April 14, 1953 E. W. KELLOGG ET AL 2,635,194

METHOD OF AND APPARATUS FOR AMPOULE INSPECTION

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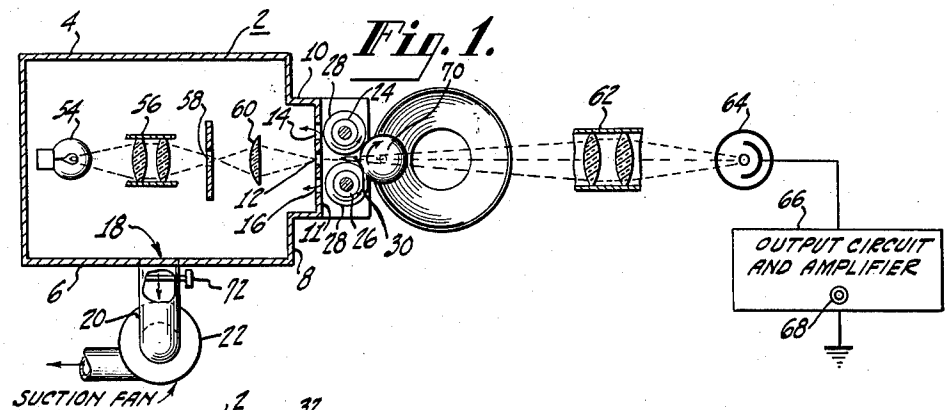


Fig. 1.

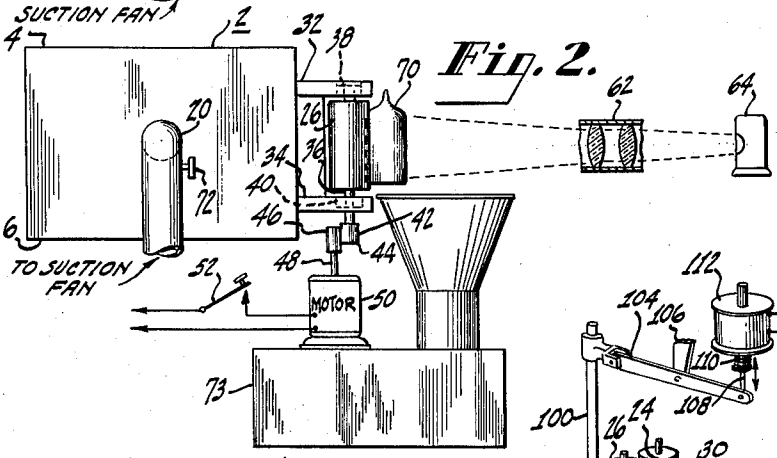


Fig. 2.

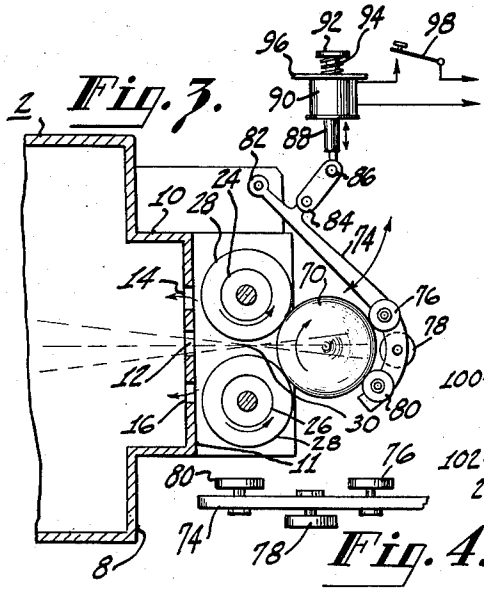


Fig. 3.

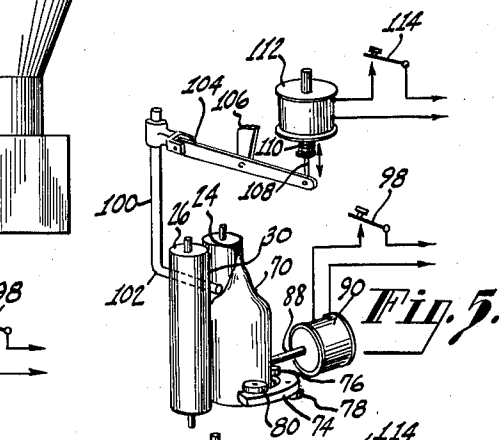


Fig. 5.

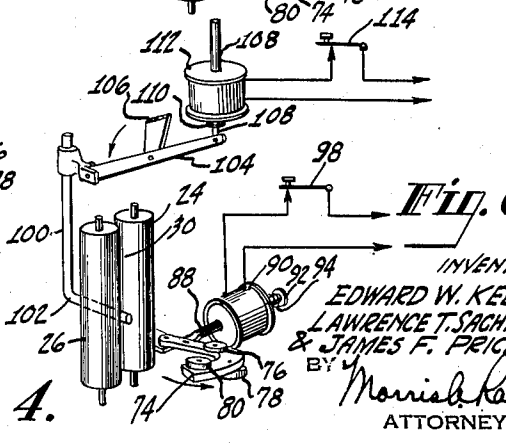


Fig. 6.

Fig. 4.

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METHOD OF AND APPARATUS FOR AMPOULE INSPECTION

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4 Claims. (Cl. 250—218)

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This invention relates to a method of and apparatus for inspecting the contents of light transmitting cyclindrically shaped bodies, such as medical ampules. More particularly, the invention relates to a method of and apparatus for inspecting the contents of individual ampules for the presence of contaminating particles.

Serums and other liquids intended for therapeutic use are frequently packaged in small, hermetically sealed, substantially cylindrical containers made of glass or other transparent materials. It is usually necessary that the contents be of a high degree of purity and free of any suspended particles large enough to be visible to the unaided eye. However, in the processes of manufacturing many of these medicinals, many mechanical handling steps, such as filtration, are utilized. Tiny particles or slivers of the filtering medium, for example, may be introduced into the liquid, and containers which include such particles or slivers must be discarded. This necessitates very careful inspection by many operators in order to detect and remove from each batch those ampules containing contaminating substances.

Heretofore, this inspection had to be conducted visually and the ampules separated into "passed" and "rejected" categories entirely by hand. Furthermore, an inspector who had to minutely examine many units in the course of a day was subject to great eyestrain and eyefatigue so that there was always present the danger of passing ampules which should have been rejected because of the presence of contaminating matter.

The present invention, although not designed for completely automatic handling of the ampules, eliminates the necessity for the visual inspection and provides a rapid means for electronically inspecting each unit for particles which may be either more or less dense than the liquid in which they are present.

Briefly, the essential feature of the invention is the employment of a novel apparatus and method for spinning an ampule just prior to inspection and for holding the ampule in position during the inspection period without interfering with the passage of a beam of light therethrough. This is accomplished by providing a pair of driven rollers with an opening therebetween, and adapted to impart rotational motion to the ampule when the ampule is in frictional contact with the rollers. A beam of light is passed through the opening and thence through the ampule, and light leaving the ampule is directed

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to a photocell. A differential in air pressure is created on either side of the opening between the rollers, and this serves to increase the frictional contact between the ampule and the rollers so that the ampule, even though in an upright position, can be rotated rapidly, abruptly halted, and inspected without utilizing any further means for holding the ampule in position. With some ampules, however, an additional means to hold the ampules while spinning is desirable, and a mechanical ejector may be used to free the ampule from the holding effect of the air pressure after the inspection period is over.

One object of the present invention is to provide an improved apparatus for electronically inspecting the contents of individual, light-transmitting, liquid-filled containers, having a generally cylindrical shape.

Another object of the invention is to provide an improved method of electronically inspecting the contents of individual, light-transmitting, liquid-filled containers for the presence of contaminating particles.

Another object of the invention is to provide an improved apparatus especially adapted to inspect electronically the contents of relatively small containers filled with liquid.

Another object of the invention is to provide an improved apparatus for inspecting the contents of relatively small, liquid-filled medical ampules while the contents are rapidly whirling within the container.

Another object of the invention is to provide an improved apparatus for imparting a whirling motion to the contents of a liquid-filled ampule and inspecting the whirling contents electronically, without interfering with the passage of a beam of light passing through the ampule.

Another object of the invention is to provide a means of substituting electronic inspection for visual inspection of relatively small medical ampules.

A further object of the invention is to provide an improved means and method for holding a small cylindrical body during a spinning operation, and means for releasing the body at the end of an operational period.

Still another object of the invention is to provide an improved method and apparatus for spinning a relatively fragile glass body and holding it during an inspection process.

These and other objects will be more apparent and the invention will be better understood with

reference to the following description and the accompanying drawings, of which:

Figure 1 is a plan view, partially in section and partly diagrammatic, of the essential parts of an apparatus which may be utilized to carry out the objects of the present invention,

Figure 2 is an elevation view of part of the apparatus of Figure 1,

Figure 3 is a plan view, partially in section, of a modification of part of the apparatus shown in Figures 1 and 2,

Figure 4 is a detail front view of part of the apparatus of Figure 3,

Figure 5 is a perspective view of a modification of part of the apparatus shown in Figures 1, 2 or 3 during one stage of operation, and

Figure 6 is a perspective view of the apparatus of Figure 5 during another stage of its operation.

Patent No. 2,132,447 of George Philip Stout describes a method of and apparatus for inspecting a liquid which is within a bottle, the method including holding the bottle between rotatable chucks, rapidly spinning the bottle between rotatable chucks, rapidly spinning the bottle and its contents, suddenly stopping the rotation of the bottle, and, immediately thereafter, photoelectrically inspecting the contents of the bottle while the liquid is still rotating but while the bottle is stationary. A beam of light is focussed at a plane cutting through the bottle and the light is directed through the bottle to a photoelectric cell on the other side. Any particle of contaminating matter suspended in the liquid moves rapidly back and forth through the light beam due to the whirling motion of the liquid and a signal is produced in the output circuit of the photocell due to intermittent interruption of the passage of part of the light. The characteristics of the bottle, itself, do not influence the results of the inspection since the bottle is stationary during the inspection period and since the inspection apparatus responds only to intermittent interruption of the light beam.

The previously used apparatus, which has been designed to utilize the above described method, operates very well when the liquid containers are relatively large and have considerable structural strength. However, the apparatus disclosed in the said Stout patent and in those patents directed to improvements thereon is not adapted to handle relatively small objects such as medical ampules, which may have a volume of only 1 to 10 cc. and which may be only 1 to 3 inches in length and about ¼ to ¾ of an inch in diameter. Moreover, medical ampules are usually quite fragile with relatively thin walls.

Accordingly, the present invention has been developed to utilize the basic inspection method described above but to apply it to the inspection of the contents of relatively small containers of a fragile nature.

Referring, now, to Figure 1, there has been provided a vacuum chest **2** which may be made of any suitable material, such as sheet metal. This chest has a box-like portion **4**, having side, back, bottom, and top walls **6** generally square or rectangular in outline. The front wall **8**, of the chest, is provided with a protruding bay **10**. The front wall **11** of the bay is provided with an opening **12** in the form of a narrow slit and may also be provided with additional openings **14** and **16**, spaced adjacent the central slit.

One of the sidewalls is provided with an opening **18** leading to a conduit **20**, which is connected to means **22** for creating a reduced pressure within the chest. The means for creating the reduced pressure may be any device, such as a suction fan, which is adapted to produce a low vacuum.

Two cylindrically shaped rollers **24** and **26**, having surfaces **28** of a resilient material, such as rubber, are mounted on the front of the bay **10** such that one is positioned on either side of the slit **12**. An opening **30** is provided between the rollers which are spaced apart a distance approximately equal to the width of the slit. The rollers are rotatably mounted between a top bracket **32** and a bottom bracket **34** and are spaced just far enough from the front wall **11** of the bay such that they are free to rotate. Each roller is provided with an axle **36** which rotates within top and bottom ball-bearings **38** and **40**, carried by the top and bottom mounting brackets **32** and **34**, respectively.

Means, now to be further described with reference to Figure 2, is also provided for driving both of the rollers in the same direction. Each of the axles **36** of the rollers extends downward through the bottom bearings **40** and has a downwardly protruding portion **42** extending beyond the lower mounting bracket. Each of the protruding portions is provided with a thickened sleeve **44**. Bearing against both sleeves is a rubber tired driving wheel **46**, which is rotated by means of a shaft **48** driven by motor **50**. The motor is connected to a power source (not shown) and may be turned on and off by means of a key, or switch, **52**. The motor is preferably a universal type having brushes and commutator. Since the driven parts are relatively light in weight and fit tightly, their motion can be started and stopped relatively abruptly.

A light source and optical systems are provided within the vacuum chest. The light source may be a lamp **54** mounted adjacent the end of the chest opposite the bay **10**. Between the light source and the central slit **12**, which serves to define the light beam, is an optical system comprising a set of condensing lenses **56**, another optical slit **58**, and a cylindrical lens **60**, which system is for the purpose of focussing the beam from the light source at a plane just beyond the opening between the rollers.

The remainder of the complete optical system comprises another set of lenses **62**, positioned beyond the rollers outside the vacuum chest, while the inspection device is a photoelectric cell **64** having a conventional output circuit **66**, which is connected to an indicating device **68**, such as a signal light or buzzer. It is preferable, of course, to shield the photocell from the effects of stray light and spurious reflections.

The operation of the device is as follows. An ampule **70**, containing liquid, is placed over the opening **30** in frictional contact with the resilient outer walls **28** of the rollers **24** and **26**. At the same time, the suction means is placed in operation such that there is a suction of about 0.5 to 1 ounce per square inch at the opening between the rollers. Since there is a lowered air pressure just within the opening between the rollers, the ampule is held in position against the rollers by the relatively higher outside atmospheric pressure pressing against the ampule. The slits **14** and **16**, positioned on either side of the optical slit **12** enable a larger volume of air to be drawn through the vacuum chest. The differential in air pressure may also be said to increase the frictional contact between the ampule and the rollers so that the ampule is held firmly against the rollers. The rollers are then spun rapidly for a short

period of time. This causes the ampule and its contents to rotate rapidly, also. The rotation of the rollers is then abruptly stopped by stopping the motor 50. The rotation of the ampule is, also, of course, suddenly halted, but the liquid continues to whirl for a time due to its own inertia. During this period, the inspection system is in operation and, if a particle of sufficient size is present in the liquid, its movement back and forth across the light beam will cause a signal to be generated in the output circuit of the photocell. This signal is amplified and may be made to operate a suitable mechanism to indicate that the ampule should be rejected. This may be a signal light or buzzer 68 or may be an automatic separating device of conventional design which directs all "passed" ampules to one receptacle and all "rejects" to another.

After the end of the inspection period, the suction may be released either by stopping the operation of the suction device or by closing a valve 72 in the suction conduit 20. The ampule will then drop away from the rollers into any receptacle 73 provided to receive it.

The above described apparatus functions well with small ampules having a diameter which is substantially uniform. Because of the means employed for holding the ampule while spinning and inspecting it, there is nothing to interfere with the passage of the light beam through the center of the ampule. In addition, the apparatus is adapted to hold the fragile ampule without applying any heavy force to its walls which would result in a large percentage of breakage. Chucks for holding the ampules had previously been tried but of necessity produced some obstruction of the light close to the bottom of the ampule, the very place where foreign particles are most likely to be present. Also, the widely varying sizes of the ampules and their peculiar shape, due to the presence of a "sealing-off" protuberance, makes it extremely difficult to design a practical chuck.

When the ampules are not of substantially uniform diameter, and are of the larger sizes, a modification of the apparatus, such as shown in Figure 3, has been found advantageous. As illustrated in the figure, a movable arm 74 carrying three small idler rollers 76, 78, and 80 may be swung into position during the spinning operation such that the idler rollers bear against the wall of the ampule and assist the suction device in holding the ampule against the surfaces of the driving rollers. At the conclusion of the spinning cycle, the idler rollers are swung out of the way by the arm 74 so as not to interfere with the inspection step. This may be accomplished either manually or automatically in the embodiment which is now to be described. The arm 74, carrying the idler rollers, is pivoted on a pin 82 located at one side of one of the driving rollers 24 such that the arm and the rollers can be swung out of the path of the light beam passing through the center of the ampule. The arm is provided with a short branch 84 integrally joined thereto at right angles. The branch is pivotally connected to a link 86 which, in turn, is pivotally joined to a plunger 88 extending through a solenoid 90. The end of the plunger is provided with a button 92, to which a spring 94 is connected. The other end of the spring is fastened to a fixed plate 96 through which the solenoid plunger also passes. When the solenoid has no current passing through it, the spring pulls the plunger forward and this motion is translated to the arm 74, moving it around in a swinging motion such that the idler rollers bear against the ampule.

At the end of the spinning cycle, and just prior to the inspection step, the solenoid is actuated from a power source (not shown) as by pressing a key 98, and this pulls the plunger 88 back into the solenoid, which action, in turn, swings the arm 74 and the idler rollers out of the path of the light beam passing through the center of the ampule to the position shown in Figure 6. The solenoid may be actuated by any conventional means such as a manual contact switch, as shown, or automatically operated by a relay (not shown).

The difference in pressure on either side of the opening between the rollers 30 may also be created in a different manner. Instead of applying suction through the opening, a stream of compressed air may be directed towards the opening from the outside. An object placed across the opening will thus be held on the rollers by the increased air pressure directed against its exposed walls. This is not as satisfactory, however, as the previously described embodiment.

Although the ampule may be released from the rollers at the end of the inspection period by cutting off the suction in the manner previously described, it is possible to release the ampule without cutting off the suction, in a manner which is now to be described.

Referring now to Figure 5, there is shown an ampule 70, being held against rollers 24 and 26 by means of a differential in air pressure which may be maintained by means such as previously described. Idler rollers 76, 78 and 80 may also be swung into position against the ampule to aid in holding it against the rollers during the time the ampule is being spun. When larger diameter ampules are being spun, the two outer idler rollers 76 and 80 make contact with the walls of the ampule. When ampules of the smallest diameters are spun, only the center idler 78 makes contact with the ampule. The ampule ejecting apparatus comprises an ejector arm 100, positioned between and immediately behind the ampule spinning rollers 24 and 26, the lower end of the arm being provided with a toe portion 102 extending forwardly through the opening 30 between the rollers.

The ejector arm is provided with means for imparting reciprocating vertical motion thereto. This means may comprise a horizontal lever arm 104, pivoted about a centrally positioned fulcrum 106, with one end of the lever arm being pivotally connected to the top end of the ejector arm and the other end being pivotally connected to the lower end of a plunger 108, which is adapted to be drawn upwards against the biasing action of a spring 110, by a solenoid 112, which may be energized by closing a key switch 114, using a conventional power source (not shown). The spring is adjusted to normally hold the plunger at the downward extremity of its stroke when the solenoid is not energized.

During the period in which the ampule is being spun and the following period in which the ampule is stationary but the contents are still spinning, the ejector arm is held at the upward extremity of its stroke so that it does not interfere with the passage of the inspection beam through the ampule. This position is illustrated in Figure 5.

Immediately after the rollers 24 and 26 have stopped spinning and just prior to the start of the inspection period, the idler solenoid 90 is de-energized, whereupon the idler rollers are swung

away from the ampule as previously described. The inspection period then follows.

Immediately following the inspection period, the solenoid is actuated, drawing the plunger 108 upward and moving the ejector arm downward (as shown in Figure 6), whereupon the forwardly extending toe 102 pushes against the ampule and kicks it forward, away from the ampule-spinning rollers 24 and 26, causing the ampule to fall downward into the waiting receptacle.

There has thus been described an improved method and apparatus which can be applied broadly to conducting any operational step on a cylindrical object which must be spun rapidly during the course of a process. The object is held against a pair of rollers by a force created by a differential in air pressure between two different points on its external surface and the object is then spun by driving the rollers. At the end of the operational period, the object may be released from its contact with the rollers by producing a sufficient force in opposition to the force which is due to the differential in air pressure or else by shutting off the means which produced the pressure differential. The opposing force may be either an ejector arm or any other mechanical equivalent such as a reverse air blast. Various other modifications in the apparatus may also be made within the spirit of the invention, which has a particular application to the method of inspection described.

We claim as our invention:

1. Apparatus for inspecting the contents of a transparent container having substantially cylindrical side walls, including a pair of driven rollers having an opening therebetween and adapted to impart rotational motion to said container when said walls are in frictional contact with said rollers, means for passing a beam of light through said opening and through said container, means for creating a differential in air pressure on either side of said opening whereby the frictional contact of said walls with said rollers is increased, and auxiliary means for holding said container against said rollers while said container is rotating.

2. Apparatus according to claim 1 including means for moving said auxiliary holding means out of the path of said beam of light.

3. A method of inspecting the fluid contents of a transparent container having substantially cylindrically shaped side walls, said method comprising holding said walls in frictional contact with a pair of rotatable rollers by means of a differential in air pressure between different points on said walls, rotating said container and its contents by rotation of said rollers, stopping the rotation of said container while the contents remain in rotation, and photoelectrically inspecting said rotating contents.

4. A method of inspecting the fluid contents of a transparent container having substantially cylindrically shaped side walls, said method comprising holding said walls in frictional contact with a pair of rotatable rollers by means of a force created by the differential in air pressure between different points on said walls, rotating said container and its contents by rotation of said rollers, stopping the rotation of said container while the contents remain in rotation, photoelectrically inspecting said rotating contents, and releasing said container from said contact with a force in opposition to the force caused by said differential in air pressure.

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