

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

An improved method of and Apparatus for Producing Thin-Walled Vessels from Thermoplastic Material

We, RYBURN ENGINEERING COMPANY LIMITED, a British Company, of 20—21 Tooks Court, Chancery Lane, London E.C.4, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of producing thin-walled vessels which are open towards one end, for example cups, from thermoplastic material, and to apparatus for carrying out such a method.

The processing of thermoplastic materials is effected by moulding, die-casting or extrusion. Of these processes only the last two are suitable for the production of thin-walled vessels when additional measures and apparatus of a particular nature are employed. Since, however, the thickness of the wall of the vessel is very small in proportion to its expanse the force of the plunger in a die-casting operation or the force of the worm in an extrusion press must be very high in order to ensure that the mould is wholly and completely filled. In this way the strain and the wear on the plunger and cylinder, or the worm, in these processes are very considerable. Moreover, in such processes a mould is required making use of a core.

It is the main object of the present invention to provide a method for the production of thin-walled vessels which are open towards one end, which method avoids the disadvantages referred to.

According to the invention this object is accomplished by the fact that a heated foil of synthetic material is placed in front of the aperture of a mould corresponding to the external form of the vessel and is pressed by the edge of this aperture against a supporting table, whereupon the part of the foil located within the mould aperture is urged into the mould by the admission of compressed air into a pipe opening out into the surface of the supporting table opposite the aperture in the

mould, there being forced backwards a plunger which, prior to commencement of the supply of compressed air, bears against the foil and the side of which directed towards the foil corresponds to the external form of the bottom of the vessel being produced, the plunger being movable into the mould up to an abutment in opposition to the force of a spring, which has a substantially flat characteristic or that of a weight.

The method according to the invention permits of the production of thin-walled vessels, which are open towards one end and have a wall which may as thin as desired, in rapid, simple and economical manner. For carrying out the method there is required merely a mould, which corresponds to the external form of the vessel to be produced, without a core. The mould may be produced from a material of comparatively poor quality, as hardly any sliding movement of the material takes place against the surface of the mould, so that wear of the mould is very small. The means for carrying out the method according to the invention are of a simple and robust nature. The force with which the mould requires to be pressed against the foil of synthetic material is considerably less than the force of the plunger or the worm necessary in the case of a die-casting machine or an extrusion press. The pressure of the mould need merely be sufficient to prevent parts of the synthetic foil located outside of the mould from performing a follow-up movement into the mould during the admission of compressed air and to ensure at least an approximately airtight closure towards the outside of the space which is filled with compressed air upon the introduction thereof. A special ejecting device for removal of the finished vessel from the mould is not required, as the plunger governed by a spring or a weight takes over automatically the removal of the vessel immediately the mould is moved away from the supporting table.

When employing a mould which tapers to-

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wards the bottom thereof, the plunger subjected to the action of a spring or a weight and bearing against the foil of synthetic material before commencement of the supply of compressed air covers only a part of the foil held between the edge of the mould and the supporting table. Between the edge of the mould and the outer edge of the plunger there remains an uncovered area, which upon the production of circular-symmetrical vessels possesses the form of a circular ring. Upon immediate impingement of the compressed air against the total portion of the foil to be moulded there might be produced by the air in the said uncovered area an annular bead which, by reason of its enlargement behind the plunger, would prevent movement of the latter into the mould. Finally, the bead might possibly burst, and proper operation of the apparatus would be impossible.

To avoid such contingencies the compressed air, in accordance with the invention, is caused at first to impinge against the still unmoulded foil of synthetic material only over a small surface located opposite the plunger. In this way there may be moulded at first, whilst the plunger is forced backwards, only that portion of the foil which bears against the plunger. Following thereon compressed air is allowed to impinge against the entire foil surface to be moulded, this surface, with the plunger being forced additionally backwards, being moved by the air into the mould. This method of operation may be achieved with a very simple form of apparatus by providing the table with an annular supporting surface, which co-operates with the edge of the mould movable vertically in relation to the table. In addition, there is also provided on the supporting table opposite the plunger a smaller supporting surface, into which there opens out the supply pipe for the compressed air. Between these two supporting surfaces there is formed in the table an annular recess. Until the foil of synthetic material has been raised somewhat from the smaller supporting surface, with a forcing back of the plunger, and has already been moulded to a certain extent, compressed air is allowed to impinge only on that part of the foil which is situated immediately in front of the mouth of the compressed air supply pipe. Following thereon the air pressure is propagated by way of the annular recess in the supporting table to the entire area of the foil to be moulded.

The method according to the invention is preferably carried out by the use of foils of synthetic material in the form of elongated bands, which are moved intermittently in time with the air-admitting operation through the otherwise stationary apparatus, and which behind the point of introduction of the air are cut by means of knives into transverse strips. At the same time a stamping device may also be provided, which cuts out the completed ves-

sels adhering to the remainder of the band.

Two or more moulds with appertaining supporting tables and compressed air supply means may be located side by side transversely of the direction of movement of the band of synthetic material which, when the moulds are so arranged is made of a suitable width to extend across both or all of the said moulds.

Thus two or more series of side-by-side hollow vessels are moulded from the said band, two or more vessels, one in each series, being moulded simultaneously.

In order that the invention may be more clearly understood, an embodiment thereof will now be described, by way of example with reference to the accompanying drawings, in which

Fig. 1 is a section through the apparatus taken in the longitudinal direction along the line A—B in Fig. 2.

Fig. 2 is a section in the transverse direction taken along the line C—D in Fig. 1.

The apparatus possesses a fixed supporting table 1 and two vertically shiftable moulds 2 and 3, which are arranged to be adjacent to one another transversely of the direction of movement of an elongated band 4 of a foil of synthetic material being processed. The inner surface 5 of the mould corresponds to the form of the vessels to be produced. The moulds contain a plunger 6, the side 7 of which directed towards the foil corresponds to the external form of the bottom of the vessel. The plunger 6 is secured to a rod 8, which is guided on a part 9 carrying the moulds. The plunger is acted upon by a flat spring 10. Movement of the plunger 6 into the mould is limited by a stop 11. The plunger 6 is movable against the action of the spring 10 up to the bottom 12 of the mould, which acts as an abutment. The supporting table 1 possesses opposite the plunger 7 a small central supporting surface 13 and an outer supporting surface 14, which co-operates with the edge 15 of the mould 2, or 3. Into the central supporting surface 13 there opens out a compressed air pipe 16, which at 17 may be connected by the usual connecting means to a compressed air source. The part 9 carrying the moulds 2 and 3 is guided on the cylindrical guide rods 18, which are mounted on the supporting table 1 and also carry a crosshead 19. The part 9, and accordingly the moulds 2 and 3, are movable in a vertical direction by means of a pressure member 20.

For the feeding movement of the band of foil 4 of synthetic material there are provided two pairs of rollers 21 and 22 disposed vertically one above the other. The lower roller 21 is driven. It possesses over a portion 23 of its periphery a radius smaller than that of the remaining portion 24.

On the part 9 carrying the moulds 2 and 3 there is mounted a knife 25, which co-operates with a cutting edge 26 located on the

Supporting table 1.

The central supporting surface 13 possesses a recess 28 which is concentric with the compressed air pipe 16 and into which there is capable of fitting a projection 29 on the plunger 6.

The operation of the device is as follows:

The heated foil 4 of synthetic material is conducted through the apparatus by friction so long as the peripheral portion 24 of the roller 21 is located opposite the roller 22. The roller 21 is driven with a constant circumferential velocity. Immediately the peripheral portion 23 thereof having the reduced radius is situated opposite the roller 22 the foil 4 remains stationary. By means of the pressure member 20 the part 9, and accordingly the two moulds 2 and 3, are moved downwards and the foil 4 is clamped firmly between the surfaces 14 and 15. At the same time the plunger 6 takes up a position against the foil, viz., opposite the point where the compressed air pipe 16 opens out into the surface 13. At the same time the central portion of the foil 4 is pressed by the force of the plunger 6 into the recess 28 and about the projection 29. In this way there is formed in the foil a recess which, owing to the cooling at this point, immediately becomes hard and against which the middle portion of the foil is centred by means of the projection 29 during the admission of the air. Following thereon compressed air is admitted, and the foil 4 is moulded upwards in its middle portion, forcing back the plunger 6. After a certain degree of moulding has taken place the pressure from the pipe 16 passes by way of the annular recess 27 to the entire clamped portion of the foil 4. The plunger 6 is forced further backwards and the clamped portion is urged into the moulds 2 and 3. When the plunger 6 has reached its stop the supply of compressed air is terminated after a short time, and the mould 2 and 3 are moved upwards by the pressure member 20. Owing to its spring control the plunger 6 acts simultaneously as ejecting means and prevents the finished vessel from adhering to the mould. At this time there again commences movement of the band of material towards the right by means of the rollers 21 and 22. A completed vessel 30 is located during the following moulding operation with its centre approximately in the plane containing the axes of the conveying rollers 21 and 22, and a further vessel 31 is situated outside of the device. Upon the next downward movement of the part 9 the band located outside of the device is severed from the foil 4 by means of the knife 25 and the cutting edge 26. In the example illustrated two completed vessels 31 are shown in conjunction with the band. Additionally to the knife 25, or also in place thereof, there may be provided on the part 9 a stamping device by means of which the completed vessels may be stamped out

from the remainder of the band to which they still adhere.

The pressure member 20 may be moved by compressed air. If the supply of compressed air to the pressure chamber of the member 20 and to the compressed air pipe 16 is controlled by means of a common valve, there is provided, according to the invention, in front of the connection 17, a retarding valve, which is effective in such a way that the compressed air pipe 16 does not receive pressure until the pressure member 20 has been moved downwards and the foil is securely held between the surface 14 and 15. The retarding valve may be constructed at the same time as a regulable restrictor. Variation in the thickness of wall of the vessels produced may be effected by variation in the throttling action of the retarding valve and by varying the effect of the spring or weight acting on the plunger 6.

What we claim is:—

1. A method of producing thin-walled vessels which are open towards one end, for example cups, from thermoplastic material, characterised in that a heated foil of synthetic material is placed in front of the aperture of a mould corresponding to the external form of the vessel and is pressed by the edge of this aperture against a supporting table, whereupon the part of the foil located within the mould aperture is urged into the mould by the introduction of compressed air into a pipe opening out into the surface of the supporting table opposite the aperture in the mould, there being forced backwards a plunger which, prior to commencement of the supply of compressed air, bears against the foil and the side of which directed towards the foil corresponds to the external form of the bottom of the vessel being produced, the plunger being movable into the mould up to an abutment in opposition to the force of a spring, which has a substantially flat characteristic or that of a weight.

2. A method according to claim 1, characterised in that compressed air is caused to impinge against the still unmoulded foil of synthetic material over a small surface located opposite the plunger, and after a certain degree of moulding has taken place compressed air is allowed to impinge over the entire surface to be moulded, the plunger being forced back.

3. A method according to Claim 1 or Claim 2, characterised by the use of foils of thermoplastic material in the form of elongated bands.

4. An apparatus for carrying out the method according to any of Claims 1 to 3, characterised in that the supporting table for the foil of synthetic material possesses an annular supporting surface, which co-operates with the edge of the mould movable vertically in relation to the supporting table, and a small supporting surface, which is located opposite the plunger, and into which there opens out a sup-



Supporting table 1.

The central supporting surface 13 possesses a recess 28 which is concentric with the compressed air pipe 16 and into which there is capable of fitting a projection 29 on the plunger 6.

The operation of the device is as follows:

The heated foil 4 of synthetic material is conducted through the apparatus by friction so long as the peripheral portion 24 of the roller 21 is located opposite the roller 22. The roller 21 is driven with a constant circumferential velocity. Immediately the peripheral portion 23 thereof having the reduced radius is situated opposite the roller 22 the foil 4 remains stationary. By means of the pressure member 20 the part 9, and accordingly the two moulds 2 and 3, are moved downwards, and the foil 4 is clamped firmly between the surfaces 14 and 15. At the same time the plunger 6 takes up a position against the foil, viz., opposite the point where the compressed air pipe 16 opens out into the surface 13. At the same time the central portion of the foil 4 is pressed by the force of the plunger 6 into the recess 28 and about the projection 29. In this way there is formed in the foil a recess which, owing to the cooling at this point, immediately becomes hard and against which the middle portion of the foil is centred by means of the projection 29 during the admission of the air. Following thereon compressed air is admitted, and the foil 4 is moulded upwardly in its middle portion, forcing back the plunger 6. After a certain degree of moulding has taken place the pressure from the pipe 16 passes by way of the annular recess 27 to the entire clamped portion of the foil 4. The plunger 6 is forced further backwards and the clamped portion is urged into the moulds 2 and 3. When the plunger 6 has reached its stop the supply of compressed air is terminated after a short time, and the mould 2 and 3 are moved upwards by the pressure member 20. Owing to its spring control the plunger 6 acts simultaneously as ejecting means and prevents the finished vessel from adhering to the mould. At this time there again commences movement of the band of material towards the right by means of the rollers 21 and 22. A completed vessel 30 is located during the following moulding operation with its centre approximately in the plane containing the axes of the conveying rollers 21 and 22, and a further vessel 31 is situated outside of the device. Upon the next downward movement of the part 9 the band located outside of the device is severed from the foil 4 by means of the knife 25 and the cutting edge 26. In the example illustrated two completed vessels 31 are shown in conjunction with the band. Additionally to the knife 25, or also in place thereof, there may be provided on the part 9 a stamping device by means of which the completed vessels may be stamped out

from the remainder of the band to which they still adhere.

The pressure member 20 may be moved by compressed air. If the supply of compressed air to the pressure chamber of the member 20 and to the compressed air pipe 16 is controlled by means of a common valve, there is provided, according to the invention, in front of the connection 17, a retarding valve, which is effective in such a way that the compressed air pipe 16 does not receive pressure until the pressure member 20 has been moved downwards and the foil is securely held between the surface 14 and 15. The retarding valve may be constructed at the same time as a regulable restrictor. Variation in the thickness of wall of the vessels produced may be effected by variation in the throttling action of the retarding valve and by varying the effect of the spring or weight acting on the plunger 6.

What we claim is:—

1. A method of producing thin-walled vessels which are open towards one end, for example cups, from thermoplastic material, characterised in that a heated foil of synthetic material is placed in front of the aperture of a mould corresponding to the external form of the vessel and is pressed by the edge of this aperture against a supporting table, whereupon the part of the foil located within the mould aperture is urged into the mould by the introduction of compressed air into a pipe opening out into the surface of the supporting table opposite the aperture in the mould, there being forced backwards a plunger which, prior to commencement of the supply of compressed air, bears against the foil and the side of which directed towards the foil corresponds to the external form of the bottom of the vessel being produced, the plunger being movable into the mould up to an abutment in opposition to the force of a spring, which has a substantially flat characteristic or that of a weight.

2. A method according to claim 1, characterised in that compressed air is caused to impinge against the still unmoulded foil of synthetic material over a small surface located opposite the plunger, and after a certain degree of moulding has taken place compressed air is allowed to impinge over the entire surface to be moulded, the plunger being forced back.

3. A method according to Claim 1 or Claim 2, characterised by the use of foils of thermoplastic material in the form of elongated bands.

4. An apparatus for carrying out the method according to any of Claims 1 to 3, characterised in that the supporting table for the foil of synthetic material possesses an annular supporting surface, which co-operates with the edge of the mould movable vertically in relation to the supporting table, and a small supporting surface, which is located opposite the plunger, and into which there opens out a sup-

ply pipe for the supply of compressed air.

5. An apparatus according to Claim 4, characterised in that the mould is tapered in conical fashion towards its bottom.

5 6. An apparatus according to Claim 4 or Claim 5, for carrying out the method according to Claim 3, characterised by two pairs of oppositely disposed rollers for conveying a band of synthetic material, which rollers engage with the two outer edges of the band, one roller of each pair being driven at a constant speed and having over a portion of its periphery a radius which is smaller than that of the remaining part of its periphery.

10 7. An apparatus according to any of Claims 4 to 6, for carrying out the method according to Claim 3, characterised in that two or more adjacently disposed moulds with apertaining supporting tables and compressed air supply pipes are disposed side-by-side in a direction perpendicular to the direction of movement of the band so that two or more series of side-by-side hollow vessels are moulded from the said band.

15 8. An apparatus according to any of Claims 4 to 7, for carrying out the method according to Claim 3, characterised in that on the movable part carrying the moulds, viewed in the direction of movement of the band of synthetic material, there is provided behind the point of admission of the air a knife, which co-operates with a knife edge on the supporting table, and by means of which the band of material upon downward movement of the part carrying the mould is cut into transverse strips, to which there adhere a number of completed vessels corresponding to the number of adjacently disposed moulds.

9. An apparatus according to any of Claims

4 to 8, characterised by a stamping device, by means of which the completed vessels are stamped out from the band of synthetic material, and the movable portion of which is connected with the part carrying the moulds.

10. An apparatus according to any of Claims 4 to 9, characterised by a projection on the side of the plunger directed towards the foil of synthetic material, and a corresponding recess in the central supporting surface of the table concentric with the supply pipe for the compressed air.

11. An apparatus according to any of Claims 4 to 10, characterised in that the pressure member for moving the moulds is moved by compressed air, and the supply of compressed air to the pressure chamber of the said pressure member and to the point of admission to the mould or moulds is controlled by a common valve, and that in the supply pipe to the said point of admission there is provided a retarding valve.

12. An apparatus according to Claim 11, characterised in that the retarding valve is at the same time formed as a restrictor.

13. A method of producing thin-walled vessels which are open towards one end, for example cups, from thermoplastic material, substantially as hereinbefore described with reference to the accompanying drawings.

14. An apparatus for producing thin-walled vessels which are open towards one end, for example cups, from thermoplastic material, substantially as hereinbefore described with reference to the accompanying drawings.

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