

May 9, 1939.

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2,157,438

DEVICE FOR COUNTING BACTERIA AND THE LIKE

Filed May 10, 1937

2 Sheets-Sheet 1

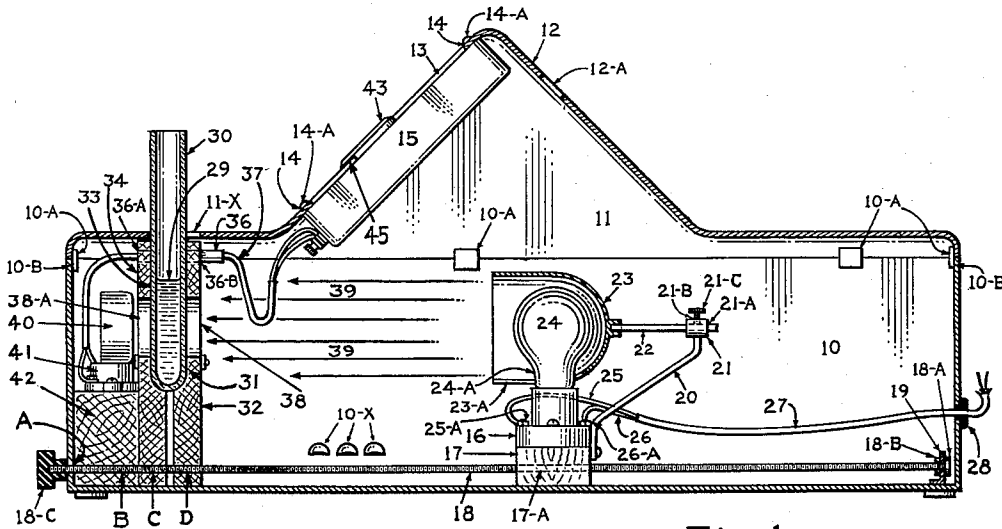


Fig. 1

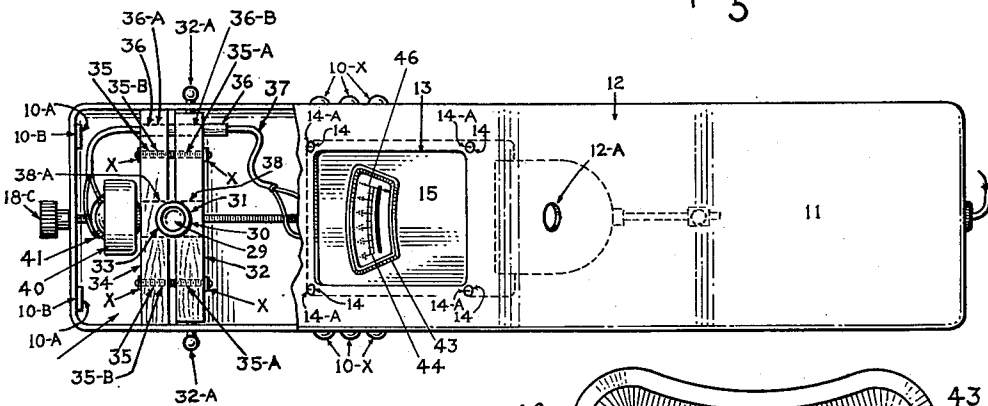


Fig. 2

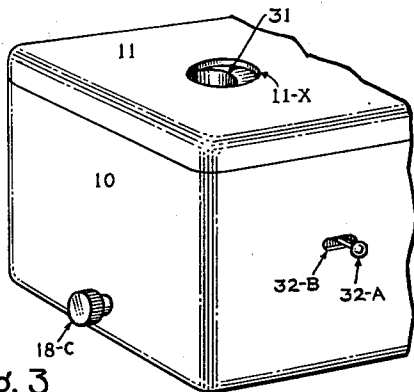


Fig. 3

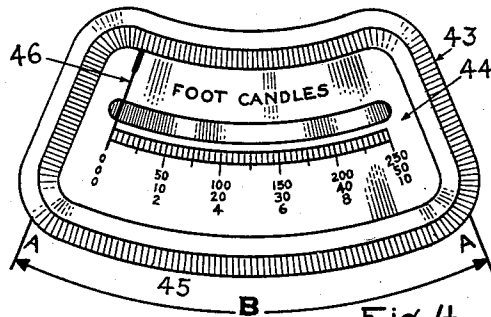


Fig. 4

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2 Sheets-Sheet 2

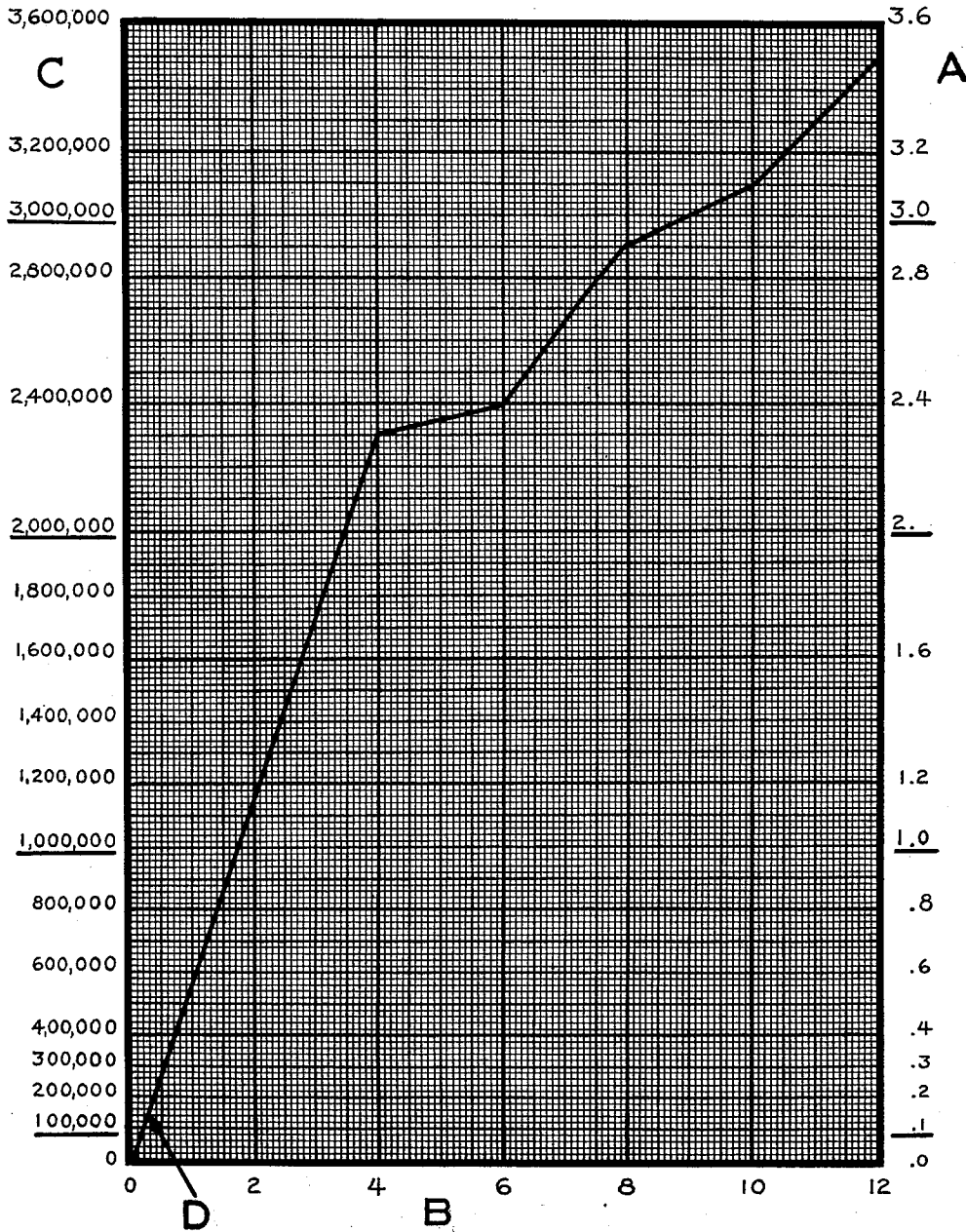


Fig. 5

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DEVICE FOR COUNTING BACTERIA AND THE LIKE

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Application May 10, 1937, Serial No. 141,731

2 Claims. (Cl. 88—14)

This invention relates to devices for determining the number of bacteria present in liquid bacterial culture at varying intervals during the process of incubation and multiplication, and particularly to that type of device for counting the number of organisms present, based on the turbidity of the liquid media and culture.

An object of my invention is to provide means for determining the relationship between the number of organisms in a liquid media and its turbidity.

Another object of my invention is to provide in a device of this type relatively rapid means for revealing in terms of foot-candles the number of organisms in liquid media and culture.

A further object of my invention is to provide in connection with a device of this type means for visual and graphic interpretation of the foot-candle readings in a manner to affect as well the ready charting of conditions evident at reading intervals, the total time consumed for a complete count, and the multiplication of organisms in the liquid media over a set time period.

A still further object of my invention is the provision therein of an adjustable light source to facilitate the ready standardization of media for use in various types of work and experiments.

A further purpose is to provide simple and novel means for holding various sizes of test tubes in position to permit the direction of light rays therethru.

Another purpose is to provide simple and novel structure for supporting a photoelectric cell which in co-operation with a foot-candle meter is in turn adapted to indicate in terms of foot-candles the turbidity of fluid within the test tube.

It is my purpose to provide such an apparatus that may be used with different foot-candle meter scale panels which may be changed for the purpose of running tests with different types of media.

It is also a purpose of my invention to provide novel features hereinafter more fully set forth in the structure of the closure for the device.

With these and other objects in view, my invention consists in the construction, arrangement, and combination of the various parts of my turbidimeter, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which:

Fig. 1 is a side sectional view of my improved turbidimeter, parts being shown in elevation.

Fig. 2 is a top plan view of my improved turbidimeter, part of the lid of the closure being broken away.

Fig. 3 is a fragmentary perspective view taken from the front end of my turbidimeter.

Fig. 4 is a plan view of the scale panel of the foot-candle meter in my turbidimeter, the double

arrow indicating the length of the slot in the lower edge of the panel frame, although the actual slot is not apparent in this view.

Fig. 5 is a plan view setting forth an actual graph made from an actual turbidity test made with my improved turbidimeter.

My device includes certain facilities and means as will be readily apparent to those skilled in the art, by reference to the specification, claims and drawings referring to my improved turbidimeter, for rendering it adaptable for handling liquid bacterial culture and the like, or, for handling ingredients which may be held in temporary or permanent suspension in liquid, such as gun powder, face powder, paint pigments and the like, to determine the size of and fix the standards of said powder and pigments, for, while the larger granules or particles settle out of suspension, leaving the smaller ones suspended to settle slower, the size of the "grind" or individual powder particles may be noted and governed for the purpose of standardization or for varying the quality of the products mentioned.

In the accompanying drawings I have used the reference numeral 10 to indicate generally the main housing in which my apparatus is assembled, and the numeral 11 to indicate generally the cover for said housing 10.

For convenience I shall hereafter in the specification generally refer to my apparatus as a turbidimeter without specific mention of its being adapted for other uses than for liquid bacterial culture.

My improved turbidimeter includes said main housing 10 and said cover 11, comprising in the particular form shown here a raised portion 12 located substantially in the center of said cover 11, a relatively large thru opening 13 in one face of the raised portion 12, thru holes 14 adjacent to the edge of said thru opening 13, said holes 14 adapted to receive the screws 14—A which in turn engage one face of a foot-candle meter 15. It will of course be understood that the foot-candle meter 15 may be fastened to the raised portion 12 in any suitable way as here shown.

I shall describe the purpose of the foot-candle meter conjointly with that of the hereinafter mentioned photoelectric cell 40 more fully at a later point in the specification.

A thru hole 11—X is provided in said cover 11 located in a position correspondingly with the test tube 30, said hole being somewhat larger than would be needed for insertion of a relatively smaller size tube, but large enough to accommodate a relatively larger size tube.

The cover 11 may be removably mounted on the housing 10 in the following manner: Secured by welding, soldering or other means to the inner sides adjacent the upper edge of the housing 10 are the tongues 10—A which project upwardly

from said housing 10 as shown in Fig. 1. When the cover 11 is lowered into place on the housing 10 the exposed outer face 10—B of the tongues 10—A slidably engage the inner face of the cover 11 at spaced points around the periphery thereof to maintain the snug and secure position of said cover 11 on the housing 10.

It will be understood that other suitable means may be employed to ensure the necessary and correct fitting of said cover 11 as here shown.

I desire it to be understood that while I have shown in the drawings a certain well known type of photoelectric cell and foot-candle meter, I make no separate claims designed for the specific coverage of these items as such, but I do claim as new and novel the use thereof in combination with the structure and arrangement of the several other parts of my improved turbidimeter for the purposes as herein set forth and as shown in certain views of the accompanying drawings.

I shall now describe the means by which bacteria is counted with my improved turbidimeter.

Air intake louvers 10—X are provided on opposite sides of said housing 10, while the aperture 12—A is provided in the rear face of the raised portion 12 of said cover 11 for attachment of a vacuum hose nozzle (not shown) to withdraw from the interior of the housing the heat from the electric bulb 24 when in use.

An electric light socket member 16 is mounted for adjustment longitudinally of the main housing 10 and disposed centrally therein by means of the base member 17 having the threaded thru hole 17—A centrally therethru, said threaded hole 17—A adapted for engagement with a threaded rotatable adjusting rod 18 having at its inner end the flanged head 18—A and the fixed nut 18—B adapted to hold this end of said rod 18 in rotatable engagement with the angle member 19 which is integrally mounted by welding or other suitable means to the bottom of the housing 10, said rod 18 having fixedly mounted on its outer end the knurled control handle 18—C.

Mounted rearwardly on said base member 17 is a supporting arm 20 carrying in fixed position on its upper end the body 21 having the thru hole 21—A, the threaded hole 21—B and the set screw 21—C. A slide rod 22 is adapted for slidable engagement with said thru hole 21—A in the body 21, and the set screw 21—C is, of course, adapted to set the position of said rod 22 in said body 21 in order to properly adjust and fix the position of the reflector 23 which is integrally mounted on the forward end of said rod 22 for the purpose of facilitating the direction of light rays 39 from an electric light bulb 24 mounted in the socket 16. A slot 23—A is provided in the lower portion of said reflector 23 to accommodate the neck 24—A of said electric bulb 24.

The electric wires 25 and 26 are secured to the contacts 25—A and 26—A of said socket 16 and extend parallelly within the standard cord or insulation 27 thru the outlet bushing 28 mounted in the rear wall of said housing 10 into contact with any standard electric light receptacle by means of any standard electric cord plug.

In preparing the "broth" by which term I shall for convenience hereinafter refer to the liquid bacterial culture, said broth may be "standardized" before use, thus to establish a normal and safe basis on and from which to conduct the successive bacterial counts.

The broth 29 when suitably inoculated is placed within the test tube 30. Said test tube 30 is inserted in the tubular receptacle formed by the

groove 31 in the movable transverse partition member 32 and the groove 33 in the fixed transverse partition member 34, as shown in Figs. 1 and 2 in the drawings.

The coil spring members 35 extending thru the thru holes 35—A and 35—B in the transverse partition members 32 and 34 respectively serve to hold said movable transverse partition member 32 in yieldable contact with said fixed transverse partition member 34, thus permitting the insertion of test tubes of different diameters within a reasonable scope of variation.

The flanged heads X on opposite ends of said coil spring members 35 maintain these spring members in position as shown.

The knob members 32—A fixedly mounted on opposite ends of the movable transverse member 32 are adapted for projection thru the slots 32—B disposed in opposite sides of the housing 10 so that when inserting the test tube 30 in my improved turbidimeter either of the knobs 32—A may be grasped by the hand of the operator to cause the movable transverse member 32 to move away from the fixed transverse member 34, thus widening the space between the grooves 31 and 33 to facilitate the easy insertion of the test tube 30 therebetween.

A conduit member 36 is fixedly mounted in the thru hole 36—A in the fixed transverse partition member 34 and slidably engages the thru hole 36—B in the movable transverse partition member 32 to serve as a protection and passage for the electric wire 37.

A pair of horizontally and correspondingly disposed thru holes 38 and 38—A are substantially elliptical in shape and are arranged in the transverse partition members 32 and 34 respectively in direct alignment with the light rays indicated by the arrows 39 directed by said reflector 23 from said electric bulb 24. These holes 38 and 38—A are of suitable width to cause the light rays thus directed to pass through the test tube 30 and its contents the broth 29 to be received by the photoelectric cell 40 (which of course is equipped with a highly light-sensitive disc), and transformed into electrical energy which is interpreted and indicated in terms of foot-candles by means of the foot-candle meter 15 being connected to and in co-operation with said photoelectric cell 40 by means of said electric wire 37.

It is obvious that the terminals of the positive and negative wires are connected in the usual well known manner to said photoelectric cell 40 and said foot-candle meter 15 and further detailed description here is deemed unnecessary to enable a complete understanding thereof.

The receptacle 41 in which said photoelectric cell 40 is mounted is in turn mounted on a fixed base 42. Smooth, aligned thru holes A, B, C, and D are provided in the front wall of the housing 10, the fixed base 42, the fixed transverse partition member 34, and the movable transverse partition member 32 respectively to admit said adjusting rod 18 for rotatable non-threadable action therein.

The foot-candle readings are taken on the scale panel of the foot-candle meter 15, one example of which is shown in Fig. 2 and particularly in Fig. 4, wherein the frame 43 is shown encasing one type of scale panel 44. An open slot 45 is indicated as extending from "A" to "A" by the double arrow B. By means of this slot 45 different types of scale panels may be inserted for use in various types of work to be done with my im-

proved turbidimeter. The indicator needle is shown by the numeral 46.

The usual procedure in counting bacteria with my turbidimeter is of course to first standardize the broth as hereinbefore mentioned, by calibration or other suitable means. Then the test tube containing the broth is placed in the turbidimeter and the electric power turned into the electric light socket 16 to light the bulb 24.

The resulting action conjointly of the directed light rays 39 with the photoelectric cell 40 wired to the foot-candle meter 15 as hereinbefore explained enables actual counting of bacteria by foot candle readings taken at stated intervals, and at the same time enables a graphic charted record of the count, the intervals of count, and the reading in foot-candles at each count made.

By means of my turbidimeter the exact time the physiological and chemical changes take place may be determined within a relatively minimum length of time and with but a small part of the time and labor involved in the old well known "plate" method of counting bacteria.

The actual counting of bacteria and the graphic recording of each count is done as follows:

When the standardized broth is placed in this turbidimeter, for example, using the lower scale from 0 to 10 as shown in Fig. 4 of the drawings, at the first reading taken, say, one hour after the broth is placed in the turbidimeter, there will be but little perceptible increase in the number of bacteria present. The light rays, therefore, will continue their action on the photoelectric cell with only a slight increase of the turbidity of the broth to cut off but a small amount of light passing through the test tube to said photoelectric cell.

It will appear obvious to those skilled in the art that as the bacteria multiplies in the test tube the resulting increase of turbidity will close out a proportionate amount of light rays being directed toward the photoelectric cell and thereby govern the swing of the indicator needle 46 across the scale panel 44.

For example, when the indicator needle 46 registers at "10" on the lower scale of the scale panel 44 with particular reference to Fig. 4, this indicates that 10 foot-candles of light are passing through the foot-candle meter and that the broth 29 in the test tube 30 is "set" or standardized to begin at "10", having a transparency to permit said 10 foot-candles of light to pass thru it.

Then, when the turbidity of the broth increases, and the indicator needle 46 moves from "10" to "8" for example, this indicates that 8 foot-candles of light are passing through the foot-candle meter, 2 foot-candle meters of light having been closed off by increased turbidity in the broth within the test tube.

Foot-candle readings are taken in reverse for this work, for example, with the indicator needle 46 at "9" on the scale panel 44 the reverse reading would be interpreted as "1" (shown in column "A" Fig. 5), or, as the presence of 1,000,000 bacteria (shown in column "C" in Fig. 5), with the needle 46 at "8" on the scale panel 44 the reverse reading would be interpreted as "2" (shown in column "A" Fig. 5), or as the presence of 2,000,000 bacteria (shown in column "C" in Fig. 5), with the

needle 46 at "7" on the scale panel 44 the reverse reading would be "3" (shown in column "A" of Fig. 5), or the presence of 3,000,000 bacteria (shown in column "C" of Fig. 5).

The numerals shown in column "B" of Fig. 5 indicate one-hour intervals in a twelve-hour time period.

It will be apparent to those skilled in the art that the different scales on different scale panels may be utilized to handle various types of liquid bacteria as well as other forms of ingredients that may be held in suspension in liquid.

As an example of a typical graphic chart record of a test run in my improved turbidimeter, with particular reference to Fig. 5, the graph line "D" shows the result of a test conducted over a period of twelve-hours time, showing how, by foot-candle readings as hereinbefore outlined the increase of turbidity of the standardized broth was actually gauged at intervals of time to enable the counting and recording of the number of bacteria per c. c. at each of said time intervals.

I claim:

1. In a device of the character described the combination of a housing, a removable cover for said housing, a photoelectric cell mounted at one end of said housing, an opening in said cover, an illumination meter mounted in said cover, said meter being visible through said opening, said meter being also cooperatively connected with said photoelectric cell, an opaque wall comprising two members mounted transversely of said housing adjacent said cell, one of said wall members being fixed and the other movable longitudinally of the housing, said wall members having aligned windows therethrough, and also having aligned grooves in the faces thereof forming a socket, a transparent receptacle inserted in said socket, a light bulb mounted for longitudinal adjustment on the opposite side of said wall from said cell, said cell, windows, receptacle and bulb being in longitudinal alignment with one another, and coil springs having their ends attached to said members to force the movable member toward the fixed member.

2. In a device of the character described the combination of a housing, a removable cover for said housing, a photoelectric cell mounted at one end of said housing, an opening in said cover, an illumination meter mounted in said cover, said meter being visible through said opening, said meter being also cooperatively connected with said photoelectric cell, an opaque wall comprising two members mounted transversely of said housing adjacent said cell, one of said wall members being fixed and the other movable longitudinally of the housing, said wall members having aligned windows therethrough, and also having aligned grooves in the faces thereof forming a socket, a transparent receptacle inserted in said socket, a light bulb mounted for longitudinal adjustment on the opposite side of said wall from said cell, said cell, windows, receptacle and bulb being in longitudinal alignment with one another, and coil springs having their ends attached to said members to force the movable member toward the fixed member, and a projection on each end of said movable member and extending outside said housing for manually moving said movable member apart from said fixed member.

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