Oct. 15, 1963 A. MADWED 3,106,927

VAPOR CHAMBER-TANK UNIT

Filed Jan. 15, 1962 3 Sheets-Sheet 1

Fig. 1

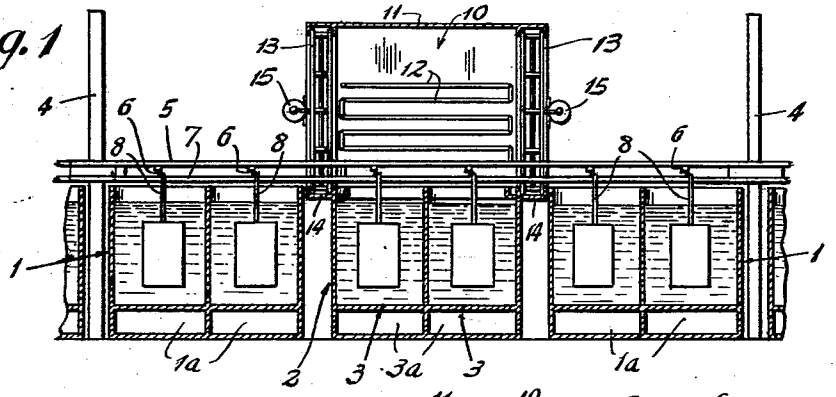


Fig. 2

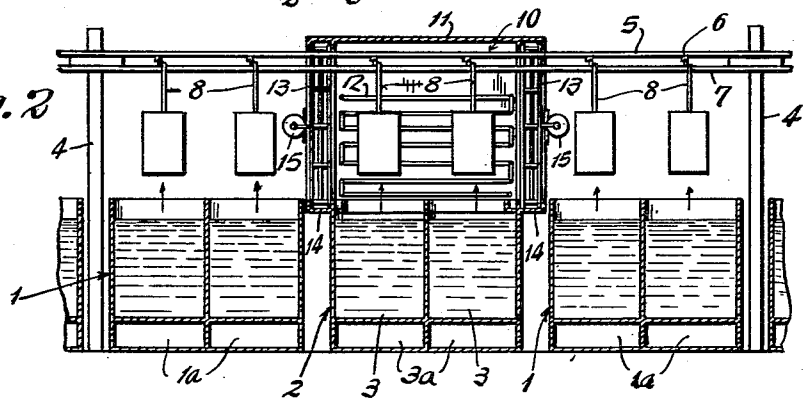
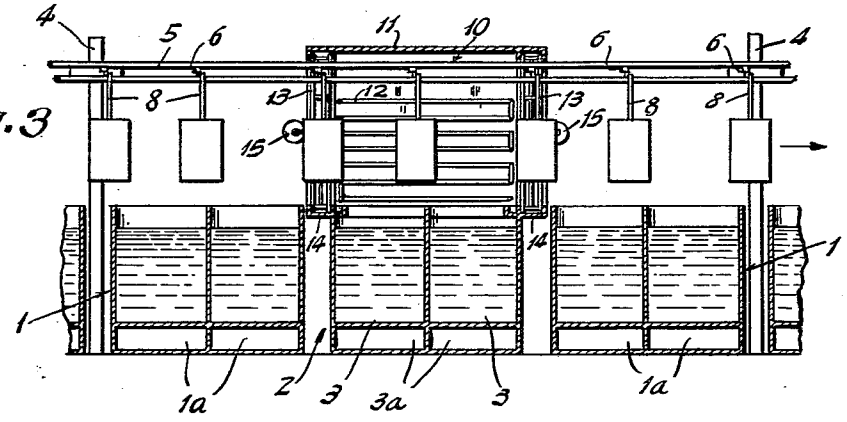


Fig. 3



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Oct. 15, 1963 A. MADWED 3,106,927

VAPOR CHAMBER-TANK UNIT

Filed Jan. 15, 1962 3 Sheets-Sheet 2

Fig. 4

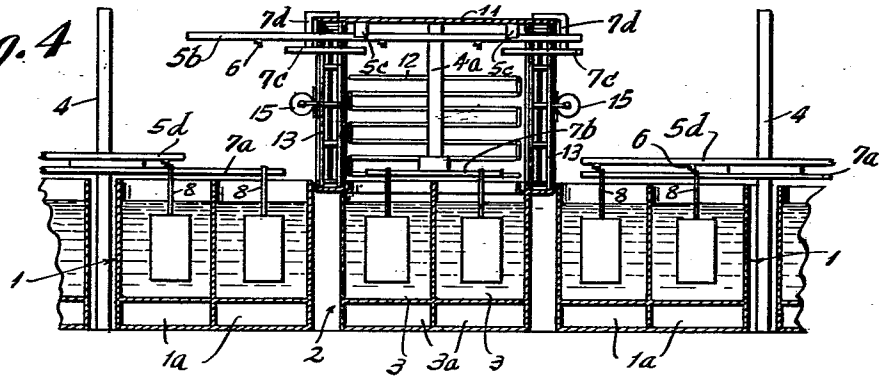


Fig. 5

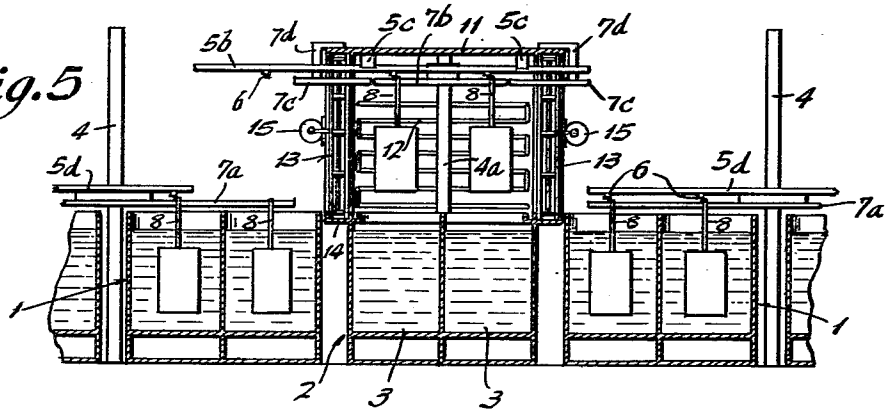
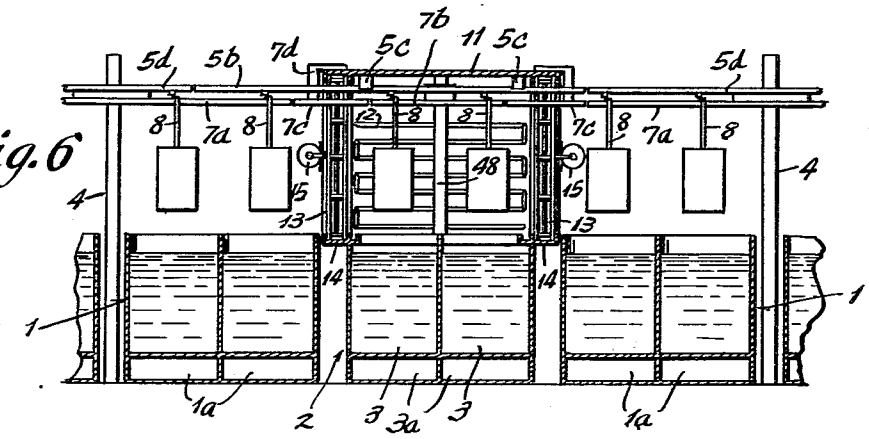


Fig. 6



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VAPOR CHAMBER-TANK UNIT

Filed Jan. 15, 1962 3 Sheets-Sheet 3

Fig. 7

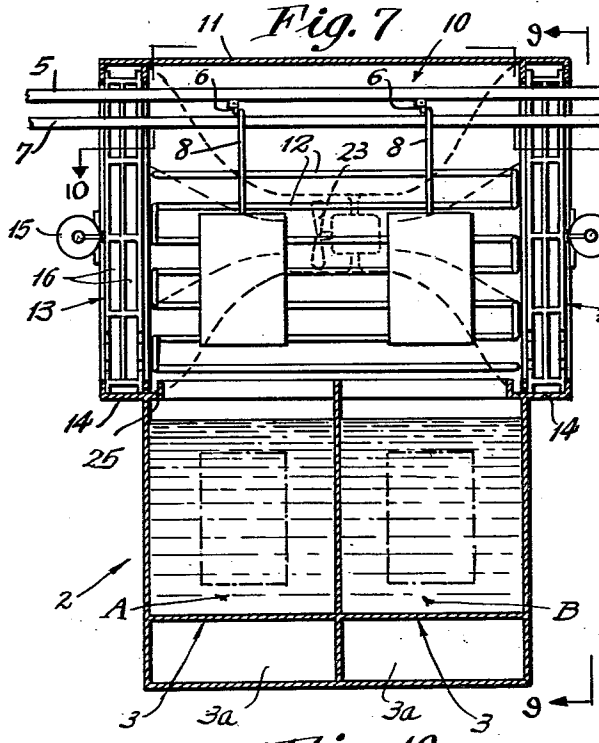


Fig. 8

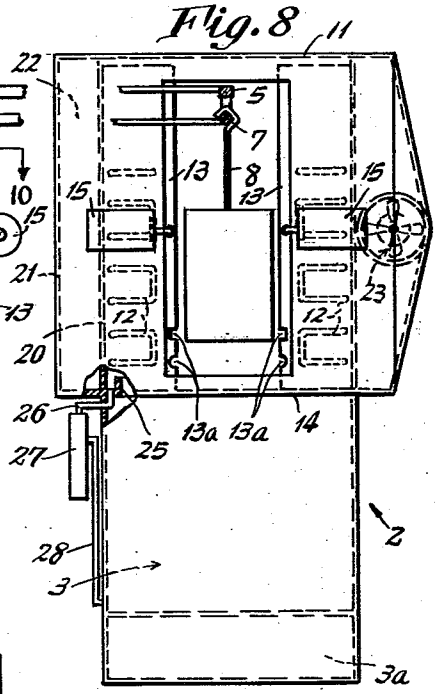


Fig. 10

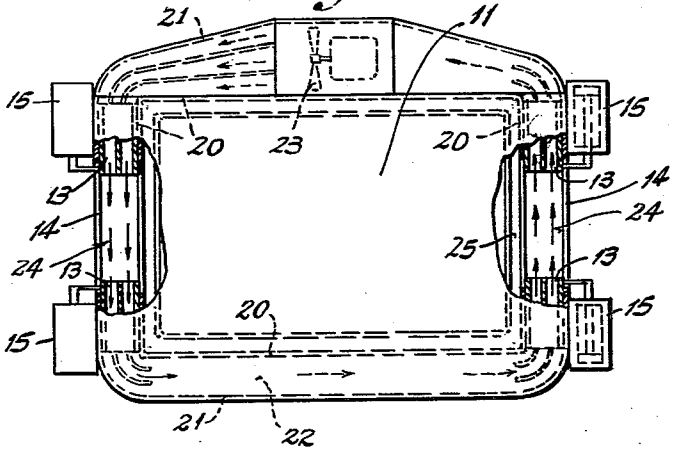
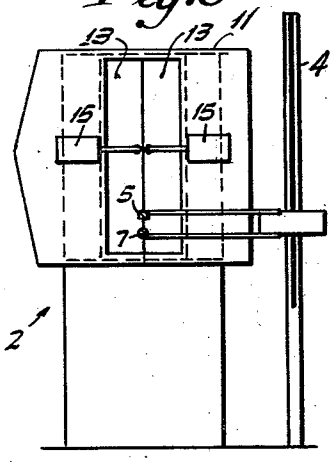


Fig. 9



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3,106,927

VAPOR CHAMBER-TANK UNIT

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Filed Jan. 15, 1962, Ser. No. 166,227
11 Claims. (Cl. 134—76)

This invention relates to a novel unit for the treatment of workpieces which are advanced therethrough on racks or hangers suspended from a conveying rail or the like. More specifically the invention relates to a solvent treatment unit, such as a degreaser or dryer, adapted to be inserted at any desired position in line with other treatment tanks in a conventional conveyor-type plating apparatus.

Until the present it has been impossible or at least highly impractical to dry or otherwise treat workpieces with highly volatile organic solvents in a continuous conveyor-type treatment apparatus such as an electroplating apparatus of the type disclosed in U.S. Patents Nos. 2,650,600 and 2,912,094. Such apparatus comprises a series of treatment tanks or stations containing washing, rinsing and plating liquids generally aligned in a row, and a conveying rail section over the row on which spaced workpiece carriers may be advanced by suitable pusher means. The rail sections mounted on the frame of the apparatus may be raised and lowered to cause the workpieces to be immersed in and withdrawn from the treating baths progressively.

The continuous conveyor-type plating apparatus has met with widespread success but does have serious disadvantages in that it requires that the treating tanks be open at the top to provide access for the workpieces and that the liquid in each tank be substantially at the same level. This has prohibited the use in such continuous conveyor apparatus of volatile organic treatment baths, highly advantageous for degreasing and drying the workpieces because the volatile materials would escape through the open top of the tanks. The additional height of a conventional tank extending upwardly to provide a vapor chamber prevents its use on any conveyor-type plating apparatus since the height to which the workpiece carriers are raised is only sufficient to clear the partitions or walls separating the other tanks and is not nearly sufficient to clear the additional height required by a vapor chamber. To cause the carriers to be raised, this additional height would require a rebuilding of the complete apparatus. This is costly and unsatisfactory since the additional height of the machine would materially interfere with its timing, would increase the amount of time required for the workpieces to be taken from one bath to the next and would require much additional headroom for operation.

An object of the present invention is to provide a treatment tank adapted to contain volatile organic treating liquids and having a superposed vapor chamber and adapted to be used on a conventional conveyor-type treating apparatus in a safe and facile manner.

Another object of this invention is to provide a conveyor-type treating apparatus having a vapor chamber-tank unit in combination with workpiece carriers which may be raised and lowered independently of the remaining workpiece carriers on the apparatus.

Accordingly a feature of this invention is the provision of a treatment tank which may be closed at the top and have in the sides of the vapor chamber aligned passages through which the work rack may travel to and from the vapor chamber, thereby avoiding the necessity of increasing the lift and fall of the work beyond the normal range. The passages in the side of the vapor chamber are, according to the present invention effectively closed, while the work is being treated, against substantial escape of vapors from the chamber.

Other objects, features and advantages will be apparent in the light of the following description and accompanying drawings, in which:

FIGURE 1 is a side elevational view of a segment of a conveyor-type plating machine containing a vapor chamber-tank unit according to the present invention, the conveyor chasssis being shown in the lowered position.

FIG. 2 is a side elevational view corresponding to FIG. 1 but showing the chassis in the raised position.

FIG. 3 is a side elevational view corresponding to FIG. 2 but showing the workpiece carriers in transit being pushed along the conveyor rail from one bath to the next.

FIG. 4 is a side elevational view of a segment of a conveyor-type plating machine containing a vapor chamber-tank unit in combination with a rail segment and workpiece carriers which may be raised and lowered independently of the remaining rail section of the apparatus, all of the workpiece carriers being shown in the lowered position.

FIG. 5 is a side elevational view corresponding to FIG. 4 but showing the rail section and workpiece carriers in the vapor chamber in the raised position.

FIG. 6 is a side elevational view corresponding to FIG. 4 but showing the rail and workpiece carriers in raised position, the carriers being pushed along and in transit from one bath to the next.

FIG. 7 is a side elevational view of a vapor chamber-tank unit according to the present invention and corresponding to the one shown in FIG. 2 having the chassis in raised position and indicating by dotted lines the corresponding position of the chassis when moved to the lowered position.

FIG. 8 is a front elevational view on the line 2—2 of FIG. 7 showing the chassis in raised position and the vapor chamber doors in open position.

FIG. 9 is a front elevational view on the line 2—2 of FIG. 7 showing the chassis in lowered position and the doors of the vapor chamber in closed position.

FIG. 10 is a top plan view on the line 3—3 of FIG. 7 showing the vapor chamber doors in open position and illustrating the flow of air between the inner and outer walls of the chamber creating an air curtain across the work carrier passages.

In a conventional conveyor type plating apparatus of the type heretofore mentioned, the workpieces are placed on the carrier at the introductory end of the apparatus. The first carrier is pushed along the rail into position over the first tank or station containing for instance a washing solution, automatically lowered so as to immerse the workpieces in the washing liquid, automatically raised after a preset time and pushed along the rail into position over the second tank or station containing for instance a second washing solution. At the same time, a second workpiece carrier, onto which other workpieces have been placed, is introduced onto the rail in spaced relationship to the first carrier and is pushed into position over the first tank or station. Simultaneously both carriers are lowered into the respective washing solutions, raised after a preset time, and pushed along the rail into position over the next tank or station, while a new carrier with workpieces is introduced onto the rail in spaced relationship to the second carrier for simultaneous treatment in the manner outlined.

Depending upon the number of treatment tanks or stations of the apparatus, a large number of workpiece carriers, each containing several workpieces, are simultaneously advanced, lowered, raised and again advanced horizontally step-by-step from one station to the next. In this way the workpieces are uniformly treated with washing, rinsing and other baths prior to plating and then uniformly treated in the plating baths prior to their exit from the apparatus. Thus, while some of the workpieces

are being immersed in washing baths, others are simultaneously being immersed in rinsing baths, while others are being immersed in plating solution. Each workpiece is in turn immersed in the bath at each station for the same length of time as the preceding workpieces.

FIGS. 1 to 3 illustrate a segment of a conveyor-type electroplating apparatus having a series of suitable treating tanks **1** filled to substantially the same level with liquid washing, rinsing or plating compositions, in combination with a vapor chamber-tank unit **2** having two treating bath tanks **3** filled with volatile organic degreasing or drying solvents to substantially the same level as the other tanks **1**. All of the tanks are mounted on a suitable base support such as a concrete slab or floor, the vapor chamber-tank unit preferably being removably mounted.

To the base support are attached vertical chassis supports or columns **4**. The chassis comprising the horizontal pusher bar **5** mounted for reciprocating movement and carrying pivoted pushers **6**, and the rail section **7** having removably and slidably attached thereto workpiece carriers **8**, is mounted for vertical movement on the columns **4** by bracket-mounted rollers or the like (not shown). The pivoted pushers **6** are adapted to advance the carrier **8** on forward movement and to pivot on reverse movement or back stroke to clear the next carrier **8** and fall into position therebehind to advance the same on the next forward stroke.

The vapor chamber-tank unit **2**, as more clearly illustrated by FIGS. 7 to 10, comprises an upper vapor condensing chamber **10** covered by a top section **11**, preferably removable, and having mounted on or in the side walls thereof condenser coils **12** containing coolant. On the front and rear walls of the vapor chamber are slidably mounted access and exit doors **13** adapted to be opened and closed along tracks **14** by means of hydraulic pistons **15** or the like in a direction perpendicular to the direction of the chassis which is adapted to pass therethrough.

Thus, as may be seen from the drawings, the vapor condensing chamber **10** is closed on all sides except for an open bottom providing access to the lower tank section and except for the doors which may be opened to provide passages through which the work carriers are adapted to travel into and out of the vapor chamber.

The doors **13** are preferably constructed to provide horizontal air spaces or channels **16** therein and thus allow for the passage of air therethrough. The door tracks **14** and the doors **13** are mounted within the inner and outer walls of the vapor chamber as may be more clearly seen from FIG. 10 which shows the inner walls **20** and the outer walls **21**. Between the inner and outer walls is an air space **22** surrounding the entire circumference of the vapor chamber and having mounted therein a fan **23** or other air impelling means for creating a strong flow of air around the air space **22** sufficient to create an air curtain **24** across the entry and exit passages when the doors **13** are opened. This substantially prevents the escape of any uncondensed vapors from the vapor chamber.

Around the entire inner circumference at the bottom of the inner wall of the vapor chamber is a gutter **25** for collecting the condensed solvent vapors which liquefy along the inner wall and on the inner surface of the doors **13**. The gutter is provided with a drainage pipe **26** leading to a separator **27** which extracts impurities such as water from the organic bath solution and return the latter to the desired receptacle or tank **3** in the base of the unit by means of pipe **28**. The separator may also be connected by a drainage pipe to the door housings to remove vapors condensed within the hollow doors and in the air space **22** between the walls, if desired.

The entry and exit doors **13** on the front and back walls of the vapor chamber are caused to open and close automatically in timed relationship with the movement of the chassis and the transit of the workpiece carriers. The doors are only closed when the chassis is in the lowered position and the workpiece carriers are immersed in the treating baths. The doors are automatically retracted when the chassis has been raised to withdraw the workpiece carriers from the bath.

Upon leaving the bath, the remaining volatile degreasing or drying solvent evaporates from the workpieces and from the carrier, but it is prevented from escaping from the vapor chamber by the air curtains **24** created by the swift current of air circulating within the air spaces **22** and through the hollow air passages **16** in the doors.

Next the pushers **6** on the pusher rod **5** make contact with the slidably mounted carriers **8** on the rail section **7** and advance the carriers to the next receptacle or tank as illustrated by FIG. 3. Each workpiece carrier is, in turn, advanced through the entry air curtain, immersed in bath A of the vapor chamber tank, retracted, immersed in bath B of the vapor chamber tank, retracted and advanced through the exit air curtain in perfectly dry condition, free of any water stains or the like.

The vapor chamber doors are provided on their lower edges with cutaway portions **13***a* (FIG. 8) preferably having gaskets or bushings, so as to envelop the pusher rod and rail and provide a seal when the doors are closed so that the entire unit is relatively airtight. However, it is sufficient in many instances to provide the cutaway portions on the doors so that they close snugly around the rod and rail and substantially prevent the escape of volatiles.

In the case of electroplating, current is applied to the conductive rail section **7** in known manner and passes through the conductive workpiece carriers **8** to the workpieces when the chassis is in the lowered position.

The liquid bath tanks **1** and **3** may be provided with suitable heating means such as a burner, hot plate or the like in base spaces **1***a* and **3***a*, if desired, to maintain the baths at a constant and elevated temperature.

In another embodiment of the present invention, as illustrated by FIGS. 4 to 6 of the drawing, the workpiece carriers within the vapor chamber may be raised and lowered independently of the remaining carriers on the apparatus. The principal advantages of such embodiment are that it is generally preferred to immerse the workpieces in the degreasing or drying solvents in the tanks of the vapor chamber unit for shorter periods of time and to withdraw them from the solvents at a slower rate than is the case with the workpieces in the other washing, rinsing or plating tanks on the apparatus. In this way, the workpieces may be immersed for a short time in the drying or degreasing solvent and slowly withdrawn to allow the liquid solvent such as trichloroethylene to flow from the workpieces. Any residual solvent remaining on cracks and crevices of the workpieces is evaporated in the vapor chamber, condensed, collected by the gutter **25**, purified to separate the solvent from water or the like, and returned to the solvent tank **3**.

As shown by FIGS. 4 to 6, the independent vertical suspension of the workpiece carriers **8** in the vapor chamber-tank unit is brought about by providing the unit with a vertical column **4***a* in the center thereof having mounted for vertical movement thereon a rail section **7***b* adapted to support two workpiece carriers, as illustrated, and positioned to align in the raised position with rail sections **7***c* mounted in the upper front and rear walls of the vapor chamber by mounts **7***d*. Rail sections **7***c* are positioned to align with rail sections **7***a* on the chassis when the chassis is in raised position so as to form a continuous rail over which the workpiece carriers may be pushed for transit from one bath to the next.

The vapor chamber-tank unit also has horizontally slidably mounted thereon pusher bar section **5***b* on mounts **5***c*, the bar section being so positioned to align with pusher bar sections **5***d* when the latter are brought to the raised position, to form a continuous pusher bar for advancing the workpiece carriers as illustrated by FIG. 6.

The doors of the vapor chamber of FIGS. 4 to 6 are

similar in construction and operation to the doors discussed hereinbefore and illustrated for instance by FIG. 8, with the exception that the cutaway portions 13*a* adapted to envelop the pusher bar and rail are located on the upper edges of the doors, since the bar and rail sections at the entry and exit passages of the chamber remain at the raised position as illustrated by FIG. 4. The rail sections 7*c* are supported by braces (not shown) so positioned as not to interfere with the transit of the workpiece carriers over the rail. The pusher bar section 5*b* is slidably attached to mounts 5*c* which support the bar without interfering with the longitudinal reciprocation thereof or the movement of the pivoted pushers.

In view of the discontinuity of the rail sections supporting the workpiece carriers, suitable means are used to conduct current to the workpieces in the case of electroplating, as is obvious to those skilled in the art.

As mentioned hereinbefore, the vapor chamber-tank unit of the present invention may be inserted at any desired position on a conventional conveyor-type plating apparatus or the like. This may be accomplished by removing the top section 11 of the device to provide access to the chamber for the pusher bar and rail sections and then replacing the top section, or by disassembling the pusher bar and rail sections and then reassembling them within the chamber and through the door openings.

On a continuous electroplating apparatus the vapor unit 2 may be positioned at or near the beginning or introductory end of the apparatus and the tank may contain suitable volatile degreasing liquid. The solvent in receptacle A, such as trichlorethylene or perchlorethylene, removes grease and grit from the workpieces. The workpieces then are moved to receptacle B which contains the same solvent but in purer form free from grease and grit. When the workpieces leave the vapor chamber unit, they are completely clean and free from grease and grit.

The vapor unit may also be positioned at the end of the apparatus for drying the plated or otherwise treated workpieces before they leave the apparatus. For this purpose the liquid in the vapor chamber tank may be trichlorethylene or perchlorethylene in which case the workpieces must first be immersed in a water-displacing oil. The oily workpieces are then brought into the vapor unit whereby they are cleaned of oil and dried. The water-displacing oil treatment may be dispensed with if the liquid in the vapor chamber tank is a drying liquid such as a modified trichlorethylene available under the name Trisec.

After the drying treatment in the vapor unit, the workpieces are completely clean and dry even in the cracks and crevices or recesses of intricately shaped workpieces. This is in sharp contrast to conventional drying methods using ovens, sawdust, centrifuges, hot and cold blast dryers and the like, which require that the workpieces be removed from the conveyor apparatus and which leave the workpieces with water stains, particularly in the case of intricately shaped parts.

The blower means illustrated for instance in FIG. 10 of the drawings as a motor-operated fan 23 is in operative communication with the space between the inner and outer walls of the vapor chamber and may be varied depending upon the size of the unit and the efficiency of the air curtain desired. Also the blower may be mounted outside the unit provided that the blower remains in operative communication with the space between the inner and outer walls and the air current therefrom is channeled into the air space 22 to provide the desired result. In most cases the blower is in continuous operation to provide a continuous air curtain even when the doors are in closed position, particularly when the swiftness of operation of the conveying apparatus and the short dwell time of the workpieces in the vapor unit make it impractical to intermittently operate the blower.

Although the present invention has been described most particularly with respect to its use in connection with electroplating apparatus, it should be understood that the present vapor chamber device may be advantageously used as an integral part of any conveying apparatus whether it be used for plating, bright pickling, blackening, phosphating, or the like.

It should also be understood that the vapor chamber-tank unit of the present invention has been described specifically to correspond with the accompanying drawings but that many variations will be obvious to those skilled in the art in the light of the foregoing description. For instance it is not necessary that the chamber doors be wide and hollow as illustrated. Thin doors may be mounted against the inner or outer wall of the vapor chamber so that the air curtain need not pass through the doors. Also, other suitable power-operated door-actuating means may be used in place of the pistons illustrated.

Although the dual receptacle tank section of the present unit, as illustrated, is the preferred form of the present invention, there is no criticality in the number of receptacles, and the end use will in most cases determine whether one or more receptacles are required.

Various other modifications and alterations in the construction of the present vapor chamber device may be made without departing from the scope of the present invention as indicated by the appended claims.

I claim:

1. In work treating apparatus having means for conveying work carriers horizontally step-by-step from one station to another and means for moving the work carriers vertically at at least some of said work stations, one of said stations having a tank section open at the top adapted to contain an amount of volatile liquid material into which the work carriers may be submerged by said means for moving the same vertically, and a vapor collecting chamber section above said tank section and open at the bottom into which the work carriers may be raised from the volatile liquid material in the tank section by said means for moving the carriers vertically, means in said vapor chamber to condense said liquid material when volatilized, said vapor chamber being closed on all sides except for said open bottom and work carrier passages on two oppositely positioned walls of said chamber, doors adapted to close and open said passages, said doors in open position being adapted to permit entry of said work carriers on said conveying apparatus to said vapor chamber and said doors having openings to receive said conveyor means when in closed position, and means in the vapor chamber section for substantially preventing the escape of said volatilized liquid material from said vapor chamber when the doors thereof are in the open position.

2. Work treating apparatus as defined in claim 1 in which said vapor chamber section has spaced inner and outer walls and said doors slide in said space between said inner and outer walls between open and closed positions.

3. Work treating apparatus as defined in claim 1 in which said vapor chamber section has spaced inner and outer walls and means for substantially preventing the escape of said volatilized material comprising a blower in operative communication with the space between said inner and outer walls, said inner and outer walls of the vapor chamber section directing an air curtain from said blower across said work carrier passages when the doors are in the open position.

4. Work treating apparatus as defined in claim 1 in which there are power-operated means for opening said doors to permit entry of said work carriers on said conveying apparatus and for closing said doors after entry of said work carriers.

5. In work treating apparatus having means for conveying work carriers horizontally step-by-step from one station to another and means for moving the work carriers vertically at at least some of said work stations, one of said stations having a tank section open at the top adapted to contain an amount of volatile liquid ma-

terial into which the work carriers may be submerged by said means for moving the same vertically, and a vapor collecting chamber section above said tank section and open at the bottom into which the work carriers may be raised from the volatile liquid material in the tank section by said means for moving the carriers vertically, means in said vapor chamber to condense said liquid material when volatilized, said vapor chamber section having spaced inner and outer walls and being closed on all sides except for said open bottom and work carrier passages on two oppositely positioned walls which form a portion of said spaced inner and outer walls of said chamber, and means in the vapor chamber section between said spaced inner and outer walls for providing an air curtain across said passages for substantially preventing the escape of said volatilized liquid material from said vapor chamber.

6. Work treating apparatus as defined in claim 1 in which said vapor chamber section has spaced inner and outer walls, work carrier passages on two oppositely positioned inner and outer walls of said chamber, and said doors slide in said space between said inner and outer walls, between open and closed positions, said doors having spaced inner and outer panels and open edges and the means for substantially preventing escape of volatilized material comprises a blower in operative communication with the space between said inner and outer walls, said inner and outer walls of the vapor chamber section and the inner and outer panels of the doors directing an air curtain from said blower passing through said open edges horizontally across said passages when the doors are in the open position.

7. A vapor unit having a tank section open at the top and adapted to contain an amount of volatile liquid material into which workpieces to be treated may be immersed and a vapor collecting chamber section above said tank section and open at the bottom into which workpieces to be dried are adapted to be raised from said volatile liquid material in said tank section, means in said vapor chamber to condense said liquid material when volatilized, said vapor chamber section having spaced inner and outer walls and being closed on all sides except for said open bottom and work carrier passages on two oppositely positioned walls which form a portion of said spaced inner and outer walls of said chamber, and means in the vapor chamber section between said spaced inner and outer walls for providing an air curtain across said passages for substantially preventing the escape of said volatilized liquid material from said vapor chamber.

8. A unit having a tank section open at the top and adapted to contain an amount of volatile liquid material into which workpieces to be treated may be immersed and a vapor collecting chamber section above said tank section and open at the bottom into which workpieces to be dried are adapted to be raised from said volatile liquid material in said tank section, means in said vapor chamber to condense said liquid material when volatilized, said vapor chamber being closed on all sides except for said open bottom and work carrier passages on two oppositely positioned walls of said chamber, doors adapted to close and open said passages, said doors in open position being adapted to permit entry of work carriers to said vapor chamber and said doors in the closed position being adapted to substantially prevent the escape of said volatilized liquid material, power-operated means for opening said doors to permit entry of said work carriers to said vapor chamber and for closing said doors after entry of said work carriers, and means in the vapor chamber section for substantially preventing the escape of said volatilized liquid material from said vapor chamber when the doors thereof are in the open position.

9. A unit as defined in claim 8 in which said vapor chamber section has spaced inner and outer walls, and said two oppositely positioned walls form a portion of said spaced inner and outer walls, and said doors slide in said space between said inner and outer walls between open and closed positions.

10. A unit as defined in claim 8 in which said vapor chamber section has spaced inner and outer walls, and said two oppositely positioned walls form a portion of said spaced inner and outer walls, and means for substantially preventing escape of said volatilized material comprising a blower in operative communication with the space between said inner and outer walls, said inner and outer walls of the vapor chamber section directing an air curtain from said blower across said work carrier passages when the doors are in the open position.

11. A unit as defined in claim 8 in which said vapor chamber section has spaced inner and outer walls, work carrier passages on two oppositely positioned walls which form a portion of said spaced inner and outer walls of said chamber, and said doors slide in said space between said inner and outer walls between open and closed positions, said doors having spaced inner and outer panels and open edges, and the means for substantially preventing escape of volatilized material comprises a blower in operative communication with the space between said inner and outer walls, said inner and outer walls of the vapor chamber section and inner and outer panels of the doors directing an air curtain from said blower passing through said open edges horizontally across said passages when the doors are in the open position.

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