

gether, each in three pieces. In constructing the cores, *e, e, &c.*, plain square bodies of sand of the dimensions of the interior of the casting, are, in the first place, formed in boxes of the same size, including, at the same time, the iron frames enveloped in the cores. Now, the small cores that are necessary to the oblong openings in the sides of the casting are simply attached in their proper positions to the sides of the main cores, *e, e, &c.* They are formed and fixed on by simply applying upon the larger core, an open box of the form required, into which sand is packed, thus causing it to adhere to the main core; when the box is filled, the sand is squared off by a straight edge, flush with the surface of it. It is evident that if the box be lifted off, it leaves its core behind it. All the other smaller cores having been made, and set in their places, the moulding is finally closed, the upper box being replaced, as seen in section, *i, i*, fig. 9. This requires to be done cautiously, and in a truly vertical direction, as it now receives the upper ends of the cores which project above the moulding, and also bears upon the other cores, large and small, which do not require any additional security.

When convenient, two or more gates are connected to one central reservoir, all built on the surface of the sand. Gates at considerable distances from others, are usually supplied separately with iron from hand ladles. The other gates that are connected, are supplied from crane ladles, which are conveyed by cranes from the cupola to the moulding. The ladles will be afterwards described. The flow-gates, while the metal is being formed, are plugged with clay-balls, to "keep down the air" in the moulding. These plugs are drawn out when the moulding is filled, and the iron flows up. It is thus judged whether the casting is complete. The plugs must not be prematurely drawn, as by the too free egress given to the air, the bottom of the mould is apt to be disturbed by the air confined in the sand.

When the metal is poured, the "feeders" are immediately applied at the flow-gates. These are rods of iron, which are plunged into the liquid iron, and wrought up and down in it. By this agitative process, the liquidity of the iron about the gates is longer than otherwise maintained. It is, therefore, enabled to supply itself with additional iron from the flow-gates, for it must be understood that in the cooling down of large bodies of metal, the surface sets, while the interior is liquid; and, therefore, when the interior farther contracts, it draws in the surface metal towards the centre, and if not fed as above described, the casting assumes a vesicular structure, which weakens it considerably. To avoid such a result as far as possible, is the object of the agitation produced by the rod.

(To be continued.)

Jeffery's Marine Glue.

[A recent invention, called Marine Glue, has been produced by Mr. Jeffery, of Limehouse, which demands our attention, as from its extraordinary qualities it is likely to become hereafter of great impor-

tance in the various purposes of ship building. We have taken the following account of it for our readers, from the inventor's description.]

Mr. Jeffery, the inventor of this substance, who was one of the early producers of copper plates by galvanic action, considered that the manufacture of copper sheathing for vessels might be improved by that process. But finding that he could not diminish the cost of production below that of plates made by the ordinary method, and that the waste by oxidation on the one hand, and on the other hand, the mischief of foul bottoms when oxidation was checked, formed insuperable barriers to success in the application of this process, he desisted from the attempt. The idea also occurred of applying gums insoluble in water, as a protection for the bottoms of ships; and by combining elastic gum with non-elastic, and charging the whole composition with ingredients destructive both to animal and vegetable life; that such a coating would protect the timbers from the contact of the water, and also prevent any adhesion, or accumulation of animal, or vegetable matter, and resist the attack of the *teredo navalis*. Mr. Jeffery accordingly made a series of experiments, and succeeded in producing a composition likely to realize all his wishes and expectations. He then deposited a sealed paper, descriptive of his discovery, in the Admiralty, with a statement as to the probable effect of the composition, and, at the same time, several blocks of wood were experimentally sunk in Portsmouth harbor, to prove that the marine glue possessed properties most useful and important for ship building, and other purposes.

Every one knows that the timbers which compose a ship, are exposed to constant strain from winds and waves, from the time the ship is launched until she is broken up. One of the qualities required in a substance used to join those timbers, must be insolubility in water, or it would be useless; it must be impervious to water, so as to prevent leakage; it must be elastic, so as to contract and expand according to the strain on the timber, or the vicissitudes of climate; it should be sufficiently solid to fill up the joint, and give strength; it should be adhesive, so as to connect the timbers firmly together. These properties Mr. Jeffery has combined, in an eminent degree, in the marine glue. One of the experiments made to test the power of this glue, was the following:

Two blocks of African oak, eighteen inches long, by nine inches wide, and four and a-half inches thick, were joined together longitudinally by the marine glue, and a bolt of one and a quarter inch in diameter, was passed through each of them from end to end, and a chain attached to it.

On the next day attempts were made to draw the blocks asunder longitudinally, by means of the hydraulic machine in Woolwich Dockyard, applied to the chain, in the presence of Sir Francis A. Collier, and the master shipwrights of the Royal Dockyards at Plymouth, Portsmouth, Sheerness, Chatham, and Woolwich. A strain, to the extent of nineteen tons, broke one of the bolts, but the junction of the wood by the glue remained perfect. Two bolts of one and a

half inch in diameter, were inserted on the following day into the same block, and the strain was again applied, until it reached twenty-one tons, when one of the bolts was broken; the junction of the wood still remaining perfect, and apparently not affected.

Two blocks of African oak, of similar dimensions, were glued together, with bolts at the opposite ends, so that the strain might be applied at right angles, to the junction made with the glue. With the strain of five tons, one of the blocks split asunder at a short space from the point, but the joint remained perfect.

The result of these last experiments was deemed more extraordinary by those assembled, inasmuch as African oak is a very difficult wood to unite.

Numerous experiments have been made to ascertain the best proportions of the mixture constituting the marine glue for various sorts of wood; and in one case, where it was applied to elm, it resisted a strain equal to 368 lbs. on the square inch. This trial was made whilst the block was in a wet state, which state is considered most favorable for the effect of the glue.

Several large pieces of timber glued together, were precipitated from the top of the shears in the Dockyard at Woolwich, a height of about 70 feet above the ground, on to the granite pavement below, in order to test the effect of the concussion. The wood was shattered and split, but the glue yielded only in one case, in which the joint was badly made, and after the third fall. This falling from a height on to a hard substance, is a very severe test of the strength of a joint. The explosion of a shell has greater power in rending wood, but does not produce so great an amount of vibration.

From the elastic nature of the marine glue, it contracts when the timbers to which it is applied are swollen by water, and expands when the timbers shrink from heat, or any other cause.

A block of wood with a rend in it was taken, and the rend filled with the glue. It was then immersed for a month in a mast-pond at Chatham, at a temperature ranging between 30° and 40° Fahrenheit. On taking it out of the pond, the glue, from the pressure of the wood, was slightly squeezed out, so as to present a raised surface above the rend, but after this block had been a month in the Chatham hoop-house, at a temperature from 70° to 80° Fahrenheit, it assumed a concave figure on the surface of the rend. This block experiment is still going on, and it is intended to place the block in the hoop-house and mast-pond alternately for the space of a year, in order to ascertain whether the result will be equally successful. But in preparing the glue, its elasticity may be increased, or diminished, as circumstances may require.

This quality renders the glue most valuable as a remedy to be applied to the rends and fissures of timber; and, in fact, renders defects of that nature of little consequence—a result, of which the practical shipwright will perceive the immense importance. It is also available with peculiar advantages for the seams of vessels, in lieu of pitch; seams which were payed with it about a year since, and were exposed to the heat of last summer, appear but little changed, and are

quite free from leakage, although they were executed under very unfavorable circumstances. For the deck seams it will be found peculiarly suited; and where it is used the crew will never have reason to complain of the glue sticking to their feet. The surface of the seams after heavy rains, or from a damp atmosphere, will become slightly convex, and under a warm temperature will become slightly concave; but it will not liquefy by solar heat, and it will, under all circumstances, adhere with its original tenacity. All practical seamen will perceive the vast importance, in point of economy, comfort, and security from leakage, which these qualities ensure, especially in hot climates.

Another important experiment has been made with the glue in reference to its being a substitute for copper sheathing. This composition was applied without poison, to four surfaces of some nearly cubical blocks of wood, and on the other two surfaces, it was applied in combination with poison, equally destructive to animal, as to vegetable, life. After the lapse of twenty-three months, these blocks were taken up, and were found to present the following appearances—small shell-fish were adhering to the four unpoisoned sides, whilst the two sides charged with the poison, were perfectly clean. The whole of the composition was slightly changed in color, but was not deteriorated, or affected, in respect of its useful qualities.

Another most important use of the marine glue, is evidently in its application to the construction of masts. Its power of adhesion, and elasticity, admirably fit it for the purpose of joining the spars of which masts are composed. A great reduction of expense is likely to follow its adoption for this purpose, as shorter and smaller timbers may be rendered available, and most, if not all, of the internal fastenings may be dispensed with.

The following account of some experiments on this point are from daily journals. The masts alluded to, have been glued with such proportions of elasticity, given to the glue, which deflect in about the same ratio as the wood itself, or as if the wood were in one solid piece.

“Experiments were carried on, January 4th, and 5th, at Chatham, in the presence of Capt. W. H. Shirreff, Superintendent, and Mr. John Finchman, master shipwright, at the Dockyard, with the marine glue, invented by Mr. Jeffery. The experiments which were carried on last year at Woolwich, with the view of improving its immense adhesive power, and that it would be more difficult to separate the joinings made with it, than it would be to tear the solid wood in pieces, by shots from the large guns of the ordnance, and the result of the trials so convinced the master shipwrights then assembled to consider improvements which might be brought forward for the benefit of the Royal Navy, that they recommended its adoption, and its application to naval purposes was approved by the Lords Commissioners of the Admiralty. The main-masts of the following vessels have been joined with it, under the instructions of Mr. Jeffery. The main-mast of the *Eagle*, 50-gun ship, was first fitted with it, and it now stands exposed to all the changes of our variable atmosphere; the

main-mast of the *Trafalgar*, 120-gun ship, built at Woolwich, has been joined with marine glue, and appears to be finished in a most substantial manner; and some idea may be formed of the number of joinings, when it is stated, the dimensions of the mast is 125 feet in length, with a diameter of 40 inches. The main-mast of the *Curacoa*, formerly a 32-gun ship, but at present being reduced to a 24-gun vessel, is in progress of being joined with the composition. The whole of the practical workmen speak highly of its merits, and have expressed an opinion that its general use will save a great amount of labor in placing internal fastenings, which may now be nearly dispensed with. Mr. Jeffery had an officer from Pembroke Dockyard under his instruction, who returned home with a quantity of the composition to be used in laying the decks of the *Victoria* and *Albert* steam vessel, for the especial use of her Majesty, and his Royal Highness Prince Albert.

"The experiments formerly made and tested, were undertaken at a period when a high degree of summer temperature existed, and it was imagined by some, that it would be difficult to use it in winter, so as to have equal adhesive, and strengthening powers. In order to satisfy himself on this point, the inventor had several pieces joined together during the present cold weather, and the following is the result of the trials of their qualities:

"Eight pieces of wood 12 feet long, and 6 inches in diameter at one end, and 5 inches at the other, were each cut lengthways into four pieces, and joined together with the marine glue, two of the pieces with a new sample of the composition, and the others in the usual manner, only varying the proportions of shell lac of $\frac{6}{12}$ and $\frac{9}{12}$. These pieces of wood were alternately attached by strong bolts to the floor of the mould loft; and an iron collar and chain having been placed in the centre, the following weights were placed on a balance to shew the deflection, or strain. No. 1, with the new sample, with a strain of 25 cwt., bent 3 inches exactly, and on the withdrawal of the power, returned to its former position with the greatest elasticity. No. 2, with a strain of 27 cwt., only yielded $2\frac{1}{2}$ inches. No. 3, with a strain of 27 cwt., bent $2\frac{3}{8}$ inches. No. 4, with a strain of 27 cwt., yielded $3\frac{3}{8}$ inches, having been joined by the new sample. No. 5, with a strain of 27 cwt., showed a deflection of $2\frac{1}{8}$ inches. No. 6, with a strain of 27 cwt., only yielded 2 inches. No. 7, with a strain of 27 cwt., bent $1\frac{7}{8}$ inches; with 29 $\frac{1}{4}$ cwt., $2\frac{1}{8}$ inches; with 31 $\frac{1}{2}$ cwt., 2 $\frac{1}{2}$ inches. It was then attempted to break this model mast, and additional weights were put on, until it amounted to 45 cwt., when the strain made it yield 3 $\frac{1}{4}$ inches, and fractured the upper part of the wood, but did not separate the joinings, or thoroughly break the wood, and afforded those present an opportunity of satisfying themselves that the joined pieces were far stronger, in every respect, than solid wood of the same dimensions. No. 8, was tested in a similar manner, and with a strain of 45 cwt., yielded 3 $\frac{1}{2}$ inches, and at one end the joining opened a little in one direction, which will afford the inventor an opportunity of judging of the best degree of mixture of the various substances of which it is composed. The experiments were

carried on at a temperature of 40 degrees, and that was the height of the thermometer in the mould-loft at the time they were completed, 4 o'clock, P. M. on the 5th, it being only 8 degrees above freezing point. The value of the materials and invention has now been completely established, and its importance to her Majesty's Navy will be very great, as it has hitherto been found very difficult to obtain trees of sufficient length and diameter, about 22 or 23 inches, for main-top-masts for first rates; but they may now be made from any number of pieces, and from the nature of the marine glue, they will never be subject to the dry rot.

Another experiment was made by joining two pieces of wood 9 inches square, by 20 inches long, and placed in such a position that 21 cwt. of iron, forming a pile 6 feet high, about 7 inches broad, and 20 inches long, and it bore the whole weight without yielding at the time. On the second day, the wood gave way under the immense pressure, shewing the cement was more powerful and secure, than the solid timbers." We shall, in a future number, enter into further details of the value to the navy of this important discovery.

The extraordinary utility of the marine glue will not be fully appreciated, until vessels, in the construction of which it has been applied throughout, from the keelson to the main-top, shall have been exposed to disasters in which ordinary vessels would go to pieces, or founder, from leakage. In many such cases the superiority of the marine glue will hereafter be manifested, in the preservation of vessels, together with the property and lives of the persons on board.

No attempt is here made to enumerate the various constructions, such as dock gates, piers, aqueducts, floating bridges, &c. &c., to which the marine glue may be applied with advantage; the present design being simply to point out some of its principal qualities as shown by experiment.

March 25th, 1843.

Naut. Mag.

On the Principles of Aerial Navigation. By Sir GEO. CAYLEY, Bart.

Sir,—Mr. Henson having now published a description of the ærial machine, with which he proposes to make his experiments, and feeling an earnest desire that success may attend the practical development of principles which, however difficult in execution, are, undoubtedly, true in theory; I trust it will not be thought obtrusive in me to state a few leading observations with reference to the present scheme.

The magnitude of the proposed vehicle, will, I much fear, militate against its success. There appears to be a limit in nature to the convenient application of winged surfaces. We have millions of winged insects; hundreds of the smallest descriptions of birds; but the eagle, condor, and albatross, sail unmolested, as the sole tenants of the loftier regions of the atmosphere; and these, the largest of birds, probably never exceed one hundred pounds in weight. Muscular power and animal heat, appear to bear a direct ratio to the carbon consumed in a given time by the oxygen to which the blood is exposed in the