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Sykes et al.

[11] 3,868,485
[45] Feb. 25, 1975

[54] DENSITY SENSING PROBE SWITCH WITH ADJUSTABLE FLOAT

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[73] Assignee: Philip A. Hunt, Palisades, N.J.

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[21] Appl. No.: 287,054

[52] U.S. Cl. .... 200/61.2, 200/84 C, 340/244 B, 73/322.5
[51] Int. Cl. H01h 36/02
[58] Field of Search .... 200/61.04–61.07, 61.42–61.44, 61.62, 81.9 HG, 81.0 M, 84 R, 84 B, 84 C, 170 R, 172 R, 172 A, 190, 230, 335, 61.2; 335/205, 151–154; 73/305, 313, 315, 322.5, 451–454; 340/244 R, 244 B

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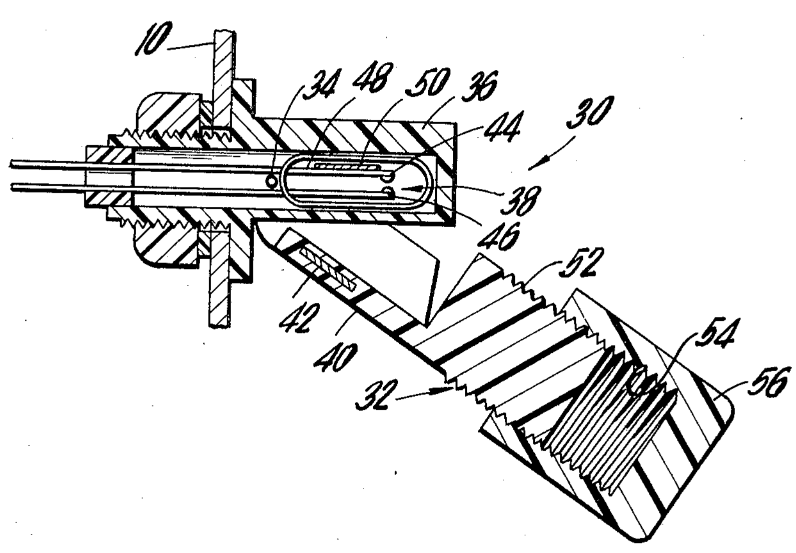
Attorney, Agent, or Firm—Kirschstein, Kirschstein, Ottinger & Frank

[57] ABSTRACT

A density sensing probe for use in a bath for etching metal. The etching bath operates with its upper surface at a fixed level. As etching proceeds, dissolved metal added to the bath by the etching process increases the density of the bath. Too great an increase reduces etching efficiency. A density sensing probe maintains the density of the bath substantially constant. The probe includes a member the specific gravity of which is slightly greater than a preselected bath density so that the member will sink when the density of the bath is slightly less than the preselected density, but will rise when the density of the bath is slightly greater than the preselected density. When the member rises, such motion closes a switch that actuates circuitry for supplying a replenishing liquid to the bath, which replenishing liquid has a density less than the preselected density. Thus, the density of the bath is maintained at about the preselected density, increasing as more metal is etched and decreasing when the probe causes replenishing liquid to be added.

6 Claims, 5 Drawing Figures



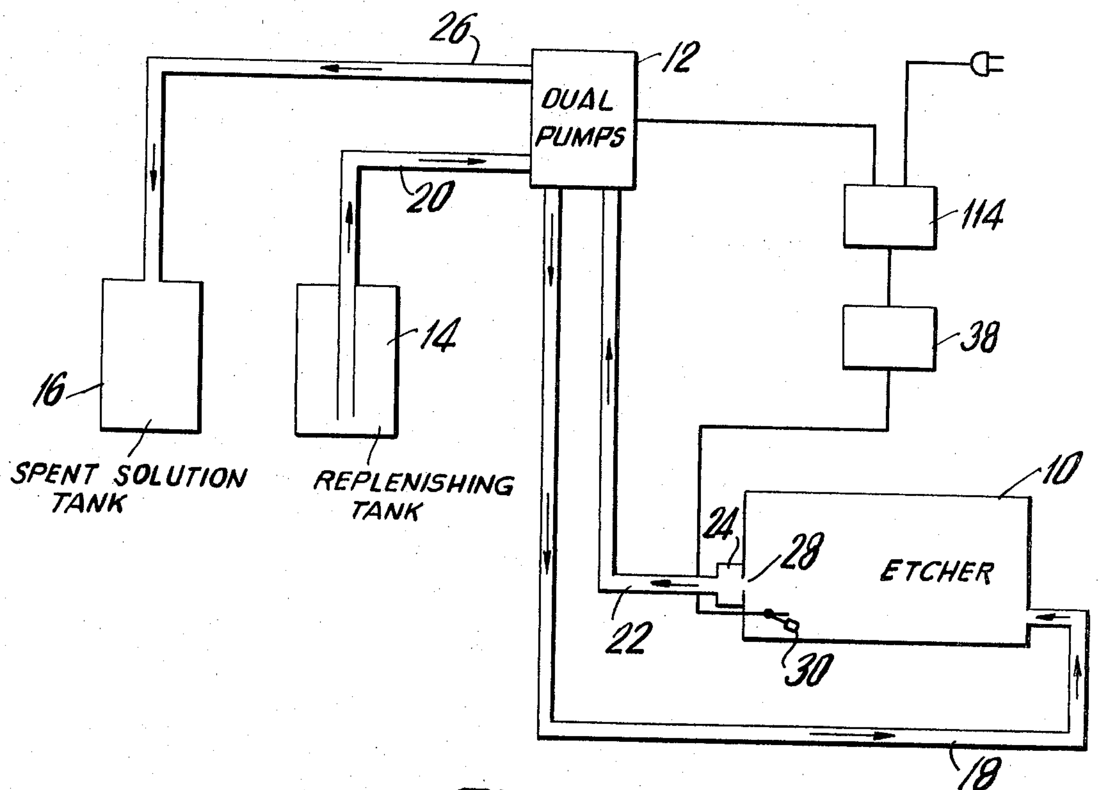
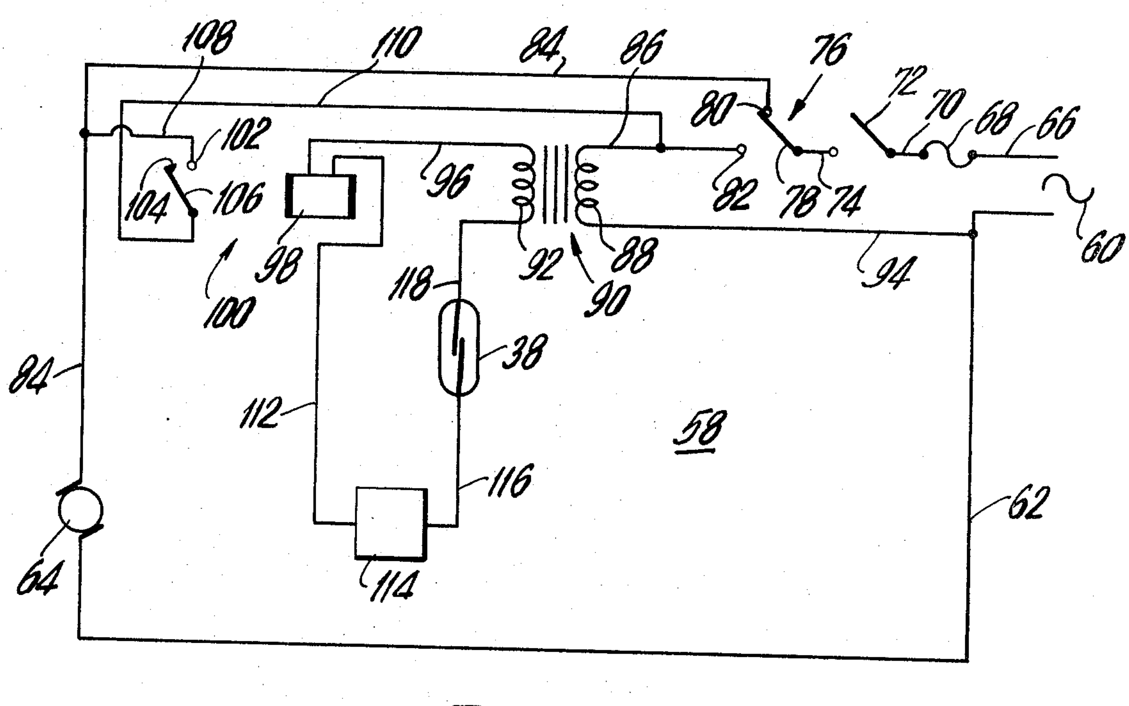

26
12
DUAL PUMPS
20
114
38
14
16
SPENT SOLUTION TANK
REPLENISHING TANK
10
24
28
ETCHER
22
30
18

FIG. 1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64
114

FIG. 5

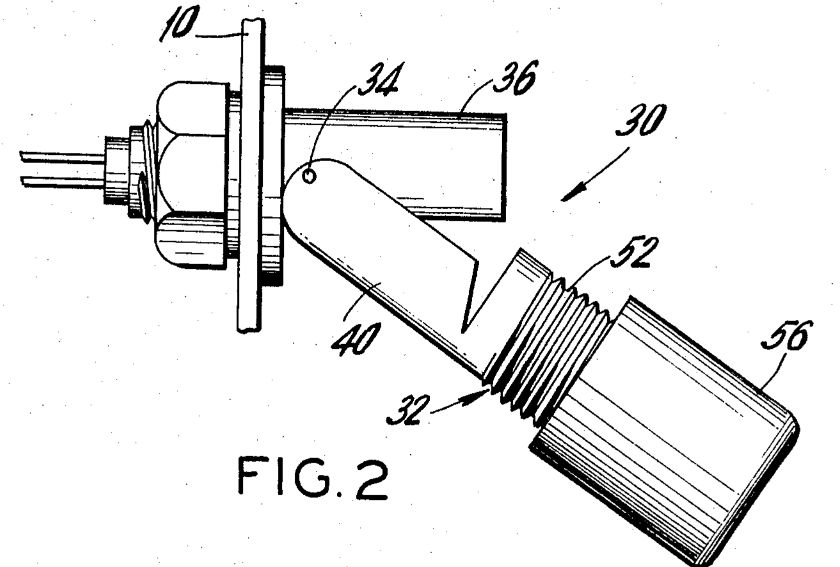

FIG. 2

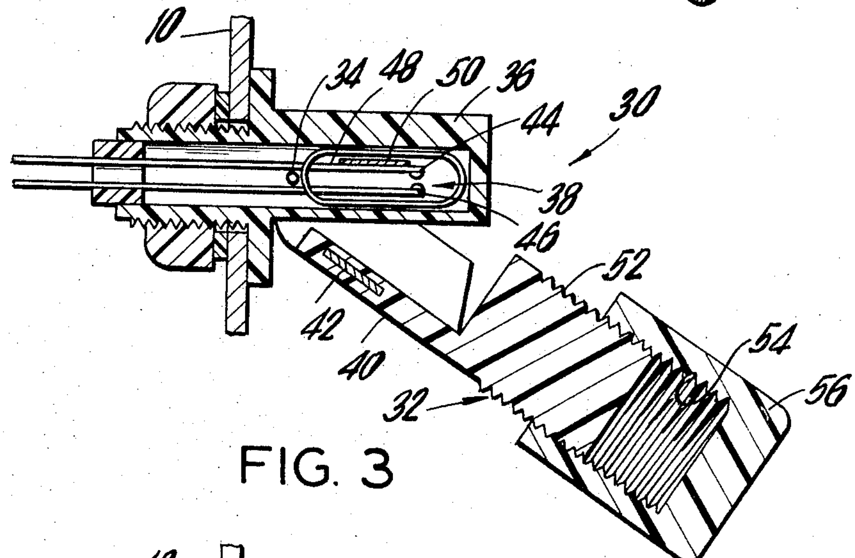

FIG. 3

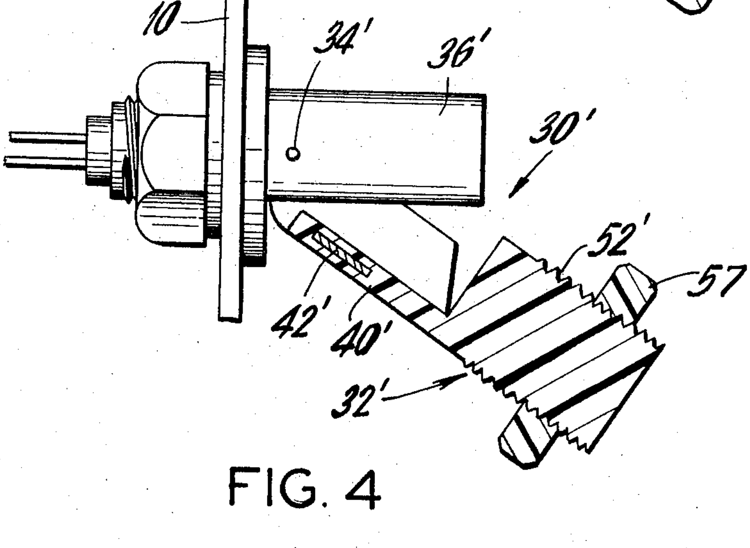

FIG. 4

DENSITY SENSING PROBE SWITCH WITH ADJUSTABLE FLOAT

BACKGROUND OF THE INVENTION

1. Field of the Invention

A density sensing probe for etching a metal with an etching bath including an arrangement to monitor the density of the bath along with a device for replenishing the bath with a liquid having a density less than a preselected bath density, replenishment taking place when the bath density is in excess of a preselected value. The replenishing operation is halted when the density of the bath drops below said preselected value, thereby etching can be carried out for long periods of time without having to dump the etching bath.

2. Description of the Prior Art

The present invention deals with the etching of metallic copper and finds its principal application in the etching of thin layers of metallic copper supported on substrates as for the purpose of making an etched circuitboard. During the etching, the density of the etching bath increases as copper dissolves in the bath. Eventually, the dissolved copper concentration reaches a value at which etching efficiency and quality are optimal. A typical value is in the order of 16 to 20 ounces of copper per gallon of bath. It is desirable to maintain the density at about this preselector optimal value. This is done by removing a part of the liquid from the bath, which removed liquid contains copper above the optimal value, and to substitute for that liquid an approximately equal amount of replenishing liquid having lower than the aforesaid preselected density, whereby the level of the upper surface of the liquid will remain constant and at the same time the density will remain approximately constant. For this purpose there is provided a density sensing probe which includes a body hinged to a support. The body has a density such that it will sink in the bath when the bath has a density less than the preselected value and it will rise in the bath when the density of the bath exceeds the preselected value. Rising of the body closes a switch which actuates an electrical device that adds the lower density replenishing liquid to the bath. The excess of liquid in the bath above the constant level is removed.

The new probe replaces sophisticated equipment heretofore used, in general, for measuring density, the replacement being with a very simple, reliable and efficient density sensing means that constitutes relatively few and simple parts.

SUMMARY OF THE INVENTION

1. Purposes of the Invention

It is an object of the invention to provide a density sensing probe for a liquid bath that etches metal and which operates at a constant level for its upper surface, the probe functioning in a simple mechanical fashion with the use of very few parts to maintain such a bath at a substantially constant level, and the probe, furthermore, including adjusting means which is in threaded engagemente with a peripheral thread on a body that constitutes a movable element of the probe so as to permit an operator to vary a preselected value of density to be maintained by the probe.

2. Brief Description of the Invention

It has been found that the simplest, most economical and most easily maintained arrangement for the monitoring of the copper ion content in a copper etching system is by observation of the specific gravity, i.e., density, of the solution, inasmuch as the addition of copper ions to the solution causes a direct increase in density or specific gravity. Accordingly, in the preferred form of the invention a sensor is included somewhere in the liquid system. Most desirably, the sensor is located in a body of the etching solution, preferably in a relatively quiescent site, for example, in a tank or sump in which such liquid is present. rather than, for instance, near or in a conduit through which the liquid flows, although such location is not excluded.

The sensor is of relatively simple form. It includes a body which has a specific gravity about equal to that of the etching solution when the etching solution has a predetermined amount of copper ions therein per unit volume, this being an amount at which an efficient etching operation will be effected. The preferred amount is in the order of (±10%) 16 to 20 ounces of copper ion per gallon. Hence, if the amount of copper present in the etching solution is less than the aforesaid range, usually only slightly less, for example, one ounce less, the body will sink in the solution, but when the amount exceeds said range, the body will become buoyant in the denser solution and will rise.

Structural elements are included to prevent the body from moving randomly within the etching solution, the body desirably being constrained for movement in a direction having a substantial vertical component.

In a preferred form of the invention, the body is pivoted for rotation about a horizontal axis at a point off-center from the center of buoyancy of the body. Thereby when the density of the solution exceeds the density of the body, the body will lift.

A sensing mechanism is included which is responsive to the elevation of the body. Exemplificatively, the body includes a permanent magnet and the sensing mechanism is a reed switch having a ferrous armature, preferably a soft iron armature, functionally integral with a contact-carrying reed, the arrangement being such that when the body rises it will attract the armature so as to close the normally open contacts of a switch. The switch is in a circuit, either a power circuit or a relay circuit, that when closed energizes two pumps, one pump being in a flow path from a source of replenishing solution to the tank for the etching solution, and the other pump being in a flow path from the etching tank to a tank for spent etching solution. In view of the highly chemically active nature of the etching solution, even at the high level of copper content, it is desirable to use pumps which present chemically inert surfaces to the solutions, e.g., peristaltic or bellows pumps. Desirably, moreover, the two pumps can be incorporated into a single structure wherein a common member actuates both pumps so that the rate of supply of the replenishing solution bears a constant ratio to the rate of withdrawal of spent solution, the two usually being substantially equal and, if there is any excess, it being in favor of the withdrawal of spent solution.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings in which are shown various possible embodiments of the invention;

FIG. 1 is a flow diagram schematically indicating the various components of the new system and the connections therebetween;

FIG. 2 is a side view of a density sensor body employed in the system;

FIG. 3 is a vertical sectional view through the body of FIG. 2;

FIG. 4 is a view similar to FIG. 3 of a density sensor embodying a modified form of the invention; and

FIG. 5 is a wiring diagram of the electrical circuit of the aforesaid system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The mechanical components of a system embodying the present invention include an etcher **10**, dual pumps **12**, a tank **14** containing a replenishing solution, and a tank **16** containing spent etching solution.

The flow connections among these components are illustrated in FIG. **1**. Thus, a conduit **18** runs from an outlet of one pump of the dual pumps **12** to the etcher **10** and a companionconduit **20** runs from the replenishing tank **14** to the inlet of the same one of the dual pumps so that when the dual pumps are activated replenishing solution will be withdrawn from the replenishing tank and pumped into the etcher. A conduit **22** runs from an overflow box **24** associated with the etcher to the inlet of the other pump of the dual pumps **12** and a conduit **26** runs from the outlet of said other dual pump to the spent etching tank **16**. When the other dual pump is actuated, which will be concurrently with actuation of the first one of the dual pumps, spent liquid will be pumped from the overflow box **24** to the spent etching tank **16**.

The etcher has been schematically represented as a rectangle with an overflow outlet **28**. As indicated hereinabove, the etcher may be of any standard type, a typical etcher being shown in U.S. Pat. No. 3,348,657. Conventionally, the etcher includes a tank or sump containing etching solution. A conduit (not shown) runs from the sump to the inlet of a pump (not shown) and another conduit runs from the outlet of the pump to spray heads (not shown) or the like which project droplets of the etching solution onto a copper coating on a substrate that is disposed within the etcher, being either stationary or, as illustrated in the aforesaid patent, traveling through the etcher while spraying is taking place.

As also mentioned previously, any other well known type of etcher can be employed as, for example, a paddle or splash etcher or even, if the occasion arises, a submersion type etcher, i.e. an etcher in which a copper coating on a substrate is subjected to the action of an etching solution by submerging the coated substrate in such solution. In the etching tank or sump the etching solution is at a substantially constant level during operation.

The dual pumps **12** are of a conventional self-priming type which may be used to handle chemically active liquids such as the etching solution employed. Typical such pumps are peristaltic pumps and bellow pumps, inasmuch as these can be readily made in such a fashion that metal moving parts are never in contact with the etching solution. Preferably, the two pumps, one for moving the etching solution from the replenishing tank to the etcher and the other for moving spent etching solution from the etcher to the spent solution tank, are mechanically interconnected so as to be commonly actuated by a single motor or two separate pumps electrically interconnected. In this way a fixed ratio for the delivery rates of the pumps is easily maintained.

Preferably, the two pumps move liquid at substantially the same rate. Desirably, the rate of the pump which moves the replenishing solution to the etcher is slightly less than the rate of the pump which moves spent solution from the etcher to the spent solution tank. The replenishing solution moved from the replenishing tank to the etcher moves constantly as long as the dual pumps are actuated. However, the spent solution may not flow at a constant rate because the spent solution leaves the etcher via the overflow outlet **18** so that what occurs is that spent solution does not leave the tank until fresh replenishing solution is introduced into the tank to raise the height of the liquid in the tank to above the level of the overflow outlet after which the spent solution runs into the overflow box **24** from which it is withdrawn via the conduit **12**, the other dual pump and the conduit **26** to the tank **16**.

Pursuant to the present invention, the motor of the dual pumps is controlled to actuate said pumps responsive to the amount of copper ions in the etcher tank with respect to a certain pre-determined value which may be referred to as a null valve and typically is in the order of (±10%) the range of 16–20 ounces per gallon of etching solution. It has been observed that when the copper ion content of the etching solution is at about this null value, an efficient etching operation is performed. When the value is substantially exceeded or when the weight of copper ions in the etcher is substantially below this value, efficiency of etching falls off.

The etching solution in the etcher contains conventional constituents. However, the ratios of these constituents and the ratios of the constituents in the replenisher are selected to fall within ranges such that by maintaining the copper ion constant at approximately the null value through feeding in of fresh replenishing solution when said level is exceeded, the system can function on a continuous basis, that is to say, etching can be performed either continually or intermittently, and fresh replenishing solution will be supplied as needed to maintain the copper ion content at approximately the aforesaid null level.

The material etched in an etching system of the present invention is metallic copper, although the metallic copper does not have to assume any particular physical form inasmuch as the etching system is capable of dissolving copper regardless of its configuration. In the preferred use of the system the copper is present as a coating on a substrate, e.g., as a coating on an electrically non-conductive panel, selective portions of which are to be etched away in order to form a circuitboard. Etching is selectively performed by forming on the exposed surface of the copper coating an etch resist which is patterned to conform to the desired configuration of the copper coating in a finished circuitboard. Where the copper coating is not protected by the etch resist, the metallic copper will be dissolved, i.e. etched away, upon exposure thereof to the etching solution in the etcher. It will be appreciated that although the foregoing is the main present commercial usage of an etching system of the present invention, said system lends itself readily to all types of etching whether it be of copper or other metals or semiconductors (with different etching solutions) where an element or mixture of elements is attacked by an etching solution and dissolved so as to change the density of the etching solution.

Conventional constituents of a copper etching solution are water, ammonium chloride, ammonium hydroxide and copper ions as metallic copper. Such an etching solution will dissolve metallic copper.

Copper obviously is heavier than water so that, as cuprous ions are added to the etching solution during etching, the density of the solution increases in direct proportion to the amount of copper etched, and, therefore, dissolved. It has been observed that when a certain value of dissolved copper ions is present, etching proceeds efficiently. This is the level referred to above as the null value. It is believed that this is in the order of approximately (±10%) 16 to 20 ounces of dissolved copper per gallon of etching solution at conventional etching temperatures, e.g. 100°–120°F. Hence, when this amount is exceeded, it is desirable to actuate the dual pumps to pump in replenishing solution and to withdraw some of the spent (copper-loaded) etching solution in order to reduce the density of the copper ions to substantially the null level. For this purpose the replenishing solution contains copper ions in an amount below, and, desirably, substantially below, the null level. In the preferred form of the system now being described, the replenishing solution contains no copper ions whatsoever as this most rapidly will drop the average level of the copper ions in the etching solution.

Pursuant to this means is included to continually monitor, i.e. sense, thie specific gravity, i.e. density, of the etching solution. The present invention for the aforesaid purpose utilizes a density sensing probe **30.** This probe is situated in the etcher.

Referring to FIGS. **2** and **3**, the probe constitutes a body **32,** the specific gravity of which is the desired null value, i.e. the predetermined specific gravity, of an etching containing the number of copper ions, i.e. the weight of copper ions, per unit volume at which etching is performed efficiently. Desirably, this body is located in a portion of the tank where the least motion of the etching liquid occurs so that flow currents of the etching solution will not too greatly affect the movement of the body. As long as the weight of copper per unit volume of the etching solution in the etcher is somewhat below the null value, the body which has a specific gravity greater than the etching solution at this time will tend to sink. However, as the weight of copper ions per unit volume increases while etching progresses, the specific gravity of the etching liquid will reach and exceed the specific gravity of the body so that the body becomes buoyant in the etching liquid and will rise. As mentioned earlier and as will be explained in detail shortly hereinafter, when the body rises an electric circuit is completed which, after a given short period of time, will energize the motor for the dual pumps so that replenishing liquid will be introduced into the etcher and spent liquid will be transferred to the spent solution tank.

In order to better regulate the operation of the body and the switch controlled thereby, it is desirable to so mount the body that it moves in a predetermined fashion having a substantial vertical component. To this end, the body is pivoted about a horizontal axle **34** carried by a casing **36.** The casing includes a normally open electrical switch **38** which is closed when the body rises into proximity therewith.

More particularly, the body **32** constitutes an arm **40** of chemically inert plastic pivoted on the axle **34.** Embedded in the plastic arm is a permanent magnet **42.** The switch **38** is of the proximity type having normally open contacts which are closed when approached by a permanent magnet. A typical switch of this nature includes a pair of normally open contacts **44, 46,** one of which is fixed and the other of which is mounted on a flexible reed **48.** The reed has an armature **50** affixed thereto which will be attracted by the permanent magnet when the body **32** lifts upon the specific gravity of the etching solution exceeding the aforesaid null value thereby to close the open contacts **44, 46.**

Depending upon the specific constituents of the etching solution, it sometimes may be desirable to enable the operator to vary the null value at which the switch is set to operate. This is done by varying the specific gravity of the body **32.** Suitable means is included to enable this to be accomplished. Typically, such adjusting means is in the form of a male thread **52** formed on the distal end of the arm **40.** The male thread is engaged by the internal thread **54** of a cap **56.** The two threads have a good mutual fit which is close enough to prevent seeping of any etching solution through the threads into the cap. However, the fit is not so close as to prevent ingress or egress of air into and from the cap. Thus, to vary the specific gravity of the body it merely is necessary to screw the cap further onto the arm or to screw the cap further away from the axle **34.** It will be appreciated that as the cap approaches more closely to the axle the air space between the tip of the arm and the bottom of the cap becomes smaller and that the reverse occurs when the cap is screwed further away from the axle. Inasmuch as the weight of the body remains constant regardless of the position of the cap and the volume of the body decreases when the cap is screwed toward the axle and increases when the cap is screwed away from the axle, screwing the cap toward the axle will increase the specific gravity of the body and screwing the cap away from the axle will decrease the specific gravity of the body. Thereby the operator is able to select any desired null value of specific gravity. The aforesaid density sensing pobe constitutes a magnetic float switch which will close an electrical path when the specific gravity of the etching solution exceeds a null value and which will open the path when the aforesaid specific gravity is below the null value. It will be appreciated that the volume defined by the cap and the tip of the arm contains a material, in this instance air, which has a specific gravity considerably different (here less than) from the specific gravity of the etching solution, so that by adjusting the size of said volume the user can, at will, vary the overall specific gravity of the body and thus select any desired null value of specific gravity above and below which the sensor is to operate. It should be pointed out that air is not the only material which could be used. For example, a foamed plastic could be substituted, preferably one having a closed cell structure so that there will not be any absorption of etching solution in the event that the fit between the cap and the body is not liquid-tight.

In FIG. **4** there is shown a density sensor **30'** embodying an alternate form of means for adjusting the responsive of the arm to the specific gravity of the solution, that is to say, for adjusting the arm to move in response to selected different values of specific gravity of the etching solution. In general, the sensor **30'** of FIG. **4** is identical to the sensor **30** illustrated in FIG. **3** and all identical parts have been referred by the same reference numerals in the drawings and have not been redescribed.

The adjusting means in the sensor 30' constitutes a member such as a nut 57 which is designed to mesh with the male thread 52 on the arm 40. Said member 57 is made of a material, e.g., polyvinylchloride having a specific gravity different from the specific gravity of the etching solution, so that when this member is moved axially of the arm the torque biasing the arm upwardly will change as a function of the position of the member, that is to say, the member exerts an upward biasing force which increases when the solution becomes denser and which force is not a function of the position of the member. However, the torque arm over which such force acts varies with the axial position of the member on the arm, so that by moving the member closer to the axle 34 that response of the sensor is changed to cause the arm to rise at a higher specific gravity of the etching solution than it would with the member further away from the axle, and vice versa. The following are examples of starter and replenishing solutions which perform satisfactory in the etcher 10.

Starter	Moles/Liter
Copper ions as metallic copper	2.00
Ammonium chloride	5.0
Ammonium hydroxide	6.0
Ammonium phosphate	.01
Water q.s. to	1 liter
pH	8.0 – 8.5
Replenisher	
Copper ions as metallic copper	0
Ammonium chloride	4.5
Ammonium hydroxide	6.0
Ammonium phosphate	.01
Water q.s. to	1 liter
pH	9.5

Suitable means is included in the form of an electrical circuits 58 to operate the motor of the dual pumps when the density of the copper etching solution in the etcher exceeds the null value as monitored by the density sensing probe 30. Said means can take any effective form and one suitable electrical circuit for this purpose is illustrated in FIG. 5. The illustrated circuit is simple and basic and will perform the desired functions as described hereinabove. It is designed to operate with electromechanical components and a single relay, the control portion of the circuit working on a reduced voltage and the power portion of the circuit working at line voltage. Various modifications may be employed as is well known to skilled workers in the art. Thus, a pair of relays may be employed, one for the control circuitry and one for the power circuitry, or the control circuitry can work on line voltage with either one or two relays. In another modification, each of the relays may have paired contacts to share the current load. If desired, the circuit can be transistorized as with the use, for example, SCR's to avoid utilization of electromechanical relays, and thus provide a circuit with no moving parts except for the probe switch 38.

Referring again to FIG. 5, the reference numeral 38 denotes the reed switch already described above in detail with respect to FIGS. 2 and 3, the same being part of the magnetic float switch. The circuit 58 is energized from an AC source 60 of electric power, e.g. 110 volts AC. One lead 62 extends from one side of the AC source of power to a motor 64 for the dual pumps 12.

The other lead 66 runs to a fuse 68 from which a lead 70 runs to an OFF/ON switch 72. A lead 74 extends from the OFF/ON switch to a manual/automatic single-pole double-throw switch 76. The blade 78 of the switch 76 is designed to be manually swung between its pair of associated contacts 80, 82, the contact 80 being a manual contact and the contact 82 being an automatic contact. A lead 84 runs from the manual contact 80 to the other terminal of the motor 64. Hence, when the switch 76 is in manual position closure of the OFF/ON switch 72 will energize the pump motor 64.

A lead 86 extends from the automatic contact 82 to one terminal of a primary winding 88 of a step-down transformer 90 having a secondary winding 92 which supplies a low control voltage, e.g. 24 volts. A lead 94 runs from the other terminal of the primary winding 88 back to the lead 62 that is connected to one of the terminals of the AC source of power. Hence, when the switch 78 is in automatic mode and the switch 72 is closed, the transformer 90 is energized and a 24-volt potential will appear across the terminals of the secondary winding 92.

A lead 96 extends from one terminal of the secondary winding 92 to one terminal of an operational winding 98 of a control relay 100 having a pair of normally open contacts 102, 104. The contact 104 is a movable contact fixed to an armature 106 of the relay 100. The contact 102 is stationary and is engaged by the contact 104 when the operational winding 98 of the relay is energized. A lead 108 extends from the stationary contact 102 to the lead 84. A lead 110 extends from the movable contact 104 to the lead 86. Thus, when the operational winding 98 is energized, line voltage is supplied from the lead 96 to the lead 84 40 energize the motor 64.

A lead 112 connects the other terminal of the operational winding to one terminal of a time-delay relay 114, the other terminal of which is connected by a lead 116 to one terminal of the reed switch 38. The other terminal of the reed switch 38 is connected by a lead 118 to the other terminal of the secondary winding 92 of the step-down transformer 90. The time-delay relay 114 is conventional. When potential is applied thereto, it sets a timer into operation while maintaining a high internal resistance. After the expiration of a preselected period of time, the resistance suddenly drops to a very low value so that, in effect, the time-delay relay then consitutes a negligible resistance in the line. Moreover, the time-delay relay 114 is of the automatic reset type, this being one in which when the potential applied thereto is removed the timer will return automatically to its starting position. The purpose of including a time-delay relay in the comtrol circuit which also has therein the reed switch 38 is to prevent immediate operation of the dual pumps when the arm 40 lifts for reasons other than an increase in the density of the etching solution above the null value, as, for example, when the density of the etching solution is near but slightly less than the null value and a liquid current develops in the vicinity of the arm which is sufficient to raise the arm to its closing position from which it will immediately drop when the current stops. This would result in a short spurt of operation of the motor and pumps which is unnecessary.

As during the replenishing period the replenishing pump forces into the etcher a replenishing solution having little or no copper ions therein, and as a substantially equal quantity of replenishing solution, in which there is contained approximately the null value of copper ions, overflows from the tank and is pumped to the spent etching solution tank, the average amount of copper ions in the etching solution in the etcher slowly reduces and gradually falls below the null value, eventually causing the arm **40** to drop, because its specific gravity then exceeds the specific gravity of the etching solution in the etcher. Consequently the switch **38** eventually will open and shut off the pump motor.

It is not desirable for the replenishing cycle to operate for very short periods of time, i.e. to turn off and then start up again after a brief interval, particularly since the maintenance of the aforesaid preselected null value at a precise level is not critical. Efficient etching will occur with minor variances (±10%) from the aforesaid range of null values. This stretch out of the pumping and idle periods may be accomplished easily in various fashions. For example, the friction binding between the plastic arm **40** and the axle **34** may be sufficient to create a large enough coefficient of static friction for the desired lengthy intervals to be created. Alternatively and/or additionally, the point of introduction of the replenishing solution into the etcher may be remote from the location of the sensing probe **30,** as shown in FIG. **1.** With such an arrangement a certain period of time is required for the effect of the introduction of the lower density replenishing solution to reach the sensor and actuator the same. Still further, the circuit illustrated in FIG. **5** may include a timer interposed in the lead **112,** and which, when actuated, will provide a pair of closed contacts shunting the switch **38** for a predetermined period of time, e.g. 2 minutes, so that the minimum period of operation of the replenishing pump will be fixed. (The maximum period will be controlled by opening of the switch **38**). It is not necessary to fix the period of idleness of the pump, and indeed, it would not even be desirable. The period of idleness will be determined by the amount of replenishing solution supplied to the etcher and by the degree of etching activity which takes place in the etcher after a supply of replenishing solution has been furnished thereto.

Having thus described the invention there is claimed as new and desired to be secured by Letters Patent:

1. A density sensing probe for controlling the operation of an electric device that maintains substantially constant density of a body of liquid the level of which is substantially constant, said probe comprising a support adapted to be at least partially disposed in the body of liquid, a body largely disposed below said support and in said liquid, means connecting said body to said support for guiding said body and its movement relative to said support, means to selectively adjust movement of the body in response to a change in the density of the liquid, said adjusting means being disposed on the periphery of the body, said periphery and said adjusting means including complimentary threaded portions, switch means responsive to a change in position of said body, an electrical device associated with said liquid the actuation of which reduces the density of the liquid, and circuit means connecting the switch means to the electrical device to actuate the electrical device when the body of liquid experiences an increase in density so as to lower the density and maintain the density substantially constant.

2. A density sensing probe as set forth in claim **1** wherein the connecting means constitutes a horizontal axle.

3. A density sensing probe as set forth in claim **1** wherein the means responsive to a change in position of said body comprises a reed switch having a ferrous member and also comprises a permanent magnet member, one of said members being carried by said support and the other of said members being carried by said body.

4. A density sensing probe as set forth in claim **1** wherein the selective adjusting means includes means defining a space movable with the body and wherein the adjusting means adjusts the volume of such space.

5. A density sensing probe as set forth in claim **1** wherein the adjusting means includes a cap and means mounting the cap for telescopic movement relative to an end of the body without permitting entry of liquid into the cap whereby as the cap is moved toward and away from the body it varies the size of a space defined by the cap and the body.

6. A density sensing probe as set forth in claim **2** wherein the body is elongated and wherein the adjusting means includes a member having a specific gravity different from the specific gravity of the liquid, and means mounting the member for adjustable movement along the length of the body in a position at least partially submerged in the liquid body.

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