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Wachter et al.

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[45] **Sept. 18, 1973**

[54] **GAS OR DUST DETECTING AND MEASURING APPARATUS**

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[21] Appl. No.: **287,220**

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **73/421.5 R**

[51] **Int. Cl.** **G01n 1/24**

[58] **Field of Search** ..... 73/421.5 R, 28; 417/470, 472

[56] **References Cited**

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Primary Examiner—Donald O. Woodiel

Attorney—John J. McGlew et al.

[57] **ABSTRACT**

The apparatus includes a bellows pump for drawing in a sample to be analyzed, with the pump having a movable part and being expanded by spring bias, during a working stroke, and collapsed, by a mechanical drive, during a return stroke. The mechanical drive is a continuously driven spindle drive including a driving motor. The spindle drive is automatically coupled to the movable part of the pump responsive to termination of the working stroke thereof, and is automatically uncoupled from the movable part of the pump responsive to the termination of the return stroke. In one embodiment of the invention, the spindle drive includes a stationary threaded spindle secured to the movable pump part and a split nut rotatable by the motor and movable into and out of threaded engagement with the spindle. A toggle or tilting lever mechanism effects engagement and disengagement of the split nut with the stationary spindle. In a second embodiment, the motor drives two rotatable threaded spindles having their axes in spaced parallel relation, and a connecting bar, having threads at each end, is connected to the movable part of the pump and is swung into and out of threaded engagement with the two spindles. The third embodiment also has two rotatable threaded spindles driven by the motor but cooperable with a split nut in the same manner as in the first embodiment.

10 Claims, 11 Drawing Figures

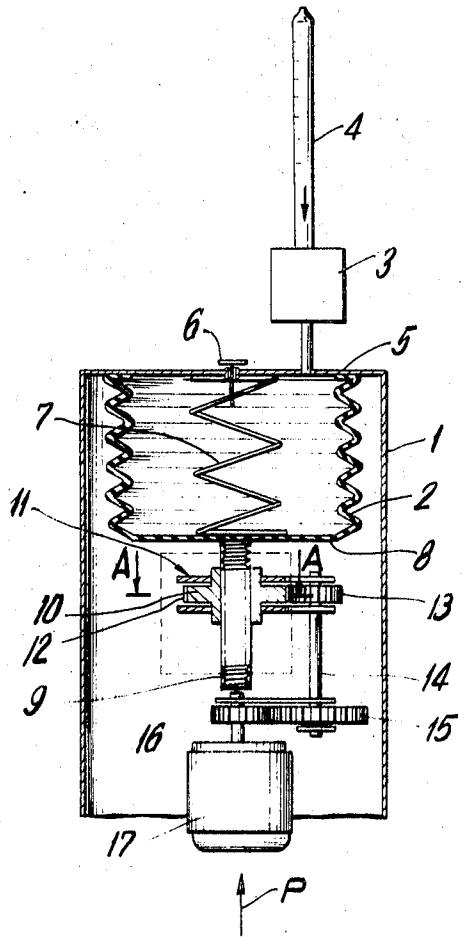
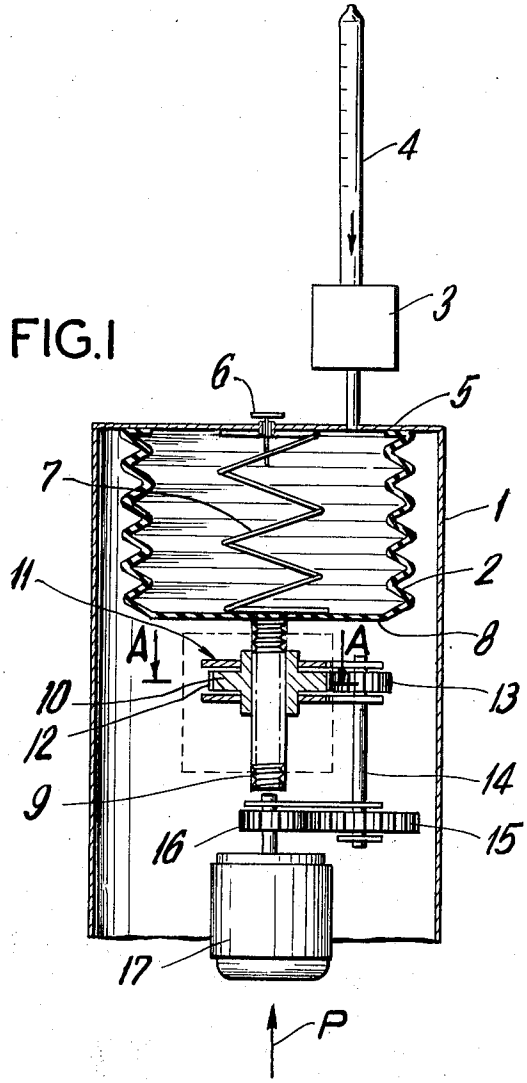


FIG.1



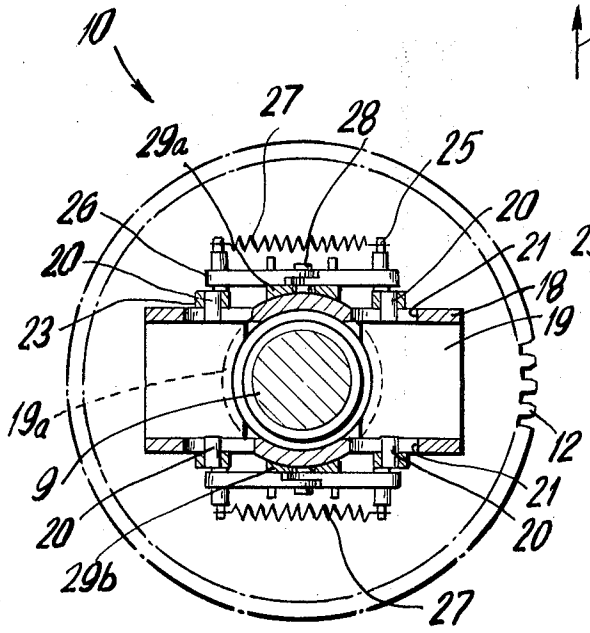


FIG.2a

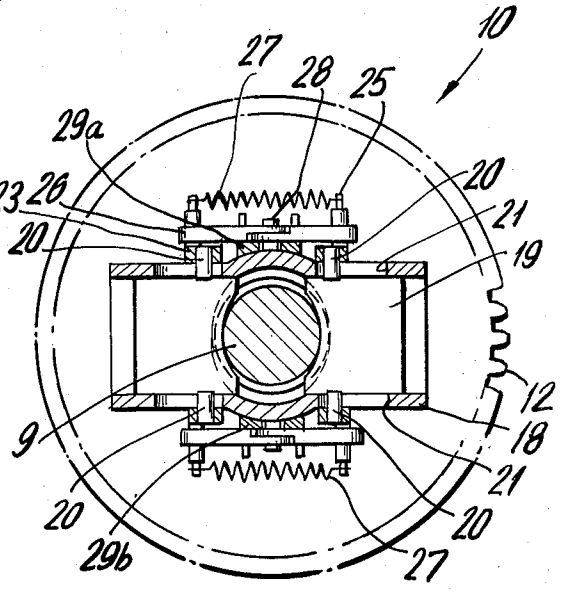


FIG.2b

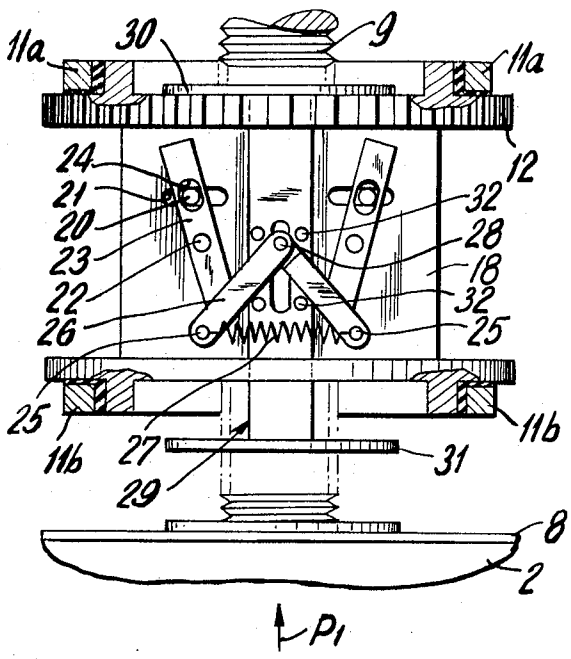


FIG.3a

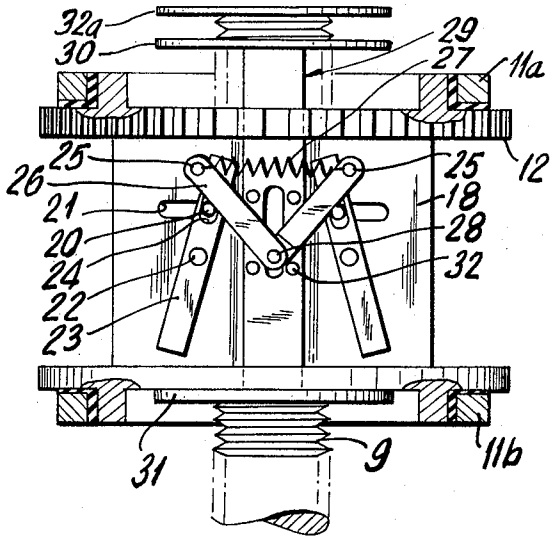


FIG.3b

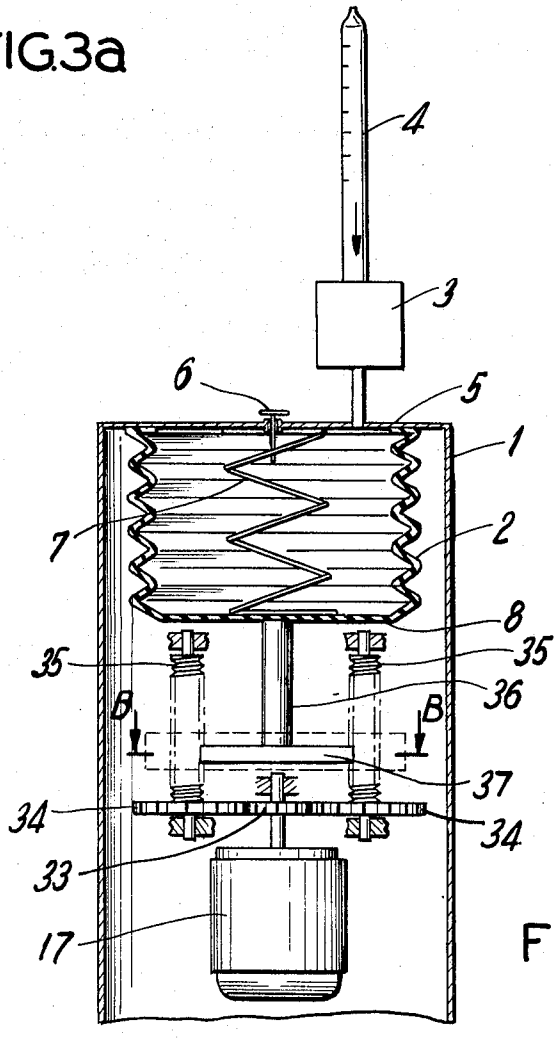


FIG.4

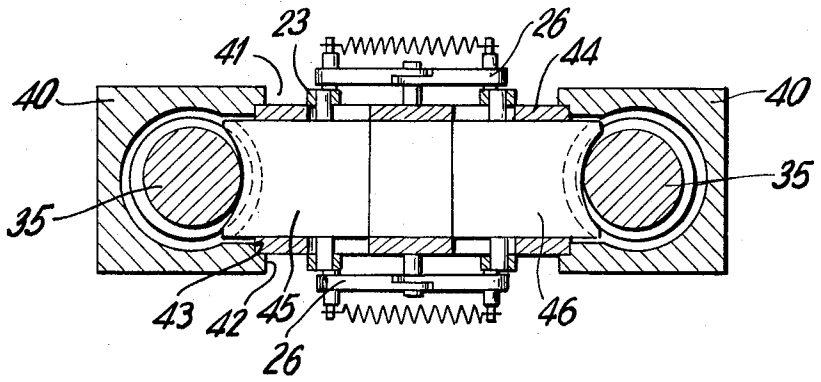


FIG.8

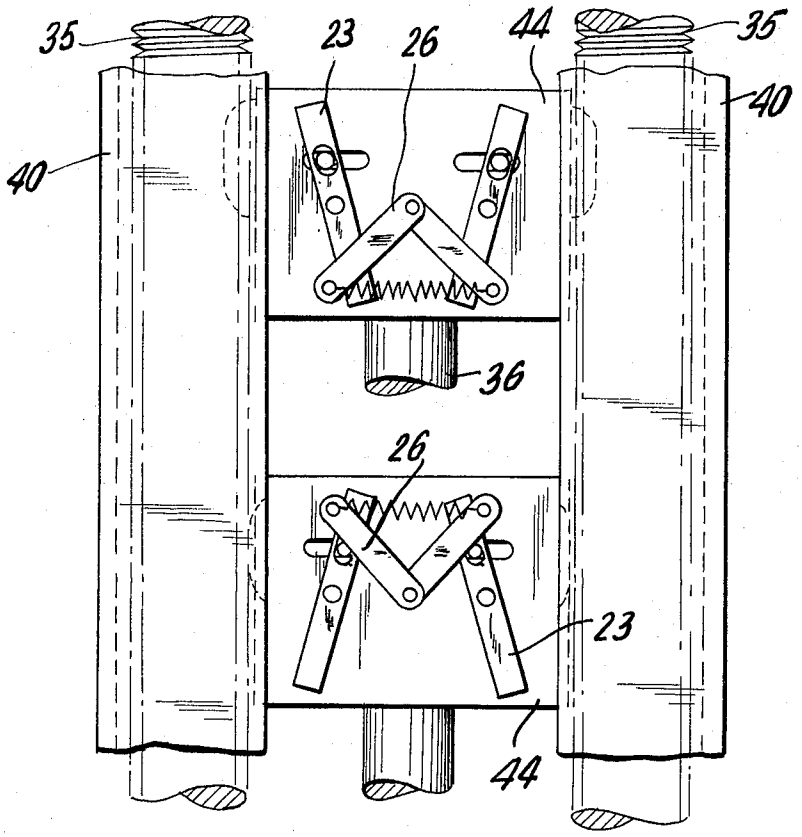


FIG. 9

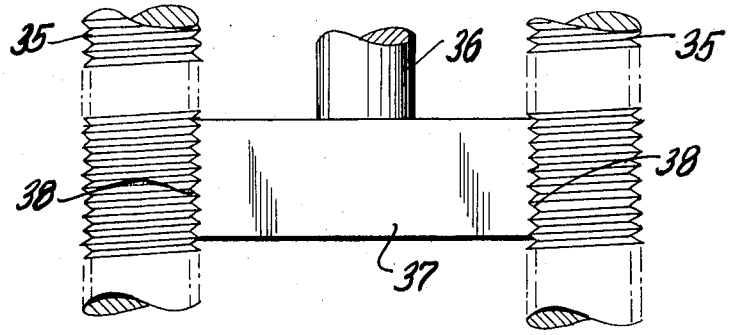


FIG.5

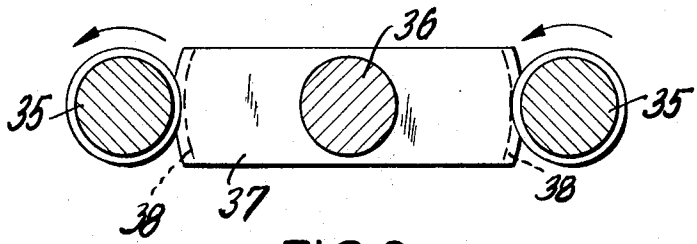


FIG.6

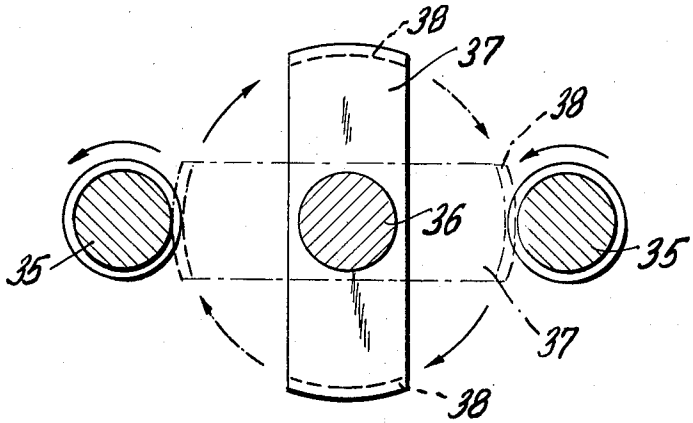


FIG.7

GAS OR DUST DETECTING AND MEASURING APPARATUS

FIELD AND BACKGROUND OF THE INVENTION

This invention relates to gas or dust detecting and measuring apparatus of the type including a bellows pump for drawing in a sample to be analyzed and, more particularly, to an improved mechanical drive for effecting the return stroke of the bellows pump, the working stroke being effected under spring bias.

There is a known device, for detecting foreign gases or suspended matter in air, wherein the air is drawn in through a test vessel by means of an air conveyor. The suction or drawing in device comprises a bellows or bellows pump which is expanded by a spring into its extended end position, the expansion or extension, effected by the spring bias, being used to draw in the conveying air. The extension of the bellows can be limited by suitable bands or straps. Furthermore, the bellows pump can be provided with only one outlet valve, and the air resistance of the suction port is greater than the resistance of the outlet port. With this known suction device, a defined amount of air is sucked or drawn in during each working stroke, through the test vessel, which usually has the form of a test tube. The suction rate depends on the resistance of the test tube and on the spring force of the driving spring.

In using apparatus of this type, it is necessary, in most cases, to compress the bellows pump repeatedly by hand in order to deliver a certain amount of air. This tires the hand muscles, so that the intervals between the individual working strokes are not exactly constant and the reading can be affected. For reference, see German Pat. No. 1,007,523.

There is a known similar gas or dust detecting and measuring apparatus where the moving part of the bellows pump is arranged in the path of movement of a pressure plate moved back and forth by a driving means, for example, a clockwork or an electric motor. Its speed is greather than the speed of the moving bellows part during the working stroke of the pump. Additionally, the drive is so controlled that the pressure valve is moved back and forth through a full movement stroke, while the pressure member stands still in one end position during the further course of the working stroke of the bellows pump.

As an air conveyor, there can be used a known spring-loaded gas-detecting hand pump. To the suction side of the bellows pump there can be connected a pressure measuring member, such as a pressure cell, which shuts off the drive at an underpressure on the suction side of the pump while it starts the drive at normal pressure on the suction side of the pump.

In another embodiment, a pressure measuring member, such as a pressure cell, is connected to the pressure side of the bellows pump, and shuts off the drive at an overpressure on the outlet side of the pump while starting the drive at normal pressure on the outlet side of the pump. Furthermore, a break contact, controlled by a pressure cell arranged on the suction side of the bellows pump, can be connected into the circuit of an electric drive, this break contact being opened at an underpressure on the suction side of the pump and closed at normal pressure on the suction side of the pump. This apparatus, which is disclosed in German DAS 1,598,332, and wherein manual operation is eliminated, requires a relatively strong drive.

SUMMARY OF THE INVENTION

The invention is directed to the problem of providing a gas or dust detecting and measuring apparatus which has a mechanically driven air conveyor in the form of a bellows pump, whose drive is simple in design and operation, and which has a low power consumption. More particularly, the invention is directed to such a detecting and measuring apparatus having a bellows pump whose working stroke is produced by spring force and whose return stroke is produced by a mechanical drive.

In accordance with the invention, the mechanical drive is a continuously driven spindle drive which is connected, for engagement and disengagement, with the moving part of the bellows pump in such a way that the drive disengages automatically at the end of the return or tension stroke of the bellows pump and engages automatically at the end of the working stroke of the pump. The invention arrangement has the advantage of an air conveyor which is very simple in its construction and operation and which uses a known bellows pump. In addition, the power consumption of the drive is relatively low.

In a simple embodiment of the invention, the moving front plate of the bellows pump is provided with a stationary spindle, preferably threaded, on which there acts a continuously driven engageable and disengageable component. The engageable and disengageable component can be designed in various ways. In a simple design, this component is a split lock nut. The split nut can be mounted rotatably in a housing but restrained against axial displacement, and can be provided with a toggle or tilting or tipping lever-type lock by means of which the split nut is forced into one of its two terminal positions. Stops are provided which act on the control means of the toggle or tipping lever in the two positions of the lock nut, that is in the spindle engaging position and in the spindle disengaging position.

In another very simple form of the invention, the spindle drive comprises two parallel spindles, and the moving front plate of the bellows pump is provided with a component mounted between the spindles and which can be engaged and disengaged simultaneously with respect to both spindles. The engageable and disengageable component again can be designed in the manner of a split nut, with each half nut being directed to the outside and being engageable and disengageable with respect to a respective one of the two spindles.

In accordance with another feature of the invention, and for controlling the apparatus described above, the lock or split nut type of engageable and disengageable component can be provided with a tipping or toggle lever-type lock by means of which the split nut is forced into one or the other of its two positions, stops being provided to act on the control means of the toggle or tipping lever type lock in each position of the lock nut.

As a further embodiment of the invention, and also one which is very simple, the moving front plate of the bellows pump is provided with a pressure plate arranged between the two spindles and turning about an axis parallel to the axes of the spindles. This pressure plate is provided, at both opposite ends, with a thread corresponding to the spindle threads, and with a control device which moves the pressure plate automatically between the engaged and disengaged positions in dependence on the end position of the front plate.

An object of the invention is to provide a gas or dust detecting and measuring apparatus with a mechanically driven air conveyor whose drive is simple in design and operation and which has a low power consumption.

Another object of the invention is to provide such an apparatus in which a bellows pump is moved through a working stroke by spring force and is moved in a return stroke by a mechanical drive.

A further object of the invention is to provide such an apparatus in which the mechanical drive is a continuously driven spindle drive arranged for engagement and disengagement relative to a moving part of the bellows pump.

Another object of the invention is to provide such an apparatus in which the drive is disengaged automatically at the end of the return stroke of the bellows pump and is engaged automatically at the end of the working stroke of the bellows pump.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a side elevation view, partly in section, of one embodiment of a gas or dust detecting and measuring apparatus in accordance with the invention;

FIGS. 2*a* and 2*b* are sections on the plane A—A of FIG. 1, taken through the lock nut, with FIG. 2*a* illustrating the lock nut in the open position and FIG. 2*b* illustrating the lock or split nut in the closed position;

FIGS. 3*a* and 3*b* are elevations of that part of FIG. 1 outlined in broken lines, namely the lock nut, with FIG. 3*a* illustrating the open position and FIG. 3*b* illustrating the closed position;

FIG. 4 is an elevation view, partly in section, of another embodiment of the invention;

FIG. 5 is an enlarged detail view of that portion of FIG. 4 outlined in broken lines;

FIGS. 6 and 7 are sections on the line B—B of FIG. 4, with FIG. 6 illustrating the engaged position and FIG. 7 illustrating the disengaged position;

FIG. 8 is a sectional view on the line B—B of FIG. 4 wherein a pressure plate is replaced by a split nut member; and

FIG. 9 is a top plan view of FIG. 8 illustrating both positions of the split-nut type part.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to the embodiment of the invention shown in FIG. 1, a casing 1 contains the bellows 2 of a bellows pump which is connected to the intake 3 to receive a test tube 4. In the front face 5 of the bellows, which is also the front face of casing 1, there is arranged a relief valve 6. Bellows 2 is tensioned or expanded by a spring 7 which bears between front wall or face 5 and movable end wall or face 8 of the bellows.

Movable end wall 8 of the bellows has secured thereon a threaded spindle 9 which is engageable by the split lock nut 10. Nut 10 is mounted in a bearing 11 of which only the parts 11*a* and 11*b* are illustrated in FIGS. 3*a* and 3*b*. Bearing 11 prevents axial displacement of nut 10, which otherwise can turn freely about spindle 9. Nut 10 is formed with a gear rim 12 meshing with a pinion 13 of a driving spindle 14 having a driving gear 15 secured to its opposite end and meshing with the output pinion 16 of a driving motor 17.

With nut 10 closed, spindle 9 is moved in the direction of arrow P when motor 17 is operating the spindle drive, and bellows 2 thus is compressed. The air contained in the bellows escapes through relief valve 6 to atmosphere. When the bellows has been compressed, lock split nut 10 is disengaged by an automatic control so as to release spindle 9. Bellows 2 now is expanded or extended by spring 7, in a working stroke, and a certain amount of air is drawn in through test tube 4. After the working stroke is completed, lock 10 is again engaged with spindle 9 by an automatic control, and the return or compression stroke of bellows 2 is initiated.

The essential parts of lock nut 10, and its controls, are shown in FIGS. 2*a* – 3*b*. Lock or split nut 10 comprises substantially a housing 18 in which two pistons 19 are mounted for displacement transversely of the axis of rotation of nut 10. Pistons 19 are provided with guide pins 20 which project to the exterior through corresponding slots in housing 18. Journals 22 are secured on housing 18 and serve to support adjusting levers 23 formed with oblong slots 24 receiving pins 20. Levers 26 are pivotally mounted at their opposite ends on a common supporting stud 28 secured on housing 18. In effect, the combination of levers 23 and 26 constitutes a toggle joint, there being one of these toggle joints on either side of spindle 9.

In housing 18, there is mounted a distributing slide member 29 comprising two circular cross-section parts 29*a* and 29*b* which are interconnected with each other, at their end faces, by annular members 30 and 31. These members surround housing 18 with play, and slide member 29 carries, on each side, four control pins 32 by means of which tilting levers 26 are pivoted.

FIGS. 2*a* and 3*a* illustrate nut 10 in the open position. Bellows 2 extends in the direction of the arrow P_1 and finally its movable end face 8 strikes against ring surface 31 of slide member 29. As a result, pins 32 are moved upwardly and the pairs of tilting levers 26, on opposite sides of spindle 9, are pivoted from the position shown in FIG. 3, under the action of spring 27, beyond dead centers, so that levers 26 finally snap into the position shown in FIG. 3*b*. As a result, pistons 19 are moved into the closed position of nut 10 through levers 23 and pins 20. The inner end faces of pistons 19 are provided with threads 19a which correspond to the thread of spindle 9.

With nut 10 closed, bellows member 8 moves, in the return stroke, in the direction of arrow P and bellows 2 is compressed against the bias of spring 7. Finally, spindle 9 reaches the position shown in FIG. 3*b* in which control plate 32*a* secured on the free end of spindle 9 finally acts on front plate 30 of slide member 29 and returns the toggle levers 23, 26 back to the initial position so that the nut 10 opens to disengage spindle 9 and bellows 2 can be expanded by spring 7.

The embodiments of the invention shown in FIGS. 4 through 7 differ from that shown in FIGS. 1 through 3*b* in that driving motor 17 has a pinion 33 meshing with two spur gears 34, each secured to a respective rotatable threaded spindle 35, spindles 35 having their axes in spaced parallel relation to each other. A pressure member or shaft 36 is secured to movable end wall 8 of bellows 2, and terminates in a cross member 37. Member 37 is mounted for rotation about the axis of

pressure shaft 36, and is provided, at its opposite ends 38, with threads corresponding to the threads of rotatable spindles 35. FIG. 6 illustrates member 37 in the spindle engaging position, and FIG. 7 illustrates this member in the spindle disengaging position. Engagement and disengagement are effected by a device which has not been illustrated.

FIG. 4 illustrates the apparatus with member 37 in the engaging position during the return stroke of the bellows, and in which the opposite ends 38 of member 37 threadedly engage the respective driving spindles 35. Bellows 2 is compressed through pressure member 36. When bellows 2 is compressed to its terminal position, member 37 is rotated through 90° by a control device, which has not been shown, from the position represented in FIG. 6 into the position represented in FIG. 7. End wall 8 of bellows 2 is thus disconnected from the spindles 35, and the bellows performs its suction stroke under the bias of spring 7. At the end of the suction or working stroke, member 37 is again brought into engagement with spindles 35, as shown in FIG. 6, by a control device which has not been shown.

FIGS. 8 and 9 illustrate an embodiment of the invention which corresponds, with respect to the driving spindles 35, to the embodiment of the invention shown in FIG. 4 but, with respect to the engageable and disengageable component, to the embodiment shown in FIGS. 2*a* – 3*b*. Spindles 35 are mounted in the opposite ends of a housing 40, which is illustrated broken off at both ends so that the bearings are visible. Housing 40 has a center part 41 which is provided, on both sides, with an opening, the inwardly directed end faces 42 of the housing walls being formed with guide grooves 43 for the lock housing members 44. In lock housing members 44 there are mounted, for lateral displacement, two pistons 45 and 46 designed in the same manner as the pistons of the split nut shown in FIGS. 2*a* – 3*b*. The controls of this lock also correspond to that of the lock shown in FIGS. 2*a* – 3*b*, so that reference can be made to the description of FIGS. 2*a* – 3*b*.

In the upper part of FIG. 9, as viewed in the drawings, and in FIG. 8, the lock is shown in the engaged position with pistons 45 and 46 pushed to the outside through the tipping levers 23 and 26 forming the toggle lever mechanism. The lock nut is engaged with the spindles 35, and the spindle drive now compresses the bellows through pressure member 36. In the lower part of FIG. 9, the lock nut is represented in the open position into which it is moved when the bellows is at the end of the return stroke. The bellows can now expand under the bias of spring 7 to initiate the suction or working stroke.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In a gas or dust detecting and measuring apparatus of the type including a bellows pump for drawing in a sample to be analyzed, with the bellows pump having a movable part and being expanded by the bias of a spring, during a working stroke, and collapsed by a mechanical drive, during a return stroke, an improved mechanical drive comprising, in combination, a continuously driven spindle drive including a drive means therefor; and means operable automatically, responsive to termination of the working stroke, under spring bias, of said bellows pump, to couple said spindle drive to said movable part to perform the return stroke and, responsive to termination of the return stroke, by said spindle drive, of said bellows, to uncouple said spindle drive from said movable part to condition said bellows pump to perform the working stroke under the spring bias.

2. An improved mechanical drive, as claimed in claim 1, in which said continuously driven spindle drive comprises a threaded spindle fixedly secured to said movable part; said last-named means comprising means automatically engageable and disengageable with said threaded spindle.

3. An improved mechanical drive, as claimed in claim 2, in which said engageable and disengageable means comprises a split nut rotatable by said continuously driven spindle drive.

4. An improved mechanical drive, as claimed in claim 3, including a rotatable housing mounting said split nut while restraining said split nut against axial displacement; toggle lever mechanism mounted on said housing and connected to the relatively movable parts of said split nut; control means displaceably mounted on said housing and connected to said toggle lever mechanism to move the same between a first position, in which said split nut is engaged with said threaded spindle, and a second position, in which said split nut is disengaged from said threaded spindle; and actuating means movable with said threaded spindle and engageable with said control means at the end of the working stroke and at the end of the return stroke of said bellows pump to actuate said toggle mechanism to engage and disengage said split nut relative to said threaded spindle.

5. An improved mechanical drive, as claimed in claim 4, in which said actuating means comprises said movable part of said bellows pump and a control plate secured to said threaded spindle in axially spaced relation to said movable part of said bellows pump, said movable part of said bellows pump and said control plate being engageable with respective opposite ends of said displaceable control means.

6. An improved mechanical drive, as claimed in claim 5, in which there are a pair of toggle mechanisms; each toggle mechanism including a pair of tipping levers pivoted intermediate their ends on said housing and pivotally connected, adjacent a first end thereof, to the halves of said split nut, said displaceable control means comprising a pair of slides displaceable parallel to the axis of said threaded spindle and each having a respective elongated slot receiving a respective guide pivot; and stop pins on each slide engageable with the associated toggle levers to snap the associated toggle mechanism past the dead center point to move the two halves of the split nut into and out of engagement with said threaded spindle.

7. An improved mechanical drive, as claimed in claim 1, in which said spindle drive comprises a pair of rotatable threaded spindles rotatable about spaced parallel axes by said drive means; said automatically operable means comprising a component carried by said movable part of said bellow pumps and positioned between said threaded spindles; said component being simultaneously threadedly engageable with both spindles and simultaneously disengageable from both spindles.

8. An improved mechanical drive, as claimed in claim 7, in which said component forms a split nut; the threads of the two halves of the split nut being directed radially outwardly and each being engageable and disengageable relative to a respective rotatable threaded spindle.

9. An improved mechanical drive, as claimed in claim 8, including toggle lever mechanism engageable with the two halves of the split nut; control means displaceable parallel to said rotatable threaded spindles; and stops on said control means engageable with said toggle lever mechanism to displace said split nut halves simultaneously into engagement with respective rotatable threaded spindles and simultaneously out of engagement with respective rotatable threaded spindles.

10. An improved mechanical drive, as claimed in claim 7, in which said component movable with said movable part of said bellows pump comprises an elongated transversely extending member oscillatable about an axis parallel to the axes of said rotatable threaded spindles; each end of said member being formed with a thread engageable with the thread of a respective rotatable threaded spindle; said automatically operable means oscillating said member between a first position in which said threaded ends are threadedly engaged with respective rotatable threaded spindles and a second position in which said threaded ends are disengaged from the associated rotatable threaded spindles.

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