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Mandle et al.

[11] **3,773,647**

[45] **Nov. 20, 1973**

[54] **LOW VOLTAGE ELECTROPHORETIC TESTING SYSTEM**

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[73] Assignee: **Electro-Nucleonics Laboratories, Inc.**, Bethesda, Md.

[22] Filed: **May 12, 1972**

[21] Appl. No.: **252,817**

[52] **U.S. Cl.** ..... **204/299**, 204/180 G

[51] **Int. Cl.** **B01k 5/00**

[58] **Field of Search** ..... 204/180 S, 180 G, 204/299

[56] **References Cited**

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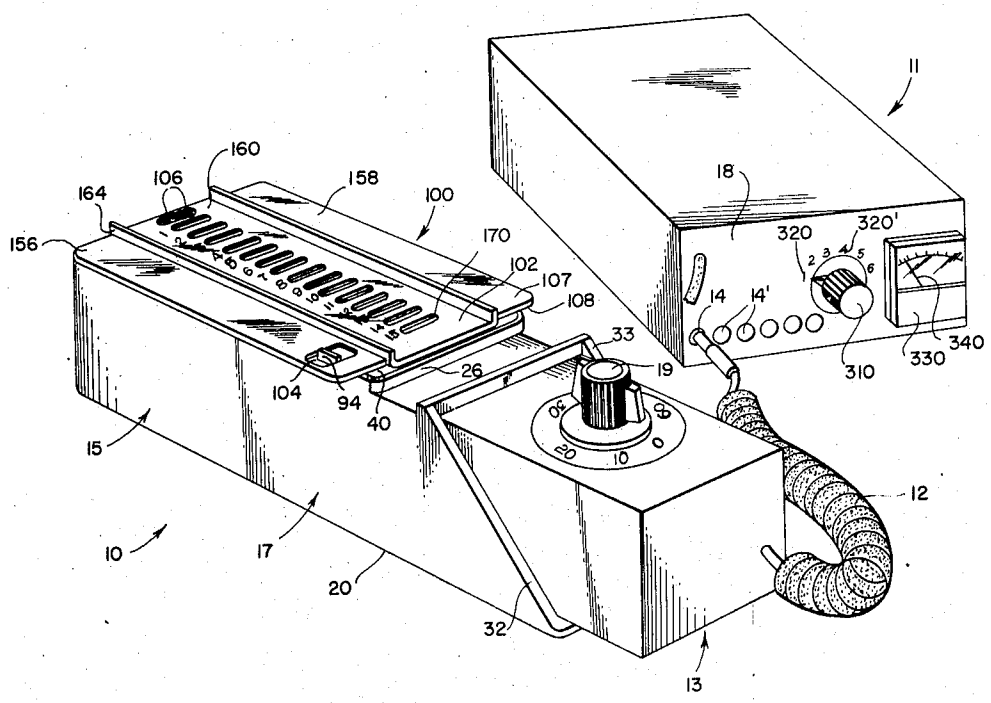
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Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney—Jesse C. Bowyer

[57] **ABSTRACT**

A low voltage electrophoretic testing system is provided incorporating the various individual components thereof, the system being adapted especially for use with the electrophoresis test kit units, including the various modifications thereof, disclosed and claimed in our copending application, filed even date herewith and entitled "Electrophoresis Test Kits and Method of Making the Same."

39 Claims, 8 Drawing Figures



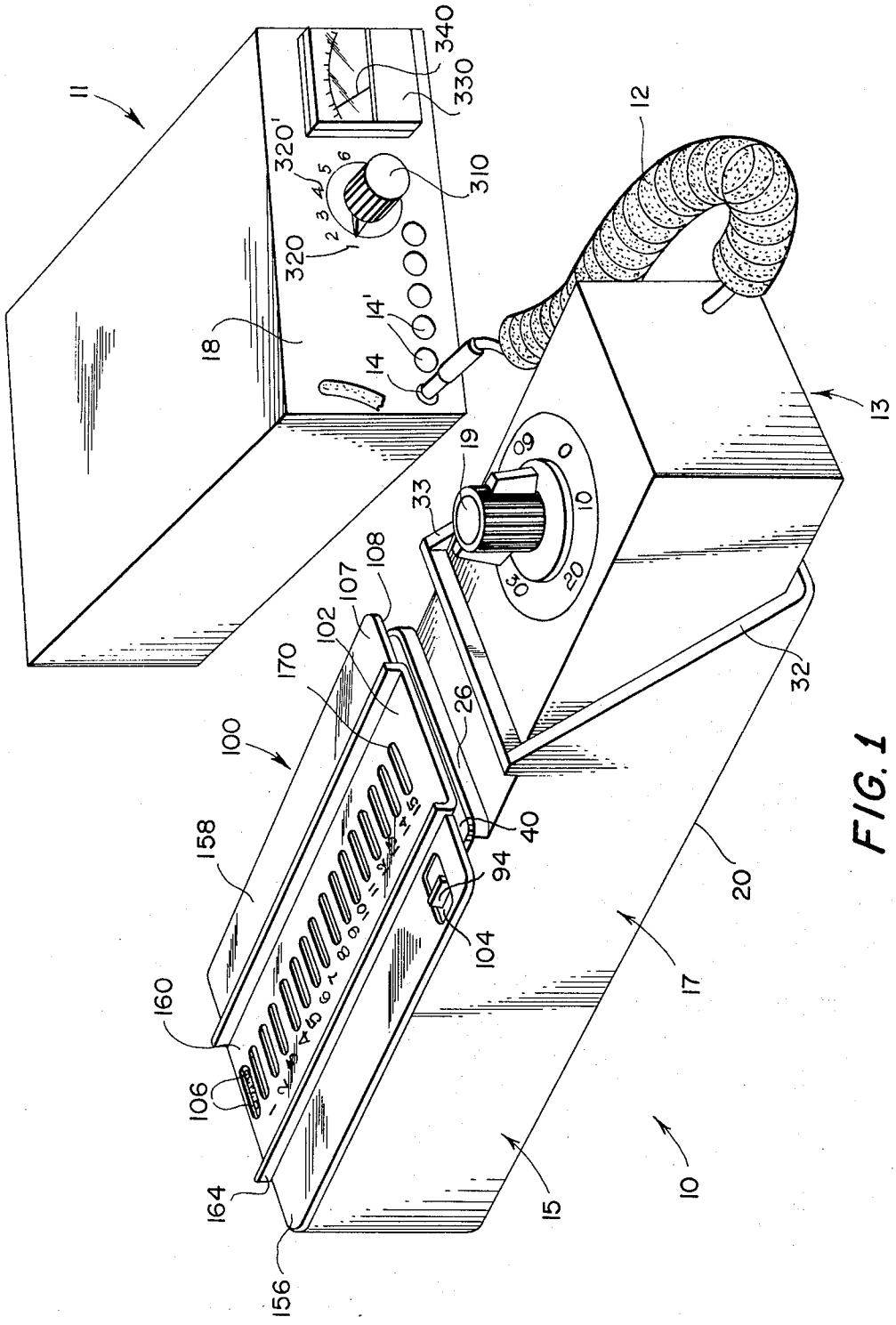

11
340
330
320'
310
320
18
14'
14
12
13
19
33
108
107
102
170
26
32
100
158
40
94
104
160
106
164
156
20
17
15
10

FIG. 1

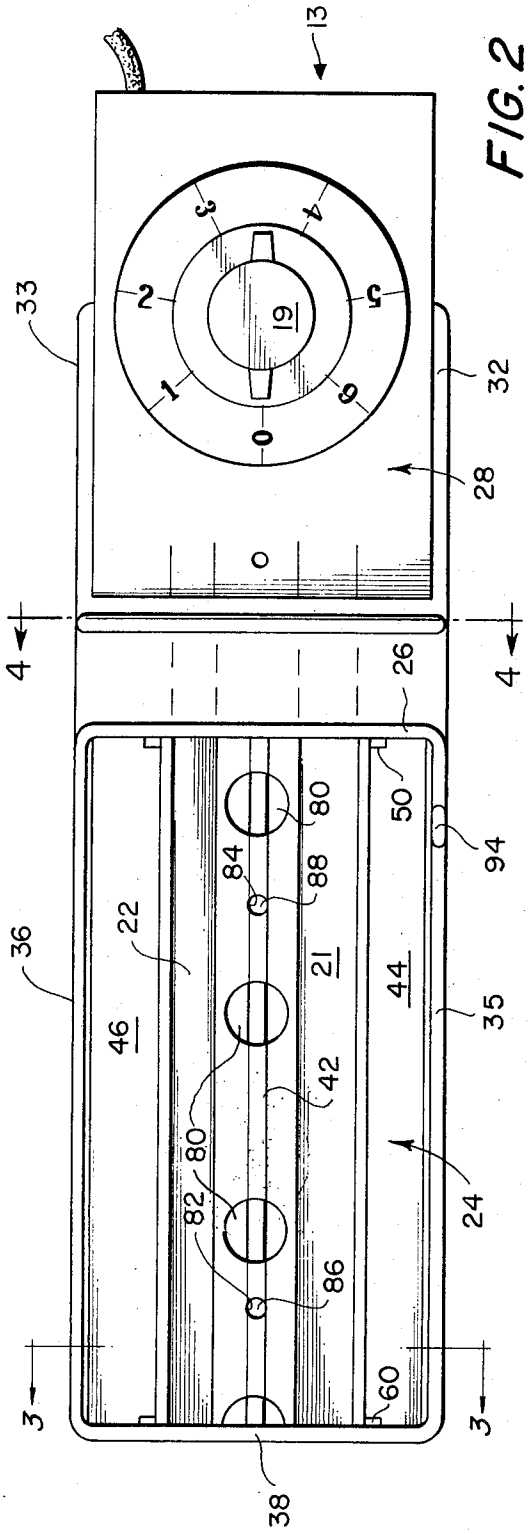


FIG. 2

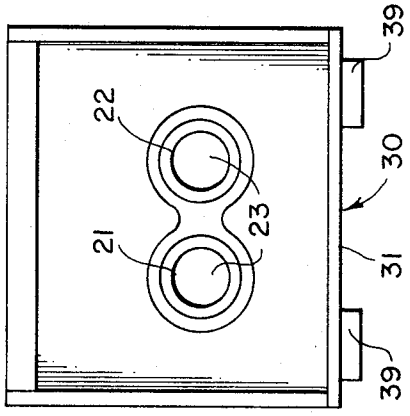


FIG. 4

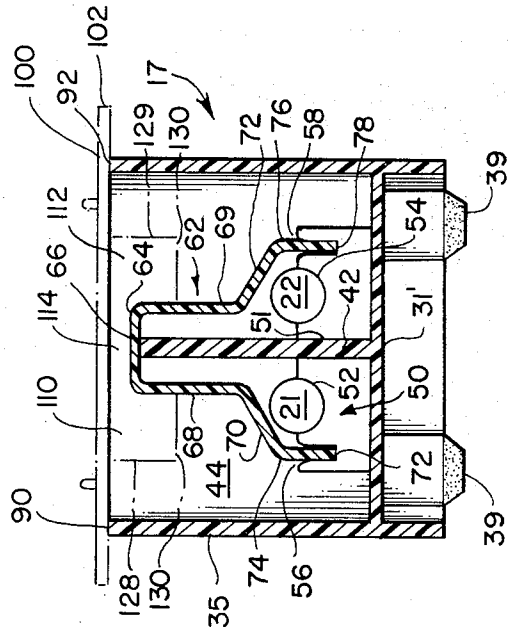


FIG. 3

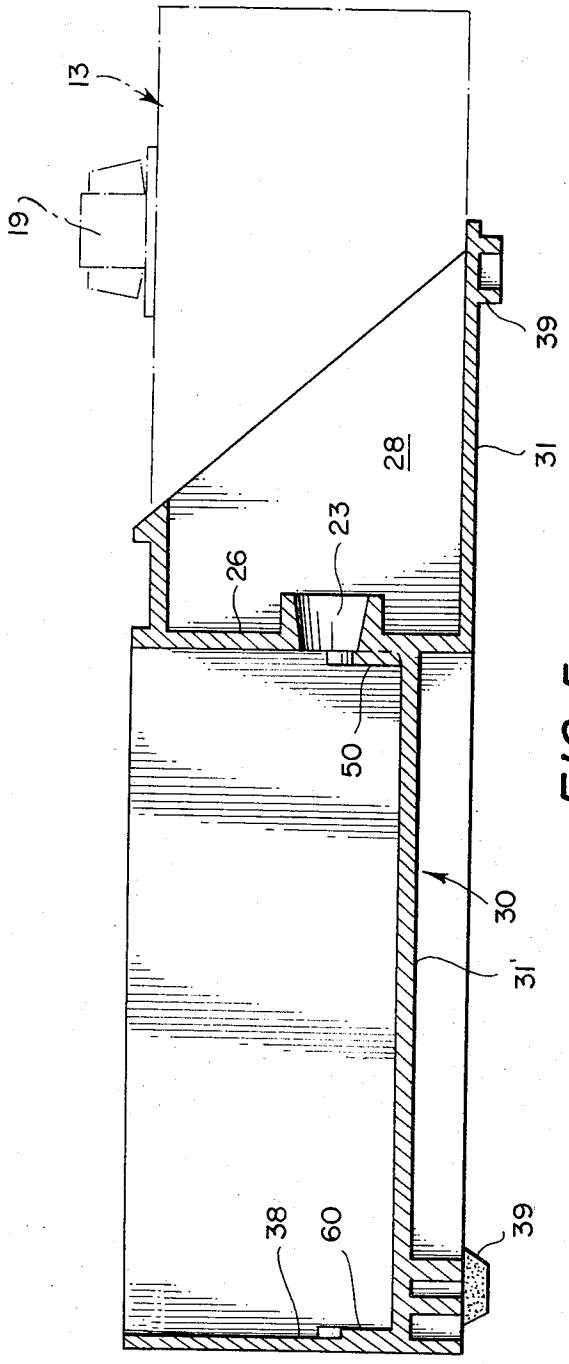


FIG. 5

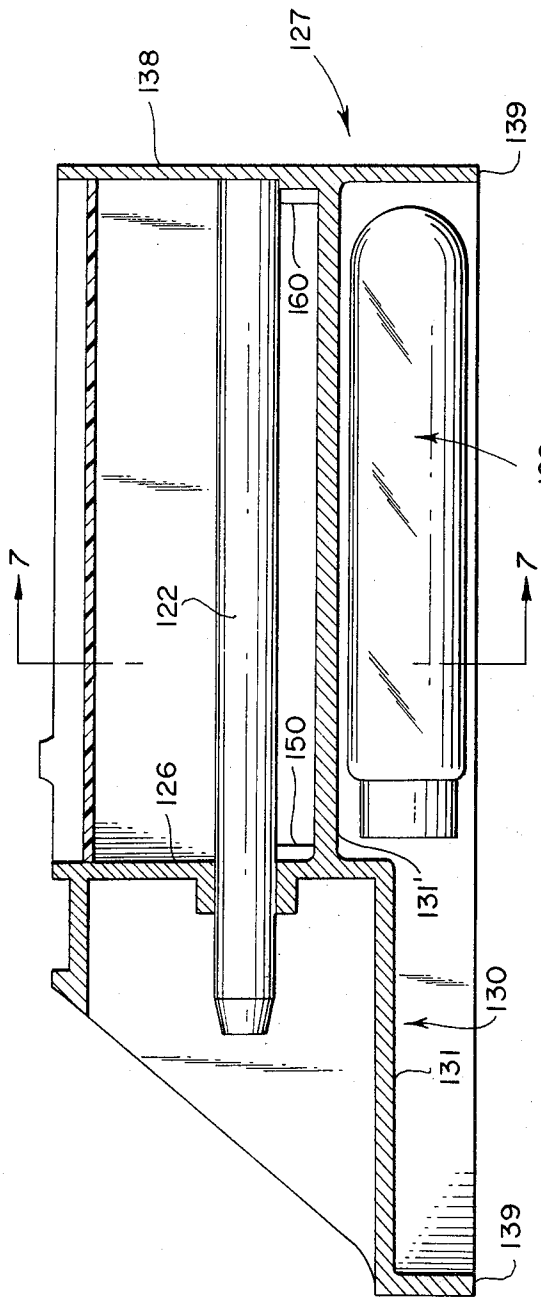

138
127
139
160
180
7
7
122
150
126
131'
130
131
139

FIG. 6

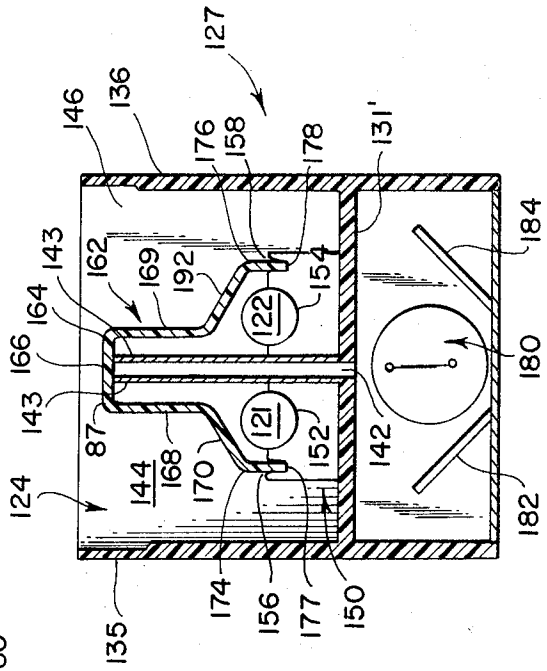

127
146
136
176
158
178
131'
184
143
162
169
192
154
164
122
166
180
143
87
121
152
142
144
168
170
124
182
135
174
156
177
150

FIG. 7

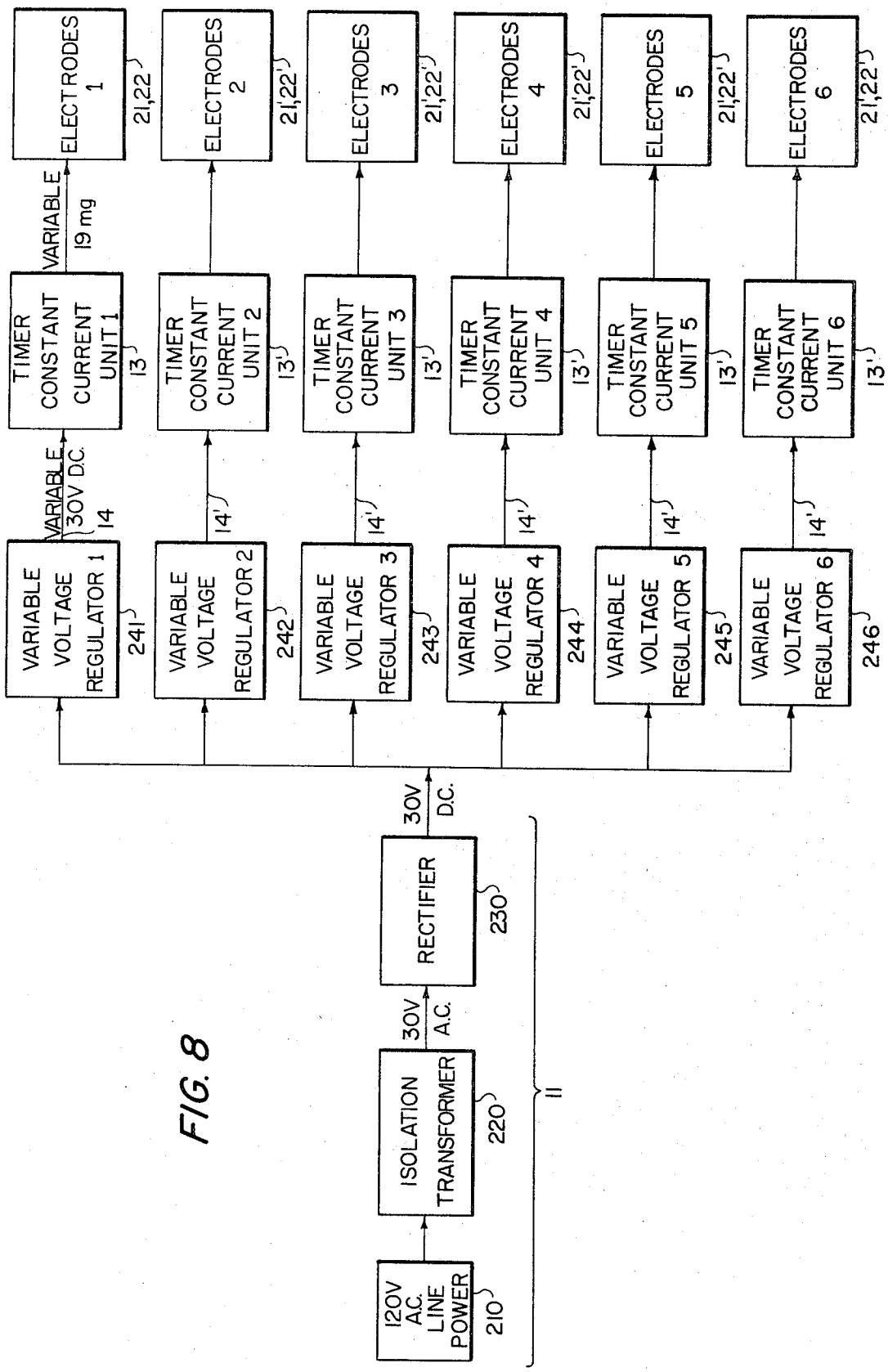

120V A.C. LINE POWER
210
ISOLATION TRANSFORMER
220
30V A.C.
RECTIFIER
230
30V D.C.
11
VARIABLE VOLTAGE REGULATOR 1
241
VARIABLE VOLTAGE REGULATOR 2
242
VARIABLE VOLTAGE REGULATOR 3
243
VARIABLE VOLTAGE REGULATOR 4
244
VARIABLE VOLTAGE REGULATOR 5
245
VARIABLE VOLTAGE REGULATOR 6
246
VARIABLE 30V D.C.
14
14'
TIMER CONSTANT CURRENT UNIT 1
TIMER CONSTANT CURRENT UNIT 2
TIMER CONSTANT CURRENT UNIT 3
TIMER CONSTANT CURRENT UNIT 4
TIMER CONSTANT CURRENT UNIT 5
TIMER CONSTANT CURRENT UNIT 6
13
13'
VARIABLE 19 mg
ELECTRODES 1
ELECTRODES 2
ELECTRODES 3
ELECTRODES 4
ELECTRODES 5
ELECTRODES 6
21,22
21',22'

FIG. 8

LOW VOLTAGE ELECTROPHORETIC TESTING SYSTEM

Such electrophoresis test kit units include an integral gel or gel-like unit, preferably of U-shape, and having relatively thick elongated gel legs and a relatively thinner integral bridging gel layer, the bridging gel unit being formed with integral wells, preferably in matched or paired rows. The entire gel unit is preferably hermetically sealed to prevent syneresis and contamination.

The system of the invention provides a preferably adjustable constant current, constant voltage supply for electrodes which extend into electrolyte compartments.

The electrolyte compartments are adapted for insertion therein of the lower portions of the gel legs, the integral gel unit of the test kit serving to complete the electrical path of the system and provide electrophoretic migration for testing.

RELATED U. S. APPLICATION DATA

Application filed even date herewith entitled "Electrophoresis Test Kits and Methods of Making Same." U.S. Pat. Ser. No. 252,639.

BACKGROUND OF THE INVENTION

The present invention relates to electrophoretic test systems, including the coactive components thereof, which produce an adjustable low electrical voltage, accurately controllable and preferably constant as to voltage and amperage.

The testing of fluids such as blood sera and similr sera, or other similar liquids, for analytic and research purposes has increased many hundred-fold in recent years and, as a consequence, a large variety of systems for testing such sera, both qualitatively and quantitatively, have been investigated and produced by the prior art.

Among the most promising of such systems is that generally denominated as electrophoresis. In its most generic sense electrophoresis is a process involving the movement of a charged particle suspended in a liquid due to the presence of an electrical field in electrically coacting relationship with the particle.

While a variety of systems are available to the researcher or to clinical testing personnel in the generic field of electrophoresis, those systems which have been found to be generally most attractive from the standpoint of economics and of dependability, i.e., reproduceable results, and of similar desirable features have related to what is generally designated as gel electrophoresis or gellified immunoelectrophoresis.

The generic term double diffusion is commonly used to describe gel tests, whether such tests are electrophoretic in nature or not, wherein two components, capable of reaction with each other, are placed in contiguous wells, or other similar openings, contained within a gel layer. In such systems the forces of movement cause the two components to diffuse in a generally universal direction; hence, if the starting wells are placed sufficiently close together, the materials placed therein will meet at a boundary line. At this line the materials may, if properly selected, precipitate and form a precipitin line, or they may form one or more boundary lines of long chain agglutinated molecules. In most cases, these boundary lines are visible to the naked eye, and, if they are not, they can be made visible or their position determined by known methods. Such an immunodiffusion process, when occurring in an applied electrical field, is generally termed immunoelectrophoresis.

In systems utilizing such electrophoresis, a first composition is placed in a well which is formed in a layer of gel and a second composition is placed in an adjacent, or paired well formed in the same layer of gel. By placing the two wells between sources of opposite electrical polarities the materials in the wells are caused to migrate towards each other through the gel. If, for example, one of the materials is an antigen, hereinafter referred to as *Ag*, and the other material is an antibody, hereinafter referred to as *Ab*, and these materials are reactive with each other, then if *Ab* is placed in one well and *Ag* is placed in the other paired well, and an electrical field is positioned with the wells placed therein between sources of opposite polarity so as to cause the migration of the *Ag* and *Ab* towards each other, there will be a position or band of positions in the gel layer in which the molecules of these two meet. If, as stated, *Ab* and *Ag* are mutually reactive, then a detectable precipitin line or lines will form wherever the *Ag* and *Ab* meet. Such a line or lines may be straight or acruate, depending upon the conditions utilized.

Accordingly, such a system of electrophoresis may be used to analyze known *Ab* against unknown *Ag* and vice-versa, in order to determine the identities or presences thereof.

As one specific example of such a material which is commonly tested, reference is made to Hepatitis-associated (Australian) Antigen (HAA). This antigen is associated with the disease generally called Serum Hepatitis, in contrast to Viral Hepatitis. It has only been in the most recent years that the wide prevalence of Serum Hepatitis has become fully evident. Studies made in this field indicate that the so-called Australian *Ag* (HAA) is associated with the causative agent for Serum Hepatitis.

Since Serum Hepatitis and HAA are more prevalent in the blood of professional donors or in the blood of individuals who have been subjected to frequent exposure to hypodermic techniques, it is becoming increasingly important before transfusion of blood to human patients that all such supplies of blood be tested to make certain they are not contaminated with Serum Heptatis.

It is essential to the utilization of such tests that an accurate testing system for supply of electrolyte and electricity be available.

SUMMARY OF THE INVENTION

The present invention discloses and embraces a system for rapid utilization by relatively inexperienced technicians which furnishes a low voltage electrophoretic testing system, providing an electrical system which is capable of the simultaneous supply of preferably adjustable, preferably constant current, preferably constant voltage electricity to a plurality of simultaneously operating electrolyte cells each of which is of compact unique construction for coaction with the test units of the above discussed copending application or with any electrophoretic test unit which is of similar shape.

The invention provides an electrode supporting structure which is minimal in size and simultaneously provides support for a unique baffle structure, whose baffles also serve as electrode shields.

Means are provided for locating the test kit units in properly oriented position as to the wells thereof and for supporting the test unit in operative position. Also provided is an alternative embodiment incorporating means to transmit light directly to the test well site during the electrophoretic test run.

Obviously, since HAA and similar electrophoretic tests must be performed in the millions, it is equally essential that a test apparatus and system be available therefor which is economical, dependable as to repeatability, and capable of efficient operation by relatively inexperienced personnel. This is accomplished by the present invention by simultaneously minimizing the chances of danger to such personnel from both the electrical portion of the equipment and the possibly infectious material containing portions thereof.

The test kit units of the invention of the copending application are preferably so inexpensive that they are single-use units; i.e., the enire test kit may be discarded after a single test run.

A large variety of gel materials may be utilized in the test kit units described herein. The most common gel for such use is an agar or agarose which has been buffered with a mildly alkaline buffer such as a tris buffer or a barbituate buffer or the like. Additional known gel-like materials having such utility for electrophoretic purposes are silica, pectin, starch, acrylamide, agar-acrylamide, etc. However, the use of agar is generally recommended because of its relative inexpensiveness and of its availability, if desired, in pure form. Additionally, it should be noted that the percentage of water in gelled agar is extremely high, so that the gel agar does not offer high molecular sieve resistance to the migration of particles therethrough. Accordingly, buffered purified agar or agarose gel is the preferred material for use in the present invention.

For a more complete description of such gels, including the details of manufacture and composition thereof, reference is made to *Immunoelectrophoretic Analysis* by Pierre Grabar, *Methods of Biochemical Analysis*, Volume VII, pages 3–12 (1959), *Immunodiffusion and Immunoelectrophoresis* by Orjan Ouchterlony, Ann Arbor Science Publishers, Inc., pages 4–8 (1968), *Method in Immunology and Immunochemistry*, edited by Williams and Chase, Academic Press, Volume II, Appendix II, and Volume III, pages 118–198 and 237–292 and 357–365 (1971).

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of the overall electrophoretic testing system with a test kit unit in operable position;

FIG. 2 is a top plan view of the combined timer and constant current unit and electrolyte compartmental housing of the testing system;

FIG. 3 is a vertical sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is a vertical sectional view taken on the line 4—4 of FIG. 2;

FIG. 5 is a vertical sectional view of the overall housing unit for the constant current and timer unit and electrode and electrolyte tank with the units carried thereby removed;

FIG. 6 is a vertical sectional view of an alternative embodiment of the electrode and electrolyte compartment with a means for illuminating the test unit;

FIG. 7 is a vertical sectional view taken on the line 7—7 of FIG. 6; and

FIG. 8 is a schematic flow diagram of the electrical components of the system of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference is made to the figures of the drawing, wherein the overall electrophoretic test system, indicated in its entirety at **10**, is illustrated with the electrophoresis test kit unit of the copending application, indicated in its entirety at **100**, in position on the test system for a test run. Basically, such a system includes a supply contained within a housing **11** of standard alternating current voltage of 110–120 volts which is fed to a step-down, isolation, transformer producing up to, for example 30 volts AC output, and then to an AC/DC rectifier, which feeds a plurality of controllable outputs, each of which connects to a separate voltage outlet **14, 14'**, each outlet having, for example, an adjustable available voltage of less than 30 volts of DC potential, such voltage being capable of regulation, such as over a range of about 15 to about 30 volts. It is to be understood, however, that the voltage available at each of the outlets **14, 14'** may range from 0 to about 30 volts or over a similar preset desired range, the outlets being connected in parallel electrical relationship.

This series of connecting sockets or outlets **14, 14'** is preferably provided on the front panel of supply unit **11**. Each of these outlets is connected, by appropriate leads, indicated at **12**, to a separate control and timer unit housing **13** and to an electrode unit **15** and carried by a housing member **17**, forming a separate electrophoretic electrical supply unit **20** for each test kit unit **100** being run.

Each control and timer unit **13** produces for a desired time set by a manual or other timer of any appropriate type known to the prior art and controlled by a settable knob, indicated at **19**, a constant current output. One preferred embodiment of such a constant current system includes a bridge arrangement in which one of the legs of the bridge constitutes a measuring resistance, the output of the bridge being utilized to control an amplifier, which, in turn, controls the output available from this unit and maintains such output at, for example, **19** milliamps, plus or minus one.

In *Agar Gel Electrophoresis* by R. J. Wieme, Elvisier Publishers, page 72 (1965) there is shown an adjustable constant current and constant voltage supply whose general circuitry is suitable for use in electrophoretic systems such as that of the invention. It is to be understood that any conventional constant current and any conventional constant voltage circuitry may be utilized, as may be any known conventional voltage and/or current adjustment means. Each of the constant current and timer units **13**, best shown in FIGS. **1** and **2**, has electrically connected to the output thereof two preferably cylindrical electrodes **21** and **22**, formed of material such as porous carbon or the like, and these are substantially contained within an electrolyte compartment **24** forming a part of the preferably integrally formed housing member **17**. The housing member **17**, preferably cast or molded from a noncorrosive plastic, has a first vertical wall **26** which carries in fluid sealing relation electrodes **21** and **22** and which divides this compartment **24** from the other or outer compartment **28** containing the timer and control elements electrically connected to the electrodes by sockets **23, 23** or

the like. The entire housing member 17 has a base wall 30 having an outer compartment portion 31 and an electrolyte compartment portion 31', which are shown as being on different levels, but may be uniplanar if desired. The base wall 31 and side walls 32 and 33 of the outer compartment preferably frictionally support the power control unit 13 in oriented position with the electrodes connected thereto and sealingly extending into the forward electrolyte compartment 24 through wall 26, any suitable form of sealing being utilized.

The electrolyte compartment 24 is provided with side walls 35, 36 having substantially equal height and an end wall 38, also, preferably of the same height, as is wall 26. Walls 26, 31, 35, 36 and 38 define the electrolyte compartment, leaving an open top thereto, indicated at 40.

Unit 17 is supported at appropriate portions of bottom wall 30 by legs 39, 39, if desired. These legs may be formed of electrically insulative material as are preferably all of the above described walls.

Positioned within the electrolyte compartment 24 is a second vertical, longitudinal dividing wall 42 positioned substantially at right angles to first vertical wall 26, as best shown in FIGS. 2 and 3, and which is joined to walls 30, 26 and 38 in fluid sealing relation and may be integrally formed therewith. The electrolyte tank 24 is thus divided into two electrolyte compartments or tanks 44 and 46, one for each of the electrodes 21 and 22, one of which is an anode and the other of which is a cathode.

This second vertical wall 42, which is longitudinally extending in the direction of the axes of the electrodes 21 and 22, as shown, electrically isolates these two electrodes from each other, so as to divide the forward compartment into these two side-by-side separate liquid proof compartments 44 and 46. Both of these compartments are filled to or near the top thereof with an appropriate electrolyte solution, containing an appropriate buffer, the composition of the solution being compatible with the selected test. As explained, one side compartment and the electrode and electrolyte contained therein are of positive polarity, while the opposite side compartment and the electrode and electrolyte contained therein are of opposite, negative polarity, the choice of polarity being optional.

Positioned adjacent the bottom of the electrolyte compartment 24 contiguous to wall 26 is a vertically extending member 50 extending parallel to wall 26 and which member 50 may have formed as part thereof a slot 51 for wall 42 and support saddles 52, 54 for electrodes 21 and 22. Also formed thereon are slots 56 and 58. A member 60 substantially identical to member 50 is positioned adjacent and parallel to wall 38 within compartment 24, member 60 having slots and saddles similar to those of member 50. Members 50 and 60 may be integrally formed with the wall elements 26 and 28 respectively, if desired; they serve as supports for the electrodes 21 and 22, for dividing wall 42 and for a baffle and electrode shield member 62, preferably formed of transparent, electrically insulative, plastic material, which member serves as a baffle member for directing convection circulation of the electrolyte around the electrodes 21 and 22 which it shields.

Member 62 has an upper horizontally extending shelf or wall 64 supported on the top 66 of dividing wall 42. Generally vertical baffle legs 68 and 69 extend downwardly from sheld 64 and, as shown, preferably have slanting portions 70 and 72 and outer vertical portions 74 and 76 which fit into slots 56 and 58 and their mating slots at the opposite ends of tank 24. Circulation holes for the electrolyte and heat, indicated at 80, are provided and the electrolyte is free to circulate between the top of bottom wall 31 and the bottoms 77, 78 of vertical legs 68 and 69. If desired, holes 82 and 84 may be provided in shield 62 to frictionally fit on pegs 86 and 88 formed on top 66 of wall 42. Legs 68 and 69 diverge downwardly.

Holes 80 also serve as escape vents for any gases which may be evolved at or near the surfaces of electrodes 21 and 22.

The tops 90 and 92 of side walls 35 and 36 preferably serve as supports for the test kit units of the present invention during the actual electrophoretic test runs; the shelf 64 may also be used for support purposes. A projection or the like, indicated at 94, is provided on one of the walls to provide a registration positioning means for insuring positioning of the test kit units in proper orientation relative to the cathodic and anodic tanks.

A preferred embodiment of the test kit, particularly for use in hepatitis testing, is partially shown in FIGS. 1 and 3 and is indicated in its entirety at 100. This test unit 100 includes a plate 102 which plate having an upper surface 107 and a lower surface 108 extends generally horizontally, and has formed thereon a locating means, shown here as a recess or notch 104, which coacts with the described projection 94 or the like formed on one of the walls of the compartment. This is done so that the test kit must be properly positioned with the wells 106, 107 thereof in proper polarity relationship with the electrolyte tanks 44 and 46 containing electrodes 21 and 22 of opposite polarity.

The test kit 100, which in a preferred embodiment is expendable and is molded from plastic components, includes two, spaced depending gel legs 110 and 112 which are interconnected by an integral gel bridge 114 forming an integral gel unit. The gel legs 110 and 112 are in the form of relatively large blocks having their larger horizontal dimension generally parallel to the rows of the wells 106, which wells are formed in gel bridge layer 114 under passages 170 in plate 102, as explained fully in the said copending application.

The plastic legs 128 and 129 which depend downward from plate 102 into electrolyte compartments 44 and 46 respectively are, when the test kit unit is being used in an electrophoretic test run, open at the bottoms 130 thereof so as to provide free egress of the electrolytes to the integral gel unit, including legs 110 and 112 and interconnecting gel bridge layer 114, closed or covered at the top to prevent contamination.

It will be understood that the level of electrolyte in compartments 44 and 46 is maintained at a sufficient height during electrophoretic operation, to immerse a substantial portion of legs 128 and 129 to insure electrolyte circulation through the gel unit during the electrophoretic test run duration. As explained fully in the copending application, the integral gel unit forms a low electrical resistance to the flow of current, so that heat loss and evaporation are minimized.

The plate and tank 24 are preferably so dimensioned that there is virtually no space left at 40 or elsewhere for the inadvertent insertion of the fingers of inexperienced technicians. The extensions 156 and 158 aid in this goal. The use of the low voltage and amperage de-

scribed herein further reduces the chances of injury to personnel operating the system.

It will be seen that each cell **24** has a continuous electrical flow path of low electrical resistance comprising the first electrode **21**, the buffered electrolyte in compartment **44**, the integral gel unit including legs **110** and **112** and bridge layer **114**, all substantially saturated with electrolyte, the buffered electrolyte in compartment **46** and electrode **22**.

While 15 volts is adequate to effectively operate the system at the start of the electrical electrophoretic test run, the electrical supply is capable of being increased to 30 volts during the run if necessary to maintain a substantially constant voltage gradient in the gel in the vicinity of the wells, particularly between pairs of wells. This is frequently necessary because the formation of undesirable byproducts of electrolysis increases the resistance halating around the outer surfaces of the electrodes.

Shield **62** helps to insure that any such products fall by gravity to the floor of the electrolyte compartments and are not freely circulated to increase possible contamination or dirtying of the equipment.

In use a well sealing cover is first removed and the left hand wells are filled with a patient's sera and the right hand wells are filled with antisera which will react with the sera during the electrophoretic test run if they are mutually reactive to form a centrally located precipitin line.

Each well **106** generally has an identical well **106** paired therewith to form a well pair. Generally, as shown, there is a control pair of wells at one end of the test unit in order to provide the user with a simple and accurate means of determining that the unit is functioning properly and to demonstrate the preferred reaction and precipitin line between the components contained in the wells.

The test unit is then placed astride the electrolyte dividing wall shelf **64** on the tops **90** and **92** of the side walls **35** and **36**, and, if desired, on the tops of the end walls **26, 28** with the locating notch **104** in the proper position relative to element **94**. The timer and voltage control units and properly set and the necessary electrical connections and adjustments are made to provide the desired electrical field and field gradient across the gel bridge **114**, the test kit unit wells and gel bridge being covered preferably.

In actual practice, it has been found that optimum electrophoresis of Serum Hepatitis *Ag* and *Ab* occurs with a voltage gradient between the wells **106, 106** of approximately 6 volts per centimeter. With the system described thus far, including wells spaced approximately 0.6 centimeters apart, the minimum potential which can provide such a voltage gradient is about 15 volts. The system, as explained above, can provide up to 30 volts maximum, so that an excess over the required initial 15 volts is available, as needed, to compensate for the described polarization of the electrodes and electrolytic decomposition of the electrolyte in the electrolytic tanks. The constant current regulating device described above and shown in FIGS. **1** and **2**, and connected in series with the 30 volt power supply and the electrolyte tanks and the gel path, functions to maintain the desired 6 volt per centimeter gradient between the well sites and is adjustable

It will be appreciated that this system is operated at a much lower voltage than most of the systems of the prior art, such prior art systems generally operating at about at least 100 volts and generally at about 200 to about 300 volts. Hence, the danger of electrical shock to the operator is lessened to such a degree as to be virtually negligible. As explained above, when the test unit is positioned on top of the wall of the electrolyte tank compartments, straddling the top wall **64** of the shield **62**, with one leg immersed in the anode compartment and the other leg immersed in the cathode compartment, there is formed a closed electrical circuit through the power supply, the electrodes, the electrolyte tanks, the agar or other gel blocks and the preferably integral agar or other gel bridge.

In FIGS. **6** and **7** there is illustrated a second embodiment of the invention which enables the operator of the system to observe much more distinctly, while the electrophoretic test is actually being run, the wells **106** and the gel bridge layer **114** portions therebetween to better notice or, if desired, photograph the precipitin or the like formation. Sucn enhanced observation of test run results in situ during the run may also be utilized to determine the desirability of varying one or more of the parameters of operation.

The overall housing unit **127** is substantially similar to previously described unit **27** and includes a transverse vertical wall **26** having openings through which electrodes **121** and **122** extend, these elements corresponding, respectively, to **26, 21** and **22** of the first embodiment. In like manner electrolyte compartments **144** and **146** correspond to compartments **44** and **46** and walls **130, 131, 131', 135, 136,** and **138** correspond respectively to the walls **30, 31, 31', 35, 36** and **38** of the first embodiment. Legs **139** are similar to **39**.

Saddle supports **150** and **160** and their elements are substantially similar to **50** and **60** and the components thereof described above. All of the parts **164, 168, 169, 170, 172, 174, 176, 177** and **178** of baffle and shield member **162** correspond to member **62** and its elements.

Positioned, however, beneath bottom wall **131** of compartment **124**, is a low heat source of illumination, indicated at **180**, which is preferably a monochromatic light source, such as sealed tungsten filaments, connected to a suitable source of operating voltage, not shown, such as 120 volts AC, preferably through any conventional switch, not shown.

Preferably positioned on each side of the light source with their axes generally parallel thereto are inclined reflectors **182** and **184**. Vertical, longitudinal wall **142** serves as a light pipe and is made from material such as lucite for this purpose. It may be coated with opaque layers **143**. It is understood that plate **102** may be opaque so that the light directed up pipe **142** illuminates gel layer **114** in sharp constant thereto. Also the shelf **164** may be a light pipe open upwardly at its ends **167, 167** to conduct light laterally to layer **114** against a dark background.

FIG. **8** shows schematically a simplified flow diagram of the electrical circuitry of the system of the invention, it being understood that all of the individual components are conventional in the known art.

Housing unit **11** connects the line voltage source **210** with an isolation transformer **220** which produces preferably 30 volts AC output which is fed to an AC to DC rectifier or the like **230**.

The 30 volt DC output of the rectifier **230** is preferably fed to a plurality, here shown as six, of parallel con-

nected, individual variable voltage regulators **241** through **246**. If desired, a single variable voltage regulator may be substituted for this plurality.

The outputs of regulators **241** through **246** appear at previously described output sockets **14, 14'**, shown as six in number and these are separately connected, as previously described, to the six corresponding timer and constant current housing units **13, 13'**, also shown here as six in number. These units have, as described, individually settable timers. They may also each have a separate and separately adjustable constant current regulator of any suitable type known in the art. Units **13** feed preferably **19** milliamps to the six individual electrode pairs **21, 22** and **21', 22'**, etc., each pair of electrodes being connected electrically through their surrounding electrolytes and the gel unit of the test set during an electrophoretic run.

As shown in FIG. **1**, unit **11** has associated therewith a suitable switch **310**, having a number of positions **320, 320'**, one for each outlet **14, 14'**. Switch **310** selectively connects by standard means, not shown, an ammeter or voltmeter **330**, having a scale and pointer **340**, to each of the cell units, so that an operator may monitor the cells as desired during the electrophoretic run.

What is claimed is:

1. An electrophoretic testing apparatus, comprising, in combination,

a unitary structure having a base wall,

a first vertical wall dividing said structure into an electrolyte compartment having a length and into an outer compartment,

two horizontally spaced, substantially parallel, rigid and clyindrical electrodes extending supportably through said first vertical wall in fluid-sealing relation therewith and extending substantially throughout the said length of said electrolyte compartment,

a second vertical wall positioned generally parallel to said first vertical wall and spaced therefrom by substantially said length,

two parallel side walls joined to said base wall and said two vertical walls in fluid-sealing relation,

a third vertical wall extending substantially parallel to said electrodes and positioned within said electrolyte compartment between said electrodes and dividing said electrolyte compartment into two side-by-side electrolyte compartments,

each of said side-by-side compartments containing one of said electrodes, and

a supporting saddle member for said electrodes positioned adjacent to and parallel to said second vertical wall.

2. The combination of claim **1** wherein said first vertical wall has positioned substantially adjacent and parallel thereto a second supporting saddle member for said electrodes.

3. The combination of claim **1** wherein said first saddle member is integral with said second vertical wall.

4. The combination of claim **4** wherein said second saddle member is integral with said first vertical wall.

5. The combination of claim **1** wherein said parallel side walls have separate top surfaces adapted to support an electrophoresis test kit unit.

6. The combination of claim **1** wherein said electrolyte compartment has positioned thereon orienting means adapted to insure properly oriented positioning of an electrophoresis test kit unit positionable thereon.

7. The combination of claim **7** wherein at least one of said top surfaces has a vertical projection thereon, said projection serving to orient said supported test kit unit.

8. The combination of claim **1** wherein a baffle and shield member is positioned substantially within said electrolyte compartment.

9. The combination of claim **8** wherein said third vertical wall has a top surface and said baffle and shield member is supported on said top surface on said third vertical wall.

10. The combination of claim **9** wherein said top surface has projections and said baffle and shield member has passages adapted to frictionally fit over said projections.

11. The combination of claim **8** wherein said baffle and shield member has a substantially horizontal top shelf wall and a depending vertical wall supported from each edge of said shelf wall.

12. The combination of claim **11** wherein said vertical walls diverge downwardly.

13. The combination of claim **14** wherein each separate diverging portion of said baffle and shield member walls substantially covers one of said electrodes.

14. The combination of claim **43** wherein said saddle member has two spaced positoning slots, and said electrolyte chamber has positioned therein a baffle and shield member having separate diverging vertical leg portions, each of said separate leg portions being positioned within a separate one of said slots.

15. The combination of claim **43** wherein each of said saddle members has two spaced positioning slots, and said electrolyte chamber has positioned therein a baffle and shield member having separate diverging vertical leg portions, the opposite ends of said leg portions being separately positioned within a separate one of said slots.

16. The combination of claim **14** wherein said diverging leg portions have separate leg portion ends each terminating a spaced distance from said base wall.

17. The combination of claim **15** wherein said diverging leg portions have separate leg portion ends each terminating a spaced distance from said base wall.

18. The combination of claim **8** wherein said baffle and shield member is formed of transparent electrically insulative material.

19. The combination of claim **8** wherein said baffle and shield member has formed therein at least one gas and heat escape passage.

20. The combination of claim **1** wherein a light source is positioned beneath said base wall.

24. The combination of claim **20** wherein said third vertical wall constitutes a light conductor.

22. The combination of claim **21** wherein reflective surfaces are positioned angularly adjacent to said light source.

23. The combination of claim **21** wherein said third vertical wall and a horizontal shelf wall on the top of said baffle and shield member have opaque surfaces adapted to provide dark background illumination for said electrophoresis test kit unit.

24. The combination of claim **1** wherein said outer compartment has two vertical side walls, and a timer and a substantially constant direct current housing unit is positioned within said compartment.

25. The combination of claim 24 wherein said outer compartment side walls frictionally engage said housing unit.

26. The combination of claim 24 wherein said housing unit has two horizontally spaced electrical sockets and each of said electrodes has a separate end for electrical connection for each separate one of said sockets.

27. The combination of claim 24 wherein said housing unit has an adjustable timing setting knob positioned thereon.

28. The combination of claim 24 wherein said housing unit has positioned therein a direct current adjusting circuit.

29. The combination of claim 24 wherein said housing unit has an electrical connection, and

a source of substantially constant substantially low direct current voltage in series with said electrical connection.

30. The combination of claim 29 wherein said voltage source is adjustable.

31. The combination of claim 29 wherein said direct current voltage source is series connected to a rectifier and to a step-down transformer.

32. The combination of claim 30 wherein a plurality of separate substantially constant current units are separately parallel connected to said voltage source.

33. The combination of claim 31 wherein a plurality of separate substantially constant current units are separately parallel connected to said rectifier.

34. The combination of claim 32, wherein an electrical measuring device is provided together with means to selectively connect said device to each of said units.

35. The combination of claim 33 wherein an electrical measuring device is provided together with means to selectively connect said device to each of said units.

36. The combination of claim 34 wherein said measuring instrument is current responsive.

37. The combination of claim 34 wherein said measuring instrument is voltage responsive.

38. The combination of claim 32 wherein said voltage source includes separate means to individually adjust the voltage to each of said units.

39. The combination of claim 30 wherein said voltage source is adjustable from about 15 volts to about 30 volts.

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