United States Patent

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[54] **APPARATUS FOR DISPENSING LIQUID SAMPLE**
20 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **141/130,** 23/253, 23/259
[51] **Int. Cl.** **B65b 43/50,** B67c 3/00
[50] **Field of Search** .... 141/130; 23/253, 259, (Inquired); 73/(Inquired)

[56] **References Cited**
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3,081,158 3/1963 Winter 141/130X

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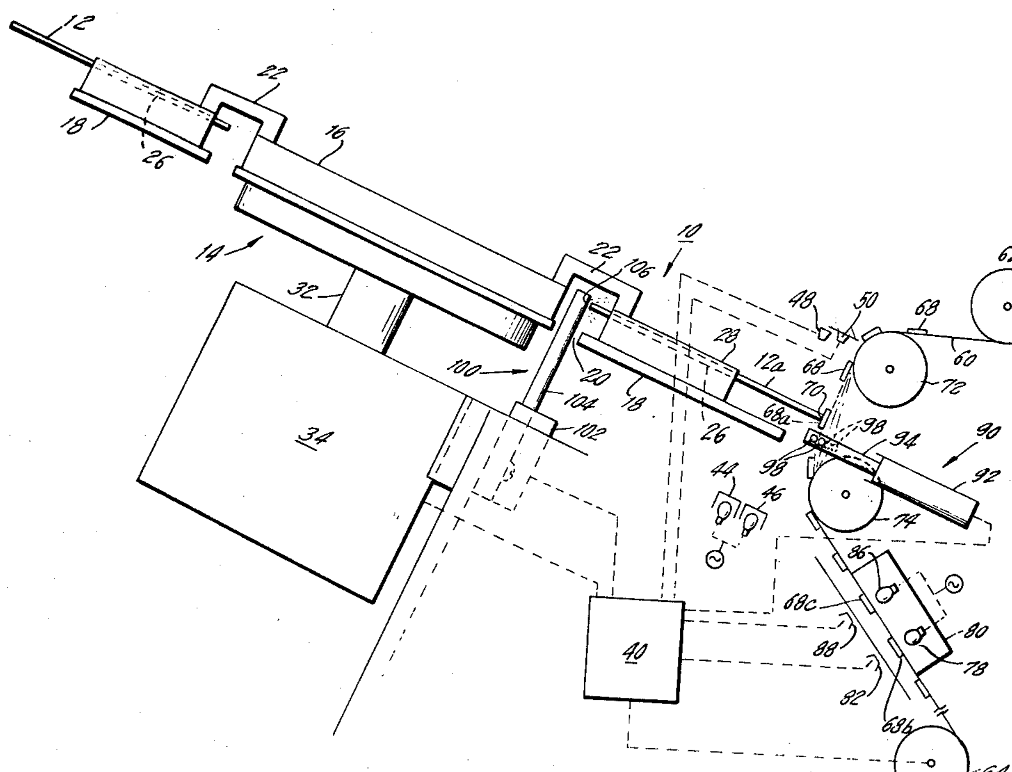
ABSTRACT: A concentrically rotatable circular disc having a plurality of spaced radially outwardly facing capillaries disposed on it; a receiving means, e.g., an elongated tape, to receive the contents of each of the capillaries in turn; each capillary being shifted, in turn, to a dispensing position where its contents may be blown out of the capillary onto the receiving means; and shifting means for shifting the receiving means toward and away from each capillary after the capillary has moved to its dispensing position, so that the contents of the capillary may be transferred to the receiving means; and timing and coordinating means for coordinating the movement of the receiving means with the movement of the disc supporting the capillaries and with the blower for emptying the capillaries.



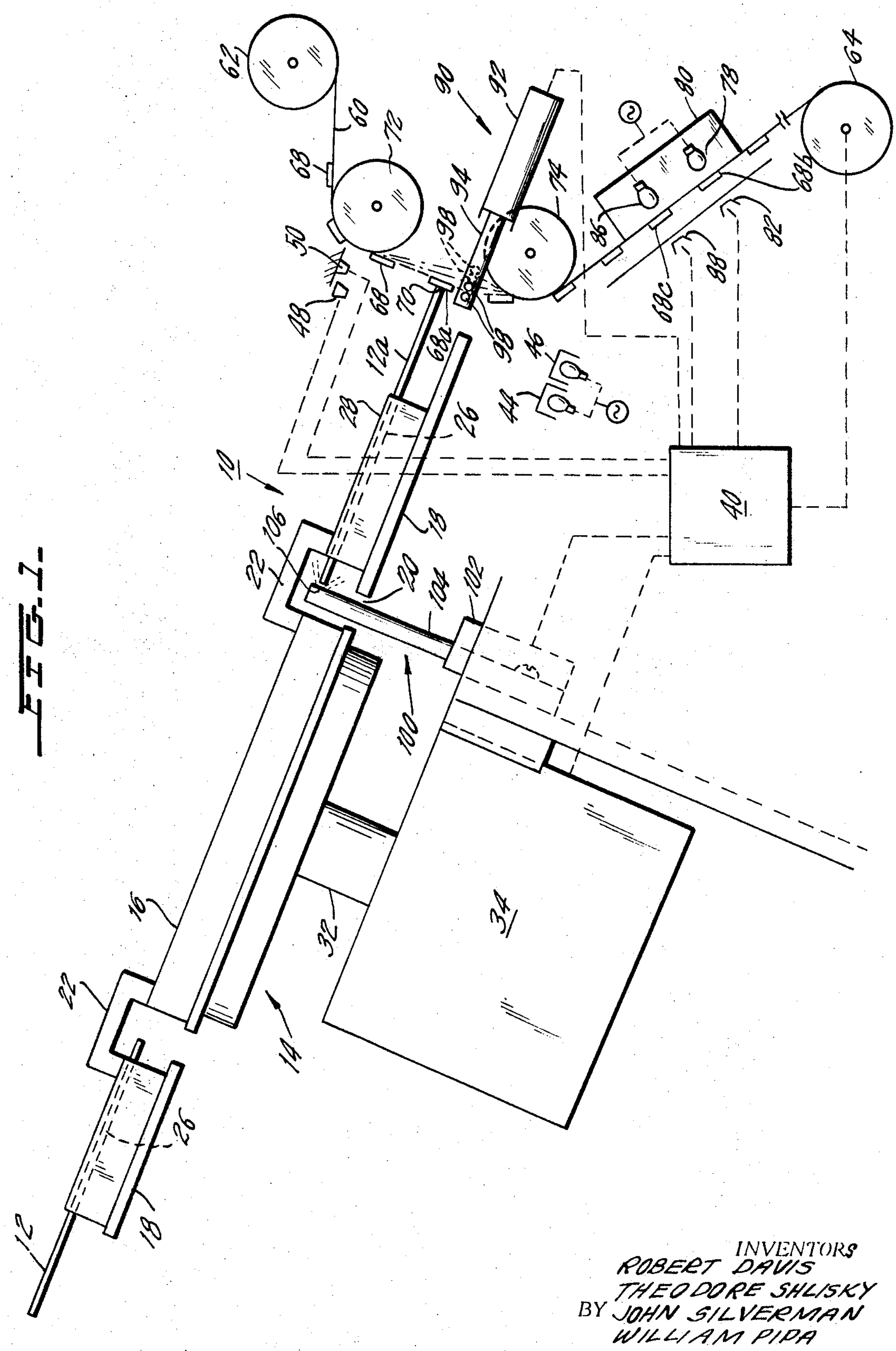


FIG. 1.

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FIG. 2.

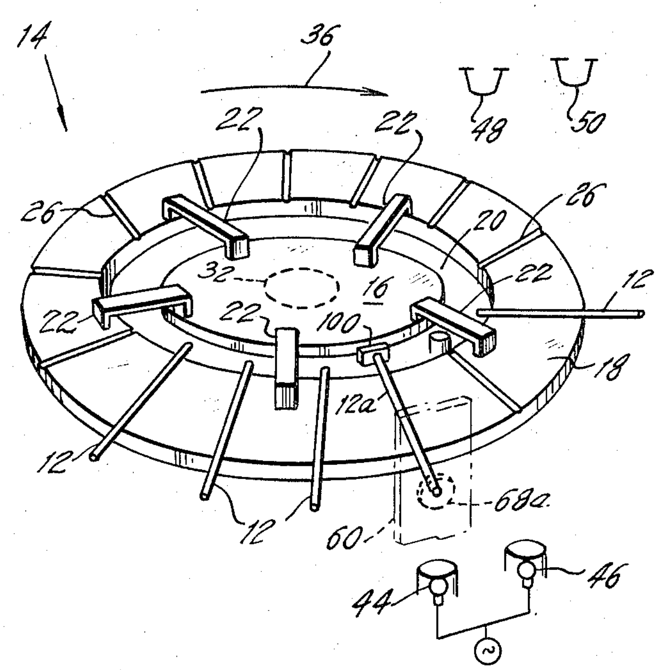

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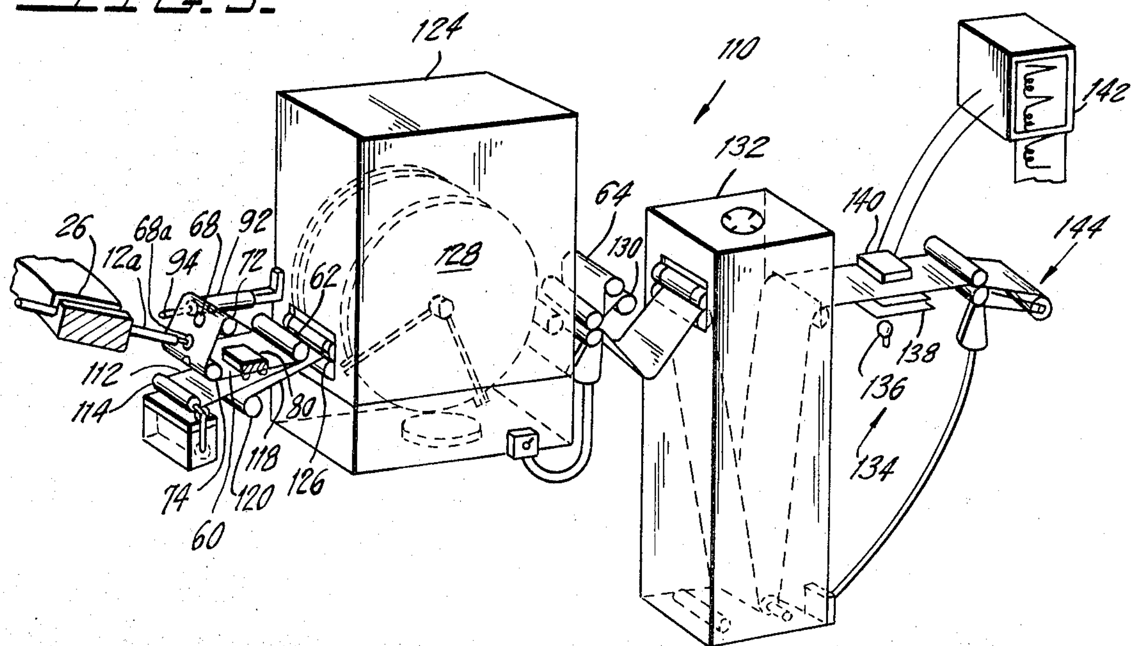
FIG. 3.



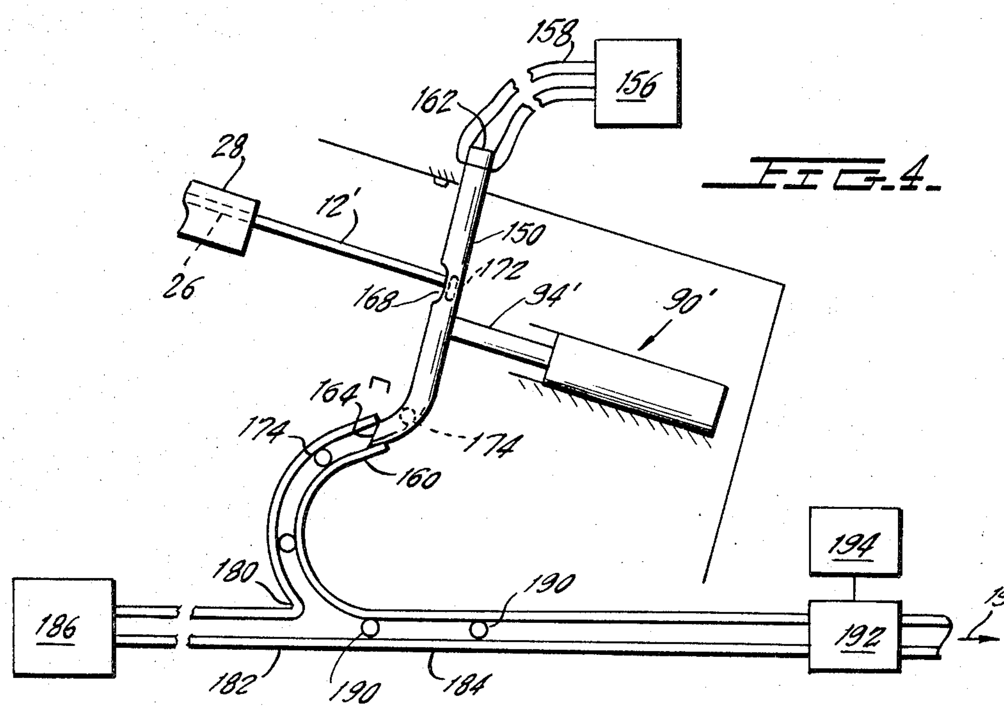


FIG. 4.

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APPARATUS FOR DISPENSING LIQUID SAMPLE

This invention relates to a dispensing means for dispensing liquid sample to a receiving means from a plurality of sample receptacles, and more particularly to such a dispensing means where each receptacle comprises a capillary tube which is holding liquid sample.

To efficiently and economically analyze each of a plurality of liquid samples, e.g., samples of a body fluid from a plurality of individuals, the samples to be analyzed are positioned on a single apparatus which rapidly analyzes each of them, in turn, without a human operator having to intervene before each analysis. Accordingly, analysis apparatus have been designed which hold a plurality of liquid samples, each in its own receptacle, and which rapidly dispense the sample from each of the receptacles, in turn, to an analyzer. Such an apparatus is shown in U.S. Pat. No. 3,036,893, issued to Samuel Natelson on May 29, 1962, entitled "Automatic Chemical Analyzer," and assigned to the assignee hereof.

Various dispensing devices are presently used for transferring liquid samples from receptacles to receiving means which move the samples into the analyzer. In one type of prior art dispensing device, (U.S. Pat. No. 3,134,263) a sample transfer device is moved or dipped into each receptacle of liquid sample. Liquid sample is drawn out of the receptacle through the transfer device and passes to a receiving means. Since the same transfer device must dip into each receptacle, here is a danger that each successive liquid sample will become contaminated by the coating on the transfer device of sample from the previous receptacle. In addition, providing a separate transfer device complicates the structure of the dispensing apparatus.

In some cases, the volume of liquid sample available for dispensing is small, e.g. a blood sample taken from a young child or a geriatric patient, neither of whom can afford to sacrifice much blood. A receptacle for holding the liquid sample would also have to be small in volume in order that the sample therein might be operated upon. A capillary tube, comprising an elongated glass tube with a narrow elongated opening passing through it, provides an ideal receptacle for a very small volume sample.

Where the sample volume and the receptacle volume are small, a transfer device which can be moved or dipped into the sample receptacle cannot be used. Accordingly, as illustrated in the aforementioned U.S. Pat. No. 3,036,893, a means has been devised in the prior art to tip or tilt or otherwise move the receptacle, e.g. a capillary tube, to a location where the contents of the receptacle can be forced out of the receptacle by any means, e.g. a puff of air or gravity, to drip on or be dispensed to the sample receiving means.

Other means have been devised which operate directly on the sample receptacle and move same to the receiving means. See, e.g. U.S. application Ser. No. 726,652, filed May 6, 1968, by Theodore Maxon, entitled "Method for Obtaining a Known Volume of Liquid and Absorption Apparatus Therefor," and assigned to the assignee hereof.

In none of the prior art apparatus is there a means which shifts the position of the receiving means, relative to each sample receptacle, to enable it to receive the contents of the receptacle. More particularly, and specifically where the receptacle is very small, e.g., a capillary tube, no means has been suggested for moving the receiving means into direct contact with or into the immediate vicinity of the sample receptacle.

There are benefits in shifting the sample receiving means with respect to the receptacles. Prior art units have held the receptacles, e.g. capillaries, in one orientation, e.g. tilt position, when no sample was being dispensed, and have moved each of the receptacles to a different orientation when samples were being dispensed. This has required adjustable mountings for each of the receptacles. If a support for liquid sample receptacles holds a large number of receptacles, it must also be provided with a large number of independently adjustable receptacle mountings, which will increase the cost of manufacturing a dispensing means and will increase the number of movable components which can wear out or malfunction.

With the present invention, the liquid sample containing receptacles may be held at an orientation which best prevents undesired premature leakage or loss of liquid sample from the receptacle, yet ensures optimum transfer of liquid sample from the receptacles to the sample receiving means.

Once the proper tilt or orientation of a receptacle, e.g. a capillary, is determined, the tilt or orientation of the receiving means can easily be varied. This provides an optimum angle of contact between the receptacle and the receiving means, e.g. a location on a strip of material or on an elongated tape or an inlet into a conduit, so that the orientation of the receiving means cooperates to permit the maximum or optimum outflow of liquid sample from each receptacle in a minimum time.

Because the orientation and tilt of each receptacle and of the receiving means for the liquid sample can be arranged to maximize the sample transfer in a minimum time and because no time need be spent in tilting and reorienting receptacles, less time will be required both between dispensing operations on successive capillaries and for each dispensing operation itself. The speed of operation of an apparatus designed in accordance with the invention is greater than that of an apparatus otherwise designed.

The present invention uses a shifting means which operates on the receiving means to shift it into a sample transfer position which is where the receiving means is in contact with or in the immediate vicinity of each receptacle, in turn, whereby the contents of each receptacle may be dispensed to the receiving means, and which then shifts the receiving means away from the sample transfer position.

In accordance with one embodiment of the invention, the receptacles each comprise a capillary tube. The capillaries are held on a support means, which may comprise a disc or an endless loop belt, for example. The support means may be movable, so as to move each capillary, in turn, to a dispensing position at which the receiving means can be moved toward each capillary to permit dispensing of the contents of the capillary.

As was noted above, the receptacle support has the receptacles thereon spaced apart from one another. For each receptacle to be in the dispensing position, the receptacle support must move an appropriate distance. This may be accomplished in one of many ways. The support may be moved a predetermined distance to position a new receptacle and then be bolted. Any conventional moving means for the support may be used for moving it the required distance.

Alternatively, the receptacle support may be provided with index marks and move each time to the next index mark, thereby properly positioning each of the capillaries in turn.

Both of the above-described receptacle positioning means, and any other such means which shifts the positions of the receptacle a distance determined by sensing the presence of a structure other than the receptacles themselves, causes error and waste in the event that a receptacle is missing from a location provided therefor. This might occur if an operator, in his haste, skipped one receptacle mounting location or did not have a sufficient number of sample filled receptacles to place at every location provided therefor. The receptacle support will stop at an empty location and there will be no transfer of liquid sample to the receiving means at this location.

In order that the receptacle support cease moving only when there is a receptacle in position to dispense its contents to the receiving means, the means for halting the movement of the receptacle support should be coupled with a means that senses the presence of a receptacle at the dispensing position. If there is a missing receptacle, the receptacle support should not halt at that location, but should continue moving. One means for sensing the presence of a receptacle is an abutment, to be struck by each receptacle as it moves into the dispensing position. The abutment is connected with a limit switch that shuts off movement of the support.

All of the sensing means which rely on mechanical indexing or mechanical contact with the receptacle support means or mechanical contact with the receptacles themselves are prone to suffer wear and to become misaligned due to the continuous movement of the apparatus.

Accordingly, a preferred form of receptacle presence sensing means would not require physical contact either with the receptacles or with the support therefor. Such a sensing means could be an optical device which "sees" a receptacle when it has arrived at the dispensing position and sends out a signal to halt the movement of the receptacle support at this time. If a receptacle is missing from one of the mounting locations therefor, no receptacle will be sensed there and the receptacle support will continue to move.

A conventional optical sensing device may be used. Such an optical device might include a light source and a photoelectric means which are both positioned so that when a receptacle is at the dispensing location, it interrupts the light beam, thereby causing the photocell to signal the capillary support to halt. A preferred optical sensing device will be considered below.

The capillary support does not immediately recommence operation after halting. Instead, there is a time delay built in which ensures that each capillary will remain stationary at the dispensing position until its contents have been dispensed. Any conventional restartable timer may be used. A preferred timer will be described below.

Two types of receiving means for receiving the liquid sample from each of the capillaries and for transferring it to an analyzing apparatus will be described. Others may thereafter be apparent to one skilled in the art.

The first and more preferred receiving means comprises a strip of material having a plurality of spaced-apart locations thereon, each for receiving liquid sample to be dispensed from one of the receptacles. The strip of material of which the receiving means is comprised is movable lengthwise in order that each sample receiving location thereon may be brought, in turn, into a receiving position where it can receive liquid sample from one of the receptacles.

A sensing means senses when the receiving means has moved so that the next sample receiving location thereon is in the receiving position and then halts the movement of the receiving means.

The sensing device may be one designed to permit a predetermined length of the strip of material to be moved. This length of material would correspond to the spacing between sample receiving locations. This imposes on the designer of the strip an onerous obligation to be sure that the locations all are accurately spaced a predetermined distance apart. Otherwise, a few slight spacing errors will add together so that the strip of material will not halt with one of the sample receiving locations in the receiving position. Alternatively, the strip itself might be notched or indexed and be permitted to move for the distance between two adjacent index marks. However, if a sample receiving location is not precisely positioned on the strip to correspond to its index mark, this location would not be in its sample receiving position when the strip of material halts.

It is simplest to use a sensing means which senses the actual presence of a sample receiving location in its receiving position. The locations would then not have to be spaced apart with great time-consuming precision. An optical sensing device is preferred and a particular embodiment of such device is described below.

The strip of material may comprise an elongated tape having as the sample receiving locations a plurality of liquid sample receiving pads positioned thereon, each of which pads is comprised of a material which holds liquid sample, as shown in aforementioned U.S. Pat. application, Ser. No. 726,652. The elongated pad supporting tape is moved lengthwise between two reels, which start and stop operating in response to a signal from the aforementioned sensing means. The means for moving the strip of material would also have a timer connected with it to restart the movement of the strip after it has halted for a predetermined period. A particular timer will be considered below.

The second type of sample receiving means is used in a dispensing apparatus employing a continuous stream of fluid transfer medium, into which stream slugs of liquid sample are inserted at desired intervals by means of the present invention. See U.S. Pat. No. 3,134,263, issued to Edward DeJong for an example of a system which can use the present invention. The transfer medium, with the spaced-apart slugs of liquid sample therein, travels into an analyzing apparatus, for example, so that each slug of liquid sample is analyzed by the apparatus. The receiving means for this embodiment comprises a short conduit in the flow path of fluid transmitting medium. The conduit has a separate inlet which receives liquid sample from each of a plurality of receptacles, in turn. The separate inlet may merely consist of an opening in the wall of the conduit, into which the outlet from a receptacle, e.g., the exit end of a capillary tube, may be inserted.

Any conventional shifting means may be used in conjunction with the present invention for shifting the receiving means toward and away from the receptacles to receive the discharge from a sample transfer position near each of the receptacles, in turn.

Where the receiving means is a strip of material or an elongated tape, the shifting means operates to move the strip or tape transversely to its normal direction of extension and to its normal direction of movement.

Where the receiving means includes a conduit in a flow path, the shifting means operates the conduit transversely to its normal direction of extension and to the direction of flow of transmitting medium to move the conduit inlet toward and away from each receptacle outlet, in turn. Either the conduit itself, or the portions of the transfer medium flow path which are connected to the inlet and outlet ends of the conduit, are made sufficiently flexible and are mounted so as to permit shifting movement of the aforementioned conduit toward and away from each capillary, in turn.

The shifting means might comprise an irregularly shaped rotating cam. When one portion of the cam engages the receiving means, the receiving means is shifted to a sample transfer position. This shifted position would usually be in the immediate vicinity of a sample receptacle. When another portion of the cam engages the receiving means, the receiving means is shifted away from the receptacle. A connecting or spring biasing means could be employed to hold the receiving means against the cam, thereby to aid the action above described. The speed of movement of the cam would determine the time interval between each movement of the receiving means toward the receptacles. Therefore, the rotating cam would also serve as a timing means for timing the shifting of the receiving means. It is apparent that the above-described shifting means may be used with either of the above-described receiving means.

A more preferred form of shifting means comprises a solenoid device, having a plunger which is in engagement with and which moves the receiving means as desired. When the solenoid device is energized, for example, its plunger shifts the receiving means away from the sample transfer position, and when the solenoid is deenergized, its plunger shifts the receiving means into the sample transfer position, which may be in the immediate vicinity of a receptacle. A particular form of solenoid device is described below.

In all forms of apparatus designed in accordance with the present invention, the shifting means must have its operation timed to be coordinated with the movement of the receptacles, so that the shifting means brings the receiving means to the sample transfer position only after the receptacle has moved into its dispensing position, and removes the receiving means from the sample transfer position after dispensing is completed and before the next receptacle is moved into the dispensing position. A conventional timer may be used which is connected to both the shifting means and to the receptacle moving means, and which will coordinate the operation of these two structures in the manner described just above.

Where the receiving means is in the form of a strip of material which is moved, the timer must also be connected with the means for moving the strip of material to coordinate the movement of the strip with the other functions so that the strip does not move while sample is being dispensed. One preferred type of timing device will be described below.

The tilt and orientation of the receptacles, especially where they are capillaries, aids in rapid dispensing. To cause the sample to be even more rapidly dispensed, a dispensing aid might be provided to operate on the contents of each receptacle. Where the receptacles are capillaries, for example, the dispensing aid might include an air blower which blows the contents of a capillary out its exit end. Other dispensing aids might be designed by one skilled in the art to aid in the rapid transfer of the contents of the receptacles to the receiving means.

A dispensing aid is especially useful where the receiving means comprises a conduit in a fluid transmitting medium flow path, because it is desirable to rapidly force the contents of each receptacle into the flowing stream of transmitting medium, so that the sample can break into the stream and form a single coherent slug of sample therein.

Where, however, it is desired to dispense only a predetermined volume of the sample in each receptacle, a dispensing aid may be less helpful, e.g. in the case of aforementioned U.S. application Ser. No. 726,652.

The operation of the dispensing aid must also be controlled by a timer so that it does not operate until after the shifting means has shifted the receiving means to the sample transfer position and so that it ceases operating before the shifting means shifts the receiving means away from this position. This timer would be coordinated with the other timers. A particular timer is described below.

It is a primary object of the present invention to provide an apparatus for dispensing liquid sample to a receiving means.

It is another object of the present invention to provide an apparatus for rapidly dispensing a plurality of liquid samples from their receptacles to a receiving means.

It is another object of the present invention to provide such a dispensing apparatus which is simpler in design and operation than those in the prior art.

It is a further object of the present invention to carry out the foregoing objects by shifting the liquid sample receiving means which receives the dispensed sample to a sample transfer position, which may be in the vicinity of the liquid sample containing receptacles.

It is another object of the present invention to provide such an apparatus which permits the sample holding receptacles to be positioned and held at an orientation which permits the most efficient dispensing of liquid sample from the receptacles.

It is another object of the present invention to provide such an apparatus which minimizes the necessary repositioning and shifting of the liquid sample holding receptacles during the dispensing operation.

It is another object of the present invention to eliminate the need for a separate transferring means for transferring sample from a receptacle to a receiving means therefor.

It is another object of the present invention to minimize the possibilities of contamination of a liquid sample during sample transfer between a receptacle holding the sample and a receiving means.

It is a further object of the present invention to coordinate the movements and operations of the various components of a sample dispensing apparatus.

It is another object of the present invention to provide a dispensing apparatus which may be used in conjunction with a chemical analyzer that analyzes a plurality of liquid samples.

These and other objects of the present invention will become apparent when the following description is read in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic vertical cross section of a preferred embodiment of dispensing apparatus designed in accordance with the present invention;

FIG. 2 is a perspective view of a plurality of sample holding capillaries and of a support therefor;

FIG. 3 shows one form of apparatus with which the dispensing apparatus of the present invention may be used; and

FIG. 4 is a fragmentary and partially schematic view of an alternate form of dispensing apparatus designed in accordance with the present invention.

The present invention is adaptable for dispensing liquid from one or more receptacles to a liquid sample receiving means. The invention will be described in conjunction with particular receptacles, receiving means, liquid samples and an analyzing apparatus for one of the components of the samples. It is to be understood that the present invention is not limited to use in conjunction with any of the particular elements described.

Turning to FIGS. 1 and 2, one embodiment of a liquid sample dispensing apparatus **10** is shown. A plurality of separate liquid samples are to be analyzed. Each of them is placed in one of a plurality of conventional capillary tubes **12** formed of glass and having a thin width opening extending completely through the capillary for holding the liquid sample.

Each of the capillaries **12** must be moved, in turn, into a dispensing position where its contents may be dispensed to the receiving means **60**. This is most readily accomplished when the capillary tubes are held on a support, like support plate **14**. Plate **14** is comprised of a central support disc **16** and an annular resilient ring **18**, formed of rubber, for example. Disc **16** and ring **18** are separated by annular gap **20** and are fixedly joined to each other by elevated arches **22**. Gap **20** is provided to permit the dispensing aid **100**, to be described further below, to reach to the radially inward end of each capillary **12**. As shown in FIG. 1, dispensing aid **100** extends toward the capillaries from the bottom of the capillary support. If the dispensing aid were to extend downward toward the capillaries from above the capillary support, there would be no need for gap **20** and arches **22**.

Ring **18** is provided on its upper surface with notches spaced at regular intervals. Into each notch a liquid sample filled capillary **12** may be placed. The resilient walled notches hold the capillaries stationary throughout the entire dispensing operation.

A drive shaft **32** is connected with capillary support **14** to rotate same clockwise in the direction of arrow **36** in FIG. 2. Shaft **32** is caused to rotate by a conventional electric drive motor **34**.

Timing device **40** starts and stops the operation of motor **34**. Movement of the capillaries **12** must be related to the shifting of the shifting means **90**, to the lengthwise movement of the elongated tape **60** and to the operation of the dispensing aid **100**. The timing and coordinating device **40** coordinates the movement of all of these elements. The role of device **40** in connection with the operation of the motor **34** will here be considered. Timing device **40** shuts off motor **34** upon receiving a signal from a capillary presence sensing device which will now be described.

In FIGS. 1 and 2, an optical sensing device is shown. It includes light sources **44** and **46** which continuously beam light respectively to light sensing means **48**, **50**. Means **48**, **50** may each be conventional photocells. First, source **44** and sensing cell **48** will be considered. So long as the beam from the source **44** is uninterrupted, no signal is sent to motor **34** to shut down. Light source **44** and receiving cell **48** are positioned with respect to each other so that a capillary positioned within a notch **26** and extending radially outward from the holder would interrupt the beam. When a capillary interrupts a beam from source **44** to cell **48**, the capillary is almost at the dispensing position. Accordingly, cell **48** sends a signal to timer **40** which, in turn, shuts down motor **34**. Support **14** coasts to a stop over a predetermined short distance each time the motor 34 is shut down. When support 14 halts, a particular capillary, like 12*a* in FIG. 2, is now in the dispensing position.

When a notch 26 is not holding any capillary, as with notch 26*a*, the beam from source 44 to cell 48 is not interrupted, no signal is sent by cell 48 to timing device 40 and motor 34 is not shut down. Thus, support 14, continues to rotate until the next capillary in sequence is in the dispensing position.

Second light sensing means 50 is connected with timing device 40 to send a signal to it when the light from source 46 beaming toward cell 50 is interrupted. Source 46 and cell 50 are so positioned with respect to each other that the light from source 46 is interrupted by a capillary in one of notches 26 when the next capillary forward or downstream is simultaneously interrupting the beam from source 44 to cell 48. If a capillary is absent, it will not interrupt the beam from source 46 and no signal will be sent by cell 50 to timing device 40 that a capillary will shortly be coming to the dispensing position. However, when a capillary 12 interrupts the beam from source 46, a signal is sent to timing device 40 that a capillary will shortly be reaching the dispensing position. Timing device 40 sends a signal to the motor 34 to cause same to slow down. This ensures that when the same capillary later interrupts the beam from source 44 and the motor 34 shuts down completely, the capillary will stop at the dispensing position.

Alternatively, the timing device 40 might be so programmed that the interruption of the beam from source 46 by a capillary will cause device 40 to shut off the motor 34 allowing the support 14 to coast to a stop. The subsequent interruption of the beam from source 44 by the same capillary will send a signal to timing device 40 that will cause it to actuate a brake which will immediately halt further rotation of support 14, whereby the capillary which just interrupted the beam from source 44 will halt in the dispensing position.

The timing device 40 also includes means, to be described further below, which after a predetermined period cause the motor 34 to again operate to rotate support 14, thereby bringing the next capillary in sequence into position to dispense its contents.

It should be noted that no means has been provided on capillary support 14 for tilting or moving each capillary 12 individually in order to cause its contents to be dispensed. The present invention does not preclude the use of such means, but renders its use optional.

As also shown in FIGS. 1 and 3, the capillary support 14 is tilted at an angle from the horizontal. While so tilted, the capillaries are sufficiently horizontal that their contents do not undesirably prematurely drip out, and are sufficiently tilted that gravity aids the draining of the sample from each of the capillaries, in turn. Capillary support 14 may be oriented in any manner which aids in the dispensing of sample from the capillaries.

Capillaries 12 dispense their contents to a receiving means. In FIGS. 1—3, the receiving means comprises an elongated tape 60, comprised, for example, of a transparent plastic. The tape is moved lengthwise between a supply reel 62 and a takeup reel 64. Connected with reel 64 is a windup means that causes the reel to rotate and to wind tape 60 onto itself. The windup means is caused to start and stop operating by the timing device 40, in a manner to be described further below. Tape 60 is of the type described with greater particularity in the aforementioned pending application, Ser. No. 726,652. It has a plurality of spaced-apart locations on it, each adapted to receive liquid sample dispensed to it. In FIG. 1, each of the locations is defined by a uniform absorbent pad 68 formed of an absorbent material, e.g. filter paper or an absorbent textile. When liquid sample is dispensed to a pad 68, the pad absorbs the sample and carries it into the analyzing apparatus, in a manner to be described further below.

When each of the capillaries 12 is in the dispensing position, the radially outward capillary end 70 of each capillary is at substantially the same location. A pad 68 is brought into contact with the capillary end 70 by the shifting means 90, to be described below.

A pair of positioning spools 72, 74 are located so that tape 60 passes over them and so that each pad 68 is between these two spools when liquid sample is being dispensed to it. Spools 72, 74 are positioned on the dispensing apparatus at respective locations such that the portion of the tape 60 passing between the spools can be properly shifted by the shifting means toward and away from the free end 70 of the capillary in the dispensing position and so that this tape portion will remain taut during the operation of the shifting means, as will be described further below.

As shown in FIG. 1, the spools 72, 74 are disposed so that the plane in which the tape moves and its direction of extension between these reels is substantially perpendicular to the direction of extension of the dispensing capillary 12*a*. The direction of extension of the receiving means, here the tape portion between spools 72, 74, may be chosen to optimize the transfer of liquid sample from the capillaries to the receiving means.

As with the capillary support, a timing device is required for commencing the operation of the tape windup reel 64, in order to move the tape so that the next absorbent pad 68 is in position to have liquid sample dispensed to it. The timing device is also needed to halt the progress of the tape when the next absorbent pad is in position to have its contents dispensed.

Any timing device which starts the operation of the windup reel 64 after the shifting means 90 has shifted the tape 60 away from the capillaries 12 and stops the operation of the windup reel before the shifting means shifts tape 60 into the vicinity of the capillaries may be used.

Various devices for timing the operation of the means for moving the receiving means, i.e. the windup reel 64, have been described above.

A preferred timing device is described here. It operates by sensing the presence of a pad 68 at the sample receiving location. It is preferable to sense the presence of the pad actually in the receiving location. However, this is difficult because the pads are small and the receiving location is often cluttered, as in the apparatus of FIGS. 1 and 3, with structures, e.g. capillary 12 and shifting means 90, directly involved in sample dispensing.

In addition, the portion of the absorbent tape between reel 72, 74 is being transversely shifted by shifting means 90 in a manner to be described. Were the pad presence sensing device to be between reels 72, 74, it would have to be designed so that the transverse shifting of tape 60 would not interfere with its operation. This might unduly complicate the design of the sensing device.

As the next best alternative, the pad sensing device senses the presence of other pads 68 which are near the pad in the receiving location. A reasonable attempt is made to have the pads 68 substantially equally spaced along tape 60. Accordingly, the pad in the receiving location and the pad the presence of which is being sensed will always be spaced apart substantially the same predetermined distance. Slight errors in the spacing of absorbent pads will be of little significance.

The sensing device shown in FIGS. 1 and 2 comprises a light source 78 enclosed within a housing 80. The beam of source 78 is directed toward a sensing means 82, which may be a photocell, and which is connected with the timing device 40. The light from source 78 passes through the thin tape 60 and is continuously sensed by sensing means 82 until the light from source 78 is interrupted by a pad 68. Alternatively, if tape 60 is opaque, the sensing means would sense the differing reflecting abilities, between the tape and the pads and would transmit a signal indicating when a pad was being sensed.

Consider a device wherein light passes through tape 60. Source 78 and sensing device 82 are located so that when one pad 68*b* moves to interrupt the light between them, another pad 68*a* on the tape is at the receiving location. When a pad moves between source 78 and sensing device 82 and interrupts the beam, sensing device 82 sends a signal to timing device 40 that a pad is now in the sample receiving location. Timing device 40, in turn, sends a signal to the reel 64 windup means to halt further progression of tape 60.

Tape 60 must remain stationary until capillary 12*a* has completed the dispensing of its contents and until after the shifting means has shifted the portion of tape 60 between reels 72, 74 so that the tape will not interfere with the movement of the capillaries by support 14. The same signal from timing device 40 which initiates the movement of the capillary support 14 for moving another capillary into the dispensing position can initiate the movement of the takeup reel 64 to move the next pad 68 into the receiving location.

There is a second light source 86 in housing 80 and a second sensing means 88 positioned on the other side of tape 60. Light from source 86 causes sensing device 88 to send a signal to timing device 40. Source 86 and sensing device 88 are so positioned with respect to each other that when pad 68*b* interrupts the beam between the source 78 and sensing device 82, the next pad 68*c* backward or upstream in sequence interrupts the beam between source 86 and sensing device 88. The two light sources 80, 86 and the two sensing devices 82, 88 are provided for the capillaries.

The housing 80 and sensing devices 82, 88 are illustrated as being forward or downstream of the receiving location. The sensing devices may be located at the receiving location or may be upstream or backward of the receiving location.

Consideration now turns to the shifting means 90 for shifting the receiving means, which in the case of FIG. 1 is the tape 60, toward and away from the vicinity of the receptacles, i.e. capillaries 12. As has been noted above, the shifting means may be any structure which moves the tape 60 transversely to its direction of extension toward and away from a sample transfer position. The illustrated shifting means comprises a solenoid device, including a solenoid coil within the housing 92 and a solenoid plunger 94 extending out of the housing and movable into and out of it in response to the energization and deenergization of the coil. As shown in FIG. 3, solenoid plunger 94 extends next to and past tape 60. As shown in FIG. 1, solenoid plunger 94 has two closely spaced lugs 98 on it which extend outward from the plunger and trap the tape 60 between them. As the plunger 94 moves into and out of housing 92, the lugs 98 shift the tape 60 toward and away from the immediate vicinity of a capillary. The lugs 98, when in the solid line position, hold tape 60 so that pad 68*a* is in the sample transfer position and is contacting the exit end 70 of capillary 12*a*. The lugs 98, when in the phantom line position, are at the location where the tape is away from the capillary.

When tape 60 is being wound onto takeup reel 64, its movement should be smooth and not jerky, lest the tape be torn. For smooth movement, the tape must be kept taut. It is drawn taut by the takeup reel 64. The position of the solenoid device is critical in that the two terminal shifting positions of the portion of tape 60 between tape support rollers 72, 74 should be equidistant from the position of tape 60 in the free taut aspect, i.e., when the tape is slack.

Solenoid device 90 is so positioned and plunger 94 thereof is designed to traverse a distance such that when lugs 98 are in their solid line position, tape 60 is taut, and when lugs 98 move to their phantom line position and the tape is shifted away from the capillaries, the tape is again held taut. There is only a short time interval during which the plunger is in transit and the tape is slack. Transference of this slackness to the portions of tape 60 outside the portion between the spools 72, 74 is delayed by these spools.

So long as tape 50 is taut when it is in the operative position to receive sample, each pad 68 will move to a predetermined sample transfer position with respect to the capillary exit 70.

When the solenoid coil is energized, plunger 94 is retracted and tape 60 is away from the vicinity of the capillaries 12. When the coil is deenergized, the plunger 94 is in the solid line position shown in FIG. 1, and the pad 68*a* is in the sample transfer position which is in the immediate vicinity of a capillary 12. The solenoid coil must be energized before motor 34 and the windup means for reel 64 begin operating, so that the tape 60 is out of the way of the capillaries before they are moved. The solenoid coil must be deenergized after motor 34 stops and the windup means for reel 64 halts, so that tape 60 shifts into the immediate vicinity of the capillaries only after both the capillaries and the tape have ceased moving. A conventional timing device may be used to obtain the proper sequence of operation. Preferably, the solenoid coil is connected with timing device 40.

The operation of timing device 40 in conjunction with motor 34, windup means for reel 64 and shifting means 90 is now described. Serving in this capacity, the timing means 40 is also a coordination means for the apparatus. Start at a time when motor 34, the tape windup means, and the solenoid coil of shifting means 90 are energized. Assume that a signal is received by the tape windup means to halt the movement of the tape. The motor 34 for the capillaries keeps operating. Were a signal normally to be first received from the capillary presence sensing device, rather than the pad 68 presence sensing device, the signal from the pad sensing device would be used as described below for the capillary sensing device.

A signal is next received by timing device 40 from the capillary presence sensing device, to shut down motor 34. This same signal is delayed a fraction of a second, by a mechanical relay for example, and then deenergizes the solenoid coil. Thus, it is not until after the tape and the capillaries have ceased moving that the solenoid device causes the tape to shift.

The timing device 40 includes a conventional monostable flip-flop. While in its stable state, this flip-flop permits a continuous current flow. The flow is temporarily interrupted by operations on the flip-flop which place it in its unstable state. The flip-flop stabilizes itself after a period of time, thereby restoring the power flow.

To deenergize the motor 34 and the solenoid, therefore, the flip-flop is placed in its unstable state. The interval during which the flip-flop remains in its unstable state is the period during which each capillary dispenses its contents, and is therefore chosen to be of a length so that the capillary contents will be properly dispensed.

When the flip-flop returns to its stable state, the solenoid coil is immediately reenergized and moves tape 60 away from the capillaries. After a fraction of a second delay, which can be obtained through the use of a mechanical relay, the motor 34 is restarted, thereby causing the next capillary in sequence to move into the dispensing position. The same signal that energizes motor 34 energizes the windup means for reel 64 and causes tape 60 to be wound.

Since speed and efficiency of operation are desirable, it may be helpful to provide a dispensing aid 100 for aiding in the dispensing of the contents of each receptacle after it has moved into the dispensing position. The dispensing aid may be any means which would aid in the transfer of liquid sample. The illustrated dispensing aid 100 is an air blower comprising an air supply and pumping means 102 which are both coupled to an air transfer conduit 104 that leads to a small opening air outlet 106. Outlet 106 is so positioned that the air exiting therefrom blows into the radially inward end of each capillary to blow the liquid sample contents out of the capillary more rapidly than they would otherwise exit. As was noted above, the arches 22 are provided to permit the air outlet conduit 104 to extend upward sufficiently to enable the air to be blown at the capillaries.

Other types of dispensing aids may be apparent to one skilled in the art, e.g. a conventional tilting means for tilting the capillary to a more vertical position to speed the flow of liquid sample out of the capillary.

In some situations, it may not be desirable to use a dispensing aid, or the dispensing aid may have to be of a particular type. For example, in the aforementioned application, Ser. No. 726,652, the absorbent pads on the tape remove liquid sample from the capillary tubes only through capillary action. After the pads become saturated, they contain a predictable volume of liquid and cannot absorb any more. However, if a dispensing aid, like an air blower, is used, this may force additional liquid sample onto each absorbent pad, so that the volume of liquid thereon will no longer be predictable.

The operation of the dispensing aid must be timed so that it will not prematurely cause the contents of the capillary to be dispensed. Therefore, the air pump **102** is connected with the timing device **40** to receive a signal which tells the pump when to commence and when to cease operation. Operation of the dispensing aid should not commence until after both the capillary and the absorbent pad have ceased moving and after the shifting means shifts the absorbent pad away from the immediate vicinity of the capillary. Commencement of operation of the dispensing aid, therefore, is delayed until after all of motor **34**, windup means for reel **64** and shifting means **90** have been deenergized, and cessation of its operation occurs before all of the above are reenergized.

With timing device **40**, there is a slight delay before the solenoid coil is deenergized, so that the plunger **94** operates in the proper sequence. A further delay, e.g. through a mechanical relay, can be provided to ensure that dispensing aid **100** operates after the shifting means **90** has ceased operating. Similarly, when the monostable flip-flop in timing device **40** returns to its stable condition, instead of the solenoid coil being the first element to be reenergized, the signal from the flip-flop would first go to the dispensing aid, which would then cease operating, and after a fraction of a second, the solenoid coil would receive the signal and become energized. Thereafter, the motor **34** and the means for moving reel **64** would be energized.

There has just been described a novel dispensing apparatus for dispensing liquid sample from a receptacle to a receiving means. The important concept in this invention lies in the moving of a liquid sample receiving means toward and away from the immediate vicinity of the liquid sample holding receptacles, instead of relying solely upon the movement of the receptacles, or upon a separate transferring means, to bring about the transfer of sample from the receptacles to the receiving means. The other features of the invention, which are described above, are provided to accomplish the foregoing.

FIG. 3 schematically illustrates an automatic chemical analyzer **110**, which is the subject of aforementioned U.S. Pat. No. 3,036,893, and with which the apparatus of the invention might be used.

Analyzer **110** utilizes three elongated tapes. The topmost tape is the sample receiving tape **60**, i.e. the receiving means. Tape **60** unwinds from reel **62**, passes over spools **72** and **74** and passes into the sample transfer zone **124**, to be described. Tape **60** carries a plurality of spaced-apart absorbent, liquid sample receiving pads **68**. Each of capillaries **12** has its contents emptied onto one of the pads **68** in the manner described above.

A tape **112** of transfer medium, e.g. a porous tape which permits liquid sample to pass through it at a predetermined flow rate, unwinds from reel **114** and moves between the sample receiving tape **60** and the analysis tape **118**, which feeds off reel **120**. Analysis tape **118** may be treated with a reagent which reacts with the sample transferred from each pad **68** to that tape.

Once sample has been applied to pads **68**, the three tapes move into the transfer zone **124** where they are pressed together first by rollers **126** and then by drum **128**. The sample of each pad **68** is squeezed through the porous transfer medium **112** onto the analysis surface of analysis tape **118**.

All three tapes exit from the transfer zone **124** and the tapes **60** and **112** are, respectively, taken up on takeup reels **64** and **130**. The analysis tape **118**, however, passes into the treatment zone **132** where the tape **118** may be treated with a reagent, if it has not already been so treated, or the tape may be washed, heated, dried or otherwise treated to bring about a desired reaction between the material being tested and the reagent.

The treated tape **118** then moves to a reading zone **134** where, for example, a light **136** is shown through a filter **138** and through tape **118**. The resulting light is sensed by a sensing means **140** which sends a signal to a recording means **142** that records the signal in visible form. The light signal transmitted to sensing means **140** will vary depending upon the type of reaction and the extent of the reaction occurring between the reagent and the sample being tested. After tape **118** has been read, it moves to the tape takeup zone **144** where it is wound up.

There has just been described one form of apparatus with which the present invention may be used. It is to be understood, of course, that the present invention is not limited to use with the form of apparatus described above, or to use only with a liquid sample analyzing apparatus.

FIG. 4 shows an alternate form of dispensing apparatus, designed in accordance with the teachings of the present invention. Its receiving means comprises a conduit **150** in a flow path for a fluid transmitting medium, into which flowing medium, the liquid sample is inserted. Similar elements to those shown in FIGS. 1—3 are similarly numbered in FIG. 4 with a prime (') appearing after the numbers.

The liquid holding receptacles, e.g. capillaries, the receptacle support, the means for moving the receptacle support, and the dispensing aid for aiding in the dispensing of liquid sample from the receptacles may be identical to those shown in FIG. 1 and are not, therefore, shown in FIG. 4. Solenoid device **90** is replaced by solenoid device **90'** which is substantially identical and operates in the same manner. The devices of FIGS. 1 and 4 differ because the plunger **94'** of solenoid device **90'** is secured directly to the rigid conduit **150**.

Transmitting medium flows of is pumped out of a reservoir **156**, and continuously flows through conduit **158** toward conduit **150**, through the conduit **150**, and out exit conduit **160**.

Near the upstream **162** and downstream **164** ends of conduit **150**, the adjacent conduits **158** and **160** are comprised of flexible material so that the plunger **94'** can move the conduit **150** toward and away from each of the capillaries **12'**, in turn. Alternatively, conduit **150** may be comprised of flexible material which will permit the portion thereof, described further below, which receives the liquid from the capillaries to be moved toward and away therefrom.

Conduit **150** has an inlet opening **168**, intermediate its ends, through which the contents of the capillaries enter the conduit. As shown in FIG. 4, capillary support **14'** and conduit **150** are each oriented in planes, and have a respective direction of extension, which permits the contents of each capillary **12'** to pour, in turn, into the opening **168** in conduit **150**, without having the liquid transmitting means which passes through conduit **150** leak out of the opening **168**.

The force of the liquid sample exiting from capillary **12'** causes this liquid to break into the flow of liquid transmitting medium through the conduit **150** and to form a bubble or slug **172** of liquid sample. If the force of the sample is great enough, as the sample exits from capillary **12'**, it halts all flow of transmitting medium and the slug **172** is coherent. Conduits **158**, **150**, **160** are small enough in diameter that the slug **172** remains coherent as it moves through these conduits.

A timing device, similar to that described above, is connected with the means for moving the capillary support **14'**, with the solenoid device **90'** and with a dispensing aid. Since there is no elongated tape to be moved, the timing device would not need connection to it. The timing device would not need connection to it. The timing device may be substantially identical to the timing device **40** of FIG. 1. The apparatus components in FIG. 4 must operate in the same sequence, and in the same manner as in the unit of FIG. 1. Accordingly, the timing device would be connected in the same manner to these elements as in FIG. 1 to cause these elements to operate in the same sequence.

As can be seen in FIG. 4, there are a plurality of slugs **174** of liquid sample which are spaced downstream of the slug **172**.

As the fluid transmitting medium flows through the conduit **160** it carries each of these coherent slugs to an apparatus which requires slugs of liquid sample. Since the apparatus of the invention operates automatically, the timing of the deposit of each slug of liquid sample into the apparatus, under the coordination provided by a timing device similar to the timing device **40** of FIG. **1**, will ensure that the slugs travel at regular, equally spaced intervals.

One form of apparatus which would use liquid sample provided in the manner just described, is shown in U.S. Pat. No. 3,134,263. The concept of the analyzing apparatus shown in that patent is now simply described. It is to be understood, however, that the particular apparatus using spaced slugs of liquid sample in a flow path of liquid transmitting medium is not limited to an analyzing apparatus.

Where the present invention is used in conjunction with an analyzing apparatus, the conduit **160** merges at a junction **180** with a conduit **182** to form a merged single conduit **184**. Conduit **182** communicates with a reservoir and pumping means **186** for transmitting reagent through conduit **182** and into merged conduit **184**. The flow of reagent through conduit **182** is continuous. Where the conduits **160** and **182** merge, both the liquid transmitting medium and each of the coherent slugs of sample to be analyzed are mixed with inflowing reagent. A chemical reaction takes place between the liquid sample in the form of a slug **190** and the reagent which mixes with it. The now treated slugs of liquid sample move through an analyzing apparatus **192**, which analyzes the reaction between the liquid sample and the reagent, and records the results of the analysis on recorder **194**. The spent transmitting medium, liquid sample and reagent exit through conduit **196** and may pass to waste, for example.

There has just been described an alternate form of apparatus for dispensing liquid sample designed in accordance with the present invention. This form of the invention is used where liquid sample is to be inserted as coherent slugs in a continuous flow of liquid transmitting medium. Other forms of apparatus designed in accordance with the present invention should be apparent to one skilled in the art.

Although the invention has been described above with respect to its preferred embodiments, it will be understood that many variations and modifications will be obvious to those skilled in the art. It is preferred therefore, that the scope of the invention be limited not by the specific disclosure herein but only by the appended claims.

We claim:

1. Apparatus for dispensing liquid sample from a receptacle holding same to a sample receiving means, comprising:

a receptacle for holding liquid sample to be dispensed;

a receiving means for receiving sample from said receptacle; said receiving means having a normal direction of extension;

shifting means operatively connected with said receiving means for shifting said receiving means transversely to its normal direction of extension into a sample transfer position to enable the sample in said receptacle to be transferred to said receiving means, and for moving said receiving means away from said sample transfer position after the sample transfer is completed;

said receptacle comprising a capillary tube;

a dispensing aid, located to operate directly upon said capillary tube, to force the liquid sample contents thereof to be dispensed to said receiving means.

2. Apparatus for dispensing liquid sample from a receptacle holding same to a sample receiving means, comprising:

a receptacle for holding liquid sample to be dispensed;

a receiving means for receiving sample from said receptacle; said receiving means having a normal direction of extension;

shifting means operatively connected with said receiving means for shifting said receiving means transversely to its normal direction of extension into a sample transfer position to enable the sample in said receptacle to be transferred to said receiving means, and for moving said receiving means away from said sample transfer position after the sample transfer is completed;

a conduit for transporting a transmitting medium;

said receiving means being a segment of said conduit and having an inlet thereinto through which the contents of said receptacle can be emptied into said segment and thereby into said conduit in order that the contents of said receptacle might be transported through said conduit.

3. Apparatus for dispensing liquid sample from a receptacle holding same to a sample receiving means, comprising:

a receptacle for holding liquid sample to be dispensed;

a receiving means for receiving sample from said receptacle; said receiving means having a normal direction of extension;

shifting means operatively connected with said receiving means for shifting said receiving means transversely to its normal direction of extension into a sample transfer position to enable the sample in said receptacle to be transferred to said receiving means, and for moving said receiving means away from said sample transfer position after the sample transfer is completed;

said shifting means comprising a solenoid device having an energized and a deenergized condition;

said solenoid device having a plunger which shifts to a first position when said solenoid device is energized and to a second position when it is deenergized;

said receiving means being connected with said plunger and being shifted by said plunger to be in the sample transfer position when said plunger is in one of said first and said second positions, and to be away from the sample transfer portion when said plunger is in the other of said first and second positions.

4. The apparatus for dispensing liquid sample of claim **3**, wherein said receiving means is in the sample transfer position when said solenoid device is deenergized and said plunger is in said second position.

5. The apparatus for dispensing liquid sample of claim **4**, including a plurality of said receptacles for holding liquid sample; a receptacle moving means for moving each receptacle, in turn, to a predetermined dispensing position from which it can dispense its contents to said receiving means.

6. Apparatus for dispensing liquid sample from a receptacle holding same to a sample receiving means, comprising:

a receptacle for holding liquid sample to be dispensed;

a receiving means for receiving sample from said receptacle; said receiving means having a normal direction of extension;

shifting means operatively connected with said receiving means for shifting said receiving means transversely to its normal direction of extension into a sample transfer position to enable the sample in said receptacle to be transferred to said receiving means, and for moving said receiving means away from said sample transfer position after the sample transfer is completed;

a plurality of said receptacles for holding liquid sample;

a receptacle moving means for moving each receptacle, in turn, to a predetermined dispensing position from which it can dispense its contents to said receiving means.

7. The apparatus for dispensing liquid sample of claim **6**, wherein said receiving means comprises an elongated strip of material having a plurality of locations thereon, each adapted to receive the sample held by one of said receptacles; and means for moving said strip lengthwise to position each location, in turn, at a receiving location at which it can receive sample from one of said receptacles after said strip has been shifted to the sample transfer position by said shifting means.

8. The apparatus for dispensing liquid sample of claim **7**, wherein said shifting means operates on said strip to shift each said location on said strip toward and away from the sample transfer position.

9. The apparatus for dispensing liquid sample of claim **8**, wherein said shifting means comprises a solenoid device having an energized and a deenergized condition;

said solenoid device having a plunger which shifts to a first position when said solenoid device is energized and to a second position when it is deenergized;

said receiving means being connected with said plunger and being shifted by said plunger to be in the sample transfer position when said plunger is in said second position, and to be away from the sample transfer position when said plunger is in said first position.

10. The apparatus for dispensing liquid sample of claim **9**, further including a timing device connected with said receptacle moving means, said solenoid device and said means for moving said strip;

said timing device being operative to both start and stop said receptacle moving means and said means for moving said strip;

a first sensing device connected with said timing device and positioned and adapted to sense when a receptacle is at said dispensing position; said first sensing device sending a signal to said timing device at this time to cause said timing device to stop said receptacle moving means;

a second sensing device connected with said timing device and positioned and adapted to sense that a new one of said sample receiving locations on said strip is positioned at said receiving location; said second sensing device sending a signal to said timing device at this time to cause said timing device to stop said means for moving said strip;

said timing device being operative to both energize and deenergize said solenoid device;

said timing device keeping said solenoid device energized while said receptacle moving means and said means for moving said strip are operating; said timing device including means to deenergize said solenoid device, to shift said strip toward the sample transfer position, after both said first and said second sensing devices have caused said timing device to stop both said receptacle moving means and said means for moving said tape;

said timing device including a time delay means which operates to hold at their stopped condition both said receptacle moving means and said means for moving said tape and to hold said solenoid device deenergized, all for a predetermined period;

said time delay means being further adapted to first reenergize said solenoid device before restarting said receptacle moving means and said means for moving said tape.

11. The apparatus for dispensing liquid sample of claim **10**, wherein said receptacle moving means comprises a support to which each of said receptacles is secured;

each of said receptacles being in spaced-apart relationship to the neighboring ones of said receptacles;

said support for said receptacles comprises a disc having the receptacles positioned thereon so that each faces substantially radially outward from said disc;

a motor connected with said disc for rotating same concentrically to bring each said receptacle into said dispensing position.

12. The apparatus for dispensing liquid sample of claim **10**, further including a dispensing aid for operating on each of said receptacles when it is at said dispensing position to aid in the dispensing of the liquid sample contents of said receptacle said timing device being connected with said dispensing aid for starting and stopping its operation; said timing device including means for delaying the starting of the operation of said dispensing aid until after said solenoid device is deenergized and including means for stopping the operation of said dispensing aid before causing said solenoid device to be reenergized.

13. The apparatus for dispensing liquid sample of claim **12**, wherein each said receptacle comprises a capillary tube; and said dispensing aid comprises an air blower for blowing out the contents of each said capillary tube.

14. The apparatus for dispensing liquid sample of claim **6**, further including a timing device connected with said shifting means and with said receptacle moving means; said timing device being operative to cause said shifting means to shift said receiving means into the sample transfer position for each said receptacle, in turn, to then shift said receiving means away from the sample transfer position after the dispensing operation for each said receptacle has been completed, and being operative to start said receptacle has been completed, and being operative to start said receptacle moving means to move another receptacle into said dispensing position and to thereafter stop said receptacle moving means; said timing device including means to delay the shifting of said receiving means by said shifting means to the sample transfer position until after another receptacle is in said dispensing position, and including means for delaying the restarting of said receptacle moving means until said shifting means has shifted said receiving means away from said sample transfer position, and including means for causing said shifting means to shift said receiving means away from said sample transfer position, only after a sufficient time interval to permit the dispensing of liquid sample.

15. The apparatus for dispensing liquid sample of claim **14**, wherein said receptacle moving means comprises a support to which each of said receptacles is secured; each of said receptacles being in spaced-apart relationship to the neighboring ones of said receptacles.

16. The apparatus for dispensing liquid sample of claim **15**, wherein each said receptacle comprises a capillary tube.

17. The apparatus for dispensing liquid sample of claim **16**, wherein said support for said capillaries comprises a disc having the capillaries positioned thereon so that each faces substantially radially outward from said disc; and further including a motor connected to said disc for rotating same concentrically to bring each said capillary into said dispensing position.

18. The apparatus for dispensing liquid sample of claim **17**, wherein said disc is supported so as to be tilted at an angle from the horizontal, whereby each of said capillaries has its radially outward end tilted downward when said receiving means moves into the sample transfer position.

19. In combination, the apparatus for dispensing liquid sample of claim **14**, and a conduit for transporting a liquid transmitting medium; said receiving means being a segment of said conduit, which has an inlet thereinto through which the contents of each receptacle can, in turn, be emptied into said segment and thereby into said conduit, in order that the contents of each said receptacle might be transported through said conduit.

20. The combination of claim **19**, wherein said shifting means comprises a solenoid device having an energized and a deenergized condition;

said solenoid device having a plunger which shifts to a first position when said solenoid device is energized and to a second position when it is deenergized;

said receiving means being connected with said plunger and being shifted by said plunger to be in the sample transfer position when said plunger is in one of said first and said second positions, and to be away from the sample transfer position when said plunger is in the other of said first and said second positions.