R. A. HADFIELD.

GUN HOUSE FOR USE IN WAR SHIPS, FORTS, AND THE LIKE.

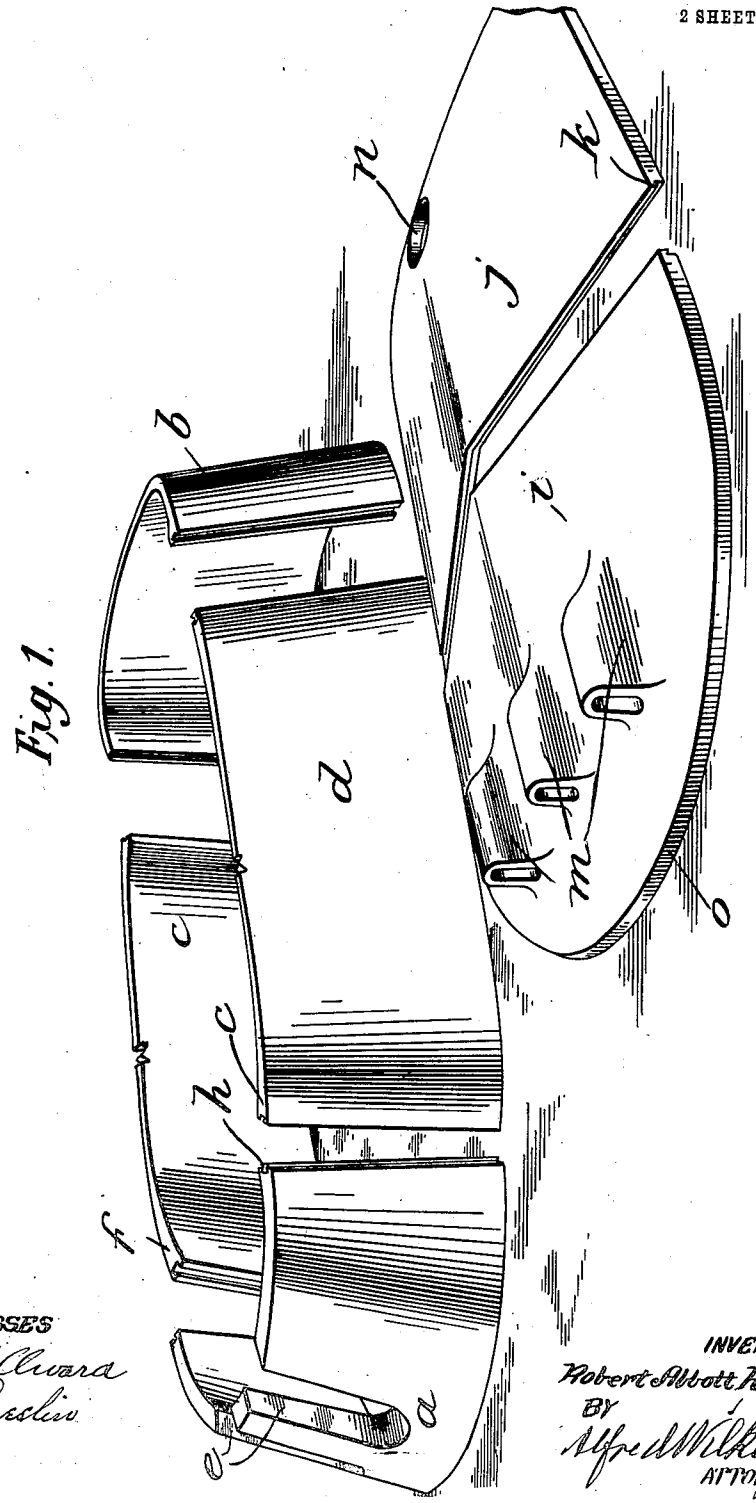
APPLICATION FILED MAR. 31, 1909.

1,055,032.

Patented Mar. 4, 1913.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

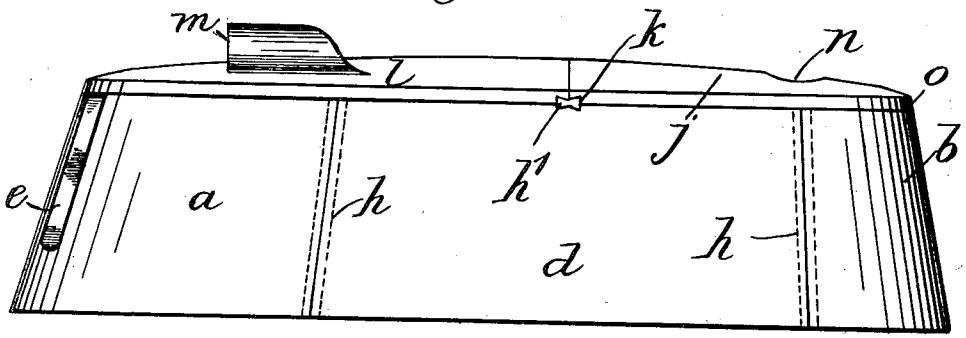


Fig. 3.

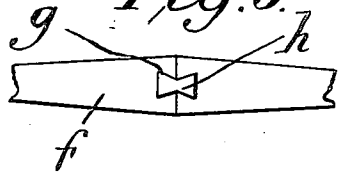


Fig. 4.

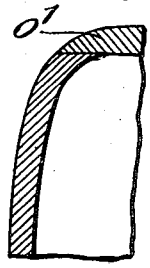
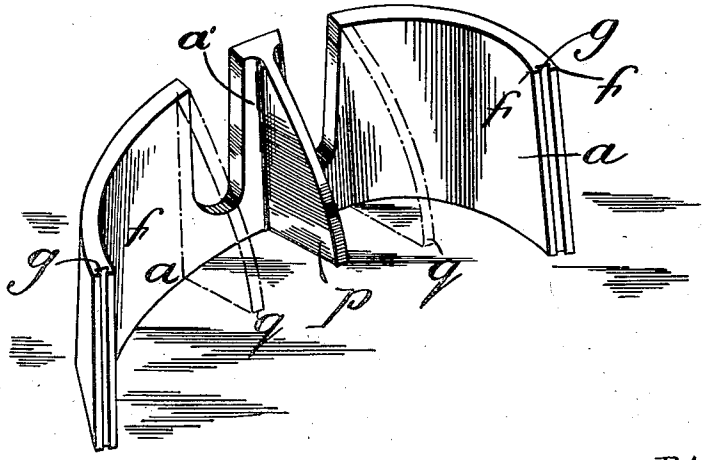


Fig. 5.



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GUN-HOUSE FOR USE IN WAR-SHIPS, FORTS, AND THE LIKE.

1,055,032. Specification of Letters Patent. Patented Mar. 4, 1913.

Application filed March 31, 1909. Serial No. 487,042.

To all whom it may concern:

Be it known that I, ROBERT ABBOTT HADFIELD, knight, a subject of the King of Great Britain and Ireland, residing at Sheffield, in the county of York, England, have invented Improvements in or Relating to Gun-Houses for Use in War-Ships, Forts, and the Like, of which the following is a specification.

This invention has reference to improvements in the construction of gun houses for use in war ships, forts and the like.

The gun houses now commonly employed for these purposes are built up of a number of rolled or forged flat steel plates, such as plates having cemented and hardened faces, suitably secured together by keys or the like (see for example Brassey's *Naval Annual* for 1908, pages 291 and 293). Such plates are costly to produce with the necessary port or other holes, which have to be machined or cut out, and moreover they cannot be readily made of a shape to best adapt them to offer the greatest resistance to the attack of projectiles, or to admit of their being secured together in the most effective manner to withstand fracture of the joints, without making them of greater thickness than would otherwise be necessary.

Now the present invention has for object to construct a gun house of fewer pieces than those above referred to and of material adapted to offer great resistance to projectiles and whereby the several pieces can be readily made of any desired shape and of different thicknesses at different parts thereof, so as to admit of the several pieces being readily adapted to offer a high resistance to the attack of projectiles, and so that the joints between the several pieces, besides being fewer in number, can be rendered much stronger than heretofore usual. For these purposes, the wall of a gun house according to the present invention is made separate from its roof and composed of a number of sections each extending the full height of the gun house wall and cast of steel, such as my "Era" steel, which offers great resistance to penetration, and which may be produced in flat or curved shapes as may be desired for the different parts of the gun house, the abutting edge portions of the sections being enlarged or strengthened at the inner side by beads, flanges or enlarged portions each made integral with the remainder of the section of which it forms part so that the sections are thicker at the joints than at other parts to admit of sufficient metal being present at the joint to enable dove-tail shaped keys, or, if desired, equivalent fastening devices, of comparatively larger cross section than heretofore usual, being employed to connect the adjacent sections together. The roof of the gun house is also cast of steel of the type referred to in one or more sections of similar material to the wall sections and adapted to rest upon and, it may be, to be secured to such sections or some of them.

According to one construction, the wall of the gun house is built up of four sections, namely, a front section made of curved or convex shape, as seen in plan view, and with one or more holes or recesses extending therethrough to accommodate one or more guns, a rear section, which may be of flat or curved shape either throughout or be curved at the end portions only, and two side sections adapted to connect the front and rear sections and each of which may be of flat or more or less curved shape, the several edge portions of the adjacent sections being enlarged at the inner side by beads or flange-like enlargements so as to form thickened edge portions that are provided with dove-tail shaped grooves of comparatively larger cross sectional area than heretofore usual for the reception of correspondingly shaped keys that are suitably driven in place. The roof of the gun house is made of suitably curved, dome or arch. shape, though it may be flat if desired, in two or more sections with any necessary holes or openings for sighting or other purposes, the joint or joints between the sections being arranged transversely or otherwise as may be desired. The joint or joints between the roof sections may conveniently extend transversely, and one of the transverse sections, say the front one, may be formed with a number, say three, of longitudinally arranged and upwardly extending hollow protuberances open at the front end and adapted to form sighting apertures. Such protuberances, when used, are formed integral with the section carrying them and not separate therefrom and secured thereto by bolts, rivets or the like, as heretofore usual. The edge portions of the roof sections are or may be suitably enlarged like the wall sections to admit of their being

securely fixed together and to the wall sections by bolts or, where practicable, by dovetail shaped keys, or, it may be, by other means. In some cases the roof may simply rest upon the side sections and not be permanently secured thereto. The general form of the wall and roof sections is preferably such that when they are assembled and secured together, the sides of the gun house incline or curve upwardly and inwardly all around and the roof is of upwardly curved, dome or arch shape in all directions, or only longitudinally and transversely. The abutting edge portions of the wall and roof sections may be of angular shape in cross section, or of convex shape so as to better adapt them to deflect projectiles impinging thereon.

The sections are or may advantageously be made of nickel chromium steel, such as my special "Era" or nickel chromium alloy steel, low in carbon and free from or low in manganese. The carbon may vary from about 0.25% (decimal two five per cent.) up to about 0.6% (decimal six per cent.), the chromium from about 0.25% (decimal two five per cent.) up to about 5% (five per cent.) and the nickel from about 0.25% (decimal two five per cent.) up to about 7% (seven per cent.). Manganese, while preferably kept low, may go up to about 0.45% (decimal four five per cent.). Silicon and aluminium may advantageously be added separately, or in conjunction, for the purpose of producing sounder and better steel. The silicon should not usually exceed about 0.4% (decimal four per cent.), ordinarily about 0.1% (decimal one per cent.), and aluminium up to about as high as 0.4% (decimal four per cent.), but ordinarily about 0.2% (decimal two per cent.). Excellent steel for the purpose of my invention can be produced by melting in a cupola, ordinary hematite pig iron of good quality, running the molten metal into a converter, decarbonizing and desiliconizing it, then adding, preferably in a molten or highly preheated condition, sufficient ferro-chromium and nickel to obtain steel of the following composition, which is given as an example of manufacture. Carbon about 0.35% (decimal three five per cent.), silicon about 0.12% (decimal one two per cent.), chromium about 1.7% (one decimal seven per cent.), nickel about 3.3% (three decimal three per cent.), manganese about 0.35% (decimal three five per cent.) and sulfur and phosphorus about 0.05% (decimal naught five per cent.) each.

Each of the sections, which may be of considerable weight, is formed in a mold made of suitable composition and having internally the formation of the intended finished section with strengthened or enlarged edge portions and, where necessary, one or more holes, apertures or recesses for guns or for sighting or other purposes, the section being formed by pouring into the mold so prepared, steel of the character above referred to. Each section is then removed from the mold, preferably while hot, and cooled down very slowly. Or the cooling may be arrested before it reaches atmospheric temperature so as to avoid any strains that might be brought about by afterward reheating the roof from the cold. Or, each section, after removal from the mold, may be submitted to a partial annealing treatment so that it will afterward be in a sufficiently tough condition to allow of its being cooled to atmospheric temperature, after which it is fettled or cleaned and, if desired, the heads or runners cut off. The partial heat treatment may also consist in putting each section into a furnace where it is allowed to attain a temperature of about 500° C. (five hundred degrees centigrade), the object of this being to allow the different parts of the casting to attain a uniform temperature, after which the casting is heated to between 750° and 800° C. (seven hundred and fifty and eight hundred degrees centigrade) and allowed to cool in the furnace to about 300° C. (three hundred degrees centigrade) or it may be, to atmospheric temperature.

Each section is then, either when not previously cooled down at all, or when cooled down after the partial annealing treatment, submitted to a special heat treatment to toughen it. This heat treatment may advantageously be carried out as follows:— The section is put into a furnace which is then heated to a high temperature, say between 900° C. (nine hundred degrees centigrade) and 1100° C. (eleven hundred degrees centigrade), after which it is withdrawn from the furnace as soon as the requisite temperature has been reached and cooled in the open air. Where the greatest possible toughness is required, it is necessary, in order to get the best results, to withdraw the section from the furnace as stated, and cool it in such a manner that its rate of cooling will proceed more quickly than if it be left in the furnace. The cooling may, of course, be effected in the furnace if desired, but cooling in the external air is preferred. The section is then heated to from 700° C. (seven hundred degrees centigrade) to 850° C. (eight hundred and fifty degrees centigrade), usually preferring about 760° C. (seven hundred and sixty degrees centigrade), and cooled down as far as desired, either slowly in the furnace, or it may be air cooled, then reheated to between 700° C. (seven hundred degrees centigrade) and 850° C. (eight hundred and fifty degrees centigrade) and cooled to between 640° C. (six hundred and forty degrees centigrade)

and 690° C. (six hundred and ninety degrees centigrade) and wholly or partially quenched in water, due care being taken that it is not allowed to remain too long in the water to produce a greater degree of hardness or stiffness than required, and to prevent cracking. Or, if the maximum stiffness is required, it may remain in the water until quite cold. The section is then heated to between 570° C. (five hundred and seventy degrees centigrade) and 640° C. (six hundred and forty degrees centigrade), or it may be up to 690° C. (six hundred and ninety degrees centigrade), the preferable temperature depending upon the particular composition of the steel used, and allowed to cool in the furnace. It is then again reheated to between 570° C. (five hundred and seventy degrees centigrade) and 640° C. (six hundred and forty degrees centigrade) and quenched outright, preferably in water. In this way, gun house sections of very high efficiency in resisting gun fire can be produced.

If it be desired to render any of the gun house sections, such as described, hard on its outer or upper surface, it may be suitably carbonized where required. For this purpose, the section, after being cast, is put into a furnace, and upon its surface a suitable carbonizing medium, for example carbon, is placed. The furnace is then raised to a high temperature, say between 900° C. (nine hundred degrees centigrade) and 1100° C. (eleven hundred degrees centigrade) and the section allowed to remain therein for several days, the actual period depending upon the extent to which the carbonizing is to be carried. The section is then allowed to cool gradually. This is usually done in the furnace, but may be done in the open air, though the latter method is chiefly preferable for a non-carbonized roof. After this treatment, the section is subjected to the heat treatment hereinbefore described, commencing in heating it to 700° C. (seven hundred degrees centigrade) to 850° C. (eight hundred and fifty degrees centigrade). In this case, after the final quenching outright of the section, in water or other cooling medium, it may be taper heated, that is to say it is heated so that the face or upper side assumes a temperature of from 700° C. (seven hundred degrees centigrade) to 810° C. (eight hundred and ten degrees centigrade) tapering to a temperature at the inner side of from 400° C. (four hundred degrees centigrade) to 600° C. (six hundred degrees centigrade), whereupon the section is dipped in or sprayed with oil or water, according to the hardness required, so that the outer or upper side, being hotter than the inner or lower side, will become hard while the inner or lower side remains soft and tough. In some cases, as for example when a very soft steel is used, that is to say, one low in carbon, a uniform instead of a "taper" heating may be adopted for the face hardening treatment.

Owing to the disposition of the material and its extraordinary toughness and tenacity, as compared with mild steel, most excellent results are obtained by the toughening treatment hereinbefore described without its being necessary to carbonize or make hard the outer or upper surface of the sections.

In the accompanying illustrative drawings, Figure 1 is a perspective view, showing the various sections, detached from each other, of a gun house of the kind hereinbefore described, suitable for the reception of two twelve inch breech loading guns and weighing about one hundred and fifty two tons. Fig. 2 shows in side elevation the various sections assembled together to form a gun house. Fig. 3 is a plan showing a detail. Figs. 4 and 5 are detail views showing modifications.

In this example, *a* and *b* are the front and rear sections and *c* and *d* the side sections to form the wall of the gun house, the front section *a* being formed with two recesses *e* to accommodate two guns and each of the sections having thickened edge portions *f* provided with dovetail shaped recesses *g* for the reception of double dovetail shaped keys *h* (see Fig. 3) which are driven endwise into the juxtaposed recesses *g* in the adjacent sections after these have been placed together to form the wall of the gun house. The said sections are, in the example, so formed that they are of curved shape, as seen in plan, and incline upwardly and inwardly. They are formed of "Era" steel by casting and are afterward subjected to the preliminary and special heat treatments hereinbefore referred to.

i and *j* are two sections to constitute the roof of the gun house, these sections, in the example, being so shaped, that when placed together they form a roof that is divided transversely and has an upper surface inclined upwardly from the front, rear and sides. The adjacent edges of the two sections are formed with grooves *k*, of angular shape to receive a locking key h^1 engaging corresponding grooves in the side wall sections *c* and *d* for connecting them together and holding them in place on the wall of the gun house. The front section *i* is formed with three hollow upwardly extending protuberances *m* to form sighting apertures, and the rear section *j* is formed with an opening *n* for look out or other purpose. The sections *i* and *j* of the roof are cast to shape of Era steel and heat treated like the wall sections *a*, *b*, *c*, *d*.

In the example shown in Figs. 1 and 2, the top and sides of the gun house terminate in

a square, or nearly square edge o, but these parts may be cast so as to form a convex corner surface as shown in section in Fig. 4 at o^1. Also, as shown in Fig. 5, the part a^1 of the part section a, between the two recesses e therein, may have cast in one piece therewith a vertical strengthening flange or bracket p, as also may the parts of the said section at the outer edges of the said recesses, as indicated in dotted lines at q, with a view of preventing, as far as possible, these parts, or any of them, being bent inward by the impact of a projectile thereon, and interfering with the proper working of the guns projecting through the said recesses. The wall sections, and also the roof sections, if desired, or any one of them, may have cast in one therewith internal brackets, flanges or other extensions for fastening, supporting or other purposes.

A gun house built up of sections cast to shape of steel of the kind referred to and heat treated in the manner referred to, will offer very great resistance to attack by armor piercing projectiles even without being rendered hard on its outer and upper surfaces by carbonizing.

What I claim is:—

1. A cast steel gun house roof provided with sighting apertures formed by longitudinally arranged and upwardly extending hollow protuberances open at the front end and formed integral with the section, substantially as described.

2. A cast steel gun house roof provided with sighting apertures formed by upwardly extending hollow protuberances having a suitable opening and formed integral with the section.

3. A cast steel sectional gun house having the abutting edges of the sections thickened for the reception of securing keys and said thickened portions arranged wholly on the inner sides of the sections substantially as described.

4. A cast steel sectional gun house formed with firing apertures in its side walls and strengthening flanges laterally extending from the wall adjacent to said apertures, the said sections having thickened inner portions at their abutting edges and slots for securing keys and suitable securing keys fitted to said slots.

5. A cast steel gun-house having two adjacent firing apertures in its side wall, and integral strengthening brackets inwardly extending from the wall, one bracket being arranged between the apertures, and other brackets arranged one adjacent to the outer edge of each aperture, said brackets extending vertically and being wide at the base and adjacent to lower edge of the wall and tapering therefrom to about the upper edge of the wall.

6. A cast steel gun-house having its side wall formed of a plurality of separate sections set with their edges in contact, said edges being thickened and formed with dovetail longitudinal recesses and double dovetail keys arranged in the adjacent recesses of the abutting edges to connect the adjacent sections.

7. A cast steel gun-house wall composed of a convex front section provided with gun apertures, a rear section having its central portion flattened and its edges curved, and two slightly curved side sections, said sections being set with their edges abutting and secured together, and said sections being of equal height and being uniformly inwardly and upwardly inclined.

8. A cast steel gun-house composed of a convex front section, a rear section having its side edges forwardly curved and two side sections, said four wall-sections being set with their edges abutting, and of a roof composed of two sections resting on the wall sections, said roof being slightly convex, and said wall sections extending the full height of the gun house wall and being uniformly inwardly and upwardly inclined.

9. A steel gun-house having side walls and a separable roof set thereon and composed of a plurality of sections, said roof sections having their adjacent edges set in contact and having double dovetail grooves formed partly in said abutting edges at the point where they engage with the side wall and partly in the upper edge of the side wall at that point, and double dovetail keys arranged in said grooves.

Signed at London, England this ninth day of March 1909.

ROBERT ABBOTT HADFIELD.

Witnesses:

WILLIAM CROSS,

WILLIAM CRAWLEY.