RECEIVED COPY.

PATENT SPECIFICATION

748,693

Date of filing Complete Specification Feb. 4, 1953.

Application Date Feb. 4, 1952. No. 2907/52.

Complete Specification Published May 9, 1956.

Index at acceptance: Classes 87(1), B1A3B, B1C1(A:F:G), B1C2(B:F:G), B1E1A, B1F(1B:2X); and 87(2), A1R(50:55), A2E1A, A2E4(A:C), A2E7(A:B), A2E8.

COMPLETE SPECIFICATION

Improvements in and relating to Building Units for example Panels or Slabs of Gypsum Plaster or other Mouldable Material

We, STANLEY HOWARD FLOWER, JOHN PARSONS and NORMAN GREENLEES WEIR LOUDON, all British subjects, and BELLROCK GYPSUM INDUSTRIES LIMITED, British Company, all of the Company's address at 41, London Street, Chertsey, in the County of Surrey, 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 prefabricated polycellular building units and to methods and apparatus for manufacturing such units (such as panels or slabs (hereinafter called panels)) of mouldable building materials comprising gypsum plaster or like compositions (hereinafter called plaster) of the type comprising a moulded integrally continuous facing sheet (hereinafter referred to as a facing or facings) on both sides of the panel and cell-forming walling extending between the facings, each cell being disposed with its walling at right-angles to the facings.

An object of the present invention is to provide an improved double faced panel of the type above indicated capable of being moulded (especially in gypsum or like quick-setting plaster composition) in room height or equivalent lengths suitable for building construction including walling, partitioning, flooring or roofing work, which may bear a substantial load or be combined with members adapted to increase the load carrying capacity.

The invention is also directed to a method and apparatus whereby the improved panel may be manufactured to predetermined standards and dimensions with expedition and accuracy.

According to the invention the improved double faced panel is characterised in that one of the pair of facings is integral and homogeneous with the cell-forming walling and the other facing of the pair is secured to said walling by means (additional to any adhesion of the plaster) on the cell rims, and constituted by keying formations which are embedded in the plaster of the second facing and provide a mechanical bond between the walling and said second facing.

The invention also includes a method of moulding a polycellular plaster panel unit as defined in the preceding paragraph comprising moulding the cellular walling in one with one facing by immersing a series or assemblage of rubber or like deformable hollow plugs having key moulding means on their exterior and disposed in spaced relationship to one another to a predetermined depth in a contained body of plaster such that the plaster forms a facing layer and rises into the clearances to form the cell walling, contracting the plugs, withdrawing them from the plaster, and adding the second facing by inverting the moulded structure and immersing the rims of cells in a second body of contained plaster for the other facing to an extent to submerge or embed the keying formations on said rims to provide the required mechanical bond.

The invention also includes apparatus for carrying out the above method, comprising a facing-mould table having displaceable side walls or flaps (hereinafter called flaps) for containing a body of plaster for the first facing and cell walling unit, an assemblage of rubber or like deformable hollow plugs having keying formations on their exterior, for moulding the cell walling in one with the facing plaster, a vertically movable framing in which the plugs are mounted in spaced relation to provide cell-wall moulding clearances whereby the plugs are immersed in the plaster of the said facing-mould table, means for contracting the plugs for their withdrawal from the moulded plaster and a second facing-mould table having displaceable flaps whereon the moulded unit is lowered for embedding the cell rims and their keying formations in the second facing plaster.

Each plug is a hollow stout walled body of appropriate form for the moulding of the interior of a cell of chosen shape, which for economic reasons is preferably hexagonal (or a component of a hexagon) such that the moulded cells lie in relation to one another in honeycomb pattern with the walling of each

[Price 3s. 0d.]

cell common to those of several adjacent cells. The plugs may be prisms; it is, however, preferred that the walls thereof should taper externally from the base, or in other words each plug is a steep frustum or a truncated pyramid having an apertured base and a truncation surface parallel to the base, the base corners or other selected part such as the truncation surface, preferably being more readily deformable than the plug walling. Although other cross-sectional shapes, such as rectangular, triangular, polygonal, circular or oval, may be employed for the plugs, the invention will hereinafter be more particularly described with reference to a basically hexagonal form.

On several or each of the plug facets a groove(s) or rib(s) is provided (for moulding the said keying formations) which is disposed in a plane(s) at right-angles or transversely to the plug axis and which preferably dies out at the corners of the figure. This grooving is so positioned axially of the plug such that the outer ends or rims of the cell walling is moulded with complementary or counterpart ribbing or grooving which is adapted to constitute the keying formations which provide the said mechanical bond positively securing the embedded ends or rims of the cells to the second facing. As described hereafter there may be several parallel rows of the ribbing and grooving in order that one set of plugs may be used for moulding panels of different thicknesses.

The deformation of each plug for facilitating their extraction or release from the plaster, is effected by the inward retraction of the plug walling preferably by decreasing the internal hydraulic (i.e. gaseous or liquid) pressure exerted within the hollow plug.

According to one mode, contraction of the plugs is effected by placing the hollow exterior of each plug in communication with a source of vacuum such that the walls or facets of the plug are retracted or rendered concave such as to create clearance between the plug walling and the moulded cell walling.

In order to support the plug facets during the moulding process against the pressure of the plaster, and also to render the truncation surface convex to ensure the expulsion of air from beneath the truncation region during moulding, the plug interiors are placed under a suitable superatmospheric pressure before or as the plugs are immersed in the plaster, the pressure being thereafter released.

Means are provided for releasing air which would otherwise be trapped in the cells during the moulding of the second facing onto the cell rims.

In the accompanying drawings which illustrate a suitable mode of carrying the invention into effect:—

Figure 1 is an isometric view of one form of the improved double faced panel in which a portion of the second facing of the panel is removed to show the interior hexagonal cellular formation.

Figure 2 is an isometric enlargement of a fragment of the cell walling and facings seen in Figure 1.

Figures 3, 4 and 5 are respectively a plan, a section and an outside elevation of a hexagonal rubber cell-forming plug with key forming grooves, a battery or assemblage of which is employed for moulding the cell walling with corresponding keys.

Figures 6, 7 and 8 are respectively a plan, an outside elevation and a sectional elevation of a half hexagonal plug for moulding certain of the cells at the edge of a panel.

Figure 9 is a plan view of a fragmentary cell suitable for use in moulding the end cells of certain panels.

Figure 10 is a fragmentary outside elevation of a standard or an axially longer form of plug suitable for moulding a larger range of panels of different thicknesses in which for thinner panels the keying formations on the plug are projecting ribs while for the thicker panels the plug is provided with key-forming grooves.

Figure 11 is a plan view of an assembly of plugs in a framework unit for moulding a facing and cell-forming walling for a panel, simultaneously and in one with one another.

Figure 12 is a view of the plug assemblage and framework in which a portion at the left-hand side of the drawing is shown in outside elevation and the remainder is shown in longitudinal section of Figure 11. In this figure the plugs are shown as in position on a mould table for moulding the first facing and cell walls but with the plaster omitted.

Figure 13 is a transverse section taken on the line 13—13 of Figure 11 but with plaster shown in position.

Figure 14 is an isometric view of a mould table suitable for use in moulding the first facing cell-forming wall and edges or margins of a panel.

Figures 15 and 16 are sectional views illustrating the moulding of a second facing to the cell walls of an element of which the first facing and cell walls are shown in the first facing-mould inverted for the second moulding operation. Figure 15 illustrating a relatively thin double faced panel while Figure 16 illustrates a similar but thicker double faced panel.

Describing in detail an example of the double faced panel made according to the invention (see Figures 1 and 2 and Figures 15 and 16, in which latter figures the panel is seen in cross-section in the moulds), a facing *a* of plaster is moulded in one and simultaneously with hexagonal cell walling *b*. The cell b^1 of the main area of the panel are full hexagons while those b^2 at the ends of the panel are fragmentary hexagons formed by plugs A^2 such as shown in Figure 9. At the sides of the panel full hexagonal cells b^1 alternate with half hexagonal cells b^3 formed by plugs A^1 as seen in

Figures 6, 7 and 8. The cell walling at the ends and side edges of the panel merge into and are bounded by peripheral or edge walling *c* which is moulded with a recessed exterior channel. The cell walling tapers steeply from the bottom of the cells towards the rim thereof. The lateral portion of the cell walling adjacent the rim of the cells has ribbing *d* moulded thereon which is embedded in and keys and provides a mechanical bond with the plaster of a second facing *e*, so that in addition to the adhesion of the plaster, the rim of the cell walling is mechanically jointed with the plaster of said facing. In Figure 16 a thicker panel is seen in the moulds than in Figure 15 and in this case there are a series of ribs *d* on the cell walling which do not come into contact with the plaster in this particular instance.

In certain cases as described hereinafter the keying adjacent the rims of the cells may take the form of grooves instead of ribs.

The cell walling is moulded with apertures *f* so that there is free communication between one cell and another to allow air to escape (ultimately to atmosphere) when the cell walling is being pressed into the plaster of the second facing *e* during a second moulding operation. The bottoms of the cells, that is to say the interior surface of the facing *a* within the cell cavities are dished or slightly concave as produced in the first moulding operation described hereinafter.

The plaster forming the facing *a* and the cell walling *b* is homogeneous throughout while the plaster of the facing *e* may be different from the plaster used for the cell walling and this facing is secured mechanically to the cell walling by keying the cell rims in said facing.

The panels are preferably moulded in lengths suitable for room height to extend from floor to ceiling and for such purpose sets may be moulded in 8 ft., 9 ft. or 10 ft. lengths. If units are to be used in bonded horizontal courses the dimension will be chosen for convenient handling and erection. The width of the panels is conveniently 2 ft. although it will be obvious that panels may be made in other chosen widths, and it may be desirable to mould panels of a width equal to the full length of a wall or partition of some fraction (such as a half) of such length. Panels may also be moulded which include gaps or openings for windows, doors and the like, by an appropriate assembly of plugs in suitable framing and corresponding mould tables.

In carrying the invention into effect according to one mode described, by way of example, for the manufacture of gypsum plaster panel units comprising double facings with cells of regular hexagonal shape extending therebetween the keyed in one of the facings, a series of rubber plugs A (Figures 3, 4 and 5) are moulded for assembly in a framework having the general reference B (Figures 11, 12, 13) for use (as herinafter described) in conjunction with a first facing-mould table C (Figure 14) for forming one facing in monolithic integrity with the cell forming walls, a second facing-mould table D (Figures 15 and 16) being provided for forming the second facing integrally on the ends of the cell walls and mechanically keyed thereto.

Each plug A for the main area of the panel unit is moulded of a sufficiently pliable rubber to enable it to be deformed or distorted by suit- differences of air pressure internally applied. The shape of the plug is that of a steep frustum or truncated pyramid having a regular hexagonal base and is in cup-like form to afford a hollow interior 1, the truncation surface 2 being the bottom of the cup whilst a rim 3 thereof is flanged to receive a base closure plate 4 secured to the rubber in an airtight manner. The facet walls 5 of the plug may be made sufficiently stout to withstand the pressure of the plaster when the plug is immersed therein without the assistance of air at superatmospheric pressure introduced into the interior of the plug but it is preferred to use a slight supporting air pressure. In the region of the plane determined for the outward extremity of the cell walls to be moulded, the facets of the plug are formed with grooves 5*a* which become shallower and die out at the corners of the hexagonal form as at 6. Where a standardised plug structure is intended for moulding panels of different thicknesses (i.e. with cell walling of lesser or greater axial extent), a series of grooves of the above character, such as 5*b*, 5*c* and 5*d*, are spaced parallel to one another so that for each thickness of panel to be moulded, grooving is available at the outward margins or rims of the cells for moulding the required keying ribbing thereon. While for the thicker panels or thicker faced panels several grooves, in addition to the marginal grooves, may come into the moulding operation in succession as the plugs become more deeply immersed in the plaster, only the ribbing near the marginal rim of the cell walling may be utilised for keying with the plaster of the second facing as hereinafter described.

The grooves are preferably of buttress tooth form as seen in the drawings or they may be of semi-circular or other cross-section. The facets 5 of the pyramid are moulded in one with the truncation surface 2 which may be made somewhat thinner or thicker than the facet walls of the plug. The relative dimensioning of the thickness of the facets and the truncation surface will depend on the relative areas exposed to the air pressure, as it is the intention that when air pressure is employed before or during the immersion of the plug it shall have a preferential effect on the truncation surface so as to cause it to become convex in order to drive out air which might otherwise be trapped beneath the truncation surface, when such contacts with the plaster.

On selected facets, for example on a pair of

opposite facets of the hexagon, ribs or projections 3 are moulded extending axially from the base of the figure. These projections are of wedge shape both laterally and longitudinally (as seen in Figures 3 and 5), the longitudinal wedge form increasing in cross-section in the direction of the truncation due to taper of the frustum. The side 7*a* of the projections 7 are preferably bevelled.

According to one suitable mode of closing the base of the pyramid, it may have a shoulder 3*a* adjoining the neck flange 3 to receive the the rim of the closure plate 4, the neck being sealed to the plate adhesively, by bonding or by pressure exerted mechanically as by a metal contractible strap 3*b* of known type. Alternatively, the base may be provided with a closure surface or member in any appropriate manner. Each closure is provided with a pair of rods 8, tapped into holes in the plate 4, adapted to form suspensory supports for the plugs in a framework described below. These rods are tubular having bores 8*a* so that they may be employed as air ducts as well as securing means, for which latter purpose they are provided with screwthreaded portions 8*b* but for convenience in making suspensory adjustments of the plugs in the framework, it may be preferred to provide separate air ducts which may be in the form of a pipe or pipes communicating with the plug interior through the base closure. In either case the rods or pipes serve as conduits for varying the air pressure within the plug by supplying air under pressure and for evacuating the interior of the plug.

Although it is preferred to make the cell-forming plugs of rubber, they may be formed of a synthetic composition such as neoprene or other pliable and resilient resin, and the flaps (described hereinafter) of the facing-moulds may be lined with a material such as polyvinyl chloride or polythene, to prevent sticking and avoid the application of grease or the like.

The rubber or other composition of which the plugs are mainly composed may be reinformed or lined with canvas or other fabric in a manner which will not interfere with their deformation or collapsing in the described manner

Plugs having the above characteristics are mounted in the framework described below for the main area of the units but for the sides of the units and at both ends special plugs which are half or a fragment of a hexagon are provided. For example, for the longer sides of the panel unit plugs A^1 (as shown in Figures 6, 7 and 8) of half hexagon shape are employed. Each of such plugs has the division taking place across the diagonal between corner and corner while the fractional plugs A^2 (see Figure 9) for the ends of a panel may be divided by a line at right-angles to a pair of parallel facets. These fractional plugs otherwise have the same characteristics and accessories as the full hexagon plugs and the same reference numerals are applied to corresponding parts.

The plugs may be made in any suitable size, a convenient width being $5\frac{1}{4}$ inches taken between parallel facets at the truncation end and $5\frac{5}{8}$ inches at the base of the pyramidal form, affording a suitably small angle of taper. The axial length of a plug may be somewhat more than 2 inches, 3 inches, 4 inches or in some cases 6 inches, or other suitable chosen dimensions, according to the thickness of the units to be moulded. It will be appreciated that if a universal plug is to be provided for moulding panels of different thicknesses, a certain limitation will exist owing to the fact that if very long plugs are used the cell walling at its base will have to be thicker than is desirable to ensure an adequate thickness of plaster at the outer end or rim of the cell walling.

The plugs shown in Figures 3—9 are suitable for moulding panels from, say, 2 inches up to about 4 inches thick (including the facings) and are provided with groovings 5*a*—5*d* for the particular axial extent of the cell walling to be moulded for the panels of the different thicknesses.

In order to provide a standard plug (see Figure 8) capable of moulding a panel from 2 inches to about 6 inches thick, the degree of the taper of the frustum is decreased in order that in moulding the cell wallings of greater axial extent, the thickness of the said walling at its base or root shall not be too thick, with the plugs spaced in relation to one another to mould the rims of the cells of sufficient thickness to be of adequate strength.

Furthermore, it will be appreciated that when moulding the cell walling with keying for a 2-inch thick panel the moulding of keys in the form of ribs on said walling may cause the truncation corner or lower part of the plug to foul or mar the ribbing in the withdrawal of the plugs from the plaster.

In order to obviate any trouble of the above kind, a modification (see Figure 10) of the keying form is made: each plug is grooved as at 5*b*, 5*c*, 5*d*, respectively for the thicker panels; the plugs are moulded with ribs 5*e*, 5*f*, respectively, for moulding 2-inch and $2\frac{3}{4}$-inch thick panels and preferably with ribs 5*g* and 5*h* for panels 3 inches and $3\frac{1}{4}$ inches thick, respectively. These ribs on the plug produce counterpart keying grooves (instead of ribs) on the cell walling when moulded and hence are sunk in relation to the plug surface and out of the path thereof during the withdrawal of the more steeply tapered plug when the facets are contracted by the reduced air pressure.

The plugs are disposed in spaced relation to one another such as to leave an adequate clearance between the exterior periphery thereof at their bases when in the moulding position for moulding the rims of the cell walling of suitable thickness. The taper form of each plug causes the walling of each cell to be moulded

of corresponding taper decreasing in thickness towards the outer end or rim of the cells of the element formed in the first moulding operation, resulting in one facing and open-ended cells.

The appropriate number of plugs A, A^1, A^2 for moulding a panel are assembled and mounted on a plate or in a spider or framework B comprising stout bars 9 (Figures 11, 12 and 13) disposed transversely of the length of the panel to be moulded, welded to longitudinal angle bars 10 and 10*a*. The plugs A are hung from the bars 9 and the plugs A^1 from short extensions 9*a* welded to the bars 9. The longitudinals 10 also support vertically depending members, such as channels 11, carrying hinged guide members 12 adapted to serve for registering with the sides or flaps of a first mould table. Similar vertical channels 11 are mounted at the ends of the framework and each vertical channel (see Figure 12) also serves as a mounting for an adjustable foot 11*a* which acts as a stop bearing upon a ledge on the sides of the mould table (described below) to limit the depth to which the plugs are immersed in the plaster according to the thickness of panel being moulded. This foot is vertically slidable in the channel and is secured by a bolted connection 11*b* affording facility for vertical adjustment.

The guide members comprise a pair of depending plates 12 pivoted at 12*a* (see Figure 13) and having a pair of transverse rollers 12*b* for engaging the outer portion of the adjacent flaps of the mould table. A pair of bell crank levers 15 pivoted at 15*a* and terminating in cam noses 15*b* are connected together by bars 15*c*. In the position shown in the drawing the cams 15*b* thrust the rollers 12*b* into the engaging position while when the levers are turned downward through 90°, the plates 12 are free to move away from the engaging position. The side and end vertical channels 11 themselves may be adjustably bolted in position and in the latter case the bolts pass through a packing block 11*c*.

The frameword end members, such as angle irons 13, are connected to the ends of the longitudinals 10, and the irons 13 are coupled to small subsidiary frames 14 for convenience in mounting the fragmentary plugs A^2 or for making up panels of a different length. The longitudinal members 10 are connectible to lifting mechanism or hoists (not shown) by hooks which are attached through holes 10*b*, for raising and allowing the plug framework to be lowered for immersion of the plugs in the plaster of the mould table. The vertically controlling mechanism or hoists for the plug framework may be mounted on carriages traversable on rails for displacing the framework and plugs as a whole horizontally in mutually perpendicular or other directions for the purpose of positioning the plugs over the mould table (or successive mould tables) and mechanism may be included for inverting the first mould table and the moulded plaster preparatory to the second moulding operation.

The plugs are connected together pneumatically in any suitable manner to afford the equal and simultaneous distribution of the air pressure effects which are applied through a header pipe 16 which extends longitudinally over the flange of the central angle iron 10*a* to which the header is attached at intervals by clips 17. The header is alternatively connectible by suitable three-way valve means to a source of compressed air and a course of evacuation (not shown in the drawings). The tubular rods 8 of the plugs have connected to them flexible pipes 18 of rubber or the like which connect a rod 8 of one plug with a rod 8 of an adjacent plug. For convenience in distributing the pneumatic pressure the plugs may be served in groups by flexible connections 18*a* from the header 16. In the plan view in Figure 11 the the arrows at the right hand side of the figure indicate a suitable intercommunicating grouping which includes some of the full hexagonal and fragmentary hexagonal plugs A, A^1, A^2.

The mould table C (see Figures 12, 13, 14), for the first moulding operation to form the cell walling in one with a facing and marginal walls or edges for a panel, comprises a bottom plate 19 of suitable rigidity or made rigid by the addition of reinforcement, or the bottom plate 19 may be of composite form comprising a pair of plates united by webs 19*a* as seen in Figure 13. The side and end margins of this plate or table have hingedly secured thereto flaps 20, the hinging at 20*a* being convenient for displacing them outwardly to release the unit at the appropriate stage in the formation thereof. The form of the hinge adjacent the pivotal axis affords stop means to limit the outward and inward hinging movement of the flaps, stops for the inward position being adapted to ensure the vertical disposal of the flaps in the moulding position. Each flap is formed with a projecting ledge 20*b* which serves as an abutment for contact with the feet 11*a* of the vertical side and end channels 11 on the plug assembly framework B (see, for example, Figure 13). The mating corners of the flaps may be mitred and rebated to secure a plaster-tight joint and the flaps at their corners are secured by tightening clamps or clips 21 of any suitable kind.

The inward sides of the flaps are provided with broad ribs or like forms 20*c* extending horizontally for moulding grooves in the outer edges or margins of the panel unit and this ribbing may be contoured to mould a channel extending into a deeper channel in the central zone of said edges. This ribbing and the corresponding moulded channels are for the purpose of forming elongated continuous cavities when moulded units are placed edge to edge for building purposes, in order that plaster or cement grouting may be poured into the cavi-

ties formed by the mated vertical channels. The ribbing also serves as a means for engaging the peripheral edges of the panel for holding it when subsequent inversion takes place.

The ribbing or internal surface of the side flaps of the first facing-mould may be made interchangeable, or side flaps themselves may be interchangeable for moulding different thicknesses of panel or changing the peripheral configuration of the edges of such element or unit. According to one mode of providing for interchangeability the hinge formation may be such that hinging knuckles are provided of a kind which may be readily detached or the arrangement may be such that the hinge may be released by withdrawing the hinge pin. Alternatively separate mould tables may be made for the different thicknesses of panels to be moulded or for the different forms of contour required for the margins or edges of the panels. The exterior of the flaps 20 is formed with a longitudinal shoulder 20*d* which acts as a stop when lowering the mould table C in the second moulding operation.

Holes 22 are formed in the end flaps 20 for allowing the escape of air from the cells during the second moulding operation. During the first moulding operation these holes are stopped with suitable extractable pins.

The mould D for the second facing employed in the second moulding operation is similar to the first mould table C described with the exception that the side and end flaps 23 (see Figures 15 and 16) hinged to the bottom plate 19 have plain interior and exterior surfaces and are designed to lie outside the flaps 20 of the first mould table in the second moulding operation, the arrangement being such that the outer part of the flaps 20 slide vertically against the inner face of the flaps 23. The vertical height of the flaps 23 will depend upon the thickness of the panel to be moulded and will agree with the dimensions of the flaps 20 of the first mould table. The upper edge of the flaps 23 operate as abutments for engaging the stop shoulders 20*d* of the flaps 20 of the first mould table to determine the downward position when lowering it upon the second mould table.

The plate surface area of both or either mould tables may be plain or formed with ornamental relief or intaglio forms or with supplemental ribbing or grooving in order to form on the outside of one or both faces keying elements to which a Portland cement or quick-setting cement or conposition of harder or different characteristics from that of the plaster may be moulded in order to render the units suitable for the outer walls of building or for other purposes.

During the moulding operations high frequency or other vibrations may be imparted to the first mould table or to both tables or to the plug supporting framework B, and it is preferred to employ a rectilinear vibration or one confined to a plane parallel to the facing.

In moulding a panel the process of moulding the cell walling *b* (Figure 1) in conjunction with the first facing *a* is as follows:—

The plugs A, A^1, A^2 assembled and secured in the framework B (Figures 11, 12, 13) are moved the correct vertical position over mould table C for the first moulding operation. When once the plugs have been mounted in the framework at the correct vertical height for a unit of predetermined dimensions they remain fixed but in order to accommodate any irregularities in the flow or displacement of the plaster owing to differences in the moulding action of the plugs, certain of the plugs may be readjusted to accommodate such variations.

The facing-mould table C with the marginal flaps 20 in position is charged with plaster which is sufficiently liquid to enable it to rise in the clearances between the plugs when they are immersed in the plaster, the quantity of plaster being predetermined such that the plaster will rise to the edge of the flaps.

Compressed air is admitted to all the plugs under sufficient pressure laterally to support the faces of the plugs against the pressure of the plaster and cause the truncation surface 2 thereof to become slightly outwardly dished or convex.

The plug framework B is then lowered, being guided by the rollered plates 12 which are locked by depressing the cam levers 15, until the truncation surface of the plugs touches the plaster level, after which the plugs are allowed to sink into the plaster under gravity action (or under applied pressure) while vibration is applied to the mould to facilitate the flow and displacement of the plaster and to avoid the occlusion of air. Instead of initially introducing compressed air, it may be admitted as the plugs are about to or after they contact the plaster. The plugs sink by gravity action into the plaster until the feet 11*a* of the vertical channels 11 rest upon the ledges 20*b* of the mould flaps 20 and further downward movement is arrested.

In Figure 12 the mould table C is appropriate for moulding a panel of a thickness involving the second series of grooving on the plugs counting upwardly from the truncation surface while in Figure 13 the mould table C is appropriate for a panel of a thickness involving all the grooving on the plugs (as for a panel about 4 inches thick).

The vertical wedge-shaped projections *j* on the plugs will mould the notches or slots *f* (see Figure 2) in the cell walls so that there is free communication between one cell cavity and another to prevent trapping of air in the second moulding operation described below. While this moulding is taking place, horizontal pins are in position in the holes in the end flaps 20 of the facing-mould C and upon withdrawal

of these pins after the plaster has set, corresponding air passages will be formed for communication with atmosphere, which will enable air to escape from all the intercommunicating cell cavities during said second moulding operation.

A period is then allowed for the plaster to set, after which the compressed air is released, enabling the convex truncation surfaces of the plugs to retract or tend to retract to their normal position. Upon the escape of compressed air, connection is made with the evacuating source and the air pressure within the cells is reduced to about 6 inches mercury pressure for example, that is to say to an extent which will render the facets of the plugs to be drawn inwards and assume a concave form, thereby releasing the moulding contact of the facets with the plaster and allowing the plugs to be withdrawn by lifting the framework B, such withdrawal taking place clear of the ribbing formed on the internal surface of the plaster walling defined the cell cavities. This leaves the moulded plaster in position in the first mould table C ready for the second moulding operation (see Figures 15 and 16).

Assuming the hinged walls of the second mould D to have been erected and its mould plate 19 charged with sufficient plaster to form the second facing *e* of chosen thickness, the plaster element first moulded, together with the first facing-mould C, still in position around it it inverted and registered over the second table D so that the flaps 20 may be slid down inside the flaps 23. The pins sealing the holes 22 in the end flaps of the table C are removed and it, together with the plaster moulding, is lowered (by machinery or by hand) until the cell walling rims contact with and enter the charged plaster. The element is allowed to settle under gravity (or pressure) aided by vibration, to the predetermined position whereat it is arrested by the contact of stop shoulder 20*d* with the top edge of the flaps 23. This position is calculated so that the plaster of the facing rises sufficiently to envelope at least one of the key-forming ribbings *d* of the cell walling (as shown in the two examples illustrated in Figures 15 and 16) so that not only is the plaster of the second facing adhesively united with the plaster of the first element but is mechanically keyed thereto by the embedding of the ribbing formation. The intercommunication of the cells through the apertures *f* (Figures 1 and 2) and the escape or vent holes 22 (Figure 11) prevent air being entrapped in the cell and so obstructing the embedding of the cell rim in the second facing plaster. The apertures *f* and holes 22 may also be utilised as a means for circulating drying air through the structure during or after moulding.

After the plaster has set, the walling flaps 20 of both mould tables are released at the clips 21 and hinged outwardly, the first facing-mould C is lifted off and the completed unit detached from the plate surface of the second mould D.

In the above described mode of carrying the invention into effect, full hexagon plugs have been described for the main cells and the use of half or fractional cells for the marginal or corner portions. It is to be understood that all the cells may, if desired, be moulded in half hexagonal (or other fractional) forms by the use of plugs of corresponding shape, each half plug having its diagonal (or radial) facet spaced from the complementary plugs such that the unit is provided with rectilinear aligned cell walls arranged either lengthwise or transversely of the unit or with the cell walls disposed according to a predetermined pattern.

The plaster employed for either or both moulding operations may be used plain or mingled with reinforcing vegetable or mineral fibres of a length such as will not interfere with the flow of the plaster and, if desired, foamed plaster may be employed for the cell walling and either or both facings; also for certain purposes it may be suitable to charge the cells when formed with foamed plaster, instead of leaving them hollow.

The rims of the cells after the first moulding operation may be dipped in a mastic, bitumen or suitable coating composition adjacent the keying grooves, and have moulded onto these rims a facing of concrete or like moulding composition, adapting the unit to present a surface suitable for exterior use or for special purposes from which damp will not seep through to the inner facing.

According to a modification the second facing may be moulded of a plaster or concrete combined with a bitumen emulsion or other waterproofing composition so that the facing as a whole is impervious to water. Furthermore, reinforcement for the facings may be provided in the form of embedded wires or wire netting by embedding such in the plaster which forms the first facing layer in the appropriate position to avoid interference with the rising of the plaster in the wall moulding clearances. For the second facing the wires or wire netting may be extended below and across the edges of the cells and forced down into the plaster during the second moulding operation. Similarly open mesh vegetable fabric or fibres may be introduced into the facings as reinforcement.

In our Patent Application No. 8620/1955, (Serial No. 748,749) divided from the present Application, is claimed a method and apparatus for moulding a single-faced panel simultaneously with cell-forming walls projecting therefrom.

What we claim is:—

1. A prefabricated polycellular double-faced panel of the type described characterised in that one of the pair of facings is moulded in one with the cell-forming walling which is provided with keying formations thereon and that

of these pins after the plaster has set, corresponding air passages will be formed for communication with atmosphere, which will enable air to escape from all the intercommunicating cell cavities during said second moulding operation.

A period is then allowed for the plaster to set, after which the compressed air is released, enabling the convex truncation surfaces of the plugs to retract or tend to retract to their normal position. Upon the escape of compressed air, connection is made with the evacuating source and the air pressure within the cells is reduced to about 6 inches mercury pressure for example, that is to say to an extent which will render the facets of the plugs to be drawn inwards and assume a concave form, thereby releasing the moulding contact of the facets with the plaster and allowing the plugs to be withdrawn by lifting the framework B, such withdrawal taking place clear of the ribbing formed on the internal surface of the plaster walling defined the cell cavities. This leaves the moulded plaster in position in the first mould table C ready for the second moulding operation (see Figures 15 and 16).

Assuming the hinged walls of the second mould D to have been erected and its mould plate 19 charged with sufficient plaster to form the second facing *e* of chosen thickness, the plaster element first moulded, together with the first facing-mould C, still in position around it it inverted and registered over the second table D so that the flaps 20 may be slid down inside the flaps 23. The pins sealing the holes 22 in the end flaps of the table C are removed and it, together with the plaster moulding, is lowered (by machinery or by hand) until the cell walling rims contact with and enter the charged plaster. The element is allowed to settle under gravity (or pressure) aided by vibration, to the predetermined position whereat it is arrested by the contact of stop shoulder 20*d* with the top edge of the flaps 23. This position is calculated so that the plaster of the facing rises sufficiently to envelope at least one of the key-forming ribbings *d* of the cell walling (as shown in the two examples illustrated in Figures 15 and 16) so that not only is the plaster of the second facing adhesively united with the plaster of the first element but is mechanically keyed thereto by the embedding of the ribbing formation. The intercommunication of the cells through the apertures *f* (Figures 1 and 2) and the escape or vent holes 22 (Figure 11) prevent air being entrapped in the cell and so obstructing the embedding of the cell rim in the second facing plaster. The apertures *f* and holes 22 may also be utilised as a means for circulating drying air through the structure during or after moulding.

After the plaster has set, the walling flaps 20 of both mould tables are released at the clips 21 and hinged outwardly, the first facing-mould C is lifted off and the completed unit detached from the plate surface of the second mould D.

In the above described mode of carrying the invention into effect, full hexagon plugs have been described for the main cells and the use of half or fractional cells for the marginal or corner portions. It is to be understood that all the cells may, if desired, be moulded in half hexagonal (or other fractional) forms by the use of plugs of corresponding shape, each half plug having its diagonal (or radial) facet spaced from the complementary plugs such that the unit is provided with rectilinear aligned cell walls arranged either lengthwise or transversely of the unit or with the cell walls disposed according to a predetermined pattern.

The plaster employed for either or both moulding operations may be used plain or mingled with reinforcing vegetable or mineral fibres of a length such as will not interfere with the flow of the plaster and, if desired, foamed plaster may be employed for the cell walling and either or both facings; also for certain purposes it may be suitable to charge the cells when formed with foamed plaster, instead of leaving them hollow.

The rims of the cells after the first moulding operation may be dipped in a mastic, bitumen or suitable coating composition adjacent the keying grooves, and have moulded onto these rims a facing of concrete or like moulding composition, adapting the unit to present a surface suitable for exterior use or for special purposes from which damp will not seep through to the inner facing.

According to a modification the second facing may be moulded of a plaster or concrete combined with a bitumen emulsion or other waterproofing composition so that the facing as a whole is impervious to water. Furthermore, reinforcement for the facings may be provided in the form of embedded wires or wire netting by embedding such in the plaster which forms the first facing layer in the appropriate position to avoid interference with the rising of the plaster in the wall moulding clearances. For the second facing the wires or wire netting may be extended below and across the edges of the cells and forced down into the plaster during the second moulding operation. Similarly open mesh vegetable fabric or fibres may be introduced into the facings as reinforcement.

In our Patent Application No. 8620/1955, (Serial No. 748,749) divided from the present Application, is claimed a method and apparatus for moulding a single-faced panel simultaneously with cell-forming walls projecting therefrom.

What we claim is:—

1. A prefabricated polycellular double-faced panel of the type described characterised in that one of the pair of facings is moulded in one with the cell-forming walling which is provided with keying formations thereon and that

the second facing of the pair is secured to said walling by having the cell rims and keying formations embedded in the second facing.

2. A panel as claimed in Claim 1 characterised in that the first-mentioned facing and cell-forming walling are in one with plaster edges bounding the margins of the panel and moulded on their outward side with channels and preferably on the inward side with keying formations.

3. A panel as claimed in Claim 2 characterised in that the cell-forming walling has apertures establishing communication between one cell and another, and the said edges of the panel have vent holes.

4. A panel as claimed in Claim 1, 2 or 3, characterised in that the interiors of the cells have concave bottoms.

5. A panel as claimed in any of the preceding claims characterised in that the plaster of the second facing includes a waterproofing composition.

6. A panel as claimed in any of the preceding claims characterised in that the rims of the cells are coated at least to the extent to which they are embedded in the paster of the second facing with a waterproofing composition.

7. A method of making a panel as claimed in any of the preceding claims comprising moulding the first facing in one with the cell-forming walling and edges at the margins of the panel by immersing in a contained body of plaster an assemblage of hollow deformable rubber or like plugs having key moulding means on their exterior, the plugs being arranged in spaced relationship to provide cell-forming wall clearances, allowing the plaster to set sufficiently, contracting the plugs to free them from the moulded plaster, withdrawing the assemblage of plugs, inverting the moulded structure and immersing the cell rims to submerge the keying formation thereon in a second contained body of plaster to form the second facing mechanically united to the cell walling by the said keying formation and freeing the completed double-faced panel from the containing means.

8. A method as claimed in Claim 7 characterised by moulding apertures in the cell-forming walling to establish communication between the cells and moulding vent holes in the said panel edges such that air may escape from the cells to atmosphere when the second facing is being moulded onto the cell rims.

9. A method as claimed in Claim 7 or 8 characterised in that the step of contracting the plugs is effected by placing such in communication with an evacuating source.

10. A method as claimed in Claim 7, 8 or 9 characterised in this that before or during the immersion of the plugs in the contained plaster for moulding the first-mentioned facing with the cell-forming walling, the interior of the plugs is subjected to superatmospheric pressure to afford support to the walling of the plugs against the pressure of the plaster and preferably also to expel air which might be trapped in the cells under the plugs by rendering the outer ends of the plugs convex, the pressure being subsequently released, and followed by placing the plugs in communication with an evacuating source to contract the plugs preparatory to their withdrawal from the plaster.

11. Apparatus for carrying out the method claimed in any of the claims 7 to 10 comprising a vertically displaceable framework, a series of hollow deformable rubber or like plugs having key moulding means on their exterior, assembled in said framework in spaced relationship to afford cell-wall forming clearances, means for contracting the walling of the plugs to facilitate their withdrawal from the moulded structure, a first facing mould table having displaceable side flaps for containing a body of plaster wherein the plugs are to be immersed for the moulding of the first facing and cell-forming walling and a second facing mould table having displaceable side flaps for containing plaster for the second facing upon which the said moulded structure is inverted for the immersion of the cell-rims and their keying formations to embed them in the second facing plaster.

12. Apparatus as claimed in Claim 11 wherein the said flaps of the first mould table have ribs on their inward side to mould channels in the edges at the margins of the first facing and cell-walling unit.

13. Apparatus as claimed in Claim 11 and having means for guiding the plug framing over the first mould table during the immersion of the plugs and stop means, preferably, adjustable, for determining the depth of immersion of the plugs in the plaster.

14. Apparatus as claimed in Claim 13 and having stop means for determining the depth of immersion of the rims of cells and their keying formations in the plaster of the second facing.

15. Apparatus as claimed in Claim 11 wherein the means associated with the hollow plugs for contracting them comprise tubular connections between the plug interiors and header piping for distributing variations of hydraulic pressure to said plugs through the tubular connections.

16. Apparatus as claimed in Claim 15 wherein each plugs has a pair of tubular connections which are arranged to establish hydraulic communication between various plugs such that pressure throughout the series of plugs may be substantially simultaneously and equally as variations in pressure takes place in the header piping.

17. Apparatus as claimed in any of the Claims 11 to 16 characterised in that the plugs each have projections formed on their exterior and extending axially from the base thereof for moulding intercommunication apertures in the

* C L M S *

cell-walling and that means, such as removable pins in the flaps, are provided for moulding vent holes in the edges at the margins of the panel.

18. Apparatus as claimed in any of the Claims 11 to 17 wherein the key-forming means on each plug comprises groovings or ribbing on the exterior surface disposed at right-angles to the plug axis for moulding corresponding keying ribbing or grooving on the cell rims.

19. Apparatus as claimed in Claim 18 wherein each plug exterior has a number of parallel grooves or ribs spaced to accord with the different thickness range of panels to be moulded from said plugs to mould counterpart ribs or grooves on the cell rims for panels of different thickness.

20. Apparatus as claimed in Claim 18 or 19 wherein the plugs are tapered and of an axial length for moulding a range of thicknesses of panels (from, say, 2" to 6" thick) the angle of the paper being proportioned to mould cell walling at its root or base of about ½ inch in thickness and at the rim or not substantially less than 1/8th inch in thickness and wherein the key moulding means on the plugs includes grooving and ribbing to form counterpart ribs or grooves on the cell rims according to the axial extent of the cell walling.

21. Apparatus as claimed in Claim 18, 19 or 20, wherein the plugs are in the form of a polygonal (preferably hexagonal) frustum having on their external facets the said grooving or ribbing in a form which dies out at the corners of the frustum.

22. Apparatus for mounting polycellular double-faced panels as claimed in Claim 1 comprising rubber or like plugs substantially as described with reference to Figures 3 to 9 or Figures 10 of the accompanying drawings.

23. Apparatus for moulding polycellular double-faced panels as claimed in Claim 1 comprising a framework, plug assemblage, piping connection and mould tables, substantially as described with reference to Figures 11 to 15 of the accompanying drawings.

24. A prefabricated polycellular double-faced panel substantially as described with reference to Figures 1 and 2 of the accompanying drawings or as moulded by the aid of plugs substantially as described with reference to Figure 10 of the accompanying drawings.

MARKS & CLERK.

PROVISIONAL SPECIFICATION

Improvements in and relating to Building Units for example Panels or Slabs of Gypsum Plaster or other Mouldable Material

We, STANLEY HOWARD FLOWER, JOHN PARSONS and NORMAN GREENLEES WEIR LOUDON, all British subjects, and BELLROCK GYPSUM INDUSTRIES LIMITED, British Company, all of the Company's address at 41, London Street, Chertsey, in the County of Surrey, do hereby declare this invention to be described in the following statement:—

This invention relates to building units and to methods and apparatus for manufacturing such units, as for example: panels or slabs of gypsum plaster or other mouldable composition (hereinafter called plaster) with or without fibrous or other reinforcement, and comprising an internal cellular structure or core (the cells of which may be hexagonal) formed with a facing sheet (hereinafter called a facing) on both sides in planes at right-angles to the axes of the cells.

The aim of the present invention is to provide an improved method and apparatus adapted to simplify and expedite the manufacture of units of the above character, the invention being calculated to lend itself to the mass production of units suitable for building constructions, including walling, partitioning, flooring or roofing work, which are capable of bearing substantial loads or of being combined with members adapted to increase the load carrying capacity.

The invention is also directed to the provision of an improved unit characterised by having a pair of facing sheets, one of which is homogeneous with the cell walling and the other of which is mechanically united or keyed to such walling.

The invention consists in moulding a cellular core or structure in one with a facing by the use of a series of rubber or other flexible and deformable plugs of counterpart shape to that of the intended cells and disposed in spaced relationship to one another to constitute the cell walling, the moulding operation being performed by immersing the plugs in plaster to force the plaster into the spaces between the plugs.

The invention also comprises a facing mould table having displaceable side walls, a series of rubber or like distortable core forming plugs for moulding cell walling in one with the said facing, a movable framing or support(s) on which the plugs are mountable in spaced relation, means for immersing the plugs in plaster of the facing mould to form the whole of the cell walling for a unit simultaneously and in one with the facing, and means for distorting or collapsing the plugs for their withdrawal from the plaster after setting.

Each plug is hollow and of appropriate form in plan for the moulding of the interior of a cell of chosen shape, which for economical reasons is preferably hexagonal (or a component of a hexagon) such that the moulded cells lie in relation to one another in honeycomb pattern. The plugs may be prisms or the walling thereof may taper externally from the base,

or in other words the plug may be a steep truncated pyramid having a closing base and a truncation surface, the base corners or other selected parts preferably being more readily deformable than the plug walling or other part. Although other cross-sectional shapes such as rectangular, triangular, polygonal, circular or oval, may be employed for the cells and plugs, the invention will hereinafter be more particularly described with reference to a basically hexagonal form.

The deformation or distortion of each plug for facilitating their extraction or release from the plaster, is effected by retraction of the cross-section of the plug walling by altering internal gaseous or liquid pressure exerted on the plug.

The deformation of the plugs is effected by placing the hollow interior of each plug in communication with a source of vacuum such that the walls or facets of the plug are rendered concave for the purpose of freeing such from the cell walling when moulded. In order to support the plug facets during the moulding process against the pressure of the plaster, and also to render the truncation surface convex to ensure the expulsion of air friom beneath the truncation region during moulding, gas, air or liquid at superatmospheric pressure is preferably introduced into the plug before or as the plug is immersed in the plaster.

A further feature of the deformable plugs lies in the provision on each of the plug facets of a groove(s) or rib(s) which is disposed in a plane(s) at right-angles to the plug axis and which die out at the corners of the figure. It is preferred to shape the ribbing or grooving of buttress tooth form with the more abrupt side uppermost. This grooving (or ribbing) is so located axially of the plug such that the outer ends of the cells are moulded with a corresponding ribbing (or grooving) which is adapted to constitute a mechanical key securing the embedded ends of the cells to a second facing, in addition to the integral union of the plaster.

For use in moulding a second facing to the cell walling by inverting the first formed element and immersing the ends of the cells in plaster, a second facing mould or table is provided. This mould is similar to the first mould but the displaceable side walls are of such depth as to mould the margins of the facing and preferably overlap to a certain extent and enclose the side walls of the first mould or the element first moulded.

Means are provided for releasing air which would otherwise be trapped by the plaster of the second facing in the cells and such means preferably comprise vertically extending projections on the plug facets in selected positions to mould apertures (in the first moulding operation) which afford free communication between cell and cell. Lateral holes are also moulded at suitable positions in the peripheral sides or edges of the first element for the exit of air from the cells to atmosphere during the moulding of the second facing. These escape holes are preferably made by introducing removable horizontal pins in the displaceable walls of the first mould.

The method according to the invention for moulding the first element consists in charging the first facing mould with plaster after the erection of the side walls, lowering the plug spider to immerse the plugs to the desired depth into the plaster with the said plugs under air pressure to cause the plaster to rise between the plugs to form the cell walling integrally with the facing, releasing the air pressure after the plaster has set and applying a vacuum or reduced air pressure to the plugs to cause the plug facets to become concave and withdrawing the plugs by raising the frame and releasing the unit by freeing the side walls of the mould.

To mould the second facing, the element moulded according to the preceding paragraph is inverted, preferably without freeing it from its facing mould and positioned over a second facing mould which also has displaceable side walls. The cell ends are immersed in the plaster of the second mould to embed at least one rib of said cell ends. After the plaster has set the double faced unit is freed by displacing the side walls of both moulds and lifting off the first mould.

In carrying the invention into effect according to one mode described, by way of example, for the manufacture of gypsum plaster panel units (suitable for walling purposes) comprising double facings with cells of regular hexagonal shape extending therebetween, and involving the immersion of the plugs in plaster, a series of rubber plugs are moulded for use in conjunction with a first facing-mould table having displaceable side walls for forming one facing in monolithic integrity with the cell forming walls, a second facing-mould table being provided for forming the second facing integrally on the ends of the cell walls and mechanically keyed thereto.

Each plug for the main area of the unit is moulded of a sufficiently pliable rubber to enable it to be deformed or distorted by suitable differences of air pressure internally applied. The shape of the plug is that of a steep truncated pyramid having a regular hexagonal base and is in cup-like form, the truncation surface being the bottom of the cup whilst the rim thereof is flanged or channelled to receive a base closure plate secured to the rubber in an airtight manner. The facets of the plug are sufficiently stout to withstand the pressure of the plaster when the plug is immersed therein with or without the assistance of air at superatmospheric pressure introduced into the interior of the plug. In the region of the plane determined for the outward extremity of the cell walls, the facets of the plug are formed with grooves which become shallower and die out at the corners of the hexagonal form. Where

the plug structure is intended for moulding panels of different thicknesses, a series of grooves of the above character are spaced parallel to one another at right-angles to the plug axes so that for each thickness of panel to be moulded a groove is provided at the outward margin or rims of the cells while for the thicker panels several grooves, in addition to the marginal groove, are provided which come into use in succession for the progessively thinner panels of the range for which the plugs can be used. The grooves may be of semi-circular cross-section or be formed with their sides bevelled. The facets of the pyramid are moulded in one with the truncation surface which may be made, if desired, somewhat thinner than the facet walls of the plug or be made with a slightly convex exterior surface, in either case the intention being that when air pressure is employed before or during the immersion of the plug in plaster, the truncation surface will become convex or increase its convexity in order to drive out air which might otherwise be trapped beneath the truncation surface, when such contacts with the plaster.

On selected facets, for example on parallel opposite facets of the hexagon, vertically edged, axially extending ribs are moulded which are of wedge shape both laterally and longitudinally, the longitudinal wedge form increasing in cross-section in the direction of the truncation due to taper of the pyramid.

According to one suitable mode of closing the base of the pyramid, it may be provided with a short circular neck portion which is inwardly channelled or flanged to receive a correspondingly shaped closure plate, the neck being sealed to the plate adhesively or by pressure exerted by a metal contractible strap of known type. Alternatively, the base may be provided with a closure surface or member in an appropriate manner. Each of the closures is provided with a pair of rods adapted to form suspensory supports for the plugs in a framework or spider described below. These rods may be tubular or semi-tubular to decrease their weight. Tubular rods may be employed as air ducts but for convenience in making adjustments of the plugs, it is preferred to provide separate air ducts which may be in the form of a pipe or pipes traversing the base closure of each plug, through which the air pressure within the plug may be varied by supplying compressed air or evacuating the interior of the plug.

Plugs having the above characteristics are provided for the main area of the units but for the sides of the units and at one or both ends special plugs which are half or a fragment of a hexagon are provided, when it is not desired to form the unit with a whole number of complete hexagonal cells. For example, for the longer sides of the panel unit plugs of half hexagon shape are employed, the division taking place across diagonals between corner and corner while the fractional plugs at the end or ends of a panel may be divided by a line at right-angles to a pair of parallel facets. These fractional plugs otherwise have the same characteristics and accessories as the full hexagon plugs.

The panels are preferably moulded in lengths suitable for room height to extend from floor to ceiling and for such purpose sets may be moulded in 8 ft., 9 ft. or 10 ft. lengths. If units are to be used in bonded horizontal courses the dimension will be chosen for convenient handling and erection. The width of the panels is conveniently 2ft. although it will be obvious that panels may be made in other chosen widths, if desired.

The plugs may be made in any suitable size, a convenient size being 5¼ inches taken between parallel facets at the truncation end and 5⅝ inches at the base of the pyramidal form. The axial length of a plug may be 2 inches, 3 inches or 4 inches, or other chosen dimensions, according to the thickness of the units to be moulded. It will be appreciated that if a universal plug is to be provided for moulding panels of different thicknesses, a certain limitation will exist owing to the fact that if very long plugs are used the cell walling at its base will have to be thicker than is desirable, while ensuring an adequate thickness of plaster at the outer end or rim of the cell walling.

The plugs are disposed in spaced relation to one another such as to leave an adequate clearance between the exterior periphery of the plugs at their base when in the moulding position for moulding the outer edge of the cell walling of suitable thickness, for example in the region of ⅛ inch. The taper form of each plug causes the walling of each cell to be moulded of corresponding taper decreasing in thickness towards the outer end of the cells of the element formed in the first moulding operation, resulting in one facing and open-ended cells.

The spider for supporting the plugs comprise stout bars disposed transversely of the length of the panel to be moulded, mounted in longitudinal channel members having depending, preferably hinged, flaps or sides adapted to register with the side walling of a mould table described below. Transverse panel end members such as angle irons, are connected to the ends of the said longitudinal channels to which are coupled hinged end flaps to register with the end walling of the said mould table. The longitudinal members may be mounted on lifting mechanism or hoists for raising and allowing the plugs to be lowered for immersion in the plaster of the mould table, or lifting means may be separate members attached to the spider. The vertically controlling mechanism for the spider may be mounted on carriages traversable on rails for displacing the spider and plugs as a whole horizontally in mutually perpendicular or other

directions for the purpose of positioning the plugs over the mould table (or successive mould tables) and moving such away.

In place of a spider or framework, a flat plate may be employed for mounting the plugs, the underside of which may be operated as a stop or moulding limit for the upper edge of the cells.

The air pipes of selected pairs of plugs are connected together in series for the equal distribution of the air pressure effects and the terminal piping of each row of plugs is connected to a header which is alternatively connectible by suitable three-way valve means to a source of compressed air and a source of evacuation. Alternatively, the air connections are disposed in any suitable manner in order to distribute the air pressure effect equally and simultaneously to all plugs for moulding a unit, and any arrangements are provided for ensuring that the pressure, having regard to the shape of the plugs, operates substantially equally in each plug whether of full or fractional form.

The mould table for the first moulding operation to form the cell walling integrally with a facing and marginal walls or edges comprises a bottom plate of suitable rigidity or made rigid by the addition of reinforcement. The margins of this plate or table have hingedly secured thereto flaps, the hinged arrangement being convenient for displacing them outwardly to release the unit at the appropriate stage in the formation thereof. Stop means are provided for the flaps to limit their outward and inward hinging movement, stops for the latter position being adapted to ensure the vertical disposal for the moulding position. The inward sides of the flaps are provided with broad ribs or like forms extending horizontally for moulding grooves in the outer edges or margins of the unit and this ribbing may be contoured to mould a channel extending into a deeper channel in the central zone of the edges. This ribbing and the corresponding moulded channels are for the purpose of forming elongated continuous cavities when moulded units are placed edge to edge for building purposes, in order that plaster or cement grouting may be poured into the vertical channels and extend along the horizontal channelling between a unit and flooring or base supports or between one unit and the next below it in the case of horizontally bonded units.

The ribbing or internal surface of the side flaps of the first facing mould may be made interchangeable, or interchangeable side walling flaps may be provided for moulding different thicknesses of the element or unit or changing the peripheral configuration or edges of such element or unit. According to one mode of providing for interchangeability the hinge formation may be such that the hinging knuckles may be readily detached or the hinge pin withdrawn.

Suitable means may be provided on the side flaps for ensuring the registration of the depending portions of the plug spider. For example, means may be provided which form a groove or clearance for the reception of the edges of the spider flaps the bottom of the groove serving as a downward limit for the descent of the plugs into the moulding plaster.

The vertical position of the plugs with respect to their supporting bars is determined by adjustable means associated with the suspension rods. For example, the rods may be screwthreaded and secured by nuts in any adjusted position with respect to the bars. These adjustments when made will be standard for the predetermined unit to be moulded but may be varied when using universal plugs for different thicknesses of unit. Certain of the plugs (for standard sets of plugs) may be adjusted for accommodation purposes as explained hereinafter. Any suitable means for vibrating the first (and second) facing-mould and/or the plug spider during the moulding operation may be employed.

The process of moulding the cell walling in conjunction with the first facing is as follows:—

The plugs are adjusted in the selected spider to the correct vertical position for moulding an element comprising the cell walling, including the peripheral walling of the element and a facing of the chosen thickness.

The facing-mould with the marginal walling is charged with plaster which is sufficiently liquid to enable it to rise in the plug clearances when the plugs are immersed in the plaster, the quantity of plaster being predetermined such that the plaster will rise to the edge of the mould walling.

Compressed air is admitted to all the plugs and sufficient pressure laterally to support the facets of the plugs against the pressure of the plaster and cause the truncation surface thereof to become slightly dished or convex.

The plug spider is then lowered until the truncation surface of the plugs touches the plaster level, after which the plugs are allowed to sink into the plaster under gravity action while vabration is applied to the mould to facilitate the flow and displacement of the plaster and to avoid the occlusion of air. Instead of initially introducing compressed air, it may be admitted as the plugs are about to contact the plaster. The plugs sink by gravity action (or under applied pressure) into the plaster until the edge of the side flaps of the spider rest upon the mould walling and further downward movement is arrested.

A period is then allowed for the plaster to set, after which the compressed air is released, enabling the convex truncation surfaces of the plugs to retract to their normal position. Upon the escape of compressed air, connection is made with the evacuating source and the air pressure within the cells is reduced to an

extent which will render the facets of the plugs to be drawn inwards and assume a concave form, thereby releasing the moulding contact of the facets with the plaster and allowing the plugs to be withdrawn by lifting the spider, such withdrawal taking place clear of the rib or ribs formed on the internal surface of the plaster walling defining the cell cavities. The provision of the vertical wedge-shaped projections on the plugs will mould notches in the cell walls so that there is free communication between one cell cavity and another to prevent trapping in the second moulding operation described below. While this moulding is taking place, horizontal pins are in position in the walling flaps of the facing mould and upon withdrawal of these pins, holes will be formed for communication with atmosphere, which will enable air to escape from all cell cavities during said second moulding operation.

When once the plugs have been adjusted to the correct vertical height for a unit of predetermined dimensions they remain fixed but in order to accommodate any irregularities in the flow or displacement of the plaster owing to differences in the moulding action of the plugs, certain of the plugs may be readjusted from time to time to accommodate such variations.

The second facing mould for forming a facing integrally on the ends of the cells opposite to the facing already moulded, comprises a plate or table having shallow peripheral walls hinged thereto adapted to mould the peripheral edges of the applied facing and overlap and preferably enclose the walling of the first facing-mould, the arrangement being such that the second moulding operation completes the double faced unit forming the peripheral walling of the unit as a whole symmetrical about the central horizontal plane of the unit.

Assuming the hinged walls of the second mould to have been erected and the mould charged with sufficient plaster to form a second facing of chosen thickness, the element first moulded, together with the first facing-mould still in position (but without the plugs) is inverted and lowered until the cell walling contacts with and enters the charged plaster. The element is allowed to settle under gravity aided by the vibration of the second mould, which is effected by any suitable means, to a predetermined position arrested by the contact of stop means on the respective hinged mould wallings. This position is calculated so that the plaster of the facing rises sufficiently to envelop the cell marginal rib or at least the outermost key-forming ribbing of the cell walling so that not only is the plaster of the second facing moulded adhesively integrally with the first element but is mechanically keyed thereto by the embedding of the ribbing formation. After the plaster has set, the walling flaps of both facing-moulds are displaced, the first facing-mould is lifted off and the completed unit detached from the plate surface of the second mould.

The plate surface area of both or either facing-moulds may be plain or formed with ornamental relief or intaglio forms or with ribbing or grooving in order to form (on one or both faces) keying elements to which a Portland cement or quick-setting cement or composition of harder or different characteristics from that of the plaster may be moulded in order to render the units suitable for the outer walls of buildings or for other purposes.

The flaps of both facing-moulds at their corners may be mitred, rebated or otherwise formed for the purpose of preventing leakage of plaster.

In the above described mode of carrying the invention into effect, full hexagon plugs have been described for the main cells and the use of half or fractional cells for the marginal or corners portions. It is to be understood that all the cells may, if desired, be moulded in half hexagonal form by the use of plugs of corresponding shape, each half plug having its diagonal face or walling spaced from the complementary plug such that the unit is provided with rectilinear aligned walls arranged either lengthwise or transversely of the unit.

The plaster employed for either or both moulding operations may be used plain or reinforced or mingled with vegetable or mineral fibres of a length such as will not interfere with the flow of the plaster and, if desired, foamed plaster may be employed for the cell walling and either or both facings; also for certain purposes it may be desirable to charge the cells when formed with foamed plaster, instead of leaving them hollow.

In order to provide one facing of concrete the outer edges of the cells after the first moulding operation may be dipped in a mastic, bitumen or suitable coating composition adjacent the keying grooves, and have moulded on to these edges a facing of concrete or other moulding composition, adapting the unit to present a surface suitable for exterior use or for special purposes.

Although it is preferred to make the cell-forming plugs of rubber, they may be formed of a synthetic composition such as neoprene or other pliable and resilient resin, and the side walling of the facing-moulds may be lined with a material such as polyvinyl chloride or polythene, to prevent sticking and avoid the application of grease or the like.

The rubber or other composition of which the plugs are mainly composed may be reinforced or lined with canvas or other fabric in a manner which will not interfere with their deformation or collapsing in the described manner.

During any of the moulding operations high frequency or other vibrations may be imparted to the plug supported framework, or to the mould table, or both, and it is preferred to

employ a rectilinear vibration or vibration confined to one plane.

Reinforcement for the facings may be provided in the form of embedded wires or net by laying such in the first facing plaster in the appropriate position, and for the second facing the wires or net may be extended across the edges of the cells and forced down into the plaster during the second moulding operation.

The holes or slots which afford communication between the cells for the purpose of escape of air, may be also utilised for circulating drying air throughout the cells, for which purpose the marginal apertures may be connected to a header or conduit supplying hot air or connected with a vacuum pump for drying air through the units.

In addition to providing holes or slots to provide intercommunication between the cells for the purpose of allowing air to escape, these or other holes or slots may be provided so that they are transversely and/or longitudinally aligned for the purpose of locating bolts or set screws through metal inserts embedded in the edging of one unit with a screwthreaded insert or nut member on the other unit.

MARKS & CLERK.

ERRATA

SPECIFICATION No. 748,693

Page 3, line 50, *for* "of some" *read* "or some".
Page 4, line 2, *for* "3" *read* "7"
Page 6, line 58, *for* "conposition" *read* "composition"
Page 7, line 23, *for* "defined" *read* "defining"
Page 7, line 33, *for* "it it" *read* "it is"
Page 12, line 71, *after* "flaps" *insert* ","

THE PATENT OFFICE,
6th July, 1956.

PUBLISHED BY :-
THE PATENT OFFICE,
25, SOUTHAMPTON BUILDINGS
LONDON, W.C.2.