

# PATENT SPECIFICATION

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## (54) IMPROVEMENTS IN OR RELATING TO THE MOULDING OF THERMOSETTING MATERIALS

(71) We, BRITISH INDUSTRIAL PLASTICS LIMITED, a Company organised under the laws of Great Britain, of 77 Fountain Street, Manchester M2 2EA, 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:—

The present invention relates to the injection moulding of articles from thermosetting resin compositions.

Articles are commonly formed from thermosetting resin by compression moulding of moulding compositions comprising resin in a die under pressure, and usually whilst heated above ambient temperature.

Alternatively, injection moulding may be used when the molten composition is injected under pressure into a mould which, again, is usually above ambient temperature.

The cure of the resin is substantially completed whilst the moulded article is in the die or mould and mould occupation time may be relatively high, especially in thick articles; even in injection moulding machines where the moulding composition is heated and the cure initiated before it enters the mould.

It is one object of the present invention to provide a process for the production of articles moulded from compositions comprising thermosetting resins with appreciably shorter mould occupation times in the mould cycle.

According to the present invention, an article is injection moulded from a thermosetting resin composition by injecting the composition containing a substantial proportion of an inert filler so that the composition as a whole has a very stiff plastic consistency, the method comprising injecting the composition in a viscous state under pressure into a closed, cold mould, whereby the temperature of the composition does not exceed that at which

curing is initiated and whereby the composition in the mould is cooled to make it sufficiently stiff to retain its shape on discharge from the mould, removing the cooled uncured article from the mould and subsequently heating the moulded article in a manner such that the resin is cured without the article losing its shape.

The cooling step requires much less mould occupation time than curing in the mould as used hitherto.

In consequence, the cycle time of operation of the injection moulding machine can be reduced to only a small fraction of, sometimes less than 10% of, the cycle time using the cure-in-mould technique.

The process of the present invention is based on the fact that where the composition contains a substantial proportion of an inert filler the composition as a whole may have a very stiff plastic consistency, even when using resin which is itself still flowable. Such compositions facilitate the curing of the article in an oven or other heating apparatus after removal from the mould without any distortion of the moulded article taking place. Alternatively, if the resin is not sufficiently rigid at ambient temperature to retain its shape when unsupported, it may be necessary to cool the mould below ambient temperature.

Preferably, however, the thermosetting resin in the composition is one which is rigid at ambient temperatures in which case the composition containing the resin is made sufficiently plastic to enable it to be injected into the mould by warming the composition before injection takes place. Subsequent cooling in the mould to a temperature, even somewhat above ambient temperature, renders the moulded article sufficiently rigid before it is removed from the mould, to make it self-supporting after removal from the mould. Aminoplast resins are particularly preferred.

The temperature at which the composi-

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tion is injected into the mould may be selected from within a wide range depending upon the nature of the resin, the proportion and nature of the filler or reinforcing material in the composition and also the shape of the article which is to be moulded. The temperature to which the moulded composition is cooled in the mould may also be selected from within wide limits, again in dependence upon the same factors. As an example, it has been found that with one composition which is rigid at ambient temperatures the composition becomes sufficiently plastic to be injected at a temperature of about 80°C and on cooling again in the mould to a temperature of about 50°C the article formed is sufficiently rigid to retain its shape after removal from the mould and during heating for curing. This is because, during curing, the article is subjected to little or no pressure which will bring about distortion whereas moulding may take place at pressures customarily used in injection moulding, for example 20,000 p.s.i.

Whilst the primary advantage of the method in accordance with the invention is the very great reduction in cycle time of the injection moulding machine which gives rise to very considerable economies in the cost of the machinery necessary for any particular output of mouldings, the method has a number of subsidiary advantages as well. Amongst these is that, because the mould is not heated, the composition which remains in the mould runner is not appreciably cured and in consequence this material can be re-used. Because the material in the runner is not wasted, the runner itself may be made of a greater cross-sectional area than would otherwise be economically practicable. This facilitates the moulding of compositions having very large filler contents and in particular enables compositions containing fibrous fillers, such as glass fibre or asbestos, to be moulded by this technique.

A second subsidiary advantage is that the composition will not flow down the flash line of the cold mould and in consequence the articles are moulded cleanly and the need for subsequent flash removal may be obviated.

Thirdly, because the composition is injected into a cold mold which is at, or only a little above, ambient temperature, the shape and size of the moulding is defined at this temperature. There is therefore no need to allow for shrinkage in the calculation of the mould size as is necessary when moulding takes place at an elevated temperature to enable curing to take place in the mould. The moulding of articles within very close limits is therefore facilitated.

One particular example of a thermosetting resin composition which has been used successfully for forming elements by a method in accordance with the invention comprises, in parts by weight:—

25% phenol formaldehyde resin  
50% asbestos fibre  
25% powdered inorganic filler (75% of which passed 200 mesh).

It has been found that this composition can be used with particular success in the method in accordance with the invention partly owing to the substantial proportion of asbestos fibre which makes the moulding retain its shape particularly well during curing without the curing temperature and time being at all critical.

Mouldings were made having a layer of thermosetting resin material applied to a supporting metal plate by moulding the resin material directly on to the metal plate. The metal plate, having keying formations formed in it, was loaded into the injection mould which was then closed and the material injected at 80°C under a pressure of 18,000 p.s.i. So-called 'sink holes' were obviated by ensuring that cooling took place from the face of the moulding remote from the injection nozzle and by maintaining injection pressure during cooling (when shrinkage can occur).

In all cases curing may take place in an oven either without the application of any external pressure or by application of a light pressure of less than 20 p.s.i.

#### WHAT WE CLAIM IS:—

1. A method of injection moulding an article from a thermosetting resin composition containing a substantial proportion of an inert filler so that the composition as a whole has a very stiff plastic consistency, the method comprising injecting the composition in a viscous state under pressure into a closed, cold mould, whereby the temperature of the composition does not exceed that at which curing is initiated and whereby the composition in the mould is cooled to make it sufficiently stiff to retain its shape on discharge from the mould, removing the cooled uncured article from the mould and subsequently heating the moulded article in a manner such that the resin is cured without the article losing its shape.

2. A method according to Claim 1 or Claim 2 wherein the mould is cooled below ambient temperature.

3. A method according to any one of the preceding claims, wherein the article is moulded directly to a supporting metal plate.

4. A method according to any one of the preceding claims, wherein the mould is arranged and adapted so that cooling of the article takes place from the face of the

tion is injected into the mould may be selected from within a wide range depending upon the nature of the resin, the proportion and nature of the filler or reinforcing material in the composition and also the shape of the article which is to be moulded. The temperature to which the moulded composition is cooled in the mould may also be selected from within wide limits, again in dependence upon the same factors. As an example, it has been found that with one composition which is rigid at ambient temperatures the composition becomes sufficiently plastic to be injected at a temperature of about 80°C and on cooling again in the mould to a temperature of about 50°C the article formed is sufficiently rigid to retain its shape after removal from the mould and during heating for curing. This is because, during curing, the article is subjected to little or no pressure which will bring about distortion whereas moulding may take place at pressures customarily used in injection moulding, for example 20,000 p.s.i.

Whilst the primary advantage of the method in accordance with the invention is the very great reduction in cycle time of the injection moulding machine which gives rise to very considerable economies in the cost of the machinery necessary for any particular output of mouldings, the method has a number of subsidiary advantages as well. Amongst these is that, because the mould is not heated, the composition which remains in the mould runner is not appreciably cured and in consequence this material can be re-used. Because the material in the runner is not wasted, the runner itself may be made of a greater cross-sectional area than would otherwise be economically practicable. This facilitates the moulding of compositions having very large filler contents and in particular enables compositions containing fibrous fillers, such as glass fibre or asbestos, to be moulded by this technique.

A second subsidiary advantage is that the composition will not flow down the flash line of the cold mould and in consequence the articles are moulded cleanly and the need for subsequent flash removal may be obviated.

Thirdly, because the composition is injected into a cold mold which is at, or only a little above, ambient temperature, the shape and size of the moulding is defined at this temperature. There is therefore no need to allow for shrinkage in the calculation of the mould size as is necessary when moulding takes place at an elevated temperature to enable curing to take place in the mould. The moulding of articles within very close limits is therefore facilitated.

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In all cases curing may take place in an oven either without the application of any external pressure or by application of a light pressure of less than 20 p.s.i.

#### WHAT WE CLAIM IS:—

1. A method of injection moulding an article from a thermosetting resin composition containing a substantial proportion of an inert filler so that the composition as a whole has a very stiff plastic consistency, the method comprising injecting the composition in a viscous state under pressure into a closed, cold mould, whereby the temperature of the composition does not exceed that at which curing is initiated and whereby the composition in the mould is cooled to make it sufficiently stiff to retain its shape on discharge from the mould, removing the cooled uncured article from the mould and subsequently heating the moulded article in a manner such that the resin is cured without the article losing its shape.

2. A method according to Claim 1 or Claim 2 wherein the mould is cooled below ambient temperature.

3. A method according to any one of the preceding claims, wherein the article is moulded directly to a supporting metal plate.

4. A method according to any one of the preceding claims, wherein the mould is arranged and adapted so that cooling of the article takes place from the face of the





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article remote from the injection nozzle and wherein injection pressure is maintained during cooling.

5 5. A method according to any one of the preceding claims, wherein the composition comprises an aminoplast resin.

6. A method according to any one of Claims 1 to 5, wherein the composition comprises a phenol formaldehyde resin.

10 7. A method of injection moulding an

article from a thermosetting resin composition substantially as hereinbefore described.

8. Articles moulded by a method according to any one of the preceding 15 claims.

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