A vacuum forming machine comprises a base structure, a porous plate spacedly mounted on the base structure, and a blower mounted on the base for drawing air through the porous plate. A clamping frame for plastic sheets conforms closely to the perimetric contour of the porous plate. The frame is pivoted for movement to a heating element on the base and to the porous plate, which is then inserted through an opening in the frame. A leveling arrangement is mounted on the frame and/or the porous plate, for spacing the frame from the base and for aligning the frame with the adjacent edge of the porous plate.

7 Claims, 7 Drawing Figures
1 VACUUM FORMING MACHINE

DESCRIPTION OF THE INVENTION

The present invention relates to vacuum forming machines for shaping thin, substantially two-dimensional plastic sheets into three-dimensional thermoplastic and, more particularly to a machine having an improved sheet holder or frame for positioning the plastic sheet properly with respect to the mold or other forming means of the machine.

Vacuum forming machines germane to the machine of the character described have been known for some time and generally include a hinged or pivoted frame in which a two-dimensional, substantially thermoplastic or flexible plastic is clamped. The frame can be moved to a first position relative to a heating element of the machine wherein the plastic sheet is heated to its softening temperature. The frame can then be moved to a second or forming position in the machine, relative to a "vacuum pan." One or more mold structures or forming members are disposed on the vacuum pan which is sufficiently porous that air can be drawn therethrough by a blower or the like forming part of the vacuum forming machine. The mold structures are provided with suitable aperture means communicating with the porous surface structure of the vacuum pan. The heated plastic sheet is drawn and shaped about the mold structures by air passing through the vacuum pan to create a partial vacuum between the plastic sheet and the vacuum pan, and other vacuum components of the machine. Similarly, the sheet is drawn into the various crevices or indentations in the mold structure by the aforementioned aperture means.

In the operation of such vacuum machines, it is highly desirable to orient the plastic sheet holder or frame properly with respect to the vacuum pan such that the shaped portions of the plastic sheet are properly oriented with respect to the balance or unformed portions of the sheet. In a typical vacuum forming machine, it is highly desirable, therefore to maintain the plane of the plastic sheet holder or frame substantially parallel to the vacuum pan. In previous machines, no adequate means has been provided for this purpose, with the inevitable result that the residual tensile strength of the heated plastic sheet is utilized in many cases to support or partially support the frame or holder with respect to the vacuum pan, usually at a raised position above the top surface of the base structure of the machine.

The pivoted frame or holder likewise is maintained slightly above the top surface of the machine to allow a proper pivotal movement thereof. As the plastic sheet and frame must be moved quickly from the heating element of the machine to the vacuum structure or vacuum pan thereof, little time is allowed for the operator of the machine to orientate or align manually the frame relative to the vacuum pan. In the operation of the vacuum forming machines, then, one side or other of the plastic sheet holder or frame may be permitted to sag with respect to the vacuum pan with the result that the formed areas of the sheet are misorientated relative to the perimeter or other relatively unformed areas of the plastic sheet. The three-dimensional image imparted to the sheet, moreover, is frequently distorted.

Likewise, the operator of the machine in an attempt to prevent the occurrence of the aforementioned frame sagging, may inadvertently and manually support the frame or a side thereof at some position slightly above the vacuum pan. A loss or partial loss of the partial vacuum, which would otherwise be developed between the plastic sheet and the suction passages of the machine, then occurs and the plastic sheet may be only partially formed about the mold structure or other forming members placed on the vacuum pan.

I overcome these disadvantages by providing self-aligning means on the plastic sheet holder or frame and/or on the vacuum pan structure of the machine. The self-aligning means does not interfere with the normal operation of the vacuum forming machine, in particular its pivotal frame structure. Rather, the alignment means insures in a repetitive manner the levelling of the frame structure with the vacuum pan each time the frame structure is placed thereover. Most importantly, the self-alignment means does not interfere with the proper orientation or disposition of both the frame structure and the vacuum pan at their raised positions above the base structure of vacuum forming machine.

I accomplish these desirable results by providing in a vacuum forming machine, the combination comprising a base structure for said machine, a porous plate structure spacedly mounted on said base structure, duct and blower means mounted on said base structure for drawing air through said plate structure, a clamping frame for plastic sheet material and the like, said frame conforming closely to the perimeter contour of said porous plate structure, means for mounting and pivotally moving said frame from a first position on said base structure adjacent a heating element thereof to a second position whereat said plate structure is inserted through an opening in said frame, and means secured to at least one of said frame and said plate structure for engaging and aligning said frame relative to said plate structure at said second position.

I also desirably provide a similar vacuum forming machine wherein said engaging and aligning means include at least three bracket members secured to said plate structure and spaced thereabout for engagement by and alignment of said frame member.

I also desirably provide a similar vacuum forming machine wherein said bracket members are each secured to a bottom surface of said plate member and include an outward, downwardly stepped section positioned to engage said frame and to align upper edge portions of said frame with an upper perimeter of said plate structure.

I also desirably provide a similar vacuum forming machine wherein said engaging and aligning means include a bracket member secured to said plate structure and at least one foot member secured to said frame member and engageable with an adjacent surface of said base structure to space said frame member therefrom.

During the foregoing discussion, various objects, features and advantages of the invention have been set forth. These and other objects, features and advantages of the invention together with structural details thereof will be elaborated upon during the forthcoming description of certain presently preferred embodiments of the invention and presently preferred methods of practicing the same.

In the accompanying drawings I have shown certain presently preferred embodiments of the invention and have illustrated certain presently preferred methods of practicing the same, wherein:

FIG. 1 is an isometric view of one form of vacuum forming machine arranged in accordance with the invention and showing the frame in an intermediate position;

FIG. 2 is a similar view with the frame in the heating position;

FIG. 3 is a similar view with the frame in the forming position;

FIG. 4 is a partial enlarged elevational view, partially sectioned, of the apparatus as shown in FIG. 2;

FIG. 5 is a similar view of the apparatus as shown in FIG. 3;

FIG. 6 is a front elevational view of a vacuum forming machine similar to that shown in FIG. 1, but illustrating another form of the invention; and

FIG. 7 is an enlarged partial isometric view of the apparatus as shown in FIG. 5.

With reference now to FIGS. 1-7, a vacuum forming machine 10 shown therein comprises a base structure 12, which houses a heating element 14 in a heating well or recess 16. A screen 18 or the like, covers the top opening of the well 16 to prevent inadvertent contact with the heating element 14.

The base structure 12 also houses a blower (not shown) and suitable controls therefore, for drawing air through the vacuum pan or porous plate structure 20. The vacuum pan 20 is spaced above the vacuum forming machine 10, as better
shown in FIG. 2 by means of a low profile duct 22 (FIGS. 2
and 5) which adjoins the porous plate 20 adjacent its perime-
ter. The duct 22 together with other air passages (not shown) in
the base structure 12 conducts air drawn through the vacuum pan 20 to the aforementioned blower.

A plastic sheet holder or frame 24 is pivotally mounted on the base structure 12 and is spaced above the surface thereof
(FIG. 1) to permit alignment of the frame 24 with the vacuum pan 20. The frame hinges 26 in this example are of the panto-
graphic variety to facilitate such alignment. The frame proper
includes in this example a rectangular shape of angle material
28 and a complementary rectangular member 30 of a suitable
complementary cross section and seatable therein. The com-
plementary member 30 is hinged at 31 to the angle 28 for the
purpose of clamping a plastic sheet 32 therebetween.

The plastic sheet holder 24 can be swung about the pivot
means 26 to a position (FIGS. 2 and 4) whereat the plastic
sheet 32 is closely disposed above the heating well 16. After
the plastic sheet softens, the holder 24 is quickly moved to its
position generally surrounding the periphery of the vacuum
pan 20 as shown (FIGS. 3 and 5). The aforementioned blower
is then actuated to withdraw air through the vacuum pan or
porous plate structure 20 and duct 22 (arrows 34). The soft-
ened plastic sheet 32 then is drawn downwardly, over, and
around mold structure 36 or other shaping elements (not
shown) to impart a corresponding three-dimensional shape to
the plastic sheet 32.

The forming of the plastic sheet 32 is facilitated by aperture
means 38 in the mold structure 36, which apply suction to
specific areas between the plastic sheet 32 and the adjacent
surfaces of the mold structure 36. The aperture means 38 for
example can be disposed at various recesses and indentations
or the like defining the design or message imparted to the
mold structure 36.

When the frame 24 is positioned about the vacuum pan 20,

it is highly desirable that the frame be properly aligned or
levelled with the vacuum pan 20. This assures that those
perimetric portions 32a (FIG. 5) of the sheet 32 will flushly
engage the perimetric edges 20a of the vacuum pan 20. If the
frame 24 and plastic sheet are not initially so aligned, either
ridges or depressions will appear in the plastic sheet 32 at the
vacuum pan edges 20a of varying elevations, depending on
whether the adjacent portion of the frame is depressed below
or raised upon the related edge 20a of the vacuum pan. In ad-
dition to the unsightly character of these ridges or depressions,
the form or shape imparted to the plastic sheet 32 by the mold
structure 36 will be angularly misoriented relative to the base
or perimetric portions 32a of the plastic sheet. Moreover,
if one or more sides of the frame 24 is inadvertently elevated
above the vacuum pan 20 a substantial quantity of air can
enter the resulting spaces between the adjacent sheet edge 32a
and the vacuum pan edge 20a, resulting in a partial or
complete loss of the partial vacuum necessary for the forming
operation. In consequence, the sheet 32 when formed may ex-
hibit a partial vacuum necessary for the forming operation. In
consequence, the sheet 32 when formed may exhibit a partial
or complete loss of definition.

One form of such levelling means includes, in this example,
a three-point suspension for the frame 24 in the forming posi-
tion thereof, as illustrated in FIGS. 1–3 and 5. Such suspension
means assures proper alignment of the frame 24 and the
heated plastic sheet 32, which is supported by the frame, with
the vacuum pan 20. In this arrangement, such suspension
means include an angle bracket 40 secured to the underside of
the vacuum pan 20 at its edge adjacent the hinges 26. As
evident from FIG. 5, the angle bracket 40 is shaped such that
the adjacent portions of the frame 24 seat flushly therein with
the adjacent perimetric edge portion 32a of the plastic sheet
being disposed substantially flush with the adjacent edge por-
tions 20a of the vacuum pan 20.

The front corners portions 42 (FIG. 1) of the frame 24 are
provided with feet 44, which can be in the form of grommets
or the like (FIG. 5). The feet 44 are of such elevation that the
adjacent portions of the frame 24 are supported at the proper
elevations by contact of the feet 44 with the adjacent upper
surfaces of the base structure 12 of the vacuum forming
machine 10. Thus, the front corners 42 and the remainder of
the frame structure 24 are likewise aligned with the vacuum
pan 20 such that the perimetric edge portions 32a of the sheet
24 flushly engage the perimetric edges 20a about the entire
perimeter of the vacuum pan 20. The alignment of the frame 24
in this manner is facilitated by the three-point suspension
thereof, including the angle bracket 40 and the feet or grom-
mets 44, relative to the vacuum pan 20. The hinge or pivot
members 26 can be spring or gravity loaded (for example by
conventional pins and vertical slots) to allow the frame 24 to
be thus positioned by the three-point suspension means, par-
ticularly the adjacent angle bracket 40. With the arrangement
as shown in FIGS. 1–5, it is virtually impossible for the frame
24 or any part thereof to be inadvertently positioned above or
below the vacuum pan 20 such that the aforementioned ridges
or recesses will appear in the sheet 32 at the vacuum pan
edges 20a or such that vacuum leakage will occur at one or
more of these edges.

It is contemplated that other arrangements of the aforemen-
tioned frame suspension means can be employed within the
context of my invention. For example, the feet or grommets
44 of FIGS. 1–5 can be replaced by angle brackets similar to
the bracket 40 (FIG. 5). As shown in FIG. 6, the plastic sheet
holder or frame 24 is supported adjacent its front corner por-
tions 42 by a pair of angle brackets 46 respectively. Each of
the brackets 46 is secured in this example beneath the vacuum
pan 20 for proper engagement by the frame 24. The brackets
46 can be secured (by sheet metal screws or the like) to a sup-
porting flange 48 of the air duct 22. The brackets 46, which
are disposed adjacent the front corners of the vacuum pan 20
and remote from the hinges 26, together with the angle
bracket 40 (FIG. 5) thus form a desirably three-point suspen-
sion of the frame 24' in alignment with the vacuum pan 20'
as described previously. In this arrangement, the angle brackets
46 extend from the sides of the vacuum pan 20' adjacent the
front corners thereof as better shown in FIG. 7. The brackets
40, 46 in addition support the frame 24' at the proper spacing
above the adjacent upper surface of the base structure 12 of
the vacuum forming machine 10.

Other modifications of the suspending means are contem-
plated within the teachings of my present invention. For ex-
ample, the brackets 40, 46 of FIG. 5 and 6 can each be replaced
by a foot or grommet similar to the foot 44 (FIGS. 1–5) at
each corner of the frame 24. Likewise, the angle bracket 40
(FIG. 5) can be removed and its function replaced by a pair of
angle brackets similar to the brackets 46 of FIGS. 5 and 6
disposed adjacent the rear corners of the vacuum pan 20'.

Relative to FIGS. 1–5, the angle bracket 40 can extend the
distance length of the adjacent edge portion of the vacuum pan
20. It is preferred, however, that the angle bracket be con-
siderably shorter for example nominally about the width of
the angle bracket 46 of FIGS. 5 and 6, and disposed adjacent
the midpoint of the adjacent edge of the vacuum pan 20, in order
to afford a desirably three-point suspension of the frame or
holder 24. The three-point suspension of course, facilitates the
self-alignment of the frame 24 when it is moved from its heal-
ing position (FIG. 2) to its forming position (FIG. 3).

From the foregoing it will be apparent that novel and effi-
cient forms of Vacuum Forming Machine have been described
herein. While I have shown and described certain presently
preferred embodiments of the invention and have illustrated
presently preferred methods of practicing the same, it is to be
distinctly understood that the invention is not limited thereto
but may be otherwise variously embodied and practiced
within the spirit and scope of the invention.

1. claim:

In a vacuum forming machine, the combination comprising
a base structure for said machine, a porous plate structure
spacedly mounted on said base structure, duct and blower
means mounted on said base structure for drawing air through

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said plate porous structure, a clamping frame for plastic sheet
material and the like, said frame conforming closely to the
perimetric contour of said porous plate structure, means for
mounting and pivotally moving said frame between a first
position on said base structure adjacent a heating element
thereof and a second position whereby said plate structure is
inserted through an opening in said frame, and at least one
foot member mounted on a lower surface of said frame remote
from said hinge means, said foot member being engageable
with an adjacent surface of said base structure for spacing said
frame therefrom and for aligning said frame with the adjacent
edge of said plate member.
2. The combination according to claim 1 wherein a pair of
said foot members are provided, said foot members being
secured to said frame adjacent corner sections thereof remote
from said hinge means.
3. The combination according to claim 2 wherein a frame
supporting bracket is secured to said plate structure at a loca-
tion remote from said feet members for engagement and align-
ment of the adjacent portion of said frame.
4. In a vacuum forming machine, the combination compris-
ing a base structure for said machine, a porous plate structure
spacedly mounted on said base structure, duct and blower
means mounted on said base structure for drawing air through
said plate porous structure, a clamping frame for plastic sheet
material and the like, said frame conforming closely to the
perimetric contour of said porous plate structure, means for
mounting and pivotally moving said frame from a first position
on said base structure adjacent a heating element thereof to a
second position whereby said plate structure is inserted
through an opening in said frame, and means secured to at
least one of said frame and said plate structure for engaging
and aligning said frame relative to said plate structure at said
second position.
5. The combination according to claim 4 wherein said en-
gaging and aligning means include at least three bracket mem-
bers secured to said plate structure and spaced thereabout for
engagement by and alignment of said frame members.
6. The combination according to claim 5 wherein said
bracket members are each secured to a bottom surface of said
plate member and include an outward, downwardly stepped
section positioned to engage said frame and to align upper
edge portions of said frame with an upper perimeter of said
plate structure.
7. The combination according to claim 4 wherein said en-
gaging and aligning means include a bracket member secured
to said plate structure and at least one foot member secured to
said frame member and engageable with an adjacent surface
of said base structure to space said frame member therefrom.