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[54] APPARATUS FOR PERFORMING CHEMICAL ANALYSES

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[52] U.S. Cl. ....23/259, 23/230 R, 23/253 R, 73/425.4, 141/130, 141/168

[51] Int. Cl. G01n 1/10, G01n 1/14

[58] Field of Search 23/253, 259, 230; 141/130, 141/168; 73/425.4

[56] References Cited

UNITED STATES PATENTS

3,151,073	9/1964	Anthon	23/259 X
3,178,266	4/1965	Anthon	23/253
3,193,358	7/1965	Baruch	23/253
3,413,097	11/1968	Jungner	23/253 X
3,449,959	6/1969	Grimshaw	23/253 UX
3,475,130	10/1969	Baruch	23/259 X

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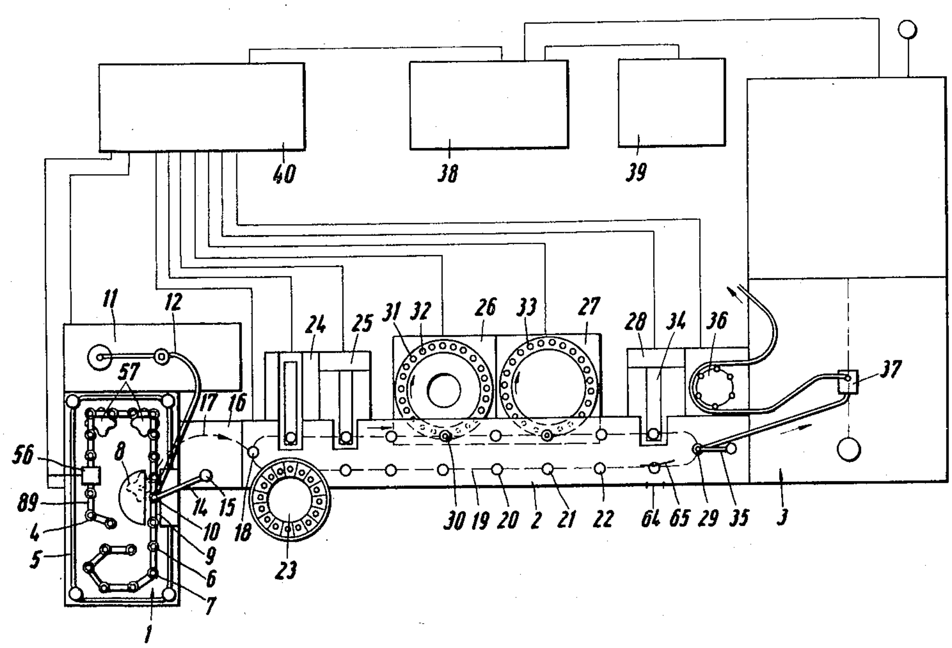
[57] ABSTRACT

Apparatus for handling samples of material wherein a first transport system intermittently moves units of the material in small steps and a second transport system receives sample portions of said units and intermittently moves these portions in larger steps; both systems operating with the same cadence.

7 Claims, 8 Drawing Figures



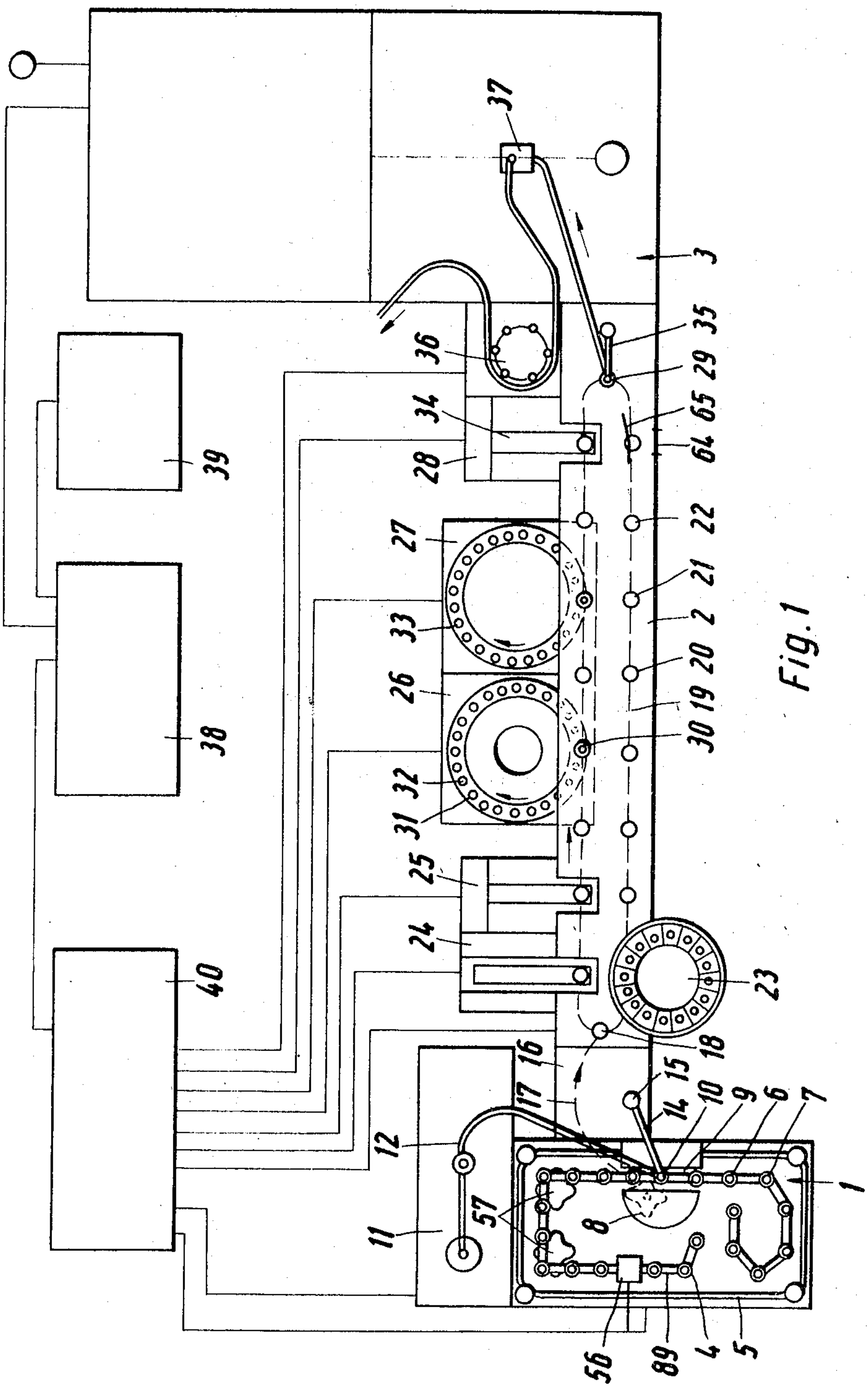


Fig. 1

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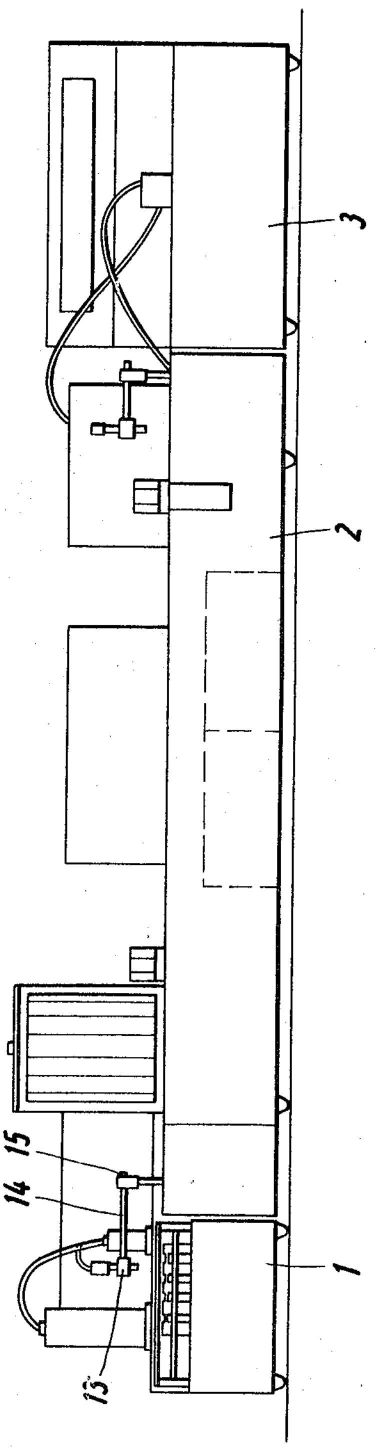

Fig. 2

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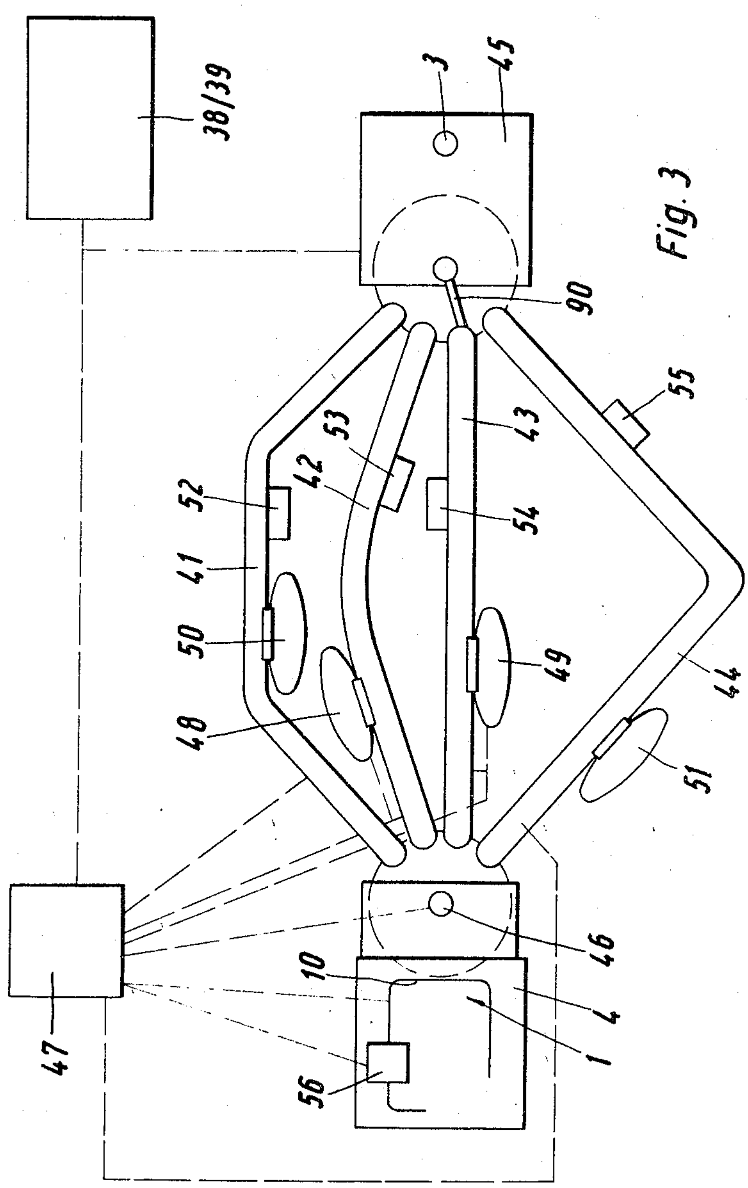

Fig. 3

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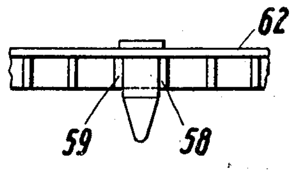

Fig. 4

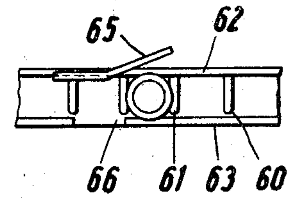

Fig. 5

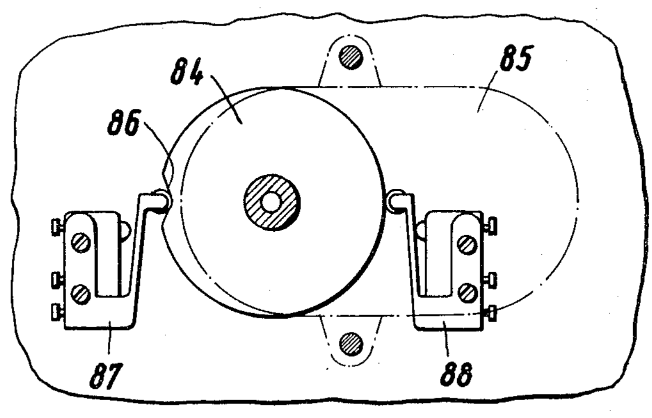

Fig. 8

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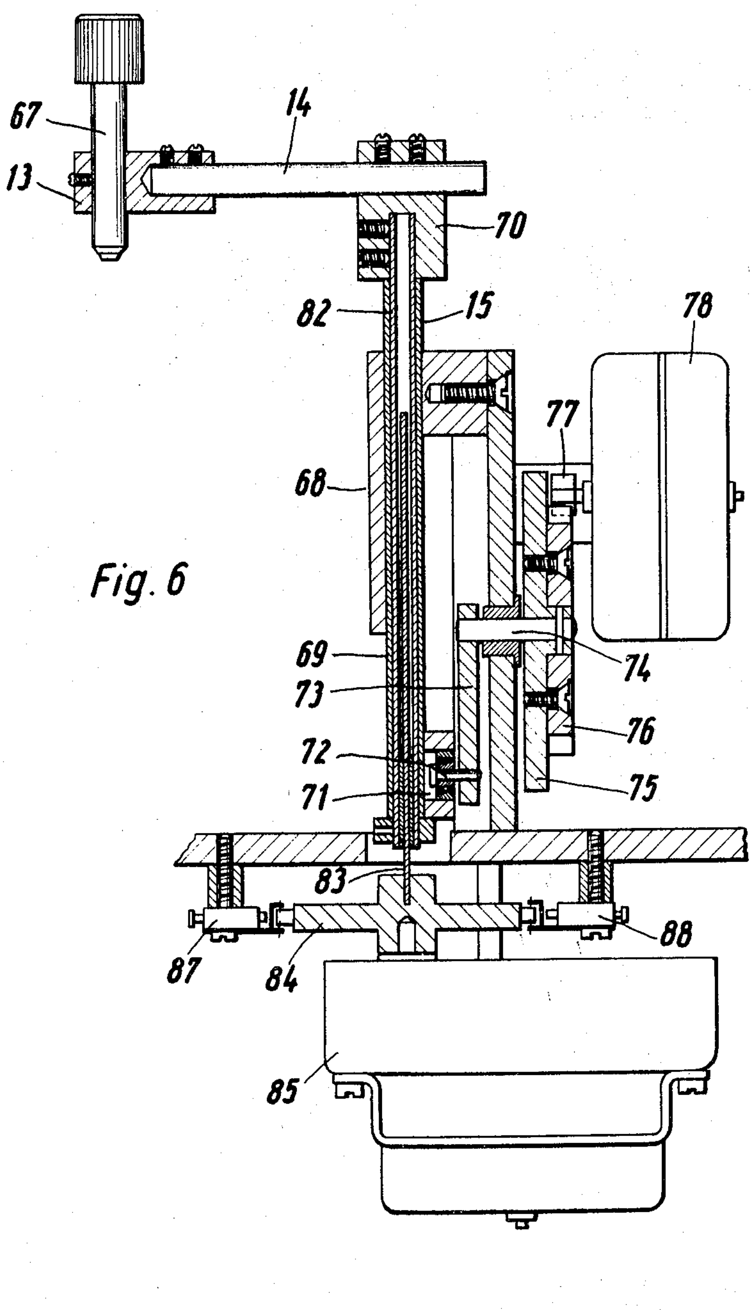

Fig. 6

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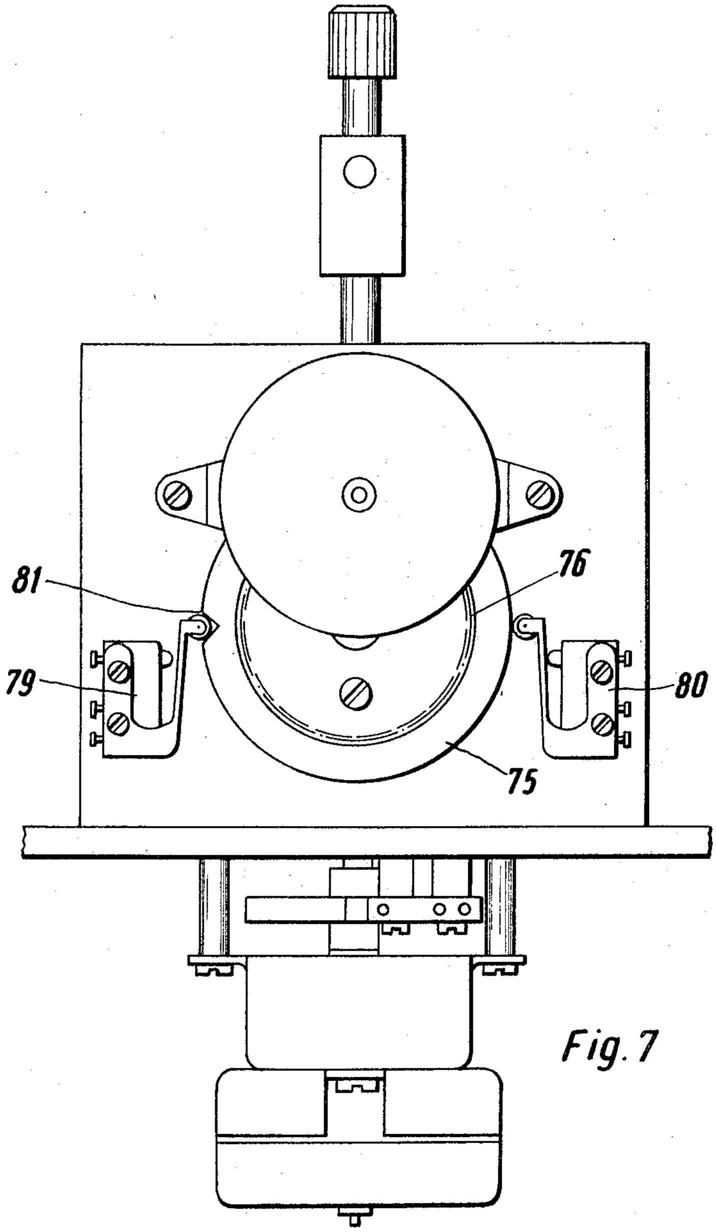

Fig. 7

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APPARATUS FOR PERFORMING CHEMICAL ANALYSES

BACKGROUND OF THE INVENTION

For the diagnosis of the various diseases of the organs, the concentration of certain substances in the body fluids (blood, serum, urine, etc.) plays an important part. There are methods for determining the concentration of a large number of substances, which are carried out more or less frequently according to the frequency of the various diseases. The present invention relates in particular to determination methods which must be carried out very frequently in the clinical-chemical laboratory and where it is important to perform the many analyses with a limited staff.

Most determinations are carried out photometrically. When a substance having a color of its own is concerned, it may be measured with a photometer. The intensity of the coloration, on a suitable scale, is directly proportional to the concentration of the substance. Thus, the concentration can be determined by multiplication by a known factor. For optically nonabsorbing substances, a coloration specific to the substance to be analyzed is produced by addition of a reagent, and then the concentration is determined by photometry.

Devices are known which render possible a mechanization of the individual steps of chemical analysis in the following manner. Several samples are, for example, made ready on a sample plate and the samples are successively mixed with reagents in a hose system in certain proportions and, if necessary, heated and cooled off again. The photometric measurement is carried out with a photometer.

The multiple utilization of the apparatus with this working method is also known, in the sense that several portions of a sample are taken and analyzed in separate apparatus units by different methods.

In addition, another analysis technique is known in which the manual steps are mechanized. With a mechanized pipette, for example, a certain quantity from the sample is taken for the analysis and transferred to another vessel. A certain quantity of reagent is added from a supply vessel, the mixture is heated to a fixed temperature for a defined period of time for the reaction to take place, and after cooling, a sample is siphoned off, measured, and evaluated in the manner described above. This apparatus operates with substance quantities of a few milliliters and uses reaction vessels of glass, which are cleaned and reused after the reaction has taken place. Piston pumps with valves are used as proportioning pumps for the reagents, and siphon the reagent from supply bottles.

For a mechanization of the manual technique, it is also known to insert sample vessels in so-called identification units, wherein the samples are identified by reading devices, possibly taking them from the units to several treatment zones and treating them by different methods. The matching of the mechanically read sample identification with the analysis results, which are available after the delay required for the analysis, makes it necessary in the known systems to store the sample marking. In addition, the analysis results must be stored until the analysis which takes the longest is completed. Only then, on the basis of the initially established identical order of the samples in the individual analysis zones, can the measured values be matched with the sample.

SUMMARY OF THE INVENTION

The invention relates to an apparatus for performing chemical analyses, in particular in the field of clinical chemistry, with the use of vessels which are moved intermittently one after the other in a transport arrangement.

The problem underlying the invention is to provide an arrangement in which different analyses can be automatically carried out. Sample vessels can be arranged in any desired sequence, and fully automatic treatment of the sample takes place in so-called treatment zones. Furthermore, there can be a multiplication of the arrangement without requiring in principle, differently constructed components.

This problem is solved by the invention, wherein at least two intermittently working transport systems are provided, in which vessels are successively transported and/or analysis samples are subjected to a treatment; at least one transport arrangement having a step length differing from the other, or others.

In particular, the invention provides a first transport system containing the analysis samples in a vessel for supplying a receiving or dispensing station, and a second transport system (hereinafter also called treatment zone) for supplying a portion of the sample in another vessel to stations for analytical treatment. The first transport system works in small steps and the second transport system works in larger steps. There is illustrated a rational design of the apparatus whereby advantageous spatial dimensions are achieved. When the first transport system works with a step length corresponding to the vessel division in a transport chain, a large number of vessels can be accommodated within a small space; on the other hand, the actual treatment zone advantageously has a step length which is determined as a function of a standard distance between various devices which are arranged in the treatment zone.

An object of the invention is to provide a combination of different transport systems for vessels wherein at least one transport system zone starts from a receiving or dispensing station. At the receiving or dispensing station, a portion of the sample is transferred from the first transport system into a new vessel in the second transport system, where the steps are much larger.

According to another object of the invention, there is provided a transport system which functions simultaneously as a feed and discharge system for an additional transport system.

In accordance with the last-mentioned object, there is included an additional branch in the transport path for a vessel, and conduction in and out of another transport system takes place preferably at the same location, the movement phases of the two transport systems being displaced in time in relation to each other. The length of the treatment zone results from the spatial extent of the treatment stations, and from the number of stations.

The time requirement for the various analysis processes differs primarily due to the fact that the chemical reactions which must take place require differing amounts of time. The invention therefore provides that reactions whose time requirement is much longer than the plurality of the following operations: "receiving the sample, adding reagent, centrifuging, mixing, and measuring," are carried out in storage areas coupled to the treatment zone.

Another object of the invention is to provide at a treatment zone, a storage device for the storing of vessels, advantageously arranged as an additional transport system, into and from which vessels from the treatment zone are transferred for the duration of a certain number of steps of the treatment zone, after which they are reintroduced into the treatment zone.

Another object of the invention is to provide a third transport system, forming a storage which is advantageously driven with small steps, and in the simplest case may consist of a circular plate carrying a plurality of mounts for vessels on the circumference.

In one embodiment of the invention, the feed or first transport system has several treatment zones parallel with one another and that at the treatment zones different numbers of treatment devices are provided. In this way, a branching is provided at the receiving or dispensing station, and it becomes possible to treat portions of the same sample differently. Parallel treatment zones have, in a particularly advantageous form of the invention, a different length from the input station, or respectively from the receiving or dispensing station to an evaluating or measuring station; the difference in length or in the number of steps being compensated if the step length in the treatment zones is the same, by a storage device. At the evaluating or measuring station, the sample portions prepared for measuring, which are taken from the same sample at the input, are available for testing in a measuring instrument either simultaneously or sequentially.

In a particularly advantageous embodiment of the invention, there is provided a common measuring instrument for several parallel treatment zones. The sample portions taken from the same sample at the entrance are tested in sequence, one immediately following the other. The evaluation can thereby be greatly facilitated, in particular by successively recording in table form, the test results on different portions of a sample.

Since photometric measuring and the subsequent evaluation of the results are very fast, and since the measuring apparatus constitutes a major portion of the total cost, it is another object of the invention to use only one photometer for the measuring and evaluation of the measurement of several analyses.

An essential characteristic of the invention resides in that the time difference between the dispensing of the sample at the dispensing station and the testing of the treated sample in the photometer is exactly fixed at a central control by the cadence time and the number of cadences for an analysis.

For the construction of an embodiment of the invention with a measuring instrument, it is advantageous to provide that in a central control equipment, the cadence time of the different treatment zones is displaced by the measuring time in the photometer. For example, there may be provided as the length of stay of the transport systems, the measuring time at the photometer multiplied by the number of treatment zones. In the photometer, the described multiple utilization requires a change of cuvettes when the measured value of the next treatment zone is available.

For mechanical evaluation, it is essential that the identification of the sample be given in recording the test results. The point of departure must be that the sample vessels introduced in the first transport system have a marking. In a particularly advantageous form of construction, the invention provides for the connection of a number of links corresponding to the number of cadences of the treatment or analysis in the first transport system or feed system between a reading station and the receiving or dispensing station, at which sample portions are transferred into treatment zones. In this way, the marking of the sample is available synchronously with the measured value for the sample. Thus, one saves storage of the marking and facilitates the matching of the sample identification with the measured value on a mechanized arrangement.

Advantageously, each treatment zone consists of an endless chain with holding devices for the sample vessels and has a dispenser for the timed feeding of a sample vessel before the receiving or dispensing station and an ejector in the direction of movement behind the measuring instrument.

In the path of the treatment zone or zones, means for the sealing, heating, cooling, and shaking or centrifuging the vessels are provided. The means for these processes become operative partly in the treatment zone and partly after a vessel is taken from the treatment zone, for example, in a further transport system which is designed in the manner of a storage unit. The actual number of steps of a vessel from the receiving or dispensing station to the measuring station is increased by detour into the treatment devices for heating, cooling, or centrifuging.

The objects and features of the present invention will be more fully understood and appreciated from the following description which is made with reference to the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic plan view of an embodiment of the invention with a feed arrangement and a treatment zone;

FIG. 2 is a side view of the embodiment shown in FIG. 1;

FIG. 3 is a diagrammatic illustration of an embodiment of the invention with several treatment zones;

FIG. 4 is a partial side view of a conveyor of a treatment zone;

FIG. 5 is a partial top view of the conveyor of a treatment zone illustrating an ejector arrangement for the vessels;

FIG. 6 is a view shown partly in section of a control arrangement for transferring a quantity of reagent from the feed transport system to the treatment zone;

FIG. 7 is a side view of FIG. 6, seen from the right;

FIG. 8 is a bottom view of FIG. 6 with some parts omitted.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 and 2 show a first transport or feed system 1 and the so-called treatment zone 2. Further, there is shown in these figures the evaluating or measuring station 3 at which a photometer is located. The feed system 1 includes a feed table 4 with a platform on which is arranged a chain type series of sample vessels 6, 7. This series of vessels forms a feed chain 89. Advantageously, there is chosen a construction which can be lengthened as desired, and wherein conventional or a special form of links having a joint are provided. On the feed table 4, the transport system comprises, for example, a transport wheel 8, and a channel 9 whose width corresponds to that of the chain or of the sample vessels. The transport wheel 8 is positioned so that an arm protrudes into the channel 9 and engages between two vessels or into an opening in the chain. With each 90° rotational step of the wheel 8, the chain is moved on by one sample. With each step, a vessel is moved into a certain position 10, in which a quantity of reagent is received. This position is defined.

A reading station 56 is also arranged on the feed table 4. Between the reading station and the dispensing station at position 10, a positive guide 57 for the feed chain 89 is provided. The guide path is of such length that the number of links between the vessel at position 10 and the reading station 56 corresponds to the number of work cycles or cadences of the following treatment or analysis zone 2. Functional connections in a central control device 40 and the reading station 56, in combination with a computer 38 and printer 39, insure that the marking on the vessel in the reading station 56 is subsequently fed into the printer when the measured results of the sample from this vessel are being recorded.

In a typical arrangement, the treatment zone 2 or respectively, the feed system 1, has correlated therewith a sample or reagent proportioning unit 11 with a controlled pump. The pump siphons a defined sample quantity of, for example, 20 microliters into a receiving vessel such as the hose 12. The specific design of unit 11 need not be described in detail. As illustrated in FIG. 2, the hose 12 terminates in a holder 13, which is fastened on a pivot arm 14. The latter is arranged on a column 15 in a special unit 16, which functions as the receiving or dispensing station, and is provided in connection with the treatment zone 2 and with the feed system 1. The receiving or dispensing station receives sample portions from the vessels on the feed table 4, and at this location the treatment zone 2 takes up sample portions. At the receiving or dispensing station 16, there is up and down movement of the holder 13, as well as a pivotal movement, as illustrated by the arrow 17 for transporting the holder to a point 18 over the treatment zone. The specific design for the control will be described with reference to FIGS. 6, 7 and 8. Let it be remarked here only that the mouthpiece of hose 12, which extends downwardly from the holder 13, is first immersed into sample vessels at position 10 on the feed table 4, after which a certain sample quantity is siphoned and this sample quantity is transferred into a vessel at location 18 of the treatment zone 2, where the proportioning unit 11 transfers the sample quantity into another vessel. The proportioning unit 11 forces first the sample and then an adjustable quantity of reagent, for example, 200 microliters, into the vessel present at location 18 and thus rinses all traces of sample out of the transfer hose 12.

The treatment zone 2 has a conveyor 19, designed for example as a chain, which is formed at least at points 20, 21, 22...for the pickup of vessels. The vessels are supplied from a dispenser 23. The apparatus may be designed so that the conveyor 19 has mounts for vessels at points 20, 21, 22 spaced from each other, or a chain may be used which has pickup elements for vessels immediately following each other. The dispenser **23** operates so that vessels are supplied to conveyor **19** with a spacing corresponding to the interval between vessels or one-step length of the conveyor **19**. It can be seen that this distance is greater than the distance between two vessels **6, 7** in the transport system on the feed table **4**.

In the illustrative embodiment of FIGS. **1** and **2**, there are also provided in the treatment zone **2**: a device **24** for sealing the vessels; a device **25** for the mixing of vessel's contents, for example, by mechanical vibration; a device **26** for heating the contents of vessels; storage unit **27**; a device **28** designed as mixer; and a station **29** at which the portion of the sample which has been prepared for the measurement, is extracted. It can be seen that there is a length of one step between the action of the devices **24, 25**, while between the action of the devices **26, 27**, and **28** there is a length of two steps. This is accomplished by the mechanical construction of the individual devices or by the necessary lengths of stay between successive actions.

At position **18**, a vessel is filled with a sample portion. Thereafter, with each step of the conveyor **19**, a new vessel is brought to position **18**.

When a vessel enters heating station **30**, the vessel is taken off the conveyor **19**; for example, it may fall into the unit **26**. The extraction of the vessel may be effected with a device of the type shown in FIGS. **6** to **8**, or the mounts of the conveyor may be of an expandable type which permit removal of the vessels. In principle, mounts for vessels on the conveyor belt are included, which permit vessels to be admitted and removed from above or upward, downward, or sideways, selectively.

In the example, the heating unit **26** is designed as a rotational body of metal which has on a circular circumference a series of bores **31, 32** which can be heated to a predetermined temperature which is transmitted to the liquid in the vessel. As illustrated, the heating unit **26** has 24 bores. If the length of stay of individual vessels equals two work steps of the conveyor **19**, the rotational body of apparatus **26** would rotate by substantially 180° with every work step of the conveyor **19**. Since the conveyor **19** has certain lengths of stay in the treatment zone **2**, the assumed rotation of 180° is reduced by the interval between bores on the rotational body in order to pick up a vessel from a mount in the treatment zone, whereupon the unit is moved on by one interval to transfer the vessel presently in the unit during the length of stay of the conveyor. Thus, the insertion into and extraction out of the additional conveyor, here formed by the heating unit **26**, takes place at the same location. Obviously, the length of stay can easily be adjusted differently by selecting a different rate of rotation. The movement of individual vessels within the unit is determined by the desired number of work steps.

In like manner, the storage device **27** is designed with a rotational body **33**, which is rotated intermittently and delays the passage of the vessels to the following mixing device **28** by any desired number of steps. The purpose of this is to control the arrival of the vessels at station **29** to afford a perfectly uniform movement of the conveyor **19**; this is essential particularly for the intended combined operation with the reading station **56**. The storage device **27** may also have a chain in the manner of the conveyor **19**, thereby permitting greater freedom with respect to the selection of the length of stay.

The mixing device **28** may be designed, for example, to detach a condensate which forms at the cover of the vessels during temperature control. The required mixing operation may be carried out advantageously by turning each vessel 180° on a relatively large semicircle whose radius is determined by the length of an arm **34**, so that the cover of the vessel is at the bottom for a short time.

At extraction station **29**, a quantity of sample required for photometric measurement is extracted by means of a vertically movable cannula which is arranged on a supporting arm **35**. The cover of the vessel is pierced by this cannula and a hose pump **36** siphons the test substance into a flow cell or cuvette **37**. The cuvette is in the light path of the photometer **3** during the measuring process. The measured degree of transmission of the sampled substance is fed into a computer **38** and evaluated. This value resulting from the computer operation is fed to a printer **39** and printed out.

FIG. **1** also shows a central control unit **40**, which is functionally connected with the other parts of the apparatus and synchronizes the individual movements, i.e., the movements for execution of the required lifting and forward movements, in the correct sequence and in the proper cadence.

FIG. **3** shows an embodiment of the invention having a feed arrangement **1** with a feed table **4**, and four treatment zones **41, 42, 43, 44**, all having different lengths. A common measuring station **45** with a photometer **3** and connected devices **38, 39**, is associated with this arrangement. In this embodiment, sample portions are successively transferred from a vessel at **10** into the various treatment zones **41–44** at a receiving and dispensing station **46**. This can be effected with a unit of the type shown in FIGS. **6–8**. It is pointed out that here, too, the feed table is constructed with a reading station **56**. A central control equipment **47**, comparable to the central control equipment **40** discussed in connection with FIG. **1**, operates all treatment zones **41–44** and the respective devices in equal work steps, but with the phase displacement set forth in the introduction. The central control device **47** preferably has for each analysis system a control cylinder which is driven with a synchronous motor.

The receiving or dispensing station **46**, which is arranged between the feed arrangement **1** and the treatment zones, is so designed that it successively extracts from a vessel at position **10** on the feed table **4**, four quantities of reagent and transfers them into vessels in the various treatment zones.

The treatment zones **41–44**, which may be designed for different tests, may include conveyors operating in different numbers of steps, as indicated by the different lengths, to the evaluating or measuring station **45**. For example, there may be provided a treatment zone for blood sugar tests, a treatment zone for bilirubin analysis, a treatment zone for urinalysis, and a treatment zone for phosphatase analysis.

Assuming that for the photometric measuring system at **3** with the connected printer **38, 39**, a work cadence of 5 seconds is required, it follows that for the successive evaluation of four samples, 20 sec. are needed. In this example, therefore, unless other conditions are required on the basis of treatment devices, the length of stay between two work steps in the treatment zones is 20 sec. The different portions of a sample are successively extracted by adjusting pivot arm **90** to different angular positions. It is clear that for this type of operation, different cuvettes are used to present each sample portion for evaluation by the photometer **3**. Advantageously, however, a phase displacement of 5 seconds is provided between individual work steps of the treatment zones **41–44**. Thus, the length of stay in the individual treatment zones need be only 5 seconds, because the vessels of the treatment zones **41** to **44** enter the evaluating or measuring station **45** successively in the order in which the sample portions are dispensed.

FIG. **3** also illustrates that individual treatment zones can be held completely in readiness for different tests and also can be arranged, as needed, individually or in combinations between a feed system **1** and an evaluating or measuring station **45**. Optimum utilization is made possible by the work cadence control provided by control device **47**.

A special feature of the invention resides in the arrangement of the storage unit **27** shown in FIG. **1**. The storage drive of this unit is adjusted so that the individual samples are fed to the evaluating or measuring station **45** in the same order, and for example, with a phase displacement of 5 seconds, so that the recording in the printer **39** can be effected line by line. In other words, various results from tests on a vessel on the feed table can be reproduced in the evaluation report in lines one after the other.

It can be seen that when the treatment zone 44 is the longest, a storage 50 is provided in the treatment zone 41, a storage 48 is provided in the treatment zone 42, and a storage 49 is provided in the treatment zone 43. In other instances, a treatment device such as the unit 26 in FIG. 1 may be operating with a corresponding delay. Moreover, for the sake of completeness, there may be provided treatment devices 51–55 for the execution of treatments outside or alongside the individual treatment zones.

With the essential principle of the invention having been described, reference will now be made to the remaining figures, in order to explain the details.

The dispenser 23 in FIG. 1, consists, for example, of a column with stacks of vessels arranged on the circumference. Such columns are known. The column rotates over a conveyor 19 and, by means of known control equipments, discharges a vessel, at a point provided for that purpose, into a holding means on the conveyor 19, or respectively into a treatment zone. With reference to FIGS. 4 and 5, for example, a vessel falls between two holding arms 58 of a transport chain which is driven intermittently. These holding arms, and others such as 60 and 61, are fastened to a belt 62, which is guided according to the progress of the conveyor 19, i.e., of a treatment zone. In regions where the vessel remains in the conveyor, a web 63 lies in front of the free ends of the holding arms 56–61. At a station such as 64 in FIG. 1, a scraper 65 is provided above and below belt 62, and the web 63 is open, as shown at 66. At this point vessels are ejected. Belt 62 can be driven in the required number of steps by conventional transport means, such as rolls, or sprocket wheels. It is also possible to secure a mount with holding arms 58, 59 by means of a plate mounted rotatable on belt 62. In this way, the vessel can be rotated in the plane of its axis by special abutments or rotational means in the region of the transport chains.

As previously noted, the vessels can be sealed. The closing can be effected for example by the device 24 in FIG. 1. After treatment, the cover can be pierced, for example in the region of station 59, by moving a cannula back and forth in a vertical direction. FIGS. 6, 7 and 8 show a special form of construction of the receiving or dispensing station 16, 46. Although the controls are shown adjacent to this station, let it be pointed out that corresponding controls may be provided elsewhere, for example in the region of the evaluating or measuring station 29, 45, in which case only the connected fittings are different. An armature 67 for receiving the end of the hose 12 is provided on holder 13. As noted when discussing FIG. 1, the holder 13 must be raised and lowered in order to guide the hose end into a vessel and to lift it out of the vessel. After these operations, a pivotal movement about the column is necessary to transfer the liquid to the treatment zone.

FIGS. 6 to 8 show a construction for transferring the liquid to only one treatment zone. Column 15 is mounted rotatably in a holder 68. The column consists of several elements telescoping one into the other. An outer tube 69, on which is arranged the fastening device 70 for the pivot arm 14, carries a takeup 71 for a crankpin 72, whose crank 73 is rotatable with a shaft 74 that is rotatably mounted in the holder 68. On shaft 74 a nonrotational cam wheel 75 is secured along with a cogwheel 76, which is driven through a pinion 77 by an electric gear motor 78. The latter is under the control of two switches 79, 80, which are mounted on the holder 68. The actuating arms of switches 79, 80 cooperate with a cam notch 81 on the cam wheel 75. In this embodiment, switch 79 is open and switch 80 closed. The dimensions are selected so that cam disk 75 rotates by 180° when the crank 73 is moved by 180°. Thus, a switch always turns off the drive by the electric gear motor 78 when the holder 13 is in its top or bottom position.

A guide tube 82 is mounted in tube 69 and has a nonrotationally mounted tongue 83 projecting downward and engaging with a cam disk 84. This engagement remains intact when the column 15 is lifted, because the tongue 83 is adapted to be moved downwardly out of the column. The cam disk 84 is driven by an electric gear motor 85 and has a cam notch 81. The disk 84 also has associated therewith two switches 87, 88, which are in the circuit of the electric gear motor 85. The switches are opened when their actuating arms are adjacent to the cam notch. These switches stop the rotational drive for the column 15 after a rotation of 180°. After stopping, the drive of the electric gear motor 78 becomes operative for the lifting and lowering in the region of the standstill. The mutual locking arrangements are not illustrated in detail but are visibly evident to the specialist. If the construction is such that the pivot arm 14 is pivoted by an angle other than 180°, it suffices to displace the two switches 87, 88 by a corresponding angle in relation to each other; but then the drive of the electric gear motor 85 must be reversed each time.

When several treatment zones 41–44 are to be charged successively with such an arrangement, there result different pivot angles one after the other. This can be achieved by distributing several switches at corresponding angles about the circumference of the cam disk 84, with measures being taken whereby individual switches are rendered inoperative alternately in succession. The apparatus shown in FIGS. 6 to 8 can also be used to lift or transfer vessels. To transfer vessels to the heating unit 26, or to the storage unit and back, a fitting for gripping the vessel would be mounted on the holder 13.

Several embodiments of the invention have been shown and described in detail. It will be appreciated that these embodiments are illustrative only, and numerous modifications will be immediately apparent to those skilled in the art. All modifications which come within the spirit and teachings of this invention are intended to be embraced within the scope of the following claims:

What is claimed is:

1. Apparatus for carrying out chemical analyses of material wherein units of the material are moved intermittently, comprising first conveyor means driven in steps and moving a plurality of material units in a row; second conveyor means arranged as an endless chain conveyor driven in steps and having spaced holding elements for vessels; first transfer means for transferring a sample from a material unit on said first conveyor means into a vessel on the second conveyor means; a dispenser disposed upstream of said transfer means and being adapted to feed vessels to the second conveyor means; an ejector disposed upstream of said dispenser which removes the vessels from said second conveyor means, treatment devices cooperating with the second conveyor means between said transfer means and said ejector; and a measuring device for the samples on said second conveyor means disposed at a position between said treatment devices and said ejector.

2. Apparatus as defined in claim 1, wherein the material units on said first conveyor means are arranged with a first interval from each other, the vessels and vessel holders respectively on the second conveyor means being arranged with a second interval from each other, the first and second conveyor means being moved in the same cycle with different velocities such that one material unit of the first conveyor mans and one vessel of the second conveyor means arrive simultaneously at said first transfer means.

3. Apparatus as defined in claim 1, wherein said treatment devices are designed as third conveyor means which form a closed path for vessels, comprising means for transferring vessels from said second conveyor means into said third conveyor means and retransferring said vessels into said second conveyor means, the vessels being held in said third conveyor means for the duration of a certain number of steps of said second conveyor means.

4. Apparatus as defined in claim 3, wherein said third conveyor means are driven with a working stroke staggered in time relative to the working stroke of said second conveyor means, the transfer and retransfer of vessels from and into said second conveyor means taking place at the same point of these conveyor means.

5. Apparatus as defined in claim 1, wherein a central control device, a reading station associated with said first conveyor means, a computer, and a printer, are arranged and in-

terconnected with said measuring device and said conveyor means, the identification of said vessels being fed from the the reading station via the computer into the printer at a time when the measuring results from the measuring device are fed into the printer.

6. Apparatus for carrying out chemical analyses of material where units of the material are moved intermittently, comprising first conveyor means driven in steps and moving a plurality of material units in a row; first transfer means which cooperate with the material units of said first conveyor means; a measuring device for checking treated amounts of samples; second transfer means which cooperate with the measuring device; a plurality of treatment zones between said first and second transfer means each having a second conveyor means designed as an endless chain conveyor driven in steps and having spaced holding elements for vessels, a dispenser adapted to transfer vessels into said holding elements and an ejector disposed downstream of said second transfer means; said first transfer means being arranged at one end of the treatment zones for transferring samples from a material unit in said first conveyor means successively into each of said treatment zones; different treatment devices being arranged in individual treatment zones; and said second transfer means being arranged at the other end of the treatment zones for transferring the sample parts from the treatment zones into said measuring device.

7. Apparatus as defined in claim **6** wherein the treatment zones have different lengths and the respective associated treatment devices are provided for different analyses, treatment devices being provided in at least some treatment zones which are designed as third conveyor means and which form a closed circle for vessels, a transfer of vessels taking place from the second conveyor means into the third conveyor means and a retransfer of the vessels into the second conveyor means, the vessels being held in the third conveyor means for the duration of a certain number of steps of the second conveyor means.

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