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LATEX MOULDING BY PLASTER CASTING

by

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SUMMARY.—Methods for producing cast figures from latex concern mainly, first, the use of porous moulds and secondly, the use of metal moulds with heat sensitised latex.

Particular reference is made to the production of hard figures for display purposes in which a plaster mould is filled with compounded latex. When a deposit has formed on the mould surface, the excess latex is removed and the deposit is dried sufficiently to allow removal of the mould. The figure is then dried and vulcanised in hot air.

Mention is also made of soft figure production, and the use of rubber moulds for casting plaster figures.

Many references can be found in the literature to the production of hollow rubber articles by casting latex into hollow moulds. The methods described are varied but mainly concern the use of porous moulds, and the use of metal moulds in conjunction with heat-sensitised latex. The idea of using a porous surface for the deposition of rubber is by no means new, for as long ago as 1864, Hancock[1] suggested the production of figured rubber by casting latex on to a plaster of Paris design and peeling the rubber off when dry.

The hollow articles are produced by filling the mould with latex and allowing a deposit of rubber to form on the walls of the mould, either by absorption of moisture in the case of plaster moulds, or by coagulation of heat-sensitised latex with metal moulds heated to a temperature that will promote gelation. An alternative method is to rotate the mould containing sufficient latex to form the necessary deposit.

In 1930, Metallgesellschaft Aktiengesellschaft[2] described the production of moulded articles of composition resembling wood. This comprises preparing a latex containing vulcanising ingredients and a coarse filler such as wood flour, and preferably flocculated to a thixotropic mass. The mixture is poured into a mould, and after remaining in contact for a period necessary to produce the required thickness of deposit on the walls of the mould, the still-mobile portion is poured out. The cavity can then be filled with sawdust, the moulding removed from the mould, and finally dried and vulcanised. A plaster mould can be used for the above, and similar moulds were suggested by Leseberg[3] in 1933 for the production of rubber articles by a pouring process using a stabilised latex containing substances, such as gypsum, capable of chemically binding water. A similar process was suggested by Faber[4] in 1935, for the production of hollow rubber articles such as balls, water-bottles, toys, and bathing caps. Both Leseberg and Faber suggest deposition on the inner surface of the mould, by partially filling the mould, and then rotating it so that the mass can distribute itself uniformly over the walls of the mould.

Heat sensitivity.—The first of the "Kaysam"[5] patents (1931) covered the manufacture of cast rubber articles from heat-sensitised latex. This process concerns the addition to latex of substances which cause instability of the latex at elevated temperatures. Sufficient latex, containing vulcanising ingredients and the gelation agent, such as ammonium nitrate, is poured into a hollow metal mould. The mould should be of the split type to facilitate removal of the moulding. The mould containing the latex is revolved in order to deposit the latex on the inner surface and is heated sufficiently to cause gelation of the latex. Thus a lining of rubber is formed on the inside of the mould. The mould is opened and the moulding is removed, vulcanised, washed and dried. This, however, is not the first reference to heat sensitised latex. In 1927 the Societa Italiana Pirelli covered the use of heat-sensitised latex,[6] and gave as an example the addition of calcium sulphate (0·3 per cent. on the dry rubber) to latex to produce a mixture capable of coagulation when heated, but stable at room temperature. More recently Chassaing and other French workers have claimed advantages for the production of heat-sensitised latex by the addition of zinc oxide to aged latex, or to latex which has been artificially aged by the addition of trypsin (powdered pig pancreas). As an example, latex to which 0·1 per cent. trypsin has been added is allowed to stand for at least 24 hours. Vulcanising ingredients, including 3 per cent. zinc oxide on dry rubber, are then added. This latex mixture will gel at a temperature of 85° C. The advantage of this method is that the product requires no water-wash, as do the other heat-sensitised processes in order to remove undesirable water-soluble residues. Finally, the German method of heat sensitisation utilises the property of polyvinyl methylether (Igevin M50) to remain in solution at room temperature and become insoluble at 35° C. Polyvinyl methylether (3–7 per cent. on the dry rubber content) is added to the latex in the form of a 15 per cent. solution. This latex can be stored for many weeks at 25° C., the polyvinyl methylether in solution acting as a stabiliser, but when the temperature is raised above 35° C. the polyvinyl methylether becomes insoluble and causes the destabilising of the latex.

The use of metal moulds has the advantage that great numbers of rubber reproductions can be produced from one mould, whereas with plaster moulds only limited numbers of articles can be reproduced owing to surface breakdown. More shrinkage however is apparent when metal moulds are used, all the water in the deposit has to be dried out, and generally the operation is a more delicate one. With porous moulds much of the water is taken up by the plaster, and they are particularly suitable where only small numbers of articles of certain design are required. This method has much scope where change of design is an important factor. Moulds of plaster of Paris are easy to produce, and a mould can be made of several pieces to accommodate intricate design. This method has thus proved suitable for the production of toys and general display models, including advertising, anatomical and educational figures. The method of manufacture is similar in all cases. The plaster mould is filled with latex and allowed to remain so until the necessary thickness has been deposited on the inside of the mould. The excess is then removed from the mould, and the mould (with deposit) is dried sufficiently to permit the mould to be opened and the moulding removed without damage or distortion. The moulding is then dried and vulcanised and finally cleaned and coloured.

Soft articles for toys.—For advertising and similar figures it is necessary that the final material should be as hard as possible and still of an unbreakable nature, but for toys, products of various hardness may be required. Perhaps the most attractive toys prepared by this method are the pure gum specimens, which being hollow with an all-rubber skin, are particularly suitable as floating bath toys. For the preparation of such toys, pre-vulcanised latex appears the most suitable, but as the rubber skin is complete without a hole or vent, it is not practical to use heat for drying owing to the risk of bursting. This means that drying must be carried out at room temperature, and as the initial drying takes place while the toy is still in the mould, the toy monopolises the mould for far too long a period. A vulcanised concentrated latex would require some three hours contact with a plaster surface to give a deposit sufficient to result in a final thickness of 2·5 mm. After the 3 hours' contact time, the excess latex would be poured out, and the pouring hole plugged with a close fitting plaster bung to ensure a continuous rubber film, but the mould could not be opened with safety for a further 12 hours. These long production times can be considerably curtailed by using flocculated latex, but care must be taken that the latex is not allowed to become too thick and thus hamper pouring. A latex flocculated by the addition of 25 per cent. of a 5 per cent. alum solution will give a deposit of 2·7 mm. thickness after 30 minutes contact with a plaster surface, compared with a thickness of 1·1 mm. from untreated latex under similar conditions. Compared with the times of 3 hours and 12 hours mentioned above, a flocculated latex would require ½ hour and 3 hours for similar production.

Hard figures.—To obtain the required hardness for advertising figures it is necessary to incorporate fillers into the latex, and as the figures can be open-based or need not have the pouring hole plugged, drying can be carried out at elevated temperatures. Vulcanisable latex can therefore be used with advantage, and vulcanising ingredients incorporated to suit the facilities at the manufacturer's disposal. Choice of fillers is important, as some fillers which can be used with advantage in dry rubber prove unsatisfactory when added to latex. Slate dust, for example, tends to promote coagulation, and pumice powder, although readily wetted, leads to considerable frothing and air occlusion. For self-coloured goods, whiting and china clay can be used; whiting for preference as it requires less water for wetting and promotes less froth than clay. The less water present in the latex mixture means, of course, less water to be got rid of during manufacture, and the use of a good wetting agent is therefore of utmost importance. The presence of a wetting agent increases the stability of the latex mixture which is a matter of first consideration. Large proportions of wetting agent should however be avoided as not only do they increase froth formation, but also tend to retard the deposit build-up and also the subsequent drying. A recommended method of latex mixture preparation is to wet the filler with a 1 per cent. solution of suitable wetting agent; add the vulcanising ingredients as dispersions, and grind the whole to a smooth paste in a suitable mill, for instance a cone mill or end-runner. The concentrated latex containing a small quantity of stabiliser, 0·5 per cent. casein on the dry rubber content, is added to the filler paste, and after the latex mixture has stood for 24 hours to allow the bubbles to rise, it is ready for pouring into the moulds. Up to 300 parts of whiting are used with 100 parts of rubber, and no addition of a flocculating agent to this mixture is needed to ensure sufficient deposit in a reasonable time. After 5–15 minutes contact time, the excess latex is removed, and this excess can be used again. The mould is heated at a temperature of up to 100° C., until the rubber film is sufficiently strong to allow the mould to be removed from it without distortion or rupture of the subject (the seam is particularly vulnerable). Shape and design of mould and moulding will influence the time and temperature needed for this initial drying, but as a guide, 30 minutes at 100° C. is usually sufficient. Once the moulding is removed from the mould, it can be returned to the oven for final drying and vulcanising. Time and temperature for this operation may be varied to suit other considerations, but at a temperature of 100° C., the time necessary for final drying and curing is about 1 hour for a latex compound containing 1 per cent. ZDC on the dry rubber. As an example the following mixture for hard figures is suggested:—

	Parts by weight
Latex (60 per cent. D.R.C.)	167
10 per cent. casein solution	5
Whiting	300
50 per cent. sulphur dispersion	6
50 per cent. zinc oxide dispersion	10
33⅓ per cent. zinc diethyldithiocarbamate dispersion	3
1 per cent. wetting agent solution	78

With such high proportions of filler present, the wet strength of the film is low, and if the moulding is too intricate it is impossible to remove the rubber from the mould within reasonable time without causing damage. When such an intricate design is required, the difficulty can be overcome by using a double-pour method. The mould is first filled with the highly loaded latex to give the necessary hard finish, and immediately after the excess has been removed the mould is again filled, this time with a lightly loaded latex to give sufficient wet strength to enable the removal of the resultant two layers. The excess latex of the second mixture is removed and procedure continued as described above.

Finishing.—It is important that the final figure should have a smooth finish and be suitably coloured. As the material is of such a hard nature, seam marks, etc., are removed by the usual abrasive methods, and the surface can be painted with cellulose finishes. The pure-gum figures, mentioned earlier, are however much too flexible for the hard finish of a cellulose paint, but the use of oil soluble colours, applied from solution to dye the rubber, has been tried with success. Solutions of such colours in xylene have been found suitable, and the addition of aluminium stearate is advantageous to thicken the dye solutions and enable clear cut definition to be obtained. This method of colouring has the advantage of maintaining the attractive matt finish which is usually desirable with pure gum articles.

It will be gathered from the foregoing that the manufacture of figures from latex is comparatively simple, and that no great expense is necessary to operate the process successfully. Thus, the existing manufacturer of papier-mache or plaster figures can change over to latex without great difficulty. Much of the technique is similar and little alteration of plant is necessary.

Rubber moulds.—Mention might now be made of the converse of the above method, where a plaster cast is made in a rubber mould. The replacement of gelatine by rubber for this purpose is fairly well established now, and much has been published describing methods for preparing rubber moulds from latex. Wall plaques, and other casts that can be made from a single piece skin mould, will not suffer from the usual seam marks. The master figure is first dipped into or sprayed with vulcanised latex, and when the skin of rubber is formed, coats are applied of a mixture of latex and china clay to produce an outer coating to give the necessary rigidity to support the cast material. If the stiffness is such that it will not permit the removal of the mould, then in place of the loaded latex coating, a plaster casing is made. This can be made in several pieces to facilitate removal, and when this outer casing has been removed, the rubber skin can be peeled from the casing revealing perfect reproduction. Latex-rubber moulds are of particular interest at the moment for use with the popular cast resins.

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