Jan. 8, 1963 C. S. MARTZ 3,072,133

ETCHING APPARATUS AND METHOD OF ETCHING

Filed April 13, 1959 2 Sheets-Sheet 1

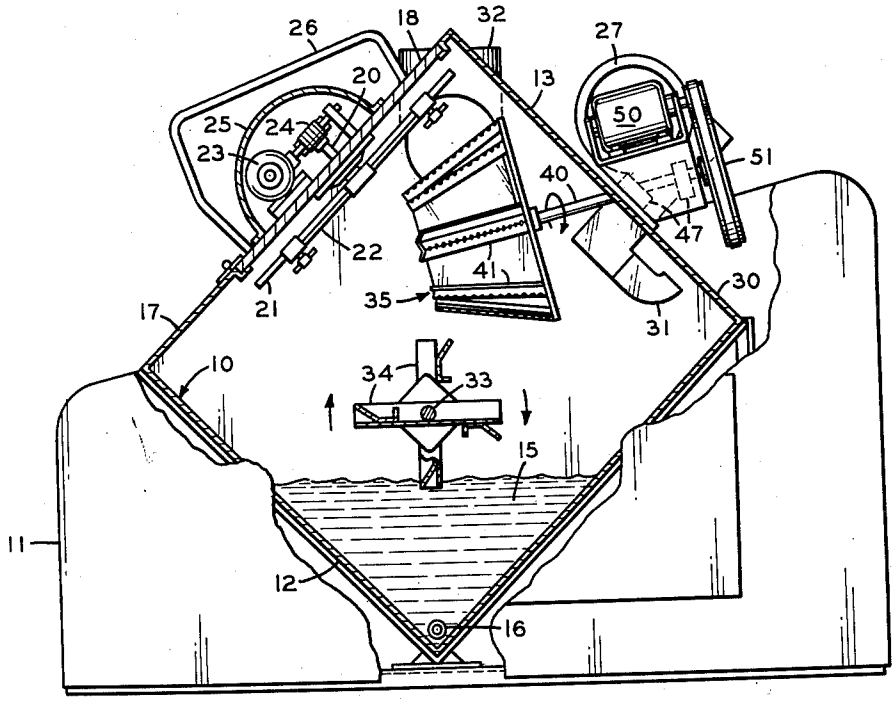


FIG. 1

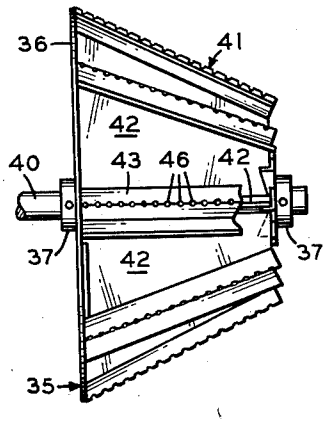


FIG. 2

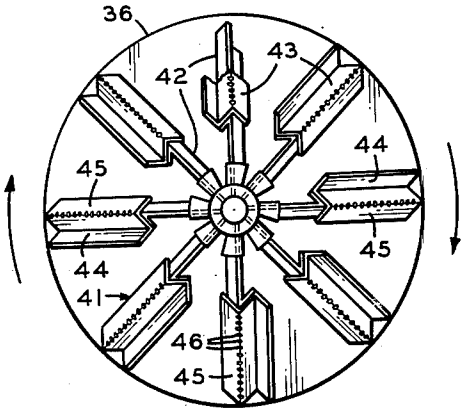


FIG. 3

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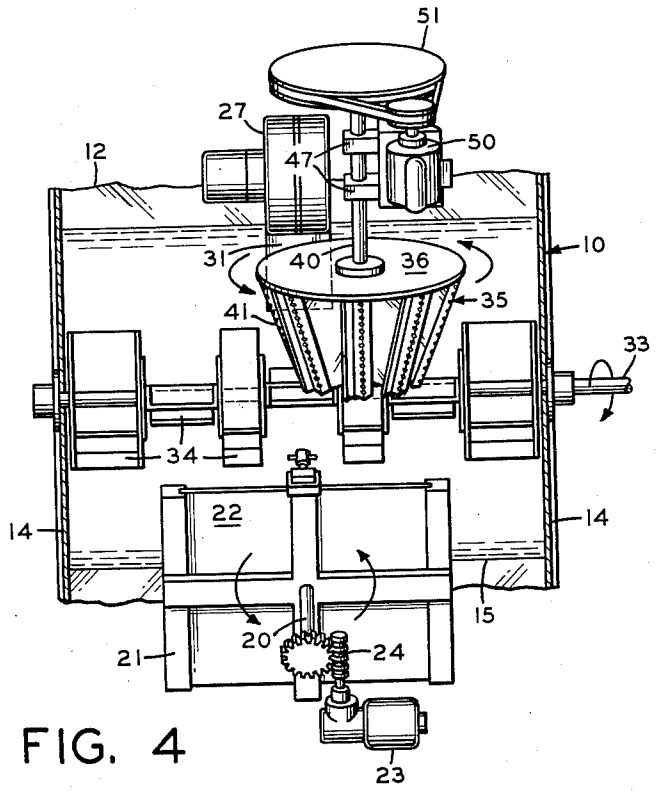


FIG. 4

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3,072,133
ETCHING APPARATUS AND METHOD OF ETCHING

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5 Claims. (Cl. 134—183)

This invention relates generally to improvements in etching apparatus and method of etching, and more particularly to improvements in mechanism for and method of distributing etchant on a work piece.

An important objective of the present invention is to provide means in an etching tank which is adapted to catch the etchant as it is deflected off of the work piece after being thrown on the work piece by a primary distributing means, such etchant catching device being adapted to throw the etchant immediately back onto the work piece.

The present development provides improved etching results in that the etching is done faster and the depth of etching is greater and more uniform.

Another important object is provided by the structural arrangement of a work piece in an etching tank above a supply of etchant in a position so that an etchant spray thrown on the work piece from the etchant supply is deflected off at an angle and in a path so that the deflected etchant spray is caught by a secondary distributing means. The secondary distributing means is constructed and positioned so that it catches the deflected etchant spray and throws it back on to the work piece immediately for improved etching results.

Still another important object is realized by the provision of a turbine distributor disposed in the path of the etchant spray as it is deflected from the work piece, the turbine distributor having vanes that are adapted to throw the etchant back on the work piece upon rotation of the turbine distributor.

Yet another important object is achieved by the particular structural arrangement of the turbine distributor so that it is adapted to catch the etchant spray and redistribute it immediately back on the work piece. The turbine distributor consists of a plate that is rotatively mounted on a shaft, and a plurality of vanes extending outwardly from one side of the plate and extending radially outwardly from the rotative axis.

Other important advantages are realized by providing a substantially S-shaped element on the end of each vane, such element being provided with holes through which etchant is discharged and being connected to the web of the vane so that its structure realizes more efficient distribution of etchant upon rotation of the turbine distributor.

Another important objective is achieved by the improved method of etching which comprises the steps of throwing the etchant in a spray in one direction on to a work piece disposed at an acute angle to the direction of spray, catching the etchant as it deflects from the work piece in another direction, and immediately throwing the caught etchant back so as to redistribute the etchant on the work piece.

Another important object is achieved by providing an etching machine having a turbine distributor constituting a secondary distributing means, such apparatus being simple and durable in construction, efficient in operation and economical to manufacture.

This application is a continuation-in-part of copending application filed March 24, 1958, Serial No. 723,532 and entitled Etching Machine and Paddle Element Therefor, now U.S. Patent No. 2,976,635.

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 side elevational view of the etching machine, illustrating the tank broken away in order to more clearly show the structure and the relationship of the component parts mounted within such tank;

FIG. 2 is a side elevational view of the turbine distributor having one vane partially broken away to more clearly illustrate the construction;

FIG. 3 is an end elevational view of the turbine distributor as seen from the right of FIG. 2, one of the vanes being broken away in order to more clearly illustrate the construction, and

FIG. 4 is a top plan view of the component parts of the etching machine with the top portion of the tank broken away in order to more clearly illustrate the structural relationship of the work piece, paddles and turbine distributor.

Referring now by characters of reference to the drawings, and first to FIG. 1, it is seen that the etching machine includes an etchant tank, generally indicated at **10**, which consists of a substantially cubical container disposed on one corner and supported by side members indicated at **11** that seat on a subjacent supporting surface such as a floor. When disposed on one corner, as described, the tank **10** includes a V-shaped bottom wall **12** and an inverted V-shaped top wall **13**. As seen in FIG. 4, the tank **10** is partially defined by opposed side walls **14**.

The tank **10** is adapted to hold a quantity of etching liquor **15**. A perforated pipe **16** is located at the apex of the lower V-shaped tank wall **12** and is submerged in the etchant supply **15**. Air is forced through pipe **16** and is emitted from pipe **16** in the form of many fine bubbles that agitate the etchant supply **15** and serve to raise the etchant level for the purpose more fully described in applicant's above identified copending application.

The forward portion **17** of inverted V-shaped top wall **13** is provided with a hinged lid **18** that opens to the interior of tank **10**. Rotatively mounted by drive shaft **20** on lid **18** is a clamping device **21** adapted to hold the work piece to be etched. Such a work piece **22** is shown attached to the clamping device **21** in FIG. 4. The lid **18** may be opened about its hinged connection in order to attach the work piece **22** to the clamping device **21**. Then, the lid **18** is closed, in which position the clamping device **21** and work piece **22** are located within the tank **10**. As best seen in FIG. 1, the work piece is held in an inclined position relative to the vertical.

Power means is provided for rotating the clamping device **21**, and hence rotating the work piece **22** during the etching process. An electric motor **23** is operatively connected to the drive shaft **20** through gearing **24**, such power means being mounted on the top side of hinged lid **18**. A housing **25** is disposed over the drive means **23—24** and mounted on the lid **18**.

A handle means **26** is attached to lid **18** to facilitate opening and closing of the lid.

A blower **27** is mounted on the rear portion **30** of the inverted V-shaped top wall **13**. The blower **27** is adapted to blow air through duct **31** into the interior of etching tank **10**, thus passing a continuous flow of cooling air over the etchant supply **15**. The air introduced into the tank **10** by means of the perforated pipe **16** and the blower **27** is exhausted back into the atmosphere through chimney pipe **32** mounted on one side wall **14** of tank **10** adjacent the apex of the inverted V-shaped top wall **13**.

A paddle shaft **33** is rotatively mounted on side tank walls **14**, one end of shaft **33** extending outwardly of the tank **10** for operative connection to a drive means (not

shown) adapted to rotate the shaft 33. Fixed on shaft 33 and located within the tank 10 are a plurality of paddles 34 which are adapted to dip into the etchant supply 15 and throw the etchant upwardly onto the work piece upon rotation of shaft 33. The particular structure, mode of operation and functional results of paddles 34 are described more fully in applicant's above identified co-pending application.

Located above the paddles 34 and at one side of the work piece 22 within tank 10 is a turbine distributor generally indicated at 53. The detailed structure of the turbine distributor 35 is perhaps more clearly shown in FIGS. 2 and 3.

This turbine distributor 35 includes a circular rear plate 36 fixed to a sleeve 37 that is drivingly attached to a shaft 40. A plurality of vanes indicated at 41 are attached to one side of end plate 36 and central sleeve 37. The vanes 41 taper forwardly from the rear plate 36 and extend radially outwardly from the central sleeve 37.

Each vane 41 includes a web 42 that extends radially outwardly from the center rotative axis. Attached to the outer end of each web 42 is a substantially S-shaped plate element 43 that provides an outwardly facing trough portion 44 and inwardly facing trough portion 45. Each web 42 is connected to the S-shaped plate element 43 substantially at the apex of the inwardly facing trough 45. The S-shaped plate 43 is provided with a plurality of apertures 46 along the apex of the inwardly facing trough 45 at that side of the web 42 that leads in the direction of rotation as is best shown in FIG. 3. It is seen that with this structure, upon rotation of the turbine distributor 35, the S-shaped plate 43 is disposed so that the inwardly facing trough 45 leads the outwardly facing trough 44.

The drive shaft 40 of the turbine distributor 35 extends outwardly of tank 10 and is supported on the rear portion 30 of the inverted V-shaped top wall 13 by a pair of self-aligning bearings 47. An electric motor 50 mounted on tank 10 is drivingly attached to the shaft 40 by a belt and pulley connection referred to generally at 51.

It is thought that the method of etching, mode of operation of the etching machine and its functional results, all have become fully apparent from the foregoing detailed description of parts, but for completeness of disclosure the method and operation will be briefly set forth.

It is seen that the work piece 22 is disposed above the etchant bath and rotated during etching. The etchant is picked up from the etchant supply 15 and thrown upwardly onto the work piece 22 in a spray. The etchant spray deflected from the work piece 22 is caught and thrown immediately back on to the work piece for further etching action.

From FIG. 1, it is apparent that the etchant is thrown upwardly from the etchant bath in one direction on to the work piece 22 that is held at an inclined position relative to the vertical. The etchant spray deflecting from the work piece 22 travels in another direction and is caught. The caught etchant spray is then immediately thrown back substantially in the direction of the deflected etchant spray on to the work piece for further etching.

Describing the operation more fully relative to the structure, it is seen that the tank is first supplied with a quantity of etchant 15. Then the work piece 22 is clamped in place on the article-positioning means 21 and rotated by the drive means 23—24. The paddles 34 are then rotated in the direction illustrated by arrows in FIGS. 1 and 4, and the turbine distributor is rotated in the direction illustrated by the arrows in FIGS. 1, 3 and 4.

The padles 34 dip into the etchant supply 15 and throw the etchant in a spray upwardly on to the work piece 22. A certain portion of the etchant spray is deflected from the work piece 22 and caught by the turbine distributor 35. More particularly, the deflected etchant spray is caught by the rear plate 36 of the turbine distributor, moved outwardly, under the centrifugal force created by rotation of the turbine, along the webs 42 and guided into the inwardly facing trough portion 45 of the S-shaped plate element 43. This etchant within the inwardly facing trough 45 of the plate element 43 is thrown outwardly through the apertures 46 back on to the work piece 22.

Some of the deflected etchant spray does not reach the interior of the vanes 41, but is caught by the outwardly facing trough portion 44 of each plate element 43. Upon rotation of the turbine distributor 35, the rear lip defining the outwardly facing trough portion 44 serves to throw the etchant caught in the trough portion 44 outwardly back onto the work piece 22. Thus it is seen that because of the particular structure of the S-shaped plate element 43, there is a dual action in redistributing the deflected etchant spray back on to the work piece. This provides a faster and improved etching operation.

A minor portion of the etchant thrown upwardly by paddles 34 does not reach the work piece 22, but because of the particular structural relationship of the turbine distributor above the paddles 34, the outwardly facing trough portion 44 of each plate element 43 catches this part of the etchant spray and throws it onto the work piece upon rotation of the turbine distributor 35.

The etching solution collected by the turbine distributor 35 is that portion which deflects or drops off of the plate being etched and that portion which is thrown too low by the paddles to reach the plate. The turbine distributor then redistributes this caught etchant to the upper portion of the plate which is least affected by the normal paddle action. This improved distribution of the etchant on the work piece, as provided by the turbine distributor 35, results in a faster etching action and provides a greater and more uniform depth of etching.

Although the invention has been described by making detailed reference to a method of etching and a single preferred embodiment of an etching machine, 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 apparatus, a tank for holding a supply of etchant, means in the tank engaging the etchant supply for throwing the etchant in a spray in one direction, means supporting the work piece in the tank in the etchant spray and disposing the work piece at an acute angle to the direction of spray, and a turbine distributor in the tank above and out of the etchant supply and disposed in the path of the etchant as it deflects directly from the work piece, and means rotating the turbine distributor, the turbine distributor having means throwing the caught etchant directly back on the work piece.

2. In an etching apparatus, a tank for holding a supply of etchant, support means located above the etchant supply, a work piece held by said support means, paddle means mounted in the tank and engaging the etchant supply, means rotating the paddle means to throw an etchant spray upward onto the work piece, the support means holding the work piece at an acute angle to the direction of etchant spray, a turbine distributor mounted in the tank above and out of the etchant supply and at one side of the work piece to catch the spray deflected directly from the work piece, and means for rotating said turbine distributor, the turbine distributor having vanes throwing the caught deflected etchant spray back onto the work piece.

3. The combination and arrangement of elements as recited above in claim 2, but further characterized in that the turbine distributor includes a back plate extending crosswise to the direction of deflected spray from the work piece, said vanes extending from one side of the plate and extending radially outward from the rotative axis of the plate.

4. In an etching apparatus, a tank holding a supply of etchant, the tank including an inverted V-shaped top

wall above the etchant supply, support means mounted on one portion of the inverted V-shaped top wall, a turbine distributor mounted on the other portion of said inverted V-shaped top wall, a workpiece held by said support means, paddle means mounted in said tank and engaging the etchant supply, means rotating the paddle means to throw an etchant spray on the work piece, the turbine distributor being located above and out of the etchant supply and above the paddle means and being located at one side of the work piece to catch the etchant spray deflected directly from the work piece, the turbine distributor having a back plate with a plurality of vanes extending from one side of the plate and extending radially outward from the rotative axis of the plate, and means attached to the plate for rotating the turbine distributor, the vanes throwing the deflected etchant spray back onto the work piece.

5. In an etching apparatus, a tank holding a supply of etchant, means in the tank adapted to support a work piece above the etchant supply, means engaging the etchant supply for throwing an etchant spray on the work piece, a turbine distributor located above and out of the etchant supply, and located at one side of the work piece, the turbine distributor having means catching the etchant spray deflected directly from the work piece, and means for rotating the turbine distributor, the turbine distributor having means throwing the deflected etchant spray back on the work piece.

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