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# CARE OF ARTILLERY MATÉRIEL

## ACCIDENTS OF FIRE

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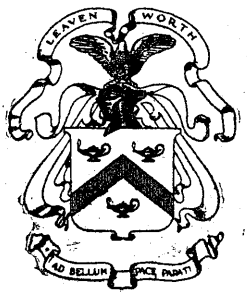
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WASHINGTON, *November 21, 1917.*

The following pamphlet, entitled "Care of Artillery Matériel, Accidents of Fire," is published for the information of all concerned.

[062.1, A. G. O.]

JOHN BIDDLE,
*Major General, Acting Chief of Staff.*

OFFICIAL:
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# CARE OF ARTILLERY MATÉRIEL.

## ACCIDENTS OF FIRE.

Translated from the official document of the French Artillery School by the Army War College, November, 1917.

In all circumstances every artilleryman, of whatever rank, should have at heart the preservation of the matériel which is intrusted to him, in order to obtain from it the maximum use and service.

This duty is more imperative than ever during actual war. The consumption of ammunition having exceeded all previous calculations, the wear on matériel is considerable and necessitates an assiduous, watchful, and continuous maintenance.

The increase of the quantity of matériel in service is recognized by all as an absolute necessity, whose limit no one can conceive. But, whatever the rate of production, it will not furnish an appreciable increase in the number of cannon in service, and will be even unable to maintain the number in effective use if the matériel is submitted to premature wear because of insufficient care and is put rapidly out of commission.

The rôle of officers, and especially of the officers of a battery, in this connection is multiple. Even if it offers no difficulty it requires conscientious and unceasing vigilance. And it shows itself immediately in its results, for one has only to compare the length of service (number of rounds fired before junking) of guns of the same kind in different batteries.

Precision of fire is equally a direct result of the good condition of the matériel.

To sum up, the following measures are essential:

(1) To take the necessary steps on the march and in action for avoiding waste and premature deterioration, and for preventing accidents which may happen under any circumstances.

(2) To hold an inspection of the matériel each day between periods of firing[1] and to replace worn parts at proper times. It is indispensable that we should be able to detect deteriorations,

[1] Inspection by the chief mechanic, under the supervision of a battery officer (battery commander or officer in charge of matériel).

to estimate their gravity, to take the necessary steps to avoid their repetition, and to distinguish the repairs which can be made by the battery mechanics from those which require sending to the rear.

(3) To clean carefully the different parts and to lubricate the bearing surfaces. Cleanliness is of such great importance that an increase in the number of accidents and repairs always occurs in bad weather. Rust spots should be considered as starting points for more serious deterioration. Cleaning includes not only daily care but the withdrawal from action of each gun in turn for a whole day, so that it can be removed, demounted, inspected, cleaned, and oiled completely.

The gun book issued to each section permits the keeping of an accurate history of the piece. It shows the number of rounds fired each day and the charges used; it shows the result of each visit of the inspector of matériel; and it describes the different accidents which have happened. It is advantageously completed by any useful information; for example, in the case of tractor matériel, the number of kilometers covered, the nature of the road, etc.

## EXAMPLE OF THE METHOD OF KEEPING THE NOTE-BOOKS.

155-mm. gun, model 1877.
Number of gun: 1517.
Number of barrel: Creusot 1884, No. 678.

| Dates. | Number rounds fired. | Nature of change. | Observations. |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| January 15 | 25 | 2 | |
| | 12 | 0 | |
| 18 | 34 | 1 | Inspection by subinspector. |
| 21 | 57 | 1 | Barrel in good condition. |
| | 23 | 0 | |
| 22 | | | Sent to workshop. Wear+4. |

First, we will summarize the principal causes of wear and deterioration common to all matériel, and the measures intended to lessen this wear or to avoid deterioration. Then we will study the special directions relative to certain matériel.

## DIRECTIONS COMMON TO ALL MATÉRIEL.

### (a) TUBES.

The tube inspection is made by looking at the inside by means of a diffused light. The light is reflected, if need be, by a screen of white paper inclined at the proper angle and held in front of the opposite end from that through which the inspection is made. The inspection should be made successively at each end of the tube.

If it is desired to estimate the particular importance of wear detected by the means above mentioned, the bore may be directly lighted by some process; for example, when the appropriate artillery parks apparatus is lacking, by attaching a piece of candle to the end of a narrow strip of wood and introducing it into the bore. But we must not commence the examination by this direct lighting, for it is blinding and it greatly hinders observation.

#### EROSION AND WEARING AT THE BEGINNING OF THE LANDS.

Generally a gun becomes unserviceable because of erosions and wearing at the beginning of the lands. These erosions are produced in the metal by the gas of the charge at high temperature. They are wide streaks with rounded edges, which are found generally in groups near the chamber slope and at the beginning of the grooves. As they develop they spread on either side of the chamber slope. The projectile is then no longer properly seated in its chamber and the fire loses all precision. By the extension of the erosions, or, in time, by the wear on the metal, the lands may be completely eaten away at their beginnings. The inconveniences are exactly the same as those above.

Powders, according to their composition, have different erosive actions; but anything which reduces the temperature of the metal is of a nature to diminish and retard the phenomena of erosion and wear, and therefore to prolong the life of the piece and maintain its precision.

It is always necessary to use reduced charges unless the use of the largest charge is absolutely necessary to reach a given range or obtain a given effect.

The rate of fire considerably influences the temperature of the metal. Unless, therefore, the circumstances or the tactical situation imperatively requires it, there should be no attempt to attain the greatest rapidity of fire which the matériel permits. If the rate of fire is slightly accelerated, it is necessary

to allow each of the pieces of the battery in turn several minutes' rest,[1] and to profit by this interruption to cool the tube by washing the bore with water. For this purpose full buckets should be kept permanently near the pieces. When a supply of water is not obtainable a simple cooling by air with the breech open is necessary.

As frequently as possible, and in every case after washing the tube with water, a light oiling is particularly desirable.[2] It diminishes slightly the resistance to the passage of the projectile.

A heavy oiling of the anterior shoulder of the rifling band of the projectile is indispensable as a lubricant to retard the wear at the beginning of the grooves.

If the erosion and the wear of the lands has made too great headway and if the gun, after the copper has been removed from the barrel, gives too great a fire dispersion, it should be pronounced unserviceable.

*Copper fouling.*—This results from the deposit of copper at the base of the lands from the rotating band of the projectile. It occurs toward the muzzle and at the beginning of the grooves.

Copper fouling at the muzzle is revealed by a very clear red color (pure copper) and is of no importance.

Copper fouling at the beginning of the grooves may extend 40 cm. or even more beyond the shoulder of the chamber. The particles of copper, mixed with residue from burnt powder, have a black color. The deposit commences along the driving edges of the groove, then extends over the whole groove, and may fill it up even with the lands.

From the time it is noticeable copper fouling causes the loss of all precision of fire. The rotating band being beveled off (by the deposits of copper) more than in normal guns, it results in a slight overpressure of gas at the start. During the rest of the course of the projectile in the bore the obturation is incomplete. If the deposit is great, there will be a complete beveling

[1] For example, a suspension of fire is necessary after 20 rounds for the 155 gun, and after 150 to 200 rounds for the 75.

[2] Only lubricant in good condition and free from water should be used. It is necessary to supervise the proper protection of the supplies. See that the casks and receptacles are water-tight, constantly closed, and sheltered from rain. It is also necessary to keep the rammers, sponges, brushes, etc., used for drying and oiling in perfect state of cleanliness. The lubrication should be light to avoid the production of smoke.

off of the rifling and a failure to follow the grooves; the projectile will not acquire sufficient rotation to assure stability in the air.

Copper fouling is produced especially in very rapid fire. Hence, again, the necessity of using reduced charges whenever possible.

Copper fouling is due to the mechanical action which the rotating band undergoes when it is cut on the lands. When the gun shows traces of wear at the beginning of the rifling, the rotating band gets its proper diameter only after a certain course of the projectile. If, because of lack of care or the firing of a projectile not properly cleaned, the bottoms of the grooves become uneven, copper fouling occurs very rapidly and can not be avoided but only delayed. A careful cleaning of the gun after each fire is therefore indispensable. A frequent but light lubrication of the bore, together with liberal oiling of the shoulder of the rotating band (which also avoids premature wear of the tube), is of capital importance against copper fouling. The lack of lubricant facilitates copper fouling, for the oil prevents the adherence of deposits of copper.

If in spite of these preventive measures copper fouling is produced, it is advisable to proceed immediately to a chemical removal of the copper—a process which, however, is effective only if the thickness of the copper is very slight. If it is absolutely necessary, this may be done in the battery. After completely cleaning the barrel and removing the oil with soap or potash, wash the coppered parts with brushes or cloths dipped in ammonia (obtained on special request from the Artillery park). It is better, however, to send the gun to the park to have copper removed.

As the liquid used is oxidizing, the tube should be dried and oiled immediately after the work; otherwise it will appear red because of oxidation.

*Foreign bodies.*—The presence of foreign bodies, whatever their nature, inside the tube is very dangerous during fire, and may even cause explosion. Even if the projectile passes them without igniting the fuse they may still produce a roughening or damage to the bore—an effect which should be avoided, even though it causes no bad effects in firing.

The precautions against this class of accidents especially concerns ammunition, whose cleanliness should be the object of attentive care and whose contact with the ground should always be avoided, both in shelters and during handling.

Whenever circumstances permit, an examination should be made before loading to see that no foreign matter is in the bore—bits of shell cases or other matter, or even grains of powder not completely burned (during fire at night, use the sponge).

When enemy shells have burst near a gun, it is indispensable to see that no pieces have struck the barrel. If a fragment of this kind has caused a slight roughness at the muzzle, it can often be reduced with a file. But if an explosion outside the barrel has caused a dent in the metal in the interior (as often happens) fire should be stopped and the gun sent to the rear for repairs. If the fire should be continued, it will invariably put the gun out of commission, either by a premature explosion of the projectile in the gun or by torsion of the barrel, which gives way under the force of the projectile and becomes entirely deformed. If the matériel is at once sent to the rear, its repair in the shops offers no difficulty, and it will return fit for long service if it is not otherwise worn.

### SWELLINGS—EXPLOSIONS.

Swellings and explosions, when they are not due to the presence of foreign matter in the bore at the time of firing, are certainly due to abnormal pressure or poor condition of the ammunition.

To avoid abnormal pressure, all handling of the charges, except that necessary to reduce a charge, should be absolutely forbidden. The charges are composed of a carefully determined mixture, taking into account the initial velocity to be attained and the admissible pressure for the gun. In particular, the powder obtained by reducing charges should in no case be used for making new charges, but should be sent to the rear.

Ammunition which has been preserved for long years in closed magazines in the interior of the country is very sensitive to conditions to which it will be exposed at the front. In a few months at the front dangerous changes in its condition may occur. It is advantageous, therefore, to keep in stock at the batteries only the amount of ammunition required for a short period, to use the oldest ammunition first,[1] and to assure renewal by the movement from the rear to the front of successive sections.

[1] These rules, naturally, may be ignored in certain cases; for example, if ammunition is received in wooden cases in damp weather it should be used before that received in metal cases.

The ammunition should be protected not only against dampness but also against too great heat. In summer it should be sheltered from the direct rays of the sun by being covered with canvas, branches, etc., so that the free circulation of air is permitted.

The black metal cases are particularly apt to absorb heat if they are not properly protected. The decomposition of powder is evidenced by deformations in the walls of the case and by the characteristic odor which arises when the cover is removed.

It is forbidden to leave the pieces loaded, and in particular after rapid fire has raised the temperature of the guns, to load them with a view to subsequent fire.

Small swellings may not put the gun out of commission at once, and may even permit the continuation of fire. But if they become accentuated they are dangerous, because the resistance of the metal is altered and the projectile, inaccurately guided on part of its course, is exposed to blows which may burst it in the gun. In case of doubt, where there is an opportunity to continue fire with a slightly swollen gun, the inspector of matériel should be consulted. When such a gun may still be used it is necessary to examine it frequently to insure that the swelling has not increased.

### (b) BREECHES AND OBTURATORS.

Injury to breeches and difficulties in breech operation are obviated by care, demounting, and daily lubrication. If wear is produced in the threads, the fault may be corrected with a file.

All parts in bad condition should be replaced, especially obturators (in all matériel in which they are used), as soon as an insufficient obturation is recognized, for with insufficient obturation the piece will be exposed to grave deteriorations in the breech system, due to the passage of the gas of the charge.

### (c) RECOIL CYLINDER AND RECUPERATORS.

Recoil cylinder should be full, but not too full,[1] and tested with this idea in view, the matériel being cooled.

A recoil cylinder which is too full may, by reason of the heating due to fire, prevent complete return to battery. The majority of recoil cylinders are of variable volume, and the liquid

[1] To within several cubic centimeters when the recoil cylinder is separate from recuperator. Refer to special instructions for different matériel.

expanded by heat may require a volume greater than that which will be left to it by the complete return to battery.

A cylinder insufficiently filled will not completely perform its rôle. The recoil may be exaggerated and may even amount to a shock (which may break the piston rod).

Because of the inevitable leaks at the joints, the recoil cylinder should be continually watched and refilled as often as necessary, even, if need be, in the course of fire, if the length of recoil becomes excessive.

The recuperators should have an initial tension sufficiently great to return the gun completely to battery, but without shock. A shock on the return to battery indicates an exaggerated initial tension of the recuperator before fire, or one due to heating in rapid fire or a defect in the operation of the buffer (wear in the valve).

The operation of the recoil mechanism and recuperator, even during the course of fire, should be watched.

### (d) CARRIAGES.

The parts to be watched in carriages are the rivets and bolts. Every loosened rivet should be noted; every unscrewed bolt should be tightened immediately. The rivets and bolts are always the starting points for fissures which are caused by excessive wear in the body of the carriages. This wear may be expected on the march or in action.

Injuries to carriages and wheels from marching are particularly frequent in matériel drawn by automobiles, especially in matériel for which auto traction has been adopted, but which was not originally designed for that kind of traction. It is imperative that their speed should not exceed that which would result from horse traction over the same terrain. The axles' hubs should be greased regularly.

In fire, the limits laid down for the different charges should be strictly observed. Thus, for certain howitzers, it is necessary to avoid the use of the heaviest charges when the quadrant elevation is small, for under these conditions the carriage lacks stability and will be exposed to deteriorations (falling back after being lifted off the ground). In general the use of reduced charges whenever possible conserves the carriage as well as the barrel.

The traversing and elevating mechanism must be carefully attended to.

### (e) CARE OF AIMING INSTRUMENTS.

Good care of the aiming instruments has an enormous influence on the precision of fire. Their adjustment should be frequently tested, and the accuracy of agreement of the different instruments of the battery carefully studied.[1]

The first condition for their proper preservation is to handle them without roughness and with care, just as it is natural to handle instruments composed principally of glass. It is important in the handling of them to avoid shocks and especially to avoid dropping them. The attention of the personnel charged with their handling should be called to this point.

The supports should be kept well cleaned and oiled.

The glasses should never be rubbed with the fingers, cloth, gloves, or any other material likely to scratch the glass or make it greasy.

The surface of the glass is cleaned by breathing on it to blow away the dust, and then rubbing it with a piece of fine white cloth which is free from lint. If a glass is very soiled, and especially if it is oily, rub it lightly with a cloth dipped in alcohol, and clean it as above.

Avoid all blows which injure the flanges or supporting seats of levels, goniometers, etc.

## THE 75-MM. GUN, MODEL 1897.

The operations prescribed by the regulations (Part IV, Annex I, Chaps. II and III) include daily care combined with complete periodical cleaning.

The daily care has for its principal object the lubrication of the mechanism which needs it and for which constant automatic lubrication is not provided. This supply of lubricating material should be furnished with the same regularity as food to living beings. The daily care is therefore the basis of the preservation of the matériel.

The periodical cleanings have for their object the removal of dirt or waste matter which may become causes of wear or oxidation. These cleanings may be fairly infrequent, especially if the daily care is properly attended to; but, on the other hand, they should be thorough.

[1] Take into consideration the results obtained and make the desired corrections for each piece so that the pieces of the battery may agree among themselves.

A summary inspection of matériel (Part IV, Chap. II, art. 3) should be made daily at the battery by the chief of section and verified by the battery commander.

A detailed inspection (Part IV, Annex I, Chap. III, art. 3) should be made by the battery commander as often as possible, and especially every time the battery is at rest.

The regulations should be carefully conformed to, with particular attention to the following points:

*Guide rails* (Part IV, Annex I, Chap. III, art. 2).—Lack of proper care leads to a wearing of the inclined planes, which produces an increase in the length of the recoil and in the rapidity of the return to battery. The influence of wear on the inclined planes on the functioning of the piece is negligible when this wear is not too great and when the recoil system itself is not worn, but when the wear is considerable its influence, added to that of the wear of the recoil system, tends to put the latter out of service.

Too much wear necessitates the use of additional metal strips underneath the guides, and this can only be done by a construction establishment.

Exaggerated wear is avoided by periodically cleaning and oiling the guide rails after dismounting the piece.

*Friction piece and wiper* (Part IV, Annex I, Chap. III, arts. 1 and 3).—The wearing of the wiper shows in the uncertainty in aiming in direction. It may be repaired or replaced.

*Trunnions* (Part IV, Annex I, Chap. II, art. 3, and Chap. III, arts. 1, 2, 3, and 4).—The cradle trunnions and those of the rocker often show hard wear, which manifests itself by producing on the trunnions raised parts corresponding to the grooves which are made for lubrication in the trunnion hoop when the carriage is constructed. This wear causes inaccuracy in aiming for elevation and consequently in range.

Excessive wear of the trunnions is the result of negligence in care. One often finds on dismounting a piece that the surfaces of the trunnions and their housings are quite free from any kind of lubricant, or else are well covered over by some dry material, which acts as an agent of wear rather than of lubrication. Once in a while we find water or rust between these surfaces.

Wear of the trunnions can be repaired only in an approximate way by filing the surfaces of the raised parts. This method of repair lessens the trouble, but can not remedy it completely. To

obtain the best results from a piece so repaired particular care should be taken in the oiling of the trunnions, so that those which are worn, and are therefore smaller than their housings, automatically fall under the weight of the piece and because of the lubrication into a position at the lowest part of the housing.

The lubrication of the trunnions presents special difficulties, because the wearing surfaces can not be laid bare to sight to verify their condition, and because the weight of the piece, resting on the trunnions, tends to expel the lubricant, so that there remains, after the best oiling, only extremely small particles of oil between the bearing surfaces.

From this results the necessity of frequent and regular lubrication to prevent the wear of the trunnions. Lubrication should be a part of the daily care, as provided in the regulations. (Part III, Annex I, No. 27.)

Several special precautions should be taken if the oiling is to be effective, because of the difficulties above mentioned. It is not sufficient to inject oil from a special oil can through holes 7 and 8, but, when the oil is introduced, the aiming mechanism and the indented sector of the cradle must be moved their entire length, and successively, so that the oil will cover the whole surface of the trunnions. This process will be facilitated by lifting up the muzzle of the piece so as to relieve the trunnions.

The precautions indicated above are particularly recommended when, from faulty care or long exposure to humidity, either a complete drying of the contact surfaces or an introduction of water between the surfaces is feared.

*Elevating screw* (Pt. V, Annex I, Chap. III, arts. 1–3).—The elevating screw often has a considerable play, as a result of its bronze nut. This play may be discovered easily by attempting to raise the breech. It has no inconvenience from the point of view of regularity of fire, provided the piece is sufficiently well cared for to permit the heavy weight of the breech to maintain the threads of the screw in contact with those of the nut. There is, however, a grave inconvenience when the wear exceeds certain limits, for this necessitates replacing the nut of the elevating screw, and this replacement, because of the method of construction, can be done only in a construction shop.

The care of the screw and its nut is very easy, since the screw is easily accessible, and a thorough cleaning periodically, with demounting of the trunnion, will guarantee this part against too great wear.

*Elevation drum and handle* (Pt. IV, Annex I, Ch. II, art. 3, and Ch. III, arts. 2, 3, and 4).—The elevating drum may be put out of service because of excessive wear on the mechanism for taking up play in the drum; the same is true for the elevating handle. The wear is such that it can easily be remedied by replacing the parts. The wear on these parts may be avoided by carefully oiling the drum and elevating handle as a part of the daily care.

With regard to the elevating handle, it should be noticed that the mechanism for controlling the nut of the elevating screw by means of this handle does not have any arrangement for taking up the play. There is always more or less lost motion in this control. It amounts to almost nothing in new matériel, but it can not be kept down in used matériel. It is therefore a mistake to try for an accurate adjustment in range by making specified movements of the handle (one or two notches, for example). This method of operation, which was not contemplated either by the builders of the matériel or by the authors of the regulations, can only be effected by taking at the same time certain supplementary precautions to make sure that the movements ordered on the elevating handle are really transmitted to the elevating screw, and are not merely absorbed in lost motion.

*Sliding movement of the carriage on the axle* (Pt. IV, Annex I, Ch. II, art. 3, and Ch. III, art. 3).—The wear in the sliding of the carriage on the axle is shown by lost motion in aiming direction. This lost motion causes inaccuracy in aiming when it reaches a half turn of the handle. It should be repaired when it exceeds a quarter turn of the handle. This requires considerable work. To avoid wear, the visible parts of the axle should be kept clean, as provided in the regulations.

*Support of the aiming apparatus* (Pt. IV, Annex I, Ch. II, art. 3, and Ch. III, arts. 2 and 3).—Wear on the sight support of the aiming apparatus is shown by throwing out of adjustment of the lines of sight. It may be corrected by the repair squad when the wear is slight, but it necessitates replacing the support when the wear is great. This replacement can be done only in a construction shop.

The wear is always due to lack of care. The care required is very little, since it consists principally of oiling through the holes Nos. 20 to 24. But this oiling should be done regularly and frequently, being a part of the daily care provided for by the regulations.

There are occasions when the sight support, because of improper care or insufficient lubrication, is hard to manipulate, even after a proper oiling. In such a case wash it with petroleum injected through the oiling holes, and then finish by heavy oiling, so that after the oiling no petroleum remains in the support. If this difficulty remains after washing with petroleum and oiling, it is necessary to repair or replace the support, for its use in such condition invariably leads to rapid deterioration.

*Front sight.*—The front sight may become inaccurate because of the fact that, during cleaning, a cannoneer places a tool in the opening of the drift sight (screw driver) and, in removing it, involuntarily bears on the sight leaves. Such damage is harmful, since the verification of the line of sight depends on the condition of the front sight. The cannoneers should be ordered not to place tools in this opening of the front sight.

*Fissures at the muzzle.*—In certain 75-mm. guns still in service the hoop of the muzzle is connected to the barrel by strap bolts, which are often the cause of fissures at the right of their emplacements. These fissures appear as narrow cracks, the depth of which can scarcely be gauged. A muzzle which presents such deterioration should be carefully watched, the fissures having a tendency to extend longitudinally and to deepen rapidly, tending to put the gun out of commission.

*Recoil mechanism* (Pt. IV, Annex I, Chap. II, art. 4).—The amount of oil in the reserve reservoir should be verified only when the recoil mechanism is cold, and care should be taken to add the proper amount when there is found to be not enough. If the gauge is examined when the recoil mechanism is still hot, its subsequent return to position, which is due to cooling, may cause us to think there is a leakage in the recoil mechanism.

To ascertain if a recoil cylinder really has a leak—

(*a*) The recoil mechanism having been at rest for some time, we fill up the reserve reservoir under given temperature conditions.

(*b*) We leave the recoil mechanism at rest and verify the condition of the reserve reservoir under the same temperature conditions. If the reserve reservoir empties itself in less than 12 hours the recoil cylinder has a leakage, which should be remedied by sending it to the artillery park.

Slight leakage at the piston joints may show during fire. It is indicated by the presence of oil between the piston and the forward plug, but it offers no serious inconvenience. If it reduces the amount of oil, we must refill the recoil mechanism.

The recoil mechanism becomes hot in firing. The pieces should be alternately put out of action and cooled after about 150 rounds. This time should be used to empty the reserve reservoir and refill it with clean oil, which cools the joints and prevents any emulsion which might put the recoil mechanism out of commission.

## THE 155-MM. SCHNEIDER HOWITZER.

*Number of rounds fired*, 6,500 rounds per piece for a group of two batteries.

In a general way the matériel acted well.

### I. THE PIECE.

The reported incidents were as follows:

1. *Breech.*—Some roughening at the entrance of the breech screw in its nut when the gun was first put in use. Remedy: An expert ironworker. Triangular file for the screw. Special nut file among the tools and supplies.

2. *Safety bolt against a hangfire* (Salos latch).—Does not function, or breaks. Remedy: Remove and have the arming cam raised by an ironworker. In recently built pieces it is completely removed.

3. *Operating rods for firing.*—The firing handles break. Remedy, lubricate them carefully (there are no holes for oiling).

4. *Extraction of the cartridge case.*—In fire with charge 0 (powder B. G. 5) it frequently happens that the extractor does not operate. The rammer must be used. In a charge 0 there is often produced a wedging of the rear part of the cartridge case into the cut-out sector of the breechblock. It jams. Remedy: In recent pieces the obturation of the shell case is replaced by a Schneider plastic obturator, which it is forbidden to wet when it softens in the course of prolonged fire. Delay the fire. Cool with air.

5. *Life of the piece.*—The number of rounds fired since putting the matériel in service does not permit of approximating the life of the piece; although certain pieces have fired more than 6,000 rounds, none have been yet out of service by wear. This is primarily due to a judicious use of reduced charges and to the care observed in the execution of fire. Howitzers firing on fixed targets rarely execute rapid fire.

## II. CARRIAGE.

(1) *Trail.*—Fissures at the level of the axis of the folding spade. The folding spade warps. Remedy: Never use pieces of wood to support it. When the ground is frozen make the emplacement of the spade soft by working the soil with picks and shovels.

(2) *The loading tray.*—Do not allow loading with I. A. fuses.

(3) *Recoil mechanism.*—The recoil buffer valve has been replaced in one gun after about 2,150 rounds, in others after 4,000 rounds. The bronzing of the recoil buffer lasts about 3,500 rounds. The joints are changed after between 2,000 and 3,500 rounds.

(4) *Incomplete return to battery.*—In this case, prohibit unlocking to put the piece in march order. Test the recoil cylinder and recuperator, and fill with air and liquid. Otherwise the two piston rods and the recuperator will be thrown out of adjustment and it will be impossible to place the gun in battery because of the flexion of the piston-rod supporting plate.

## III. AIMING MECHANISM.

This is good, but the periscopic mechanism is greatly superior.

The graduations in 20 mils is hard to read through the mica of the opening.

The rear sight extension leaf of the aiming mechanism is very primitive. It does not correct the inclination of the trunnions. It breaks on supports during fire, or at least warps out of adjustment.

## IV. AMMUNITION.

Recent pieces: Charges in cartridge bags (plastic obturators).

Pieces in service. Charges in cartridge cases. The charge O, of $BG_5$ powder, is indivisible. The parks receive a certain percentage of charge of $BG_5$, from which wear and copper fouling result.

Charges from 1 to 5, of B. S. P. powder, are divisible.

*Projectile.*—It is necessary to oil the shoulder and to place a rim of grease just above the rotating band. When the pro-

jectile is on the loading tray the loader should turn it over to see if the rotating band shows any roughness.

In the ammunition shelter we must separate the layers or rows by strips of wood to avoid roughening the rotating bands when they are not protected by band guards.

