position of the palms and the direction of centre of shaft. Guided by these moulds and the detailed drawing, the pattern for casting the A brackets is made.

The projections of the plate and longitudinal sight edges are drawn in the body plan on the floor by measuring their distances from the middle fine along each frame line in the half- block model, on which they have been already arranged, enlarging the measurements to full size and setting them off round the corresponding square stations in the body. The points so found should lie on fair curves, if the sight edges have been properly arranged on the model, except of course where discontinuities in the curves may occur, as where a plate sight edge crosses a longitudinal sight edge to avoid an acute intersection. The edges of the sunken strakes of plating are drawn parallel to and distant the width of the lap from the sight edges, and as already stated, the breadths of the bottom plates are measured between the lines of plate edges so found and used in ordering the material from the manufacturers.

The surface of the inner bottom is defined relatively to the outer bottom by the depth of the vertical keel and longitudinal frames given in the specification: The outline of the vertical keel is also shown in the sheer drawing, and the general shape of the inner bottom by the midship section, which is often supplemented by a section through the engine-room where the double bottom is locally made deeper. The surface of the longitudinal is arranged so that its trace with the plane of each square station is approximately normal to the curve of the square station; taken in conjunction with the method of drawing the sight edges so as to cut the frame lines as nearly as possible at right angles, this is approximately the same thing as generating the surface of the longitudinal by the normal to the ship’s surface as it moves along the sight edge. The depths given in the specification are depths measured in the plane of the square stations, and, when the longitudinals are fitted on a raised strake of outer bottom plating, are greater by the thickness of that plating than the distance to be set in from the frame fine to find the inside of the frame on the inner bottom. The latter is usually worked with the strakes of plating disposed “ clinker ” fashion, or is sometimes flush with edge strips fitted on the underside. Points in the sections of the inner bottom frame surface by the planes of the square stations are obtained by setting in the depth of the longitudinals, and the surface of the inner bottom is faired by diagonal and water lines in the same way as the outer frame surface. In the engine-room space where the depth of the double bottom is increased, and where there are usually plane surfaces to take the structure under the engine bed, and a cylindrical recess to provide clearance for the engine cranks, these special features must be faired separately, so also is any bossing of the inner bottom at the after end to allow clearance for the shaft tube and fittings.

The plate edges already arranged on the model of the inner bottom must be transferred to the floor and faired in the same way as those of the outer bottom; and the breadths of the plates measured from the floor must be used in ordering the material from the manufacturers.

Before and abaft the double bottom the transverse frames may consist of zed bars, split at their lower ends for the insertion of a floor plate. The longitudinals are reduced in depth, and are intercostal between the frames until they coalesce with flats or fore and aft bulkheads, or they are con- tinued as deep zed bars slotted over the narrower trans- verse frames. The inner surface of the frames therefore does not require any process of general fairing; but the upper parts of the floor plates are drawn on the floor, and are faired locally throughout the lengths of the ship where they maintain a uniform character.

The freeboard forward and aft and amidships is generally given in the specification and can be measured from the sheer drawing.

Guided by these dimensions and by the deck lines shown in the sheer drawing, the heights of the intersections of the beam at middle with the square stations are marked on the corresponding square stations of the contracted sheer plan and faired, and the intersections with the square stations are then pro­jected to the middle line of the body plan. The round up or camber of the midship beam of each deck is shown on the midship section drawing. The camber line is a circular arc, the round up being the versed sine of half the arc and the breadth of the ship at the level of the beam the chord. A mould is readily constructed to these data and is applied so that the chord is perpendicular to and its middle point coincident with the middle line of the body plan on the floor. When the centre of the arc coincides with a point projected from the beam at middle line the arc cuts the corresponding square station at a point in the projection of the beam-end line. The points in the beam-end or beam-at-side line so formed should lie on a fair curve, which is tested by projection into the contracted sheer plan, and the line is then rased in in the body plan.

The shape of the lower protective deck in a battleship is shown in the sheer drawing. Throughout that part of the length of the ship covered by the main armour belt, which rests on this deck, the deck edge usually lies in a water plane. The middle part of the deck also ties in a water plane, except where it is raised up over the engines, and the sloping sides form cylindrical surfaces. The straight lines of the sides and middle part of the deck section are joined Dy arcs of circles of uniform radius, and this part of the deck is necessarily fair from the nature of the method of constructing the sections of its surface. At the ends of the ship the beam-at-middle and beam-at-side lines are copied from the sheer drawing and faired on the floor and the beam surface between these points may be faired by one or more bow and buttock lines.

The surface of the framing behind the main armour belt in a war- ship, arranged as shown by the midship section depicted, is parallel to the surface of the armour and distant from it the thickness of armour and wood backing plus the thickness of plating behind armour, generally a double thickness of plating flush jointed. This distance, less the thickness of the shell plating already taken off in getting in the frame lines, is set in normal to the surface shown by the lines on the floor in wake of the armoured side by approximate methods similar to those used in taking off the plank and plating, and the projections of the frame lines behind armour in the body plan are thus obtained and drawn in. The frames are usually single zed bars extending vertically from deck to deck and are completely defined by these fines without the necessity of drawing any inside surface lines.

Projections of the intersection of the surface of the frames behind armour with the beam surface of the deck at the top of the frames and with the plate surface of the deck at their heels are drawn in the half-breadth plan, and expansion drawings of the frame surface are prepared in a manner somewhat similar to that which will be described later in dealing with the expansion of the surface of each separate armour plate, except that in the present case the whole length of the surface is expanded in two or three ½-in. scale drawings. The expanded positions of the frame lines, and of any longitudinal girders which may be fitted behind armour are shown on this drawing, also the approximate positions of the armour plate butts and edges and of the armour bolts. The butts and edges of the plating behind armour are arranged on this drawing and the dimensions of the plates measured therefrom in ordering them from the manufacturers.

Thin protective plating beyond the ends of the main armour belt usually projects from the ship’s side and is secured without wood backing direct to the shell plating, which is worked in two thicknesses flush jointed in wake of the protective plating. In this case the frame surface of the ship already laid off is the frame surface behind armour, and the disposition of the butts and edges of the plating behind armour and of the armour itself is arranged on the half block model; but only the plating behind the armour is ordered to dimensions taken from the model.

It is important that the detailed information giving the shapes and dimensions of the armour plates should be in the hands of the manufacturers as early as possible on account of the time required for the manufacture of this material. As, more- over, modern armour plate steel is so hard that it is im- possible to cut it with machine tools, the plates must be delivered of the exact size required, and the information sent to the manufacturers must be of a, high degree of accuracy. For this reason the shapes and sizes of the armour plates are sometimes obtained by the “ mocking up ” process, in which the surface of the armour is represented in three dimensions by making moulds or batten frames to the sections of the surface in the body plan on the floor and erecting them in their correct lateral and fore and aft relative positions. The positions of the butts and edges of the plates being marked on the frames so erected, the moulds for each plate, as described below, can be made with great accuracy, and this process is practically necessary if there is any considerable twist in the surface of the ship where covered by the armour.

In general, however, the armoured side is very little twisted and can be treated for practicable purposes as a developable surface, in which case the necessary information can be obtained by a process of laying off as described below, which, though obviously only approximate, is found by experience to be sufficiently accurate for practical purposes.

In fig. 107 the portion of the body plan shows sections of the armour surface by planes of the frames, which are generally 2 ft. apart behind the armour, and the half breadth shows projections of the upper and lower boundaries of the armour surface, and of the joint between the two strakes, which îs arranged to lie in a level plane. The armour belt extends from the main deck above to the armour deck below. The upper edge of the armour, therefore, follows the beam-at-side line of the main deck; but is generally allowed to be about ¾ in. below it, so as to make sure of getting in the armour, in spite of possible small inaccuracies in building the rest of the structure, which might result in restriction of the space between the two decks. The lower edge follows the armour deck edge, which is usually a level line throughout the length of the belt; but is kept an inch or two above it to avoid making the armour plates with a sharp edge, to fit the acute angle between the protective deck and the ship’s side ; the armour, how- ever, actually rests on the deck as shown by the midship section depicted. The butts of the armour are arranged “brick fashion," that is, the butts of one strake at the middle of a plate in the adjacent