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(54) **Injection moulding**

(57) A method for forming an article by injection moulding, such as a shoe, comprises the formation of a mould (5) by coating a master pattern of the article with a pourable, heat-resistant moulding compound, such as an epoxy resin, or polyurethane or silicone rubber. The master mould (5) so formed is secured in a mould casing (1) of an injection moulding apparatus and moulding material such as poly-vinyl chloride or polyurethane is injected to form the finished article. The master mould may be formed directly in the mould casing (1) to which it can be secured such as by mechanical securing and locating means (8) or by being adhered thereto. In an alternative embodiment of the invention, the master mould may be formed in a mould box and subsequently fitted into the mould casing (1) for reproduction of the article.

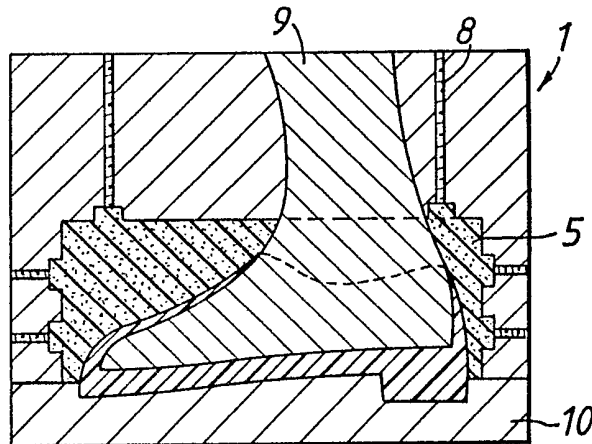
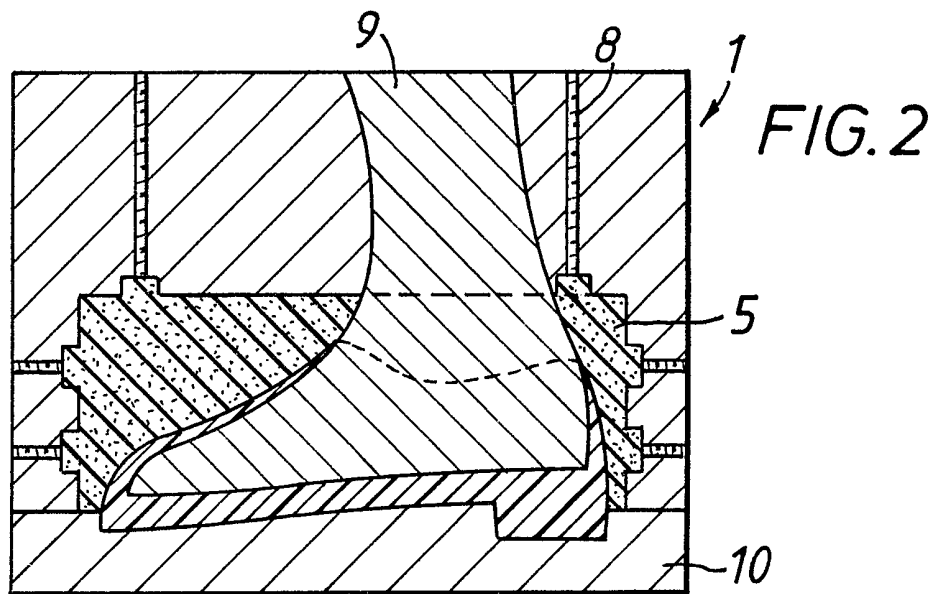
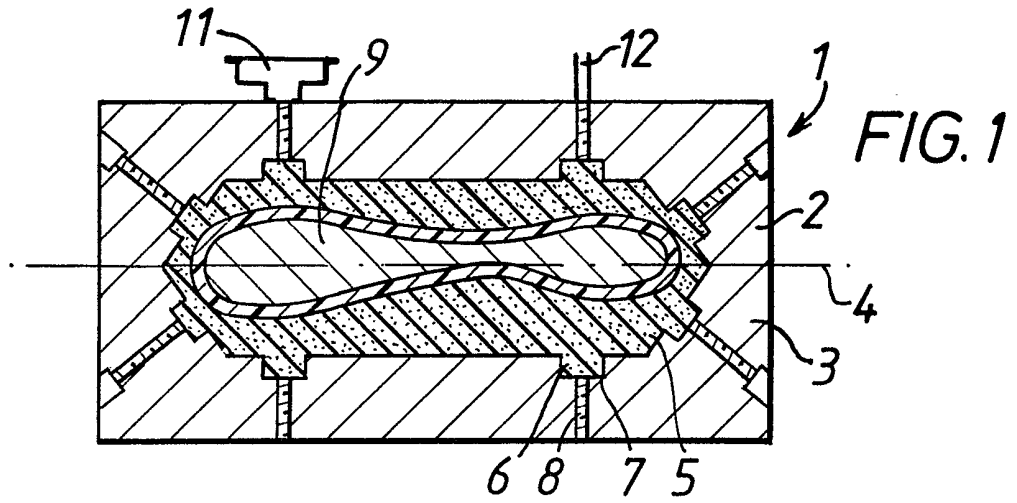


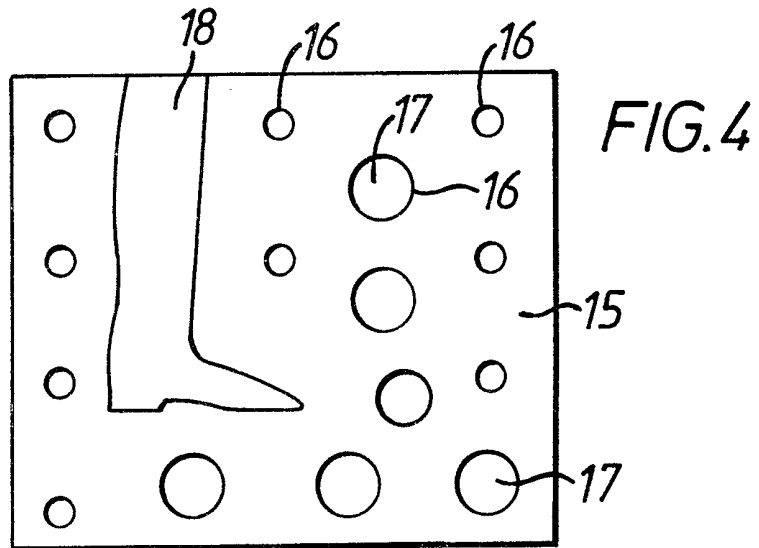
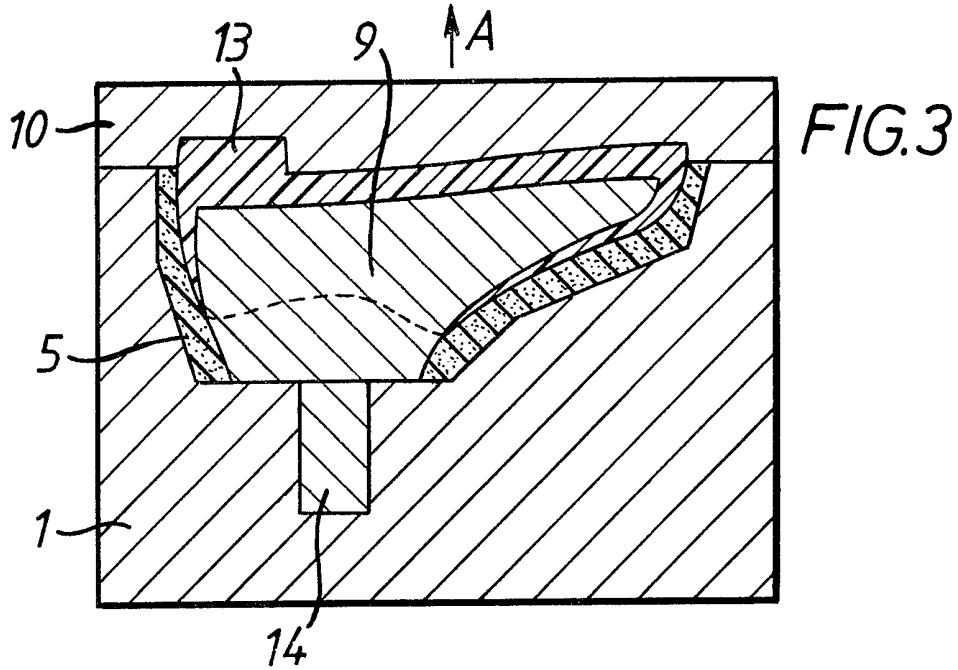
FIG. 2

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SPECIFICATION

Injection moulding apparatus and a method of forming an article in said apparatus

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This invention relates to a method of forming an article by means of an injection moulding process and also relates to injection moulding apparatus for carrying out the method.

10 It is already known to form articles, such as shoes from plastics materials by means of an injection moulding process in which the plastics material, typically PVC or polyurethane, is injected into a mould formed by a metal die. The shape of the
15 article, is, of course, defined by the internal contours of the die. It is sometimes desired to give the surface of the article a particular appearance or to have particular patterns impressed therein and this is achieved by provided an appropriate surface finish
20 to the die by cutting the pattern into the surface of the die. Typically, this is carried out by electro etching the surface of the die or by machine or handworking of the die. However, the known methods, which all involve the "working" of the
25 metal of the die do not enable a very high definition for a pattern on the finished article to be achieved. As a result, attempts to reproduce surfaces having fine details, such as crocodile or lizard skin, have not been successful, the resultant finishes being relative-
30 ly crude and unattractive.

The present invention seeks to provide a new method of forming a mould which overcomes the limitations of the known methods, particularly where elevated pressures and temperatures are adopted.

35 According to one aspect of the invention there is provided a method of forming an article by means of an injection moulding process, said process consisting of the steps of placing a master pattern of said article in a mould casing to define a mould space or
40 cavity, between said master pattern and said casing, filling the mould space or cavity with a pourable, heat-resistant moulding compound having minimal shrinkage on curing to form a mould corresponding to said master pattern and which is supported by
45 said mould casing, removing the master pattern after opening the casing, closing the casing and injecting a moulding material into the mould space or cavity to reproduce said article.

50 According to another aspect of the present invention there is provided a method of forming an article by means of an injection moulding process, including the steps of, placing a master of said article in a mould box, filling the mould with a settable moulding compound having minimal shrinkage on curing
55 to form a mould of said master, inserting the mould of said master in a moulding casing which is such as to support the mould, closing the casing and injecting a moulding material into the mould to reproduce said article.

60 As suitable moulding compound, an epoxy resin which cures at high temperature, such as that sold under the trade name FORMITE EH10, a thermo-curing polyurethane or silicone rubber may be used.

65 The present invention also provides an injection moulding apparatus for carrying out the method,

which comprises a mould casing in which is located a mould of a master pattern formed from a pourable heat-resistant moulding compound having minimal shrinkage on curing, said mould being positioned for
70 support in said casing, means for closing and opening the mould casing and means for introducing an injection moulding material into the mould casing to reproduce the master pattern.

75 Preferably, location means are provided to locate and secure the mould in the mould casing. In one form, the location means may comprise a plurality of recesses in the mould casing in which projections on the mould are located. The projections in the mould may have embedded therein screw-threaded mem-
80 bers, such as nuts which are engagable by similarly screw threaded members, such as screws or bolts, in the mould casing.

85 Alternatively, projections which may be in the form of bolts secured to the mould casing, may be provided on the interior surface of the mould casing. In an alternative form, the location means is provided by a bonding agent applied to the interior of the mould casing whereby said mould of the master is bonded to the mould casing.

90 In a preferred embodiment of the method in accordance with the present invention when a two-part mould casing is used, the master is supported so as to be partially in a lower part of the casing with space between the master and the
95 casing for the moulding compound, the gap between the master and the lower part of the casing being sealed by a formable material adapted to give a removable seal, the upper part of the casing is placed on the lower part to close the mould casing and a moulding compound is poured into the upper
100 part to form an upper part mould insert, after this has cured the mould casing is inverted and opened, the formable seal material is removed, a release agent is coated on the thus exposed part of the
105 upper part mould insert, the casing is closed and moulding compound is poured into the second part of the mould casing to form the second part of the mould insert. Alternatively, the two parts of the mould insert may be bonded together, if desired for
110 particular applications, by omitting the release agent and, if necessary coating the joint with a bonding agent.

The present invention also provides a novel construction of a two-part mould casing comprising
115 a first wall on one of said parts and a second wall on the other of said parts spaced from said first wall when the mould is closed by a plurality of columnar elements being adapted to support the clamping forces securing the two mould parts together during
120 a moulding operation.

The invention will now be described by way of example with reference to the accompanying drawings in which:

125 *Figure 1* shows a section end view of a mould casing and,

Figure 2 shows a sectional plan view of *Figure 1*,
Figure 3 shows a section plan view of a further embodiment of the invention, and

130 *Figure 4* shows a representation of a novel form of a mould casing.

Figure 1 shows a schematic end view of a mould for an injection moulding process having a rigid mould casing 1 formed of metal, and which is split into two parts 2 and 3 along a central plane 4. Within the mould casing there is located a mould 5 which is formed, by a method to be described hereinafter, of a pourable, heat-resistant moulding compound such as an epoxy resing which is curable at an elevated temperature, for example that which is sold under the trade name FORMITE EH10, a thermo-curing polyurethane or silicone rubber. The interior of the mould 5 defines accurately the shape and surface contour of the article to be moulded. The mould casing may, in certain circumstances, be made of non metallic material.

After being formed, the mould 5 is cut along a dividing line such that when it is placed in the mould casing, the dividing line will be aligned with the central plane 4 of the article. Preferably, the mould 4 is formed to be a snug fit in the casing so that its exterior surface is supported throughout by the interior of the mould casing 1.

To ensure that the mould 5 is accurately located in the casing 1 and securing in position in the embodiment shown in Figures 1 or 2 it is provided on its exterior surface with projections 6 which locate in associated recesses 7 in the casing 1. A screw threaded nut (not shown) may be embedded in some or all of the projections during the formation of the mould 5 and the mould casing 1 is provided with screw threaded studs or bolts 8 which engage the nuts to secure the mould 5 rigidly and immovably to the casing 1.

As shown more clearly in Figure 2, this embodiment is intended particularly for the formation of an injection moulded shoe and therefore the interior of the mould 5 is adapted to receive a last 9 so that the shoe is defined by the space between the last 9 and mould 5. The last 9 is secured in known fashion to the casing 1.

After the mould 5 has been secured to the two casing parts 2 and 3 and the last 9 has been secured in position, the mould casing 1 is closed by an end plate 10 which, in conjunction with the last 9, defines and closes the interior of the mould 5, the outline of the sole of the shoe together with any tread formation being formed in the end plate 10. The sole of the shoe could be defined by an additional part of the mould 5 which would be secured to the end plate 10, but in practice, the high definition provided by the mould 5 is not usually required for a sole. The shoe is then formed in a conventional way by means of an injection moulding process in which a moulding material such as polyvinyl chloride or polyurethane is injected by means of ram injection or extruder injection into the mould through one or more passages (not shown) in the end plate 10. The injection moulding process follows conventional techniques, for example, using pressures of 281.23 kg/cm² and a temperature of 180°C.

The mould 5 is formed by placing a master pattern of the article to be formed, a shoe in the present example, in a two-part mould casing 1, having the two mould halves 2 and 3. The present invention is particularly applicable to the formation of shoes

having a fine surface pattern or ornamentation such as is found on crocodile skin or lizard skin. A shoe made of the natural material which is to be reproduced forms a master pattern which, after being coated with a release agent, is supported on a last in the casing so as to lie half in the lower part 3 and half in the upper part.

In this way, the parting line in the finished article (the shoe) extends along the centre line of the shoe.

The upper casing part 2 is removed and the gap between the edge of the master pattern and the wall of the mould casing part 3 is sealed with a formable sealing compound to close off the (empty) lower interior of the casing part 3. The formable sealing compound may be clay, putty, silicon rubber or similar material such as that sold under the trade mark "PLASTICENE", designed to give a removable seal. The top surface of the sealing compound is levelled flush with the top edge of the casing part 3, i.e., to lie on the parting line 4. The mould casing is then closed. The heat-resistant moulding compound, is then poured into the upper part 2 through the reservoir 11 until it fills the mould casing part 2 and enters the outlet vent 12. The moulding compound is then cured in the known way.

When the moulding compound is set, it can be removed from the mould casing and thus forms a mould of the master pattern to be inserted in the mould casing for reproduction of the article to be reproduced, in this case a shoe.

After the moulding compound has cured the mould casing is inverted, opened and the formable sealing compound is removed. The region covered by the sealing compound is cleaned using a solvent such as ethyl-alcohol. The exposed surface of the mould insert is coated with a release agent. The casing is then closed and, in a similar manner to the first stage, moulding compound is poured into the casing part 3 (which is now uppermost) to form the second part of the mould insert. When this part has cured the casing is opened, the master pattern is removed and the mould casing used to mass produce reproductions of the master.

Figure 3 shows a modified embodiment in a view corresponding to that of the embodiment illustrated in Figure 2. In this embodiment the mould is formed in one piece directly in the mould casing 1 which is closed by an end plate 10. The master of the shoe is supported in the casing 1 on a suitable last 9 and the moulding compound is poured through an inlet (not shown) into the space between the mould casing and the shoe where it sets to from the mould 5.

The shoe and last are then removed and since the mould is formed of a resilient material, it has a tendency to be compressed when subjected to pressure. The thickness of the mould 5 is then to be controlled within predetermined limits throughout its profile so as to reduce the tendency to compression when the final moulding compound is injected into the mould.

The interior of surface of the mould casing 1 is suitably prepared to receive the moulding compound and this may be achieved by treating the surface so that the mould bonds directly thereto or by coating it with a bonding agent prior to pouring

the moulding compound. It will be appreciated that the mould could be formed in a separate casing for subsequent bonding to the mould casing 1.

After being removed from the mould casing, the mould 5 is cut with a very fine cutting means, such as a sharp blade or a laser beam along its centre line so that one half can be secured in the casing part 2 of the mould casing 1 and the other part in the corresponding mould part 3. The two parts of the mould 5 made accurately in the mould casing, so that the normal flash line which is usually obtained in the moulding process is virtually eliminated, so improving the appearance of the finished article.

An article is formed in a subsequent injection moulding operation.

The last 9 is located in the casing 1 by means of a spigot 14. With this arrangement, the last 9 is removable in the direction of arrow A as is the final product, the article 13. This embodiment is particularly suitable for the mass production of three dimensional hollow articles such as over-reach boots for horses, and handbags.

It has been found that the use of the mould insert from the high definition moulding compound enables the finest detail on the master pattern to be transferred to the reproduced article, so that it is possible to reproduce by injection moulding processes, a realistic reproduction of fine detail such as that of crocodile or lizard skin.

Although described with reference to the injection moulding of footwear, it would be readily appreciated that the present invention is easily applicable to the injection moulding of other articles where a high surface definition is required for a pattern or profile on the finished article, such as imitation leather goods or a wide range of other articles such as toys and scale models. It will also be understood that many variations may be made within the general concept of providing a mould insert formed from a master pattern by means of a particular choice of moulding compound.

The invention also provides a novel form of construction of a mould casing, as shown in Figure 4 schematically. The casing has a lower part consisting of a first lower wall 15 having therein a plurality of punched holes 16 which are adapted to receive, and have secured therein by welding or the like, associated columns 17. The columns 17 abut an upper wall (not shown) which forms part of the upper part of the mould casing. A last 18, suitably shaped for the article to be moulded, is located in the casing and the space between the walls 15 between the columns is filled with epoxy resin moulding compound. The clamping forces necessary to hold the two parts of the mould casing together during a moulding operation are supported by the columns. As substantially all of the forces are carried by the columns, which typically are formed of steel barstock, the remainder of the casing is relatively unstressed and can be made very economically. The mould insert is formed in the same way as described earlier.

The interior surface of the mould 1 is suitably prepared to receive the moulding compound and this may be by treating the surface so that the mould

bonds directly thereto or by coating it with a bonding agent prior to pouring the moulding compound although a releasable mould insert may be used instead.

70 It will be appreciated that the mould 5 may be formed in a separate casing for subsequent bonding to the mould casing.

75 CLAIMS

1. A method of forming an article by means of an injection moulding process, said process consisting of the steps of placing a master pattern of said article in a mould casing to define a mould space or cavity, between said master pattern and said casing, filling the mould space or cavity with a pourable, heat-resistant moulding compound having minimal shrinkage of curing to form a mould corresponding to said master pattern and which is supported by said mould casing, removing the master pattern after opening the casing, closing the casing and injecting a moulding material into the mould space or cavity to reproduce said article.
2. A method according to claim 1 wherein the moulding compound is a settable material having a co-efficient of thermal expansion which is substantially similar to that of the mould casing.
3. A method according to claim 1 or claim 2 wherein the moulding compound is an epoxy resin.
4. A method according to claim 1 or claim 2 wherein the moulding compound is a polyurethane.
5. A method according to claim 1 or claim 2 wherein the moulding compound is silicone rubber.
6. A method according to any one of claims 1 to 6 wherein the mould casing comprises two parts, the master pattern being supported so as to be partially in a lower part of the mould casing with a space between the master pattern and the casing for the moulding compound, the gap between the master pattern and the lower part of the casing being sealable by a formable material adapted to give a removable seal, placing the upper part of the casing on the lower part to close the mould casing and pouring a moulding compound into the upper part of the mould casing to form an upper part mould insert, after curing, inverting and opening the mould casing, removing the formable seal material, coating the exposed part of the mould insert with a release agent, closing the casing and pouring the moulding compound into the second part of the mould casing to form the second part of the mould insert.
7. A method according to claim 6 wherein the two parts of the mould insert are bonded together in the absence of a release agent.
8. An apparatus for forming an injection-moulded article comprising a mould casing in which is located a mould of a master pattern formed from a pourable, heat-resistant moulding compound having minimal shrinkage on curing, said mould being positioned for support in said casing, means for closing an opening the mould casing and means for introducing injection moulding material into the mould casing to reproduce the master pattern.
9. Apparatus according to claim 8 wherein the

moulding casing is provided with means to support and locate the mould in the mould casing.

10. Apparatus according to claim 9 wherein said supporting and locating means comprise a plurality of recesses provided in the mould casing that receive corresponding projections on the mould.

11. Apparatus according to claim 9 or claim 10 wherein the supporting and locating means consist of screw-threaded members provided on the mould which are engagable with screw-threaded members provided on the mould casing.

12. Apparatus according to claim 7 wherein the mould is located and supported in the mould casing by being secured thereto with a bonding agent.

13. Apparatus according to any one of claims 8 to 12 wherein the mould casing consists of two parts and comprises a first wall on one of said parts and a second wall on the other of said parts spaced from said first wall when the mould casing is closed by a plurality of columnar elements, the columnar elements being adapted to support clamping forces which secure the two mould casing parts together during a molding operation.

14. An apparatus for forming an article having a high definition surface finish by means of an injection moulding process.

15. A method of forming an article by an injection moulding process substantially as hereinbefore described and with reference to the accompanying drawings.

16. An apparatus for forming an article by an injection moulding process substantially as hereinbefore described and with reference to the accompanying drawings.

17. An injection mould article produced in accordance with the method hereinbefore described and with reference to the accompanying drawings.