March 28, 1961 C. S. MARTZ 2,976,635

ETCHING MACHINE AND PADDLE ELEMENT THEREFOR

Filed March 24, 1958 3 Sheets-Sheet 1

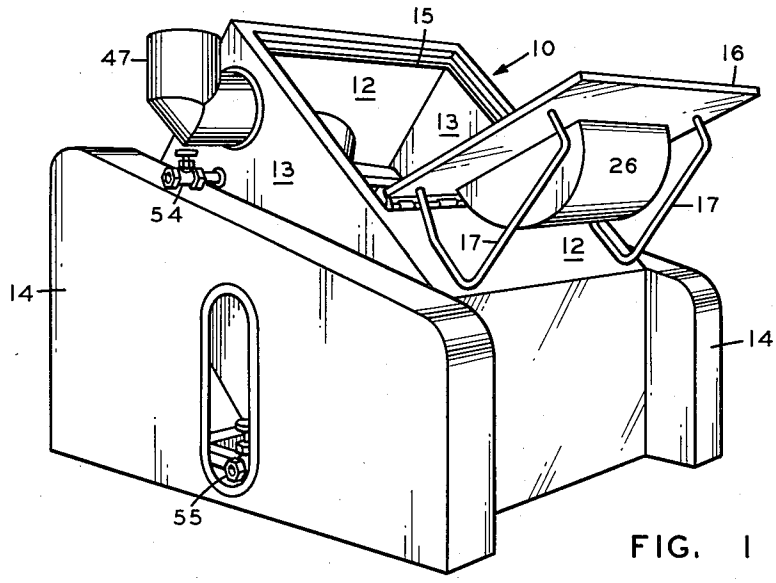


FIG. 1

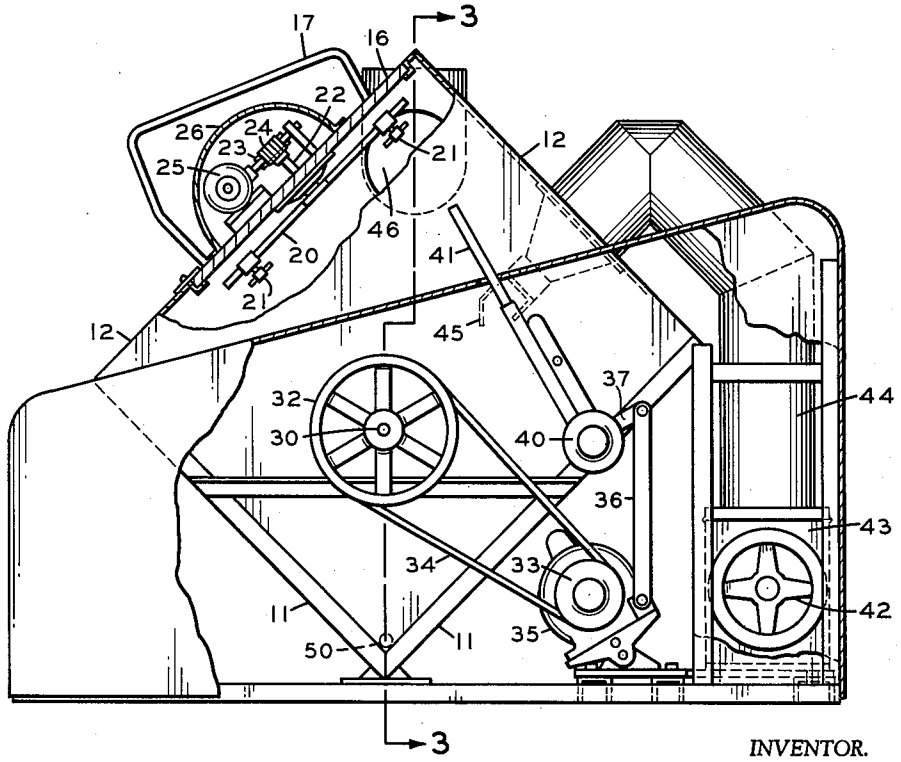


FIG. 2

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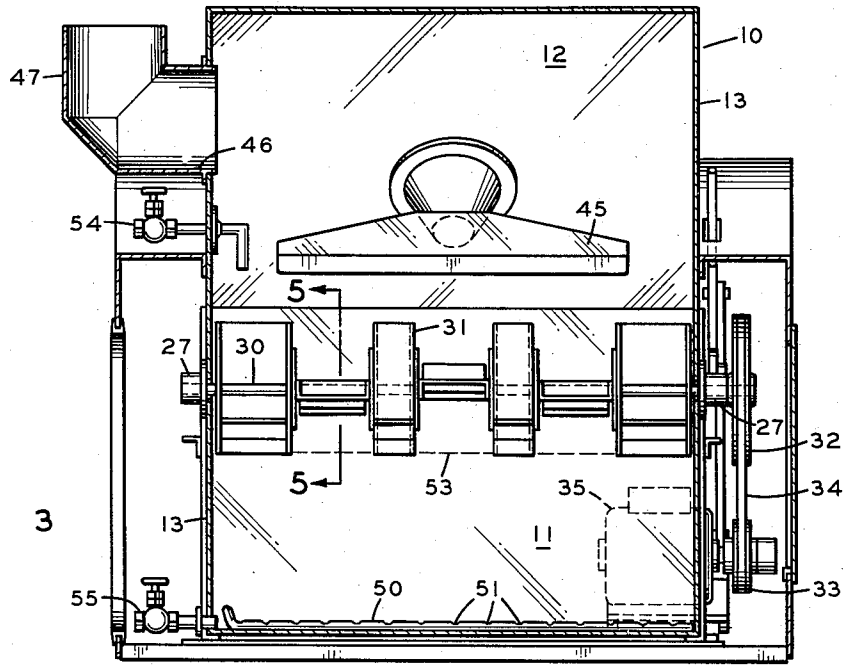


FIG. 3

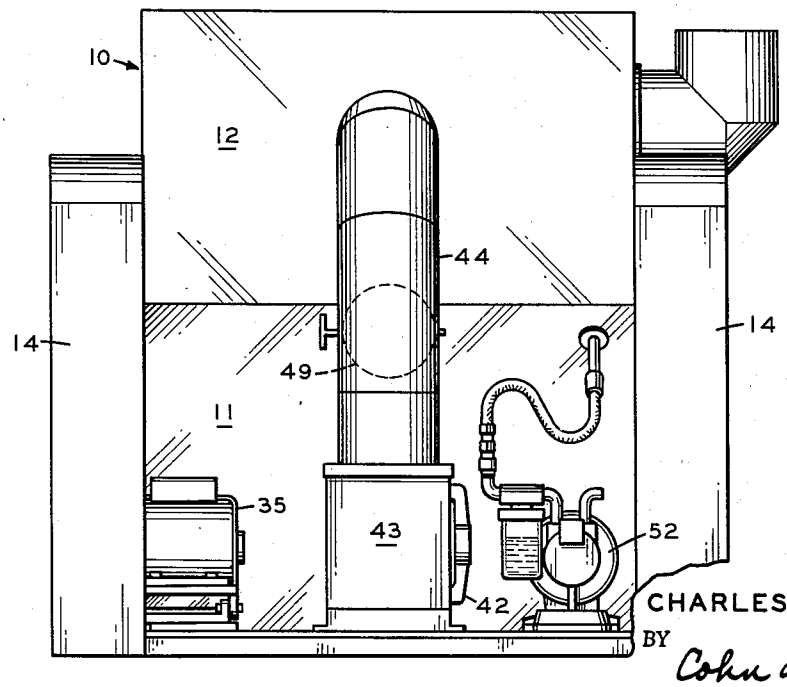


FIG. 4

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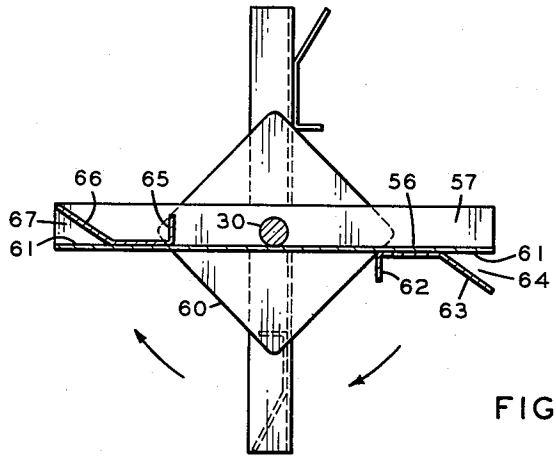


FIG. 5

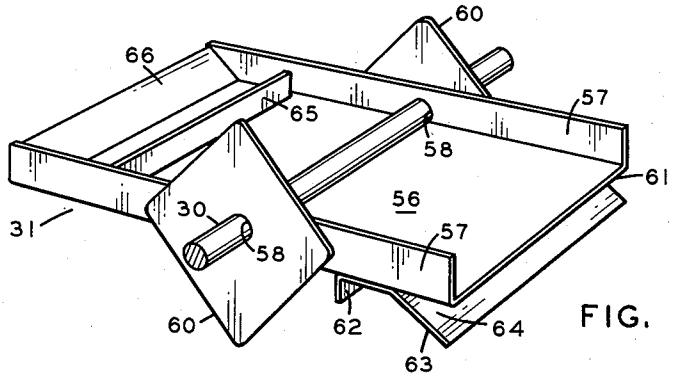


FIG. 6

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ETCHING MACHINE AND PADDLE ELEMENT THEREFOR

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10 Claims. (Cl. 41—9)

This invention relates to improvements in an etching machine.

It is a major objective of the present improvements to provide a paddle construction particularly adapted for use in an etching machine which realizes a more effective and efficient distribution of the etchant on the work piece.

An important objective is achieved by the provision of an air agitator for the supply of etchant in the tank which operates to raise the etchant level so that particular paddle portions will effectively contact and hold etchant upon operation of the paddle.

Another important object is realized by the construction and disposition of the etchant tank so that a minimal quantity of etchant can be used, thus resulting in considerable economies because the etchant is easily contaminated and requires replacement at frequent intervals.

Yet another important object is provided by an improved tank construction and cooperating apparatus for cooling the etchant during the etching process.

Still another important object is achieved by the provision of an etching machine that is durable in construction, and economical and efficient in operation.

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 perspective view of the etching machine with the lid in an opened position;

Fig. 2 is a side elevational view of the etching machine showing various parts broken away to more clearly illustrate the paddle drive, the cooling mechanism, and the work-supporting and -rotating mechanism;

Fig. 3 is a cross sectional view of the machine as seen along staggered line 3—3 of Fig. 2;

Fig. 4 is a rear elevational view of the etching machine;

Fig. 5 is an enlarged cross sectional view of the paddle as seen along line 5—5 of Fig. 3, and

Fig. 6 is a perspective view of one paddle with connected gussets.

Referring now by characters of reference to the drawings, it is seen that the tank generally indicated at **10** is a box-like structure including angularly related bottom walls **11** arranged with their apex lowermost as is more clearly illustrated in Fig. 2. Further, tank **10** includes angularly related top walls **12** connected to bottom walls **11**, and includes side walls **13**.

Holding the tank **10** in its inclined position are a pair of side supports **14** which are attached to the side walls **13** of the tank and are provided with lower margins that seat on a subjacent surface such as the floor.

The front top wall **12** of the tank **10** is provided with an aperture **15** that extends substantially the width of the tank. The opening **15** is closed by a lid **16** hinged to the front top wall **12**. A pair of handles **17** is attached to lid **16** to facilitate opening and closing of the lid, the handles formed to seat on the front top wall **12** when the lid **16** is opened so as to retain the lid in such open position.

The work piece to be etched is disposed in the tank **10** above the etchant level. More particularly, the work piece is attached to holder bars **20** by clamps **21**, the holder **20** being carried by shaft **22** extending through lid **16**. A gear **23** on shaft **22** engages worm gear **24** provided on the drive shaft of motor **25**. A housing **26** is placed over the motor **25** and gearing **23—24** and is secured to the top of lid **16**.

Journalled in bearings **27** between side walls **13** of the etchant tank, is a paddle shaft **30**. A plurality of paddles generally referred to at **31** are attached to shaft **30** in angularly staggered relation. Figs. 3 and 5 illustrate that each paddle **31** is arranged at approximately right angles to each adjacent paddle on the shaft **30**.

One end of paddle shaft **30** is provided with a pulley **32** connected to a motor pulley **33** by a belt **34**. Electric motor **35** is mounted at the rear of the tank **10**.

A variable speed transmission is provided by arms **36** pivotally connected to the motor **35**, smaller arm **37** being pivoted to arm **36** and attached to pivot plate **40**, and handle **41** being attached to pivot plate **40**. The belt and pulley assembly and the transmission mechanism are located within the housing provided by side support **14**. The handle **41** extends upwardly through one side support **14** for ready manipulation.

Located at the rear of tank **10** is a squirrel cage fan **42** located within housing **43**. Pipe **44** extends upwardly from housing **43** and extends through the back top wall **12** of tank **10**. The pipe **44** places the interior of tank **10** in communication with fan **42**.

A trough-like nozzle **45** is attached to the upper end of pipe **44**, the nozzle **45** being located within the tank **10** and extending substantially the entire width of such tank so that the cooling air supplied by fan **42** is delivered over the etchant for substantially the entire width of the tank.

The heated air is exhausted from tank **10** through an exhaust port **46** provided in the upper portion of one side wall **13**. A chimney pipe **47** is attached to side wall **13** at exhaust port **46** and extends upwardly.

It is seen that the cooling air supplied by fan **42** is delivered downwardly over the etchant by nozzle **46**, is heated by the etchant and is forced outwardly through exhaust port **46**. A baffle **49** is provided in pipe **44** to control the flow of air from the fan to the nozzle **45**.

Disposed transversely of tank **10** and located at the apex of bottom walls **11** is a tubing **50** that is provided with a plurality of air holes **51**, best shown in Fig. 3. The tubing **50** extends outwardly of one side wall **13** and rearwardly for connection to a compressor unit **52**.

As will be explained more fully in subsequent description of parts, the tank **10** is filled with an etchant to the level indicated by dotted lines in Fig. 3 and referred to by reference numeral **53**. The etchant level **53** is just above the lower end of the paddles **31** when disposed in a vertical position. In order for the paddles **31** to operate efficient and effectively, the etchant level **53** must be raised slightly during operation of the etching machine. For this purpose, the air bubbles emitting from air holes **51** cause a turbulence in the etchant at the etchant level **53** which has the effect of raising such level. In addition, aeration of the etchant by the air supplied through tube **50** mixes the etchant thoroughly and maintains the temperature within the desired limits.

The etchant is introduced into tank **10** through the inlet valve and tube **54**, and is drained through valve and tube **55**.

The paddles **31** utilized in the etching machine are of identical construction, differing only in width. The paddle construction is best shown in Figs. **5** and **6**.

Each paddle 31 includes a body portion formed of a channel member having a flat web plate 56 and side flanges 57. Aligned apertures 58 are provided in side flanges 57 closely adjacent the web plate 56, the apertures 58 receiving the paddle shaft 30. Gusset plates 60 are attached to the outer surfaces of side flanges 57 and are disposed over the paddle shaft 30, the gusset plates 60 serving to connect and maintain adjacent paddles 31 in right-angular relation.

The ends of web plate 56 are provided with straight transverse margins that serve as etchant-engaging lips 61.

Attached to one side of web plate 56 at one end of paddle 31 is a plate member consisting of a baffle flange 62 extending transversely of the web plate 56, and an inclined leading lip 63 extending transversely of the web plate 56 and inclined forwardly of straight trailing lip 61 in the direction of paddle rotation to provide a pocket 64 therebetween. It will be noted that when the paddle 31 is disposed in a vertical plane, the outer edges of inclined lip 63 and straight lip 61 lie in the same horizontal plane.

A similar plate member is attached to the other side of web plate 56 at the opposite end of the paddle 31. This plate member includes a baffle flange 65 extending transversely of the web plate 56 in bridging relation to side flanges 57. Further, an inclined leading lip 66 is provided, extending forwardly in the direction of paddle rotation to form a pocket 67 with straight trailing lip 61.

Again it will be noted that the outermost edges of lip 66 and lip 61 lie in substantially the same horizontal plane when the paddle is disposed vertically.

Assuming a clockwise rotation as indicated by the arrows in Fig. 5, it will be seen that the inclined lip 63 dips into and scoops up a quantity of etchant, such etchant being held by the trough formation formed by baffle flange 62 and inclined lip 63. The etchant scooped up by inclined lip 63 is thrown upwardly against the work piece upon further rotation of paddle 31.

Following the movement of inclined lip 63 into the etchant, the straight lip 61 dips into the etchant also and scoops a quantity into the open-end pocket 64. As explained previously, this action is possible since the turbulence in the etchant level caused by aeration has the effect of raising the etchant level behind the inclined lip 63. The etchant carried by pocket 64 is thrown substantially radially outwardly upon the work piece upon further rotation of paddles 31.

Upon continued rotation of paddle 31, the opposite end of the paddle comes into operative contact with the etchant. First, the inclined lip 66 dips into and scoops up a quantity of etchant into the compartment formed by inclined lip 66, baffle flange 65 and the bridging portions of side flanges 57. Obviously, this structure of the paddle 31 holds a greater amount of etchant for a longer period of time during rotation than does the pocket formed by flanges 62 and lip 63 at the opposite end of the paddle previously described. Thus, upon continued rotation of paddle 31 the etchant held by lip 66 and flange 65 is deposited at a point higher up on the work piece.

Following the action of inclined lip 66, the straight lip 61 immediately behind dips into and scoops up a quantity of etchant into pocket 67. Again, it is obvious that the etchant in pocket 67 will be held for a greater period of time than the etchant disposed in corresponding pocket 64 at the opposite end of the paddle 31 because of the provision of enclosing side portions formed by side flanges 57.

As explained previously with respect to lip 61 at the opposite end of paddle 31, the straight lip 61 partially defining pocket 67 dips into the etchant because the aeration of the etchant has the effect of raising the etchant level immediately behind the inclined lip 66. The etchant held by pocket 67 is thrown radially outwardly and deposited on the work piece upon continued rotation of paddle 31.

The particular structure of the paddle, and the efficient and effective operation of the component parts in depositing etchant on the work piece provides a complete and uniform etching of the work piece.

In utilizing the etching machine, the work piece is clamped to holder 20 and motor 25 is energized to rotate the work piece when the lid 16 is closed. A predetermined amount of etchant is introduced into the tank 10, and the aerator is started to mix the etchant and cause turbulence at the etchant level. Further, the fan 42 is energized to introduce a supply of cooling air into the tank compartment above the etchant level and to force the heated air out of the exhaust port 46. Then, motor 35 is energized to rotate the paddle shaft and the paddles 31. As described previously, the paddles operate to deposit the etchant onto the work piece. After elapse of a predetermined time period sufficient to cause complete etching of the work piece, the motor 33 is deenergized and the rotation of paddles 31 is stopped.

Motor 25 is then deenergized to stop rotation of the work piece. Then, the lid 16 is opened and the work piece removed from holder 20.

Although the invention has been described by making detailed reference to a single preferred embodiment, and parts thereof, 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. A paddle for an etching machine comprising a body member having means for providing a transverse rotative axis, the body member including a leading lip and a trailing lip at one end, said lips being angularly related to provide an open-end pocket therebetween, said lips extending for substantially the same distance from the said rotative axis so that said trailing lip is adapted to scoop etchant into said pocket.

2. The combination and arrangement of elements as recited above in claim 1, but further characterized in that the body member is provided with side flanges between said lips.

3. A paddle for an etching machine comprising a body member, means on said body member for providing a transverse rotative axis medially, the body member including at each end on opposite sides of the rotative axis, a straight trailing lip and leading lip inclined relative to said trailing lip to provide an open-end pocket therebetween, said lips extending for substantially the same distance from said rotative axis so that said trailing lips are adapted to scoop etchant into said pockets.

4. A paddle for an etching machine comprising a body member, means medially on said body member providing a transverse rotative axis, the body member including at each end an outwardly projecting trailing lip and a leading lip inclined relative to said trailing lip to provide an open-end pocket therebetween, said lips extending substantially the same distance from said rotative axis so that said trailing lips are adapted to scoop etchant into said pockets, a baffle flange extending transversely of the body member on each side of the rotative axis, the baffle flange of each end being spaced inwardly from the leading lip, the baffle flange and leading lip at one end being adapted to hold a quantity of etchant, and side flanges on the other end of said body member between the baffle flange and leading lip to provide a compartment adapted to hold a greater amount of etchant for a longer period during paddle rotation than the leading lips and baffle flange at the opposite end of the body member.

5. In a paddle for an etching machine, a U-shaped channel member having a flat plate portion and side flanges, the side flanges being provided with means medially of the channel member for affording a transverse rotative axis, one end of said channel member having a straight trailing lip provided by one end of the plate portion, an inclined leading lip attached to one side of the

plate portion and arranged at an angle to the straight trailing lip said leading and trailing lips being angularly related to provide an open-end pocket therebetween, said lips extending substantially the same distance from the rotative axis so that said trailing lip is adapted to scoop etchant into said pocket, a baffle flange attached to the same side of the plate portion and extending transversely of the channel member, the baffle flange being spaced inwardly from the inclined leading lip and adapted to cooperate with the inclined leading lip to hold a quantity of etchant, the opposite end of the channel member having a second straight trailing lip provided by that end of the plate portion, a second inclined leading lip connected to the opposite side of the plate portion, the inclined leading lip extending transversely of the plate portion between the side flanges, the said second inclined leading lip being angularly related to the said second straight trailing lip to provide an end-open pocket between said second leading and trailing lips, and a second baffle flange attached to the plate portion and extending transversely of the channel member between said side flanges, the said second baffle flange being spaced inwardly from the said second inclined leading lip to provide a compartment for holding a greater amount of etchant for a longer period during rotation than the first said leading lip and baffle flange at the opposite end of the plate portion.

6. In an etching machine, an etching tank for holding a supply of etchant, a paddle in said tank, means for rotating said paddle, said paddle including a body member having a straight lip at one end and an angularly related forward lip forwardly of the straight lip in the same plane of rotation and inclined in the direction of paddle rotation to provide an end-open pocket between said lips, the inclined lip being adapted to dip into the etchant and deposit it on the work piece, and an air tube in said tank for agitating the etchant to raise the level so that the following straight lip is adapted to scoop etchant into said pocket.

7. In an etching machine, an etching tank for holding a supply of etchant, a paddle in said tank, said paddle comprising a body member having means medially thereof for providing a transverse rotative axis, each end of said body member being provided with a straight lip, and an angularly related lip disposed in the same plane of rotation with said straight lip and inclined forwardly of the straight lip in the direction of paddle rotation to provide an end-open pocket between said lips, the distance from the rotative axis to the outer end of straight lip being no greater than the distance between the rotative axis and the end of the adjacent respective inclined lip, the inclined lips being adapted to dip into the etchant and deposit on the work piece, and an air tube in said tank for agitating the etchant to raise the level so that the following straight lips are adapted to scoop etchant into said pockets.

8. In an etching machine, an etching tank for holding a supply of etchant, a paddle in said tank, said paddle comprising a U-shaped channel member having a flat plate portion and side flanges, the side flanges being provided with means for affording a transverse rotative axis, one end of said channel member having a straight lip provided by the end of the plate portion, an inclined lip attached to one side of the plate portion and extending transversely of the channel member, the inclined lip being angularly related to the straight lip and arranged forwardly of the straight lip in the direction of paddle rotation and in the same plane of rotation to provide an end-open pocket between said lips, the opposite end of said channel member having a second straight lip provided by the opposite end of the plate portion, and a second inclined lip attached to the plate portion in the same plane of rotation with said second straight lip and extending transversely of the channel member between the said side flanges, the second inclined lip being angularly related forwardly of the said second straight lip in the direction of panel rotation to provide an end-open pocket between said second lips, the inclined lip at each end of the channel member being adapted to dip into etchant and deposit it on the work piece, and an air tube in said tank for agitating the etchant to raise the level so that the following straight lips are adapted to scoop etchant into said pockets.

9. A paddle for an etching machine comprising a body member, means medially on said body member providing a transverse rotative axis, the body member including at each end an outwardly projecting trailing lip and a leading lip inclined relative to said trailing lip to provide an open-end pocket therebetween, said leading and trailing lips extending substantially the same distance from said rotative axis so that said trailing lip is adapted to scoop etchant into said pocket, said flanges between the leading and trailing lips at one end of said body member so that the pocket formed thereby is adapted to hold a greater amount of etchant for a longer period of time during rotation than the pocket at the opposite end of the body member, a baffle flange extending transversely of the body member on each side of the rotative axis, the baffle flange of each end being spaced inwardly from the leading lip, the baffle flange and leading lip at one end being adapted to hold a quantity of etchant, and side flanges on the other end of said body member between the baffle flange and leading lip to provide a compartment adapted to hold a greater amount of etchant for a longer period of time during paddle rotation than the leading lip and baffle flange at the opposite end of the body member.

10. In an etching machine, an etching tank for holding a supply of etchant, a paddle in said tank, means for rotating said paddle, said paddle including a body member having a trailing lip at one end and an angularly related leading lip in the same plane of rotation to provide an end-open pocket between said lips, the leading lip being adapted to dip into the etchant and deposit it on the work piece, and an air tube in said tank for agitating the etchant to raise the level so that the following trailing lip is adapted to scoop etchant into said pocket.

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