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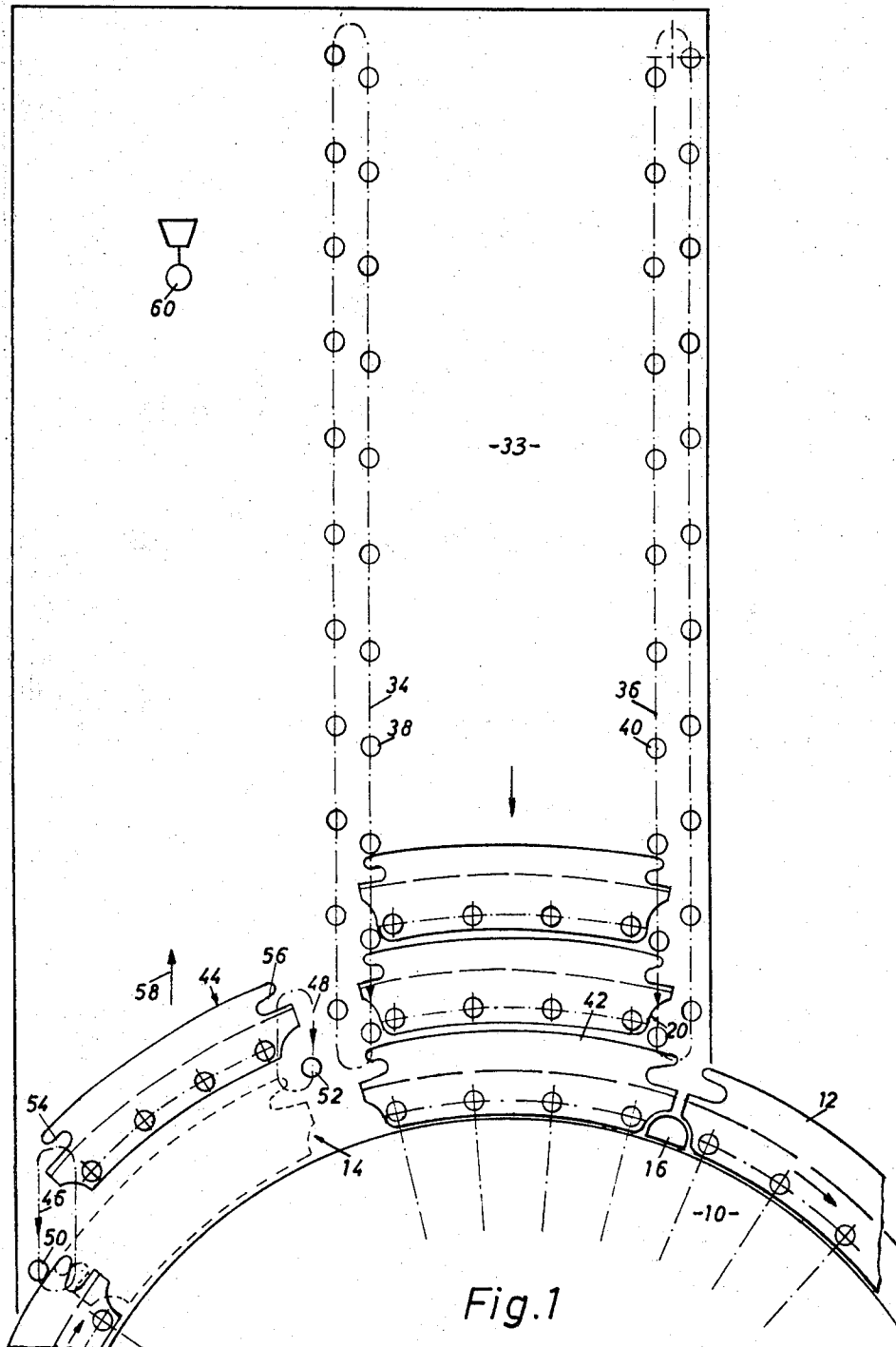
G. PODSCHADLY ET AL

3,545,933

SAMPLE CONVEYING ARRANGEMENT FOR CHEMICAL ANALYSIS APPARATUS

Filed Oct. 3, 1968

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

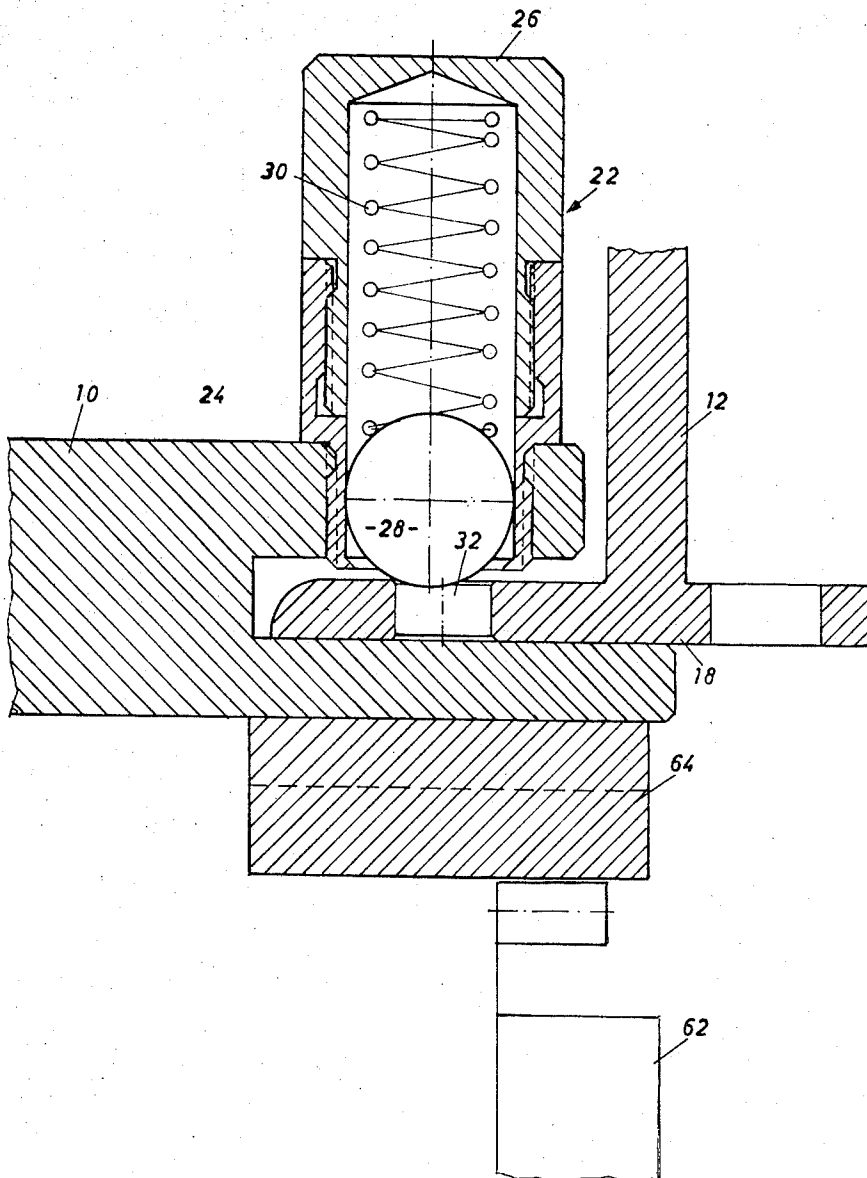


Fig.2

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SAMPLE CONVEYING ARRANGEMENT FOR CHEMICAL ANALYSIS APPARATUS

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U.S. Cl. 23—253 8 Claims

ABSTRACT OF THE DISCLOSURE

In an automatic analytical apparatus, a first conveying means is provided for sample vessel holders at a first position adjacent the periphery of a rotary transport and is adapted for conveying the sample vessel holders toward the transport in a radial direction. The transport includes means positioned near an outer circumference of the transport adapted for receiving and supporting the sample vessel holders which are conveyed thereto. A second conveying means is provided at a second position adjacent the transport periphery and is adapted for withdrawing vessel holders from the receptacle space and for conveying the vessel holders away from the transport. The movement of the first and second conveying means is synchronized with the movement of the rotary transport.

The present invention relates to chemical analysis apparatus. The invention relates more particularly to sample conveying arrangements for use with automatic chemical analysis apparatus.

In an apparatus for automatically carrying out chemical analyses, an array of sample vessels are arranged at the periphery of a rotary transport such as a turntable which is advanced past sample insertion, reaction, and analysis states. Undosed quantities of sample substance are introduced to the apparatus in sample vessels at the sample insertion station. Reaction vessels are positioned radially inwardly of these sample vessels. As the sample vessel is advanced to the reaction station, a dosing pump removes sample quantities from each sample vessel and transfers dosed amounts into the reaction vessels. Reagents are admixed to the sample volumes contained in the reaction vessels during the continued advancement of the turntable. After a predetermined reaction time, the sample volumes are removed and transported to a photometer cell at the analysis station. By means of a photometric analysis the intensity of the reaction is evaluated quantitatively as described and claimed in copending U.S. patent application Ser. No. 689,516, filed Dec. 11, 1967, and which is assigned to the assignee of the present invention.

In one sample transport arrangement, the sample vessels are positioned in segmental sample vessel holders which are secured to the turntable at the periphery thereof. These sample vessel holders are provided with information carriers on a peripheral portion thereof, such as punched cards carrying information serving for sample identification. These information carriers are scanned at the analysis station and the information serving for sam-

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ple identification is printed out conjointly with the respective measuring data of the photometer. A sample transport arrangement of this type is described and claimed in copending U.S. patent application Ser. No. 738,191, filed June 19, 1968, which is assigned to the assignee of this invention.

It is an object of the present invention to provide an automatic arrangement for insertion and removal of the sample vessel holders in transport apparatus of the type described.

Another object of the invention is to increase the rate at which samples are continuously, automatically analyzed without significantly increasing the size of the turntable.

Another object of the invention is to provide a sample transport arrangement which provides for the introduction and removal of the associated information carriers, respectively, simultaneously with the introduction and removal of the sample vessel holder to the analysis apparatus.

In accordance with features of the present invention, a first conveying means is provided for sample vessel holders at a first position adjacent the periphery of an annular shaped rotary transport and is adapted for conveying sample vessel holders toward the turntable in a substantially radial direction. The transport includes means positioned near an outer circumference of the transport adapted for receiving and supporting the sample vessel holders conveyed thereto. A second conveying means is provided at a second position adjacent the transport periphery and is adapted for withdrawing vessel holders from the receptacle spaces and conveying the vessel holders away from the transport. The movement of the first and second conveying means is synchronized with the movement of the rotary transport. The apparatus according to the present invention advantageously operates both with uniform or nonuniform, and continuous or stepwise movements of the turntable provided the stepwise movement is relatively smooth.

These and other objects and features of the present invention will become apparent with reference to the following specifications and drawings wherein:

FIG. 1 is a partial top view of a sample conveying device according to the invention; and,

FIG. 2 shows a vertical section through a click-stop device for centering the sample vessel holders.

The general arrangement of a rotary transport for use with the present invention is described in the above-referred-to patent application Ser. No. 738,191. FIG. 1 illustrates demountable segment sample vessel holders 12 mounted along the periphery of a rotary transport 10 comprising a parallel turntable. The turntable 10 includes a plurality of peripheral locations 14 at which the sample vessel holders 12 are mounted. A plurality of elongated semicircular members 16 are mounted on the periphery of the turntable between the locations 14 and extend in the direction of the thickness of the turntable. The members 16 define and insure that the sample vessel holders 12 are mounted on the turntable at predetermined locations along the turntable.

A sample vessel holder 12 includes an elongated horizontal base 18 curved to form a corresponding arc about the turntable 10. This base 18 is formed with two quadrantal recesses 20 at the inner corner. The recesses 20 of adjacent sample vessel holders 12 supplement each other

to form a semicircle extending around the projections 16. In this manner a sample vessel holder 12 is mounted in a defined position on the turntable 10.

For accurately aligning and securing a sample vessel holder to the turntable 10 there is further provided a locking means 22. The locking means includes a projection 24 at the turntable 10 which projects over the base 18 of the sample vessel holder 12 to form a groove in the periphery of the turntable. On the projection 24 there is mounted a downwardly open cylindrical cap 26 in which there is arranged a ball 28 engaged in an aperture 32 in the base 18 by the force of a spring 30. The ball abuts an inner edge of the sample vessel holder 12. As the sample vessel holder 12 is forced inwardly, it is thereby centered and locked at the projections 16. The holder is thereby demountably mounted in a manner for providing that the locking means 22 is released when sufficient pull is exerted on the sample vessel holder 12. When such a force is exerted, the ball 28 is forced upwardly against the bias force of the spring 30.

Automatic and mechanized insertion of a sample vessel holder 12 in a groove is provided by a first conveying means generally referenced as 33. This conveying means 33 comprises two endless chains 34 and 36, represented diagrammatically in FIG. 1, and arranged below a sliding surface for the sample vessel holders. These chains 34, 36 are guided in a substantially radial direction toward the turntable along an inner path facing the other chain, and thereafter around a chain wheel, not illustrated, and are returned along an outer path parallel to the inner path. At the radially outer end of the conveying means 33 the chains 34, 36 are again guided around chain wheels, not shown.

The chains 34 and 36 have a plurality of upwardly projecting chain bolts 38, 40 which abut the outer peripheral portions 42 of the sample vessel holders 12 on the inner chain paths in the region of the quadrantal recesses of the next following sample vessel holder 12. The chains 34 and 36 are driven in opposite sense, and that is in a manner such that they run radially inwardly on the respective inner paths. In this manner the sample vessel holders 12 are successively conveyed to and positioned at predetermined locations 14 of the turntable 10 by the chain bolts 38, 40. The chain bolts 38, 40 then are automatically withdrawn and return with the chains 34 and 36, respectively on the outer path laterally of the assemblage of sample vessel holders 12.

Upon insertion of a sample vessel holder, the turntable 10 rotates in a clockwise direction as viewed in FIG. 1, and the sample vessel holders are continuously inserted. As the turntable and sample vessel holders rotate together a reaction and analysis is carried out as indicated hereinbefore. Information carriers for sample identification are provided on the outer periphery of the sample holder 12. At the end of the reaction time, the samples are analyzed photometrically and the measured result is printed out conjointly with the scanned contents of the information carriers.

After this cycle the sample vessel holders are automatically removed from the turntable and are horizontally assembled. This is accomplished by means of a conveying device 44 which is similarly provided with two endless chains 46, 48 driven in opposite sense. The chains 46, 48 are guided around two chain wheels each, not shown, and run below a sliding surface for the sample vessel holders along inner paths facing each other and are then returned around the chain wheels and along outer paths. The sense of rotation of the chains 46, 48 is opposite that of the chains 34, 36. The chains 46, 48 then progress in a direction radially outwardly along the inner paths. For convenience in the layout of FIG. 1, the chains and direction of holder motion are shown parallel to that of the holder convey means 33. However, it is to be understood that the conveying means for withdrawing the holders are arranged in a radial direction with respect to the turn-

table. Of course, that may be physically arranged as illustrated in FIG. 1 when surface space requirements so dictate. Each of the chains 46, 48 includes a chain bolt 50 and 52, respectively, projecting upwardly into the plane of the sample vessel holders. The base 18 of each sample vessel holder 12 includes U-shaped grooves 54 and 56 in the vicinity of the outer rim extending in a peripheral direction from both sides. Upon movement of the chains 46 and 48 the chain bolts 50 and 52, respectively, engage into these grooves 54 and 56, respectively, and automatically withdraw the sample vessel holders 12 from the turntable 10 and convey the same through a certain distance in the direction of the arrow 58, FIG. 1. As a sample holder is withdrawn, the click-stop 22 is released as the ball 28 is forced upwardly, FIG. 2. Successively withdrawn sample vessel holders 12 push on previously withdrawn sample holders so that an assemblage of used sample vessel holders is formed on a sliding surface. When the assemblage extends a predetermined distance on the surface, a signal device 60 is actuated.

Control of the conveying means for insertion and removal is effected in the following manner: the endless chains of each conveying means are driven by an associated motor. These motors are electrically excited when switching means comprising microswitches 62 arrayed below the turntable 10, FIG. 2, are actuated. The microswitches are actuated by a plurality of switch cams 64 mounted below the turntable 10 near each location 14 and transported therewith. The chain bolts projecting upwardly also actuate a microswitch for deenergizing the motors after each completed insertion and removal step.

The arrangement operates as follows: The turntable 10 is stepped onto the insertion station at which position the switch 62 is actuated by cam 64. The chain bolts 38, 40 push a segmental sample vessel holder into the insertion space 14 of the turntable 10. The ball 28, FIG. 2, engages and abuts the inner edge of the aperture 32 in a manner providing that the sample vessel holder 12 is forced inwardly and abuts the projections 16 with the quadrantal recesses 20. Thus, the sample vessel holder 12 is retained in the turntable until it reaches the sample holder withdrawal station. A microswitch is actuated by the switch cam 64, which energizes the motor for the conveying means 44 and the sample vessel holder 12 is then withdrawn by the chain bolts 50, 52.

While we have illustrated and described a particular embodiment of our invention, it will be understood that various modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims.

We claim:

1. In an apparatus for the automatic chemical analysis of sample substances said apparatus having an annular shaped rotary transport for advancing sample vessel holders between a sample insertion and an analysis station, an arrangement for introducing and withdrawing the vessel holder from the transport comprising:

means for receiving and demountably supporting and securing a holder at a plurality of locations about a periphery of the transport;

means for automatically conveying to the transport and transferring a sample holder to said receptacle means at a sample holder insertion station adjacent the periphery of said transport; and,

means for automatically withdrawing a sample holder from said receptacle at a sample holder withdrawal station.

2. The apparatus of claim 1 wherein said insertion and withdrawing and conveying means convey said sample holder in a radial direction with respect to said rotary transport.

3. The apparatus of claim 1 including means for defining a plurality of sample holder locations arrayed about the periphery of said transport.

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4. The apparatus of claim 1 including means for synchronizing the insertion and withdrawal of sample holders with the movement of said transport.

5. The apparatus of claim 1 wherein said sample holder includes an elongated base having a segment extending radially toward said transport and said demountable receptacle means comprises a groove formed in the periphery of said transport for receiving said base and means for exerting a force on said base for securing said base in said groove.

6. The apparatus of claim 5 wherein said base segment includes an aperture located therein and said force-exerting means comprises a spring biased member adapted for engaging said aperture.

7. The apparatus of claim 6 wherein said first exerting means comprises a click-stop device.

8. The apparatus of claim 1 wherein one of said con-

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veying means comprises first and second endless chains aligned in parallel and each of said chains includes means for engaging said sample holder for conveying said sample holder from a relatively remote location to said injection station.

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