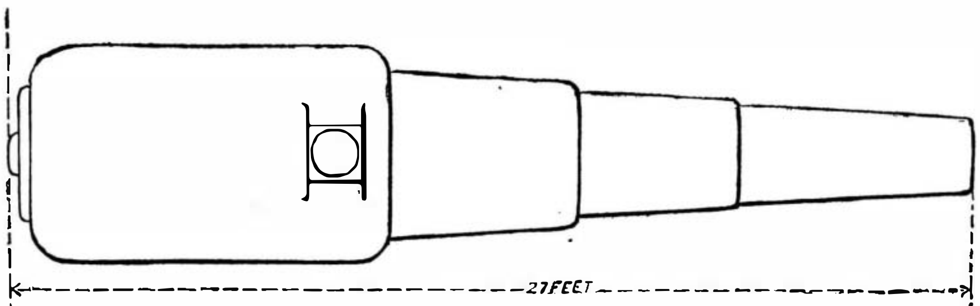
New Eighty-one Tun Gun.

Only two years ago the sobriquet "Woolwich infant" was playfully applied to a gun which had just been constructed in the gun factories of the Royal Arsenal at Woolwich, of the then unprecedented size of thirty-five tuns. Recent events have, however, proved that the name was by no means ill chosen, for a decision has been arrived at which will necessitate our viewing this gun actually in the light of a mere baby, a series of monstrous successors having been designed which will put its nose out of joint altogether. The first four of these, which are intended to form the armament of the future ironclad Inflexible, will be proceeded with so soon as the experimental one, which is the subject of the present paper, has been completed and proved.

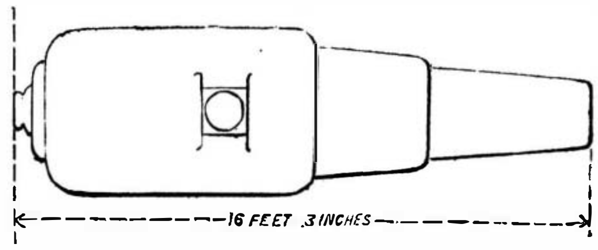
The new gun will, it is expected, be of a weight slightly over or slightly under eighty-one tuns. Its total length, including the plug screwed in at the breech end, 27 feet; the length of bore, 24 feet; the caliber will, in the first instance, be 14 inches, but ample provision is made in the thickness of the steel tube to increase that figure to 16 inches, if deemed desirable. The rifling has not as yet been decided on, but will be a matter for consideration as the gun approaches completion, by which time the result of the present series of experiments with the $\frac{35}{38}$ tun gun will doubtless have thrown considerable light upon this vexed question. The trunnions are to be 16 inches in diameter. The internal construction is similar to that of the 10 inch gun and upwards, except that the chase is divided into three portions instead of two.

The accompanying engraving will give some idea of the appearance of the proposed gun, and exhibits the grandeur of its proportions as compared even with those of its colossal predecessor. The 7 inch gun is also shown as demonstrating the immense advance that has taken place in modern artillery during the past eight years. When we consider that it was positively stated, when the 7 inch gun was produced, that we had attained the highest point we should ever reach in weight of metal, it seems almost incredible that in less than a decade we should be in possession of artillery twelve times as heavy. One is almost tempted to pervert the Latin proverb, and exclaim: "*Tempora mutantur et arma mutantur in illis.*"

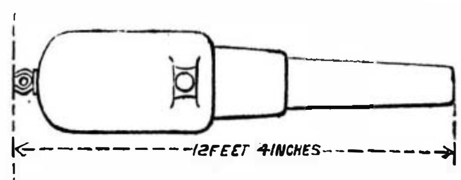
81 TUN GUN. PROJECTILE 1,200 LBS. CARTRIDGE 200 LBS.



35 TUN GUN. PROJECTILE 115 LBS. CARTRIDGE 110 LBS.



7 TUN GUN: PROJECTILE 700 LBS. CARTRIDGE 30 LBS



Neither the weight of projectile nor quantity of powder to be contained in the cartridge for the 81 tun gun has been positively fixed, but the first will probably range between 1,000 lbs. and 1,200 lbs., while the second may be estimated at about one sixth of that amount. In the following calculations as to the probable energy of the new gun, or force of impact of its projectile, at the various ranges specified, three weights of shot or shell are respectively dealt with of 1,000 lbs., 1,100 lbs., and 1,200 lbs. An initial velocity has been assumed in all cases at the muzzle of the gun of 1,800 feet per second. It would possibly be considerably greater, but we desire to be within the mark. Working by the well known formula:

The energy in *vis viva* in pounds $= \frac{WV^2}{2g}$

where W = weight of projectile in lbs.,
V = velocity in feet,
g = force of gravity (32·2),

we find at the muzzle for the 1,000 lbs. projectile a blow of 11,715 foot-tuns, for the 1,100 lbs. projectile one of 12,886 foot-tuns, and for the 1,200 lbs. projectile the terrific force of 14,058 foot-tuns! These forces would, of course, be considerably enhanced by the higher velocity which would doubtless be obtained. When we compare such energies with those of the 35 tun and 7 inch guns, namely, 8,404 and 1,855 tuns, respectively, the latter sink into utter insignificance.

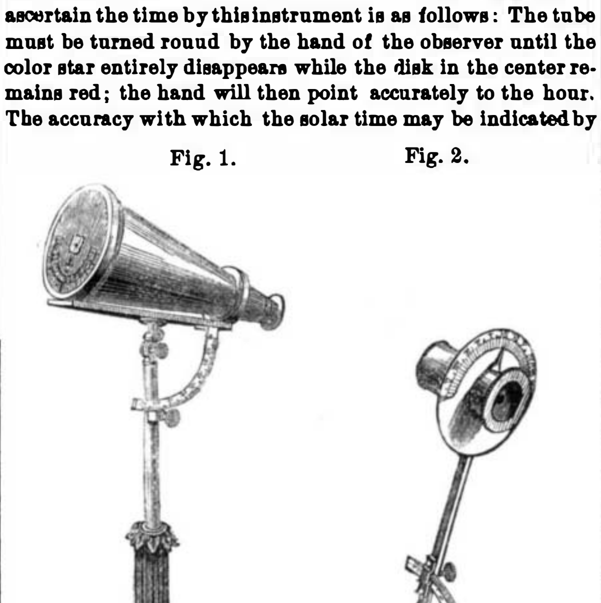
The actual penetrating powers of the 81 tun gun, as distinguished from the striking or racking powers, can only be decided by experiment. With the earlier natures of heavy ordnance, such as the 7 inch and 8 inch, a rough rule gave the penetrative or punching power as 1 inch in excess of the diameter of the projectile. Thus the 8 inch gun would penetrate armor 9 inches thick at a moderate distance. But as we ascend the series, this power developes itself in an increasing ratio, the 10 inch gun piercing armor of 12 inches in thickness, but not going through the backing; while the 12 inch gun of 36 tuns easily pierces 14 inches armor and backing, and only is arrested by the latter after going through 15 inch targets. Hence we may reasonably estimate the power of the gun now under consideration as capable of penetrating at least 19 inches or 20 inches of armor plates and their backing, at a distance of, say, 500 yards. We are aware, of course, that by increasing the diameter of the bore to 16 inches, the charge remaining the same, a loss of penetrative power would result, but we anticipate that (by employment in making up the cartridges of the slow-burning 1½ inches or 2 inch cubes of pebble powder, some of which have been manufactured at Waltham Abbey, and with which good velocities and low pressures were obtained in recent experiments with the 38 tun gun at the proof butts), as the caliber is increased, so the charge may be increased in proportion. That the 81 tun gun will ultimately have a caliber of certainly 15 inches, we little doubt.—*The Engineer.*

THE POLAR CLOCK—THE TIME OF DAY SHOWN BY COLORS.

One of the most beautiful practical applications of the polarizing instrument is presented in Sir Charles Wheatstone's polar clock, shown in our engravings and described in the following passage by the inventor:

"At the extremity of a vertical pillar is fixed, within a brass ring, a glass disk, so inclined that its plane is perpendicular to the polar axis of the earth. On the lower half of this disk is a graduated semicircle, divided into twelve parts (each of which is again subdivided into five or ten parts), and against the divisions the hours of the day are marked, commencing and terminating with VI. Within the fixed brass ring, containing the glass dial plate, the broad end of a conical tube is so fitted that it freely moves round its own axis; this broad end is closed by another glass disk, in the center of which is a small star or other figure, formed of thin films of selenite, exhibiting when examined with polarized light strongly contrasted colors; and a hand is painted in such a position as to be a prolongation of one of the principal sections of the crystaline films. At the smaller end of the conical tube a Nicol's prism is fixed so that either of its diagonals shall be 45° from the principal section of the selenite films. The instrument being so fixed that the axis of the conical tube shall coincide with the polar axis of the earth, and the eye of the observer being placed to the Nicol's prism, it will be remarked that the selenite star will, in general, be richly colored; but as the tube is turned on its axis the colors will vary in intensity, and in two positions will entirely disappear. In one of these positions a smaller circular disk in the center of the star will be a certain color (red, for instance), while in the other position it will exhibit the complementary color. This effect is obtained by placing the principal section of the small central disk 22½° from that of the other films of selenite which form the star. The rule to ascertain the time by this instrument is as follows: The tube must be turned round by the hand of the observer until the color star entirely disappears while the disk in the center remains red; the hand will then point accurately to the hour. The accuracy with which the solar time may be indicated by

Fig. 1. Fig. 2.



WHEATSTONE'S POLAR CLOCK.

this means will depend on the exactness with which the plane of polarization can be determined; one degree or change in the plane corresponds with four minutes of solar time.

"The instrument may be furnished with a graduated quadrant for the purpose of adapting it to any latitude; but if it be intended to be fixed in any locality, it may be permanently adjusted to the proper polar elevation and the expense of the graduated quadrant be saved; a spirit level will be useful to adjust it accurately. The instrument might be set to its proper azimuth by the sun's shadow at noon, or by means of a declination needle; but an observation with the instrument itself may be more readily employed for this purpose. Ascertain the true solar time by means of a good watch and a time equation table, set the hand of the polar clock to correspond thereto, and turn the vertical pillar on its axis until the colors of the selenite star entirely disappear. The instrument then will be properly adjusted.

"The advantages a polar clock possesses over a sun dial are: 1st. The polar clock being constantly directed to the same point of the sky, there is no locality in which it cannot be employed, whereas, in order that the indications of a sun dial should be observed during the whole day, no obstacle must exist at any time between the dial and the places of the sun, and it therefore cannot be applied in any confined situation. The polar clock is consequently applicable in places where a sun dial would be of no avail: on the north side of a mountain or of a lofty building, for instance. 2d. It will continue to indicate the time after sunset and before sunrise, in fact, so long as any portion of the rays of the sun are reflected from the atmosphere. 3d. It will also indicate the time, but with less accuracy, when the sky is overcast, if the clouds do not exceed a certain density.

"The plane of polarization of the north pole of the sky moves in the opposite direction to that of the hand of a watch; it is more convenient therefore to have the hours graduated on the lower semicircle, for the figures will then be read in their direct order, whereas they would be read backwards on an upper semicircle. In the southern hemisphere the upper semicircle should be employed, for the plane of polarization of the south pole of the sky changes in the same direction as the hand of a watch. If both the upper and lower semicircles be graduated, the same instrument will serve equally for both hemispheres.

"The following is a description of one among several other forms of the polar clock which have been devised. This (Fig. 3), though much less accurate in its indications than the preceding, beautifully illustrates the principle.

Fig. 3.

SELENITE POLAR CLOCK.

"On a plate of glass twenty-five films of selenite of equal thickness are arranged at equal distances radially in a semicircle; they are so placed that the line bisecting the principal sections of the films shall correspond with the radii respectively, and figures corresponding to the hours are painted above each film in regular order. This plate of glass is fixed in a frame so that its plane is inclined to the horizon 38° 32', the complement of the polar elevation; the light, passing perpendicularly through this plate, falls at the polarizing angle, 56° 45', on a reflector of black glass, which is inclined 18° 13' to the horizon. This apparatus being properly adjusted, that is, so that the glass dial plate shall be perpendicular to the polar axis of the earth, the following will be the effects when presented towards an unclouded sky: At all times of the day the radii will appear of various shades of two complementary colors, which we will assume to be red and green, and the hour is indicated by the figure placed opposite the radius which contains the most red; the half hour is indicated by the equality of two adjacent tints."

A CORRECTION.—An accidental error exists in the description of the bolt cutter of the Wood and Light Machine Co., which appeared on the first page of our issue of May 9. The beginning of the detailed reference should read: "A is the face plate of the die holder," etc. Instead of the following sentence should appear: B is the head, caused to revolve by proper mechanism, through which passes a mandrel, moving freely back and forth, in the spindle, C.

THE green color of the boron flame may be very well shown by boiling a mixture of boracic acid, alcohol, and sulphuric acid, and igniting the vapor.