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IN THE MATTER of an Application for a SINGAPORE Registration of European Patent designating UK No. 0 176 385

I, LUCIEN A DESPORT of Engineering, Management Data Processing (E.M.D.P) C.I.T. POB 37 - 3 rue de L'Arrivee, 75749 Paris Cedex, France, do hereby certify:

That I have a competent knowledge of the French and English languages;

AND That the attached document is a true and correct translation of the European Patent in the name of Engineering, Management Data Processing (E.M.D.P.) granted under No. 0 176 385.

Signed by Lucien A Desport)
this 22. day of august)
1988)

Transformable mould, for instance for the realisation of a ship's hull, and process for its its production

This invention relates to moulds and the process for their production. It relates more particularly to moulds for moulding objects having non-developable surfaces. The invention will be illustrated more particularly by the example of a ship's hull but it goes without saying that it is also applicable to other moulded objects using a simple female mould, a simple male mould, or a closed mould, these objects, consisting, for example, of polyester resin, epoxy resin or some other thermosetting resin, ordinary cement or any other suitable material.

The U-S patent US-A-1.406.117 describes equipment which makes it possible to realize some slats with various shapes provided that they are planed, but not to mould surfaces non developable.

It is already known to mould ship's hulls using a mould. Any change in the dimensions or shape of the hull makes it necessary to use a different mould. This process is expensive.

The invention remedies this disadvantage by providing a convertible mould according to the claim 1, the greater part of which can be used to mould hulls of different shapes and dimensions.

Some other characteristics of the mould derive from the dependent-claims.

Therefore, in order to convert the mould, one has only to modify the position of the heads and then apply the slats and sheets thereto. Since the elements of the frame, which is preferably demountable, the head holders, the means for fixing them in different positions and the heads themselves represent the most expensive components of the mould, a universal mould is thus produced which can be used to mould any boat.

To ensure that each row of heads defines a curve which the primary slat will follow without any deformation at the point of contact, it is generally advisable for one of the linear dimensions of the contact surface of a head with the primary slat to be less than about 1/500th of the radius of the curvature of the slat at this point. Generally, the contact surface area of a head with a slat is between 2 mm and 10 mm.

Generally, the rows of heads are arranged so that they define the timbers of the boat. The secondary slats can be to define the water lines of the boat. To prevent the secondary slats from warping or twisting and to ensure that they remain parallel to the plane tangent to the surface of the hull, it is extremely important that the surface area of contact of each head can be oriented so as to adapt to the principal lines of the hull, i.e. the timbers and the water-lines. For this reason, an impotant feature of the invention, is that each head can be oriented in two directions which differ from the direction in which the head holder extends.

The best results are obtained when each head is arranged so that it can rotate about two orthogonal axes, at least one of which is imaginary. The two axes are not necessary coplanar. One of them, which is always imaginary, is preferably in the plane tangent to the mould. The other may be real or imaginary and, in the latter case, preferably passes through the point of contact of the head with primary slat. In this way, local deformation of the slats at the points where they are supported is prevented as far as possible.

The primary slats should have sufficient rigidity so that they do not bend between the support points formed by the heads when they receive the load of the material constituting the hull. For this purpose, the heads may be placed as close together as necessary, although obviously, since the heads and the means by which they can be displaced represent a costly investment, it is advisable to have as few heads as possible. For a ship's hull weighing 85 kg/m2, a spacing between the heads in a row of between 0.30 m and 0.50 m may be used. It is also possible to provide simple supports for the slats between the heads. Finally, to achieve the best compromise between the strength which the slats should have and the need to bend them in order to fit them to curvature required for the shape of the hull, it is provided that the primary slats consist of laminate having a rigidit of more than 35.10^6 kg/mm2 and a deflection of less than 0.1 mm between two support points spaced 0.35 m apart.

The process for manufacturing the transformable mould according to the invention according to the claim 1 consists of producing the laminated primary slats by applying successive layers which form single slats over a first layer supported by the heads. Each layer is able to

deform easily. without having the required strength, but the laminate thus produced has the required strength. 36

The secondary slats may be placed closer together since this incurs hardly any extra-cost caused by the necessity of using more heads. For this reason, preferably, the distance between the secondary slats is approximately half the distance between the primary slats, given that the secondary slats may be complemented by diagonal slats.

The sheets or covers which are applied to the lattice formed by all the slats should have sufficient flexibility to take the shape of the desired surface, but sufficient rigidity to withstand the stresses and give a deflection of less than 0.1 mm, for example.

This double characteristic can be attained by using wovenglass material impregnated with resin, notably polyurethane resin, having its greatest strength in the direction of least curvature of the hull.

In the accompanying drawings, which are given solely by way of example:

Figure 1 is a partial perspective view of a frame on which the slats have not yet been placed;

Figure 2 is a partial perspective view of a frame fitted with a first constituent layer of the primary slats;

Figure 3 is a view similar to that of figure 2 but with the laminated primary slats completed;

Figure 4 is a view similar to figure 3 with the secondary slats in place;

Figure 5 is a view similar to that of figure 4 with a certain number of sheets in place;

Figure 6 is a perspective view of the frame and the head holders;

Figures 7 and 8 are perspective views illustrating two embodiments of heads.

In figure 1, the frame consists of a crossbeam 1 on which are fixed uprights 2_1, 2_2, 2_3 and 2_4 and horizontal longitudinal beams 3_1, 3_2, 3_3 and 3_4. Bars 4_1, 4_2, 4_3 and 4_4 are fixed to these uprights and longitudinal beams. The two bars 4_1 extend in a plane parallel to that of the bar 4_2 and the parallel planes in which the bars extend are equidistant. Mounted on the longitudinal beams and, in some cases, on the uprights, there are head holders 5_1, 5_2, 5_3 and 5_4 which can be displaced, using systems of jacks or screws, so that the heads 6_1, 6_2, 6_3 and 6_4 carried by each head holder can take up a prescribed position. The row of heads 6_1

thus defines a curve which corresponds to the curve of a timber of the hull of the boat.

In figure 2 a first layer 7_1 of primary slats has been placed on the row of heads 6_1 and a first layer 7_2 on the row of heads 6_2.

In figure 3, the first layers 7_1 and 7_2 have been completed by four other layers superimposed thereon so as to create the primary slats 8_1 and 8_2. The first layer 7_2 is a layer of polyvinyl chloride 2 mm thick, the second layer is a layer of polyester 2 mm thick, the third layer is a layer of polyvinyl chloride 14 mm thick, the fourth layer is a layer of polyester 2 mm thick and the fifth layer is a layer of polyvinyl chloride 2 mm thick.

In figure 4, secondary slats 9 are fixed by adhesive bonding to the primary slats 8, perpendicular thereto. Although this is not shown in figure 4, it is possible to produce the slats 9 in the same way as the slats 8 if the curvature of the slats so requires.

In figure 5, pieces of sheet 10 have been adhesively bonded to the lattice formed by the slats 8 and 9 and have been fitted end to end so as to obtain a surface which forms the mould for a ship's hull.

When moulding is completed, the slats 8 and 9 and the sheet 10 are removed and, in order to mould a boat of different shape, the position of the heads 6 is altered, whilst the arrangement of the frame is modified if necessary.

Figure 6 shows the way in which the position of the heads 6 can be varied. Each head is integral with the rod 11 of a jack so that the heads can be displaced in the direction in which the rods extend.

Figure 7 shows an alternative embodiment of heads to the invention. A screw 12 integral with a bearing fork 13 and capable of being screwed into a nut 14 makes it possible to vary the spacing of the head from the bar 4. The axis 15 of the bearing fork 13 is integral with a part 21 consisting of a circular cylindrical element the generator of which is orthogonal to the axis 15. By releasing the axis 15 using a knob 19 the part 21 can be made to rotate about the axis 15. A part 16 made up of two jaws joined by a screw 22 and clamping the part 21 into position can be displaced over the part 21 parallel to the generators of the latter or can be locked into position using a locking knob 20. Straps 18 integral with the part 16 may serve as a flat support for the primary slats. The respective perpendicular positions of the axis 15 and the axis of the geometric cylinder of which the part 21 is

an element make it possible to give any desired predetermined orientation to the plane provided by the straps 18.

Figure 8 shows an alternative embodiment in which the axis 15 in figure 7 is replaced by a circular cylindrical element 26, the axis of which is perpendicular to that of the cylinder of the part 21. The screw 22 and the locking knob 20 are replaced by a spindle 24 carrying an eccentric and a rotary knob for locking the part 16 in position on the part 21. The straps 18 in figure 7 are replaced by jaws 27 which are able to clamp the slats into position by means of one or several screw. The jaws are thus gripping means for gripping slats. The gripping means are mounted so as to be able to be shifted transversaly to the plane of the row and to adapt to the shift of a slat which is due to its torsion.

CLAIMS

1 . Transformable mould - especially for moulding objects, such as ship's hulls, which have non developable surfaces, contain first lines extending in first parallel planes and second lines extending in second parallel planes which cross the first planes and are curved differently one from others -which comprises a frame (1,2,3) of demountable bars (4), rows of head holders (5) mounted on the bars (4) so as to be capable of being fixed thereon in different positions, each row (5) extending in one of the said first planes, heads (6) held by the ends of the head holders (5), characterised by primary slats (8) supported by the heads (6), each slat (8) extending along one first line and supported by all the heads (6) of a row (5), by secondary slats (9) interlaced with the primary slats (8) and fixed thereto, the heads (6) of one row being oriented so that the primary slats (8) have a torsion such that each secondary slat (9) extends along one secondary line, and by sheets (10) applied on the secondary slats (9).

2. Mould as claimed in claim 1, wherein one of the linear dimensions of the contact surface of a head (7) with the primary slat (8) is less than approximately 1/500 th of the radius of curvature of the slat at this point.

3. Mould as claimed in claim 1 or 2, wherein each head (6) can be oriented in two directions which differ from that in which the head holder extends.

4. Mould as claimed in claim 3, wherein each head is arranged so that it can rotate around a first imaginary axis which is in the plane tangent to the mould.

5. Mould as claimed in claim 3 or 4, wherein each head is arranged so that it can rotate about a second axis which passes through the point of contact of the head with the primary slat.

6. Mould as claimed in claim 3, 4 or 5 wherein each head comprises gripping means for gripping a slat mounted so as to be able to be shifted transversely to the plane of the row in which it is situated.

7. Mould as claimed in claim 1 to 6, wherein the primary slats (8) consist of laminates.

8. Process for producing a convertible mould as claimed in claim 7, wherein it consists in producing the laminated primary slats by successively putting in layers forming single slats on top of a first layer supported by the heads.