and gears in constant, well-greased readiness. In another car of the train are stored jacks of various capacities, from an ordinary affair that may lift a few hundred pounds to one capable of raising thirty or forty tons. On a third car may be found the trucks and wheels to carry any car that may be in need of new ones. Then there is the living car, equipped with berths in which the men may rest on their way home after the wreck is cleared, and containing a cook stove and a constantly supplied larder. The engine and crew? There is generally one of the former with steam up in the yard, but should there not be, the next freight or passenger that comes by is robbed. From the telegraph operator's office to the homes of the wrecking crew—always located near the station—wires run that sound deafening gongs at the touch of a telegraph instrument. Before the brakeman, arriving on foot at the nearest station, can tell the whole of his story, wrecking men are on the way to their train. Orders are ready when they arrive. They are to stop at the next station and pick up a doctor and a telegraph operator. The operator will attach an instrument to the wire immediately upon arriving at the wreck, the doctor and his force will get into action at once, the wreckers will spare no expense in clearing the way. "Economy" and "save" are words not in their vocabularies. Cars are lifted by the huge crane—whose fires have been fanned by the rapid run until the safety valves on the boilers are lifting—and thrown over on their sides clear of the tracks. Cars that cannot be immediately righted are pitched aside until there is time to build a side track and mount them on it. Only heavy washouts on the great rivers or similar catastrophes block the roads for more than a few hours.

A NEW SIGHTING GEAR FOR NAVAL GUNS AND GUNNERY SIGNALING APPARATUS.

BY OUR LONDON CORRESPONDENT.

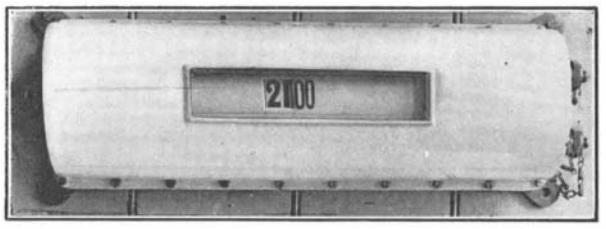
Although by constant gunnery practice and severe drill the training of expert naval gunners is carried to a high standard of efficiency with regard to the handling and firing of naval ordnance under conditions similar to actual warfare, it is an indisputable fact that the success of a naval engagement will, to a very appreciable extent, depend upon the perfection of the mechanism employed to bring the guns to bear upon the antagonist, and the means for rapidly and correctly meeting the ever varying circumstances that will arise.

The fact that naval artillery is fired upon the high seas introduces the most difficult conditions for successful practice conceivable, owing to the motion of the ship due to the action of the waves, and the extreme mobility of the target. Moreover, as the issue of an engagement, other things being equal, will almost certainly be determined by the establishment of a superiority of effective fire during the first few minutes after the commencement of hostilities, it is imperative that the handling of the gun should be rapid and accurate under all conditions.

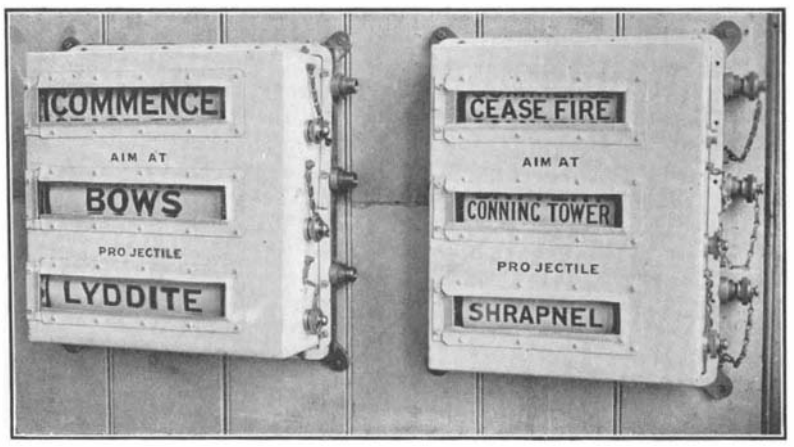
To attempt to overcome the difficulties which from the nature of the case beset the gunner in his duty of laying a naval gun upon a target, it is necessary first to define clearly the separate elements which are comprised in the art of gunnery itself; then to study their relation to the conditions under which the art is practised, and finally to so devise the necessary mechanism that it shall eliminate as far as possible any adverse effects the field of operations may create. Further, means must be provided for the most effective employment of the artillery as a whole, with prompt response to the varying and incalculable conditions of the fight.

The elements of successful gunnery irrespective of the nature of the circumstances under which it is carried out, are that the opponents should be hit frequently, and hit effectively every time.

To achieve this desideratum, two distinct operations are involved; First, that the sights should be accurately aligned upon the opponent and the gun discharged; secondly, that the angle between the axis of the gun and line of sight should be correct for the distance of the opponent. To hit the antagonist with the best advantage demands that he should be struck in the right place, with the correct projectile, and with concentrated effect.



THE SIGNAL APPARATUS INDICATING THE RANGE.



ELECTRICAL INDICATORS FOR ORDERS AND SIGNALS.

In considering these fundamental functions in the light of the conditions and requirements of an engagement at sea, it will be observed that such conditions and requirements necessitate very special adaptations of the operations involved in these functions.

These conditions and requirements may be enumerated as follows:

(1) The gun is mounted upon an unstable platform.

(2) The target is extremely mobile both in position and distance.

(3) It is of the utmost importance to establish the initial superiority of fire.

(4) The varying phases of the fight, each demanding special treatment, must be met with promptness.

(5) The superiority of fire must be maintained under all conditions until the opponent hauls down his flag or goes to the bottom.

Concerning the problem of adapting to the needs of sea work the method and means of carrying out the elementary operations of gunnery, the first process, that of aligning the sight and firing (the duties of the gun captain), is a task of extreme difficulty. Not only is the opponent constantly on the move, but the ship itself is in motion, and these together are combined with and aggravated by the roll of the ship. It may be laid down that the perfection of this operation is to maintain the sight constantly upon the opponent, giving instant readiness to fire and eliminating personal error. To attempt this the gun and sight have to be kept constantly on the move; and this is such a difficult and delicate task, that it requires the whole and concentrated attention of the gun captain, notwithstanding the common practice of assisting him by intrusting one component of the laying (the training) to another gun member.

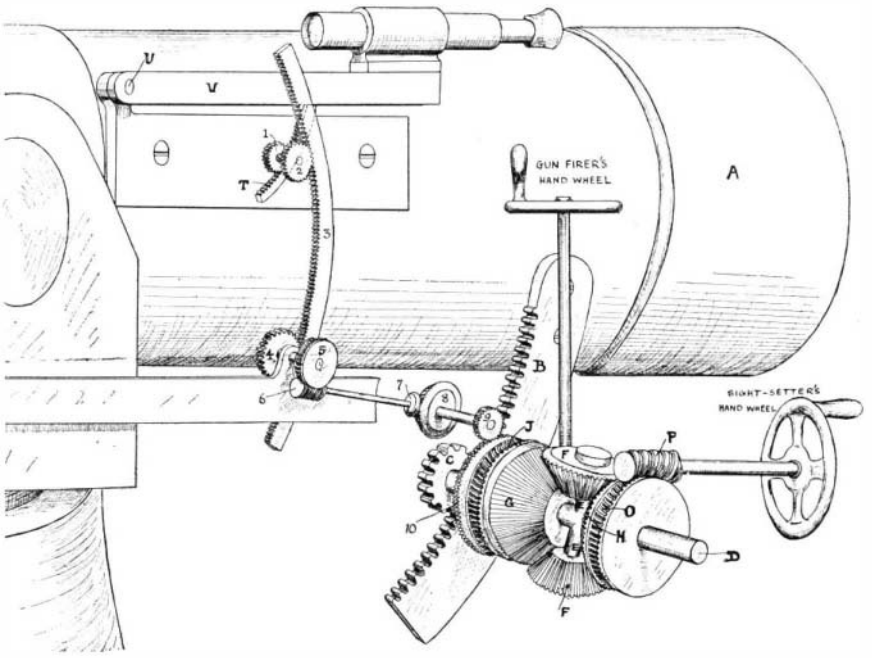
It may be confidently affirmed that the work of these two men must be simplified to the utmost, so that their whole attention may be directed to its performance. This necessitates that the mechanism in their hands must maneuver the gun with speed, and yet be simple and easy to work, and moreover that it involves the performance of that operation completely, and of that operation alone. But what of the adjustment of the angle between the axis of the gun and line of sight for the range of the antagonist? Unless this is correct the work of the gun captain will be nullified. Therefore, since it is clear that he cannot assume this duty himself without detriment to his own peculiar operation, it follows that it must be intrusted to another man, commonly called the sight setter.

The main requirement in this operation is that at the instant of discharge the angle between the axis of the gun and line of sight should be correct for the range of the opponent. The controlling conditions are the continual alterations of the range; the extreme difficulty of determining it with anything approaching to accuracy; and the vital importance of ranging upon the opponent before he ranges upon you, and subsequently maintaining an accurate fire under all conditions of change of range.

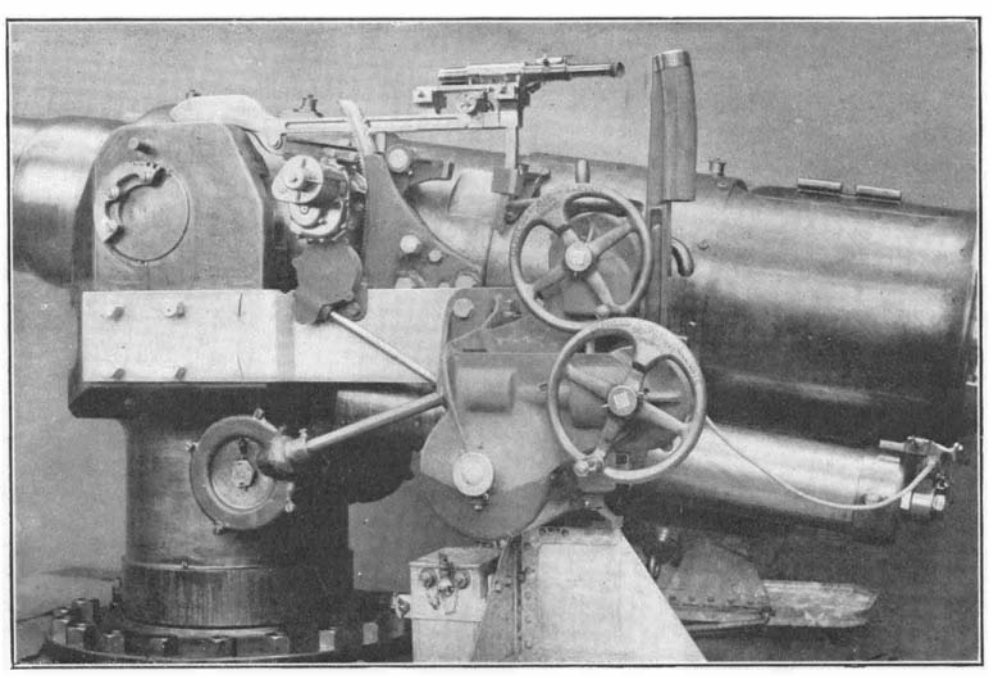
The continual alteration in the range of the opponent necessitates that the angle between the gun and sight should also be continually altering, in order to insure that at any instant the gun may be discharged with the adjustment correct. A combined aggregate closing speed between the two antagonists of 30 knots would not be excessive, and as this would give a decrease in range of 100 yards every six seconds it will be seen that this alteration may be very substantial.

The present method of adjusting the angle is to move the sight with relation to the gun and then to move the gun and sight together to align the latter. It will be observed that the gun captain has to perform the last named operation. The movement of the sight to or from the gun to effect the adjustment must, if the sight is aligned upon the target, necessarily throw the line of sight off the target, and if a telescope is employed it may possibly carry the target out of the field of the telescope altogether—in any case disturbing the aim of the gunner, who has to perform a subsidiary operation to that for counteracting the roll of the ship and movement of the target. Moreover, this disturbance of the line of sight, if effected at the moment of firing will cause either inaccurate shooting, or a delay necessary for a new alignment; and the accompanying uncertainty of the gun captain and consequent distraction of his attention are highly prejudicial to accurate shooting.

With the gear designed by Captain Hubert Grenfell of the British navy, by whose courteous permission we are enabled to publish the accompanying illustrations of the fitting on board the British cruiser



DETAILS OF THE OPERATING MECHANISM.



THE GRENFELL GUN-SIGHTING MECHANISM, SHOWING DIFFERENTIAL GEARS OPERATED BY THE GUN-SETTER.

"Narcissus," together with a diagrammatic explanation of its action, this delay, inaccuracy and distraction are entirely eliminated. The most salient feature of this device is that when effecting the adjustment of the angle between the gun and sight it is not the sight that moves, and the gun that remains still, as in the existing service mountings, thus disturbing the aim and necessitating a subsequent operation; but the gun is the moving part and the sight remains fixed. The gun is in fact moved toward and from the sight, the angle being shown by a suitable indicator marked in ranges. The consequence is that the line of sight is not disturbed in any way, the speed of adjustment is increased, and the gun captain being unconscious that the operation is taking place is left unaffected by any extraneous influence and consequently is free to devote his whole attention to his own particular duty.

Moreover, the sight setter can maintain the adjustment correct with the utmost confidence and celerity right up to the instant of discharge. He is in fact necessarily raised to his true value, and his function becomes of extreme importance, since it is no less than that of controlling the work of the firer of the gun to produce the desired result.

The operations of both the gun captain and sight setter, although each involving a distinctly different set of relative movements of gun and sight, can be carried out simultaneously as well as independently. This is effected by the introduction of a differential train of wheels into the elevating mechanism, one end of the train being under the control of the gun captain by means of his hand wheel, while the other end is under the control of the sight setter, who is provided with a similar hand wheel. The motion imparted to the gun, if both hand wheels are worked simultaneously, is the sum or difference of motion imparted by the hand wheels, depending upon whether they are worked in the same or opposite directions—but the result, as far as the alignment of the sight and the adjustment for the range are concerned, is the full amount intended by the respective operators, being wholly dependent upon the motion of their hand wheels, and completely under their separate control.

This mechanism, then, fully provides for the requirements imposed by the conditions of continual and rapid change of range, and the imperative necessity of isolating the arduous duties of the gun captain. A more comprehensive explanation of this action of the Grenfell gear is afforded by means of the accompanying diagram, wherein the mechanism of the apparatus is shown. *A* is the gun cradle, *B* is the elevating arc, *C* is the elevating pinion mounted on the shaft *D*, carried by fixed bearings on the mounting. On the shaft *D* is a differential train of wheels comprising a cross-arm *E* fixed to the shaft and carrying a pair of bevel wheels, *FF*, gearing with the driving wheels *G* and *H* mounted loosely on the shaft. Formed on the driving wheel *G* is a worm wheel *J* gearing with a worm *K* (not visible in the diagram) which is driven by a hand wheel under the control of the gun firer for bringing the gun and sight to bear on the object to be fired at *without altering the sight relatively to the gun*. Formed on the wheel *H* is a worm wheel *O* gearing with the worm *P* driven by a hand wheel under the control of the sight setter *for adjusting for range*. The sight bar *V* is pivoted on the cradle *U*, and its curved rack *T* gears with a pinion *I* carried by the cradle (bearings not shown for sake of clearness), and fixed to turn with a pinion 2 which gears with a curved rack 3 mounted with, and capable of sliding in, a curved guide (not shown) fixed to the cradle. The center of curvature of the rack 3 and of its guide, is the center of the trunnions. 4 is another pinion geared to the rack 3 and fixed to rotate with a worm wheel 5 gearing with a worm 6 that is driven through a pair of bevel wheels 7 and 8, and pinion wheel 9, by the tooth wheel 10 formed on the wheel *G* of the differential train.

The action when operated by the gun firer only is as follows: To elevate or depress the gun *without altering the sight bar relatively to the gun*, i. e., to align the sight, the gun firer turns his hand wheel in the required direction, thus turning the driving wheel *G* of the differential gear, which imparts a rotary motion to the radial bevel wheels *FF*. As the opposite wheel *H* is meanwhile held fast by the worm *P*, the driving wheel *G* causes the radial wheels *FF* to roll on the now stationary wheel *H*, thus turning the elevating shaft *D*. The gun is thus elevated or depressed, as the case may be. At the same time the tooth-wheel 10, being fixed to the driving wheel *G*, is turned, thus elevating or depressing the curved rack 3 *with the gun*. There is therefore no relative motion between the rack 3 and the pinion 2, consequently the general result is that the "*axis of the gun*" and the "*line of sight*" are raised or lowered through the same angle without altering the adjustment of the sight bar for range.

The action when operated by the sight setter only: *To alter the adjustment of the sight* for an increase or decrease of range, the *sight setter* turns his hand wheel in the required direction, thus moving the driving wheel *H* and imparting a corresponding motion to the elevating pinion *C*; the radial wheels *FF* in this case rolling on the driving wheel *G*. The latter being held stationary by its worm, no motion is given to the curved rack 3, which remains locked, its guide moving with the cradle. The pinion 2 also moves with the cradle and consequently rolls on the stationary rack 3, thereby turning the sight bar relatively to the gun cradle through the same angle as that through which the cradle moves, but in the *opposite direction*. The result is, therefore, that the "*line of sight*" does not move, but the "*axis of the gun*" under the movement of elevation or depression given to the gun by the rotation of *C*, moves up toward or down from the "line of sight," according to the direction and extent of the change in range.

The action when operated by both men together is that both wheels are worked simultaneously. The speed of both operations is therefore entirely dependent on the speed with which the wheels are turned, and the motion of the gun, as already stated, is the sum or difference of the motions imparted by the separate gears. The result in this case is precisely the same as that which would be produced if the operations were performed separately and in succession.

With mountings, however, in which the sight pivots round the trunnion axis, the intermediate gearing numbered in the sketch, is not required.

With regard to the ranging of the gun this may be achieved in various ways—by estimation; by the use of range finding instruments; by the observation of fall of shot, etc. But it is believed that the last named method is the only one that will give the required accuracy, speed, and continuity under the extremely adverse conditions of a naval engagement.

In order that the sight setter may obtain the proper data for the performance of his duties, he must be either in a position to observe for himself, not only the opposing ship and the varying conditions, but also the fall of the shot from his own particular gun.

But where two ships are hotly engaged and all guns are being fired with the utmost rapidity this will be practically impossible. Moreover, the modern practice of mounting guns in casements and in inclosed batteries does not allow of the extended view that is requisite; nor under the circumstances is the sight setter in a position for calm observation and rapid deduction.

On the other hand, if all guns are adjusted for the same range, etc., their shots would fall in close proximity to each other, and an independent observer from a satisfactory position would be able to determine the amount of correction necessary, first with the target, and subsequently to maintain effective fire.

This is the idea embodied in the system of range indicators, also devised by Captain Grenfell, herewith illustrated. The apparatus is based on the well known bracket system of ranging, and the following is a description of an installation lately fitted in the British battleship "Venerable." Close to each gun in the various groups is a range indicator, showing ranges from 1,000 to 10,000 yards. The indicators of each group of guns are actuated by a transmitter in the conning tower, whereby an operator in the last named part of the ship orders the same adjustments for all the guns.

In the fore-top is an observer whose duty is to note and inform the conning tower as to the position of the fall of the shots with relation to the target. For this purpose he is provided with a transmitter actuating a similar recorder in the conning tower showing this relative position of the shot to the target, either short or over. Upon this data the operator in the conning tower corrects and maintains the range ordered for use by the guns. Thus the sight setters are kept constantly supplied with the precise information upon which the effect of the fire depends, and a very high collective accuracy of the artillery fire is assured.

There now remain the final conditions that must be satisfied, namely, providing means to insure that the artillery is employed in the most suitable and effective manner in each of the varying phases of an engagement, and the prompt handling of exceptional and fleeting opportunities, giving in effect the captain of the ship the immediate control over all the elements in the offensive operations, so that his vessel as a whole shall respond instantly at his command to the exigencies of the moment.

For this purpose Captain Grenfell has devised a system of electrical indicators (of which the beforementioned range indicators form one part) showing the necessary orders and signals. This system has been installed in the battleship "Venerable," and in the accompanying engraving we illustrate some of the instruments.

The system embodies the following features which are essential to any practical system: (1) Ability to give *immediate* orders to *all* parts of the ship whose combined actions are the groundwork of rapid and accurate firing. For example, while all guns must be kept acquainted with the range, the nature of the fire to be employed, the antagonist and at which part of her to aim, it is not less necessary that the shell rooms and supply parties should know immediately (as the guns) what they are to supply and any change in their duties. (2) That the orders when displayed in the various parts of the ship should be very legible, and that to prevent mistakes, only one order should be seen at one time, namely, that which has to be acted upon. (3) That an order once displayed should remain visible and acted upon until countermanded by another order.

Confusion is inevitable unless these principles are carried out in the system employed.

In the Grenfell system the orders and signals are displayed upon the surfaces of drums. Each group or nature of orders is arranged upon a separate drum. Only one order of each group is rendered visible at a time, the drum being rotated so as to bring the required orders opposite an aperture in the covers of the instruments.

For the purpose of the system the various groups of guns, their shell rooms and supply parties, are taken as separate units, and all the indicators of each unit are operated by a single set of transmitters in the conning tower. By this means each group of guns can be handled separately, and the chance of a general breakdown is minimized.

The conning tower transmitters are mechanically operated while electrically actuating the receivers at the guns, etc. In this way the transmitters are very considerably reduced in size and occupy little area in the confined space of the conning tower. Moreover, it has been found possible to make them very much more substantial than electrical instruments, which as they will be exposed to the concussion of bursting shells either on, or in proximity to, the conning tower, is very desirable.

The arrangement of the indicators in a group of 6-inch guns is as follows: At each gun are instruments showing the range, the bearing, the particular ship of an enemy's squadron, the part of the opponent it is desired that that particular gun should attack, the projectile to be employed, the orders to commence slow or rapid fire, and to commence and cease fire.

In each shell room, and at each supply tube or whip is an indicator showing the nature of the projectiles to be supplied. The change of an order at any position is announced by the ringing of a gong. A similar arrangement is employed for the main armament, the range and bearing instruments, etc., being suitably placed for observation from the sighting hoods.

From this it will be realized that the captain of the ship can immediately concentrate all his fire upon any particular unit of an enemy's squadron, on any part or parts of that ship, and with the projectile most suitable to the range and the nature of the resistance offered. He can change the nature of the projectile as occasion demands with the greatest celerity, and no confusion can take place below. He can direct one group of guns to attack one part, and another group of guns to attack another part of his antagonist. In fact, with this system he can handle his ship and all the armament as a single weapon, over which he has absolute and instant control.

Brief Notes Concerning Patents.

Oscar Hammerstein, the theatrical manager, is the inventor of no less than eighty devices of various kinds on which he holds patents. His latest achievement is a machine for wrapping cigars. The thin wrapper is picked up and held against a wooden block by means of an air suction, and is passed over and around a bunch of tobacco, which it proceeds to encircle from one end to the other. Mr. Hammerstein says that at a cost of $1.50 per thousand, this machine will do the work of a man who is now getting $4.50 per thousand, and will do the work generally better.

By the invention of J. D. Kneedler, of Sioux City, Iowa, a vending machine has been made which will give up a spool of thread, cotton or silk, upon being fed a coin. As the machine gives the operator the choice of a large range of color and size, it has met with the favor of several manufacturers in the silk and cotton business, and the machines will be placed in a large number of stores throughout the country. They are said to be favored also by the store proprietors, for the reason the scheme prevents theft and relieves the salesmen of the annoyance of attending to trivial sales.

Ex-Senator Charles A. Towne, of Minnesota, recently paid a visit to Niagara Falls, for the purpose of making preliminary arrangements for the construction of a new building to accommodate a new industry. The Senator is interested in the American Carbolite Company, and it is proposed to locate a plant there for the manufacture of an acetylene gas generator and other allied industries. The works will cover about ten acres, and will give employment to about three hundred men. It is proposed to build a model city, which will be brilliantly illuminated by the use of acetylene. The process made use of by the company is the invention of Herman L. Hartenstein, of Chicago.