

1247358

PATENT SPECIFICATION

(11) 1247358

DRAWINGS ATTACHED

- (21) Application No. 10593/71 (22) Filed 5 Dec. 1968
 (62) Divided out of No. 1247357
 (31) Convention Application No. 006796 (32) Filed 5 Dec. 1967
 (31) Convention Application No. 021616 (32) Filed 3 June 1968 in
 (33) Canada (CA)
 (45) Complete Specification published 22 Sept. 1971
 (51) International Classification B 29 f 1/00
 (52) Index at acceptance

B5A 1R27 2E1E 2E8 2E9 2H5 3DX

(54) IMPROVEMENTS IN OR RELATING TO THE
MANUFACTURE OF FOOTWEAR BY INJECTION MOULDING

(71) We, THE BRITISH BATA SHOE COMPANY LIMITED, a British Company of East Tilbury, Essex, 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 and apparatus for the injection moulding of articles made of synthetic plastics material, especially articles such as footwear soles.

More particularly, the invention is concerned with improvements in injection moulding apparatus wherein the articles to be moulded are footwear soles and in which provision is made for injection moulding the soles or parts thereof in successive stages, thus allowing the use of different kinds and/or different coloured plastics materials for different parts of the soles. The soles may be injection moulded directly onto shoe uppers in known manner. Such articles will for ease of reference, be referred to in the specification and claims as 'two component' articles.

From one aspect the present invention provides apparatus for injection moulding two component synthetic plastics articles, comprising at least two mould parts defining at least in part a mould cavity, means mounting said mould parts for relative movement whereby the depth of the mould cavity can be changed, a first supply duct arranged for communication with the said mould cavity when it is relatively shallow, a separate second supply duct extending within one of said mould parts and arranged for communication with the said mould cavity when it is relatively deep, at least one injection port connecting said second supply duct to said cavity said injection port being shaped to hold a solidified injection port sprue whereby said sprue breaks at the mould internal surface as a moulded article is removed from said surface, and to retain at least a part of said injection port sprue within an outlet end

of the injection port as a sealing plug when a solidified supply duct sprue is removed from the second supply duct.

From another aspect the invention provides a method of injection moulding footwear soles from synthetic plastics material, comprising the steps of defining a sole mould cavity at least in part by closing together a sole plate and two side mould halves, injecting a first plastics compound into said cavity and allowing said compound to solidify therein, displacing said sole plate in relation to said side mould halves to define an additional mould cavity, injecting a second plastics compound through a supply duct to enter the additional mould cavity via at least one injection port in the sole plate, each injection port being shaped to hold a solidified injection port sprue for breakage at the mould inner surface and so as to be capable of severing a sealing plug from said sprue when a supply duct sprue is removed, allowing the second compound to solidify in the additional mould cavity, opening the mould and removing the two-component sole free from sole plate injection port sprues, removing the sole supply duct sprue, whereby a portion of the sole plate injection port sprue is broken to act as a sealing plug in each injection port and closing together the sole plate, with said sealing plug or plugs therein, and the two side mould halves, for subsequent injection of first plastics compound in the next cycle.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Fig. 1 is a longitudinal cross-section through footwear of the type to which this invention is primarily but not exclusively applicable,

Figs. 2 and 3 show successive stages in forming a two-component sole on such footwear by a known method,

Fig. 4 shows the improved form of the

mould used for forming such footwear according to the present invention,

Fig. 5 is a section on A—A of Fig. 4,

Fig. 6 shows the mould parts of Fig. 5 in an open position,

Fig. 7 shows a detail of an alternative method of runner porting to Figs. 5 and 6,

Figs. 8 and 9 show a transverse section on B—B of Fig. 4 showing an inserted member which causes a temporary sealing plug to be formed in the injection ports,

Fig. 10 shows the inserted member itself, in three sections and a plan view,

Fig. 11 shows an alternative form of inserted member, in section,

Fig. 12 shows a further variant of the inserted member of Fig. 10,

Figs. 13 and 14 are transverse sections through inserted members of a different internal configuration,

Fig. 15 shows a transverse section through a port configuration generally shaped as with the insert of Figs. 13 and 14,

Fig. 16 shows a transverse section of further form of insert which can be positioned through a bore in the side of a sole plate,

Figs. 17, 18 and 19 are transverse sections through further, related forms of insert and port configuration,

Figs. 20, 21 and 22 are transverse sectional views of yet further related inserts and port configurations,

Figs. 23 shows a variant port configuration in transverse section,

Fig. 24 shows a longitudinal section of a different form of insert,

Figs. 25 and 26 show in longitudinal section and projection a yet further form of insert,

Fig. 27 is a cross-section through an alternative injection port assembly configuration, and

Fig. 28 shows a component of the assembly of Fig. 27.

The kind of articles to which the present invention is primarily but not exclusively applicable is shown in Fig. 1, and comprises a first sole member 1 of synthetic plastics material and a second sole member 2 of synthetic plastics material of different mechanical or chemical characteristics, and/or colour, from the first sole member, attached to one another and attached to upper 3.

This footwear may be made in the two stages shown in Figs. 2 and 3. The equipment used essentially comprises a sole plate 4 and a side mould 5. The side mould 5, which is in two halves parting approximately along the longitudinal centre line of the footwear, and the sole plate 4 are relatively displaceable in the vertical direction. It is also known to provide a toe-cap mould part, but this is not shown in the drawing.

In the prior art embodiment shown, the side mould parting line defines a sprue or

runner duct 6 with narrower injection port 7 for the injection compound of sole member 1 and a sprue or runner duct 8 for the compound of sole member 2. The sole plate 4 includes a runner duct 9 and communicating injection ports 10 and 11 extending from the duct to the moulding surface through which the injected compound can pass to form sole member 2. A sliding valve 12 biased by spring 13 is provided to close port 11 except during injection.

As will be apparent from Figs. 2 and 3, a first compound is injected through duct 6. It is usual for the sole member 1 to have a downwardly extending rim 1a. Then the sole plate 4 and side mould 5 are relatively displaced vertically until ducts 8 and 9 coincide. A second compound is injected through ducts 8 and 9 and ports 10 and 11 (i.e. displacing, by the injection pressure, valve 12) to form sole member 2.

The disadvantages of this prior art procedure can also be seen from Figs. 2 and 3. It is obviously necessary to block ports 10 and 11 during the first stage. Valve 12 blocks port 11 at the bottom, but a plug of the compound of sole member 1 nonetheless forms in the upper part of the port. It is practised to put a temporary patch 14 over the port (see, e.g. port 10). However, this introduces another operating step and increases expense.

In summary, therefore, these known means for blocking off the ports are expensive due to the provision and positioning of patches or inadequate due to possible malfunction of movable parts 12 and 13.

Another disadvantage which arises with the equipment of Figs. 2 and 3 is that air may be trapped in the blind passage constituted by duct 9. This air would give rise to bubbles and inhomogeneities in the second sole member.

Yet another disadvantage which arises is the need of a separate handling operation to remove the injection port runner, formed in the injection port 7, when the mould halves are parted.

The above disadvantages are overcome by the equipment shown in combination in Fig. 4 and in its details in the subsequent figures.

In Fig. 4 the equipment is shown prior to injection of sole member 2. The upper 3, sole plate 4, side mould 5, ducts 6, 8 and 9 and ports 10 and 11 perform broadly the same functions as before. However, there is provided an air venting arrangement consisting of plug 15, vent hole 16 and venting clearance 17; communicating inserts 18 for ports 10 and 11; and a special formation 19 of injection port for duct 6.

The air venting arrangement is more specifically described in our co-pending application No. 57920/68 (Serial No. 1247357) dated 5th December, 1968.

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The special formation 19 of injection port for duct 6 is shown in more detail in Figs. 5 and 6. A variant is shown in Fig. 7. Essentially, the injection port is split into two outlets 19a and 19b one either side of the parting line. When the mould halves 5a and 5b are separated (Fig. 6) the material in outlets 19a and 19b will necessarily be removed from the sole member 1 without the need for a separate an expensive trimming step, and a sprue 6a will be separated from the moulded sole.

Fig. 7 shows a variant of Figs. 5 and 6 in which the duct 6 is split into two downwardly directed ports leading into sole member 1 from below, at the extreme back rim of the heel portion. Again, the runners are removed simply by opening the mould halves. With this embodiment the back of the article of footwear is particularly free from undesirable marking.

The man skilled in the art will appreciate that while two outlets, one either side of the parting line, may be preferable they are by no means essential. One outlet not on the parting line would suffice to provide a moulding method free from a separate sprue-removal step.

There now follows a description of various forms of communicating inserts or port configurations 18, which are of a nature such that removing the sole from the mould separates sole member 2 (i.e. the sole member injected through those ports) from any plug in the ports 10 and 11 to produce a sole free from such plugs, and also such that removal of a solidified sprue from duct 9 leaves a sealing plug in the outlet end of injection of the compound of sole member 1 in a following mould cycle.

The form of the insert shown in Figs. 8, 9 and 10, is that of a generally cylindrical plug inserted in a space below the outlet end of port 10 (for example) and having two non-central longitudinally through holes 23, wider at their bottom portions, and a central conical recess 24 communicating with each through hole. The various views of Fig. 10 make this clear. This conical recess lies beneath the outlet end 25. The intersection of recess 24 and holes 23 defines sharp cutting edges. The whole volume between the moulding surface and the supply duct is herein referred to as the injection port.

As will be seen from Fig. 9 as the moulded shoe is removed a break will occur at point A, which is the weakest point in the solidified material, since the sole is still warm and is not so strong as the solidified injection port sprue. Subsequently when the sprue in duct 9 is removed, the cutting edges defined between conical recess 24 and holes 23 will ensure that the plug is separated at B. (It will be noted that the widening of holes 23 at their lower portion makes the solidified

material in holes 23 stronger so that it does not break off as the sprue is removed. The holes can be smoothed off to ensure good connection with the supply duct and although they are shown tapered this "smoothing off" gives a more "flared" configuration). This plug in the outlet end of the port remains in place for the next mould cycle as a sealing plug against incursion of the compound of sole member 1 into duct 9. It will, of course, be readily pushed out by injection pressure at the next injection of compound for sole member 2; this feature is discussed more fully below.

While Figs. 8, 9 and 10 show the use of individual communicating inserts (placed in position through subsequently plugged holes 26 (Fig. 9) in the sole plate) it is possible to incorporate inserts which are integral with a portion of duct 9, as shown in Fig. 11. Such inserts can be held in place by a positioning screw 27.

Fig. 12 shows a communicating insert 28 where the through holes 29 do not intersect conical recess 30 but communicate with it via a slot 31. The insert is otherwise similar to that shown in Figs. 8, 9 and 10, and still works without the cutting edges shown in the earlier figures.

Although two holes are shown, it is possible to use more or less holes.

Fig. 13 shows an insert 34 where the port 10 is formed with an outlet end 32 tapering upwards and an inlet end 33 also having a portion tapering upwards. The same succession of separation of solidified material is effected.

Fig. 14 shows a port having the same configuration as that of Fig. 13 by virtue of small inserted member 35. In this figure outlet end 36 of the port is formed in the sole plate itself.

Fig. 15 shows the port with the outlet end referenced 37 and the inlet end 38. Sharp edge 39 between them assists in the separation. Although it is not shown in the drawings, it is possible to drill such ports, at least in part, from below, plugging the hole later as necessary.

Fig. 16 shows a totally different form of insert as a cylindrical member 40 with a diametral bore 41 constituting part of supply duct 9, lying beneath outlet end 25, of the injection port which is formed in the sole plate. The cylindrical member is provided with conical recess 42 and inlet end 43 for the injection port. The inlet end is smoothed off at 44 to ensure that the injection port inlet end sprue remains attached to the supply duct sprue.

Fig. 17 shows an insert member 45 with parallel bores 46 beneath outlet end 47 formed with a conical recess 48 (exaggerated for illustrative purposes). Fig. 18 is similar except that bores 49 are tapered and that

the inserted member 50 extends to the surface and does not contain any part of duct 9. Fig. 19 is again similar but with a still smaller inserted portion 51 containing bores 52.

Fig. 20 shows duct 9 communicating with the moulding surface by a bore 53, which communicates with bores 54 (being four bores in parallel) and outlet end bore 55. In Fig. 21 insert 56 with bores 57 communicating with outlet bore 58 fulfils the same purpose. Fig. 22 is similar to Fig. 20 but with a modified shape of bores 53', 54' and 55'. Such bores can be drilled from below (53' and 54') through a hole subsequently plugged (not shown) and above (55').

Fig. 23 shows outlet end bore 59 communicating angled bores 60 (two or more), further bores 61 and supply duct 9.

In general if large soles, using more than one injection port, are being made, it is preferable for the outlet ends of the injection ports to be straight sided. If there is too much taper on the side will of the plug in the outlet end, the pressure will build up until one plug is blown out, in a subsequent cycle; thereafter, all the moulding component will enter by the unblocked port. However, single-port ducts are adequate for small shoes such as child's shoes; in these a tapered side wall is no disadvantage, since in itself it helps sprue separation at the moulding surface when the shoe is removed.

It will be appreciated how the build-up pressure needed to dislodge a plug from a tapered port outlet end in itself leads to problems with air bubbles; hence the venting plug described above.

Fig. 24 shows yet another inserted member 62, in this case including the whole injection port. Outlet end 63 is threaded, the threads being shaped to provide adequate grip in a downward pulling direction and suitable release upwards in a subsequent moulding cycle. Inlet end 64 is again smoothed into supply duct 9.

Figs. 25 and 26 show a yet further embodiment where a communicating insert 65 is formed with bore 66, diametral bore 67 and slot 68. The same functions are carried out as before.

In the embodiment of the invention shown in Figs. 27 and 28 the sole plate 4 of the mould includes a longitudinal runner or supply duct 9 and a cavity 70 of stepped decreasing dimensions from the duct 9 to the injection port orifice 71 which is formed in the sole plate.

Within the cavity 70 is located an assembly consisting of an inserted member 72 containing an angled bore 73 which is smoothed off at 74, the circular plate 75 described in more detail below and generally conical liner 76. The injection port therefore includes an outlet end within the conical liner 76 and above

the plate 75, and an inlet end essentially constituted by angled bore 73.

Circular plate 75 is shown in Fig. 28 and includes perforations 78 and an upstanding trough-shaped portion 77 formed by bending upwards the material of the perforations. While the trough 77 is shown as extending at right angles to the longitudinal direction of the duct 9 this is mainly for clarity of illustration. It is preferable for the trough 77 to lie longitudinally in relation to the sole plate 4.

With the embodiment shown in Figs. 27 and 28 the procedure is to inject the compound of sole member 1 through the separate injection system comprising duct 6 and port 7, and after adequate solidification, to lower the sole plate in relation to the side mould parts, and thereafter to inject a second compound through duct 9 and one or more injection ports as described in Figs. 27 and 28 into the new cavity between the sole plate and the first compound to form sole member 2. As will be appreciated the perforations 78 in the circular plate 75 with the upstanding trough portion 77 allow the injection of the second compound through the port, but after solidification of the second compound prevent the solidified material in the outlet end of the injection port assembly from being removed with the sprue in the inlet end when the runner in duct 9 is pulled out at the end of a moulding cycle.

The method and equipment of the invention is as applicable to the production of loose soles as it is to the production of soles already united to an upper, although those features relating to the side mould halves are not generally relevant in such a context. Also, the features shown in Figs. 5, 6 and 7, or the venting arrangement shown in Fig. 4 are as useful in the production of one-component soles as in the production of two-component soles. Indeed, all the features shown have a general applicability to moulding practice and need not be confined to the production of footwear.

WHAT WE CLAIM IS:—

1. Apparatus for injection moulding two component synthetic plastics articles, comprising at least two mould parts defining at least in part a mould cavity, means mounting said mould parts for relative movement whereby the depth of the mould cavity can be changed, a first supply duct arranged for communication with the said mould cavity when it is relatively shallow, a separate, second supply duct extending within one of said mould parts and arranged for communication with the said mould cavity when it is relatively deep, at least one injection port connecting said second supply duct to said cavity said injection port being shaped to hold a solidified injection port sprue

the inserted member 50 extends to the surface and does not contain any part of duct 9. Fig. 19 is again similar but with a still smaller inserted portion 51 containing bores 52.

Fig. 20 shows duct 9 communicating with the moulding surface by a bore 53, which communicates with bores 54 (being four bores in parallel) and outlet end bore 55. In Fig. 21 insert 56 with bores 57 communicating with outlet bore 58 fulfils the same purpose. Fig. 22 is similar to Fig. 20 but with a modified shape of bores 53', 54' and 55'. Such bores can be drilled from below (53' and 54') through a hole subsequently plugged (not shown) and above (55').

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In the embodiment of the invention shown in Figs. 27 and 28 the sole plate 4 of the mould includes a longitudinal runner or supply duct 9 and a cavity 70 of stepped decreasing dimensions from the duct 9 to the injection port orifice 71 which is formed in the sole plate.

Within the cavity 70 is located an assembly consisting of an inserted member 72 containing an angled bore 73 which is smoothed off at 74, the circular plate 75 described in more detail below and generally conical liner 76. The injection port therefore includes an outlet end within the conical liner 76 and above

the plate 75, and an inlet end essentially constituted by angled bore 73.

Circular plate 75 is shown in Fig. 28 and includes perforations 78 and an upstanding trough-shaped portion 77 formed by bending upwards the material of the perforations. While the trough 77 is shown as extending at right angles to the longitudinal direction of the duct 9 this is mainly for clarity of illustration. It is preferable for the trough 77 to lie longitudinally in relation to the sole plate 4.

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WHAT WE CLAIM IS:—

1. Apparatus for injection moulding two component synthetic plastics articles, comprising at least two mould parts defining at least in part a mould cavity, means mounting said mould parts for relative movement whereby the depth of the mould cavity can be changed, a first supply duct arranged for communication with the said mould cavity when it is relatively shallow, a separate, second supply duct extending within one of said mould parts and arranged for communication with the said mould cavity when it is relatively deep, at least one injection port connecting said second supply duct to said cavity said injection port being shaped to hold a solidified injection port sprue



- whereby said sprue breaks at the mould internal surface as a moulded article is removed from said surface, and to retain at least a part of said injection port sprue within an outlet end of the injection port as a sealing plug when a solidified supply duct sprue is removed from the second supply duct.
- 5 2. Apparatus as claimed in claim 1, wherein the injection port is formed as two similar and successive frusto-conical portions each converging upwards, the upper constituting the outlet end with its smaller end constituting an outlet orifice and the lower joining the upper to define an inwardly projecting ring and constituting a communicating channel to the supply duct.
- 10 3. Apparatus as claimed in claim 1, wherein the or each injection port inlet end with a perforated plate lying between them, the perforations allowing supply of injection material but preventing the solidified material in said outlet end from being removed with the sprue in said inlet end.
- 15 4. Apparatus as claimed in claim 1, wherein the or each injection port comprises an outlet end tapered toward the moulding surface, a removable insert beneath said outlet end, an inlet end formed in said insert to communicate with said outlet end, and a perforated plate lying on said insert with the perforations extending between the inlet and outlet ends.
- 20 5. Apparatus as claimed in claim 4, wherein said perforated plate is circular and contains two perforations towards the centre, the material of the plate left between the perforations, in combination with the plate material bent upwards from the two perforations forming an upwardly open trough-shaped member.
- 25 6. Apparatus as claimed in claim 4, wherein said inlet end extends at an angle within the inserted member to communicate with a supply duct at an angle facilitating sprue removal.
- 30 7. Apparatus as claimed in claim 6, wherein said inlet end is smoothed off where it meets the supply channel.
- 35 8. Apparatus as claimed in any one of claims 4 to 7, wherein the outlet end contains a frustoconical liner.
- 40 9. Apparatus as claimed in claim 8, wherein said liner is flanged at its broader end and supported on said perforated plate.
- 45 10. A method of injection moulding footwear soles from synthetic plastics material, comprising the steps of defining a sole mould cavity at least in part by closing together a sole plate and two side mould halves, injecting a first plastics compound into said cavity and allowing said compound to solidify therein, displacing said sole plate in relation to said side mould halves to define an additional mould cavity, injecting a second plastics compound through a supply duct to enter the additional mould cavity via at least one injection port in the sole plate, each injection port being shaped to hold a solidified injection port sprue for breakage at the mould inner surface and so as to be capable of severing a sealing plug from said sprue when a supply duct sprue is removed, allowing the second compound to solidify in the additional mould cavity, opening the mould and removing the two-component sole free from sole plate injection port sprue, removing the sole plate supply duct sprue, whereby a portion of the sole plate injection port sprue is broken to act as a sealing plug in each injection port, and closing together the sole plate, with said sealing plug or plugs therein, and the two side mould halves, for subsequent injection of first plastics compounds in the next cycle.
- 50 11. A method as claimed in claim 10 the method being substantially as hereinbefore described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

FITZPATRICKS,
27 Chancery Lane,
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and
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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1971.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

