Nov. 30, 1971 JEAN-CLAUDE CREPIN 3,623,381

ARRANGEMENTS FOR TREATING, AND IN PARTICULAR ANALYZING, A PLURALITY OF SAMPLES

Filed Dec. 16, 1969

Fig. 1.

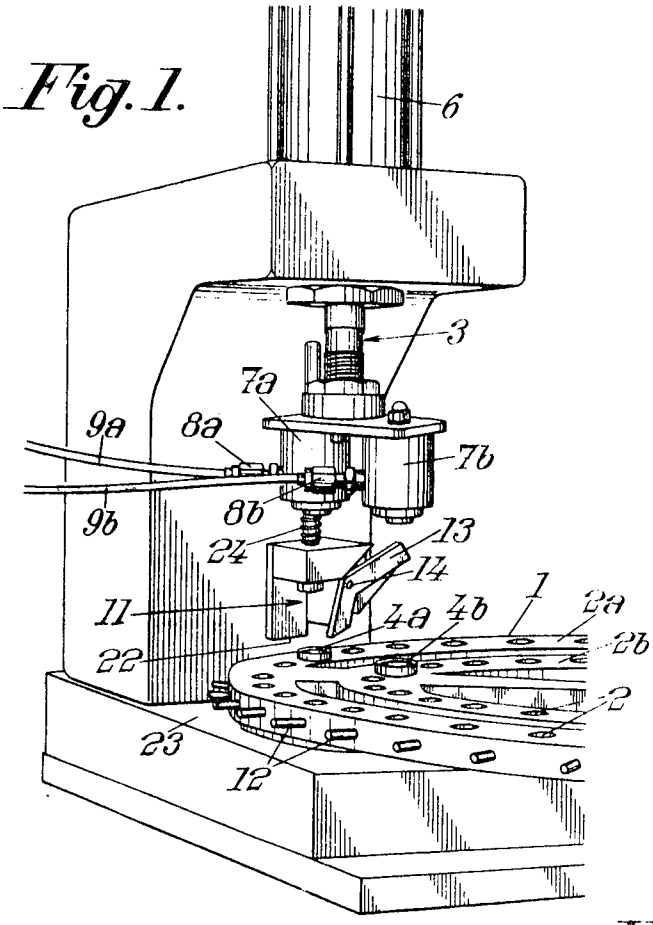


Fig. 2.

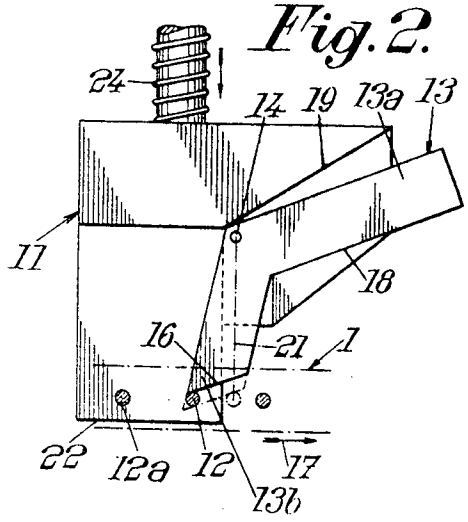
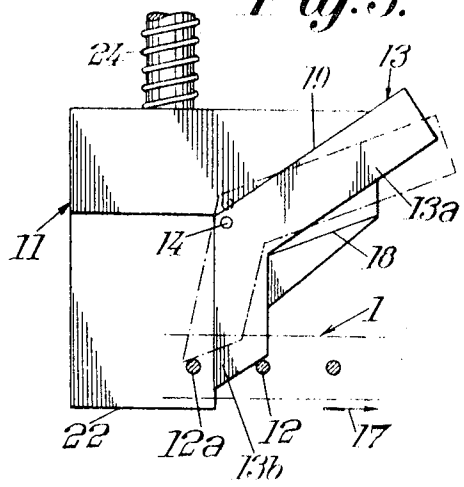


Fig. 3.



JEAN-CLAUDE CREPIN
INVENTOR

BY Fleit, Gipple & Jacobson
ATTORNEYS

United States Patent Office

3,623,381

Patented Nov. 30, 1971

3,623,381

ARRANGEMENTS FOR TREATING, AND IN PARTICULAR ANALYZING, A PLURALITY OF SAMPLES

Jean-Claude Crepin, Paris, France, assignor to Laboratories Choay, Paris, France

Filed Dec. 16, 1969, Ser. No. 885,662
Claims priority, application France, Dec. 16, 1968, 178,476
Int. Cl. B23q 17/00
U.S. Cl. 74—822 9 Claims

ABSTRACT OF THE DISCLOSURE

Arrangement for treating a plurality of samples, comprising a distributor adapted to be driven with alternate movements between a "rest position" and a "working position," in which latter it is capable of carrying out at least part of the operations on one of the samples at a fixed station, and a support on which the samples are distributed at predetermined regular intervals, adapted to bring each sample to the aforesaid fixed station in succession, wherein the support carries abutment elements in positions which correspond respectively with those of the samples and the distributor carries a rocking member adapted to repel, at the cost of its inherent rocking action from a position of equilibrium, one of the aforesaid abutment elements to produce a unitary movement of the plate every time the distributor is moved towards its working position, the aforesaid rocking action being sufficient for said member to be able to act on the following abutment element of the support after being returned to its position of equilibrium and in the course of the following alternate movement of the distributor.

This invention relates to arrangements for treating, and in particular analyzing, a plurality of samples, of the kind comprising, on the one hand, a device referred to hereinafter in a general manner by the term "distributor," which is adapted to carry out at least part of the operations of treating or analyzing each sample at a fixed station, and, on the other hand, a support adapted to go through movements by discrete values or "unitary movements" enabling it to bring successive samples up to said station (it being understood that the word "sample" indicates any treatment unit such as a container, cup or cell or the like, the contents of which can be withdrawn, made up or treated in any other manner through the medium of the distributor); and it relates more particularly, in one of its preferred applications, to an arrangement designed to permit automatic analysis by chromatography, more particularly the automatic introduction of successive samples, for example amino acids, into a chromatography column filled with ion exchange resin.

Arrangements of this kind are already known, in particular automatic arrangements, in which the movement of the support is dependent on that of the distributor or vice versa. The known arrangements, however, are generally characterized by great complexity to enable the many conditions which must be complied with for satisfactory operation thereof to be constantly fulfilled. For example, the support must not go through more than one unitary movement each time it is operated by the distributor and must moreover be locked at least during the time when the appropriate operations are being carried out by the distributor on the sample which is at aforesaid fixed station at the time; on the other hand, the distributor must not be able to reach its working position or begin the execution of one of the aforesaid operations automatically if the support has not previously gone through a complete unitary movement, etc.

The object of the invention is therefore, above all, to render these arrangements such that they meet the various requirements in practice better than heretofore, in particular as regards both the simplicity and the reliability of control of the unitary movements of the support carrying the treatment units.

The arrangement according to the invention, which comprises a distributor adapted to be driven with alternate movements between a "rest position" and a "working position," in which latter it is capable of carrying out at least part of the operations on one of the samples at a fixed station, and a support on which the samples can be distributed at predetermined regular intervals and adapted to go through unitary movements enabling each of these samples to be brought up to the aforesaid fixed station in succession, is characterized by the fact that the support carries abutment elements in positions which are respectively in correspondence with those of the samples and the distributor carries a member adapted to rock in the direction of movement of the support from a position of equilibrium in which it is disposed, more particularly when the distributor is at rest, to a given off-set position, and to repel, at the cost of its inherent rocking action, one of the aforesaid abutment elements to produce a unitary movement of the plate every time the distributor is moved towards its working position, the aforesaid rocking action being sufficient for said member to be able to act on the following abutment element of the support after being returned to its position of equilibrium and in the course of the following alternate movement of the distributor.

In a preferred constructional form of this arrangement, the distributor performs its reciprocating movements in a vertical direction and the support is constituted by a circular plate adapted to go through unitary angular movements about its axis, the samples being disposed on radii of said circular plate at respectively equal distances from the centre thereof, the driving elements being constituted by pegs projecting at the periphery of the plate and extending the aforesaid radii, the rocking member being constituted by a lever pivoting about a pin and having an inclined surface acting on the corresponding peg on the descent of the distributor.

The rocking member is advantageously carried by a part mounted on the distributor through the medium of resilient means, said part coming into abutment with a fixed part of the arrangement before the distributor has reached its "working position," the distributor being then only able to complete its travel in opposition to the action of the aforesaid resilient means.

The invention can be clearly understood in any case with the aid of the following additional description and of the accompanying drawing, which additional description and drawing are, of course, given above all by way of indication.

FIG. 1 of the drawing shows in perspective part of an arrangement for the automatic treatment of a plurality of samples;

FIGS. 2 and 3 are enlarged elevational views of one of the parts of the arrangement of FIG. 1 in two positions which it is capable of adopting in the course of the operation thereof.

An arrangement in accordance with a preferred construction form of the invention and designed to permit automatic analyses by chromatography, more particularly the automatic introduction of successive samples, for example of amino acids, into chromatography columns filled with ion exchange resin, may be constituted more particularly as follows.

First of all, with regard to this arrangement considered as a whole, it comprises:

A sample support constituted, for example, by a circular plate **1** adapted to be driven with unitary angular movements about its axis and having a series of orifices **2** disposed, for example, in two concentric circular rows **2***a* and **2***b* on radii of this circular plate and defining seats for treatment units, for example cups or cells **4***a* and **4***b* containing the samples to be analysed, the unitary movements having the effect of bringing each of these cups or cells up to a given fixed station in succession; and

A distributor designated as a whole by the reference **3** and adapted to be moved vertically and alternately between a rest or inoperative position (such as that represented in FIG. 1) and a working position at the level of the aforesaid fixed station, in which position the distributor is capable of carrying out an operation, the cups **4***a*, **4***b* located on the same radius of the circular plate **1** being situated at that instant at this fixed station perpendicularly below the distributor.

To this end, the distributor, which is preferably electropneumatically controlled, includes a jack **6**, a compensating system (not shown) enabling the rate of descent of the jack to be regulated, and two parts **7***a* and **7***b* participating in the execution of the aforesaid operation on the samples contained in the cups **4***a*, **4***b*.

In the particular application considered, these parts **7***a*, **7***b* form "elution heads" made, for instance, of plastics material known commercially by the name of Kel-F; they are disposed at the end of the shaft of the jack and symmetrically with respect thereto, each of these parts being provided with an axial duct opening at the bottom and being provided with a coupling **8***a* or **8***b*, for example of the type known by the name "Swagelock," connecting the corresponding axial duct to an elution pump (not shown) through the medium of a polyethylene tube **9***a* or **9***b*.

When the distributor is in its working position, the elution heads **7***a*, **7***b* are applied to the tops of the cups **4***a* and **4***b*, respectively, the elution pumps aforesaid being then able to introduce measured amounts of eluent in manner known per se into the cups **4***a*, **4***b* through the medium of the tubes **9***a*, **9***b* and the elution heads **7***a*, **7***b*. In the particular application considered, the cups **4***a*, **4***b* carried by the plate are pierced at their base, the samples of amino acids to be subjected to analysis being then adsorbed on a resin. In their working position, the cups **4***a*, **4***b* then communicate in manner known per se with two hollow parts (not shown), for example of "Kel-F" material, disposed below the circular plate and respectively communicating with the heads of two chromatography columns (not shown) and machined in such manner that the cups are applied intimately against them when the elution heads **7***a*, **7***b* bear on the tops of the cups **4***a*, **4***b*.

The successive cups **4***a*, **4***b* can then be brought respectively up to the aforesaid fixed station by unitary angular rotary movements of the plate **1**. Each of the concentric rows **2***a*, **2***b* comprises, for instance, forty seats **2**, so that forty pairs of samples can be treated in succession by bringing them successively to the fixed working station by unitary rotary movements through an angle of 9°.

According to the invention, the mechanical drive of the circular plate **1** for causing it to go through the angular movements respectively equal in the example considered to an angle of 9° is effected through the medium of a part

referred to as a whole by the reference **11**, carried by the distributor **3** and adapted to engage with the support in such manner that it produces an angular movement of the plate when the distributor is brought from its rest position to its working position, the distributor being able to attain this latter position only if the plate has undergone a complete unitary rotation.

More particularly, level with each group of cups **4***a*, **4***b*, the circular plate has elements **12** preferably constituted by pegs mounted at the periphery of the plate and co-operating with a movable member **13** of the part **11** on the descent of the distributor into its working position, the engagement being accompanied by a displacement of the member **13** itself with respect to its inherent rest position, this displacement being sufficient to enable it to engage with the following peg when said member has found its position of equilibrium again and on a fresh descent of the distributor.

The movable member **12** aforesaid is advantageously constituted by a pivoting lever adapted to pivot about a pin **14** fast with the part **11** and having an inclined surface **16** which, when the distributor is in its rest position, is located perpendicularly above the peg **12** corresponding to that one of the treatment units which is then at the aforesaid fixed station. The angular movement (in the direction of the arrow **17** which can be seen in FIG. 2) of the plate **1** (the relative position of which with respect to the part **11** is shown by chain-dotted lines in FIGS. 2 and 3) is obtained by the sliding action which is imposed on the peg **12** by the inclined surface **16** on the descent of the part **11** with the distributor **13** towards the working position of the latter. The position of the pin **14** with respect to the inclined surface **16** of the lever **13** is such that this lever is impelled to rock after engagement from its inherent position of equilibrium (or position of rest on a surface **18** of the part **11**) into a different off-set position (shown in FIG. 3) under the effect of the thrust exerted on the peg by the inclined surface of the lever, this rocking action being sufficient for said inclined surface to be located once more perpendicularly above the following peg **12***a* when the distributor and the part **11** have been brought back into their respective rest positions.

FIG. 2 shows the position of the lever **13** at the instant when it acts on the peg **12** which is perpendicularly below it in the course of the descent of the distributor **3**, and FIG. 3 shows the aforesaid different off-set position of the lever **13** (in abutment with a surface **19** of the part **11**) at the end of the downward travel of the part **11**.

Having returned to its position of equilibrium following the ascent of the distributor, the lever **13** will then be perpendicularly above the following peg **12***a* and when, in the course of the following descent of the distributor, it acts on this peg **12***a*, it is in the position shown in chain-dotted lines in FIG. 3.

The rocking of the lever **13** in the course of its action on a peg **12** is obtained automatically if the relative initial and final positions (shown in FIGS. 2 and 3, respectively) of the inclined surface **16** and a peg **12** are on each side of the vertical **21** (shown chain-dotted in FIG. 2) passing through the pivot **14** of the lever. The automatic return of the lever **13** to its inherent rest position is easily obtained if this rocking is accompanied by a relative raising of the centre of gravity of the lever **13**, which can be achieved by giving the part **13***a*, which is adapted to come into contact either with the abutment surface **18** or with the abutment surface **19**, a sufficient length from the pivot **14**.

The arrest of the lateral movement of the peg **12** urged by the lever **13** is controlled by the arrest of the descending movement of the part **11** itself, it being possible to obtain this arrest by the abutment of its base **22** against a fixed part, for example the pedestal **23** (FIG. 1) supporting the plate **1**. According to an advantageous

supplementary characteristic of the invention, the part **11** is normally held in a fixed relative position, in particular in a "low position," with respect to the distributor **3** through the medium of resilient means such as a spring **24**, the assembly consisting of the distributor **3** and the part **11** being arranged in such manner that the part **11** immobilizes the plate **1** before the distributor has itself completely finished its descending travel. The completion of this descending travel, resulting in the application of the elution heads **7***a*, **7***b* against the cups **4***a*, **4***b*, is then effected at the cost of a compression of the spring **24**.

As a result of which there is obtained an extremely simple system of direct mechanical rependence of the angular rotary movements of the plate on the alternating movements of the distributor **3**. This system is moreover prefectly reliable. Assuming, in fact, that the actuation of the elution pumps is automaticaly dependent on the application of the elution heads **7***a*, **7***b* to the cups **4***a*, **4***b*, it becomes impossible to introduce given volumes of eluents into the same cups accidentally two or more times. In fact, the distributor **3** can descend into its working position only if the plate has effected a unitary angular movement in concomitant fashion. Accidental locking of the plate prohibits in particular (through the medium of the part **11** and the lever **13**) the continuation of the descent of the distributor **3**, and, consequently, the continuation of the automatic analysis cycle. Moreover, the lower end **13***b* of the lever **13** prevents the plate effecting more than one unitary movement (as a result of the resultant abutment of the peg **12***a* against the lower end **13***b* of the lever **13**).

Moreover and by construction, the part **11** always brings the elution heads and the cups into coincidence, without it therefore being necessary to effect periodic adjustments of the arrangement.

Furthermore, due to the spring **24**, the final pressure of the distributor is applied only to the cups, so that the assembly can be subjected to considerable operating pressures, for example pressures of 70 kg./cm.^{2}, in particular when the pneumatic system which has just been described is employed, as a result of which leakages need not be feared.

The arrangement according to the invention may therefore, for example, operate as follows.

An electric pluse delivered to the electropneumatic control device of the jack produces the descent of the distributor **3**; the lever **13** of the part **11**, which is initially in its rest position (FIG. 2), acts on the peg **12** which is perpendicularly below its inclined surface **16** and compels it to move in the direction of the arrow **17** while the descent of the distributor **3** continues; this co-operation of the inclined surface **16** and the peg **12** in question in the course of the descent of the jack **6** produces the rocking of the lever **13** at the latest when the peg **12** passes perpendicularly below the pivot **14**; the angular movement of the plate is interrupted when the base **22** of the part **11** encounters the pedestal **23**, the lever **13** and the aforesaid peg **12** then occupying the relative positions shown in FIG. 3. The distributor then completes its travel, compressing the spring **24**, until the instant when its elution heads **7***a*, **7***b* are applied against the cups **4***a*, **4***b*; the elution pump is then able to supply given volumes of eluents to the cups **4***a*, **4***b* through the tubes **9***a*, **9***b* and the elution heads **7***a*, **7***b*; at the end of the cycle of elution of the amino acids and after the arrest of the elution pumps another pulse is delivered to the control device of the electropneumatic jack and this then reverses the compressed air circuit, thus causing the ascent of the jack. The lever **13** then returns to its rest position; and end-of-travel contact actuated when the distributor reaches is rest position produces a second electric pulse which is used to produce automatically a fresh descent of the distributor and the exchange of samples under the conditions which have been described hereinbefore.

As is obvious and as is moreover already apparent from the foregoing, the invention is by no means limited to those methods of application thereof or to those constructional forms of its various parts which have been more particularly indicated; on the contrary, it covers all variants thereof.

What is claimed is:

1. A device for treating a plurality of samples, comprising a distributor adapted to be driven with alternate movements between a "rest position" and a "working position," in which latter it is capable of carrying out at least part of the operations on one of the samples at a fixed station, and a support on which the samples can be distributed at predetermined regular intervals, the support being adapted to be displaced by specific amounts to enable each of these samples to be brought up to the aforesaid fixed station in succession, wherein the improvement comprises abutment elements carried by the support in positions which correspond respectively with those of the samples and a member carried by the distributor disposed in a position of equilibrium relative to said distributor and out of contact with any of said abutment elements when said distributor is at rest, said member adaped to rock in the direction of movement of the support from a position of equilibrium in which it is disposed when the distributor is at rest, to a given off-set position, said member being further adapted when said distributor is moved towards its working position to meet and repel one of the aforesaid abutment elements and to undergo a rocking in the direction of movement of the support to an off-set position relative to said distributor, as a result of this repelling action and of said motion of said distributor, to produce a unitary movement of the support every time the distributor is moved towards its working position, the aforesaid rocking action being sufficient for said member to be able to meet and act on the following abutment element of the support after being returned to its position of equilibrium and in the course of the following alternate movement of the distributor.

2. Device according to claim **1**, wherein the distributor can be moved alternately from its "rest position" to its "working position" in a vertical direction.

3. Device according to claim **2**, wherein the rocking member carried by the distributor comprises a lever pivotable about a pin and having a surface inclined with respect to the vertical, said inclined surface being located vertically above one of the abutment elements of the support when the distributor is in its rest position, said member going through a sufficient pivoting action about its pivot on the descent of the distributor and the driving of the support for said inclined surface to be located perpendicularly once more above the following abutment element of the support when the lever has been brought back into its position of equilibrium on the ascent of the distributor.

4. Device according to claim **3**, which comprises abutment surfaces from the lever in both its position of equilibrium and its off-set position.

5. Device according to claim **3**, wherein the pin about which the lever is pivotable is positioned such with respect to the support that the point where the inclined surface encouners the corresponding abutment element on the descent of the distributor and the point of contact of the inclined surface with the same element when the support has completed its unitary movement are situated on each side of a vertical plane passing through the pivot of the aforesaid lever.

6. Device according to claim **3**, wherein said lever has a form such that its centre of gravity is raised with respect to its pivot when it undergoes the aforesaid rocking action in the course of the driving of the support.

7. Device according to claim 2, wherein the support is constituted by a circular plate adapted to be displaced through unitary angular movements about its axis, the samples being disposed on radii of said circular plate at respectively equal distances from its centre, the abutment elements being constituted by pegs projecting radially from the periphery of the plate.

8. Device according to claim 1, wherein the rocking member is mounted on a part normally held in a given relative position in relation to the distributor through the medium of resilient means, said part coming into abutment with a fixed part of the device before the distributor has reached its "working position," the distributor being then only able to complete its travel in opposition to the action of the aforesaid resilient means.

9. Device according to claim 8, wherein the resilient

means are constituted by a spring which is compressed on the completion of the travel of the distributor towards its working position.

References Cited

UNITED STATES PATENTS

3,395,093	7/1968	Liberti	210—198
3,461,525	8/1969	Gourley	74—826 X

WILLIAM F. O'DEA, Primary Examiner

F. D. SHOEMAKER, Assistant Examiner

U.S. Cl. X.R.

74—142; 210—198