Nov. 7, 1967 C. W. HOORNSTRA 3,351,077

CURVED PLATE ETCHING APPARATUS

Filed April 2, 1965 2 Sheets-Sheet 1

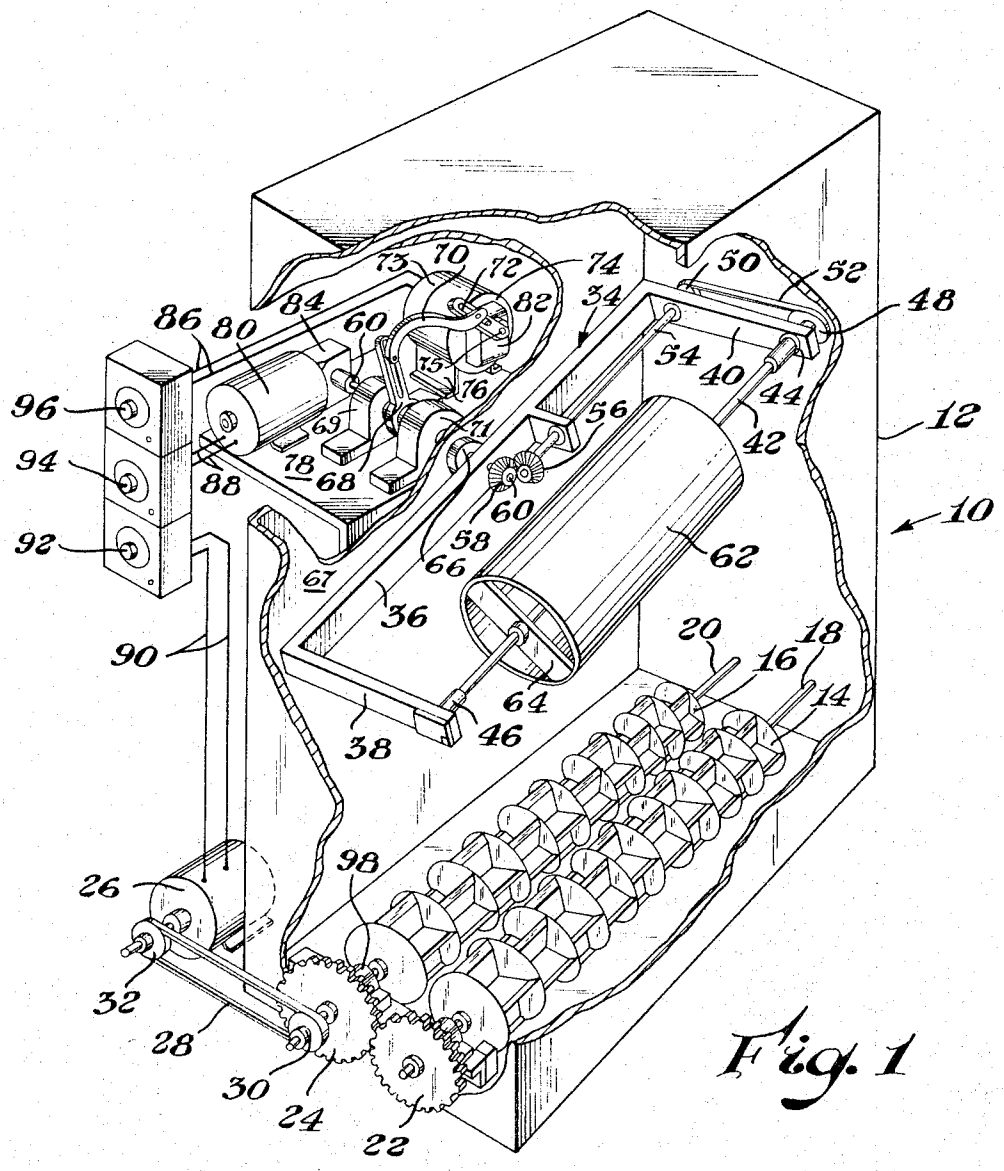


Fig. 1

INVENTOR.
Clayton W. Hoornstra

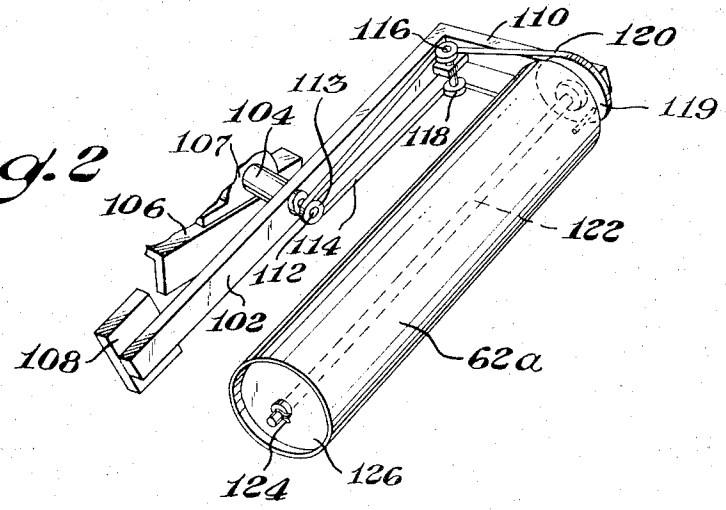
BY Earl D. Ayers
AGENT

Nov. 7, 1967 C. W. HOORNSTRA 3,351,077

CURVED PLATE ETCHING APPARATUS

Filed April 2, 1965 2 Sheets-Sheet 2

Fig. 2



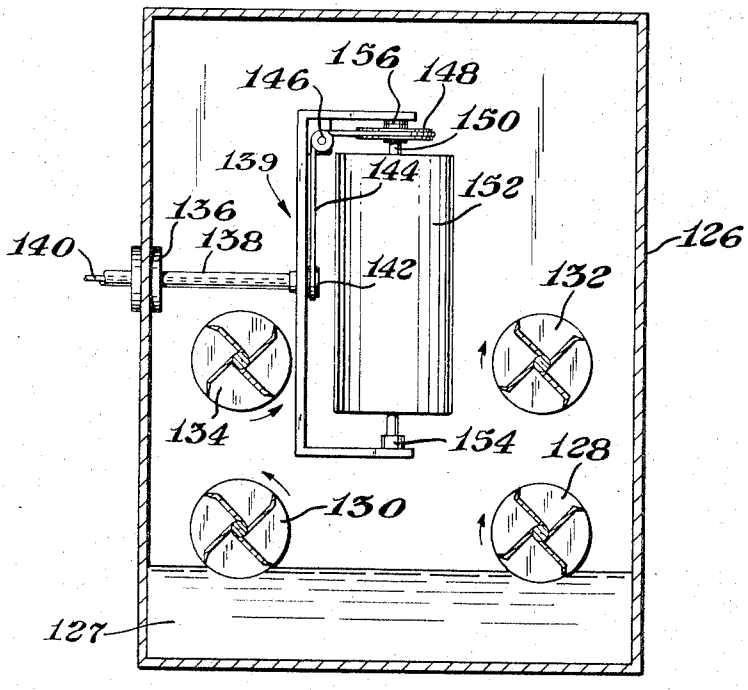


Fig. 3

INVENTOR.
Clayton W. Hoornstra

BY Earl D. Ayers

AGENT

United States Patent Office 3,351,077
Patented Nov. 7, 1967

3,351,077

CURVED PLATE ETCHING APPARATUS

Clayton W. Hoornstra, Midland, Mich., assignor to The Dow Chemical Company, Midland, Mich., a corporation of Delaware

Filed Apr. 2, 1965, Ser. No. 445,209
2 Claims. (Cl. 134—147)

This invention relates to etching machines and particularly to a machine for etching plates which have an arcuate surface configuration.

So-called powderless etching has been used with notable success for many years in connection with the etching of flat plates.

Though a number of processes and machines exist which purport to produce a relief image of high quality on curved surfaces, none actually does so.

For example, when a printing cylinder or segment thereof having type and half-tone pictures photo-printed thereon is powderlessly etched by existing processes in existing machines, the typical result shows, to a greater or lesser degree, the following defects:

(1) Shoulder assymetry; the image shoulders in circumferential directions are inordinately broad while those in axial directions are inordinately narrow or are even entirely absent so that two sides of the images are actually under cut.

(2) "Channeling"; circumferential channels are etched into the bottom of the plate between image areas.

(3) A phenomenon known variously as "tailing," "run-around," "rundown" or "bleedoff" in the vernacular of the trade; inordinately elongated shouldering occurs in circumferential directions from the boundaries of half-tone image areas with nonimage areas.

When etching a plate by the powderless etching process, there will be relative motion or "flow" between the workpiece being etched and increments of a fluid medium adapted to remove material from the workpiece. The fluid medium will collide with the workpiece and with them flow across the surface of the workpiece because of ts momentum and/or the force of gravity before departing from the surface.

It has been found that the extent of excursion of the shoulder in any direction away from the margin of a relieved image element is directly proportional to the work done in moving increments of the fluid medium across said margin in that direction.

It can be appreciated that the etching of curved plates presents substantial problems in the achieving production of uniform shoulders in an image element. The curved surface plus the force of gravity are factors which complicate the etching process.

Accordingly, a principal object of this invention is to provide an improved apparatus for making etchings on curved plates.

Another object of this invention is to provide an improved apparatus for etching image elements which have substantially uniform shoulders onto a curved plate.

A further object of this invention is to provide etching apparatus which may be used to produce etchings on a curved plate which are substantially free of channeling.

Yet another object of this invention is to provide etching apparatus which may be used to produce etchings on a curved plate which are substantially free of the phenomenon known variously as "tailing," "run-around," "rundown," or "bleedoff."

In accordance with this invention there is provided etching apparatus, comprising, within an enclosed chamber adapted to contain an etching bath, means for splashing material from said etching bath towards said curved

plate, and a plate holding and moving mechanism which is adapted to cyclically vary the axial relationship between the longitudinal axis of the plate being etched and the surface of the etching bath while rotating said plate about its longitudinal axis.

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawings, in which:

FIG. 1 is an isometric view, partly broken away to show detail, of an etching machine in accordance with this invention;

FIG. 2 is a fragmentary view of an alternative embodiment of a plate holding and moving mechanism in accordance with this invention, and

FIG. 3 is a schematic end view of an alternative embodiment of etching apparatus in accordance with this invention.

Referring to the drawing, there is shown etching apparatus, indicated generally by the numeral **10**, which comprises an enclosed chamber **12** having splasher paddles **14**, **16**, disposed on and coupled to shafts **18**, **20**, respectively. The shafts **18**, **20** extend across the chamber **12** near the bottom thereof and are parallel with the bottom of the chamber. The shafts **18**, **20** extend through the walls of the chamber **12**, but bearings and seals aren't shown for the sake of simplicity in the drawing. Gears **22**, **24**, whose teeth intermesh, are coupled to the end of the shafts **18**, **20**, respectively.

An electric motor **26** (or other suitable drive means) is coupled, via pulleys **30**, **32** on the shaft **22** and motor shaft, respectively, and drive belt **28**, to the shafts **18**, **20**.

A shaft **66** extends through one of the side walls **67** and is rigidly coupled to a generally U-shaped support member, indicated generally by the numeral **34**. The support member **34** has a base element **36** and outwardly extending arms **38**, **40**. The arms **38**, **40** are parallel to the shaft **66** and the base element **36** is perpendicular with respect to the shaft **66**.

A workpiece holding mechanism **66**, carrying a curved plate **62** to be etched, is coupled to a rotatable mandrel **42** which is journalled in suitable bearings **44**, **46** near the outer end of the arms **40**, **38**, respectively. The end of the mandrel **42** which is near the arm **40** extends through the arm **40** and has a pulley **48** coupled thereto.

The shaft **66**, journalled externally of the chamber **12** by bearings **69**, **71**, is a hollow shaft.

An inner shaft **60** extends through the shaft **66**. One end of the shaft **60** is coupled to the output gear box **84** of a drive motor **80**. The other end of the gear **60** is coupled to a bevel gear **58** whose teeth engage the teeth of a bevel gear **56**. The gear **56** is rigidly coupled to a shaft **54** which is supported parallel and rotatably with respect to the support member **34**, extending through the arm **40**. A pulley **50** is coupled to the end of the shaft **54** which extends through the arm **40**. Belt means **52** couple the pulley **50** to the pulley **48** on the mandrel **42**.

The longitudinal axis of the shaft **66** is perpendicular to the longitudinal axis of the paddle driving shafts **18**, **20** and parallel to a plane passing through the shafts **18**, **20**.

A slotted arm **68** is rigidly coupled to the shaft **66** between the bearings **69**, **71**. An oscillatory motion drive motor **73**, supported on a base **76**, has a slotted arm **72** coupled to the output shaft **75** of its gear box **82**. A rigid mechanical linkage element **70** is slidably coupled between the slots of the arms **68**, **70**.

The motors **73**, **80** and **26** are coupled, through leads **86**, **88**, **90**, respectively (all being electric motors, as illustrated) to control boxes **96**, **94**, **92** respectively. The motor **80** may be, if desired, cyclically reversed after one

or more rotations of the mandrel **42**, the reversing means being in the control box **94**, for example.

The motors, **80**, **73** and bearings **69**, **71** are rigidly coupled to a base plate **78** which is fixedly secured with respect to the side wall **67** of the chamber **12**.

In operation, with the chamber **12** suitably filled with etchant bath to slightly above the bottom of the paddles **14**, **16** (the depth the bath extends onto the paddles being desirably substantially equal along the length of the paddles), the motor **26** is operated to rotate the paddles **14**, **16**, thereby splashing the etchant bath material upwardly to impinge on the moving plate **62** to be etched.

With the motors **73**, **80** in operation, the support member **34** carrying the mandrel **42** is oscillated back and forth with respect to the level of the etchant bath, the degree of oscillation being between 20 degrees and 90 degrees, but preferably about 40 degrees to 60 degrees. Oscillation occurs at a rate of 2 to 20 oscillations per minute, but preferably at a rate of 4 to 10 oscillations per minute.

Simultaneously with the oscillation of the support member **34**, the shaft **60** causes the mandrel **42**, and consequently the plate **62** to be etched, to rotate. Rotation of the mandrel is at a rate such that the peripheral speed of the plate **62** to be etched is between 70 and 250 feet per minute, and preferably 140–200 feet per minute. The reversal of direction of rotation of the mandrel may vary between zero and 60 times per minute, but preferably is between 5 and 30 times per minute.

The amount of etchant bath thrown by the paddles will be known by those skilled in the powderless etching art.

FIG. 2 shows an alternative embodiment of etching plate movement mechanism. The shaft **104**, corresponding to the shaft **66**, has an elongated element **102** rigidly coupled perpendicularly with respect to its end which would extend into the chamber **12**. An arm **110** is coupled perpendicularly with respect to the element **102** at one end of element **102**, the arm **110** being parallel to the shaft **104**. The base **106** and bearing **107** shown correspond to the plate **78** and bearing **71** in FIG. 1.

A shaft **112**, inside the hollow shaft **104**, is coupled via pulley **113**, pulleys **116**, **118** near the junction of the element **102** and arm **110**, and pulley **119** coupled to a mandrel **122** which is rotatably supported from the outer end part of the arm **110**.

The mandrel **122** carries and supports a plate **62***a* to be etched (by means of holding element **126** held in place on the mandrel **122** by bolt **124**, for example).

A weight **108** coupled to or near the end of the element **102** which is remote from the arm **110**, counter weights the element **102** to provide a balanced load to be oscillated by the shaft **104**.

As may be seen, the oscillation of the plate **62***a* and its rotation about the mandrel **122** may be the same as in FIG. 1, though a different mechanism is used to achieve this motion.

FIG. 3 shows, in more or less schematic form, an end elevational view of etching apparatus in which a second pair of paddle elements are used. The apparatus includes the usual chamber **126**, with etching bath **127** at the bottom part thereof with its level contacting the paddles **128**, **130** which correspond generally with the paddles **14**, **16** of FIG. 1.

The shafts **138**, **140** extend through the side wall of the housing **126** (through seal **136**) generally parallel to the level of the etchant bath, and correspond in function to the shafts **66**, **60** respectively.

The V-shaped bracket **139**, rigidly coupled to the shaft **138**, corresponds to the support member **34** of FIG. 1. Pulleys **142**, **146**, **148** and belt **144** correspond to the pulley and belt arrangement of FIG. 2, for example.

The plate **152** to be etched is coupled to a mandrel **150** which is journalled in bearings **154**, **156** and which is coupled to the pulley **148**.

A second pair of paddles, **132**, **134**, corresponding in construction, for example, to the paddles **14**, **16** of FIG. 1, are disposed substantially above but axially parallel to the first pair of paddles **128**, **130**.

The operation of the apparatus of FIG. 3, with respect to the paddles **128**, **130**, and the etching plate movement mechanism, is as described previously herein. However, especially when large plates are to be etched and/or the oscillatory movement of the plate to be etched raises it a very substantial distance above the etchant bath, the so-called helper paddles help distribute further upwardly etchant bath thrown upwardly by the paddles **128**, **130**. The helper paddles **132**, **134**, thus provide means for more uniformly splashing the etching plate with etching bath material than is practicable when only a single set of paddles are used.

It is obvious that sprockets and chains may be substituted for the pulley and belt combinations illustrated. Materials of construction should be such that they are not adversely affected by nor do they adversely affect the etching bath. Temperature and other controls of the etching bath are known to those skilled in the powderless etching art and will not be detailed here.

Alternatively, a work holder which is rotatably mounted and driven with respect to a fixed mandrel may be substituted for the rotatable mandrel fixed work holder arrangements illustrated.

Normally, though not necessarily, the plate to be etched (or work piece) is mounted with the medial point of its axis of curvature at the medial point of the free portion of the mandrel about which it is carried. Preferably, the support member (**34**, for example) is configured to support the mandrel with the longitudinal axis of the mandrel intersecting the longitudinal axis of the oscillatory motion drive shaft (**66**, for example).

It should be noted, also, that the ends of the mechanical linkage element **70** may be locked in position along the slots of the arms **68**, **70**.

What is claimed is:

1. An etching machine which is useful for etching plates having arcuate surfaces, comprising means for holding a supply of etching bath material, means for applying said etching bath material against the surfaces to be etched, said means for holding a supply of etching bath material and means for applying etching bath material being enclosed in a chamber having a top and side walls, said means for applying etching bath material including a first array of paddles which contact said supply of etching bath material and a second array of paddles disposed above said first array of paddles, a plate holder having a longitudinal axis, said plate holder being mechanically transversely coupled to a drive shaft, said drive shaft extending through one of said side walls, means disposed externally of said chamber for rotating said shaft back and forth in a repetitive manner, and means for rotating said plate holder about its longitudinal axis as said drive shaft is rotated back and forth.

2. A machine in accordance with claim **1**, wherein means are provided for rotating said paddles at a uniform rate with respect to each other.

References Cited

UNITED STATES PATENTS

2,657,095	10/1953	James et al.	134—194 XR
3,072,133	1/1963	Martz	134—194 XR
3,078,857	2/1963	Guenst	134—193 XR
3,108,031	10/1963	Hasala et al.	134—161 XR
3,122,150	2/1964	Henderson	134—147 XR

CHARLES A. WILLMUTH, *Primary Examiner.*

R. L. BLEUTGE, *Assistant Examiner.*