Feb. 6, 1973 E. C. HELM 3,714,925

VACUUM PROCESSING MACHINE

Filed July 30, 1971

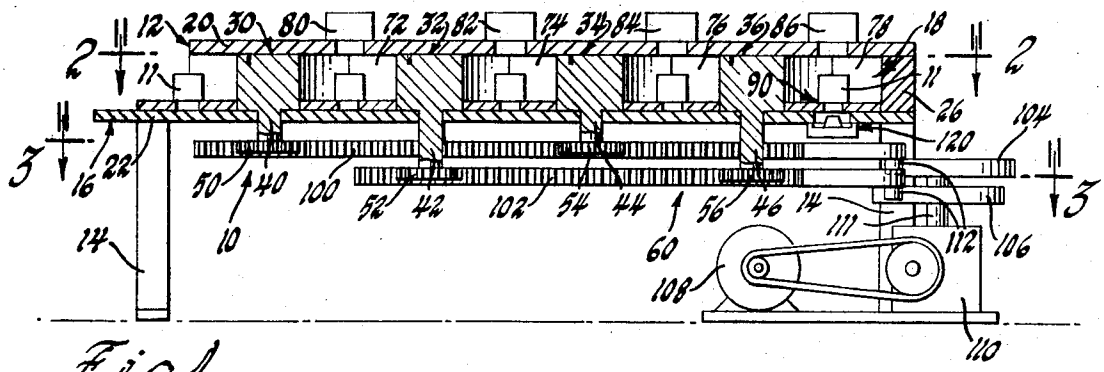

Fig. 1

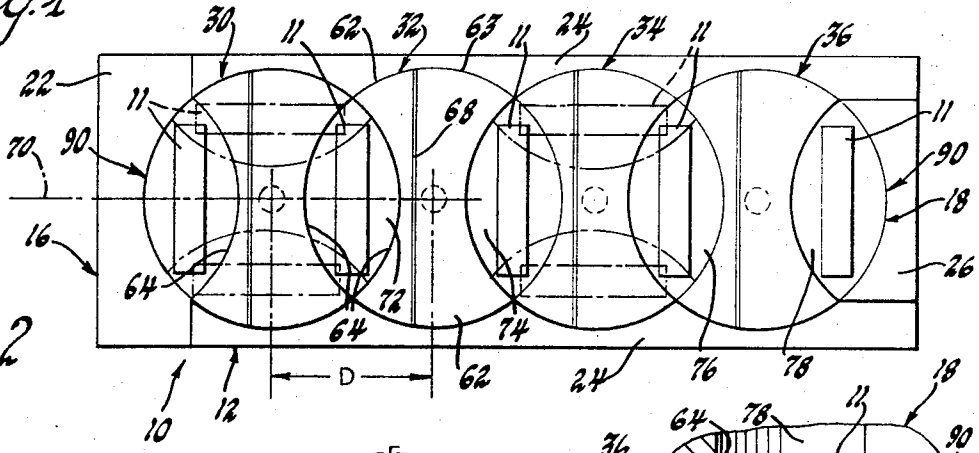

Fig. 2

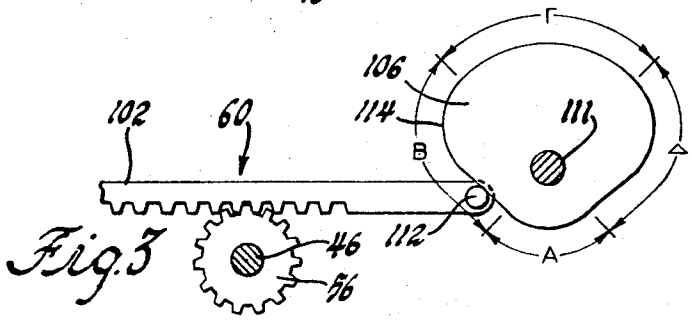

Fig. 3

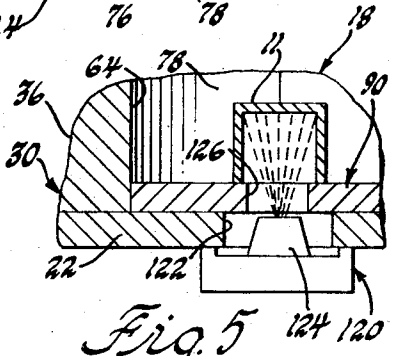

Fig. 5

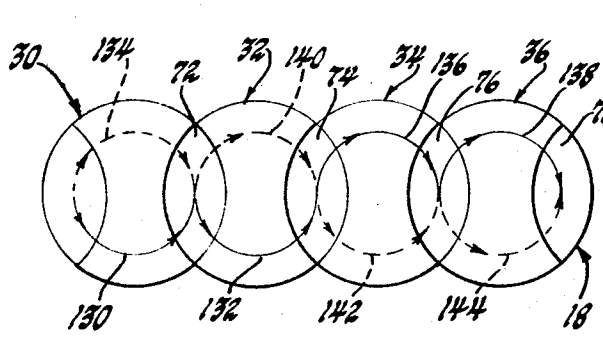

Fig. 6

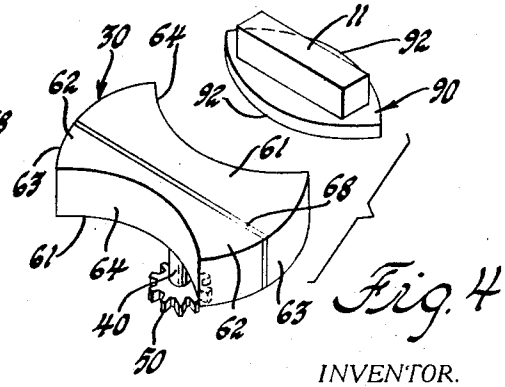

Fig. 4

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VACUUM PROCESSING MACHINE

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U.S. Cl. 118—49 1 Claim

ABSTRACT OF THE DISCLOSURE

A vacuum processing machine wherein an evacuated enclosure houses a series of intermeshing two-lobe rotors which are alternately oscillated a half-revolution to thereby circumferentially shift lenticular carrier boats received within concave recesses between the lobes to a transfer position between the rotors. The lobes of the succeeding rotors sweep the recesses to thereby shift the carrier boats to the next advanced transfer position whereby parts nested on the carrier boats are bidirectionally shifted along a common entrance and exit path in a series of arcs between handling and processing stations at opposite ends of the enclosure.

The present invention relates to a machine for transferring articles and, in particular, to a vacuum processing machine wherein finished and unfinished articles are bidirectionally shifted through a series of controlled environments between handling and processing stations at opposite ends of an evacuated enclosure.

At the present time, large and cumbersome parts such as taillight reflectors pose extremely difficult problems in subjecting the parts to a high vacuum environment such that a suitable reflective metallic coating can be applied by vapor deposition. Two methods can generally be employed for achieving suitable reflectorizing conditions for these reflectors. In one method, a single reflector is placed in a chambered fixture which is evacuated until the desired vacuum is reached at which time the reflective coating is applied. Thereafter, the chamber is repressurized and the reflector removed. However, the separate pump down time required for each article greatly limits the production rate, particularly inasmuch as the pump down time considerably exceeds the coating time. In the other method, a partial reduction in the pump down time versus the coating time is achieved by positioning multiple reflectors within a single evacuating chamber and, when the desired vacuum is reached, sequentially or simultaneously applying a reflective coating to the articles. This also is not entirely satisfactory inasmuch as the large volume chamber requires a substantial pump down time which again limits the production rate.

The present invention contemplates a continuous vacuum processing machine for applying a coating to an article wherein the reflectorizing process proceeds substantially independently of the system pump down time. Basically, this improved performance is achieved by continuously routing unfinished parts sequentially through a series of controlled environment chambers to a high vacuum processing station for application of the coating. Thereafter, the reflectors are reversely routed along the same path for exit at the handling or entrance end of the machine. The individual chambers are independently sealed and have progressively increasing vacuums toward the processing station. This provides a vacuum environment at the processing station which can be continuously maintained and is relatively unaffected by the transferring of parts.

The parts are routed through the machine by a transferring mechanism including a series of intermeshing two-lobe rotors which operatively cooperate with adjacent rotors and the enclosure to shift articles toward and away from the processing station. Each rotor includes diametrically opposed cylindrical lobes which are circumferentially spaced by concave cylindrical recesses. The rotors are spaced on shortened centers and, when the lobes of one rotor are perpendicular to the center line of the machine, the other rotor is freely rotatable and sweeps the cylindrical recesses. The articles are mounted on lenticular carrier boats having one cylindrical surface positioned within the recess and the other cylindrical surface forming a continuation of the lobes. Cam drive means are provided for alternately oscillating alternate rotors 180° or one-half revolution. In this manner, the carrier boat is circumferentially shifted along an arcuate path by the first rotor for a half revolution and stopped at a holding position between the rotors. Thereupon, the second set of rotors is rotated and the lobes thereof sweep the carrier boats from the first holding positions to second holding positions between the next adjacent rotors. At the other end of the machine during the dwelling period of the end rotor, a reflective coating is applied to the article. During the reverse rotation of the end rotor, the finished article is reversely shifted to the last holding position along its entrance path. Simultaneously, an unfinished article is shifted from the last holding position to the processing station along a diametrically opposite or parallel path. Thus, parts are alternately fed into the machine and bidirectionally carried through a series of controlled environments in parallel paths for handling and processing at opposite ends of the machine.

These and other features of the present invention will be apparent to one skilled in the art upon reading the following detailed description, reference being made to the accompanying drawings showing a preferred embodiment in which:

FIG. 1 is a side cross sectional view of a vacuum processing machine made in accordance of the present invention;

FIG. 2 is a view taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged view taken along line 3—3 of FIG. 1;

FIG. 4 is an enlarged perspective view of the carrier boat and the rotor;

FIG. 5 is an enlarged fragmentary view of the processing station; and

FIG. 6 is a process flow schematic for the vacuum processing machine.

Referring to FIGS. 1 and 2, there is shown a vacuum processing machine **10** for applying a reflective coating to articles such as taillight reflectors **11**. The machine **10** generally comprises a vacuum enclosure **12** supported on legs **14** and having an open entrance or handling station **16** at one end and an enclosed processing station **18** at the other end. The enclosure **12** includes a top wall **20**, a bottom wall **22**, a pair of spaced side walls **24**, and an end wall **26**. A series of four intermeshing two-lobe rotors **30**, **32**, **34**, **36** are rotatably carried within the enclosure **12**. The side walls **24** and the end wall **26** include interior concave surfaces conforming to the outer surfaces of the aforementioned rotors.

The rotors **30**, **32**, **34**, **36** respectively include drive shafts **40**, **42**, **44**, **46** which are journalled in and project downwardly through openings in the bottom wall **22**. Each drive shaft **40**, **42**, **44**, **46** carries a spur gear **50**, **52**, **54**, **56** respectively. Cam drive means **60** are provided for alternately oscillating alternate rotors in a manner described below.

Referring to FIG. 4, the representative rotor **30** comprises planar top and bottom surfaces **61**, a pair of diametrically opposed lobes **62** having right circular peripheral surfaces **63**, and a pair of diametrically opposed concave circular recesses **64** formed normal to the lobes **62**.

A sealing strip **68** disposed in a groove around the surfaces **61** and **63** cooperates with the wall of the enclosure to a seal between adjacent rotors. As shown in FIG. 2, the rotors are mounted on shortened centers D at a distance equal to the radius of a lobe **62** plus the radius to the base of the recess **64**. With the lobes **62** perpendicular to a longitudinal axis **70** through the centers of the rotors, each recess **64** forms a circular continuation of the peripheral surface **63** of an adjacent rotor. Additionally, the mutually facing recesses between successive rotors will establish three holding chambers **72, 74, 76**. At the processing station **18**, the rotor **36** and the end wall **26** form a processing cavity **78**. Therefore, when one set of rotors are located with the lobes perpendicular to the longitudinal axis **70**, the adjacent rotors are freely rotatable with the lobes thereof sweeping the aforementioned recess **64** and chambers.

Controlled vacuum environments are maintained between adjacent sealing strips **68** in the chambers **72, 74, 76, 78** by vacuum pumps **80, 82, 84, 86** which are respectively connected thereto. The pumps have a capacity to maintain the chambers at progressively increasing vacuums which is a minimum of around .1 micron in the processing chamber **78**. During oscillation of the rotors, adjacent pumps jointly evacuate the transient space between alternate sealing strips **68** thereby minimizing the effects of the transferring operation on the prevailing environment.

The reflectors **11** are mounted on lenticular carrier boats **90** defined by opposed convex surfaces **92** having a radii equal to the radii of the lobes **62**. Accordingly, when the carrier boat **90** is received within a recess **64**, one convex surface **92** engages the inner periphery thereof and the other convex surface forms a circular continuation of the lobes **62**.

The carrier boats **90** are bidirectionally shifted through the enclosure **12** by the rotors as controlled by the drive means **60** which includes racks **100, 102**, a pair of cams **104, 106**, and a drive train including an electric motor **108** operatively coupled to a gear reduction unit **110**. The cams **104, 106** are rotatably mounted on an output shaft **111** connected to the gear reduction unit **110**. Referring to FIG. 3, the representative rack **100** is provided with gear teeth which mesh with the spur gears **52** and **54**, of rotors **30** and **32**. In a similar manner, the rack **102** meshes with the spur gears **52, 56** of rotors **32, 36**. Cam follower pins **112** connected at the ends of the racks **100, 102** operatively engage the cam surface **114** of the cams **104, 106**.

The profile of each cam includes 90° segments comprising in clockwise circumferential order a dwell sector A (alpha), a rise sector B (beta), a dwell sector Γ (gamma), and a fall sector Δ (delta). The cams **104, 106** are circumferentially spaced 90° apart such that one cam is operating on a dwell sector while the other cam operates on an actuating sector. In this manner, the cams serve to alternately reciprocate the rack gears **100, 102** so as to alternately oscillate their respective rotors with intermediate rest periods.

The processing station **18** is provided with an aluminizer **120** which is mounted on the bottom plate **22** and registers with the cavity **78** through an aperture **122**. The aluminizer **120** includes a crucible **124** which is resistance heated to vaporize aluminum for deposition upwardly through an opening **126** in the carrier boat **90** onto the interior surface of reflector **11**. The aluminizer is conventional in construction and is appropriately energized during each dwell sector A and Γ of the end rotor **36**.

Referring to FIGS. 2 and 6, in operation unfinished reflectors are shifted along a series of semi-circular paths toward the processing station **18** while finished reflectors carried by the same rotor are reversely shifted along a parallel path toward the handling station **16**. However, with regard to an individual reflector, the identical path is used for ingress and egress. Thus, unfinished and finished parts are transferred through a series of controlled environments for entrance and exit of one end of the machine and for aluminizing at the other end.

More particularly, upon machine start up, a first or odd numbered carrier boat **90** is positioned within a recess **64** of the entrance rotor **30**. During the rise sector B, the cam **104** drives the rack **100** to the left thereby rotating rotor **30** one-half revoltion or 180° in the counterclockwise direction. The intermediate positions of the rotor **30** and **34** is shown by phantom lines in FIG. 2. At the same time, the cam **106** is traversing the dwell sector Δ and the intermediate rotor **32** remains stationary. Accordingly, as shown in FIG. 6, the carrier boat **90** is carried on a semi-circular path from the handling station **16** to the first holding chamber **72** along a semi-circular circumferential path **130**. When the first carrier boat reaches the holding cavity **72**, the entrance rotor **30** is locked in place as the cam **104** traverses the dwell sector Γ. Simultaneously therewith, the cam **106** traverses a rise sector B thereby shifting the rack **102** to the left and oscillating the intermediate rotor **32** one-half revolution in a counterclockwise direction. This movement shifts the first carrier boat in a semi-circular path **132** to the second holding chamber **74**.

During the dwell sector Γ of the rotor **30**, a second or even numbered carrier boat is positioned within the recess **64**. As the cam **104** traverses the fall sector Δ (delta), the rack **100** is shifted to the right and the rotor **30** carries the second part, as shown by the dotted lines, in a clockwise direction along a path **134** for deposit at the holding cavity **72** while the intermediate rotor **34** transfers the first carrier boat to the holding chamber **76** along a path **136**.

During the next 90° sector, the rotors **32** and **36** are driven in a clockwise direction by the fall sector Δ of the cam **106** and the first and second carrier boats are transferred to the processing chamber **78** and the second holding chamber **74** along paths **138** and **140**, respectively.

During the next dwell periods of the rotor **30, 34**, the second carrier boat and third carrier boat are transferred to the chambers **76** and **72** along paths **142, 130** respectively while the aluminizer **120** is energized for applying a coating to the reflector **11** on the first carrier boat. The second carrier boat is subsequently transferred to the processing station **18** along path **144** for aluminizing while the finished odd number reflector is transferred to the chamber **76** along the path **138**.

Regarding unfinished parts, during the next complete revolution the cam **104**, the first and odd number carrier boats will exit the machine along their entrant path **130, 132, 136** and **138**. Similarly, the second and even numbered reflectors will follow an exiting path identical to their entrant path **136, 140, 142, 144**.

Accordingly, it will be noted that the odd numbered carrier boats will follow identical paths as they are bidirectionally routed between the handling station **16** and the processing station **18**. The even numbered carrier boats will move along a path which is parallel to the mirror image of the first path. Thus, for each oscillation of the rotors, an unfinished part advances forwardly while a finished part retreats. In this manner, reflectors proceed through the machine on a continuous basis without being dependent on the pump down time of the machine. Accordingly, the production rate for the machine will be substantially solely governed by the aluminizing time at the processing station.

Although only one form of this invention has been shown and described, other forms will be readily apparent to those skilled in the art. Therefore, it is not intended to limit the scope of this invention by the embodiment selected for the purpose of this disclosure but only by the claim which follows.

What is claimed is:

1. A vacuum processing machine for applying a coating to an article, comprising: an enclosure having a

handling station at one end and a procesisng station at the other end; means for maintaining controlled environments at spaced locations along said enclosure; two sets of alternately spaced two-lobe rotors rotatably mounted within said enclosure for oscillation between a first transfer position and a second transfer position, said rotors having alternating circular lobes and concave recesses and being spaced on shortened centers such that the lobes of one rotor mesh with and sweep the recess of an adjacent rotor intermediate said transfer positions; sealing means between the rotors and the enclosure for maintaining said controlled environments; means at said processing station for applying a coating to articles positioned therein; lenticular carrier boats receivable within said recesses having a first circular surface conforming to said recesses and a second circular surface forming a continuation of said lobes; first cam drive means for oscillating one set of rotors one-half revolution to thereby advance carrier boats carrying unfinished articles in a semi-circular path between successive transfer positions toward the processing station and return carrier boats carrying finished articles in a parallel semi-circular path toward the handling station; and second cam drive means for oscillating the other

set of rotors one-half revolution when the carrier boats reach said transfer positions to thereby shift the carrier boats to the next advanced transfer positions in parallel semi-circular paths, said cam drive means alternately dwelling one set of rotors after each oscillation and during the oscillation of the other set of rotors, whereby the articles are continuously bidirectionally routed along common entrance and exit paths between the handling and processing stations.

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U.S. Cl. X.R.

198—19