United States Patent [19]

Reed

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[54] **LIQUID TRANSFER PIPETTING DEVICE WITH A TIP EJECTOR**

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[73] Assignee: **Oxford Laboratories Inc.**, Foster City, Calif.

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **73/425.6**

[51] **Int. Cl.²** **B01L 3/02**

[58] **Field of Search** 73/425.6

[56] **References Cited**

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3,853,012 12/1974 Scordato et al. 73/425.6

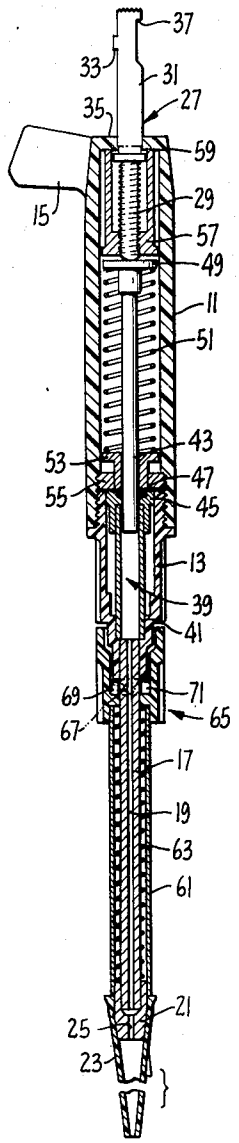
Primary Examiner—S. Clement Swisher

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[57] **ABSTRACT**

A hand-held pipetter for extracting a predetermined volume of liquid from a body of liquid, including a movable piston within a piston chamber that is in fluid communication with a liquid receiving tip. A pair of cooperating cam lobes are provided so that relative rotation therebetween produces lateral motion of an ejector mechanism to force a used detachable tip off the pipetter without the necessity of touching the used tip by hand.

7 Claims, 4 Drawing Figures



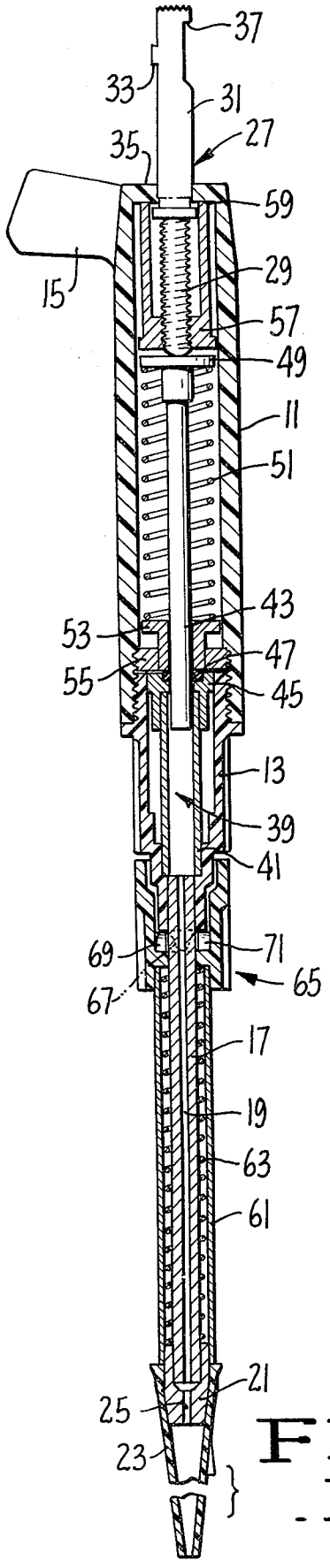


FIG. 1.

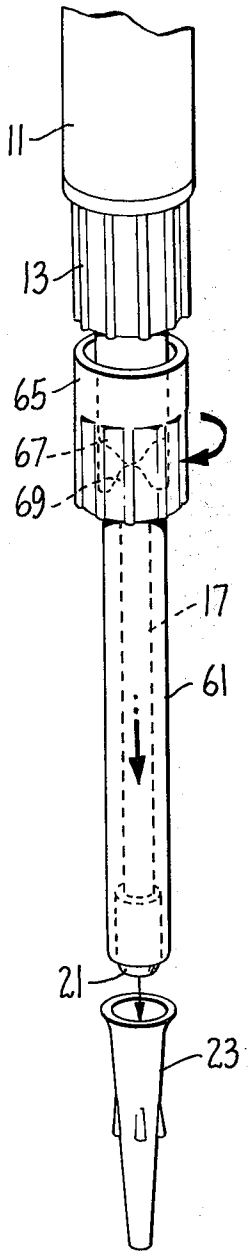


FIG. 2.

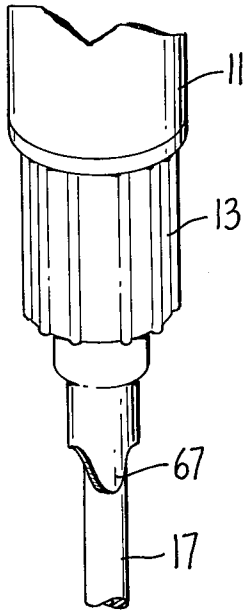


FIG. 3.

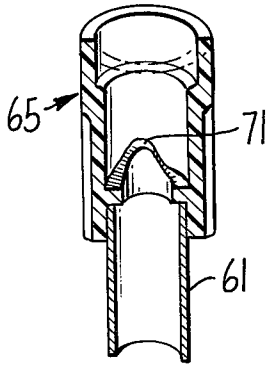


FIG. 4.

LIQUID TRANSFER PIPETTING DEVICE WITH A TIP EJECTOR

BACKGROUND OF THE INVENTION

This invention is related generally to hand-held liquid transfer devices, and, more specifically to such devices of a precision calibrated pipetting type. This application is related to an application of William J. Roach entitled, "Liquid Transfer Pipetting Device with a Factory Adjustable and Sealable Calibration Stop."

Presently available hand-held liquid pipetting instruments are of a type illustrated in U.S. Pat. No. 3,494,201 Roach (1970). Such devices include a tube-like barrel outer structure having a plunger extending outward of one end thereof and a piston attached to the other end of the plunger and positioned within a piston chamber. The piston chamber is maintained in fluid communication with an aperture at an end of the barrel handle which is shaped for frictionally engaging a detachable tip. The piston is held in a normal rest position by one or more springs within the barrel handle. When used to transfer liquid, the pipetter plunger is depressed, the attached tip is placed in a liquid and the plunger released to draw a precise amount of liquid into the tip. The pipetter is then removed to a container for discharge of the liquid. The liquid is discharged from the tip by again depressing the plunger.

In order to make sure that all of the liquid is removed from the tip, many available hand-held pipetting devices provide for moving the plunger (and thus the piston) an "overshoot" distance from the position to which they were moved prior to drawing liquid into the tip. Such an overshoot feature prevents an error occurring in the volume of liquid transfer, especially with liquids of high viscosity such as serum. The pipetter of the aforementioned U.S. Pat. No. 3,494,201 accomplished such overshoot by the use of two springs of significantly differing strengths.

Another approach for providing the overshoot feature is described in co-pending patent application Ser. No. 282,321, filed Aug. 21, 1972. In this co-pending application, a single piston return spring is utilized within the pipetting device while two spaced apart stops are provided on the plunger for engaging the barrel end, the first stop to be used upon depressing the plunger prior to drawing liquid into a tip attached thereto, and the second stop used upon discharge of the liquid from the tip with a piston overshoot distance. The two stops are selected by lateral movement of the plunger with respect to the pipetting barrel handle as the plunger is depressed.

It is a primary object of the present invention to provide as part of a hand-held pipetter a mechanism for removing detachable tips therefrom after use and thereby to allow for such removal without an operator having to touch a used tip.

It is another object of the present invention to provide an improved internal construction of a pipetter to permit a lateral movement of a plunger between positive stops thereof.

SUMMARY OF THE INVENTION

These and additional objects are accomplished by the various aspects of the present invention, one of which is the provision of a cylindrical sleeve over a tube that is attached to a pipetter barrel-like housing at one end and provided with means for engaging a hollow detachable plastic tip at its other end. The cylindrical sleeve is resiliently held away from the tip holding end of the tube so as not to normally interfere with the engagement of a tip thereon. When a tip is desired to be removed, however, the sleeve is manually actuated along the length of the tube to push a used plastic tip off the end of the tube. Plastic tips are normally frictionally engaged with the end of the tube but more positive means of latching may also be provided, the cylindrical sleeve having a capability of removing that type of tip as well.

For the convenience of an operator, a pair of cooperating cam lobes are provided, one attached to the pipetter barrel adjacent its tip holding rod and the other attached to the sleeve. The spring normally holds the two lobes adjacent one another in a manner to provide space at the end of the tube for holding a detachable tip. When the lobe on the sleeve is rotated with respect to the barrel handle, however, that lobe rides up on the cam lobe of the barrel handle to convert the rotary motion to longitudinal movement of the sleeve along the tube to dislodge the tip from the end of the tube.

The piston of the pipetter, according to another aspect of the present invention, terminates outside of the piston chamber in a disc which extends across the width of the internal portion of the pipetter barrel handle. A plunger extending through one end of the barrel handle contacts the piston member end disc but is not integrally formed therewith, thereby permitting lateral movement of the plunger for selecting a piston displacement volume without causing any such movement of the piston. A calibration stop is threadedly attached to the plunger inside the barrel handle. A spring normally urges the piston disc against the plunger and the position of the callibration stops thereon thus determines how far the piston and the plunger will be forced by the spring toward said one end of the barrel handle. The calibration stop thereby determines the amount of fluid displaced in the piston during one operation of the pipetter. The callibration stop is preferably a cylindrical sleeve which is positioned to surround the plunger, the cylindrical sleeve having its end toward the piston disc closed and threadedly attached to the plunger while the opposite open end of the cylindrical sleeve contacts an inside surface of the barrel handle's said one end for limiting travel thereof.

Additional objects, advantages and structural features of the various aspects of the present invention will become apparent from the following detailed description of a preferred embodiment thereof which should be taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates in a sectional view a pipetter including the improvements of the various aspects of the present invention;

FIG. 2 shows a perspective view of the outside of a portion of the pipetter of FIG. 1; and

FIGS. 3 and 4 show in an enlarged view two parts of the pipetter of FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring primarily to FIG. 1, an upper portion 11 of a generally cylindrical elongated barrel handle member has a lower portion 13 threadedly attached thereto. A finger hold 15 is provided integrally with the upper bar-

rel member 11. An elongated tube 17 having a small bore 19 is rigidly attached to an extreme end of the lower barrel handle portion 13. A tip member 21 is provided at the extreme end of the tube 17 and rigidly attached thereto. The outside surface of the tip member 21 is conically shaped, in a very specific form, for frictionally engaging an internal surface of a conically shaped detachable tip 23. A bore 25 is provided through the tip member 21 in order to provide fluid communication between the interior of the detachable tip 23 and the bore 19.

At the opposite end of the barrel handle member is a plunger 27 having a threaded steel member 29 encapsulated in a plastic member 31. The extreme plunger member 31 has a first stop surface 33 extending outward therefrom for limiting travel of the plunger assembly 27 into the barrel handle by engaging an extreme outside surface 35 of an end of the barrel handle member 11. A second stop surface 37 is provided for engaging the barrel handle end surface 35 for depressing the plunger assembly 27 a second further distance into the barrel handle 11. A knob, not shown, is attached to the extreme end of the plunger member 31 for receiving an operator's thumb when exerting force on the plunger assembly 27 to push it into the barrel handle member 11. When so used, the fingers of the operator's hand are normally wrapped around the barrel member 11 under the finger hold 15.

A piston chamber 39 is formed by a steel cylindrical sleeve 41 that is rigidly attached at one end thereof to the lower barrel handle member 13. A cylindrically shaped solid piston member 43 has one end thereof positioned within the piston chamber 39 through an end cap 45 attached to the steel sleeve 41. A resilient O-ring 47 surrounds the piston 43 for fluid sealing of that end of the piston chamber 39. The opposite end of the piston chamber 39 is provided in fluid communication with the bore 19 to result in fluid communication between the interior of a detachable tip 23 and the piston chamber 39.

The opposite end of the piston 43 is provided with a circular disc 49 rigidly attached thereto and extending substantially entirely across the width of the interior portion of the barrel handle member 11. A spring 51 is normally under compression to force the disc 49 and a movable member 53 away from each other. The movable member 53 is slidable within an aperture of a barrel member dividing piece 55 that is rigidly attached to the barrel member 11 at its internal threads. The spring 51 thus serves to hold the piston 43 at an extreme position with respect to the piston chamber 39 and also to exert force through the slidable member 53 against the resilient O-ring 47. A slot of the piston chamber end piece 45 in which the O-ring 47 is held is made to be smaller than the cross-sectional dimensions of the O-ring 47 so that the slidable member 53 will push down upon the O-ring 47 rather than abutting directly against the piston chamber end member 45. This force causes the O-ring 47 to expand against the piston 43 for improving the fluid seal therebetween.

In order to provide a positive limited distance of travel of the piston 43 out of the piston chamber 39, an adjustable calibration stop 57 is threadedly attached to the plunger member 29. The adjustable stop 57, in a preferred form, is a cylindrical sleeve closed at the end thereof that threadedly engages the plunger member 29. An opposite end 59 of the cylindrical stop member 57 abuts against an inside surface of an end of the barrel handle member 11.

In use of the pipetting device shown in FIG. 1, the tip 23 has its free end immersed in a liquid to be transferred to another container. The plunger member 31 has been depressed until its stop surface 33 abuts the barrel end surface 35. When the plunger 31 is permitted to return to its rest position shown in FIG. 1 under the influence of the spring 51, liquid is drawn into the tip 23 as a result of the piston 43 withdrawing a distance from within the piston chamber 39. The pipetter is then moved so that the tip 23 is positioned over a container into which the liquid is to be transferred. The plunger 31 is then depressed to force the liquid out of the tip 23. For liquid discharge, it is generally preferable to use the overshoot feature of the device by moving the plunger member 31 laterally with respect to the handle member 11 so that the stop surface 37 strikes the barrel end surface 35 rather than being limited in travel by the first stop's surface 33.

The amount of liquid that is so transferred depends upon the distance the piston 43 travels while liquid is drawn into the tip 23. This liquid volume may be easily calibrated during the manufacture of each pipetting device by placing a calibrating block between the first stop surface 33 and the barrel end surface 35. The plunger member 31 is then depressed to place this block under compression while the calibrating stop 57 is turned with respect to the plunger member 29 until its end 59 tightly engages the inside surface of the barrel end. Some appropriate thread sealant, such as an epoxy resin, is applied to hold the calibration stop 57 and the plunger member 29 firmly together to prevent relative rotation therebetween. Since force is exerted during use of the device on the engaging threads between the plunger member 29 and the calibrating stop 57, these members are preferably made of a metal such as stainless steel to prevent any change in the volume capability of the device through use and also for precision in the initial calibration.

It may also be noted that the force exerted on the O-ring 47 is increased as the plunger assembly 27 is driven down into the barrel assembly 11 since such plunger action compresses the spring 51. Therefore, the drag on the piston 43 produced by frictional engagement with the O-ring 47 is reduced as the piston 43 and plunger assembly 27 are returned by the spring 51 to the rest position shown in FIG. 1. This assures a complete and smooth return of the piston 43 to its extreme rest position and also reduces the wear on the O-ring 47 by reducing the frictional drag thereon through at least a portion of the operating cycle.

After a liquid sample has been transferred by the use of the pipetting device illustrated in FIG. 1, it is desirable to remove the detachable tip 23 without the operator having to touch it. Therefore, a mechanical tip ejector is provided as part of the pipetter structure in order to reduce the possibility that contaminated liquid may be transferred through the hands of the operator from a used pipetter tip to some other liquid or test apparatus. The tip ejector includes a hollow cylindrically shaped sleeve 61 positioned about the tube 17 with a spring 63 therebetween. An actuating member 65 is fixedly held to one end of the ejecting sleeve 61. The spring 63 normally holds the actuator 65 and the sleeve 61 as far against the lower barrel member 13 as it can. In such a normal rest position, the sleeve 61 covers only

a portion of the tip member **21**, thereby leaving sufficient surface for positioning a detachable pipetter tip **23** thereon. The spring **63** pushes against a surface of the tip member **21** at one end and pushes against a surface of the actuator **65** at its other end.

The tip ejecting mechanism of the present invention may be operated by moving the actuator **65** along the length of the tube **17** to push the detachable pipette tip off of the pipetter end. For operator convenience, however, the cylindrical sleeve **61** and actuator **65** are also made to be rotable with respect to the tube **17**. The basic pipetter and its ejecting mechanism are cooperatively designed so that such rotary motion is converted into longitudinal motion for pushing a tip **23** off the end of the pipetter. This is accomplished by providing cooperating cam lobes **67** and **69**. The cam lobe **67** is provided as an integral part of the actuator **65** on an internal surface thereof. A third cam lobe **71** is provided on the actuator **65** and displaced **180°** from its other cam lobe **69**. Only one cam lobe **67** is provided in this specific example, as part of the lower barrel handle member **13**.

In the normal rest position of the tip ejector shown in FIG. **1**, the lobes **69** and **71** of the tip actuator are positioned adjacent the lobe **67** of the barrel handle member **13**. When the actuator **65** is turned with respect to the barrel handle member **13**, however, one of the cam lobes **69** or **71** of the actuator rides up onto the cam lobe **67**, as shown in FIG. **2**, thereby compressing the spring **63** and forcing the tip ejector sleeve **61** against the tip **23**. The cam lobes are preferably shaped at their tips so that the position shown in FIG. **2** is an unstable one; that is, the lobes **67** and **69** are shaped so that the force of the spring **63** will cause the lobes **67** and **69** to slip with respect to one another from the position shown in FIG. **2** back to the rest position illustrated in FIG. **1**. Additional cams could be used in order to reduce the amount of rotation that is required to eject a tip but an increase in the number of cam lobes either reduces the longitudinal travel possible of the tip ejector sleeve **61** or makes the side slopes of the cam lobes so steep that the rotatable force required to operate them is excessive. For smooth continuous action of the tip ejector, a low slope angle on the sides of the lobes **67, 69** and **71** is preferred.

Although the various aspects of the present invention have been described with respect to a preferred embodiment, it will be understood that the invention is entitled to protection within the full scope of the appended claims.

I claim:

1. In a liquid transfer pipetting device that includes a hollow barrel shaped handle member, a piston chamber within said barrel, said piston chamber having first and second ends, a piston element in said piston chamber that extends through said first piston chamber end, means extending through one end of said barrel member for imparting reciprocal motion to said piston element, resilient means within said barrel for normally urging said piston element to a rest position toward said first end of said piston chamber, and means extending from an opposite end of said barrel for engaging a hollow detachable tip and for providing fluid communication between said second end of said piston chamber and an internal portion of said tip, the improvement comprising mechanical means associated with said tip holding means and responsive to manual actuation for disengaging a detachable tip from said tip holding means, said tip disengaging means includes a pair of cooperating cam lobes held in a manner that rotation of an actuator with respect to said handle member causes an ejecting means associated with said detachable tip engaging means to force a tip therefrom upon rotation of the actuator.

2. In a hand-held liquid transfer pipetting device that includes a manually actuated fluid pump within an enclosure member for providing fluid communication from said fluid pump to an end of said tube member remote from the enclosure, said remote tube member end being shaped for a segment to frictionally engage an interior surface of a hollow detachable tip, the improvement comprising:

a hollow sleeve held on said tube member in a manner to be rotatable with respect thereto and also movable along its length from a first position wherein said tip engaging segment of the tube member remains uncovered to a second sleeve position wherein at least a significant portion of said tip engaging segment of the tube member is covered, thereby permitting disengagement of a tip by breaking the frictional bond therebetween as the sleeve is moved from its said first to its said second position,

resilient means positioned for normally holding said hollow sleeve in its said first position, whereby a detachable tip is removed by moving said sleeve against the force of said resilient means, and

means cooperatively shaped between said tube member and said sleeve for converting rotational motion therebetween into movement of the sleeve along said tube into said second sleeve position, whereby rotation of said sleeve causes a tip to be ejected from frictional engagement with said remote tube member end.

3. The improved pipetter according to claim **2** which additionally comprises a resilient means for normally holding said hollow sleeve in its said first position, whereby a detachable tip is removed by moving said sleeve against the force of said resilient means.

4. In a hand-held liquid transfer pipetting device that includes a manually actuated fluid pump within an enclosure member for providing fluid communication from said fluid pump to an end of said tube member remote from the enclosure, said remote tube member end being shaped for a segment to frictionally engage an interior surface of a hollow detachable tip, the improvement comprising:

a hollow sleeve held on said tube member and movable along its length from a first position wherein said tip engaging segment of the tube member remains uncovered to a second sleeve position wherein at least a significant portion of said tip engaging segment of the tube member is covered, thereby permitting disengagement of a tip by breaking the frictional bond therebetween as the sleeve is moved from its said first to its said second position,

a resilient means for normally holding said hollow sleeve in its said first position, whereby a detachable tip is removed by moving said sleeve against the force of said resilient means, and

a first cam lobe attached to said enclosure member, a second mating cam lobe held fixed with respect to said sleeve and means for rotating said cam lobes

with respect to one another, thereby providing movement of said sleeve between its said first and second positions in response to rotation of said lobe rotating means.

5. In a hand-held liquid transfer pipetting device that includes a manually actuated fluid pump within an enclosure member, and a hollow tube-like member extending from said enclosure member for providing fluid communication from said pump to an end of said tube member remote from the enclosure, said remote tube member end being shaped for holding an interior surface of a hollow detachable tip, the improvement comprising:

a hollow cylindrical sleeve held on said tube in a manner to be movable both longitudinally and rotatably with respect to said tube member,

a coiled spring positioned within said sleeve and around the outside of said tube member, said spring being attached in a manner to normally urge said sleeve toward said enclosure member,

a first cam lobe attached as part of said enclosure member and extending outward adjacent said tube member, and

an actuator fixed to said sleeve at its end adjacent the enclosure member, said actuator including a second cam lobe extending toward said enclosure member for engaging said first cam when the actuator is rotated with respect to the to the enclosure member, thereby to provide lateral movement of said sleeve along the tube member for disengagement of a tip frictionally held at a remote end of said tube member.

6. The improved pipetter according to claim **5** wherein said actuator includes a third cam lobe positioned 180° from said second cam lobe, whereby the actuator need be rotated a maximum of 180° to produce the desired laterla movement for removal of a detachable tip.

7. The improved pipetter of claim **5** wherein said actuator includes a cylindrically shaped sleeve positioned to shield said first and second cam lobes.

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