

Aug. 9, 1955

E. G. SCHLAYER ET AL

2,714,980

VIAL STOPPERING MACHINE AND METHOD

Filed Aug. 30, 1951

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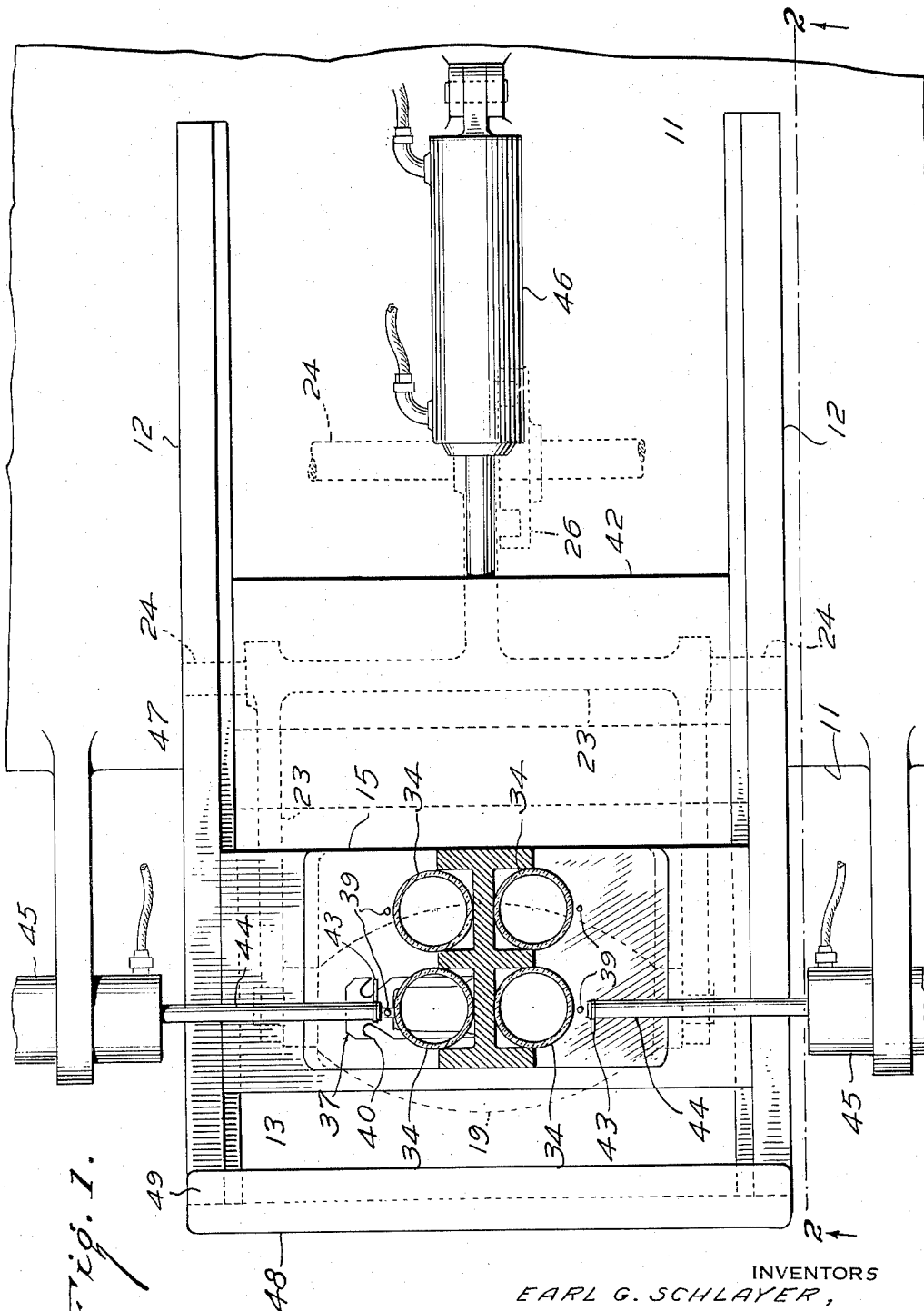


Fig. 1.

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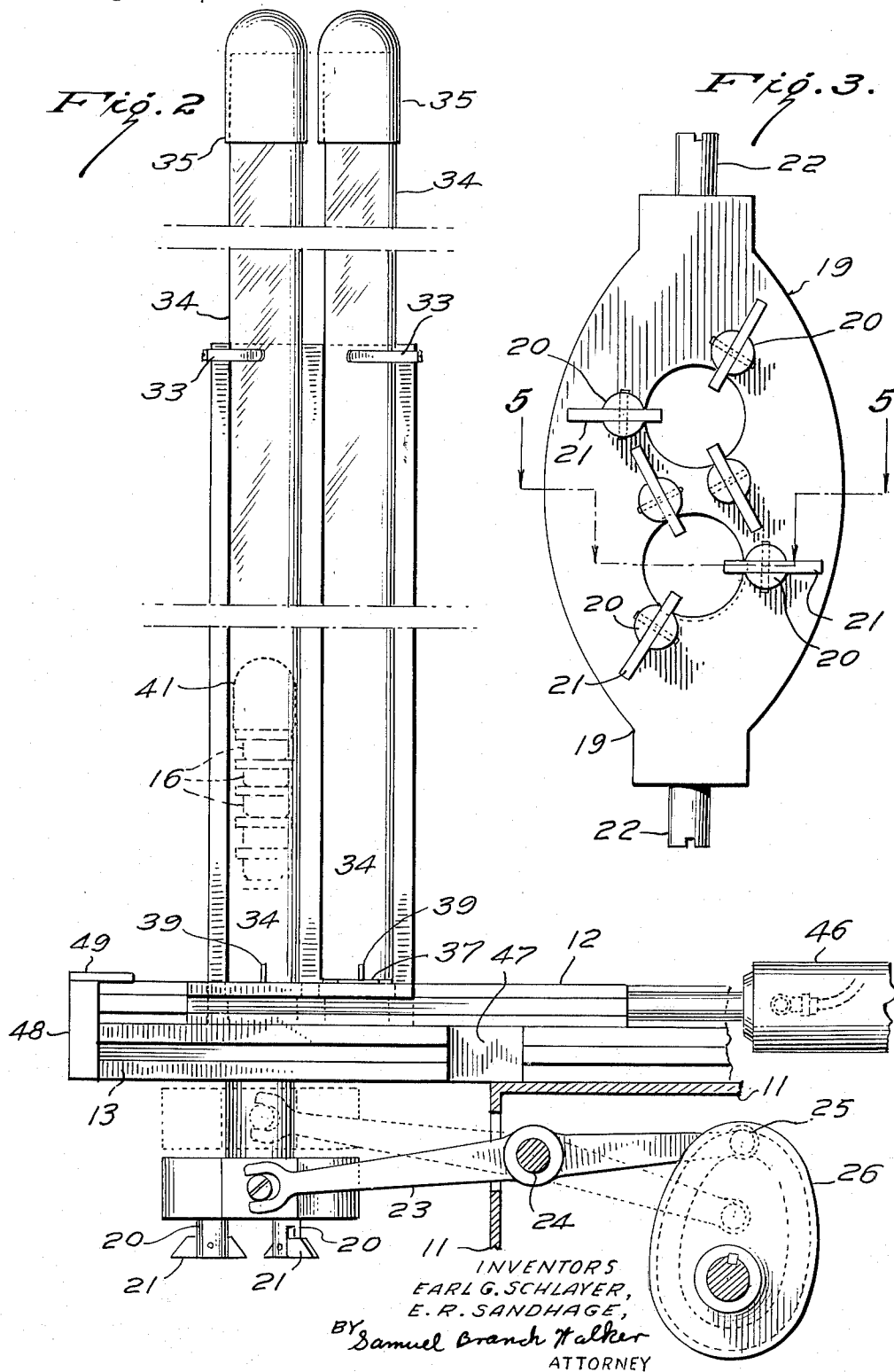
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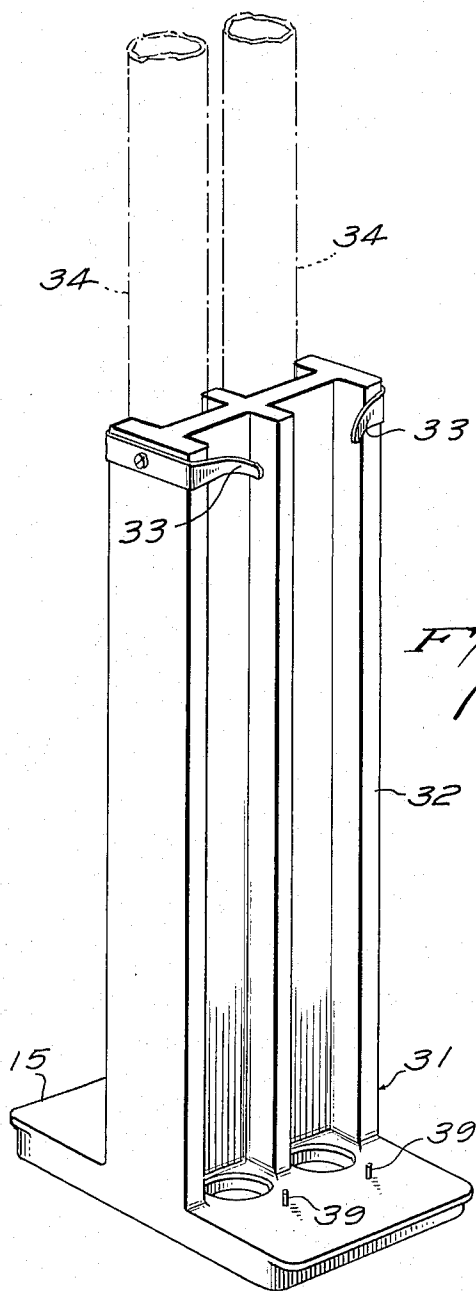


Fig. 5.

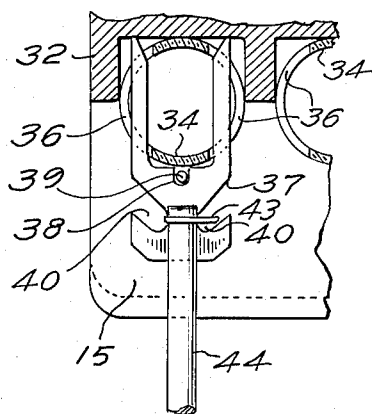


Fig. 4.

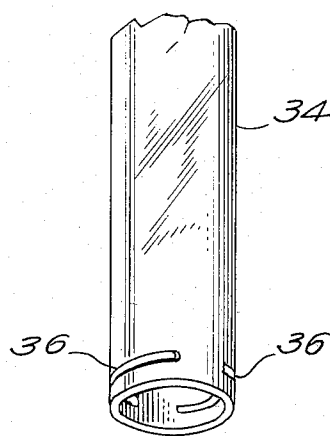


Fig. 6.

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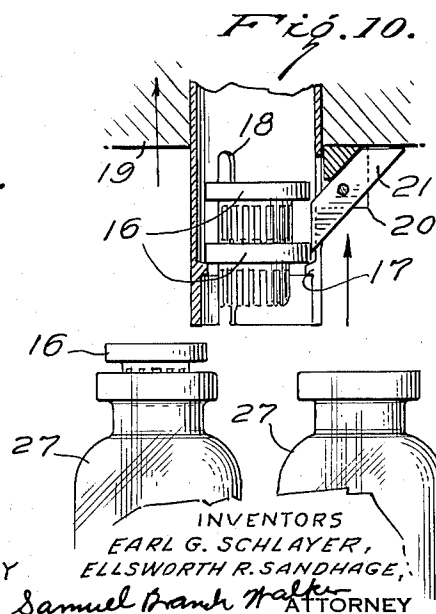
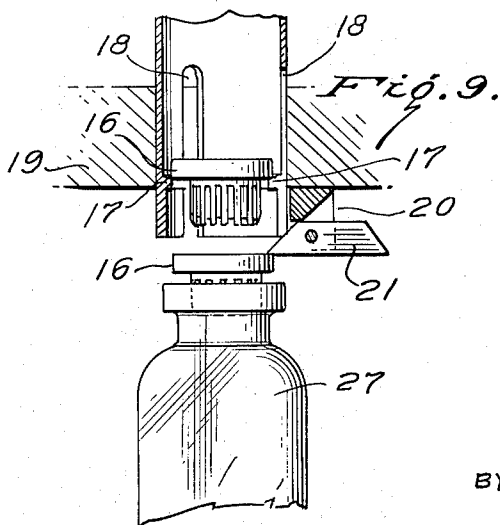
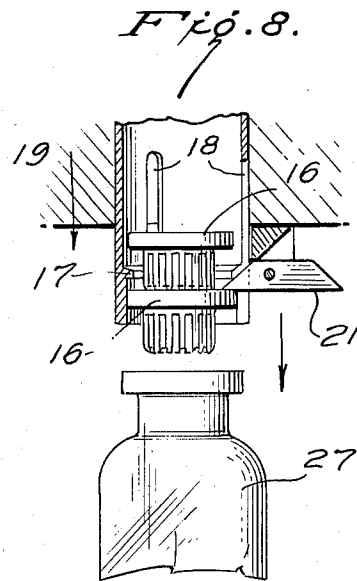
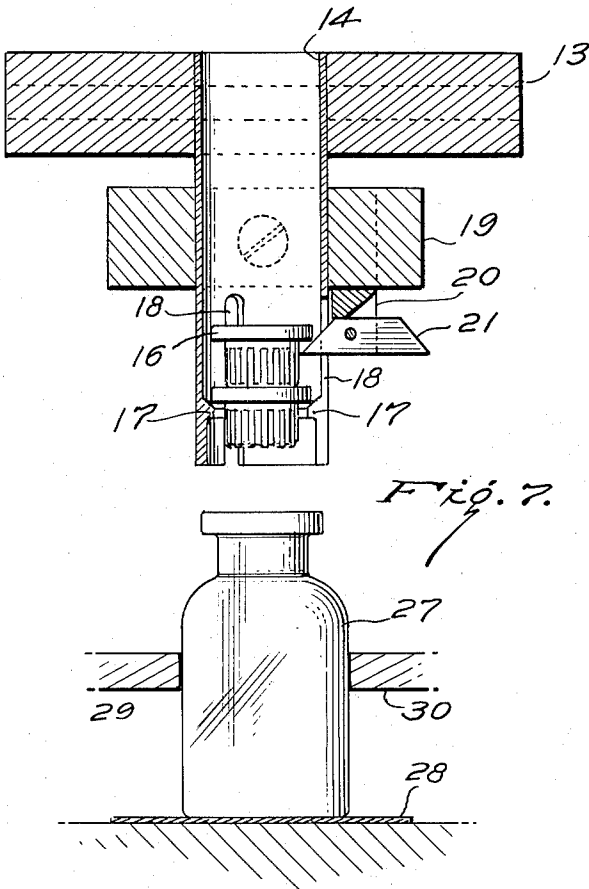
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VIAL STOPPERING MACHINE AND METHOD

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VIAL STOPPERING MACHINE AND METHOD

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Application August 30, 1951, Serial No. 244,412

8 Claims. (Cl. 226—92)

This invention relates to an apparatus and a method for inserting stoppers in vials by an automatic mechanical operation which may be conducted sterily without either the vial or the stopper being touched by human hands during the operation.

In the manufacture and packaging of many products, it is desirable that high standards of cleanliness be maintained. For certain types of products, it is necessary that absolute sterility be maintained. For some of these products, it is necessary that the container be closed under sterile conditions. In food packaging, for instance, it is normally customary to fill a container, seal it, and then sterilize the sealed container by steam heat or other operation on the final container.

In the packaging of pharmaceuticals, particularly certain biological items, the products are so sensitive to heat that their efficacy would be destroyed by any treatment which would render the product sterile. At times the contents of the vial are living organisms which would be killed by any treatment that would destroy contaminants.

In the past, it has been customary to insert sterile stoppers in sterily filled vials in a sterile chamber by the use of sterile forceps in the hands of a skilled operator. Such an operation is tedious, expensive and subject to breaks in sterility.

We have developed a machine which will insert the stoppers under conditions such that only sterile portions of the machine touch the stopper.

It is an object of our invention to provide for the stoppering of any type of vial, tube, bottle or container, hereinafter called a vial, with a stopper which may be a rubber plug, a synthetic rubber plug or a plastic plug or other substitute for rubber, or other resilient closure.

It is a principal object of our invention to insert such stoppers sterily.

It is a further object of our invention to provide a machine which has interchangeable parts to permit the rapid conversion from one size of stopper to another size of stopper, while maintaining sterility, if desired.

It is an additional object of our invention to provide a machine which may be adjusted for the heights of different vials.

It is an object of our invention to provide a machine for the partial insertion of a stopper in a vial, the degree of insertion being under the control of the operator.

It is an object of our invention to provide a vial stoppering unit that can be placed on an assembly line and used in conjunction with other machines, such as for example the powder filler shown in U. S. Patent 2,540,059, to F. E. Stirn et al.

In filling operations, it is customary to perform various operations serially. Our vial stoppering machine is adapted to be placed in such a filling line and perform the operation of stoppering the vials as they move along a travelling conveyor without the necessity for stopping the movement of the conveyor. Inasmuch as it is customary to perform such operations on a moving belt, the

stoppering machine is shown in position on a belt, independent of loading and unloading stations and other operations which may occur previous to or subsequent to the insertion of the stoppers.

Our invention can best be described in conjunction with the partial insertion of a stopper into a vial under sterile conditions. It can be used for complete insertion, and for non-sterile operations, by obvious modifications. The stoppers may have flutes in them so that the stoppers when partially inserted permit the egress of air from the vial whereby the vial with the partially inserted stopper may be passed to a second machine providing for the evacuation of the vial, and the vial, in the evacuated condition, sealed by pressing home the stopper. It is convenient to pass a group of partially stoppered vials into a vacuum chamber, evacuate the chamber and then press the stoppers all the way into the vials by a suitable ram or by the sudden introduction of a gas into the evacuated area. The operations prior to the stoppering step may be any of a multiplicity of conventional operations such as for example filling the vials with a liquid under sterile conditions, freezing and drying the contents in the vial, and then sterily transferring the vials to the conveyor belt, on which other operations as desired may be performed either prior to or subsequent to the stoppering operation. The various operations may be interconnected by various safety or control mechanisms to prevent the vials from feeding at a disproportionate rate at one place, and to provide for shutting down the machine in case of a failure of one operation, as may be desired. We have found the machine particularly useful in that it may be used to feed a pre-set number of vials into an evacuating chamber, and interrupted until a new chamber is available.

It is to be understood that any size of vial may be used and that the sequence of operations other than stoppering is not an essential part of the present claimed invention. We prefer to install our stoppering machine on an adjustable base, as for example, a table on a hydraulic jack, which provides for the adjustment of the height of the stoppering machine as may be desired for a particular operation. Such a mounting provides that the stoppering machine may be raised or lowered so that it will insert stoppers to a desired depth in a particular vial, and provides maximum adjustability for variations in heights of vials.

Further objects, advantages and utility for our invention will appear as the description of a detailed embodiment thereof is understood.

In the accompanying drawings are shown an embodiment of our invention.

Figure 1 is a top view of our machine, partially diagrammatic.

Figure 2 is a side view of the machine, along line 2—2 of Figure 1 with the slide carrier removed.

Figure 3 is a view looking upward at the bottom of the oscillating head together with the associated studs and feed fingers.

Figure 4 is a view of the magazine holder.

Figure 5 is a view in partial section showing a part of the magazine holder together with the magazines and magazine retaining forks.

Figure 6 is a view of the lower end of a stopper magazine showing the retainer fork slots.

Figure 7 is a view on a larger scale in section along one of the stopper feed tubes showing the stoppers in position at the start of a cycle. For clarity, only two stoppers are shown.

Figure 8 is a partial view of the same assembly as Figure 7 as the feed fingers start to feed a stopper into a vial.

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Figure 9 is a view of the bottom of the stroke showing the stopper inserted in position.

Figure 10 shows the fingers being drawn upward to engage the next stopper and shows diagrammatically the motion of the vials under the stopper feed tube during this part of the cycle.

It is convenient to enclose the portions of the machine through which the vials pass under a transparent shield in which sterilizing radiation may be present to insure that transient air currents do not contaminate the operation. For purposes of clarity, these shields are not shown.

As shown in Figure 1, the machine incorporates a frame 11 which may in turn be mounted on a hydraulic cylinder, not shown, or other means for adjusting its height. On the frame are mounted slide carriers 12. The slide carriers have therein appropriate slots to hold at the proper elevation and in position a stoppering tube plate 13. A rear positioning block 47 and a front positioning block 48 hold it in location while in operation. A dust shield 49 protects the front portion of the magazine plate slide 42.

It is a particularly convenient feature of our machine that the stoppering tube plate may be readily placed in or withdrawn from the slide carrier so that the stoppering tube plate and associated parts may be withdrawn for sterilizing and placed in the machine without disturbing the adjustment of the rest of the machine or without its sterility being jeopardized by contact with other portions of the machine or undue handling. Removing the front positioning block 48 permits the stoppering tube plate to be withdrawn.

In the stoppering tube plate 13, as more particularly shown in Figure 7, are shown mounted at least one stopper feed tube 14. As may be seen from Figure 1, the embodiment shown in the drawings uses two such stopper feed tubes which are co-axially mounted beneath the magazine carrier plate 15, as shown in Figure 1. Each of the stopper feed tubes is of identical configuration and one only will be described. The upper portion of the stopper feed tube is of slightly greater diameter than the flanges on the stopper 16 so that a stack of stoppers may feed through the stopper feed tube without binding. Near the bottom of the stopper feed tube are located the stopper supporting shoulders 17. These shoulders, which may be formed as an integral portion of the stopper feed tube, are slightly smaller than the stopper flanges so that the stack of stoppers rests upon these stopper supporting shoulders. These shoulders retard the downward motion of the stoppers and hold them until used for the stoppering operation. From the stopper supporting shoulders to the lower end of the stopper feed tube, the diameter of the stopper feed tube is preferably slightly less than the diameter of the stopper flanges so that a slight drag occurs whereby the stoppers are kept from falling during the stoppering operation although if the distance is short, the stoppers may be permitted to fall free for this distance.

The exact dimensions are a matter of choice and will vary with the size of stoppers, and the degree to which they tend to stick. By way of example only, for a natural rubber stopper with a $\frac{3}{4}$ " diameter flange, the stopper feed tube may be about $1\frac{3}{16}$ " and the shoulder $1\frac{1}{16}$ " and the tube below the shoulder $2\frac{3}{32}$ ". A variation of 0.010" either way in these last two dimensions gives good results. The shoulder tends to break the stopper loose from the succeeding stopper if they stick, and the lesser retardation below assists in assuring an axial feed of the stopper into the vial. Separate detents may be used instead of integral shoulders, and part of the required resiliency may be incorporated in these detents or shoulders.

The lower end of the stopper feed tube has therein a plurality of stopper feed tube slots 18. The number is not critical but three are shown.

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Outside of the stopper feed tubes and in spaced relationship thereto is an oscillating head 19. Whereas separate guides may be used to control the motion of the oscillating head, we find it particularly convenient to have the oscillating head fit closely around the stopper feed tubes so that it slides up and down on the outside of the stopper feed tubes without undue lost motion. Attached to the oscillating head and projecting below it are oscillating head studs 20. In slots in these studs are feed fingers 21. The feed fingers project through the slots in the stopper feed tube and into the interior of the tube. As shown in the drawing, they may be positioned by integral counterweight portions so that they are caused to assume a horizontal position by their own weight. Springs or other positioning means may be used. The stud slots are of such shape that the feed fingers 21 cannot rotate upward inwardly but may rotate downward inwardly so that in effect the fingers act as ratchets on the stoppers, whereby as the oscillating head moves up and down the fingers engage the flange of the stopper resting on the stopper supporting shoulder and pull the stopper down with the head. The resiliency of the stopper is such that it may be forced through the restriction formed by the stopper supporting shoulders. Even if the stoppers tend to stick to each other, the shoulders hold the stack and permit a single stopper to be inserted.

The oscillating head may be provided with oscillating head projections 22. An oscillating head fork 23 is supported by an oscillating head fork pivot 24 and has its inner end provided with a cam follower 25 which rides in a cam plate 26. Each revolution of the cam plate causes the oscillating head to complete one oscillation as will be described in detail.

The vials 27 to be stoppered are positioned beneath the stopper feed tube. Any convenient conveyor system may be used in cooperation with our vial stoppering machine. As shown in Figure 7, the vials may be positioned on an endless belt 28 which carries them serially beneath the stopper feed tubes. The vials may be retained in the stoppering position under the stopper feed tubes by a vial holding clip 29 and a vial guide 30. The use of vial holding clips of various sizes for various sizes of vials is well known in the art, and different sizes of clips can be used for different sizes of vials. In timed relationship with the oscillating head, the vial holding clip positions a vial under each of the stopper feed tubes and holds the vials in position during the actual stoppering operation. Any of the various feeding means, such as are used in conjunction with filling operations in the bottling or canning industries or the pharmaceutical industry may be used to position the vials under the stopper feed tubes. The exact mechanism may be conventional and does not form a part of the instant invention. A means for positioning the vials in timed relationship with the stoppering operations is an important part of the present invention as the timed relationship is of the essence in smooth operation.

Above the stopper feed tubes may be positioned a magazine carrier 31 as shown in more detail in Figure 4. This may consist of a magazine support 32 with magazine retaining clips 33 mounted on a magazine carrier plate 15. As shown in Figure 2, a magazine 34 is provided to hold the stoppers. The magazine may consist of a glass tube. For sterile operation, the upper end of the magazine may be covered by a magazine shield 35, Figure 2. The lower end of the magazine may have therein magazine retaining fork slots 36 in which is placed a magazine retaining fork 37. The magazine retaining fork may be provided with a positioning slot 38 which is adapted to fit over a positioning pin 39 on the magazine carrier plate 15. Retractor slots 40 are provided in the magazine retaining forks.

In use, the magazine is loaded with a series of stoppers arranged to feed with the plug portion downwardly. The stoppers are retained in the magazine by the magazine

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retaining fork and the upper end is covered by the magazine shield 35. A magazine follower weight 41 is used to insure that the stoppers feed smoothly through the magazine. Each magazine is filled with stoppers and capped with the magazine shield. The lower end may be protected by a removable wrapping such as a paper shield, and the assembly sterilized. In use a series of filled magazines are positioned in the magazine carrier with the magazine retaining fork fitting over the positioning pin 39 so that it is located and held in position as shown in Figure 5. The stoppers are held up in the magazine by the fork until ready for use. The magazine carrier plate is positioned in the magazine plate slide 42 which in turn rests in slots in the slide carriers 12. The magazine carrier has positions for at least two magazines for each of the stopper feed tubes and is positioned so that one of these magazines is in axial alignment with the stopper feed tube.

Adjacent the magazine retaining fork which holds the stoppers in the magazines above the stopper feed tube is a retractor pin 43 mounted on a retractor rod 44 extending from a retractor cylinder 45. The retractor cylinder is shown as an air-operated cylinder. Other retraction means such as solenoids, linkages, gearing, etc. may be used. A timing pulse actuates the retractor cylinder which pulls back the retractor rod to which is flexibly attached the retractor pin which fits into the retractor slot in the magazine fork and withdraws the magazine fork thereby releasing the plugs in the magazine so that they move downward into the stopper feed tubes.

A counting mechanism, not shown, may be attached to the stoppering mechanism so that after a given number of vials is stoppered, and the magazines are nearing exhaustion, a pulse is fed to the magazine plate slide cylinder 46 which then shifts the magazine plate slide to its alternate position, thereby aligning a second group of magazines with the stoppering feed tubes. At this time, the empty magazines may be replaced with filled magazines by the operator, ready for the next operation of the machine.

For convenience in operation, it is desirable that the stoppering feed tubes be of such length that the magazine plate slide will slide adjacent the top of the stopper without binding on a stopper part way down the stopper feed tube during the upper dwell of the oscillating head. A counting mechanism and a timing mechanism may be incorporated so that the magazine transfer occurs during this static portion of the vial stoppering operation. It is particularly convenient to use magazines which will contain 51 or 52 stoppers in conjunction with a counting mechanism which transfers magazines after each 50 stoppering operations, thereby allowing at least one extra stopper in the magazine as a factor of safety in case of human or mechanical failure. The magazine containing the one or two extra stoppers and the magazine follower weight may then be refilled, and after refilling, again sterilized.

The stoppering operation itself is controlled by the cam plate 26. As shown in Figure 7, the feed fingers 21 come downward and engage the top of the stopper flanges and force the stopper flanges over the stopper supporting shoulders 17, and cause the individual stopper to feed downward towards a vial as shown in Figure 8. The depth of insertion of the stopper may be adjusted by controlling the height of the entire mechanism. As shown in Figure 9, it may be convenient to have the stoppers only partially inserted so that by using ribbed stoppers the stopper partially inserted permits free communication with the interior of the vial and yet the stopper may be shoved home by downward pressure without the necessity for any pushing. This is particularly convenient where the individual vials are to be evacuated in a later stage in the operations and have the stopper pushed into position in an evacuated chamber. It is to be understood, of course, that the stoppers may be completely inserted

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in the stoppering operation if the particular product being filled is such that this is desirable.

Figure 10 shows diagrammatically the feed fingers in the position of upward travel as they ratchet over the flange of the next stopper during the upward stroke of the oscillating head. Diagrammatically shown also is the transfer of the vials in which the stoppered vials are carried by the conveyor to the next operation and the subsequent unstoppered vials are fed forward to position under the stopper feed tubes.

It is particularly convenient to have the cam plate 26 so cut that the oscillating head remains in its upper position during an appreciable time interval during which the unstoppered vials may be indexed in position under the stopper feed tubes.

Many modifications and variations will suggest themselves to those skilled in the art. The number of stopper feed tubes being used is shown as two but may be one or any convenient number. The length of the magazines and the number of stoppers in each may vary within wide limits. The control means for fastening the magazines and the withdrawal of the forks may be manual or automatic, and may, of course, be timed by any suitable means. The number of feed fingers may vary from two upward, as may their relative proportions. It is frequently convenient to provide ejector chutes in which the removed magazine retaining forks fall so as to automatically remove them from the scene of operation. Protective shields, etc. may be used in accordance with the desires of an operator, depending of course upon the degree of sterility required. Such modifications and others are obvious to those skilled in this art.

It is particularly convenient to adjust our machine for various sizes of vials because a separate sterile magazine carrier plate may be readily substituted together with an appropriate sterile stopper tube plate assembly including the oscillating head so that the stopper stacking parts are changed in accordance with size requirements.

Removing the front positioning block 48, and dust shield 49 permits the stoppering tube plate and oscillating head to be drawn forward, and a replacement inserted, and also permits the magazine carrier plate to be lifted upward and replaced with a sterile one of desired size.

As our invention, we claim:

1. In a machine for inserting stoppers in vials, means for retaining a vial at a vial position, a stopper feed tube having a plurality of axial slots therein positioned above the vial position, stopper supporting shoulders integral with said stopper feed tube, an oscillating head reciprocally mounted adjacent said stopper feed tube, feed fingers operably attached to said oscillating head and projecting through said slots into the interior of said tube, said head and fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby stoppers may individually be forced past the shoulders and into position in the vials.

2. In a machine for inserting stoppers in vials, means for retaining a vial at a vial position, a stopper feed tube having a plurality of axial slots therein positioned above the vial position, stopper magazine means above said stopper feed tube, stopper supporting means to retard the passage of stoppers through said stopper feed tube, oscillating means adjacent said stopper feed tube, feed fingers operably attached to said oscillating means and projecting through said slots into said tube, said oscillating means and said fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby stoppers may be forced past the said retarding means and into vials.

3. In a machine for inserting stoppers in vials, means for retaining a vial at a vial position, a stopper feed tube having a plurality of axial slots therein positioned above the vial position, stopper magazine means comprising at

least two tubular magazines and means for interchanging the magazines above said stopper feed tube as the magazines become empty, stopper supporting shoulders in said stopper feed tube, an oscillating head reciprocally mounted adjacent said stopper feed tube, feed fingers operably attached to said oscillating head and projecting through said slots into the interior of said tube, said head and fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby stoppers may individually be forced past the shoulders and into position in the vials.

4. The machine of claim 2 in which the stopper magazine means comprises a magazine carrier plate, a magazine support, and a plurality of magazines in each of which stoppers are retained by a magazine retaining fork, means to count stoppers as fed from the magazine and means to shift to a filled stopper magazine after a predetermined count and means for withdrawing said magazine retaining fork from a stopper magazine above the said stopper feed tube.

5. The machine of claim 2 in which said stopper magazine means comprises a magazine carrier plate for changing magazines containing stoppers above said stopper feed tube.

6. In a machine for pre-positioning fluted stoppers in vials, means for retaining a vial at a vial position, a separable sterilizable stopper feed tube plate having at least one stopper feed tube having a plurality of axial slots therein in said plate, a separable sterilizable stopper magazine carrier, a plurality of stopper magazines, stopper supporting shoulders integral with said stopper feed tube, said stopper feed tube above said shoulders having a diameter greater than the outside diameter of the stoppers and below said shoulders having a diameter slightly less than the diameter of said stoppers, oscillating means adjacent said stopper feed tube, feed fingers operably attached to said oscillating means and projecting through said slots into said tube, said oscillating means and said fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby stoppers are forced past the shoulders and into a desired position in vials.

7. In a machine for pre-positioning fluted stoppers in vials, means for retaining a vial at a vial position, a sterilizable stopper feed tube having a plurality of axial slots therein positioned above the vial position, means for supporting a sterile stopper magazine above said

stopper feed tube, stopper supporting shoulders integral with said stopper feed tube, said stopper feed tube above said shoulders having a diameter greater than the outside diameter of the stoppers and below said shoulder having a diameter slightly less than the diameter of said stoppers, oscillating means adjacent said stopper feed tube, feed fingers operably attached to said oscillating means and projecting through said slots into said tube, said oscillating means and said fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby stoppers are forced past the shoulders and into a desired position in the vials.

8. In a machine for pre-positioning fluted stoppers in vials, means for retaining a vial at a vial position, a separable sterilizable stopper feed tube plate having at least one stopper feed tube having a plurality of axial slots therein, a separable sterilizable stopper magazine carrier, a plurality of stopper magazines, means for replacing an empty stopper magazine with a filled stopper magazine automatically, stopper supporting means to retard the passage of stoppers through said stopper feed tube, oscillating means adjacent said stopper feed tube, feed fingers operably attached to said oscillating means and projecting through said slots into said tube, said oscillating means and said fingers being so positioned that the fingers are in contact with the stopper until the stopper has been forced at least part way into the vial whereby said stoppers are uniformly and axially forced past the retarding means and into vials.

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