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NAVAL GUNNERY -- 1924

Lecture delivered by Commander H. K. Hewitt, U. S. Navy

10 October, 1924

Naval War College
Newport, R.I.

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In preparing this talk for the War College, I have assumed it to be my primary mission to give you the information in gunnery in the fleet that will be of the most interest to you and of the greatest assistance in your tactical studies. I shall describe, in a general way, the exercises carried out by the various types of vessels during the past year, and those which are planned for the coming year, and shall discuss more specifically such progress made and lessons learned as are believed to be worthy of special note. If I fail to touch upon any subject of interest to the class, or do not go into sufficient detail, I shall be glad to answer, to the best of my ability, any questions that may be asked.

Owing to the delay in the receipt of many reports, I have not available as complete an analysis of the results of the Gunnery Year as I hoped to have at this time. In general, however, while there have been many disappointments, I believe the work of the past year has been most satisfactory and that substantial progress in the art of gunnery has been made.

The scope of the Office of Fleet Training has recently been broadened to include a tactical section. Since gunnery problems and tactical problems are intimately related, a close liaison between these sections has been established, and in preparing future gunnery exercises, the tactical section will always be consulted.

BATTLESHIP GUNNERY

Of the eighteen battleships which were in commission during all or part of the gunnery year, only eleven completed the scheduled exercises. Due to unfavorable weather conditions

on the Southern Drill Grounds, and later, the condition of their engineer departments, four ships fired Short Range Battle Practice only. Another failed to fire Long Range Battle Practice due to necessary engineering overhaul. As a result, over 25% of the battleships received only a partial training in gunnery. Owing to the requirements of the Midshipmen's Practice Cruise, the battleships of the Scouting Fleet are always handicapped in this respect, and, as a whole, are not up to the standard of the Battle Fleet. Two vessels, newly commissioned, were not ready in time to do any firing.

Short Range Battle Practice

The past year marked a return by the battleships to the old familiar short range battle practice. The interest shown and the results obtained in this practice were highly gratifying. The average hit per gun per minute of all calibers, except the 3-inch A.A., were higher than ever before, and in the 14-inch the improvement was most marked. The average hits per gun per minute of 14-inch 50 caliber turrets was 1.50 and of 14-inch 45 caliber turrets 1.55, as against the previous high average of 1.19, obtained in 1921, an increase of about 30% in effective volume of fire. Five-inch 51 caliber guns averaged 4.50 against a previous high average, in 1920, of 3.92.

There is no doubt that this practice arouses great interest and is an excellent incentive in elementary training. It affords, however, no training whatever in director fire. Unfortunately, it has been necessary to abandon short range director practice, in order to avoid crowding the periods which can be allotted to gunnery exercises. The idea seems to be a short range battle practice which will combine both

pointer and director fire, but to date no completely satisfactory practice of this nature has been devised. The combined practice fired by the battleships in 1923 was an excellent training, but created great dissatisfaction owing to the difficulty of determining the hits, and the time which elapsed before the scores could be finally announced. The target for this form of practice must be at a range sufficiently great to avoid too many artificialities in the director system, and yet must be large enough to catch all properly aimed shots.

Night Practices

The last gunnery year marked the introduction of the new long range star shell, which permits an illumination up to about 14,000 yards with a 20° elevation and to about 10,000 yards with a 15° elevation. As the 5-inch gun mounts of the older ships have a maximum elevation of only 15° , the alteration of these mounts to give increased elevation is under consideration.

The nigh practice of last year was fired at ranges from 8,000 to 9,500 yards. It was an individual ship practice fired at two towed targets, one for the main battery and one for the secondary battery. The ship stood in with the targets broad on the starboard bow, and opened fire with the main battery and group one of the broadside battery. After one minute, it turned left to bring targets on the quarter and opened with the starboard quarter group. Then the ship turned 240 right with the standard rudder and opened fire with the port battery as rapidly as the groups began to bear.

The practice was designed to give rapid changes of range, and to simulate maneuvering conditions which might occur in a night action. It was found to be rather difficult, on account of firing with the ship under helm, and as a competitive practice it was not entirely satisfactory. As observation of the fall of shot was almost impracticable, a constructive target could not be used, and hits on the material target at that range were to some extent matters of luck, even when perfect straddles were obtained.

It was decided this year to divide the practice into two parts, one simulating a main battery action between capital ships, at a range of about 10,000 yards, and the other simulating secondary battery fire to drive off enemy light craft which has penetrated the screen. On the former practice long range star shell alone will be used, and the firing unit will be a division, there being a target for each ship.

Since all our previous experience with star shell has been with single ships, we are most anxious to obtain information on the subject of illumination by ships in formation. In order to give the division commander ample latitude in this matter, the distribtuion of the division allowance of illuminating projectile is left in his hands;that is, he may direct each ship to illuminate its own target,or may designate certain ships, or one ship, to illustrate for the entire division. Personally, I beleive that there may be chance of confusion between stars fired by adjacent ships, and that the most effective illumination can be obtained by a single ship firing spreads so spaced that the arc of illu-

mination is practically continuous and covers the division fire sector. This, however, is entirely a matter of opinion, and requires demonstration. If found practicable, it would result in greater simplicity, since the illumination would be controlled by one director and control officer, and probably main battery efficiency would be increased, since the interference and blinding effect of star guns fired at odd intervals would occur on one ship of the division only, instead of all.

It was found, with the old 6,000 yard star shell, that, if the projectile was fired to the full range, and burst about 1500 feet high, it gave effective illumination, by silhouetting, to a target at any range up to about 5500 yards. This greatly simplified control, since it permitted a single fuse setting, and a single sight setting in elevation. The same effect is obtained with the longer range projectile, but since the further behind the target the star bursts, the more nearly on in deflection it must be, it appears probable that several illumination zones should be established, with a fixed sight setting and fuse setting for each zone. Boards in the fleet will consider the entire subject of star shell control upon the completion of night firings this year, with a view to drawing up standard instructions and procedures.

In this connection, also, thought is being given to the use of aeroplane flares for target illumination, with the idea of increasing still further the main battery night range. The experiments so far conducted have not been very conclusive, due largely to the unreliability of the flares, which have been of old Army war stock. However, it is hoped the Bureau of Ordnance will soon have improved flares ready for trial.

The Battle Fleet is training its aviators for night spotting, and, it is understood, will attempt such spotting during the coming practices. This may prove a very interesting development.

The secondary battery practice is practically the old night practice of two years ago, fired at ranges between 6,000 and 5,000 yards. There is a run for each battery, the illumination on one side being by short range star shell, and on the other, by searchlight. This will not only afford a comparison between the two means of illumination at short range, but will ensure that the searchlights, as long as they are carried, are not entirely neglected. While this is essentially an individual ship practice, it is fired simultaneously by all ships of a division, in order to reduce the time necessary for carrying out the exercise.

The Office of Fleet Training, with the lessons of the night after Jutland in mind, is fully alive to the importance of night firing, and will do its utmost to develop this feature.

Long Range Battle Practice.

Main Battery.

Reduced charges were used by turret guns at Long Range Battle Practice this year, in order to permit the use of full charges at Force Practice. In other respects, this practice was unchanged from the form which has been fired for several years.

The most notable feature in the result of this practice was the greatly increased volume of fire. The maximum shots per gun per minute obtained was 2.01, which is the highest ever made. This was the performance of the TENNESSEE, which fired seven regular salvos in 3 minutes and 19 seconds, even though one salvo was slightly delayed by a wild turret. The average shots per gun per minute was 1.39, as compared with 1.20 in 1923 and 1.05 in 1922, an improvement of about 38% in two years. This improvement has been accomplished not so much through more rapid loading, as by the elimination of many delays in the other factors which go to make up the salvo interval. All battleships made very careful time studies of their operations. The accuracy has apparently not suffered since the percentage of hits, 9.01, is slightly better than the average of 1923, and only slightly less than that of 1922.

The average hits per gun per minute rose from 0.10 in 1922 and 0.09 in 1923 to 0.13 in 1924. It might be argued that the shorter range accounts for some of this improvement. However, the shorter range should not affect the rate of fire materially, since all ships were using almost maximum elevation.

The percentage of hits is believed to be about the same or possibly less than would have been obtained at full range with full charge. Reduced charges appear to be more erratic in performance than full charge and patterns averaged slightly larger than in the full charge practices of the preceding two years. Probably fewer straddles on the first salvo would have been obtained at the higher range, but it is thought that the majority of ships would have straddled at once.

Our patterns are greater than desirable, and every effort is being made to determine the cause of excessive dispersion in order that his feature of our gunnery may be improved. The calibration of the 16-inch gun ships, at 25000 yards has given excellent results, the dispersion being much less than that determined by extending the old dispersion curves out to this range. The dispersion obtained by the CALIFORNIA and TENNESSEE at this range at Long Range Battle Practice is also much less than the normal. The present indication is that, after certain ranges are reached, dispersion does not increase, and may perhaps decrease. Further along range firings will be necessary, however, to confirm this theory.

Secondary Battery

The five-inch battery performance was most disappointing, the value of fire and percentage of hits both falling off considerably from previous results. The average range was 13,000 yards; shots per gun per minute 3.84; hits per gun per minute 0.10; and the percentage of hits 3.47. A preliminary analysis indicates that this poor performance was largely due to poor control and that considerable improvement may be made by paying more attention to fire control. More firing is extremely desirable, but lack of time and funds prevent. Without highly trained control personnel, the secondary battery cannot be relied upon to stop attacking destroyers before they could enter effective torpedo range.

During Force Practice, one squadron of destroyers launched 35 torpedoes at ranges of from 9,500 to 12,000 yards. Of these, which are but a small portion of the full torpedo power of the squadron, 11 hits were made on 6 battleships. If in addition we consider the vulnerability of the secondary

battery as amply demonstrated by the IOWA firing, the necessity for light cruisers becomes most apparent.

Force Practice

Force practice, fired by the Battle Fleet in June, was the most complete form of battle practice which we have yet had. It was designed to exercise all three batteries simultaneously and also to introduce the effect of torpedo fire. The battle line was called upon to fire at a previously unknown number of battle targets and to shift fire distribution at least once during the firing. The secondary battery was to fire at pyramidal targets representing destroyers which were cast adrift on the engaged bow of the battle line. During the firing of the main battery, airplanes towing sleeve targets were to fly over and simulate a bombing attack. A squadron of destroyers also was to deliver a torpedo attack, so timed, if possible, that the torpedoes would reach the battle line during the firing. It can be seen that this procedure required very careful coordination, but it was successfully carried out by the Battle Fleet in a most efficient manner.

As a result of this practice, it is known that the three batteries can be fired simultaneously and effectively, although there is considerable interference. The blast effect on the after 5-inch guns is most severe when the after turrets fire forward of the beam. Anti-aircraft guns mounted on top of turrets are not effective. The remainder of the anti-aircraft guns were able to fire on the disengaged side, from which the air attack came, without much difficulty.

The main battery was fired with full charges at the maximum range of the shortest-ranged ship in the fleet. Full charges were used on this practice this year for the reason that it was felt Force Practice had been held for a number of years under very artificial conditions and that at the higher range the fire control difficulties of ships in formation would be greatly augmented. The practice was apparently most interesting and spectacular and was favorably commented upon by all the flag officers of the fleet. It may be repeated next year, with the exception of being fired with reduced charges instead of full charges.

Owing to the difficulty of plotting the fall of shot of so many ships firing simultaneously, some of the results are doubtful; but, on the whole, the main battery firing was not as effective as at the Long Range Battle Practice. This may be attibuted somewhat to the difficulty of ships keeping on the proper target and to range finding and spotting at the longer range. Some may also be due to smoke and gas interference upon which comment was most general. The wind was apparently nearly dead ahead.

The fire distribution and number of targets, as previously stated, were unknown until the approach. The fleet flag signalled "four enemy ships in the battle line". By previous agreement this was understood to mean the rear four targets of the tow. The fleet flag designated the 3rd target from the right as her target and the fire was distributed properly by all ships except the NEVADA, which fired at target No. 7 instead of No. 6, thereby effecting a quadruple concentraion on that target. After firing the second salvo, the fleet flag signalled "seven ships in the battle line" and designated her target as the second from

the left. The shift of fire distribution was carried out properly with the exception that the NEVADA shifted from target No. 7 to No. 5. Due to failure to receive the signal, the OKLAHOMA continued to fire on her original target. The TENNESSEE was late in receiving the signal and did not make the shift until after the 7th salvo. Target No. 4 was left unfired on during the second phase. Several ships fired occasional salvos at the wrong target. There was general difficulty in receiving flag signals from the next ahead, as in many cases these signals were not received at all by radio, or were not received properly. Battle signal stations were reported to be inadequate.

No observation could be made of the fall of shot of the secondary battery, but it was understood from the report of aircraft observers that it was on the whole very good.

The doctrine for the distribution of fire of the secondary battery developed by the Battle Fleet, and which will be mentioned later, was used effectively. Unfortunately, only three target rafts were available for the secondary battery targets. These had pyramid targets mounted at each end, which gave six targets in all. However, while it is not the present policy to concentrate with secondary batteries, the separation of the targets on the same raft was not sufficient to avoid the effect of a concentration.

The torpedo attack was most successful, as previously stated. The torpedoes reached the line in two to three minutes after commence firing. Ships were permitted to maneuver to avoid torpedoes, but only in one or two cases were such maneuvers reported. Several ships stated that the torpedoes which struck them were seen too late to be avoided. In no case is the data sufficient to determine the effect of the

maneuvering on gun fire.

Aircraft spotting

Aircraft spotting has now reached the stage where it is believed its importance is fully realized. A glance at the reports of spotting practices for this and the two years preceding will assure anyone of the ability of plane spotters to estimate the fall of shot. The poorest aircraft spotter is almost invariably ahead of the best ship's spotter. Communication between ship and plane, which was originally the greatest stumbling block, has been improved. On Long Range Battle Practice spots were received by ships in from three to four seconds after the salvo landed. However, where a number of ships are firing simultaneously, the wave lengths of the planes are so close as to cause interference, unless the receivers are tuned very sharply, and therefore, if the tune is slightly off, the plane is lost or the wrong plane received. It is reported that the tune is frequently deranged by the shock of gun fire. Another difficulty is in the shifting of tune to another wave length, when the target is shifted, which of course requires very carefully calibrated receivers and planes with carefully calibrated wave lengths, not subject to variation.

The problem was further complicated by the difficulty at times of planes identifying their proper target, or of ships in concentraion identifying the spots belonging to their own salvos. Detailed information as to the success or lack of success of aircraft spotting at Force Practice is as yet lacking. All the data in this connection has been

submitted to the Fleet Boards which are to revise the existing instructions with respect to aircraft observation. The use of a projectile giving a distinctive colored splash for each ship of a division, which will be discussed later, should greatly simplify aircraft spotting, and may completely alter the present procedures.

Indirect Fire.

The subject of indirect fire is most interesting. Two exercises of this nature have been carried out since the installation of the Stable Zenith Instruments, one in 1923 and one this year. The first exercise was entirely successful insofar as range was concerned, but there was a very large variation in deflection. The firing ship straddled on the second salvo and continued to straddle in range. In the second exercise, the firing ship could not elevate sufficiently to apply the first airplane spot of up to 30000, but continued nevertheless to fire. The range, estimated to be about 33,000 yards, was probably nearer 38,000 yards. No shot fell nearer than about 4,000 yards from the target and practically nothing was learned.

For those who may be unfamiliar with the method of indirect fire, I will outline the procedure. During the approach the observation planes estimate course, speed and range of enemy and indicate the bearing. The bearing plane places itself in line with the firing ship and target, giving a "mark" by smoke signal and radio when exactly on. The ship trains the target bearing transmitter on the bearing plane and plot notes the bearing indicated at the "mark". All the foregoing information is then set on the range keeper

which proceeds to generate range and bearing. The bearing is "freshened" from time to time by further observation of the bearing plane. The battery is kept trained on the bearing generated by the range keeper by means of the target designation system. When commence firing is ordered, the battery is fired from the Stable Zenith Director in the plotting room. This instrument is the same in principle as the ordinary director, except that instead of the target or the actual horizon, it uses a small artificial horizon line which is stabilized by the action of two gyros. . . . Range spots are applied in the usual way. Small deflection spots are also applied in the usual manner, but large range spots are applied as corrections to the generated bearing. The range keeper operator considers these spots in correcting his set-up until finally a good estimate of the enemy course and speed is obtained.

The Stable Zenith Instrument, when properly adjusted, will hold the zenith within reasonable limits under normal conditions. On large turns, however, the instrument is subject to an error which may produce a change in the mean point of impact of as much as 500 yards. The problem of indirect fire, however, as far as range is concerned, is believed to be well solved. The maneuver rules should allow the range to be established by plane spot alone.

In the case of deflection, considerable inaccuracy exists. The mean point of impact in deflection was found on the first exercise to swing from one side of the target to the other, sometimes by as much as about 1,000 yards.

Analysis has shown this error to be due to several causes, but primarily to the normal hunt of the gyro compass. Since the generated relative bearing depends on the compass, this hunt, which is usually about 40 minutes, at least, is transmitted to the battery, augmented by whatever lag may occur in the range keeper and in the designation system. It is understood that efforts are being made to develop an improved compass. The Bureau of Ordnance is studying the elimination of such of these errors as are inherent to the fire control system.

Another development in the near future is expected to be the use of the radio direction finder for indicating the bearing of the plane. The Bureau of Engineering is working on this problem and promises reasonable accuracy. If this proves successful, the advantage will be evident. At present the bearing plane must be able to -

(a) see the enemy.

(b) be visible to the firing ship, and

(c) be identified by the firing ship.

Radio bearings will remove these restrictions and the plane may indicate bearing from a position close to the target.

With the present stage of development, we may employ indirect fire to spray an enemy formation, but we cannot deliver an effective fire against a single target by this method.

Concentration of Fire

The purpose of Advance Practice "B" was to determine the efficiency of double and triple concentration, as compared with single ship fire. This practice was carried out by the TENNESSEE, IDAHO and MISSISSIPPI firing reduced charges at a range of about 12,000 yards. The TENNESSEE and MISSISSIPPI opened with a double concentraion for six salvos, after which the IDAHO joined in forming a triple concentraion for six salvos. The last six salvos of the IDAHO were fired singly.

The rate of fire obtained was uniformly high, the shots per gun per minute for all three ships being almost 1.5. Thirteen percent of hits were made. The standard instructions for the rotation of fire were followed and were found to be most satisfactory. In only two cases did a ship miss its proper turn, or were salvos fired sufficiently close together to make salvo identification difficult. These occured during triple concentration when the hitting gun range had been thoroughly established, and did not affect the fire. Aircraft spots were made and transmitted to the firing ships, but were not received or used by the fire control party. It is therefore not known what difficultythere would have been in identifying these spots.

In the double concentraion the percentage of hits was 15.4. The target was being straddled at an average interval of 19 seconds, and was being hit at the rate of 6.3 hits per minute.

In the triple concentraion, the IDAHO failed to straddle until the fifth salvo, due to an error in determining the initial gun range. Assuming a performance for that ship equal to the average of the other two, the percentage of hits was 12.8, and the target was being hit at the rate

of 6.9 hits per minute, with a straddle every 14 seconds.

In the single fire, the percentage of hits was 15.3, and the target was hit at the rate of 3.9 hits per minute, with a straddle every 44 seconds.

To summarize, the rate of hitting and percentage of hits were as follows:

Triple concentration ..... 8.9 per minute - 12.8%

Double concentration ..... 6.3 per minute - 15.4%

Single fire ..... 2.9 per minute - 15.3%

These results appear to indicate that there is no loss of efficiency in double concentration, and that the fire effect is double that of single fire. The triple concentration shows a loss in percentage of hits and only a very slight gain in fire effect over the double.

Quoting the conclusions of the Commander-in-Chief, Battle Fleet, in his report of this practice, "It is obvious that conclusions based on one practice must be accepted as tentative and in the nature of the best obtainable information to date but subject to future modification. In so far as general conclusions can be drawn from single experiments the Commander-in-Chief considers the following to be established:

(a) That the doctrine governing firing intervals for double and triple concentration is practicable, permitting proper identification of salvos.

(b) That double concentration involves no loss of fire effect as compared with single ship fire.

(c) That triple concentration involves a marked loss of fire effect as compared with single ship fire or double concentration.

(d) That, regardless of economy of fire or average fire effect of individual ships engaged, double concentration in its total effect is equally as destructive as triple concentration and perhaps more so, from which it follows that no conceivable fire distribution of a battle line should include both single ship fire and triple concentration at the same time. In other words, all enemy ships should be under double concentration before triple concentration is attempted."

The Bureau of Ordnance has developed a means of coloring the splashes of projectiles. On tests at Dahlgren, and on the calibration practices of the COLORADO and WEST VIRGINIA, these have proven quite satisfactory, even under adverse light conditions. It now remains to make a final determination of the best colors, and the number which can be made readily distinguishable. When adjacent ships are firing projectile which make distinctly different colored splashes, there should be little difficulty in identifying salvos, and it may be possible to remove the time sector restrictions now governing triple concentration. This would result in a higher rate of fire, and a correspondingly greater fire effect.

SECONDARY BATTERY FIRE DISTRIBUTION

Advanwe Practice "C" was designed to simulate secondary battery fire by two divisions of battleships on a squadron of attacking destroyers, with the view of testing existing instructions for secondary battery fire distribution, and of determining the hitting power under such conditions.

Nineteen pyramid targets were to be anchored, or allowed to drift, in positions simulating destroyer attack formation.

The instructions for secondary battery fire distribution are as follows:

" (a) Save in exceptional circumstances, the fire of a broadside will not be divided, but will be controlled as one group. Departure from this rule may be made, however, in the discretion of Commanding Officer.

(b) Ordinarily the broadside batterties of two or more ships will not be concentrated on one target. Commanding Officers may make exceptions to this rule but should do so for short bursts of fire only, and then only when an attack appears to be particularly dangerous, as when delivered at moderate range under cover of a smoke screen.

(c) The division shall be the tactical unit for the control of fire against destroyers, the same as against capital ships. The O.T.C. will ordinarily leave the direction of such fire and the assignment of targets entirely to the Division Commanders but may, at any time, order such broadside fire as he may wish. The commander of the division nearest the attack shall initiate the action for repelling the attack. As the range and bearing of targets become more favorable for succeeding divisions to engage, the commanders of such divisions will open fire. As soon as a leading division notices that another division is engaging their targets, fire shall be shifted to succeeding targets.

(d) Signals in connection with secondary battery firing will be reduced to a minimum. Division Commanders shall open secondary battery fire in accordance with this doctrine without signal from the O.T.C. When a division flagship opens fire on a target, other ships of the

division shall open fire, each ship taking one target in regular order in such a manner as not to cross fire. When the flagship shifts target the other ships will shift in the same direction so as to keep all targets under fire. Commanding officers shall open fire at targets suddenly presented in positions favorable for immediate and effective torpedo fire, such as destroyers appearing at short range through smoke or fog.

(c) Commanding Officers shall engage main battery target with secondary battery when the range is favorable but only when no other secondary battery targets are available."

Owing to the small number of targets available (nine), the firing unit was reduced to two divisions of two battleships each.

No fall of shot data was taken, but all targets, except one, were hit. The fire distribution instructions were declared to be practicable and satisfactory. It was also found practicable for one ship to keep a number of targets in the same formation under fire, by shifting from one to another in rotation.

Efficient secondary battery control requires that the director be in the same station and under the direct observation of the control officer. This condition obtains in the TENNESSEE and MARYLAND classes, but not in the older ships. It can only be corrected after strengthening the masts, and should be combined with the work of increasing the height of the control stations. Increased height of control stations will not only improve spotting, but should lessen casualties among control personnel by removing them further from the zone of flying fragments.

Advanced Practices for Present Year.

For the present gunnery year, Advance Practice "A" and

"C" will be repetitions of the indirect fire and secondary battery fire distribution practices of this year, with the exception that, due to reasons of economy, the indirect fire will probably have to be fired with reduced charge at a range of not over 23000 yards.

Advance Practice "B" will be a practice designed to determine the efficiency with which turret fire may be controlled during a turn of 180°. This practice was fired during 1923, and demonstrated that such a turn can be made practically without loss of fire effect, except that due to halving the volume of fire while one group of turrets does not bear, and is training around to meet the target on the opposite side. No difficulty is experienced by director or turret trainers in keeping on, and the deflection can be held on if the plotting room keeps introducing the proper correction for trunnion tilt, as the target bearing charges. This is made necessary by the list of the ship during the turn.

I mention this, in view of the present maneuver rules for loss of fire effect during turns. I believe the penalties for changes of course, particularly of own ship, to be greatly excessive, and liable to lead to false conclusions of the game board. Since the installation of the "Follow-the-Pointer" system in elevation, director corrections may be changed quickly, and change of course of 30° are made regularly at target practice, without apparent loss of fire effect by well trained ships. If the director, and the plotting room are informed promptly when the rudder is put over, there is no difficulty in meeting the situation.

Anti-Aircraft Gunnery

All anti-aircraft practices of battleships are now fired using a towed sleeve target, which is the most satisfactory yet developed. The present size of sleeve, however, is rather difficult to see at times, particularly at extreme ranges. It is hoped that the sleeve of improved form recently designed will permit larger sleeves to be towed. Gliders, capable of being launched from planes, have been manufactured and are to be given a trial as targets in both the Battle and Scouting Fleets.

The rapidity of fire and other conditions connected with anti-aircraft fire are such that accurate observation is not possible. The results of the year's firing therefore do not indicate whether or not any advance in this form of fire has been made. It is known that a fairly efficient method of determining speed and altitude of the plane, by tracking with ranges and position angles, has been in general use.

There are several methods of controlling anti-aircraft gun fire, and one, termed a "one minute barrage", originated by Mr. Charpentier of the Bureau of Ordnance, has recently been submitted to the fleet for trial. A board has been appointed in the Battle Fleet to consider all matters connected with anti-aircraft fire, and to recommend a standard procedure.

It is not believed that any marked advance can be made in anti-aircraft gunnery until the installation of a director system. While the design of such a system involves many complicated problems, the Bureau of Ordnance believes that it has arrived at a satisfactory solution. One complete installation has been ordered manufactured for the MARYLAND, and will probably be ready about July 1.

A 5" 25 caliber anti-aircraft gun with power loading arrangements has passed successful tests at the proving ground. Batteries of these guns are being manufactured for the MARYLAND class, and the aircraft carriers.

DESTROYER GUNNERY

General.

In the destroyers, while there has been a steady increase in efficiency, progress in gunnery has been greatly hampered by shifting officer personnel, and by lack of officer personnel with adequate gunnery experience. It is believed the detail of an experienced gunnery officer on the staff of each destroyer squadron commander has been a step in the right direction. A certain amount of ammunition is allowed yearly to each squadron for training purposes. This ammunition is expended as directed by the squadron commander by the vessel designated by him as the gunnery training vessel. The only restrictions placed by the Department on the expenditure of this ammunition is that each training practice shall be conducted for the definite purpose of testing or demonstrating proposed fire control methods, and that a report shall be made stating the object of the practice, the results, and the conclusions drawn therefrom.

At present individual destroyers fire two forms of gun practices, and three forms of torpedo practice. One of these torpedo practices (B) is fired in combination with the long range gun practice, thus requiring the practically simultaneous use of both guns and torpedoes. In addition to the individual ship practice, each division of destroyers is required to fire a division practice. There are three forms of division practice, a different form being assigned by squadron commanders to each division of their squadron. There is also an Advanced Torpedo Practice conducted as a tactical exercise in conjunction with the yearly fleet mobilization, and the firing of torpedoes against the battleships in force practice.

Gun Practices.

The gun practices are short range battle practice, which requires no description, and long range battle practice. Short range director practice has been held since the installation of destroyer directors, until the present year. It is a

valuable practice, and should be continued, but the time allotted to gunnery, with the resulting crowding of gunnery schedules, made the reduction in the number of destroyer exercises advisable if not necessary. A gun practice, rather than a torpedo practice was eliminated, since the torpedo is the primary weapon, and each form of torpedo practice had a distinct purpose. The ammunition saved was utilized to give longer strings on Long Range Battle Practice.

In the long range battle practice, the towed target represents an opposing destroyer or light cruiser. It is followed at 9000 yards by two vessels outlining a battleship division, thus forming a 1700 yard torpedo target for torpedo practice "B". The destroyer stands in to the attack at 27 knots and commences firing with the gun target about 40° on bow at a range of about 5000 yards. During this gunfire, one torpedo is fired at the torpedo target. One minute and twenty seconds after "Commence Firing", the destroyer turns away 180°, opens fire with the opposite battery, and fires another torpedo at the torpedo target. The course and speed of the targets, within certain limits, are unknown to the firing vessel.

Ten rounds per gun are allowed for each battery, with a time allowance on each of 1 minute and 20 seconds. To fire the entire allowance requires a high rate of fire. Destroyer fire has been too deliberate, and the orders were drawn up with the purpose of stimulating a greater volume of fire.

All destroyers should fire a night practice, but at present time does not permit. One division of each squadron fires a night division practice each year, and the lessons learned are published to all.

Torpedo Practices

Battle Torpedo "A" is the elementary torpedo practice. The range, 10,000 yards, is marked by a reference vessel, and the target is moving at a course and speed known to the firing vessel. Four torpedoes are fired from each broadside, two being fired from each tube mount. Unfortunately, yearly torpedo losses have been greater than the replacements possible with existing appropriations. Therefore, in order to meet the wishes of the Bureau of Ordnance that the total of torpedo firing be reduced, and to gain a few additional torpedoes to be fired at other practices, it has been directed that only one broadside be fired on torpedo "A" this year.

About eight hundred torpedoes were fired at this practice during the past year and the results have been the subject of a most careful and thorough analysis. This analysis has been published in mimeograph form by the Chief of Naval Operations, and I recommend it for the consideration of anyone interested in the details of torpedo control. In general, the following conclusions were drawn:-

(a) That torpedo performance was excellent. The principal causes of failure to hit were errors in control and to a lesser extent, variations in target speed.

(b) That the ready torpedo policy is a success.

(c) That fixed or semi-fixed tube laying is superior to moving tube laying.

(d) That, in the absence of a "follow-the pointer" system, fixed tube laying is superior to semi-fixed for spread firing.

(e) That a single vessel firing at long range should not use spread.

(f) That in the case of vessels in formation firing at long range, spread should be used by each vessel.

Battle Torpedo "B" of last year, required the firing of a salvo of six torpedoes from one broadside against a target simulating a battleship division. The torpedoes had to be fired in the two minute period between six minutes and eight minutes after the "execute". At the receipt of this signal, the destroyer was required to be within a certain area, so designed as to give the commanding officer ample latitude in selecting and reaching a favorable attack position.

There has not been time to analyse the results of this practice as completely as those of Battle Torpedo "A", but the analysis which has been made fully confirms the previous conclusions. Most destroyers used the "collision course" method in obtaining estimates of the target course and speed. Owing to the lack of tracking facilities inherent to destroyers, this appears to be a most practical method, and should be developed further.

It was noted that in many cases the firing positions were not selected with any consideration of turning to fire the opposite broadside. It is desired to introduce this feature, and at the same time to retain the firing of a fairly large salvo. Therefore, for the present year, the practice has been modified so that both broadsides are required to fire. One torpedo is fired on the first broadside and four on the second.

Division Practices.

Two of the destroyer division practices are combined day gun and torpedo practices. The third is a night practice for guns alone.

Division Battle "A" combined with Division Battle Torpedo "D" simulates an action between a division of destroyers and two light cruisers, in the enemy van, during the delivery of a torpedo attack on the head of the enemy battle line. Specifically the principal objects of this practice are:-

(a) To develop a standard procedure for control and concentration of gunfire when a division of destroyers is engaged at long range with light forces, with a rapid rate of change.

(b) To develop the best open attack formation which will permit of effective gun fire during the approach and from which it will be easy to maneuver to fire torpedoes.

The gun targets are in a position with respect to the torpedo targets in which light cruisers repelling a destroyer attack might be expected to be found. The torpedo target represents a division of battleships. The division is allowed 16 rounds per gun of the engaged battery, and has 6 minutes in which to fire. At the expiration of that time it has 3 minutes more in which to deliver the torpedo attack, consisting of the actual firing of one torpedo from each vessel, and the simulated firing of the other five of the same broadside.

Division Battle "B" combined with Division Torpedo "E" is similar to the foregoing practice, except that the gun range is shorter and the opposing light forces are supposed to be destroyers. Eight pyramid targets are anchored in irregular groups of four. To obtain a comparison between pointer and director fire under such conditions, the former is required for one group of targets, and the latter for the other. The change in bearing is very rapid, and the

relative positions of the targets, as seen from the firing ships, change as the division passes.

As before, six minutes are allowed for 16 salvos and three minutes more for the delivery of the torpedo attack. In this practice all torpedoes of one broadside are required to be ready to fire. One torpedo, chosen by lot by the Chief Observer after the run starts, is actually fired.

Division Battle "C" simulates an encounter at night between a division of destroyers, and an enemy screen. The principal object of the practice is to develop and test standard procedures for control of gunfire and illumination at night, and to train the personnel in night firing. Three targets are anchored in a triangular formation. The firing division enters the target area at the base of the triangle, and changes course 45° to the right or left, as directed at the time by the Chief Umpire, in order to pass the target at the apex. Illumination is by star shell, searchlight, or both, as directed by the standard procedure. Six minutes is allowed for 16 salvos. The ranges will vary from 2000 to 3000 yards. The division is penalized for any target left unhit.

While these division practices have furnished excellent training, and much of value has been learned from them, there is yet sufficient data to establish a standard procedure for all destroyers. Methods used have varied greatly and results have been indeterminate. Furthermore, firing divisions are prone to lose sight of the general mission and to concentrate on the immediate mission, that of firing the practice. The proceduresin general have been drawn up to fit the particular practice, and have not been sufficiently broad. The type of procedure desired is well exemplified by the battleship secondary battery fire distribution instructions.

Advance Torpedo Practice.

A discussion of destroyer torpedo exercises would not be complete without adverting to the Advance Battle Torpedo Practices. Two exercises of this nature are held, in one of which the destroyer squadrons of the Battle Fleet usually form the firing force, and in the other, those of the Scouting Fleet do the actual firing. Conditions and forces are varied slightly in the two exercises.

The exercise is in general a simulated approach and engagement between two fleets, including battleship, destroyer, light mine layer, and, if available, aircraft units. The objects of the practice are stated as follows:

(a) Train officer personnel in tactics, especially in tactical scouting before a fleet action; destroyer squadron torpedo attacks during fleet action, defense against such attacks, and the tactical use of light mine layers during fleet action.

(b) Develop the tactical uses and limitations of the smoke screen under conditions simulating battle.

(c) Develop the best approach and deployment dispositions of destroyer squadrons, light cruisers, and light mine layers.

(e) Develop destroyer attack formations.

(f) Develop the system of communication to be used in tactical scouting; in the deployment of forces for battle; in handling a destroyer squadron, including maneuvering, gunfire, and torpedo fire; in handling light mine layers, including maneuvering and laying drifting mines.

As planned for last year, the fleets were to have started from positions from 40 to 60 miles apart, with light forces disposed at discretion but within a certain radius of the fleet guide. As carried out, the exercises commenced with the main bodies practically in sight contact, and with the general deployment courses known. As a result, there was no tactical scouting and all the light forces were concentrated on the flank toward which deployment was to be made. This artificiality resulted from the desire of the fleet to include aircraft units in the exercises, and the restrictions as to time imposed by the radius of action of these planes from their base. This year, tactical scouting, and the exercise in making preliminary dispositions will be preserved, at the expense, if necessary, of the participation of the aircraft.

As a practical exercise in tactics, this practice was of great value and interest to all units of the fleet, comment to that effect being most general. The reports were most complete, and after due review and analysis the results will be published in the "Annual Report of Gunnery Exercises".

While the time available does not permit a discussion of the lessons of this exercise, I desire to submit for your study a few of the major conclusions drawn by the Commander-in-Chief, Battle Fleet:

"(a) A destroyer daylight attack requires such precision of execution and such a high degree of coordination on the part of a large number of units and develops so rapidly that it is a very delicate and inherently weak proposition.

"(b) The frailty of this form of attack renders it liable to being broken up or disconcerted by a comparatively weak force.

"(c) Destroyer daylight attack is a weapon of opportunity to be held in reserve until the opportunity comes. It is not enough that the enemy's main body should be under gun-fire as a condition for launching the attack. The enemy should be not only under heavy gun-fire but should be severely punished and somewhat disorganized before the attack is launched. To do otherwise would probably mean the sacrifice of most of the attacking destroyers as against an enemy having an equality or superiority of light cruisers.

"(d) Daylight attack to be successful must be heavily supported.

"(e) The torpedoes must come in overwhelming numbers otherwise they are too easily avoided. There is a tendency to try to attack from a point too sharp on the bow. This reduces the effective target area, causes too much congestion in the vicinity from which the attack is launched and decreases the angle through which enemy's battleships must turn to avoid attack. We should train to make use of all the area forward of the beam which will give a track angle normal to the enemy's line of bearing.

"(f) The essence of a successful attack is speed. The general plan having been determined upon the attack should be launched at the highest possible speed.

"(g) The engagement between light forces which may normally be expected to precede and accompany a daylight attack amounts to several complete naval engagements crowded into an abnormally short space

of time by reason of the high speed used and the lack of resistance to punishment of the types engaged. Because of the high speed and the shortness of the attack mistakes made are unusually difficult to correct.

"(h) The principle of concentration applies with full emphasis to an engagement between light forces. Separations are bound to occur and quick decisions must be frequently made. In case the choice of action is not clear the decision should be to join the nearest support.

"(i) The need for routine employment of destroyers at reasonably high speeds is obvious. All their battle maneuvers require high speed. This means that their officers must be trained habitually to think quickly and to handle their ships, their divisions and squadrons quickly. Speeds of less than 25 knots are low speeds for destroyers and maneuvers at low speeds are not destroyer maneuvers.

"(j) 'Disturbing the enemy's gun-fire' by requiring him to turn to avoid torpedoes must not come to be considered as a sufficient warrant for a destroyer day-light attack. Turning does undoubtedly disturb gun-fire to a certain extent but probably less than is generally supposed. Even the turn is momentary for the torpedoes come and go in a few minutes. The disturbance to gun-fire is a useful by-product of torpedo attack but it is not apt to be very serious and cannot of itself justify a daylight attack."

In considering the foregoing conclusions, it is believed that careful thought should be given to target practice results with torpedoes, and battleship secondary batteries, and the demonstrated vulnerability of these batteries when the vessels are under effective main battery fire.

Battle Depth Charge Practice.

Exercise of destroyers in their anti-submarine role is retained by requiring a yearly depth charge practice. The point of submergence is represented by the splash from a gun fired by a reference vessel. A destroyer proceeds to attack using two live and six dummy depth charges. The merit for the practice is obtained by tracking the destroyer by observations from reference vessels and determining, from a diagram provided, the probability of the submarine being in the area covered.

Destroyers fitted with proper listening gear carry out a practice with an actual submarine, using dummy depth charges. In this case positions of destroyer and submarine are plotted for time of launching each charge, and merit determined accordingly. As yet, no satisfactory results have been obtained with listening gear on destroyer.

LIGHT CRUISER GUNNERY

Only a few of the new light cruisers were able to carry out any gunnery exercises last year. The practices laid out for them this year parallel the destroyer exercises, except that the gun ranges are much greater. In order to familiarize the personnel with the director system, they will all fire Short Range Director Practice. They are also to carry out a mining practice.

Submarines are handicapped in gun fire by the following conditions:-

(a) Lack of rangefinding facilities.

(b) Low spotting positions, and lack of good spotting glasses.

(c) Poor gun platform.

(d) Lack of training facilities such as check telescopes.

The criticism has also been made that submarine personnel, as a whole, believe that good results are due more to luck, than to science and skill, and do not, therefore, give enough time and thought to the use of the gun.

The following steps are being taken to overcome or lessen the foregoing defects.

(a) The Bureau of Ordnance has developed a submarine range finder, and two are being manufactured for test purposes. If they prove satisfactory, all submarines will be equipped.

(b) Small rangekeepers have been added to the allowance list of S type and later submarines.

(c) Special watertight spotting glasses are being designed.

(d) Spotting through periscopes will be given a trial. This requires improved communications between control room and gun.

(e) Watertight night telescopes with checking eyepieces are being developed.

(f) The Chief of Naval Operations has allowed each submarine ten rounds of ammunition to be used, as directed by each division commander, for the development of standard methods. It is hoped, in particular, that

information will be obtained as to the best methods of fire control, and the condition of "trim" or "bouyancy"which will give the steadiest possible gun platform, and at the same time be"safe". A submarine in the light condition is extremely tender, and the kick of the gun gives it a heavy roll even in calm water.

The surprise element and the safety of the submarine itself require that a submarine must open fire immediately and effectively when it comes to the surface. The determination of the opening range should therefore be made beforehand. The fire should be rapid with no effort to spot each shot. As in salvo firing, a small percentage of shots should be kept short.

TORPEDO PRACTICES.

The torpedo practices consist of Battle Torpedo Practices "A", "B", "C", and "D" and Advanced "A" and"B".

Battle Torpedo Practice "A" is a submerged attack on a target steering a zigzag course, speed from 8 to 13 knots. The zigzags to be used, and the speed of the target are determined by lot. This practice is fired three times during the year, one torpedo being fired on each practice. On the first two practices, curved fire must be used. On the last practice either curved fire or a straight shot may be fired. On the last practice, the target is protected by an anti-submarine screen.

Battle Torpedo Practice "B" is a submerged attack on a target protected by an anti-submarine screen, steering a zigzag course, speed 8 to 13 knots. The form of zigzag and the speed are determined as before. The Submarine fires four torpedoes, any form of torpedo spread desired can be used.

Battle Torpedo Practice "C" is a submerged attack on a target steering a steady course, speed 8 to 13 knots. Speed is determined as before. The approach is made entirely with the sound apparatus on board and the torpedo is fired on the information obtained by such sound apparatus. No officer or man attached to the submarine is allowed to use the periscope.

Battle Torpedo Practice "D" is a submerged attack by a section of three or more submarines on targets protected by an anti-submarine screen and steering a steady course, speed 8 to 13 knots. The speed is determined as before. Each submarine of the section fires one torpedo, any form of torpedo fire desired may be used.

Advanced Battle Torpedo Practice "A" is supposed to simulate the action of a section attack on a battle fleet screened. The general plan consists of a target of four battleships in any standard formation, screened by a division of destroyers. This target will be directed to pass through a given area, one section of four submarines will be detailed as the attacking submarines, while other submarines will be disposed as scouts to convey necessary information of target approach, formation, speed, etc. to the attacking section. Each submarine in the attack will fire four torpedoes.

Advanced Battle Torpedo Practice "B" consists in specially designated submarines firing a torpedo fitted with a war head and in all respects ready for a war shot at a target which will cause the detonation of the war head.

One of the weaknesses of the prescribed torpedo practices for submarines is the slow speed of the target. It is fully realized that to require submarines to fire at

slow speed targets in false training, but it is impracticable at this time to obtain targets for all submarines with a speed of over 13 knots. It is hoped in the near future to have targets for this purpose with a range of from 10 to 20 knots.

There has been much discussion both for and against the so-called "Submarine section attack". To date the section attack has only been moderately successful when used against slow speed, non-zigzagging targets protected by not more than two screening vessels. As far as is known, it has never been used against high speed zigzagging targets protected by an anti-submarine screen. Under these conditions, it is thought that the section attack, with our present day submarine, would be hopeless, due to (1) the inability of the submerged section to maneuver, (2) the lack of communication facilities, (3) the lack of sufficient submerged cruising radius, (4) the slow submerged speed and (5) the great possibility of collision while submerged. It would therefore seem that some other method of using our submarines in conjunction with a fleet engagement should be developed. Due to the low cruising speed both surface and submerged as compared with that of the ships of the fleet, our submarines are really nothing but mobile mines and should be employed accordingly.

AIRCRAFT GUNNERY

GENERAL.

The aircraft practices for the year just completed were now in almost all particulars. Therefore, a complete comparison with previous performances is not possible. However, the comment as a whole from the service on the new practices has been favorable, and it is believed that, though modified in minor particulars, they will be effective for

several years to come and a comparison of performances will be possible.

The practices have been laid out, keeping in mind the gradual development of the skill of the individual and the unit as a whole. Individual Battle Practice is the first and elementary practice of the year. It has for its object the training of the individual in the use of the weapons which he is required to man. This may be a fixed machine gun, a free machine gun, a torpedo, or a bomb, or any combination of the last three weapons named.

Progressing from this practice, the next step is the development of the aircraft crews as a unit. This is the object of the practices required in "Single Aircraft Battle Practice." The plane is manned and used under conditions which as nearly as possible simulate a single plane combat action.

Having completed these elementary forms of practice, the plane is put into formation practices. Here a division of from three to six planes is the unit and the practices are laid out with the object of developing the efficiency of the division. That is, the efficient manning of the weapons with which the aircraft are equipped, while the planes are flying in close formation. Battle conditions of attack and maneuver are approached as nearly as possible in this practice, though the necessity of getting a record for scoring and providing suitable targets greatly handicaps machine gun practices.

Torpedo Formation Battle Practice.

The most spectacular and most important insofar as it brings to light the necessity for a prompt decision

in policy of types of plane to be developed, is Torpedo Formation Battle Practice. This practice consists of a supported torpedo attack by an aircraft squadron (12 planes) on a division of three battleships steaming in column at a speed between 12 to 18 knots.

Due to unavoidable circumstances, only one torpedo plane squadron was able to carry out this practice during the gunnery year just completed. This was Torpedo and Bombing Plane Squadron No. 1, with the Scouting Fleet.

The practice was held on the Southern Drill Ground on 6 November 1923. The battleships in the target formation were the WYOMING, ARKANSA and FLORIDA, in the order named. For purposes of scoring and observation, the battleships were surrounded by a division of destroyers at 4000 yards distance. It will be noted that while these destroyers were not acting as a screen, they were disposed in positions which would be occupied by screening destroyers.

The attack was promptly and expeditiously carried out. Briefly, the attack was delivered as follows:

The attacking squadron was divided into four groups of three planes each; two groups attacking from each bow of the formation. All planes had only a 50 to 100 foot altitude while making the approach. The time elapsing from the time the first plane crossed the line of the surrounding destroyers until the last plane fired her torpedo and passed the line of surrounding destroyers outward bound, was 6 minutes and 36 seconds. The elapsed time from the dropping of the first torpedo to the dropping of the last torpedo was 37 seconds. Three hits were made, one on the leading battleship and two on the second ship in column. One tor-

pedo crossed the line of the target formation and two were lost. The other six made erratic runs. The only maneuvers made by the target group were ships left 30° shortly after the planes were first sighted and ships right 60° executed just after planes crossed line of surrounding destroyers.

It is believed that serious consideration should be given to the following questions:-

(a) Can a successful supported daylight aircraft torpedo attack be made?

(b) Assuming that it can be made, is it as effective as a bombing attack under similar conditions? Does not the latter employment seem logical in view of the torpedo menace already introduced by the employment of destroyers?

(c) What will be the method of controlling gunfire on torpedo planes which pass within the destroyer screen? How can they be attacked without endangering own ships?

(d) Assuming that we have torpedo planes which can attain an altitude of 5000 or 6000 feet fully loaded (we have none now), what is the best approach? Is it better to come in at a high altitude to escape broadside gun fire, or to approach at a low altitude, risking the broadside battery fire and depending for safety on quick attack and possible confusion in the fire control of adjacent vessels?

Deficiencies.

The aircraft practices this year have been only fairly satisfactory. However, it is hoped that with the new organiza-

tion we will have sufficient permanency in personnel to carry out the prescribed practices. During the year just completed, only eight of the twelve active aircraft units carried out all forms of practice.

The following are the salient defects of our aircraft and their equipment which have been brought out by this year's practices.

(a) Lack of efficient bombing sights. The Wimpores sight, which was developed during the war, is still in use. This sight is not efficient and is practically useless for anything but up and down the wind bombing. There are several bombing sights under development. The most promising of these is the Seversky sight. It is an electric impulse gyro stabilized sight and on test by the Army has proved to be very good. However, there is some difficulty over patent rights and exclusive use of the patents. The inventor has demanded several amounts, all of which have been considered excessive. The Navy has been working on a sight designed by Nordon. This also is a stabilized sight, but on test has not proven satisfactory. I have been advised from reliable sources that it will probably be three years at the present rate before our planes are equipped with efficient bombing sights.

(b) Bombs. For this coming year, it was decided as the culminating bombing practice of the year to have one division of each bombing squadron carry out a formation bombing practice, each plane

dropping one 1000 pound bomb. This brought to light the situation that we have only about 20 - 1000 pound bombs. They are relics of the war. Also, no suitable bombing racks for these bombs are available and it is doubtful if we have planes with enough power to lift them fully loaded to 6000 feet altitude. The Bureaus of Ordnance and Aeronautics are trying to meet these deficiencies. It remains to be seen if they can do it during the current year.

(c) A common defect, though of minor importance, was the frequent failure of synchronizing gears on fixed machine guns. This defect is being corrected.

(d) DT-2 type planes are under-powered. They can barely get off the water when loaded with torpedo and machine gun. This defect is serious and should be corrected.