reservior on the intake stroke are completely dispensed on the dispensing stroke.

Another object of this invention is to provide a pipette having the features of the foregoing objects and having a positive stopping point for the intake stroke short of the positive stopping point for the dispensing stroke.

A further object of this invention is to provide a pipette having the features of the foregoing objects wherein the positive stopping point for the intake stroke is adapted to be brought into operational position only on alternating forward strokes of the piston in the barrel.

Still another object of this invention is to provide a pipette having the features of the foregoing objects wherein the operational positioning of the positive stopping point for the intake stroke on alternating forward strokes of the piston in the barrel is accomplished automatically by means responsive to the operating stroke of the piston in the barrel.

Other objects and advantages of the present invention will become apparent from the following detailed description and accompanying drawings.

The above objects are accomplished in accordance with the present invention by providing a pipette comprising a barrel, a piston reciprocal therein, an axially displaceable plunger operable on the piston to cause forward movement of the piston in the barrel, a return spring for biasing the piston and plunger rearwardly in the barrel, and indexing means within the barrel for effecting engagement of a first set of positive stopping means upon a first forward stroke of the plunger and piston within the barrel, and a second set of positive stopping means upon the next succeeding forward stroke of the plunger and piston within the barrel. The first set of positive stopping means permits a relatively shorter stroke and is employed for the intake stroke whereas the second set of positive stopping means permits a relatively longer stroke and is employed for the dispensing stroke. The indexing means comprises an axially displaceable and circumferentially rotatable member disposed within the barrel between the piston and plunger and is automatically operative in response to the forward and return strokes of the plunger and piston within the barrel, as explained more fully hereinafter.

In the drawings, in which like reference characters refer to similar parts throughout the several views:

FIGURE 1 is a front elevational view of a pipette in accordance with the present invention;

FIG. 2 is an enlarged vertical sectional view of the pipette shown in FIG. 1, showing the operating mechanism of the pipette in position after the forward intake stroke and with dotted lines showing the push button portion of the plunger member in its initial position;

FIG. 3 is an enlarged fragmentary vertical sectional view showing in greater detail a portion of the operating mechanism in the same position as shown in FIG. 2;

FIG. 4 is a view similar to FIG. 3 showing the operating mechanism in position after the forward dispensing stroke;

FIG. 5 is a horizontal sectional view taken along the line 5—5 of FIG. 3 in the direction of the arrows;

FIG. 6 is a horizontal sectional view taken along the line 6—6 of FIG. 4 in the direction of the arrows;

FIG. 7 is an enlarged exploded fragmentary unrolled two-dimensional view of the adjoining exterior cylindrical surfaces of the indexing member and the piston member showing the radial ridges on their respective adjoining end surfaces in aligned position during the course of the forward dispensing stroke, with the position of one of the keys shown in dotted lines;

FIG. 8 is a horizontal sectional view taken along the line 8—8 of FIG. 3 in the direction of the arrows;

FIG. 9 is a horizontal sectional view taken along the line 9—9 of FIG. 3 in the direction of the arrows;

FIG. 10 is an enlarged fragmentary view showing the relative position of the cooperating portions of the indexing member, the piston member and the key at the start of the forward intake stroke;

FIG. 11 is a view similar to FIG. 10 at the completion of the forward intake stroke;

FIG. 12 is a view similar to FIG. 10 at the completion of the return intake stroke and the start of the forward dispensing stroke; and

FIG. 13 is a view similar to FIG. 10 at the completion of the forward dispensing stroke.

Referring to the drawings, a pipette **10** in accordance with the present invention comprises a barrel **11** which is the main body or housing portion and which may be variously formed as to its specific configuration and is shown here cylindrical in form with a forward tapered neck portion **12** and a projecting nozzle portion **13** having an outer end wall **14**. Extending axially within the neck portion **12** and the nozzle portion **13** is a passageway **15** having a reduced diameter portion **16** leading out through the end wall **14**.

Rearwardly of the passageway **15** in the form of an increased diameter counterbore is a cylindrical chamber **17** having a shoulder **18** formed at its forward end. At the rearward end of the cylindrical chamber **17** is the form of an increased diameter counterbore is the main bore portion **19** of the barrel **11**, which forms with the cylindrical chamber **17** a shoulder **20**. Disposed within the cylindrical chamber **17** is a removable cylindrical tube **21** which may be formed of glass, plastic or metal and which is in sealing engagement with the shoulder **18** by means of an O-ring **22**. The cylindrical tube **21** is held in place in the cylindrical chamber **17** by means of a retaining ring **23** which is threadedly engaged within the main bore **19** against the shoulder **20** and the rearward end of the tube **21**.

Disposed within the barrel **11** is a piston member indicated generally by the reference numeral **24** and shown in the form of a stepped shaft comprising a rearward shaft portion **25** having a rearward transverse end surface **26**, an intermediate shaft portion **27** of reduced diameter and forming with the rearward shaft portion **25** a shoulder **28**, and a forward shaft portion **29** of still further reduced diameter and forming with the intermediate shaft portion **27** a shoulder **30**. The forward shaft portion **29** is preferably threadedly engaged in the intermediate shaft portion **27** so that the forward shaft portion **29** may be conveniently removable and replaceable, for reasons explained more fully hereinafter. The forward shaft portion **29** of the piston member **24** extends into the cylindrical tube **21** and is adapted to slide forwardly and rearwardly therein in effective sealing engagement with the walls thereof as, for example, by means of one or more O-rings **31** around the circumference of the forward shaft portion **29**.

The intermediate shaft portion **27** and the rearward shaft portion **25** of the piston member **24** are disposed in the main bore portion **19** of the barrel **11**. The diameter of the rearward shaft portion **25** is such as to enable it to slide axially along the walls of the barrel **11**. The rearward shaft portion **25** is provided with one or more axially extending slots or keyways **32** which cooperate with one or more axially extending keys **33** projecting inwardly from the interior walls of the barrel **11** and in engagement with the keyways **32** so as to prevent circumferential rotation of the piston member **24** relative to the barrel **11**. The rearward transverse end surface **26** of the rearward shaft portion **25** of the piston member **24** is provided with a plurality of radial teeth **35**, described in greater detail hereinafter.

Disposed within the main bore portion **19** of the barrel **11** rearwardly of the piston member **24** is an indexing member **37** having a forward transverse end surface **38** in contact with the rearward transverse end surface **26** of the rearward shaft portion **25** of the piston member **24**. The forward transverse end surface **38** of the indexing member **37** is provided with a plurality of radial teeth **39**, described in greater detail hereinafter. Disposed axially around the circumference of the indexing member **37** and extending from the forward transverse end surface **38** are a plurality of relatively shorter extending slots or keyways **41** and a plurality of relatively longer extending slots or keyways **42**. As can be seen in FIG. 7, the relatively shorter extending keyways **41** and the relatively longer extending keyways **42** are equally spaced in alternating relationship to each other around the circumference of the indexing member **37**. At the rearward end of each of the relatively shorter extending keyways **41** is a shoulder **43**.

The diameter of the indexing member **37** is such as to enable it to slide axially along the walls of the barrel **11**, and its position within the barrel with respect to the keys **33** projecting inwardly from the interior walls of the barrel is such as to enable its keyways **41** and **42** to slide into and out of engagement with the keys **33**. When the keys **33** are not in engagement with either the keyways **41** or **42**, the indexing member **37** is free to rotate circumferentially in relation to both the barrel **11** and the piston member **24**. When the keys **33** are in engagement with the relatively shorter extending keyways **41**, forward axial movement of the indexing member **37** within the barrel **11** is limited by the shoulder **43**. On the other hand, when the keys **33** are in engagement with the relatively longer extending keyways **42**, the indexing member **37** is free to move forwardly within the barrel **11** a greater distance.

Disposed within the main bore portion **19** of the barrel **11** rearwardly of the indexing member **37** is a plunger member indicated generally by the reference numeral **44** and comprising a plunger head **45** in contact with the indexing member **37**, a threaded stem **46** connected to the plunger head **45** and extending rearwardly therefrom and a push button **47** threadedly connected to the rearward end of the stem **46** and extending outwardly beyond the rearward end of the barrel **11**. To provide positive alignment between the plunger member **44** and the indexing member **37**, the head **48** of the stem **46** projects forwardly of the plunger head **45** and is received within an opening **49** in the rearward end surface of the indexing member **37**. A rearward reduced diameter extension **50** of the plunger head **45** carries a spring member **51** for maintaining the plunger head **45** in pressure contact with the indexing member **37**. The spring member **51** is held in compression by means of a retaining ring **52** which is threadedly engaged within the main bore **19** of the barrel **11**. A shoulder **53** is formed in the bore **19** forwardly of the push button **47** to serve as a stop means for limiting the forward movement of the plunger member **44** within the barrel **11**. An adjustable collar **54** is attached to the stem **46** by means of a set screw **55**. The collar **54** cooperates with the retaining ring **52** to limit rearward movement of the plunger member **44** within the barrel **11**.

The entire assembly within the barrel **11** is biased rearwardly by means of a spring member **56** which is carried on the intermediate shaft portion **27** of the piston member **24** and is maintained under compression between the shoulder **28** of the piston member **24** and the retaining ring **23**.

Removably secured in air-tight engagement to the nozzle portion **13** of the barrel **11** is a disposable tip **57**, preferably formed of plastic, having an inlet orifice **58** at its forward end and a liquid-receiving compartment or reservoir **59** between the orifice **58** and the end wall **14** of the barrel **11**, in alignment with the passageway **15** in the barrel. Although the disposable tip **57** is shown in conical form secured over the nozzle portion **13** of the barrel **11** by means of a friction fit, other forms of disposable tip and other means for attaching it to the barrel may suitably be employed. For example, the disposable tip may be in the form of a cylindrical tube removably secured in air-tight engagement to the forward end wall of the barrel by means of a suitable retaining sleeve or collar.

Referring to FIG. 7, the radial teeth 39 on the forward transverse end surface 38 of the indexing member 37 are formed by alternating beveled sectors 61 and 62 on the end surface 38 which slope in opposite directions and converge alternatingly outwardly from the end surface 38 to form radial ridges 63 and inwardly toward the end surface 38 to form radial grooves 64. As shown in FIG. 7, the end surface 38 is provided with six teeth 39 having their ridges 63 equally spaced at 60 degree intervals. The beveled sectors 61 and 62 all have substantially the same width and substantially the same degree of slope so that each radial ridge 63 is spaced substantially midway between a pair of adjacent radial grooves 64. In the preferred form shown in FIG. 7, the beveled sectors 61 and 62 are each sloped at an angle of approximately 30 degrees to the horizontal transverse plane and form between them at their intersection an angle of approximately 120 degrees. As shown in FIGS. 7 and 8, the alternating axially extending keyways 41 and 42 are so positioned around the circumference of the indexing member 37 that there is one keyway disposed between each pair of adjacent radial ridges 63, with each keyway extending widthwise across radial groove 64 from a point on beveled sector 61 adjacent radial ridge 63 to a point on beveled sector 62 adjacent radial groove 64.

The radial teeth 35 on the rearward transverse end surface 26 of the rearward shaft portion 25 of the piston member 24 are formed by alternating beveled sectors 65 and 66 on the end surface 26 which slope in opposite directions and converge alternatingly outwardly from the end surface 26 to form radial ridges 67 and inwardly toward the end surface 26 to form radial grooves 68. As shown in FIG. 7, the end surfaces 26 is provided with six teeth 35 having their ridges 67 equally spaced at 60 degree intervals. The beveled sectors 65 have a narrower width and steeper slope than the beveled sectors 66, so that each radial ridge 67 is more closely spaced to one of its adjacent radial grooves 68 than to the other. In the preferred form shown in FIG. 7, the beveled sectors 65 and 66 are sloped at angles to the horizontal transverse plane of approximately 60 degrees and 30 degrees, respectively, and form between them at their intersection an angle of approximately 90 degrees. As shown in FIG. 7, the rearward shaft portion 25 of the piston member 24 is provided with three axially extending keyways 32 disposed around its circumference at alternate radial ridges 67, with each keyway 32 extending widthwise across radial ridge 67 from its more closely spaced adjacent radial groove 68 to a point on beveled sector 66 such that the radial ridge 67 lies approximately midway across the width of the keyway 32.

As can be seen in FIG. 7, each key 33 is provided with a beveled rearward end surface 69 having a rearwardmost edge 70 at one side thereof. The end surface 69 slopes in the same direction and at the same angle as beveled sector 61 on the end surface 38 of the indexing member 37, thereby facilitating sliding of these surfaces relative to each other.

The operation of the pipette of this invention may best be understood by reference to FIGS. 2 and 10 through 13. At the start of the forward intake stroke, with the push button 47 in the undepressed position indicated by the dotted lines in FIG. 2, the indexing member 37, the piston member 24, and the keys 33 projecting inwardly from the interior walls of the barrel 11, are in the relative position shown in FIG. 10. In this position, the beveled sectors 62 on the forward transverse end surface 38 of the indexing member 37 are in abutment against the radial ridges 67 on the rearward transverse end surface 26 of the piston member 24, the keyways 41 and 42 on the indexing member 37 are both out of alignment with the keys 33 which are in engagement with the keyways 32 on the piston member 24, and the rearwardmost edges 70 of the rearward end surfaces 69 of the keys 33 are leading into the relatively shorter extending keyways 41 and are just short of contact with the portion of the beveled sectors 61 immediately adjacent to the radial ridges 63 on the end surfaces 38 of the indexing member 37.

When the push button 47 is depressed toward the shoulder 53, the plunger head 45 is urged forwardly against the indexing member 37, which in turn is urged forwardly in the barrel against the piston member 24 and the keys 33. The edges 70 of the keys 33 come into contact with the beveled sectors 61 immediately adjacent to the radial ridges 63, and the beveled sectors 61 slide forwardly along the beveled end surfaces 69 of the keys 33, causing counter-clockwise rotation of the indexing member 37 relative to the keys 33 and the piston member 24. The rotational force thus imparted to the indexing member 37 is sufficient to overcome the resistance of the radial ridges 67 of the piston member 24 against the beveled sectors 62 of the indexing member 37, enabling the beveled sectors 62 to slide over the ridges 67 until the ridges 67 are cleared by the radial ridges 63 of the indexing member 37. Upon further forward movement of the indexing member 37 in the barrel, the beveled sectors 61 of the indexing member, which slope in the same direction and at the same angle as the beveled sectors 66 of the piston member, slide along the beveled sectors 66, thereby causing further counter-clockwise rotation of the indexing member until the keyways 41 on the indexing member are brought into alignment with the keys 33. Further forward movement of the indexing member in the barrel, with keys 33 in engagement with the keyways 41, urges the piston member 24 forwardly in the barrel, thereby causing the forward shaft portion 29 of the piston member to slide forwardly in the cylindrical tube 21 in sealing engagement with the walls thereof so as to expel air through the passageway 15 and 16 and the reservoir 59 and orifice 58 of the tip 57. As the piston member 24 moves forwardly in the barrel, the spring member 56 is further compressed between the shoulder 28 of the piston member and the retaining ring 23. Forward movement of the assembly in the barrel is brought to a positive stop when the keys 33 come into abutment against the shoulders 43 at the rearward ends of the keyways 41, as shown in FIG. 11. As can be seen in FIG. 2, the positive stop at the completion at the forward intake stroke leaves the push button 47 still spaced from the shoulder 53 and extending outwardly beyond the rearward end of the barrel.

At this point the tip 57 is submerged in the liquid to be transferred, and the intake stroke is completed by releasing the push button 47, whereupon the compressed spring member 56 urges rearwardly on the shoulder 28 of the piston member 24, causing the forward shaft portion 29 of the piston member to slide rearwardly in the cylindrical tube 21 in sealing engagement with the walls thereof so as to draw a predetermined volume of the liquid through the orifice 58 into the reservoir 59 of the tip 57.

As the piston member 24 is urged rearwardly in the barrel by the resiliency of the compressed spring member 56, the beveled sectors 66 on its rearward transverse end surface 26 bear directly against the beveled sectors 61 on the forward transverse end surface 38 of the indexing member 37, creating a force directed perpendicularly to the beveled sectors 61, or, in other words, in the direction of the slope of beveled sectors 65. While the keyways 41 on the indexing member 37 are in engagement with the keys 33, this force is restricted to acting only in an axial direction, urging the indexing member rearwardly in the barrel. However, when the keyways 41 become disengaged from the keys 33, the force is able to act also in a transverse direction, causing counter-clockwise rotation of the indexing member relative to the piston member and the keys and thus bringing the keyways 41 out of alignment with the keys. The counter-clockwise rotation is limited by the beveled sectors 62 of the indexing member coming into abutment against the radial ridges 67 of

the piston member, thereby bringing the members into the position shown in FIG. 12.

The indexing member **37**, as it is urged rearwardly in the barrel, in turn urges rearwardly against the plunger head **45**, causing the push button **47** to return to its initial position indicated by the dotted lines in FIG. 2. Rearward movement of the assembly in the barrel is limited by the collar **54** coming into abutment against the retaining ring **52**.

At the completion of the return intake stroke and the start of the forward dispensing stroke, the indexing member **37**, the piston member **24**, and the keys **33** are in the relative position shown in FIG. 12, which differs from their relative position at the start of the forward intake stroke shown in FIG. 10 and described above, only in that the rearwardmost edges **70** of the rearward end surfaces **69** of the keys **33** are now leading into the relatively longer extending keyways **42** of the indexing member. The movement of the parts within the barrel during the dispensing stroke is the same as that described above for the intake stroke, with the exception that the counterclockwise rotation of the indexing member **37** on the forward portion of the dispensing stroke brings the relatively longer extending keyways **42** into alignment with the keys **33**. The indexing member is then free to slide forwardly along the keys **33** in the barrel a greater distance than was possible on the intake stroke, as shown in FIG. 13, with forward movement of the assembly in the barrel being brought to a positive stop when the push button **47** comes into abutment against the shoulder **53**. The forward shaft portion **29** of the piston member **24** is hence caused to slide forwardly in the cylindrical tube **21** a distance greater than that traveled during the intake stroke. Such overtravel serves to force out of the reservoir **59** of the tip **57** any trace amounts of the liquid which might otherwise remain therein, thereby insuring that all of the predetermined volume of liquid drawn into the reservoir **59** on the intake stroke is completely dispensed on the dispensing stroke.

At the completion of the return dispensing stroke, the indexing member **37**, the piston member **24**, and the keys **33** have been returned to the relative position shown in FIG. 10, and the pipette is thus ready for the next filling and dispensing cycle.

Although for purposes of illustration, the cooperating means for effecting circumferential rotation of the indexing member **37** relative to the keys **33** has been described with some particularity in regard to the number, relative position, configuration and dimensions of the radial teeth **39** and keyways **41** and **42** on the indexing member **37** and the radial teeth **35** and keyways **32** on the piston member **24**, it will be understood that some variation may be made therein without significantly changing the basic operating mechanism described above. For example, the alternating axially extending keyways **41** and **42** may be so positioned around the circumeference of the indexing member **37** that there is one keyway at each radial ridge **63**, extending widthwise from a point on beveled sector **61** adjacent radial ridge **63**, across radial ridge **63**, to the adjacent radial groove **64**. Moreover, the rearward transverse end surface **26** of the piston member **24** may be provided with three radial teeth **35** instead of six, having their ridges **67** equally spaced at 120 degree intervals, either at or between the keyways **32**.

The predetermined volume of the liquid to be drawn into the reservoir is, of course, dependent on the volume of air expelled therefrom on the forward intake stroke, and may be varied by varying the inside diameter of the cylindrical tube **21** and, correspondingly, the diameter of the forward shaft portion **29** of the piston member **24**. For this reason, it is preferred to have both of these parts conveniently removable and changeable, as described above. Thus, if it is desired to increase the predetermined volume of the liquid to be drawn into the reservoir, the cylindrical tube **21** may be removed from the cylindrical chamber **17** by unthreading the retaining ring **23** and replaced with a similar cylindrical tube having a larger inside diameter, and the forward shaft portion **29** may be unthreaded from the intermediate shaft portion **27** and replaced with a similar forward shaft portion having a larger diameter slidable in sealing engagement with the walls of the larger inside diameter cylindrical tube.

Finer adjustment of the predetermined volume of the liquid to be drawn into the reservoir may be effected by means of the adjustable collar **54** attached to the stem **46**. For example, by setting the collar **54** more forwardly on the stem **46**, the entire displaceable assembly within the barrel will assume a more rearward initial position relative to the barrel, thereby increasing the length of the stroke and thus the volume of air expelled thereby.

The disposable tip **57** attached to the forward end of the barrel is suitably selected so as to have an appropriate reservoir capacity for accommodating the predetermined volume of liquid to be transferred. The pipette of the present invention is most suitably adapted for use in transferring volumes of liquid within the range of from about 5 to about 2000 microliters. In general, three different capacity tips will be sufficient for use over this range, i.e., a small capacity tip for volumes within the range of from about 5 to about 100 microliters, a medium capacity tip for volumes within the range of from about 100 to about 1000 microliters, and a large capacity tip for volumes within the range of from about 1000 to about 2000 microliters.

The various parts constituting the pipette of this invention may suitably be fabricated from various materials including both metal and plastic. Particularly good results have been obtained when employing aluminum for the barrel **11** and the push button **47**, nylon for the indexing member **37** and the rearward and intermediate shaft portions **25** and **27** of the piston member **24**, stainless steel for the forward shaft portion **29** of the piston member **24**, the stem **46** and the plunger head **45**, and glass for the cylindrical tube **21**.

The barrel **11** is generally made in at least two threadedly engaged sections so that convenient access may be had to the interior thereof for removing and replacing the cylindrical tube **21** and the forward shaft portion **29** of the piston member **24**. For ease in manufacturing when the barrel is fabricated from metal, it is made in three threadedly engaged sections, as shown in FIG. 2. The rearward section **81** has a forward externally threaded portion **82** of reduced outside diameter. The keys **33** are formed internally along the portion **82**. Threadedly engaged around the outside of the portion **82** is an internally threaded intermediate sleeve section **83** and a forward section **84** internally threaded at its rearward end and housing the cylindrical tube **21**. Separation of the forward section **84** from the other two sections **81** and **83** provides ready access to the cylindrical tube **21** and the forward shaft portion **29** of the piston member **24**.

It will, of course, be understood that various changes and modifications may be made in the form, details, arrangement and proportions of the various parts of the pipette shown and described herein without departing from the spirit and scope of the present invention, which is not to be limited to the specific embodiments shown and described herein.

We claim:

1. A pipette comprising in combination, a barrel having a forward end and a rearward end, a piston member slidable forwardly and rearwardly in said barrel, an indexing member in operative contact with said piston member rearwardly thereof, said indexing member being slidable axially in said barrel and being circumferentially rotatable relative to said barrel, a plunger member in operative contact with said indexing member rearwardly thereof and movable axially within said barrel, means yieldably urging said piston member rearwardly in said

barrel, a first set of cooperating means on said indexing member and said barrel for preventing forward axial movement of said indexing member in said barrel beyond a preselected distance, a second set of cooperating means on said indexing member and said barrel for permitting axial movement of said indexing member beyond said preselected distance, that portion of each of said first and second sets of cooperating means on said indexing member being circumferentially spaced apart thereon, and rotation-causing means responsive to a forward and return stroke of said plunger member in said barrel causing restricted circumferential rotation of said indexing member relative to said barrel, whereby successive forward strokes of said plunger member in said barrel effects alternating engagement of said first and second sets of cooperating means.

2. The pipette of claim 1 wherein said rotation-causing means comprises a forward stroke-responsive means and a return stroke-responsive means, said forward stroke-responsive means causing restricted circumferential rotation of said indexing member relative to said barrel so as to bring into alignment one of said first and second sets of cooperating means, and said return stroke-responsive means causing further restricted circumferential rotation of said indexing member relative to said barrel so as to bring said aligned set of cooperating means out of alignment.

3. The pipette of claim 2 wherein said forward stroke-responsive means comprises beveled radial teeth extending forwardly from the forward transverse end surface of said indexing member and, cooperative therewith, at least one inwardly extending projection on the interior walls of said barrel.

4. The pipette of claim 3 wherein said forward stroke-responsive means further comprises beveled radial teeth extending rearwardly from the rearward transverse end surface of said piston member cooperative with said teeth on said indexing member.

5. The pipette of claim 2 wherein said return stroke-responsive means comprises beveled radial teeth extending forwardly from the forward transverse end surface of said indexing member and, cooperative therewith, beveled radial teeth extending rearwardly from the rearward transverse end surface of said piston member.

6. The pipette of claim 1 wherein that portion of said first and second sets of cooperating means on said barrel comprises at least one inwardly extending projection on the interior walls of said barrel, that portion of said first set of cooperating means on said indexing member comprises a plurality of relatively shorter axially extending keyways, and that portion of said second set of cooperating means on said indexing member comprises a plurality of relatively longer axially extending keyways, said relatively shorter extending keyways and said relatively longer extending keyways being equally spaced in alternating relationship to each other around the circumference of said indexing member.

7. The pipette of claim 1, including cooperating means on said barrel and said piston member preventing circumferential rotation of said piston member relative to said barrel.

8. The pipette of claim 7 wherein said cooperating means preventing circumferential rotation of said piston member relative to said barrel comprises at least one axially extending keyway on the exterior surface of said piston member and at least one inwardly extending projection on the interior walls of said barrel, said keyway and said projection being axially slidable relative to each other.

9. The pipette of claim 1, including a hollow tip portion removably secured in air-tight engagement to said forward end of said barrel, said tip portion having a liquid-receiving compartment having its forward end open to the atmosphere and its rearward end in communication with the interior of said barrel, whereby upon rearward movement of said piston member relative to said barrel, liquid is adapted to be drawn into said tip short of said barrel, and upon subsequent forward movement of said piston member relative to said barrel, said liquid is adapted to be dispensed from said tip.

10. The pipette of claim 1 wherein said barrel has removably secured therein adjacent its forward end of cylindrical tube having an internal diameter less than that of said barrel, and said piston member has a rearward portion slidable forwardly and rearwardly in said barrel and a forward portion of reduced diameter slidable forwardly and rearwardly in said tube, said forward portion of said piston member being removably secured to said rearward portion of said piston member.

References Cited

UNITED STATES PATENTS

3,137,276	6/1964	Weisser	401—111
3,334,788	8/1967	Hamilton	222—386 X

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