Jan. 29, 1974 J. J. FRANTZEN ET AL 3,788,912
SYSTEM SUITABLE FOR CONTROLLING ETCHING
WITHOUT THE AID OF AN ETCHANT RESISTANT
Original Filed July 14, 1969 5 Sheets-Sheet 1

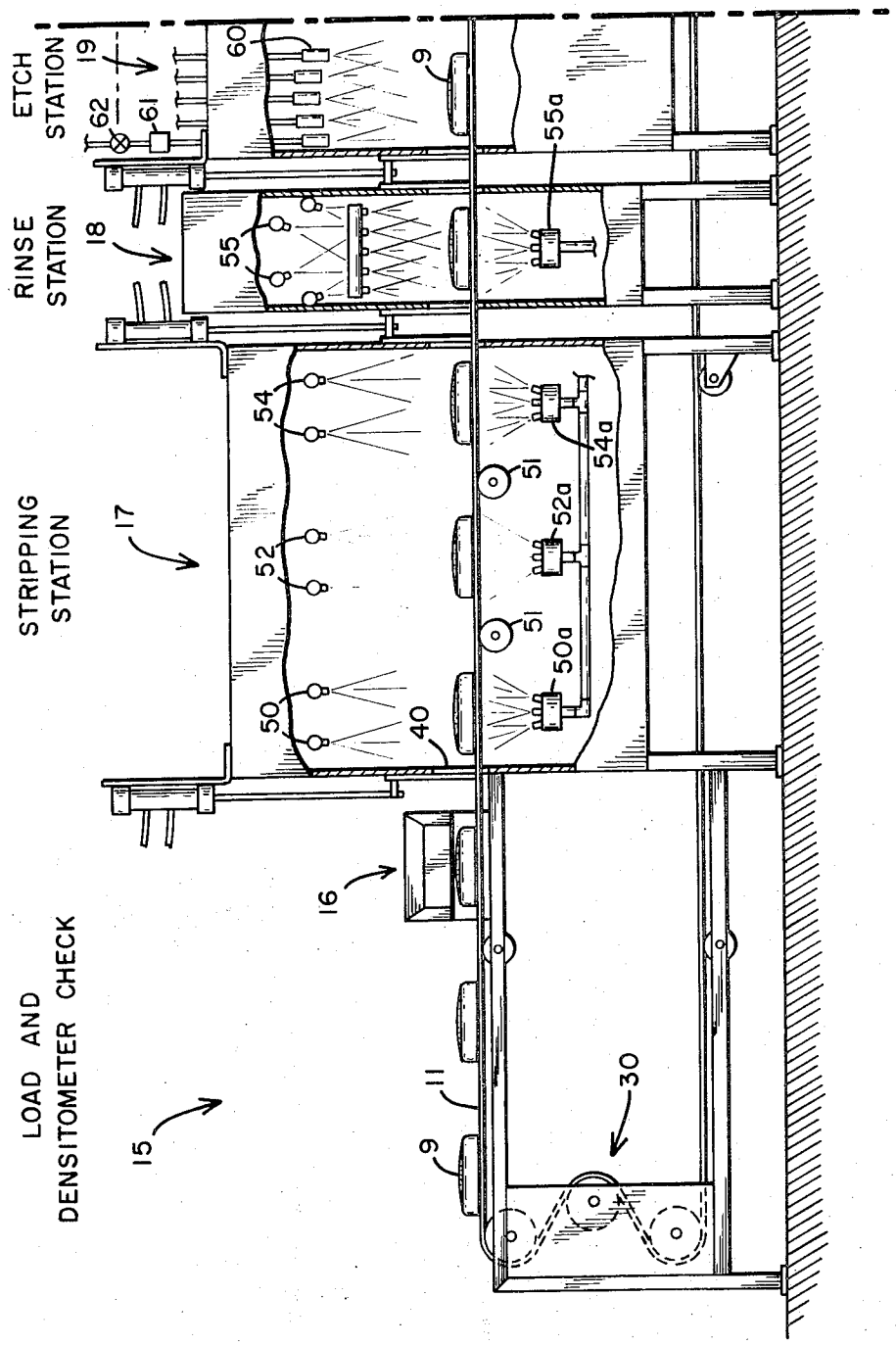

Fig. 1a

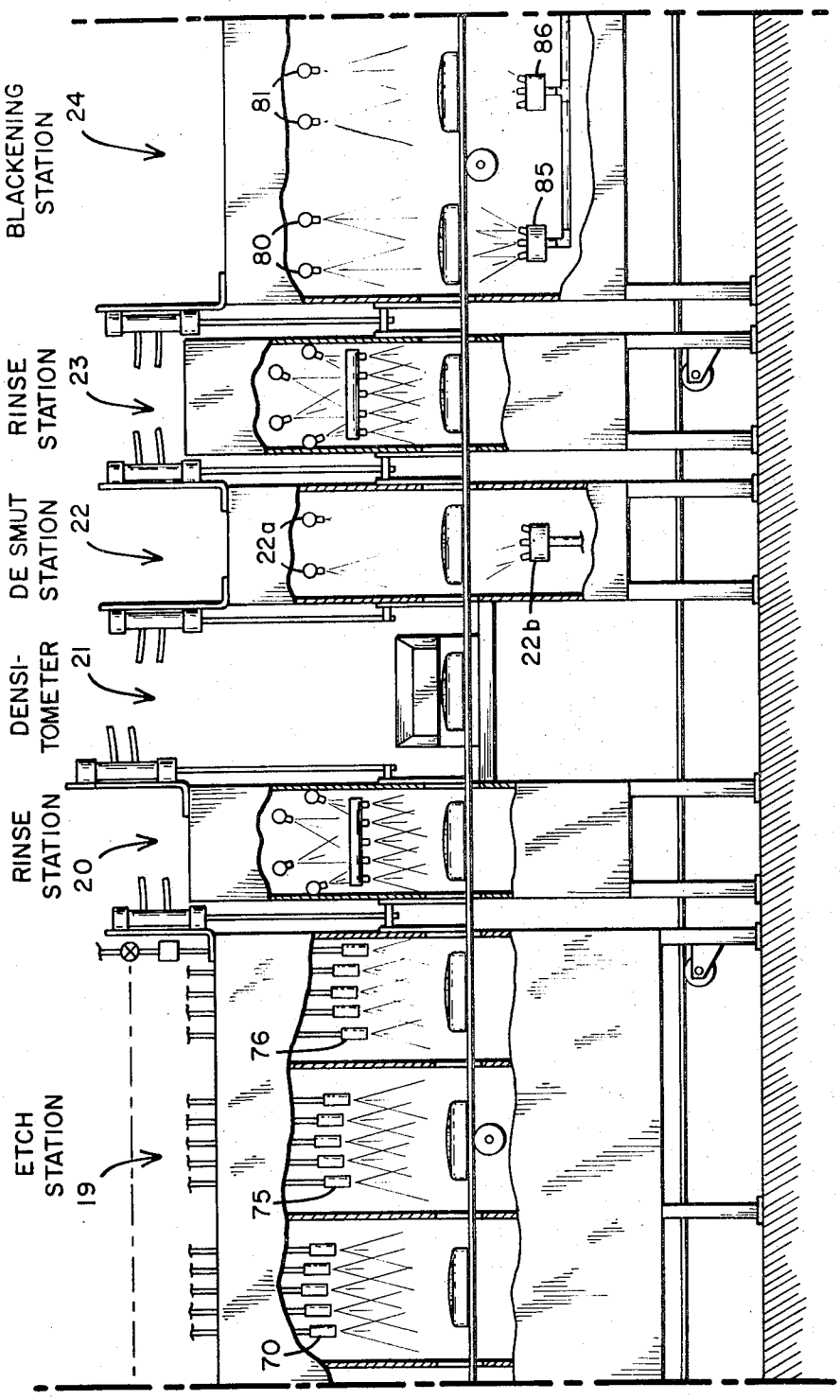
BLACKENING STATION 24
RINSE STATION 23
DE SMUT STATION 22
DENSI-TOMETER 21
RINSE STATION 20
ETCH STATION 19
81
80
86
85
22a
22b
76
75
70

Fig. 1b

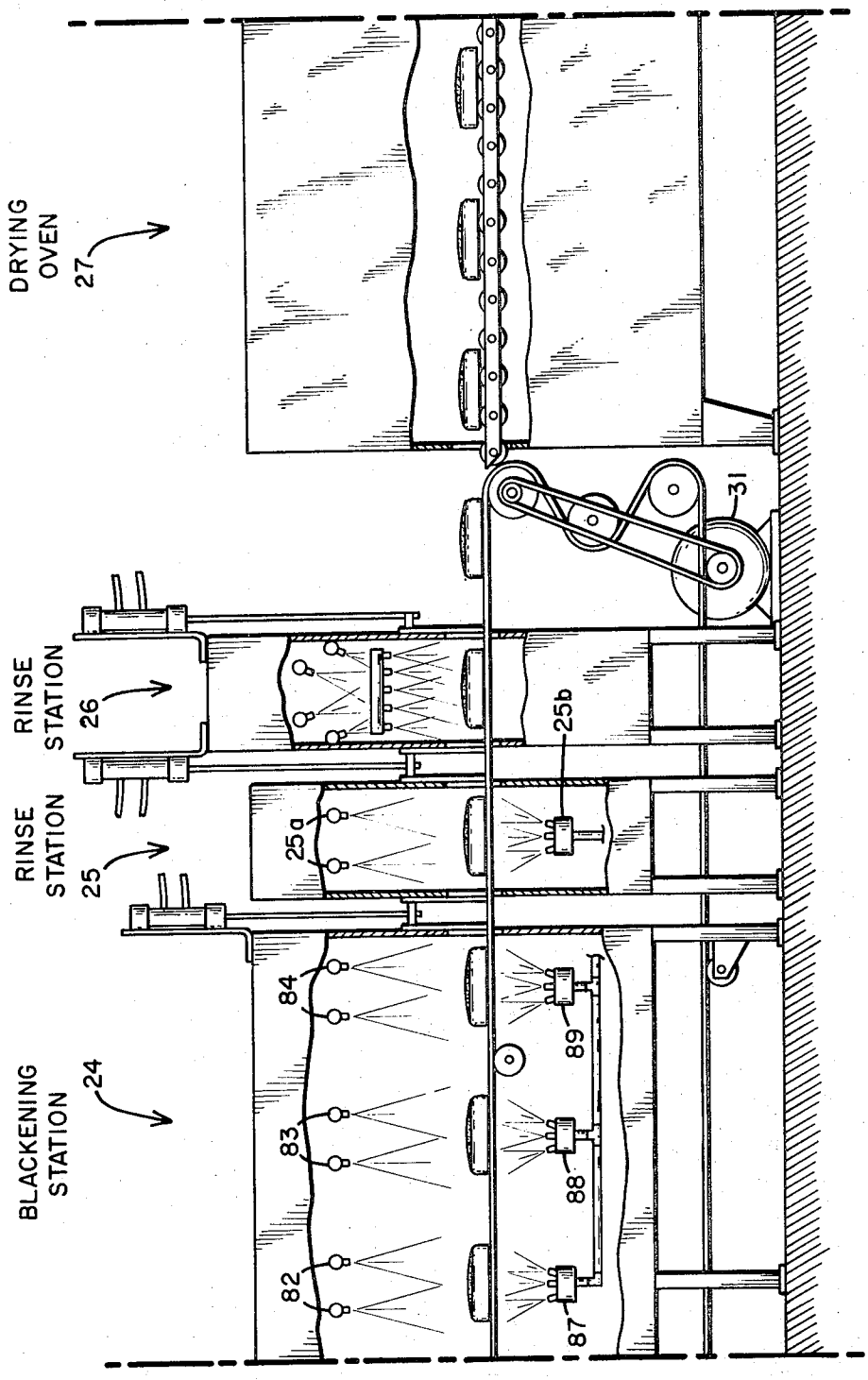
DRYING OVEN
27
RINSE STATION
26
RINSE STATION
25
BLACKENING STATION
24
31
25b
25a
84
89
83
88
82
87

Fig. 1c

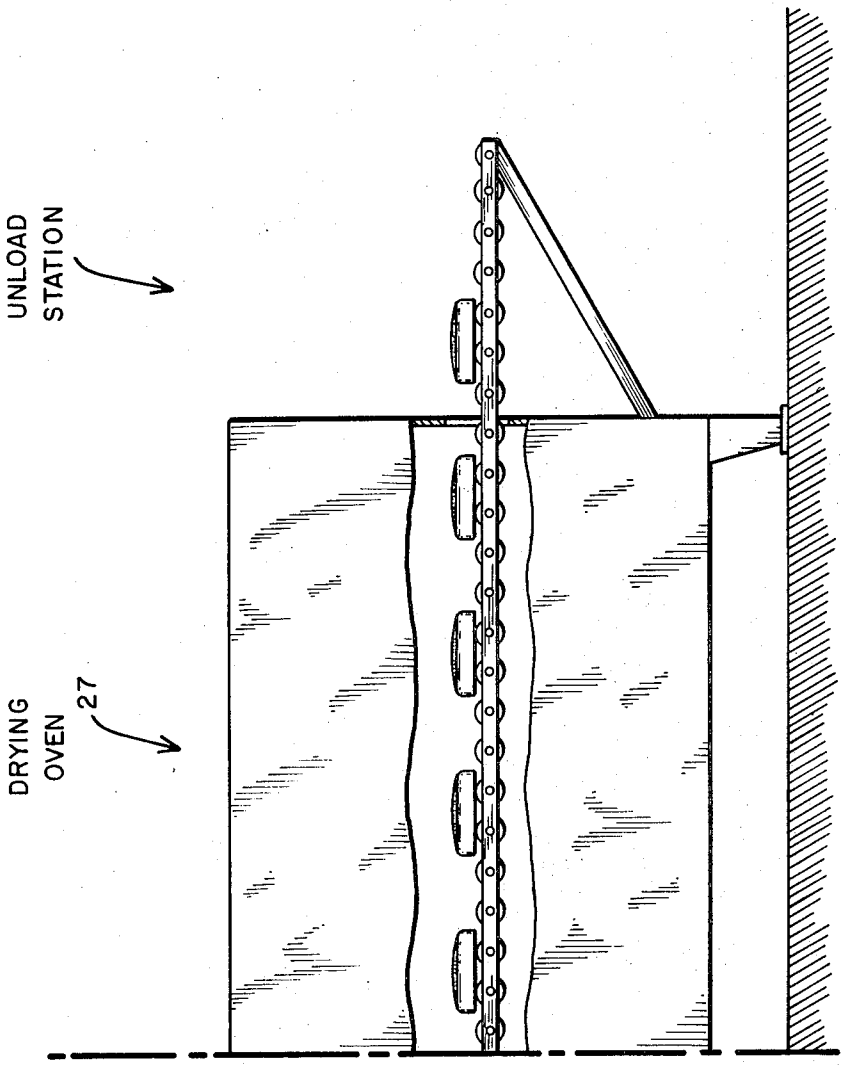

Fig. 1d

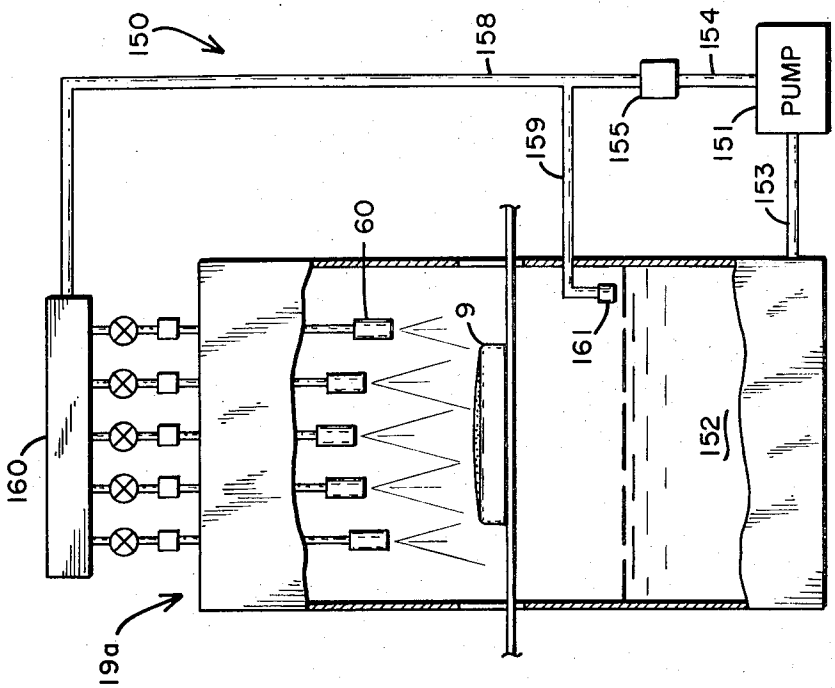
150
158
154
PUMP
155
151
159
153
60
9
161
160
152
19a

Fig. 3

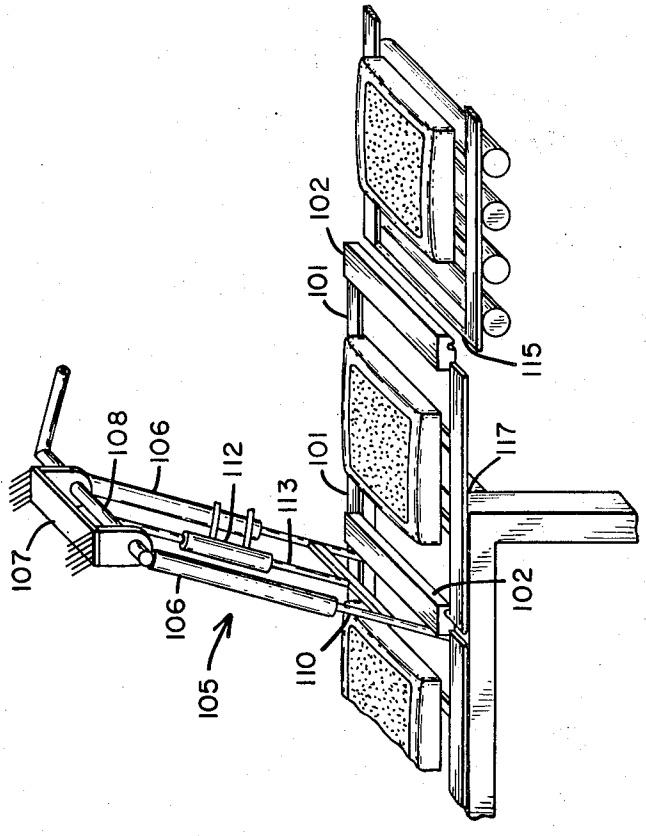
102
101
115
108
106
112
101
117
113
107
106
102
105
110

Fig. 2

United States Patent Office 3,788,912 Patented Jan. 29, 1974

3,788,912

SYSTEM SUITABLE FOR CONTROLLING ETCHING WITHOUT THE AID OF AN ETCHANT RESISTANT

John J. Frantzen, North St. Paul, and Charles M. Lund, Stillwater, Minn., assignors to Buckbee-Mears Company, St. Paul, Minn.

Original application July 14, 1969, Ser. No. 841,317. Divided and this application Nov. 10, 1971, Ser. No. 197,536

Int. Cl. C23f 1/02

U.S. Cl. 156—6 10 Claims

ABSTRACT OF THE DISCLOSURE

An etching system having sets of prearranged nozzles for dispensing etchant onto preformed masks in a predetermined pattern to allow an operator to controllably enlarge the apertures in a preformed mask without the aid of an etchant resist.

This is a division of application Ser. No. 841,317, filed July 14, 1969.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates generally to etching systems and, more particularly, to etching systems than can controllably etch without the aid of an etchant resistant.

Description of the prior art

In a typical colored television picture tube, the shadow mask or aperture mask is located between the electron guns at the rear of the tube and the phosphor coated face plate at the front, or, viewing face of the tube. Electron beams pass through the openings or apertures in the shadow mask and impinge upon a suitable color producing phosphorus dot on the face plate. Behind each of these openings in the shadow mask are three phosphorus dots, a triad, one dot for each of the primary colors. Typically, around each of these dots is an annular black area which separates the various colored phosphorus dots. During the assembly of the picture tube, the shadow mask is used as a mask or master pattern for first forming the smaller phosphorus dot pattern and then the larger black surround pattern in the face plate of the television tube. This is usually done using photographic techniques which are well known in the industry today. In order to print these phosphorus dots using known photographic techniques, it is necessary to have a first set of apertures of predetermined diameter and then to enlarge the diameter of the apertures to a second predetermined diameter. By utilizing the same mask for both sets of apertures it eliminates problems that could be produced due to different patterns on different masks such as misalignment of the electron beams with the color producing phosphorus dots.

The present invention offers as an improved system and method for producing a mask that can be used to form the first set of aperturees and then reworked to form the second larger set of apertures. Because the size of the apertures must be controlled to close tolerances (generally .0002" or less), in order to use the mask as a master pattern for forming, the two patterns on the face plate of the television tube, the etching system must be able to enlarge the apertures in a controlled manner so that the final diameter of the apertures is the proper size. Numerous methods and systems have been used to controllably enlarge the apertures within the shadow mask. One method involved placing a photoresist material over the existing aperture pattern to prevent the etchant from etching the apertures beyond a predetermined diameter. In another method the apertures are initially etched to the largest diameter with the aid of an etchant resist, then the apertures are reduced in diameter by plating additional material on the mask. After the pattern has been formed with the plated mask the plating material is then etched away leaving the original mask. These prior art methods are rather time consuming and difficult to utilize in the mass production of TV aperture shadow masks.

The present invention eliminates some of the problems associated with the prior art methods by controllably enlarging the apertures without the aid of an etchant resist. The problems inherent in etching without an etchant resist have been overcome by subjecting the mask to a spray of etchant from a plurality of nozzles for a predetermined time. The mask is also subjected to a cleaning process and rinse process under controlled conditions prior to spray etching to ensure that the etchant will properly etch the mask.

SUMMARY OF THE INVENTION

Briefly, the present invention comprises a system and apparatus having a plurality of spray stations having a set of prearranged adjustable spray nozzles for controllably spraying etchant on the mask and a means for intermittently moving the plurality of preformed masks into the plurality of stations. As the mask passes through the various stations, the mask is subject to a cleansing action, an etching action, a rinsing action, a desmutting action and a drying process before the enlarged aperture mask emerges from the end of the system.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 which is comprised of FIGS. 1*a*, 1*b*, 1*c* and 1*d*, shows a front elevation view of apparatus for cleaning, rinsing, etching, blackening and drying a plurality of preformed masks along a conveyer like member.

FIG. 2 is a partial front view of an alternate embodiment of a mechanism for pulling the masks through the various stations.

FIG. 3 is an enlarged view of the suction mechanism for preventing etchant from dripping onto the mask after the etchant supply is shut off.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1*a*, reference number **15** generally designates the first station in system **10**. Station **15** is a loading station where masks are placed onto a pair of parallel, endless, spaced chains **11** which transport masks **9** with the preformed shape upward to the various stations. Typically, the masks are loaded by an operator. However, they could also be automatically placed on chains **11**. Chains **11** are intermittently driven so that the operation or work can be preformed to the mask while the mask is stationary. After the work operation is completed the chain advances the mask to the next station. Although a pair of chains are shown for supporting and intermittently moving the masks through the various stations, other types of mask support mechanisms could also be used. For example, a pair of tracks or rails could be provided which would slidably support the masks. FIG. 2 shows such an alternate embodiment for moving along a pair of tracks by a suitable expendable intermittent drive member. This alternate embodiment is more fully described in the later portion of the specification.

Next to loading station **15** is a desitometer station **16** where the diameter of the apertures in the preformed mask can be checked by suitable means such as a light source and a photocell that measures the light transmitted through

the apertures in the shadow mask. As the number of apertures per square inch of surface area is known, the amount of light transmitted through the apertures provides the operator with the dimensions of the apertures of the shadow mask.

After the masks leave densitometer station **16**, the mask enters a stripping station **17**. Stripping station **17** sprays a cleaning solution on the surface of the mask to remove any black oxides or other material on the mask which would have an adverse effect on the etching process. A typical stripping solution that could be used is hydrochloric acid which is marketed under the trade name Fremont 348. Typically, stripping station **17** comprises three sets of spray units. At each of the units the mask is subjected to a spray of cleaning solution from nozzles located above and below the mask.

Located adjacent to station **17** is a rinse station **18** that sprays water on the mask and the chain from a first set of nozzles located above the mask and a second set of nozzles located below the mask and the chain. Rinse station **18** washes off any cleaning solution that adheres to the mask or chain to prevent the contamination of other stations by the stripping solution.

After the mask has been rinsed to wash off the stripping solution, the mask enters an etch station **19** comprised of four separate etching units **19***a*, **19***b*, **19***c* and **19***d*. Each of these units spray etchant for a predetermined time on the mask from a plurality of nozzles located above the mask. These nozzles are prearranged as to spacing and height above the face of the mask so as to direct a controlled spray of etchant onto the face of the mask to enlarge the apertures in the mask to the desired opening. Typically, ferric chloride is used as an etchant to enlarge the apertures if the mask is formed from cold rolled steel. By controlling the spray of etchant on the mask with the sets of various nozzles, the apertures can be controllably enlarged without the aid of an etchant resist. Next to etch station **19** is a second rinse station **20** that washes off any excess etchant which is clinging or adhering to the mask or the chains.

Located after the rinse station **20** is a second densitometer check station **21**. The purpose of station **21** is to measure the diameter of the apertures to determine if the apertures of the masks have been enlarged to the proper diameter. If the diameter of the aperture of the mask is proper, the mask moves into a desmut station **22** that removes the carbon particles on the surface of the mask. The typical mask formed from cold rolled steel contains carbon particles. As these carbon particles are not affected by the etchant that is used to etch away the steel mask, they must be removed by spraying a carbon cleaning solution on the mask. A typical cleaning or desmut solution suitable for removing these carbon particles is phosphoric acid.

The next station is a third rinse station **23** that washes off any desmutting solution on the mask. From rinse station **23** the mask enters a blackening station **24** that contains five separate blacking units that spray a blacking agent on the mask from above and below the mask. The blacking agent produces a coating on the outside of the mask that protects the mask from oxidation during its latter handling and usage steps. Typically, a suitable blacking agent such as iron phosphate is sprayed on the mask to protect its surface. However, other protective agents could also be used.

After blackening station **24** there is a fourth rinse station **25** that washes off excess blackening agent on the mask. Located after rinse station **25** is a deionized water rinse station **26** that sprays deionized water on the mask to remove any contaminants on the mask. The deionized water also assists in setting the blackening agent on the mask.

The last station in the system is a drying station **27** that forces warm air over the mask to evaporate any moisture on the surface of the mask.

The foregoing has been a brief discription of the various functions of the stations within the system. A more detailed description of the operation of the apparatus and the various stations will not be given.

To initiate the action an operator loads preformed masks **9** onto the conveyor at the first loading station. As the masks are identical, they are all identified by reference number **9**. Typically, the conveying station **30** comprises a pair of endless tracks which are derived by a suitable drive unit such as an electric motor **31**. The chain drive is intermittently movable, that is, the chain advances for a predetermined time and then remains stationary for a predetermined time and then advances again for a predetermined time. During the time interval the chain and masks are stationary, the stations are in an operative condition and correspondingly during the time interval the chain and masks are moving the stations are in an inoperative condition. This type of operation allows the mask to move from station to station or from unit to unit within a particular station without having the operation of one unit or station having an adverse effect on and adjacent station through splattering of the various solutions out of the various stations. The first movement of the chain **11** moves mask **9** into densitometer check station **16** to measure the diameter of the apertures.

After the diameter of the apertures are measured in densitometer check station **16**, a pressure signal is sent to pressure actuated cylinder **42** to raise slidable door **40** located at the entrance to stripping station **17**. Similarly, pressure signals are sent to all the pressure actuated cylinders to raise all the slidable doors at the front and rear of the stations.

As all the slidable doors and their operation are identical, they will not be described in detail. The main purposes of the slidable doors is to seal the chamber within the stations to provide a closed return system and also to prevent etchant and other chemicals which are used in the various station from splashing out of the station to contaminate the adjacent station or the mask in the adjacent station.

After door **40** is raised, mask **9** advances into stripping station **17** where the mask remains for three intervals of time. For illustrative purposes assume that the time interval chain **11** is at lest is 15 seconds. Thus, mask **9** is in station **17** for a total work time of 45 seconds. During this time the mask is first subjected by spray from above by a first set of nozzles **50** and from below by a second set of nozzles **50***a*. After the mask has been subjected to spray from nozzles **50** and **50***a*, chain **11** advances mask **9** into the second work position between roller chain supports **51** where mask **9** is subjected to spray from above by a third set of nozzles **52** and from below by a fourth set of nozzles **52***a*. After being subjected to spray from nozzles **52** and **52***a*, chain **11** advances mask **9** into the third work position within station **17**. In the third work position mask **9** is subjected to spray from above by a fifth set of nozzles **54** and from below by a sixth set of nozzles **54***a*. The various work positions within station **17** are not individually separated from one another as the splatter or spray of cleaning solution from the adjacent nozzles is not harmful and as the cleaning solution only removes surface coatings on the mask and does not attack and erode the mask. An example of a typical stripping solution is Fremont 348 which is a diluted hydrochloric acid. When this solution is sprayed onto the surface of the mask through the various sets of nozzles it removes any oxides on the mask which would act as an etchant resist and produce uneven etching during the multiple step etching process.

After mask **9** leaves stripping station **17**, it enters into rinse station **18** through the aforementioned slidable doors. In station **18** masks **9** and chains **11** are subjected to a water spray rinse from nozzles **55** located above the mask and from nozzles **55***a* located below the mask. As clean water is continually being supplied to nozzles **55**

and nozzles 55*a* and the rinse water is disposed of, it leaves the mask in a condition where the only foreign solution on the mask is the water. This prevents contamination of the etching station **19** due to any material or solution from stripping station **17** which could adhere to the mask and follow the mask into the etching station **19** where it would become part of the recirculating etchant.

After mask **9** has been subjected to a spray rinse for a predetermined time interval, the doors on the sides of rinse station **18** automatically open. After the doors are opened, chain **11** advances moving mask **9** into etching station **19**. Etching station **19** comprises four separate etching units **19***a*, **19***b*, **19***c*, and **19***d* which successively sprays an etchant solution, such as ferric chloride, onto the top of a particular mask. First, a set of prearranged nozzles **60** spray etchant onto the mask for a predetermined time. Nozzles **60** are spaced vertically and horizontally in a preformed pattern to enable the etchant to be properly distributed over the top surface of the mask. Each of the nozzles are adjustable vertically so that the spacing of the nozzles above the mask can be controlled to thereby vary the spray pattern of the etchant on the mask. Each nozzle has a flow meter **61** and a regulating valve **62** so that the amount of etchant supplied through each nozzle can be preselected by the operator. Each of the nozzles is connected to a plenum chamber which prevents back pressure at any one nozzle from affecting the flow of etchant through the other nozzles. The purpose of the flow meter is to provide a convenient visual indication as to whether or not the etchant is flowing through the nozzle. If one of the nozzles should become clogged and thus reduce the supply of etchant to a localized area of the mask, it would produce an improperly etched mask. Therefore, it is necessary to have a convenient method of determining whether the nozzles are properly dispensing the etchant onto the mask.

After mask **9** has been subjected to etchant spray from set of nozzles **60** for a predetermined time, the supply of etchant is shut off to prevent any etchant from dripping from the nozzles onto the mask. If etchant should drip onto the mask, it would produce enlarged openings in portions of the mask and it could also bend the thin mask by the force of the etchant droplets landing on the mask. In order to ensure that any etchant in the supply line does not drip from nozzles **60** and onto the mask **9**, there is provided a suction system which is shown in FIG. 3.

In order to control the enlargement of the apertures in the domed mask, it is preferred to space the adjustable nozzles **60** in a vertical pattern that somewhat follows the general dome-shaped appearance of mask **9**. However, it should be understood that the vertical spacing of the nozzles above mask **9** can be varied to control the spray pattern on mask **9**. In addition, more or less etchant can be sprayed through the individual nozzles by adjusting the individual valves **62** connected together. In a typical operating unit approximately 30 nozzles are located above the mask in a spaced relationship to produce an etchant spray pattern that can enlarge the apertures in mask **9** in a controlled manner. However, no limitation is intended thereto.

Located within the etching station **19** is a second etching unit **19***b* which has a second set of prearranged nozzles **70**. Nozzles **70** are preferably arranged in a different pattern and spacing than nozzles **60** so as to produce a different etchant spray pattern on mask **9**. Similarly, a third set of prearranged nozzles **75** are located in etching unit **19***c*. Nozzles **75** are also preferably arranged in different pattern and spacing than nozzles **60** or **70** to produce a different etchant spray pattern on mask **9**.

A final etching unit **19***d* contains still another set of prearranged nozzles **76** which are preferably located in a different pattern and spacing than the previous nozzles so as to produce a different spray pattern on mask **9**. By having four sets of nozzles located in different patterns and individually adjustable as to vertical spacing and etchant flow, an operator can select the proper adjustments through a trial and error procedure so that he can controllably enlarge the apertures in mask **9** without an etchant resist. Etching station **19** has all of the different ses of nozzles located above the mask so that the etching is performed primarily on the convex side of dome-shaped mask **9**. In the etching enlarging process it is usually necessary to uniformly enlarge the apertures throughout the mask. To accomplish a uniform enlargement of the apertures, it is necessary to space the nozzles at various heights and at various locations but the preferred location is one in which the end points of the nozzles generally conform to a three dimensional pattern that is similar to the dome-shape of the mask. However, the three dimensional pattern that the end points of the nozzles define generally is more pronounced than the dome-shape of the mask. However, no limitation is intended thereto, as one of the features of the present system is its aspect of etchant supply control through flow adjustment, prearranged spacing of nozzles, with respect to one other, variable spacing of the nozzles above the mask and the different sets of nozzles to produce the desired etchant spray pattern. Although the etchant spray nozzles are shown located above the masks, it is envisioned that with suitable adjustment of the nozzles and the equipment, the nozzles could be located horizontally rather than vertically as shown in the system.

Located after etch station **19** is a rinse station **20** that sprays water on mask **9** to rinse off any etchant on the surface of the mask. If the etchant were not rinsed off it would continue to erode the aperture mask and thus produce localized etching that would produce oversized apertures in certain areas and consequently a mask that is unacceptable for use in a television tube. After mask **9** passes through the rinse station **20**, the mask enters a densitometer check station **21** where the aperture size is checked to determine if the unit has been properly etched.

After the mask leaves densitometer station **21** it enters into a desmut station **22** which sprays a desmutting solution on the mask from nozzles **22***a* located above the mask and nozzles **22***b* located below the mask. Typically, this desmutting solution could be phosphoric acid or the like which removes the carbon particles on the surface of the mask. As the mask is usually made from cold rolled steel containing carbon particles and is usually etched with ferric chloride, which etches the metal but not the carbon particles, it is necessary to remove these carbon particles from the mask by a second etchant. After removal of the carbon particles in desmut station **22**, the mask enters into a rinse station **23** that rinses off any excess phosphoric acid or desmutting solution on mask **9**. The mask then enters a blackening tank **24** where the mask is sprayed from above and below with an iron phosphate solution. The blackening station contains five sets of nozzles **80**, **81**, **82**, **83** and **84** which are located above the mask and five sets of nozzles **85**, **86**, **87**, **88** and **89** which are located below the mask. These nozzles spray blackening solution completely over the top and bottom of the mask to produce a coating that will give corrosion resistance and this prevent oxidation of the mask before it is put into use. In order to insure proper protection of the mask, the mask is subjected to spray from these five sets of nozzles for a time interval of five times the present which, in this case, would be 75 seconds.

After the mask leaves blacking station **24**, it enters into rinse station **25** that sprays top water onto the mask from nozzle **25***a* and **25***b*. These nozzles remove any excess blacking agent on the mask The mask then enters a final rinse station **26** where deionized water is sprayed on the mask to remove any contaminants on the mask. The deionized water spray also assists in settling the blacking agent on the mask.

The last station in the system is a drying oven **27** that force warm air to evaporate any water that is on the mask.

Referring to FIG. 2, there is shown an alternate embodiment of the intermittent drive mechanism for advancing the mask through the various stations. Typically, the intermittent drive mechanism comprises a set of mask support racks **101** having a hook **102** located at the front of the support racks. During travel through the various stations hook **102** forms interlocking engagement with rear bar **115** of the mask support rack located in front thereof. This produces an interconnected set of mask support racks that can be pulled through the various stations on a rack support track by a rotatable extendible advance mechanism **105**. Advance mechanism **105** comprises a pair of arms that are rotatably mounted to support **107** through a shaft **108**. Located on the lower end of member **106** are a pair of telescoping rods **110** that are extendible into engagement with the backside of hook **102** through a pressure actuated mechanism **112** having a linear extendible rod **113**.

FIG. 2 shows advance mechanism **105** in the position prior to advancing the train of masks. To advance the masks a signal is sent which rotates shaft **108** and advance mechanism counterclockwise until the mask support rack has moved up one rack length. As the mask support rack moves forward, the mask support rack immediately ahead of the advance mechanism drops onto a set of rollers **116** that support and drive the rack into the drying station. Rollers **116** are at a slightly lower elevation than track **117** so that the forward mask support rack disengages from the rear mask support rack as the mask drops onto rollers **116**.

After advance mechanism **105** has advanced the mask support rack forward, a pressure signal is applied to pressure cylinder **112** which causes rod **113** to retract thereby retracting telescoping pusher rods **110** into arm **106**. This allows one to rotate the advance mechanism clockwise into the position shown in FIG. 2 where a pressure signal is applied to the pressure cylinder **112** to extend the pusher arms **110** into frictional pushing engagement with the back or another mask support rack. This type of arrangement provides an intermittent drive unit for advancing one mask at a time through the various stations of the system. This system offers an advantage over the chain type of supports in that there is not a continual wear motion of a chain as it passes through the various washing, etching and heating stations which could cause deterioration of the chain.

Referring to FIG. 3, reference numeral **150** designates the suction system for preventing etchant from dripping onto the mask. Although suction system **150** is shown connected to etching unit **19***a*, the other etching units similarly have a suction system to prevent dripping of the etchant onto the mask.

During the spray etching process a pump **151** draws etchant from receiver **152** through pipe **153** and discharges it under pressure through outlet **154**. The etchant flows through an open pneumatic valve and into pipe **158** and pipe **159**. The etchant in pipe **158** flows through a plenum chamber **160** and the various flow meter valves, and nozzles to issue in the form of a spray from the end of nozzles **60**. The etchant in pipe **159** flows into receiver **152** through an orifice **161** or other suitable fluid flow resistance. By closing valve **155** with etchant flowing through both pipe **158** and pipe **159**, the supply of etchant to both pipe **158** and pipe **159** is shut off. Because of the momentum of the fluid in pipe **159** and the lesser gravitational field, the fluid in pipe **159** continues to flow from nozzle **161** which produces a slightly lower pressure in pipe **158**. This lower pressure momentarily stops the flow of fluid through nozzles **60** because of the back pressure in the nozzles. Typically, the etchant issuing from nozzles **60** abruptly stops for a period of two to four seconds which is sufficient time to advance the mask from beneath nozzles **60** to a second position beneath.

Another embodiment for preventing the etchant from falling on the masks when the etchant supply is shut off involves sliding a tray between the mask and the nozzles as soon as the supply of etchant to the nozzles is shut off. The tray then catches any etchant droplets that would fall on the mask and cause damage to the mask.

We claim:

1. The method of controllably enlarging apertures in a preformed metal mask without an etchant resist comprising the steps of:

cleaning said preformed metal mask to remove materials that would act as an etchant resist;

subjecting said preformed metal mask to etchant issuing in a predetermined spray pattern by employing a plurality of spray changers wherein multiple spray heads are vertically arranged to apply a superimposed spray pattern on the surface of said preformed metal mask for a predetermined time to thereby enlarge the apertures in said preformed metal mask;

abruptly shutting off the spray pattern of etchant issuing from said multiple spray heads by controlling the pressure in said multiple spray heads to prevent supplying further etchant to said preformed metal mask which would continue to etch said preformed metal mask; and

removing any excess etchant that adheres to said preformed metal mask.

2. The method of claim **1** wherein said mask is subjected to etchant issuing in a second predetermined spray pattern for a predetermined time to further enlarge the apertures in said preformed metal mask.

3. The method of claim **1** including the step of subjecting said preformed metal mask to etchant issuing in a third predetermined spray pattern for a predetermined time to further enlarge the apertures in said mask.

4. The method of claim **3** including the step of subjecting said preformed mask to etchant issuing in a fourth predetermined spray pattern for a predetermined time to further enlarge the apertures in said preformed metal mask.

5. The method of claim **4** including the step of decreasing the etchant supply after the predetermined time has elapsed to prevent etchant from dripping onto said preformed metal mask.

6. The process of controllably enlarging apertures in a preformed domed metal mask having a plurality of apertures therein by use of an etchant and without the use of an etchant resist on said preformed domed metal mask comprising the steps of:

(a) cleaning the preformed metal mask having a plurality of apertures therein to remove materials from said preformed metal mask that would act as an etchant resist;

(b) subjecting the preformed metal mask having a plurality of apertures therein to a predetermined spray pattern by employing a plurality of spray chambers wherein multiple spray heads are arranged to apply a superimposed spray pattern on the surface of said preformed metal mask for a predetermined time to thereby enlarge the apertures in said preformed metal mask;

(c) abruptly decreasing the etchant issuing from said multiple spray heads by controlling the pressure in said multiple spray heads to prevent supplying further etchant to said preformed domed metal mask which would continue to enlarge the aperture in said preformed domed metal mask;

(d) measuring the size of the apertures in the preformed domed metal mask to determine if the apertures have been enlarged to the proper dimension.

7. The process of claim **6** including the step of applying the spray pattern of etchant on the domed portion of the preformed aperture mask.

8. The method of claim 7 wherein the preformed domed mask is sprayed with etchant from at least two different positions and at least two different intervals.

9. The method of claim 8 wherein the preformed domed mask is sprayed with etchant from at least three different positions and at least three different intervals.

10. The method of claim 9 wherein the preformed domed mask is sprayed with etchant from at least four different positions and at least four different intervals.

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JACOB H. STEINBERG, Primary Examiner

U.S. Cl. X.R.

156—2, 18

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,788,912 Dated January 29, 1974

Inventor(s) John J. Frantzen and Charles M. Lund

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Claim 1, line 8, "changers" should be -- chambers --.

Signed and sealed this 23rd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334