Jan. 4, 1966 C. S. MARTZ 3,227,166

ETCHING MACHINE

Filed Sept. 12, 1962 2 Sheets-Sheet 1

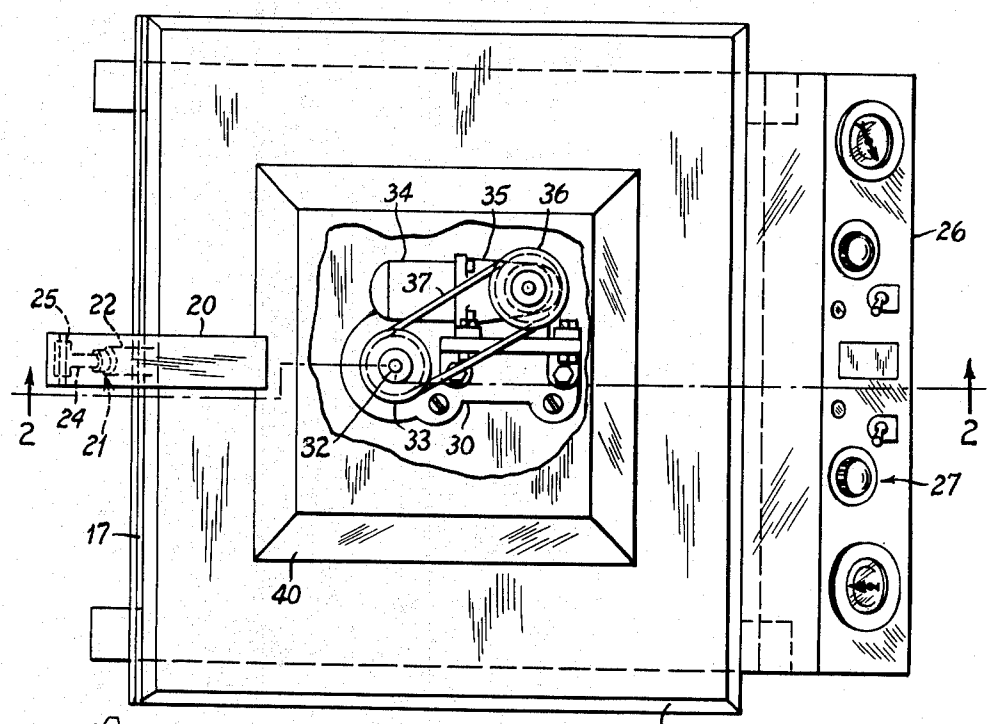


FIG. 1.

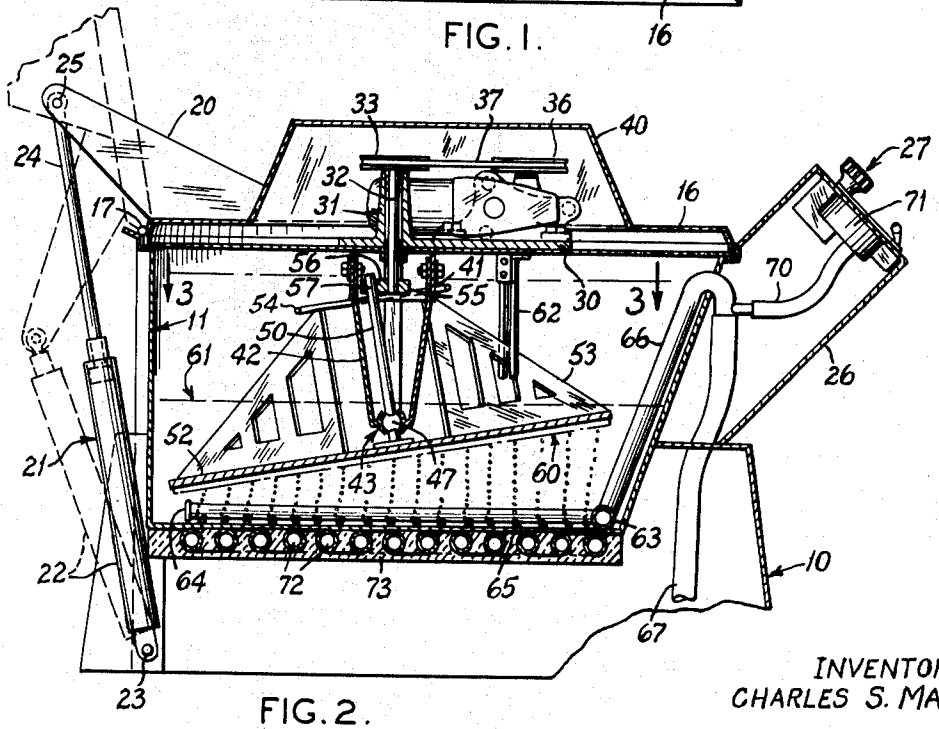


FIG. 2.

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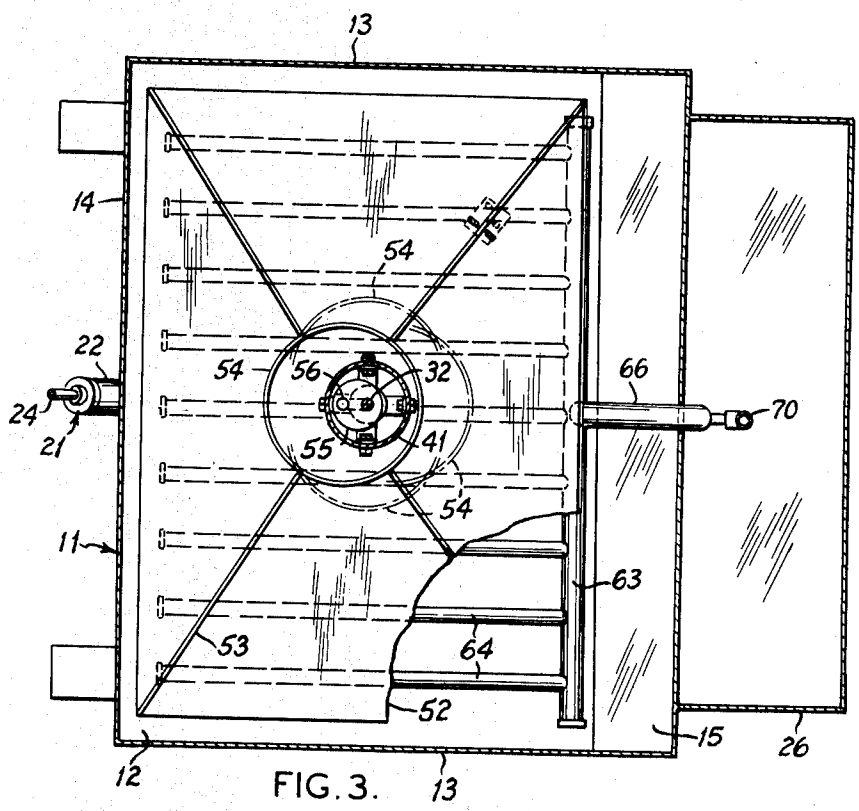


FIG. 3.

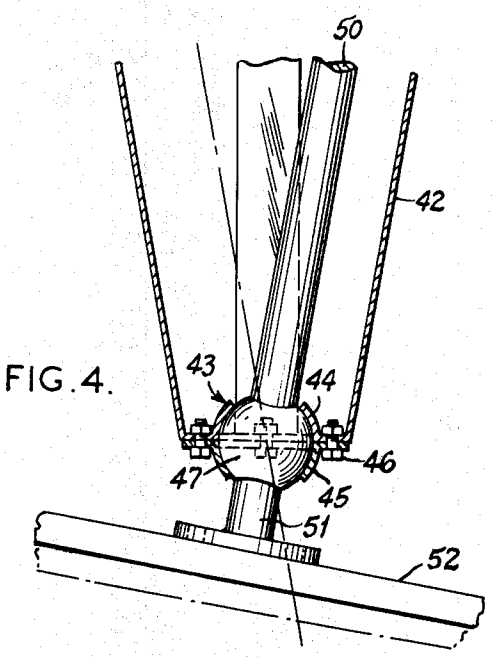


FIG. 4.

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3,227,166

ETCHING MACHINE

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12 Claims. (Cl. 134—94)

This application is a continuation-in-part of copending application Serial No. 25,921, filed May 2, 1960, now Patent No. 3,136,671.

This invention relates generally to improvements in an etching machine, and more particularly to improvements in an apparatus involving an etching bath in which a protective bath additive is utilized.

Various apparatus and methods, together with the attendant advantages, pertaining to so-called powderless etching are fully discussed in the above identified copending application.

An important objective is achieved by submerging the plate to be etched completely in the etching bath, and imparting a wobble motion to the workpiece, while bombarding the lower plate face with a profusion of bubbles passed upwardly through the bath so as to impinge and roll upwardly on the plate. Because of the wobble motion, the direction of bubble flow up along the lower face of the submerged plate is constantly changing.

The protective film formed by the bath additive is in contact with the plate at all times because the plate is submerged in the bath. The air bubbles remove the bath additive in the open areas to be etched. In addition, the flow of the solution across the plate caused by the changing paths of the bubbles and by the wobble motion of the plate, also causes removal of the protective bath additive in the open areas to be etched, yet completely protects the side walls.

Another important objective is realized by the use of the previously described wobble motion of the plate during the etching action in that the tank's size can be only slightly larger than the plate. Obviously, this desirable feature affords the use of a much smaller bath and also saves floor space, all of which contributes considerably to economy of manufacture and operation.

Still another important object is realized by an improved mechanism for actuating the submerged plate with a wobble motion that tilts the plate at a predetermined angle relative to the horizontal or bath level in all directions for optimum side wall uniformity.

An important object is provided by the provision of a rod holding the workpiece, a ball-and-socket connection mounting the rod, and a cam means actuating the rod to impart the wobble motion to the workpiece.

Other important advantages are realized in that the cam means includes a cam plate attached to and driven by a drive shaft, the cam plate engaging and swinging one end of the universally mounted rod to provide the wobble motion without rotating either the rod or workpiece.

Another important object is achieved by the provision of means that interconnect the workholder with a stationary portion of the tank assembly so that the workholder, and hence the workpiece, is precluded from rotation yet allowed to wobble.

Yet another important object is to provide a compact etching machine that is simple and durable in construction, economical to manufacture, efficient in operation, costs less to maintain, reduces bath cost because of the longer bath life obtained and because of the smaller bath size required, enables a reduction in tank size, and which saves floor space.

The foregoing and numerous other objects and advantages of the invention will more clearly appear from the following detailed description of a preferred embodiment, particularly when considered in connection with the accompanying drawings, in which:

FIG. 1 is a top plan view of the etching machine with the top housing broken away to illustrate the drive mechanism;

FIG. 2 is a cross sectional view as seen along line 2—2 of FIG. 1;

FIG. 3 is a view partly in section as seen along line 3—3 of FIG. 2, and

FIG. 4 is an enlarged, fragmentary view partly in section of the ball and socket connection and mounting of the workholder.

Referring now by characters of reference to the drawings, and first to FIGS. 2 and 3, it is seen that the etching machine includes a base generally indicated at **10** which holds a tank referred to at **11**. From FIG. 3, it is seen that the tank **11** has a bottom wall **12**, opposed vertical side walls **13**, a vertical rear wall **14** and an upwardly and outwardly inclined front wall **15**. A lid **16** for the tank **11** is hingedly mounted at **17** to the upper margin of rear wall **14**. Attached to the upper surface of lid **16** is a rearwardly extending arm **20**.

Operatively interconnecting the base **10** with the lid **16** is a hydraulic ram **21** adapted to raise and lower the lid **16** relative to the tank **11**. More particularly, the cylinder **22** of ram **21** is pivotally connected by pin **23** to the base **10** while the coacting piston **24** is pivotally connected by pin **25** to the rearmost end of arm **20**. It is seen from FIG. 2 that as piston **24** is retracted in cylinder **22** the lid **16** is swung upwardly from its closed position illustrated in full lines to the raised position indicated by broken lines. Of course, the ram **21** is allowed to adjust its angular position necessary to provide this result by its pivotal connections **23** and **25** to the base **10** and arm **20**. The piston **24** is then extended to swing the lid **16** to its closed position.

Extending forwardly from the front tank wall **15** is a panel assembly **26** on which the various control instruments such as those indicated at **27** in FIGS. 1 and 2 can be mounted.

The drive mechanism is mounted on and carried by the tank lid **16**. For example, a casting **30** is secured to the top of lid **16**, the casting **30** including an upright post **31** providing a rotative bearing mounting for a vertical drive shaft **32**. A pulley **33** is drivingly connected to the upper end of drive shaft **32**. Mounted on the casting **30** is a drive motor **34** that operates through a speed-reducing unit to rotate a coacting pulley **36**. The pulleys **33** and **36** are operatively interconnected by a drive belt **37**. As is best seen in FIGS. 1 and 2, the drive mechanism is enclosed on the lid **16** by a housing **40**.

Attached to the underside of lid **16** and disposed about the lower end of drive shaft **32** is a cylindrical member **41** that constitutes a part of a wobble-imparting mechanism described in detail subsequently. Attached to the cylindrical member **41** are a plurality (a total of four in the embodiment disclosed) of regularly spaced, depending straps **42**. These straps **42** taper downwardly and are constructed to provide a ball socket formation indicated at **43** and clearly shown in FIG. 4. Specifically, these lower ends of straps **42** are provided with rounded upturned flanges **44**. Cooperating arcuate flanges **45** are secured by fasteners **46** to the underside of the lower ends of straps **42**. These arcuate flanges **44** and **45** cooperate to form the ball socket **43**.

Universally mounted in the ball socket **43** is a ball **47**. Carried by and movable with the ball **47** is a rod **50**. The lower end **51** of rod **50** is attached to a workholder **52**.

The workholder **52** is substantially rectangular in configuration as is best seen in FIG. 3 and closely approximates the internal dimensions of the tank **11**. As will

be clear upon subsequent description of parts, the tank size may be only slightly larger than the workholder **52** because the workholder **52** is not rotated during etching, but on the contrary is moved with a wobble motion.

A plurality of triangular braces **53** are secured to the upper surface of the workholder **52** and are secured together at their upper edges by a circular ring **54**.

Drivingly connected to the lower end of drive shaft **32** is a cam **55**, the cam **55** being provided with an aperture **56** offset laterally from the drive shaft **32**. The upper rod end **57** is disposed in cam aperture **56** and is carried by the cam **55** upon rotation of drive shaft **32**.

In the preferred embodiment, it is seen that the ball **47** and cooperating socket **43** is aligned axially with the drive shaft **32**. Because the upper rod end **57** is offset laterally from the drive shaft axis and is rotated in a circle by the cam **55** upon rotation of the drive shaft **32**, the lower rod end **51** and hence the workholder **52** is moved with a wobble motion so that the workholder **52** is tilted at an angle to the horizontal in all directions.

A workpiece indicated at **60** is attached to the underside of the workholder **52** by any suitable and conventional means, the workpiece **60** being tilted with a wobble motion with the workholder **52**. Preferably, the workpiece **60** is tilted at an approximate angle of eight (8) degrees in all directions for most effective etching action.

The tank **11** holds a quantity of etchant the level of which must be above the corners of the workholder **52** when the corners are in the high position as is indicated by level line **61** in FIG. 2. It will be noted that the workpiece **60** is maintained completely submerged in the etchant bath at all times during etching.

To preclude the workholder **52** and hence the workpiece **60** from rotating during the wobble motion imparted by rod **50**, a pair of resilient fingers **62** grip opposite sides of one of the braces **53** when the lid **16** is closed. The fingers **62** are attached to the underside of lid **16**.

Located at the bottom of tank **11** and supported on the bottom wall **12** is an aeration assembly including a header **63** that operatively connects and communicates with a plurality of elongate, parallel air tubes **64** extending transversely of tank **11**. Each of the air tubes **64** is provided with a plurality of small air holes **65** on its underside. A feed line **66** is connected to the header **63** and also connects to a centrifugal pump (not shown) by tubing **67**. Another tubing **70** communicates the feed line **66** with an air gauge **71** on the control panel **26**, the gauge **71** being used only to check back pressure. Enough air must be put into the system to force it out every hole **65** at the same velocity. To do this, more air is used than can escape out of the system. The back pressure gauge **71** records excess air pressure.

Air is forced through the air tubes **64** and is emitted through the air holes **65** in the form of fine bubbles that rise upwardly through the etching bath and impinge and roll upwardly on the workpiece **60**. In addition to this etching action of the bubbles as explained later, the air emitted through air holes **65** keeps the bath agitated and thoroughly mixed.

As is usual in etching machines and methods of etching, temperature of the bath must be maintained within certain specified limits in order to obtain best results. Formed as a part of the bottom wall **12** are refrigeration coils **72** as is best seen in FIG. 2. Suitable insulation **73** is provided about such coils **72**. Upon selective operation of the refrigeration coils **72**, either manually or automatically by control means, the bath temperature can be maintained at a desired operating point.

It is thought that the operation and functional advantages of the machine and method have become fully apparent from the detailed description of parts, but for completeness of disclosure, such operation will be briefly described.

In making the particular "powderless" etching bath, the tank **11** is filled with water to a preset water gauge and then the nitric acid is added. The water and acid go into solution. This mixture is cooled to about 75 degrees and then the bath additive is introduced. The air pump is turned on and the air emitted from air holes **65** rises upwardly through the bath to provide thorough agitation that mixes the oils, water and acid. Because the mixture is not a true emulsion, the oils will rise to the sur-extremely important that the bath must be agitated before the workpiece **60** is placed into the bath or else the face of the bath if the air is turned off. Therefore, it is oil will cover the workpiece and attach itself so completely that the acid cannot etch the plate at all.

Assuming that the print on the workpiece **60** is properly exposed, developed and burnt-in, the first step is to paint out the large bare zinc areas with any lacquer preparation that will stand up under the acid and the oil in the powderless etching both. The space painting is not absolutely essential to etching and will have very little effect upon the actual etching process. Then, the dry plate is brushed thoroughly with a prepared mixture of nitric acid, water and a metal cleaning solution in order to remove scum. This de-scum solution is flushed off of the plate and then the print is brushed or sponged with a pre-etch solution consisting of nitric acid and water. After pre-etching the plate, the plate is flushed with water prior to gumming. Then a few drops of a regular gum arabic solution is dropped on the wet plate and brushed over the entire surface, thus eliminating oxidation and keeping the plate from drying out while being attached to the workholder **52**.

The air pump is started in order to cause agitation of the bath before the lid **16** is closed. The lid **16** is then closed, and the workpiece **60** is completely submerged in the etching bath. The drive means **34** is energized so as to rotate the drive shaft **32**. As explained previously, upon rotation of the drive shaft **32**, the cam **55** will act through the universally mounted ball **47** and rod **50** to impart a wobble motion to the workholder **52** and hence to the workpiece **60**.

It is seen that etching action is achieved by submerging the workpiece **60** completely in the etching bath and imparting a wobble motion to the workpiece **60** while bombarding the lower plate face with a profusion of bubbles passed upwardly through the bath so as to impinge and roll upwardly on the plate. Because of the wobble motion, the direction of bubble flow up along the lower face of the submerged plate is constantly changing.

Briefly stated, the drive mechanism actuates the submerged workpiece **60** with a wobble motion that tilts the workpiece at a predetermined angle, preferably eight (8) degrees, relative to the horizontal or bath level in all directions for optimum side wall uniformity.

The protective film formed by the bath additive is in contact with the plate at all times because the plate is submerged in the bath. The air bubbles remove the bath additive in the open areas to be etched. In addition, the flow of the solution across the plate caused by the changing paths of the bubbles and by the wobble motion of the plate, also causes removal of the protective bath additive in the open areas to be etched, yet completely protects the side walls. For example, the air bubbles remove the oil in the open areas to be etched, allowing the acid to act, but as any bubble moves along the plate, the bath following the bubbles again covers the plate and the protective oil or bath additive again provides side wall protection.

With the workpiece **60** tilted there is less action on the side opposite to the direction of bubble flow. The greater side wall protection is formed on the high side of the image, and because of the wobble motion of the workpiece **60** all sides of all images are put on the high side and hence the side walls are evenly protected. This produces better protection and again aids in producing shoulders or side walls with less porosity. When poros-

ity is eliminated or greatly reduced, half-tone etching, especially fine line half-tones, takes on added quality.

During the wobble motion of the workpiece **60**, the workholder **52** and hence the workpiece **60** are precluded from rotation. By using only a wobble motion of the plate during the etching action in the tank **11**, the tank size can be only slightly larger than the workpiece **60**. Obviously, this desirable feature affords the use of a much smaller bath and also saves floor space, all of which contribute considerably to economy of manufacture and operation.

Although the invention has been described by making detailed reference to a single preferred embodiment, such detail is to be understood in an instructive, rather than in any restrictive sense, many variants being possible within the scope of the claims hereunto appended.

I claim as my invention:

1. In an etching machine:
(a) a tank holding etchant,
(b) means holding a workpiece submerged in said etchant,
(c) means releasing air bubbles in said etchant below the workpiece,
(d) means imparting a wobble motion to the workpiece to tilt the workpiece in all directions at an angle to the horizontal so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing, and
(e) means precluding rotation of said workpiece during said wobble motion.

2. In an etching machine:
(a) a tank holding etchant,
(b) means including a ball and socket connection holding a workpiece submerged in said etchant,
(c) means releasing air bubbles in said etchant below the workpiece, and
(d) cam means imparting a wobble motion to the workpiece through the ball and socket connection so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

3. In an etching machine:
(a) a tank holding etchant,
(b) a rod holding a workpiece submerged in said etchant,
(c) a ball and socket connection mounting said rod,
(d) means releasing air bubbles in said etchant below the workpiece, and
(e) cam means actuating said rod to impart a wobble motion to the workpiece through the ball and socket connection so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

4. In an etching machine:
(a) a tank holding etchant,
(b) a rod holding a workpiece submerged in said etchant,
(c) a ball and socket connection mounting said rod,
(d) means releasing air bubbles in said etchant below the workpiece,
(e) a drive shaft,
(f) a cam plate attached to and rotated by said drive shaft, the cam plate being operatively connected to said rod to swing the rod and hence impart a wobble motion to the workpiece so as to tilt the workpiece at an angle to the horizontal in all directions so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

5. In an etching machine:
(a) a tank holding etchant,
(b) a rod having one end operatively attached to a workpiece and holding said workpiece submerged in said etchant,
(c) a ball and socket connection mounting said rod,

(d) means releasing air bubbles in said etchant below the workpiece,
(e) a drive shaft,
(f) a cam plate attached to and rotated by said drive shaft, the cam plate being provided with an opening, and
(g) said rod having its opposite end received loosely in said opening yet connected to the cam plate so that the plate swings the rod and hence imparts a wobble motion to the workpiece through the ball and socket connection so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

6. In an etching machine:
(a) a tank holding etchant,
(b) a rod,
(c) a ball and socket mounting said rod between its ends, a workholder attached to one end of said rod and holding a workpiece submerged in said etchant,
(d) means releasing air bubbles in said etchant below the workpiece,
(e) a drive shaft,
(f) a cam plate attached to and rotated by said drive shaft, said cam plate being provided with an opening,
(g) said rod having its opposite end received loosely in said opening yet operatively connected to the cam plate so that the plate swings the rod and hence imparts a woble motion to the workholder and hence to the workpiece through the ball and socket connection so as to tilt the workpiece at an angle to the horizontal in all directions so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing, and
(h) means engaging said workholder to preclude rotation of said workpiece during said wobble motion.

7. In an etching machine:
(a) a tank holding etchant,
(b) a rod holding a workpiece submerged in said etchant,
(c) means universally mounting said rod between its ends,
(d) means releasing bubbles in said etchant below said workpiece, and
(e) means swinging said rod about its mounting to impart a wobble motion to the workpiece so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

8. In an etching machine:
(a) a tank holding etchant,
(b) a rod holding a workpiece submerged in said etchant,
(c) a ball and socket connection universally mounting said rod between its ends,
(d) means releasing bubbles in said etchant below said workpiece,
(e) a drive shaft, and
(f) a cam plate attached to and rotated by said drive shaft, the cam plate being operatively connected to said rod to swing the rod and hence impart a wobble motion to the workpiece through the ball and socket connection so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

9. In an etching machine:
(a) a tank holding etchant,
(b) a rod,
(c) a ball and socket universally mounting said rod between its ends,
(d) a workholder for a workpiece attached to one end of said rod and submerged in said etchant,
(e) means releasing bubbles in said etchant below the workpiece,
(f) a drive shaft,
(g) a cam plate attached to and rotated by said drive shaft, the cam plate provided with an opening, and

(h) the opposite end of said rod being received loosely in said opening yet connected to the cam plate so that the plate swings the rod and hence imparts a wobble motion to the workholder and workpiece through the ball and socket connection to tilt the workpiece at an angle to the horizontal at all directions so that the direction of bubble flow up along the upper face of the submerged workpiece is constantly changing.

10. In an etching machine:

(a) a tank holding etchant,

(b) means including a socket,

(c) a ball loosely mounted in said socket,

(d) a workholder adapted to hold a workpiece,

(e) means attaching said workholder to said ball for movement therewith and holding said workpiece submerged in said etchant,

(f) means releasing bubbles in said etchant below said workpiece, and

(g) means moving said ball in said socket to impart a wobble motion to the workpiece so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

11. In an etching machine:

(a) a tank holding etchant,

(b) means including a socket,

(c) a ball loosely mounted in said socket,

(d) a workholder adapted to hold a workpiece,

(e) a rod having one portion attaching said workholder to said ball for movement therewith and holding said workpiece submerged in said etchant,

(f) means releasing bubbles in said etchant below said workpiece,

(g) a drive shaft,

(h) a cam plate attached to and rotated by said drive shaft, and

(i) said rod having another portion operatively connected to said cam plate so as to swing the rod and hence impart a wobble motion to the workpiece so that the direction of bubble flow up along the lower face of the submerged workpiece is constantly changing.

12. The combination and arrangement of elements as recited in claim **11**, but further characterized by the provision of means engaging said workholder to preclude rotation of said workpiece during said wobble motion.

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