Parallel straight lines A1G1, A2G2, the distance between which is equal to the normal distance between the two involutes in the body plan, are drawn in any convenient position on the floor, and perpendicular ordinates, 1, 2, 3, 4, 5, 6, 7, drawn between them distant the frame space apart. The longitudinal is developed in this plan on the assumption that when its surface is unrolled the involutes *a1 b1 g1* and *a2 b2* g2 will coincide with the straight lines A1G1 and A2G2 respectively. Taking *g1g2* in the body, represented by G1G2 in the plan,' as the fixed end of the longitudinal from which the surface is to be unrolled, the lengths *g1f1, g1e1,* &c., are measured along the curve of the involute and set off along the lines 6, 5, 4, &c., in the plan giving the points F3, E3, &c., which represent with sufficient approximation the true positions of points of the line *a1 b1 c1 d1 e1 f1* *g*1 in space relatively to a straight line through g1 perpendicular to the body plane. A batten is bent through the points G1 F3 E3 D3 C2 B3 A3 thus obtained, and the positions of the points marked on the batten, which is then allowed to spring straight along the line G1A1, the points F1 E1 D1 C1 B1 A1 being marked from the corresponding marks on the batten. The points F2 E2 D2 C2 B2 A2 are ob­tained from the other involute in a similar manner, and the straight lines F1F2, E1E2, &c., obtained by joining corresponding points are regarded as the expanded positions of the traces of the longitudinal surface with the planes of the frames. The distances G2G, E2E, E2E, &c., are then made equal to *g2g, f2f, e2e,* &c., in the body, and the curve G F E D C B A through the points so found is the expanded sight edge of the longitudinal. The distances GGo, FF0, EE0, &c., are then made equal to the depth of the longitudinal in the plane of the corresponding frame stations, when G0 F0 E0 D0 C0 B0 A0 will be the expanded shape of the inner edge of the longitudinal.

The method described above is sufficiently accurate to lay off a whole longitudinal in one length, if it is not abnormally twisted. A modification of this method, in which the involutes *a1 b1 g1* and *a2 b2 g2* are replaced by straight lines perpendicular to the trace, from which the longitudinal is to be unrolled, may be used; but, without affording any substantial simplification of the work, its accuracy is so much less than that of the method described above, that it is not safe to lay off more than two or three plates of the longitudinal in one length by it.

When the longitudinal is much twisted, as, for example, when the longitudinal surface at its end is to be made continuous with a deck flat, which is not normal to the surface of the ship, it is generally desirable to use the more laborious but reliable method of “ mocking up.”

In fig. 109 the curves numbered 1 to 6 are projections of frame lines in the body plan. *a b c d e f* is the projection of the sight edge of the longitudinal breaking into the projection of the edge of a deck flat at *a,* and *a1 b1 c1 d1 e1 f1* is the projection of the inner edge of the longitudinal. The edges of the longitudinal are faired so that the traces of the longi- tudinal with the planes of the frames shall turn uniformly from the horizontal position of the deck flat at *aa1* to the position of the main part of the longitudinal normal to the frame lines at 6 and beyond, the depth of the longitudinal in the planes of the frames being kept constant.

LL is the trace of a level plane drawn conveniently near to the sight edge in such a position that it is entirely below all the traces of the longitudinal with the planes of the frames throughout the length which is to be mocked up. Trapezoidal frames made of four straight battens nailed together at the corners, such as X Y E E in the figure, are made to show the relative position of the traces of the longitudinal surface and of the level plane with the plane of each frame. The outer and inner ends of the trace of the longitudinal surface are marked on the upper batten of each frame as at *e, e1,* and a point O1, fixing the lateral position of each batten frame relatively to a convenient straight line perpendicular to the planes of the ship’s frames, is marked on the lower batten. A diagonal plane such as DD can be used instead of the level plane LL for convenience in allowing smaller and better-shaped batten frames to be used; and the process is precisely the same.

The batten frames are then erected on their bases XY in planes perpendicular to the floor, parallel to one another and distant the frame space apart, with the points O in all the frames lying in one straight line perpendicular to the batten frames. The upper edges of the upper battens then define the true shape of the longitudinal surface in three dimensions, and a fair curve through the points *e,* &e., marked on the battens represents the outer edge, and through points *e1*, &c., the inner edge of the longitudinal.

Whether the shape of the longitudinal has been obtained by development on the floor or by the mocking-up process, batten moulds are made to the outline of each plate, the butts being arranged to come in the middle of a frame space allotted to them in the draw­ing, giving the shift of butts of bottom plating and longitudinals. Cross battens are fitted to mark the position of each transverse frame, and diagonal battens in each frame space to stiffen the mould, and to carry marks or figures indicating the shape and dimensions of the lightening hole, which occurs between each pair of frames in non-watertight longitudinals. These moulds are used by the workmen for marking off the shape of the plates and the positions of the rivet holes in them, the size and spacing of the rivets being given by the specification. No moulds giving the twist of the longitudinal are required, as that is so small that the plane plate can be pressed down into shape on the ends of the parts of the transverse frames, which must be already in position when the longitudinal is erected at the ship.

The external sectional shape of the bilge keel in a sheathed ship consists of a single steel plate in the middle of the section covered over by wood trimmed to shape. The plate lies in a diagonal plane and is readily laid off by rabatting the diagonal plane. This gives the true form of the intersection of the bilge keel plate with the surface of the frames, and the outer edge of the plate is obtained by setting out from the inner edge the specified width of the keel plate plus an allowance for the thickness of the shell-plating.

In an unsheathed ship the bilge keel is of triangular section, as shown in the body plan in fig. 99, and is formed by two steel plates riveted together at their outer edges and connected to the shell- plating by angle bars at their inner edges, the space between the plates being filled with wood. In this case the middle plane of the keel is a diagonal plane, as shown by 2D in the figure. The depth of the bilge keel at each frame plus the allowance for shell-plating is set out from the frame line along the diagonal, giving the vertex of the section of the keel at each frame station. A triangular mould is then made to the section of the bilge keel shown in the midship section drawing and is applied with its vertex coinciding with the points on the floor found as described above and with its centre line coinciding with the diagonal, and the traces of the sides of the keel are drawn by it at each frame station as *ab, dc,* in the figure.

The surface of each side of the keel is then developed in the same way as the surface of a longitudinal except that in this case, since all the traces are parallel, the involutes used in the case of the longitudinal become straight lines, and the development is strictly accurate. A mould to each plate of the bilge keel, similar to the mould for a longitudinal plate, is prepared from the expansion on the floor and issued for the guidance of the workmen. A triangular batten mould, made to show the angle between the diagonal plane, in which the centre of the bilge keel lies, and the horizontal, and having marked on it a point to be set at a given distance from the middle line plane of the ship at the height of the under side of the keel, is also issued to enable the position of the centre line of the bilge keel to be sighted-in on the bottom plating of the ship.

The remaining information issued for the erection of the ship is mostly in the form of drawings, which are largely descriptive rather than dimensioned, inasmuch as the frames and beams of the ship being once erected all other principal parts have to conform to them in shape, even where a slight difference may occur between their shape as erected and as laid off on the mould loft floor.

All the drawings of the structure and of the fittings must be pushed on and issued to the shipyard in good time. Very much of the success achieved in actual building will depend upon the efficiency of the drawing office, and the rapidity with which the various detailed working plans can be supplied for guidance. These plans must be accurate and complete, and must be ready as soon as required. The drawing-office staff has the oversight of weights actually worked into the ship, a careful record of which should be kept. Each firm has its own system of work in these departments, but experience shows that the more thorough and systematic the work in the drawing office and its adjunct, the mould loft, the better the general result. Another important record is the cost of materials and labour. In all shipyards careful account is kept of workmen’s time, whether employed on piece or by the day. Many different systems are in vogue; but whatever the system, the aim is to record the cost of the labour in each trade, and the detailed cost of various parts of the ship.

While the work connected with laying-off and obtaining materials, &c., is going on, the shipwrights, assisted by handy labourers, prepare the ground for the keel blocks, lay the *blocks* at the proper height and inclination, and secure them against being floated away by the tide or being accidentally tripped while the ship is building. The blocks consist