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MACHINE FOR SHAPING THERMOPLASTIC SHEETS

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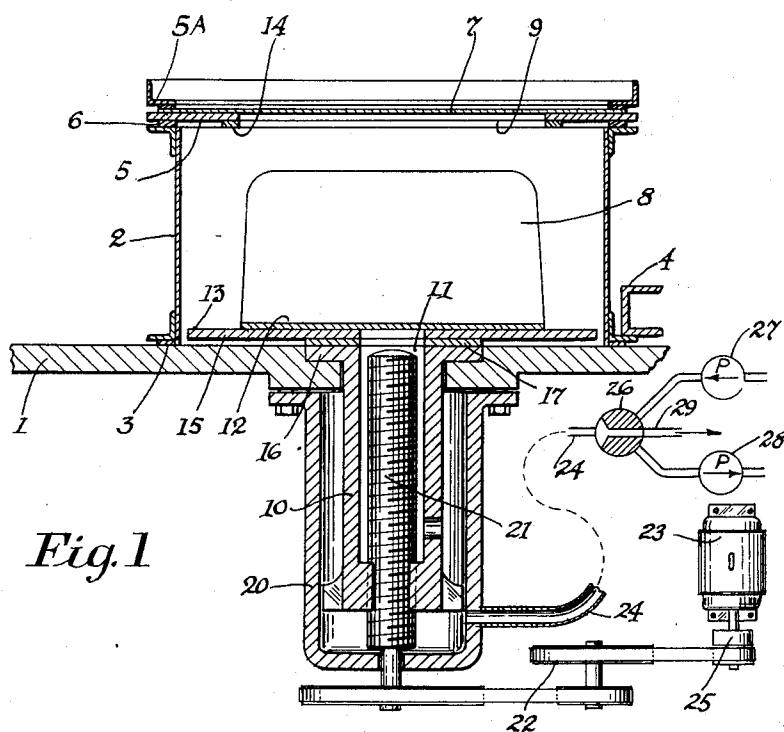


Fig. 1

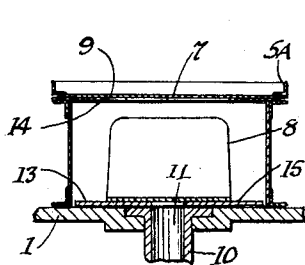


Fig. 2

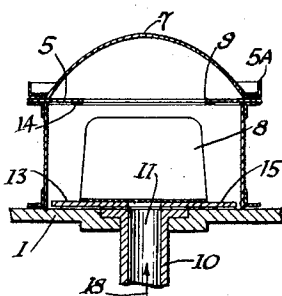


Fig. 3

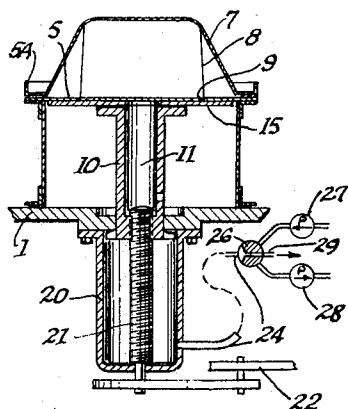


Fig. 4

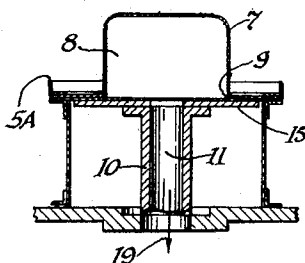


Fig. 5

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MACHINE FOR SHAPING THERMOPLASTIC SHEETS

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1 Claim. (Cl. 18—19)

The invention relates to a machine for shaping thermoplastic sheets or foils, which machine is provided with a device for heating the material to be shaped and with an air-suction device.

As a result of this invention, it is now possible, to produce any desired shapes, out-of-round or box-like, in a simple manner, from thermoplastic sheets or foils, in such a manner that, for example, the bottom of a box is made thinner during processing to such an extent that with the residual thinning, and acceptable uniformity of the drawn portion of the synthetic material is obtained. It is no longer necessary to have to use larger blanks of sheet or foil material in order to obtain an acceptable uniformity of wall thickness. For this reason alone, the new method is considerably more economical to work than prior known processes.

According to the invention, the sheet is clamped so that it seals off an air-tight chamber or a compartment, and is subsequently heated and preliminarily stretched by blowing compressed air into the chamber. After this, the sheet is roughly shaped by means of an upwardly travelling forming die, and finally brought into the ultimate shape by producing a vacuum in the chamber in which the raised die remains. In a specific embodiment of the method, the chamber is brought into communication with the atmosphere after the compressed air has been blown in, when the preliminary stretching process is completed, or before the production of a vacuum in the chamber.

For the purpose of preliminarily stretching the sheet to be shaped, the novel machine for carrying out this method is provided with a device for introducing compressed air into the chamber which is sealed off in an air-tight manner by the clamped sheet, while at the same time, said device is combined with a suction device, so as to carry out the final shaping of the sheet by means of a vacuum. The forming die of the machine, used for the shaping, is carried by a piston which can travel in and out of the above-mentioned air-tight chamber. The two devices may be combined in such a manner that the air to be blown in and sucked out passes through an air passage in the piston and is in communication, through a three-way valve, either with a source of high pressure or vacuum, or with the atmosphere. The method is carried out in such a manner that, after the preliminary stretching by compressed air, the three-way valve is set so that the excess pressure is first released and only then does the vacuum come into action for the further processing.

In a specific embodiment of the invention, the said chamber which is sealed off in an air-tight manner is formed by a box which is detachably connected on one side to a table plate, and on the other side to a clamping frame to receive the material to be shaped, the piston carrying the die passing through the table plate in an air-tight manner. As a result of this arrangement, all possibility of injury to the operator through carelessness is completely eliminated. In addition, the forming die is protected from any damage by the box.

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In a further embodiment of the invention, the piston is coupled to a screw-spindle which is connected to any desired drive. In comparison with machines driven by pressure-oil, this novel feature offers the advantages outlined below:

During the vacuum drawing the air is sucked out of the box chamber through the passage 11. As a result, the outer atmosphere exerts a force in that the piston receives a high additional load from above. In hydraulically operated installations, the cylinder must be dimensioned in such a manner that it withstands these maximum pressures while only a fraction of the power is needed to shape the foil. When using a screw-spindle, however, the motor and all the transmission members can be adapted to the power which is necessary for shaping the foil, while only the spindle is so strongly designed as to withstand the demands of this additional load when stationary. The spindle is constructed in such a manner that it is frictionally on the border-line of non reversibility and does not perform any reverse movement as a result of these additional pressures.

At the same time, motive power, motor equipment, and transmission members can be dimensioned very sparingly and yet be adequate to meet all requirements in operation.

One embodiment of the invention is illustrated by way of example in the drawing.

Figure 1 shows a longitudinal section through the machine according to the invention, in which the shaping takes place; and

Figures 2 to 5 show four stages in the shaping process with the machine as shown in Figure 1.

With the interposition of seals 3, a box 2 is detachably clamped, by means of rails 4 or the like, on the table plate 1 of a machine for shaping thermoplastic sheets or foils. With the interposition of a seal 6, the top of the box is covered by a frame 5 which receives the material to be shaped, for example, the thermoplastic sheet 7. Inside the box is the forming die 8, which can travel upwards through the aperture 9 in the frame 5 to carry out the shaping work. The die 8 is mounted on the piston 10, which can travel in an air-tight manner in and out of the interior of the box 2 through the table plate 1. Interposed between the die and the top of the piston, which is provided with an air passage 11, is a spacer 12, or the like, which forms a connection for conveying air from the passage 11 to the interior of the box 2 and vice versa. Also in the region of the connection between the die and the piston is an annular bearing surface 13 which co-operates with a seal 14 on the frame 5 when the die travels upwards. To prevent air from reaching the air passage 11 in the piston from the interior of the box 2 when the die is in this position, a further seal 17 is inserted between the disc 15 forming the contact surface 13 and the piston flange 16.

With the device described, the shaping work takes place step by step, as shown in Figures 2 to 5.

Figure 2 shows the initial position in which the die 8 is inside the box 2 in its lowest position. The sheet 7, clamped on the frame 5 by a clamping flange 5A, is still unshaped. Now, as shown in Figure 3, compressed air is supplied in the direction of the arrow 18, through the air passage 11 in the piston 10, and through the spacer 12 into the interior of the box 2, and causes a preliminary stretching of the sheet 7, as indicated in the drawing. Now, as shown in Figure 4, the piston is moved upwards and the die 8 passes through the aperture 9 in the frame 5 into its upper terminal position, shaping the sheet 7 as it does so. The supply of compressed air is shut off and a vacuum then established so that the air still present inside the sheet 7 is sucked out through the spacer 12 and the air passage 11 in the piston 10, in the direction of the

arrow 19, as shown in Figure 5, and the sheet 7 assumes its final shape.

As can be seen from Figure 1, the piston 10 works inside an air-tight cylinder 20 and is driven by a screw-spindle 21 for upwards and downwards movement. The screw-spindle is connected through gearing 22 to the driving motor 23. The cylinder 20 has a connection 24 for an air supply line which is connected, through a three-way valve 26 to a source of vacuum or high pressure.

The driving motor is preferably constructed in the form of a brake motor which, at the moment when the bearing surface 13 comes into contact with the seal 14, on the frame 5, meets a resistance and cuts out and temporarily brakes the motor relay through an overload relay. With this arrangement it is not necessary to have a fixed stroke for the die and it adapts itself automatically to the height of box used.

An adjustable slipping clutch 25 may also be provided between the motor and the spindle, which clutch compensates the brake path of the motor according to the amplitude of the leakage pressure.

When the die and the piston have travelled to their uppermost position, they are retained in this position by the brake motor. The working surface formed by the disc 15 and the frame 5 corresponds to a normal work table when the die is removed. This table comprises an air-suction hole and thus offers the possibility of mounting any desired moulds for negative shaping. The working surface is not in any way restricted by the structures described above used for positive shaping.

As can be seen in Figure 1, the above-mentioned three-way valve 26 is connected to a pressure pump 27 for supplying compressed air for preliminarily stretching the clamped sheet (Figure 3) and also with a suction pump 28 for providing a vacuum for the purpose of finally shaping the sheet (Figure 5). When the preliminary stretching process is completed, the pipe 24, which was previously connected to the pump 27, is brought, by changing over the valve 26, into communication with the pipe 29 which leads to the atmosphere so that the pressure previously applied in the chamber is reduced to nil. The valve is now changed over further so that the vacuum is produced in the chamber by means of the pump 28, through the pipe 24.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend

such modifications within this invention as may fall within the scope of the appended claim.

I claim:

An apparatus for shaping thin sheets of deformable material comprising a box, a frame closing one side of said box to form a chamber therewith, there being an opening in said frame of said chamber, a clamping flange having a diameter greater than that of said frame opening and detachably mounted on the exterior surface of said frame surrounding said opening to clamp a sheet of deformable material against the exterior surface of said chamber frame, a piston in said chamber and movable toward the exterior thereof, a bearing surface greater in area than said opening positioned on said piston, a forming die on said bearing surface for movement through said opening toward the exterior of said chamber, a fluid passage within said piston and opening through said forming die into said chamber, a sealing ring on the interior surface of said chamber frame surrounding said opening and engageable with said bearing surface when the forming die is in its advanced position so that said fluid passage opening is sealed off from said chamber and communicates solely with the cavity on the under side of said deformable sheet material, and means for connecting said fluid passage with a source of pressure while said piston is moving toward its advanced position so as to stretch said sheet material prior to engagement thereof by said forming die and for disconnecting said fluid passage from said source of pressure and connecting said fluid passage to a source of suction when said ram is in the advanced position so that said fluid passage communicates only with the cavity under said sheet to draw the sheet material inwardly against said forming die.

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