and has its peculiar features of mark, among which may be mentioned the handsome "council chamber" wherein the managing editor daily meets his staff to confer upon the affairs of the day, determine the course to be taken, and assign to each his *rôle* in the next morning's editorial demonstration. Near to this is the manager's private office, and connected with it an inner sanctum where a Wheatstone's telegraph communicates with the senior proprietor's residence on Washington Heights, eight or ten miles distant, by a private line of wires erected expressly for the purpose. The library is a large apartment not yet fitted up, designed for shelves from floor to ceiling, accessible by stairs and balconies, and to contain thousands of books of reference on the innumerable subjects constantly arising in a daily paper. The numerous editors and editorial writers have their separate apartments on this floor, and the reporters' room has accommodations for more than a dozen at once. There is also a reception room furnished with files of the daily papers, and a doorkeeper always in attendance at the entrance, to admit or exclude. The proof-reading room is a good-sized apartment on the floor beneath the compositors', connected with the latter—like the editorial and publication offices—by small hand elevators and pipes. One of the excellent features of the system is the index office, where every event and subject noticed in the paper is indexed daily, and may be referred to in a moment, many years back. For system, completeness, and extent, the now *Herald* establishment, editorial, mechanical, and commercial, is probably without a rival.

For the Scientific American.

THE FIFTEEN-INCH BALL VS. ARMOR PLATES.

The fifteen-inch cast-iron navy smooth bore cast by Alger, of Boston and sent to England for the British ordnance officers and iron plate commissioners to experiment with, underwent its preliminary trials for "velocity, range, and accuracy," at Shoeburyness, on the 27th June last. Fifteen rounds were fired with cast iron balls averaging a little more than 450 pounds each.

The first three rounds were fired with 35 pounds of the "mammoth grain" powder. Elevation 2 degrees; range, 711, 740, 737 yards respectively; velocity of ball averaged 920 feet per second; deviation of shot, $\frac{6}{10}$ of a yard to the right.

Next three rounds with 50 pounds "mammoth grain." Elevation as before; range averaged 987 yards. Velocity of ball, 1,110, 1,120, 1,133 feet per second respectively; deviation from 2 to 3·2 yards to the right.

Next round, 60 pounds of "mammoth grain" powder—elevation the same. Range, 1,138 yards; velocity of ball, 1,210 feet per second; deviation of shot, 1·4 yards.

Next three rounds with 35 pounds of English powder of the following character and composition: Number of grains to an ounce, 500; niter, 75·3 per cent; sulphur, 10·3; charcoal, 14·4; moisture, 1·07; density, 1·74. Elevation the same; average range, 873(?) yards; velocity, 1,044 feet per second; deviation of shot, ninth round "flew absolutely straight;" greatest deviation of the other two, 1 yard.

Next three rounds with 50 pounds of the same powder—elevation as before. Last round gave a range of 1,140 yards, with a velocity of 1,214 feet per second. Deviation—one round "flew straight to the mark;" last round deviated 2·4 yards.

Two rounds were then fired with 60 pounds of the "mammoth grain" powder, with about the same results as the other rounds with the same powder.

These preliminary trials seem to have astonished the British artillerists not a little, with respect to both velocity, range, and accuracy. *Engineering* remarks: "After Thursday's experiments we trust we shall hear little more of this parrot cry about *low velocity*;" and "As regards accuracy, we fancy the results must have surprised some of the judges not a little." Not only were the British artillerists astonished, but it was shown that one of the most distinguished of this fraternity, Captain Noble, of the Royal Engineers, who wrote the elaborate report to the Ordnance Select Committee, did not understand certain elements which should be regarded in computing the effect of large spherical shot. This officer, in the report alluded to, after extolling the power of the 9-inch wrought-iron Woolwich rifle, the favorite English gun, made a calculation which seemed to prove that the 15-inch American smooth bore was a mighty poor concern. These calculations, together with the termination of the gallant Captain's report, in which he pooh-poohed the American gun, seem to have been extremely gratifying to the British journalists. Ponderous leaders were written, and Lord Elcho was for the time pretty well put down for his Parliamentary attacks on the extravagance and inefficiency of the Ordnance Department of the government. He was for the time looked upon pretty much as our artillerists and engineers regard Mr. Wiard.

On page 30 of his report, Captain Noble sets forth as the result of his calculations on the American smooth bore, that with 50 pounds charge of English powder and a 484-pound spherical shot. a velocity of 1,070 feet per second will be the result. This is equivalent to a dynamic force represented by 8,658,760 foot-pounds, and 8,658,760÷50=173,175 foot-pounds to each pound of powder.

Now on the trials for range, velocity, etc., which are given above, it is seen that Captain Noble himself propelled the 450-pound 15-inch ball with 50 pounds of English powder with the velocity of no less than 1,214 feet per second. The dynamic force of this ball was therefore represented by 10,328,400 foot-pounds, or 10,328,400÷50=206,570 foot-pounds to each pound of powder, that is, 206,570—173,175=33,395 foot-pounds *more* energy per pound of powder than stated in his calculation on which he based his erroneous opinion of the power of the gun.

In no case which has fallen under the observation of the writer has a pound of powder in the English 9-inch rifle developed a greater energy than 175,000 foot-pounds; this with a 250-pound cylinder will give a velocity of about 1,490 feet per second.

Having thus shown that Captain Noble made a mistake of 1,569,634 foot-pounds in his calculations based on a charge of but 50 pounds, let us turn to the trials which took place at Shoeburyness in July last with the 15-inch gun against armor. The target was constructed of John Brown's celebrated solid iron slabs, 8 inches thick, laid on a teak backing 18 inches thick, placed on the ¾-inch iron skin of the ship, to which were secured "a double number of supporting ribs." It is almost unnecessary to remark that such a cuirass as this is not carried by any French or English iron-clad, and that the *Warrior*, with her 4½-inch plates and 18 inch teak backing, represents the average impregnability of the iron-clads of the powers alluded to; and bearing in mind that the shot-resisting power of solid slabs varies as the square of their thickness, the immense difference between such a protection and the target fired at will be seen.

Against this target three rounds were fired from the 15-inch gun, as follows:

First Round—Range, 70 yards; American cast-iron spherical shot, weight 453 pounds, diameter 14·895 inches; charge 60 pounds of "mammoth grain" powder; velocity, 1,174 feet per second. The effect, according to the London *Mechanics' Magazine*, was as follows:—"The shot struck the target near the horizontal junction of the armor plates, nipping about two inches only of the lower one, and smashing a deep indent of four inches into the plate, rebounded nearly entire—the striking face being flattened and a few largish fragments splintered off—twelve feet back from the front of the target. The armor plates were separated from each other vertically at the left edge about two inches, the space tapering along the whole plate to the right. The buckling from the indent extended over forty-one inches of area, and at the striking point (three feet from the left edge of the target) was inward to the extent of five inches," and the effect on the rear of the target was to bend the six supporting ribs "some inches," and to "slightly crack" them, and six butt-joints of the skin plates were opened along their entire length.

Second Round—Range the same. Pontypool No. 6 cast-iron spherical shot, weight 452·5 pounds, diameter 14·89 inches; charge same as before. According to the same authority, the effect was that the ball "struck about two feet six inches from the right end of the armor plate on the median line. Half the shot stuck in the indent (seven inches). the other half splintering off to a ragged, nearly flat face. Buckle on the vertical line; three inches at the middle of the width of the plate, and on the horizontal line, 1·6 inches, extending over a surface of five feet,"

Third Round—Firth's steel spherical shot, tempered in oil, weight 498 pounds; charge same as before; velocity 1,134 feet per second; it pierced the plate 8·2 inches. The *Mechanics' Magazine* says: "It struck about five feet from the left end and a foot from the top edge of the lower armor plate, and stood out from its front perfectly entire (except six or eight radiating narrow fissures) for about eight inches, the remainder being buried in the indent it had made in the plate."

Now in order that the reader may have a correct idea of the relation between the power of the 15-inch gun and the resisting capability of this tremendous target, it will be enough to state that about 40 per cent less than the real power of the gun was employed in these trials, and as an examination of the results show, a slight increase in the velocity of the big balls would have put them through the target. In short, as a cotemporary remarked, "what the effect of ten pounds more powder would have been, was drearily confessed by all the spectators of the trial." "The *Hercules*," says the *London Herald*, "ought to keep these missiles out; but she is not yet afloat. But it is something essential to know that henceforth no English man-of-war could be laid broadside against an American ship carrying guns of this caliber."

The English journals, both scientific and popular, have made a curious mistake with regard to the strength and quantity of the powder employed by us in the 15-inch gun. They call the "mammoth grain" powder used in these trials "American" powder, in contradistinction to their own, and state that sixty pounds of the "mammoth" is the maximum charge. The following extract from the instructions of the Naval Ordnance Bureau, issued during the war—April 1, 1864—while the experiments for endurance with the 15-inch gun were progressing, will show how very much less than the real power of the piece was used on the late trial: "Sixty pounds may be used for twenty rounds of solid shot. Cannon powder only should be used, as 35 pounds of this kind gives a greater range than 50 pounds mammoth powder."

Thus it is seen that the weight of the charge of "mammoth grain" used on the trial against the English target was equal to less than 42 pounds of such powder as is always used in the 15-inch navy gun, and 60 pounds of our powder gives a velocity of over 1,400 feet, against less than 1,200 obtained on the English trial ground against their target. Remembering that the power varies as the square of the speed, it cannot fail to be seen that the proper charge would have pierced and smashed this tremendous target. Seventy pounds of our cannon powder has been frequently employed on the trial ground, and a few months since a velocity of nearly 1,600 feet per second was achieved with the 15-inch gun with 100 pounds of "mammoth grain."

Perhaps the natural delicacy of John Bull has made him fearful of injuring the Yankee gun, but it is much more likely that his great care of the gun is due to his fear, not of bursting the piece, but of bursting his target and his reputation at the same time. N.

GUNPOWDER—ITS MATERIAL AND MANUFACTURE.

The origin of this composition, which may be considered, next to steam, as the most influential agent in human progress, is involved in hopeless obscurity. It certainly was known to the Chinese and Hindoos at a very early period. The Chinese histories make repeated mention of it at a time when European nations were sunk in semi-barbarism, and Philostratus in his life of Apollonius Tyanæus speaks of the Oxydracæ, a people living between the Hyphasis and the Ganges, whom Alexander declined to attack because "they come not out to fight those who attack them, but those holy men, beloved of the gods, overthrow their enemies with tempests and thunderbolts shot from their walls." Hercules and Bacchus, who from Egypt overran India, were repulsed by these people "with storms of thunderbolts and lightnings hurled from above." The invention of gunpowder has been attributed to a German monk and alchemist of the 14th century, named Schwartz, and also to Roger Bacon, commonly known as Friar Bacon, who lived in the 13th century. But it is certain the latter referred to it as a composition already known as a scientific toy or means of amusement, and if so the claims of Schwartz who lived years afterward are of no value. It is somewhat remarkable that to ministers of the gospel of peace should be attributed the credit of inventing such an agent for the destruction of human life. It is singular, also, that the composition and the proportions of the constituents of gunpowder should remain radically unchanged from the earliest period to the present time.

Gunpowder is composed of niter, charcoal, and sulphur; according to Benton the proportions used by the United States government are niter, 76; charcoal, 14, and sulphur 10. According to the same authority the parts performed by these ingredients are shown by the following table:

COMPOSITION OF GUNPOWDER.

BEFORE COMBUSTION.		AFTER COMBUSTION.
3 parts of carbon,	3 carbon,	3 carbonic acid (gas).
1 part of nitrate of potassa,	6 oxygen,	
	1 nitrogen,	1 nitrogen (gas).
	1 potassium,	1 sulphide of potassium (solid).
1 part of sulphur,	1 sulphur,	

A gunpowder can be made of niter and charcoal alone; but it is not so strong as when sulphur is present; beside, the substance of the grain is friable, has considerable affinity for moisture, and rapidly fouls the arms in which it is used. Theoretically, sulphur does not contribute directly to the explosive force of gunpowder by furnishing materials for gas, but by uniting with the niter it affords a large amount of heat, and prevents the carbonic acid from uniting with the nitrate of potassa, or niter, and forming a solid compound, the carbonate of potassa. It is to the heat and carbonic acid thus formed that gunpowder mainly owes its explosive force.

Niter does not absorb moisture from the ordinary atmosphere, a very important quality in the principal ingredient of gunpowder; it is decomposed when strongly heated and oxygen is evolved at first; finally nitrogen is given off, and peroxide of potassium remains. When heated with combustible materials it is completely deprived of its oxygen; this is the part it plays in gunpowder. Charcoal is an absorbent of oxygen and very combustible. In burning, a large amount of carbonic acid is evolved. When first prepared by heating in a closed iron retort, it will, if pulverized, absorb so much of the oxygen of the atmosphere and so rapidly, as sometimes to ignite by spontaneous combustion. The properties of sulphur in gunpowder have been already described.

The explosion of gunpowder is a deflagration in which the combination of the ingredients is completed at once, the whole, or most, passing almost instantly into a gaseous condition by the influence of heat. The gases are combinations of the carbon of the charcoal with the oxygen of the niter; the sulphur serving to decompose the nitrate of potash by combining with its metallic base and thus setting free another atom of oxygen for producing more carbonic acid. The accession of heat thus engendered, also greatly adds to the effect. The sulphur and niter are refined to a point of almost absolute purity, and great care is exercised in the preparation of the charcoal and in the selection of the material from which it is produced. It is usually made from the twigs of the black dogwood, black alder, or the willow, the latter being exclusively used in this country. It is charred in closed retorts of cast iron at a low temperture, as it is found that the lower the heat by which the change is effected the greater the combustibility of the charcoal. Each of the ingredients is ground to impalpable powder and bolted. They are then weighed in proportions and sifted into a trough or cylinder in which are revolving fans which intimately mix the constituents.

They are then taken to a mill similar to that known as the Chilean mill for grinding gold-bearing quartz, which is simply a vertical shaft, having on two projecting horizontal arms immensely heavy rollers of cast iron which revolve on a circular cast iron bed having wooden sides. From forty to fifty pounds are put into the mill, moistened with water, and ground by revolving rollers. It is in this grinding process that those fearful accidents occur which occasionally horrify the public. The mill is isolated and at a distance from others, which are protected by trees or earth traverses. It requires from three to five hours to complete the grinding process. If a particle of grit gets into the mill during the process the result is almost unavoidably an explosion.

When taken out it is dried and presents the appearance of grayish black cakes called mill cake. It is then sprinkled with water and spread on brass plates in a press and subjected to immense pressure. This press is a hydraulic press, as the flying dust of the powder might become ignited by the friction of a screw. It comes out in thin, hard cakes, and is broken and granulated by being passed between fluted rollers, one series after another, being passed from one to the other over sieves which have a reciprocating or shaking motion.