AUTOMATED INCUBATION APPARATUS

Original Filed Jan. 22, 1968

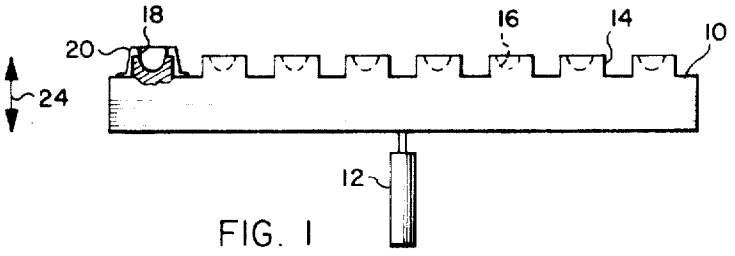


FIG. 1

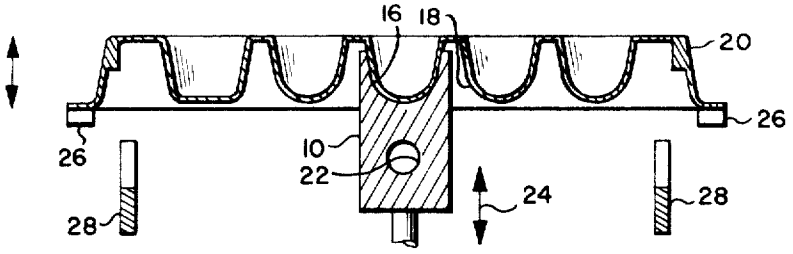


FIG. 2

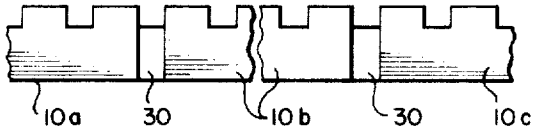


FIG. 3

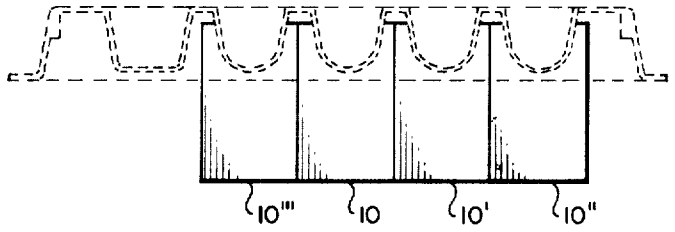


FIG. 4

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AUTOMATED INCUBATION APPARATUS

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Int. Cl. G01n *1/00*

U.S. Cl. 23—253 R 9 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

An incubator for use in automated chemical analyzer systems having the form of a serrated block of aluminum or the like, each serration or tooth being hollowed out and having an inner surface into which the outer surface of a capsule cup is adapted to fit snugly, the aluminum block containing a heater controlled by a thermoswitch and serving by contact with the capsule cup to heat liquid contained in the cup for the incubation thereof, the block being mounted for vertical movement and adapted to be brought up to engage around the cup of the capsule.

This application is related to application Ser. No. 699,-618 filed concurrently herewith for Automated Chemical Analyzer by Jerry E. Rochte et al.

The present invention relates to apparatus for heating or incubating chemical, biological or other types of samples and more particularly to incubation apparatus for use in an automated chemical analyzer in which the sample is contained in individual capsules having a hollow body and a plurality of cups formed therein. It is often necessary in the analysis of chemical or clinical samples to apply heat thereto in order to incubate the sample and bring it to a state of development necessary in the analysis thereof.

It is therefore an object of the present invention to provide incubator apparatus which is adapted to use in an automated chemical analyzer.

Another object is the provision of an incubation apparatus which is simple and economical to construct and operates in a facile manner.

A further object is to provide an incubation apparatus in which the combination of the stations thereof and the range of temperatures at which the apparatus may be maintained provides a substantial range of incubation periods so as to have utility in the incubation of a great varety of samples.

These and other objects and advantages are achieved by an incubation apparatus of the present invention which contemplates and is concerned with a massive block of aluminum formed with serrations or toothlike projections, each of which is machined out to provide a surface therein which fits snugly about a cup in a sample capsule, the block being maintained at a predetermined temperature, as by an electric heater or the like controlled by a thermoswitch.

Other objects, advantages and features of the present invention will become better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

FIG. 1 schematically illustrates the incubation apparatus embodying the principles of the present invention;

FIG. 2 is a vertical section, on a larger scale, showing the relationship of the incubation apparatus to a cup in a sample capsule;

FIG. 3 is a fragmentary view similar to FIG. 1 but

illustrating a composite block differentially heated; and

FIG. 4 is a view similar to FIG. 2 but showing an arrangement for simultaneously incubating the contents of several cups of the capsule.

Referring now to the drawing, there is shown in FIG. 1 a massive block **10** of suitable material, for example, aluminum or the like, which is of elongated, serrated form conveniently coupled to a vertical air cylinder **12**. Each serration or tooth like projection **14** of the block is hollowed out by precision machining to provide a recess **16** with an inner surface fitting snugly about the outside surface of a cup **18** in the sample capsule **20** and constitutes a heat exchange station. The block **10** is provided with an elongated bore **22** (FIG. 2) which receives any suitable heating means controlled to maintain the block at a predetermined temperature; for example, an electric heater controlled by a thermoswitch.

The incubation apparatus of the present invention is particularly adapted for use with the automated chemical analyzer described in the aforementioned application Ser. No. 699,618 and reference may be made thereto for a clearer understanding of the environmental use of the incubation apparatus and its relation to the other components of the analyzer.

Thus, in the use of the incubation apparatus, the temperature controlled block **10** is vertically reciprocated, as indicated by the double-headed arrow **24**, and is brought up under the capsule so as to engage with the cup containing the fluid to be incubated and applies heat thereto during a heat exchange dwell period, say 58 seconds out of every minute, that the block **10** is in contact with the cup in the capsule. As will be appreciated from reference to the aforementioned application Ser. No. 699,618 the capsule **20** is supported on a pair of vertically reciprocated rails **26** and moved therealong by horizontally reciprocated teeth **28**, the movement of the incubator block **10** being coordinated or synchronized with that of the rails and teeth so that the capsule is moved over a toothlike projection **14** while the block is down. Thus, with each cycle the capsule is progressively moved to the next projection **14**, in sequence, and the contents of the cup **18** are subjected to heating during a dwell period which constitutes the major portion of a cyclic interval. It will therefore be understood that by selecting the number of heat exchange stations, the temperature at which they are maintained, the length of the cycle and dwell period, any desired period of incubation may be obtained. Also, with but a very brief transition time between dwell periods, substantially all of the time of each cyclic interval is devoted to heat exchange.

Although the incubation apparatus has been shown as having only one block, it will be appreciated that the block could, as shown of FIG. 3, be in shorter sections **10a**, **10b**, **10c**, put together to provide an elongated composite block of shorter sections, each shorter block section having its own heater element and maintained at a predetermined desired temperature to the end that, at first, the sample may be subjected to a higher temperature by section **10a** in order to bring it up to incubating temperature quickly, then passing it on to section **10b** which is maintained at the incubation temperature. Furthermore, if it is desired to cool the sample during the latter stages of incubation, the last block section **10c** in the apparatus may be provided with means to cool the section and thereby cool the sample in the cup engaged thereby. Insulation **30**, as necessary, may be provided between the block sections.

Moreover, although the incubation apparatus is shown as engaging only one of the cups in the capsules, it is understood that, as shown in FIG. 4, several blocks **10'**, **10''**, **10'''**, could be mounted adjacent block **10** side by side, insulated from each other if necessary, in order

that several cups in an individual capsule may be heated in order to incubate samples therein.

There has thus been provided an incubation apparatus which is simple and economical in construction and operates in a reliable and facile manner for maintaining a sample in a capsule cup, at any desired temperature.

Although the present invention has been described in detail in connection with several illustrative embodiments, it should be understood that the novelty of the invention is not limited to the specific embodiments illustrated and described but is defined only by the scope of the appended claims.

What is claimed is:

1. An incubation apparatus for use in an automated chemical analyzer processing sample capsules having at least one cup therein the contents of which are to be incubated, said apparatus comprising, in combination:
- an elongated structure having a set of toothlike projections, each projection providing a heat exchange station; and
- *vertically reciprocal* means periodically placing one of said heat exchange stations and said capsule cup in engagement with each other for a predetermined heat exchange dwell period.

2. The apparatus of claim 1 wherein:
- each said projection has a recess in which said capsule cup fits snugly.

3. An incubation apparatus for use in an automated chemical analyzer processing discrete sample capsules each having at least one cup therein the contents of which are to be incubated, said apparatus comprising, in combination:
- transport means for progressively advancing one of said capsules to different spaced positions along a path;
- a structure *located below said transport means and* having a plurality of heat exchange stations extending in generally the same direction as said path, said stations being spaced apart a distance corresponding to the spacing between said positions; and
- means for shifting said structure and transport means relative to one another when said capsule is located in any one of said positions so as to bring said capsule cup into engagement with one of said heat exchange stations for a predetermined heat exchange dwell period, *said shifting means vertically reciprocating said structure in timed relation to the advancement of said capsule by said transport means.*

[4. The apparatus of claim 3 wherein:
- said structure is located below said transport means; and
- said shifting means vertically reciprocates said structure in timed relation to the advancement of said capsule by said transport means.]

5. The apparatus of claim 3 wherein:
- said structure is formed with a plurality of spaced toothlike projections; and
- said heat exchange stations comprise recesses formed in said projections and generally conforming to the outside surface of said capsule cup.

6. An incubation apparatus for use in an automated chemical analyzer processing discrete sample capsules each having at least one cup therein the contents of which are to be incubated, said apparatus comprising, in combination:
- a structure provided with a plurality of spaced heat exchange stations;
- means for progressively advancing said capsule cup in stepwise fashion to positions adjacent to said stations; and
- *vertically reciprocal* means for placing said capsule cup in engagement with each of said heat exchange stations as said cup is positioned adjacent thereto by said advancing means.

7. The apparatus of claim 6 including:
- means for differentially heating said structure, said heating means maintaining the first several of said heat exchange stations at a temperature above that necessary for incubation of the contents of the capsule cup in order that the cup contents may be brought up to said incubation temperature quickly; and
- said heating means maintaining the remainder of the heat exchange stations at said incubation temperature.

8. The apparatus of claim 7 wherein:
- said heating means maintains the last several heat exchange stations of said remainder at a temperature below said incubation temperature for cooling said capsule cup contents.

9. An incubation apparatus for use in an automated chemical analyzer processing discrete sample capsules each having at least one cup therein the contents of which are to be incubated, said apparatus comprising, in combination:
- *a structure provided with a plurality of spaced heat exchange stations;*
- *means for progressively advancing said capsule cup in stepwise fashion to positions adjacent to said stations; and*
- *means for placing said capsule cup in engagement with each of said heat exchange stations as said cup is positioned adjacent thereto by said advancing means, said placing means effecting engagement of said capsule cup with said heat exchange stations without any significant agitation of the contents of said cup.*

10. An incubation apparatus for use in an automated chemical analyzer processing discrete sample capsules each having at least one cup formed therein the contents of which are to be incubated, said apparatus comprising, in combination:
- *transport means for automatically conveying said capsules in stepwise fashion to different positions along a path;*
- *a structure located below said transport means and including a plurality of spaced heat exchange stations extending in generally the same direction as said path, each station being adapted to fit about a cup of said capsule;*
- *said capsule during transport thereof by said transport means along said path progressively moving to positions above said heat exchange stations; and*
- *means for periodically shifting said structure vertically upwardly to bring said heat exchange stations into contact with the cup of said capsule during transport of said capsule along said path.*

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U.S. Cl. X.R.

23—259; 119—36; 195—139