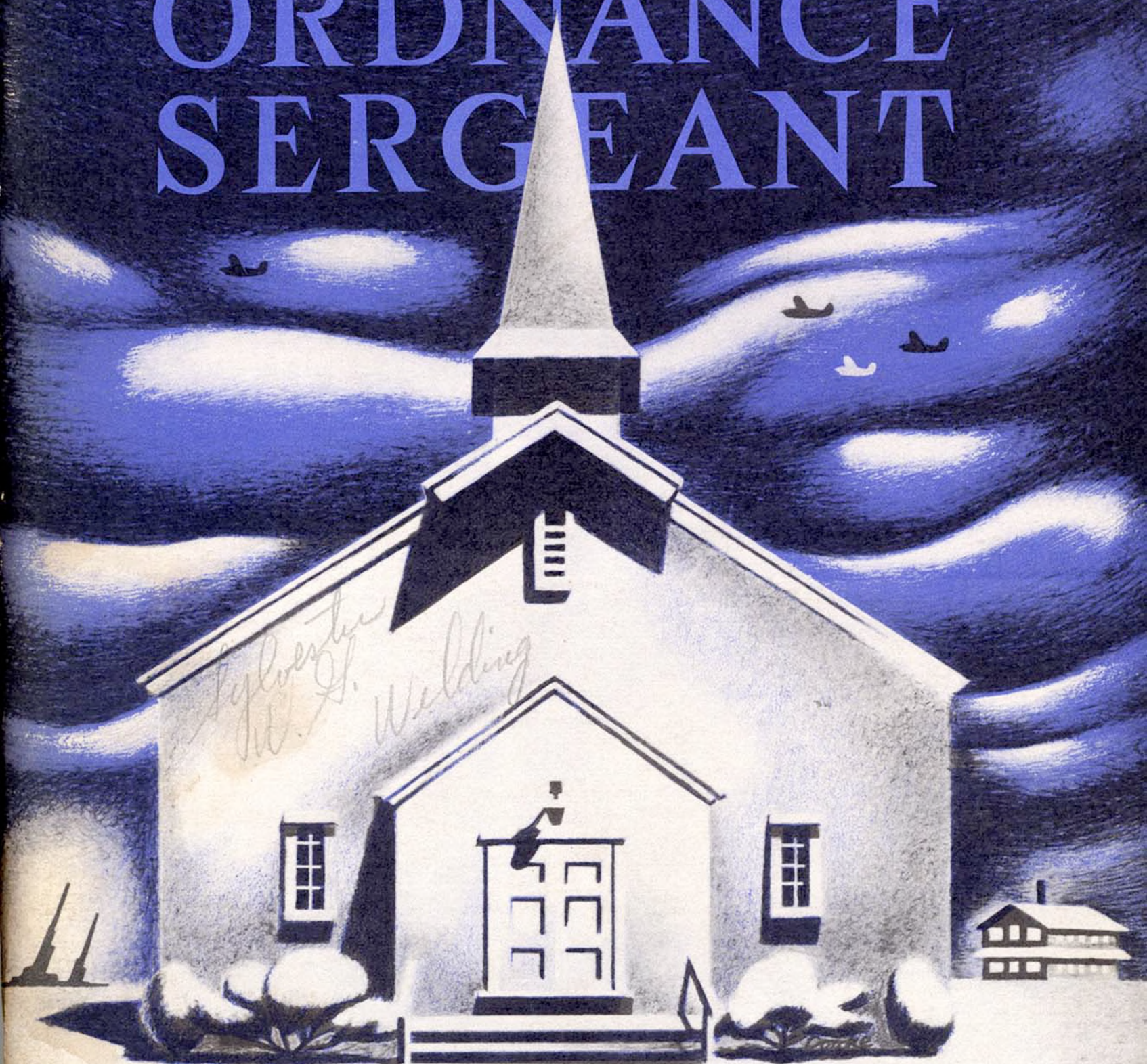


THE ORDNANCE SERGEANT



VOLUME 4 DECEMBER 1942 NUMBER 6

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RESTRICTED

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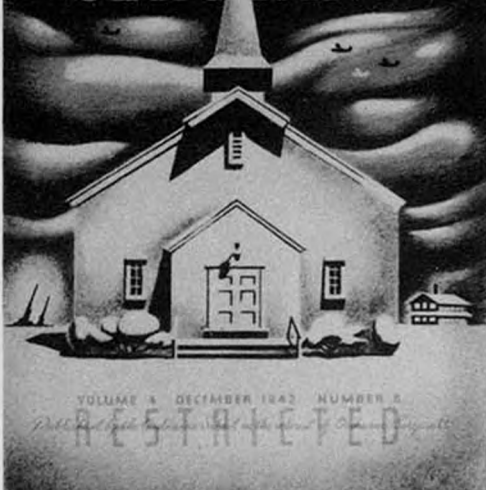
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THE ORDNANCE SERGEANT



Cover drawing by Private James E. Cook, of the Art Section of The Ordnance School, based on photographs by the Photographic Section of The Ordnance School.

HIGHLIGHTS

Recovery and evacuation of materiel from the battlefield is rapidly becoming a most important subject. Much is still to be learned about it, but knowledge is increasing daily. Provided for your information in this issue is a rather comprehensive study of the subject, dealing both in organization and in technique. See page 508.

Closely allied to Recovery and Evacuation are such subjects as Field Rigging, on pages 517 to 535, Data on Materiel on page 537, Camouflage on pages 538 to 542, and Booby Traps on page 543.

Have you serviced a gasoline field range yet? If not, you probably will before this war is over. This is now a function of Ordnance maintenance troops, inherited from the Quartermaster Corps. A brief study of the gasoline Field Range, M1937, is to be found on page 544. Also, plans are provided for the local manufacture of a trailer designed to service the field range, approved by the Office of the Chief of Ordnance.

Generator Control Systems, beginning on page 559, tells a lot of things about the nervous system of the automotive vehicle.

Desertion, now that we are at war, is a most serious offense. It calls for a great deal of paper work, and this sometimes troublesome subject is discussed in an article beginning on page 572.

A knowledge of mechanical drawing principles makes any shop man more valuable. A review of the discussion of this subject beginning on page 580 will add a little finish or polish to your shop value. This is the forerunner to a series of articles on Shop Mathematics, which will begin in the January, 1943, issue.

Address all communications to: THE ORDNANCE SERGEANT, The Ordnance School, Ordnance Training Center, Aberdeen Proving Ground, Maryland.

REPRODUCTION PLANT
THE ORDNANCE SCHOOL
ABERDEEN PROVING GROUND
MARYLAND

Greetings
of the
Season

The Ordnance School

1942

THE ORDNANCE SERGEANT

This month we observe our second wartime Christmas of the present war. There is a vast difference between Christmas this year and Christmas a year ago. A year ago we were just recovering from the first shock of war, for even the expected is a shock when it suddenly brings tragedy to us. A year ago we were poised, but not sure how far we could leap. We had not reached our stride; we had not settled down to the long and gruelling task ahead of us.

This year we find ourselves in a different position. We have become a well organized war machine. We have not yet reached our stride, for our best of yesterday is exceeded today, and our utmost efforts of today will be more than equalled tomorrow. We know not our own strength. We do know, as our enemies fear, that our might shall continue to grow, even as our enemies weaken, until our task is done — until peace replaces war.

Today American fighting youth are in their places on all the far flung battlefields of a world at war. Under the blistering sun they force their war across desert sands. In the frozen snow and ice of the north-land they guard and enforce the principles of freedom. In the swamps and jungles of the tropics they fight and die that the rights of others may live.

Wherever American fighting men go they find close behind them the men who keep them supplied with the implements of war which they will wield to insure peace. And at home, in the training camps and in the Arsenals of Democracy, Ordnance personnel adds to the effort. Of glory these men receive but little; of that inner realization of service well done they experience much.

To each and every individual of the Ordnance Department, wherever they may be, and to every fighting man they serve, The Ordnance School extends greetings of the Season.

May the Christmas Season bring to you that success which shall guarantee every Christmas of the future. May the New Year signal not a beginning, but a continuation of the courage and heroism which has always brought glory to American arms.

"After the hideous fires of hate
Burn down and their hot flames decrease,
Across the earth, though soon or late,
There will come peace."

COOKE

RECOVERY & EVACUATION



A STUDY OF A NEW DEVELOPMENT IN ORDNANCE ACTIVITY

by
R. C. Jerome *A. T. Vick*
CAPT. ORD. DEPT. CAPT. ORD. DEPT.

There was a day when Ordnance equipment consisted almost entirely of those weapons carried by the individuals engaged in combat. In our early wars these weapons were often the property of the individuals who used them, brought with them from their homes when they offered their services to the armed forces of the Nation, or to their Colonial or State Militia.

Methods of warfare have advanced along with the more desirable phases of civilization. The more or less haphazard open warfare of our early days succumbed to the theories of trench warfare in the first World War. Artillery became a supporting arm rather than one used for any purpose in any situation, wherever its use might be possible, even if not practical.

Born of the first World War was the moving, or rolling or crawling fortification — the tank. The day of mobility had begun. Other vehicles, too, were added to the list of fighting equipment in use. The day of the individual weapon had definitely passed into history. In its place had come the "weapon" manned and operated by a group of men. The individual weapon could be kept in the possession of its owner as long as he retained the strength to grasp it. When this was no longer possible, the loss of his weapon meant practically nothing. The man who took his place would have a weapon of his own.

Modern fighting vehicles present an entirely different problem. The tank, for example, when it becomes disabled, cannot be carried from the field of battle by the men who have taken it there. This item of Ordnance materiel must therefore be removed by some other agency.

Loss of the materiel represents a different problem too. It must be replaced by another manufactured at great cost and transported perhaps thousands of miles at the ex-

pense of time, labor, ships, and money. Loss of materiel in this case is very real.

To meet this modern situation new methods of recovery and evacuation of Ordnance materiel must be, and are being, devised. This study represents the opinions of the authors. It is tentative in every way, and as yet has not been approved by either the Ordnance Department or the War Department. It is subject, also, to revisions based upon the recommendations of the combat forces.

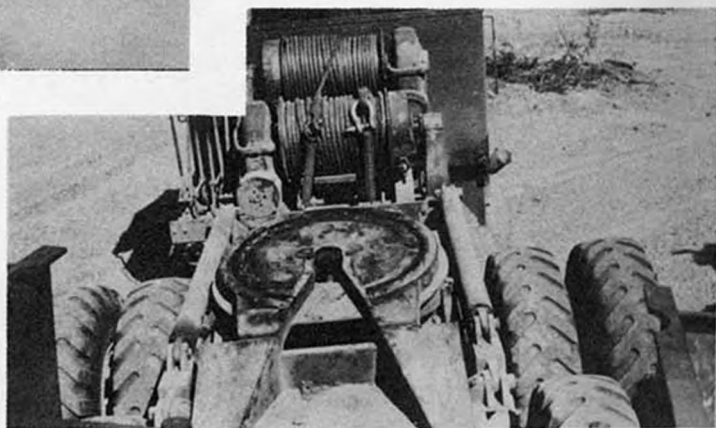
The organization for recovery and evacuation suggested herein is merely one means by which the task may be accomplished. It is probable that organizations similar to that described

herein will be activated in the near future. Recent T/O's for Ordnance maintenance companies show the trend toward recovery operations. The Heavy Maintenance Company has a Recovery subsection in its Automotive Section, equipped with three (3) 40-ton trailers, recovery. The Medium Maintenance Company has in its Automotive Section one (1) of these trailers, as well as a heavy wrecker which may or may not be intended and used for recovery operations. The new Light Maintenance Company, now assigned to the Infantry Division, has a Recovery Subsection in its Automotive Section. The fact that this unit has no recovery equipment except one (1) heavy wrecker, however, may be an indication that it will engage only in light recovery operations and will be supported by Medium or Heavy Maintenance Companies, or possibly by one or more Evacuation Companies, depending upon the situation, as indicated in this study.

Related to the general subject of Recovery and Evacuation, of course, are certain other subjects, such as camouflage, rigging, and the removal of wounded personnel. These subjects are covered briefly in this study.



Tractor of T-3 unit



Tractor of T-3 unit with trailer dropped

RECOVERY AND EVACUATION

The prompt recovery* and repair of equipment which has been abandoned or disabled in the field, the exploitation of enemy supplies, and the utilization of waste materials are important measures for conservation of military resources. Modern warfare has shown that the prompt recovery and repair of materiel is as important as the initial production of equipment. Immediate recovery lightens the heavy transportation requirements of supply and is particularly essential where supply lines are vulnerable to enemy attacks and where the status of supply of certain items is critical. Prompt recovery from the battlefield prevents the materiel from falling into enemy hands and prevents further destruction by the enemy. Battles in the present war indicate that a stalled vehicle immediately becomes the target for all enemy guns. Therefore, if a tank is not removed from the battlefield almost as soon as it is disabled, it will be damaged to such an extent that its recovery will not be possible except by salvage operations after the battle has passed on elsewhere. Recovery also secures enemy materiel, thus preventing its repair and re-use by the enemy and thereby doubly increasing our own resources. The recovery of enemy materiel will usually make available information concerning new developments in their equipment.

It is the responsibility of the using troops to recover disabled materiel and to perform first and second echelon maintenance operations. The recovery operations of these units consist of repairing materiel on the spot or towing it to a place where an Ordnance unit can take it over.

The Ordnance Department is responsible, among other things, for the reception and reclamation of captured enemy or abandoned friendly Ordnance materiel, general supplies, and ammunition. It is also responsible for the destruction of ammunition when required. This latter responsibility includes the destruction or removal of duds or delayed-action bombs and other ammunition.

Ordnance staff officers, in addition to their other duties, are responsible for the recovery and repair of Ordnance materiel in their respective echelons. The Ordnance officers of the communications zone must control the reception, classification, and assignment for repair of all Ordnance materiel evacuated from the combat zone by the Ordnance service of the armies, or released to the Ordnance service of the communications zone by the central quartermaster salvage* agency.

Preparing to drop the
T-3 trailer



Ordnance staff officers will prepare plans to prevent Ordnance stores from falling into enemy hands. Such plans will provide for

* Definitions of terms indicated by an asterisk will be found on page 516.

the evacuation* and for destruction if evacuation is impracticable. Actual destruction will not be carried out without orders from the commander responsible for the stores, unless communication with the commander is impossible.

The collection and study of captured equipment and materiel is an intelligence function of the supply arms and services. Intelligence functions must be specifically allocated to an officer on the staff of every Ordnance battalion; both maintenance and ammunition, and to specific officers on the staffs of Ordnance officers of all echelons in the theater of operations. These staff officers will prepare plans and instructions for the disposition of any enemy Ordnance materiel which may be captured. These plans will be prepared in conjunction with G-2. In general, such plans will include lists of enemy equipment on which information is specifically desired, component parts required for repair of captured materiel, or ammunition for such weapons. Competent specialists in the various echelons of maintenance will examine enemy equipment for new or improved types and will send samples to the communications zone for further study and test as directed by higher headquarters.

Damaged materiel found on the battlefields will be repaired, if possible, by the first and

Winter Weiss trailer with M3 tank



second echelons of maintenance. If the maintenance required is beyond the capabilities of the using troops, they will evacuate the materiel to a collecting point*, where it is accessible to an Ordnance unit, or will report its location to such a unit. Liaison agents from the maintenance battalion and/or evacuation company will contact the combat troops and will notify their headquarters of materiel being sent to the collecting point. On the basis of this report or the report of liaison agents at the collecting point, the maintenance battalion will send either a contact party* from one of the maintenance companies with the necessary personnel and equipment for the repair of the item at the collecting point, or, if necessary, a unit from the evacuation company to transport the materiel back to the field shop. If the damage is beyond the capabilities of the maintenance battalion, or if the maintenance load is already excessive, the evacuation unit will normally be directed to carry the materiel to a higher maintenance echelon. The above procedure applies equally as well to captured enemy materiel as to our own.

Collecting points are designated in administrative orders of divisions and higher units. They will usually be in locations easily accessible to vehicles for transportation to the rear. These points should NOT be places of limited area where equipment is grouped together in large quantities. Such disposition furnishes an excellent target for enemy aircraft and artillery. Rather, a collecting point will usually be a gen-



Broken track

M3 tank digging in on towing without a track



eral area in which materiel will be dispersed either in small groups, in the case of small items, or individually, in the case of tanks or other large vehicles. Camouflage will be used extensively in such areas, especially where the enemy observation and combat forces are active.

When items of Ordnance materiel are brought to a collecting point, there are two alternatives for its disposal. These are:

Repairable materiel. - Serviceable and repairable Ordnance property is reported to the Ordnance maintenance echelon in support of the troops. The maintenance unit will send suitable transportation to pick up this materiel, or, if the materiel is in excess of requirements, will instruct the quartermaster service to evacuate it to the communications zone. In the case of heavy equipment, such as tanks, combat cars, etc., they will send a unit from the evacuation company to transport it to the proper maintenance echelon. For small items of equipment, a truck will be dispatched from one of the maintenance companies. Upon repair, such equipment is returned to the chain of supply as a replacement item. Items brought to the maintenance shop by any organization, other than the using arm, loses its ownership and becomes merely

Beginning recovery of tank shown on preceding page



an item of reissue. Items which are to be evacuated to base shops and which contain required parts will be cannibalized* in the maintenance shops for such serviceable parts. Items obtained in this manner will be replaced by the unserviceable parts which they displace. This gives the higher echelon a complete major item to repair. Parts which are beyond repair will be turned over to the quartermaster salvage service for disposition by the higher echelon.

Irreparable materiel. - Small items of Ordnance materiel which are beyond repair and which do not contain any usable or repairable required parts may be left in the hands of the quartermaster salvage service for evacuation to the communications zone. In the event any usable Ordnance materiel is evacuated by the quartermaster salvage service, it will be sorted out in the salvage depot under the supervision of the Ordnance personnel attached to the

The recovery unit in operation



depot and will be turned over to the Ordnance shops in the communications zone for disposition.

Special cases. - Delicate instruments. - Instruments of a delicate nature, such as most optical instruments, data computers, height finders, etc., require special handling and special care during transportation. Consequently, these items of equipment must be evacuated through Ordnance channels by men accustomed to handling them. Therefore, when any instruments of this type are found in the field or picked up and brought to the collecting point, the Ordnance

representative there will inform the supporting Ordnance maintenance company of the materiel collected. Then, a contact party from the instrument repair section of the company will be sent out with the necessary personnel and equipment to take over the responsibility for disposition of such instruments.

Ammunition. - Collection. - The Ordnance personnel at the collecting point or salvage dump will arrange for ammunition companies to take custody of recovered ammunition and salvageable components which can be placed into depot stocks. Salvage and combat troops must be informed of enemy ammunition which can be used. Such items will be disposed of in the same way as our own ammunition. Enemy ammunition which is not usable and which does not have any intelligence value will, if possible, be destroyed on the spot.

Inspection. - Prompt examination of recovered or captured ammunition by qualified Ordnance personnel is the responsibility of the Ordnance representative at the salvage dump. Such personnel will recommend the disposition of the ammunition in accordance with instructions from higher headquarters. Care should be exercised in the examination of enemy ammunition in order to avoid booby traps*.

Disposition by ammunition companies. - Serviceable ammunition taken over by the ammunition company is placed in the ASP stock and reported to the army Ordnance officer, and it may be immediately reissued to troop units as required.

It may be frequently found that major items of Ordnance materiel will include items from other services. This is exemplified by the radios found in tanks (Signal Corps equipment). Plans for the evacuation and disposition of this equipment should be worked out between the pertinent services, and these plans transmitted to the maintenance companies.

Equipment which is found serviceable may be left as an integral part of the major item and returned to service with it after the major item is repaired.

The recovery unit in operation



Above: The tank approaches the trailer, and below: it is drawn onto the trailer by cables

If the equipment is found unserviceable, the pertinent service will be notified through the special staff or through G-4 in order that the proper personnel and equipment may be sent to the Ordnance maintenance shop to repair or replace the damaged item.

If the major item is beyond repair, the pertinent service will be notified in order that they may have the opportunity to salvage such of their equipment as may be desirable.

Liaison must be maintained between the collecting point and the Ordnance maintenance echelon. In periods of relative quiet this liaison may be performed by contact parties from the Ordnance maintenance battalions, or, in the case of the triangular infantry division, the light maintenance company. A daily visit to the collecting point designated for the units served by the contact party will usually suffice. In active operations, however, liaison between the collecting point and the Ordnance maintenance battalion must be continuous. Permanent liaison agents should be assigned to each collecting point. It will be the responsibility of these agents to determine the disposition of all Ordnance materiel brought to the collecting point. He will also see that contact parties or evacuation units coming to the collecting point are shown the location of the equipment which they have been sent to repair or evacuate. Liaison agents will normally maintain communication with the maintenance battalion by means of radio. They will send in their reports and also receive instructions by this means. Radio communication will be supplemented by telephone wherever possible. In the event that neither means of communication is available, messengers will be used to maintain contact between the various units.

Maintenance echelons of the using troops are equipped with vehicles which may be used for recovery operations. These vehicles include the prime movers, trucks, wreckers, and tractors. Also any combat vehicle may be used to tow another vehicle of the same type or one which is lighter. These vehicles will be used to unditch bogged vehicles or weapons, to right overturned equipment, and tow disabled materiel to collecting points, where it is turned over to Ordnance maintenance echelons for repair and reissue.

The armored force presents a special recovery problem in that the equipment involved is heavy and cumbersome. However, the organic vehicles of the combat troops are capable of doing their own recovery. For example, a tank can be towed by another tank, a half-track by another half-track, etc. In general any vehicle can tow a similar vehicle or a lighter one.

To assist in this work of recovery, the maintenance section of each tank company, the appropriate section of each armored infantry regiment, and engineer and field artillery battalions are assigned special recovery vehicles. This vehicle is an armored tractor, armed with a cal. .50 machine gun for its own protection. It carries a maintenance crew and operates on the battlefield. If the damaged item requires repairs beyond the capabilities of the crew, they will tow the disabled equipment from the scene of combat to second echelon maintenance shops or to collecting points, depending upon the extent of repairs necessary.



Above: Tractor of T-3 unit using winch to tow tank in difficult terrain. Below: The tank being towed.

The training of combat units should include methods of covering the recovery vehicle and crew by fire when they go forward to save a damaged vehicle during the battle. Full consideration should be given to the use of smoke by the recovery crew, whenever the situation allows, to cover their operations on the battlefield.

Combat troops of the infantry division recover their own unserviceable materiel. In the case of small items, these are transported to the division maintenance office by ammunition trains on their way to the rear for ammunition. If the organization does not have the facilities or transportation to accomplish this movement, the maintenance office will arrange with the corps maintenance battalion for the necessary facilities to move the materiel.

The Air Forces have their own organization for recovery. In the process of recovery of their own and captured planes, they will recover Ordnance materiel which forms a part of the unit. Such recovered items will be turned over to the proper Ordnance section as a maintenance job.



Showing skid in place to guide tank onto trailer while being loaded

Care must be exercised in the handling of materiel which may have been contaminated with gas. Whenever possible, this materiel should be decontaminated by the recovery unit before being moved, or, in any event, as soon as practicable. When decontamination is beyond their means or there are chemical warfare troops available, the recovery unit will plainly tag the materiel and report its location to the Chemical Warfare Service. Upon the completion of the task of decontamination, the chemical troops concerned will notify the appropriate recovery unit.

After damaged materiel has been decontaminated, its disposition is the same as that of other recovered materiel. However, as a precautionary measure, all such equipment should be plainly tagged with date and type of contamination, and the measures employed.

Any equipment which, for any reason, is not recovered should be thoroughly destroyed. In

the opinion of experienced observers, the removal of an essential part from a stalled vehicle left on the battlefield is not an effective means of denying the use of the vehicle to the enemy. Such a system requires a very thorough disciplinary drill to insure that the men remove the same part every time. If they do not, as is usually the case in the excitement of battle conditions, the enemy can use two abandoned vehicles to make one which can operate. Therefore, the only practicable solution seems to be the complete destruction of vehicles and other equipment which are not recovered. Instructions for such destruction are issued with each major item by the issuing service.

Evacuation operations are assigned to Ordnance evacuation companies. These are equipped with large transporter units capable of carrying heavy items of Ordnance materiel. A detailed description of a proposed organization for these companies is included later in this study.

Each maintenance battalion in an armored division will have an evacuation company. In the field army, one company will be assigned to the maintenance and supply battalion. Theater reserve will also include evacuation companies which may be assigned to assist in evacuation operations as required.

Left:

A close-up of the skid in use

Below:

A side view showing the skid in use



The Ordnance evacuation company is essentially a transporting agency. It is charged with the following specific missions:

- (1) Clearing recovered equipment from collecting points and the transportation of such material to the proper maintenance shop for repair.
- (2) Transportation of serviceable materiel to the front.
- (3) Assisting in the movement of Ordnance general depots and maintenance shops.
- (4) Assisting the quartermaster salvage service in clearing battlefields of salvage when not otherwise engaged. Its main function on the mission will be the handling of large and heavy items with which the quartermaster is not equipped to deal.



Above: The skid in place over rear wheels of trailer. Below: Ramp and ramp skid in place

Salvage operations in the theater of operations are a responsibility of the Quartermaster Corps, which may be assisted by Ordnance evacuating units or combat troops when these are not otherwise employed.

The quartermaster agency charged with the collection and evacuation of salvaged materiel is the salvage collecting company (T/O 10-187). This is a theater reserve unit. Its mission is the receipt, collection, basic classification, and evacuation to depots in the communications zone of all classes of waste material, salvage, abandoned property, and unserviceable supplies from combat areas, collecting points, dumps, and railheads. The company has attached to it specialists from the Ordnance Department, Chemical Warfare Service, and Signal Corps for the supervision of the basic segregation of technical property of their respective services. Such specialists also make recommendations as to the proper disposition of such materiel.

The EVACUATION COMPANY

The following is a discussion of the organization and functions of the evacuation company. This company is the Ordnance organization charged with the responsibility for the solution of the problem of evacuation which has been discussed. The arrangement given here of personnel and equipment within the organization should not be considered as limiting in any respect. It is offered merely as a guide, and it may be altered in the field by responsible commanders to fit any particular situation.

The mission of the Ordnance evacuation company is as follows:

- a. The transportation of disabled Ordnance materiel from points along the axis of supply and evacuation* and from collecting points to Ordnance shops for repair.
- b. In the case of a retirement by our troops, the evacuation of all Ordnance materiel from those areas which are likely to fall into the hands of the enemy.
- c. Assisting in the movement of depots and maintenance shops whenever the time and/or equipment is available.
- d. The transportation of materiel between maintenance echelons.
- e. The transportation of serviceable items forward.
- f. Assisting the quartermaster salvage troops after an advance in clearing areas of large items of salvage equipment which the quartermaster service is not equipped to handle.

When the company is operating as part of a maintenance battalion, it will be supplied through the supply office of the battalion in accordance with the procedures outlined in paragraphs 142 and 143 of FM 9-10. When the com-

pany is on a detached mission, it will normally draw its supplies from the echelon to which it is attached.

The company commander is responsible for the training of the company. He must continuously plan a course of action to be carried out in all foreseen circumstances and must supervise the training of personnel in the proper performance of their duties. This training must work toward the goal of automatic performance of duties so that they will be carried on even in times of great stress, and so that a high degree of coordination between individuals and units will weld the whole into an efficient working team.

One evacuation company is assigned to the maintenance and supply battalion of the army.

In addition to the above, one company is assigned to the maintenance battalion of each armored division.

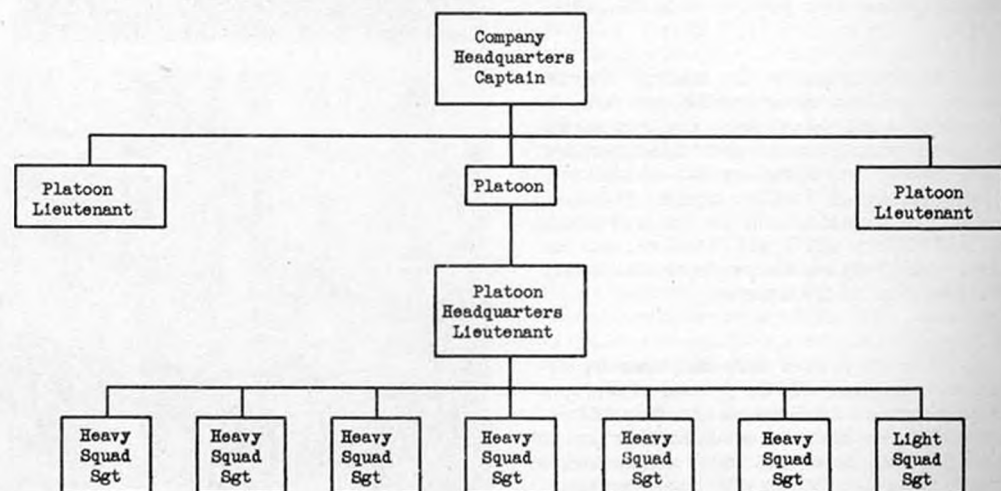
Other companies will be assigned to theater reserve, where they can be assigned to combat units as the situation demands.

The organization of an evacuation company is shown in T/O 9-187, on this page.

The evacuation company is divided into three platoons of 6 heavy and 1 light squads each. A schematic diagram of the organization is shown on the next page.

All personnel of the evacuation company are armed. In general, officers and NCO's of the first three grades will carry carbines, and the rest of the enlisted men will carry the cal. .30 rifle. Since it is expected that these companies will usually operate some distance behind the front lines they carry only defensive weapons. Evacuating units will be armored against cal. .30 fire and will carry a cal. .50 machine gun for antiaircraft and ground protection.

ORGANIZATION OF ORDNANCE EVACUATION COMPANY



Sections of the company will have personnel assigned to them as required.

The general-purpose vehicles assigned to this company are:

Truck, 1/4-ton, 4 x 4
Truck, 3/4-ton, 4 x 4 (command with winch)
Truck, 3/4-ton, 4 x 4 (weapon carrier)
Truck, 2-1/2-ton, 6 x 6, cargo with winch

All these vehicles are common throughout the army, and no description of them will be given here.

Each heavy squad in the operating platoon is equipped with a special transporter unit. This unit is a vehicle capable of transporting tanks and other heavy items of Ordnance materiel. The light squad is equipped with a heavy wrecker.

In order for the evacuation company to operate at peak efficiency and with a minimum loss of down-time, the evacuation loads should be equally distributed between the various platoons. This will not always be possible, but should be constantly borne in mind as the ideal solution. This ideal will be particularly difficult to obtain when the company is operating over a wide area, as in the case of the evacuation company assigned to the field army, or in cases where the situation is changing rapidly. The actual solution adopted will depend on the tactical situation. The preparation of plans to fit the particular situation is the responsibility of the company commander. He is also responsible for the execution of these plans when they are approved by higher headquarters. Two possible solutions to the problem are suggested below.

Centralized company control. - In this situation, the entire company would operate from a central bivouac; the loads on the platoons would be equalized by the assignment of missions from company headquarters to the platoon with the lightest load. This method requires a high degree of direct supervision of the company. Company supply and messing problems are decreased. However, the average distance to be covered per mission will be high, and the number of missions to be handled in a given time will be small.

Dispersed platoon control. - This solution allows the platoon to operate from a location convenient to its work. This will decrease the down-time and increase the number of missions that can be handled. Also, liaison work will be facilitated by the close proximity to the collecting point, and movement of platoons will be facilitated. The disadvantages of this solution are that the supply and messing of the company becomes complicated; it is difficult for company headquarters to maintain close control over the platoons, and this may result in wide variations in the load imposed on any one platoon. Within this solution, there are two methods of assigning the evacuation platoons. These are:

Assignment to tactical units. - Platoons may be assigned to support definite tactical organizations. This arrangement allows the platoon and the tactical unit to get acquainted with each other - to learn each other's requirements, methods of operation, capabilities, and limitations - thereby improving coordination and the quality of Ordnance service rendered. However, the work required by a tactical unit will vary widely, resulting in poor equalization of the evacuation load. Also, the tactical unit may make a sudden movement of some length, requiring the platoon either to follow or to make other arrangements. This necessitates close liaison between company headquarters and the platoons.

Assignment to specific areas. - Platoons may be assigned definite areas instead of definite tactical units. Much of the discussion in the preceding paragraph will apply also in this case. However, the loads may be more easily equalized by adjusting the areas from time to time as the need arises, and platoons will not be required to follow tactical units.

Reports

In order to facilitate the equalization of loads on the various platoons, company head-

T/O 9-187

TABLE OF ORGANIZATION
No. 9-187

WAR DEPARTMENT,
WASHINGTON, October 2, 1942.

ORDNANCE EVACUATION COMPANY

Designation: †-----Ordnance Evacuation Company

1	2	3	4	5	6	7	8	9	10
Unit	Technician grade	Headquarters section	Platoon headquarters	6 heavy squads (each)	1 light squad	Total platoon	Total company	Enlisted cadre	Remarks
2 Captain.....	1						1		†Insert number of company.
3 First lieutenant.....	1						1		* Executive officer.
4 Second lieutenant.....	1						1		b Property, mess and liaison officer.
5 Total commissioned.....	3	1				1	6		c One of these men will also act as orderly (695).
6 First sergeant (585).....	1						1	1	d Will also drive tanks in recovery operations.
7 Technical sergeant, including.....	1						1	3	e These guns are mounted 1 per 4 2½-ton trucks (or heavier) listed on this table.
8 Platoon chief (014).....	1						1	3	The serial number symbol shown in parentheses is an inseparable part of the specialist designation. A number below 500 refers to an occupational specialist whose qualification analysis is found in AR 615-26. A number above 500 refers to a military occupational specialist listed in Circular No. 14, War Department, 1942.
9 Staff sergeant, including.....	3						3	2	
10 Mess (824).....	(1)						(1)	(1)	
11 Motor (813).....	(1)						(1)	(1)	
12 Supply (821).....	(1)						(1)	(1)	
13 Sergeant, including.....	2	1	1	9	27	5			
14 Reconnaissance (744).....	(2)					(6)	(2)	(3)	
15 Squad leader (653).....	(1)					(7)	(21)	(3)	
16 Corporal, including.....	1						1	1	
17 Clerk, company (405).....	(1)						(1)	(1)	
18 Technician, grade 4.....							2	1	
19 Technician, grade 5.....							40	6	
20 Private, first class.....	15	8	5	5	43	42	40	4	
21 Private.....							60		
22 Chauffeur (344).....	5	(1)					(1)		
23 Chauffeur (344).....	4	(3)					(3)	(13)	
24 Chauffeur (245).....	5		(1)				(6)	(18)	
25 Chauffeur (245).....				(1)			(1)	(3)	
26 Cook (060).....	4	(2)					(2)	(1)	
27 Cook (060).....	5	(2)					(2)	(1)	
28 Cook's helper (521).....	5	(3)					(3)		
29 Mechanic, tank (404).....			(1)	(1)	(7)	(21)	(3)		
30 Rigger (189).....			(3)	(2)	(20)	(60)	(3)		
31 Welder, general (256).....				(1)	(3)	(1)	(3)		
32 Basic (521).....		(3)	(5)			(5)	(18)		
33 Total enlisted.....	20	11	6	6	53	179	23		
34 Aggregate.....	23	12	6	6	54	185	23		
35 O Carbine, cal. .30.....	17	10	4	4	38	131			
36 O Gun, machine, cal. .50, H.B., flexible.....	2	2			2	8			
37 O Gun, submachine, cal. .45.....	2	2			1	3	11		
38 O Launcher, rocket, antitank.....	2	1				1	5		
39 O Rifle, cal. .30.....	4		2	1	13	43			
40 O Trailer, 1-ton, 2-wheel, cargo.....	2					2			
41 O Truck, ¼-ton.....	1	2				2	7		
42 O Truck, ¾-ton, command and reconnaissance with winch.....	1						1		
43 O Truck, ¾-ton, weapon carrier, with winch.....						1	3		
44 O Truck, 2½-ton, cargo, with winch.....	3						3		
45 O Truck, wrecking, heavy.....				1	1	3			
46 O Truck, 40-ton, tank recovery.....				1		6	18		

[A. G. 320.2 (9-24-42).]

488889-42

REPORT OF OPERATIONS, _____ Ord. Co.

Period: FROM _____ To _____

Platoon	1st	2nd	3rd	Totals
No. of trips				
Total Mileage				
Destination	No. of Trips	No. of Trips	No. of Trips	Total

REPORT OF COMPANY OPERATIONS

quarters must keep a close check on the work performed by each. This check will also be necessary to enable the company to prepare reports required by higher headquarters. When the company is operating as a unit, the check will be maintained by requiring all calls for missions to pass through company headquarters and by requiring all trip tickets to be turned in to company headquarters. If the platoons are dispersed, their headquarters will be required to send a report to company headquarters at prescribed intervals, giving the details of the missions performed.

In order to enable the company commander to keep informed of the missions carried out by the various platoons, a record will be kept of all missions performed. A convenient form for this purpose is a trip ticket. This will be used as the authorization for a squad to perform a given mission and will be prepared in duplicate by the headquarters assigning the mission. It will give the item of material to be moved, its location, the apparent trouble with it, and the place to which it is to

Trip Ticket
(Reverse Side)

Special Instructions & Remarks:
Pick up tank I Corps Maintenance Shop No. 2 - take to 45 Armored Regt. 372-785.

132	Ord. Co.	2	Plat.
Date:	1942	Nov.	130915
	Year	Mo.	Time
Sq No.	8	Trip No.	413
Material <u>1st Tank</u>			
Location <u>374.6-785.9 100 yards</u>			
<u>N of creek near farm house</u>			
Trouble <u>Engine knocked out</u>			
Take to <u>Army Shop No. 6</u>			
Delivered to <u>Army Shop No. 6</u>			
Date	<u>131630</u>		
Signature _____			
Ret to Hq _____ <u>140145</u>			
Trip Mileage _____			
(Over)			

Trip Ticket
(Obverse side)

be moved. Space will also be provided for special instructions, such as new materiel to be carried forward. The trip ticket will contain spaces for the inclusion of the designation of the squad performing the task, time of departure, time of return, mileage covered, and remarks. When a squad is on a mission the duplicate of this ticket should be kept in an active file or posted on an operations board in platoon headquarters. Upon completion of the mission this duplicate may be destroyed. The

REPORT OF OPERATIONS

Platoon, _____ Ord. Co.

Period: From _____ To _____

Trip No.	Squad No.	Load	Origin	Destination	Miles	Remarks

Signature _____

REPORT OF PLATOON OPERATIONS

information contained in the original is posted to a consolidated report, and the original trip ticket is disposed of as directed by the company commander.

The consolidated report is submitted to company headquarters at prescribed intervals. It shows in consolidated form the pertinent information contained in all trip tickets for missions performed during the reporting period. This form is prepared in duplicate by platoon headquarters, the original being transmitted to company headquarters at the end of the reporting period. The duplicate is retained by platoon headquarters and filed for their own information.

Company headquarters will use the consolidated reports received from the platoons to prepare a breakdown of the work performed by the company as a whole. This will give the company commander a check on the equalization of the loads on the platoons and will assist him in reassignment of spheres of action for the platoons.

In order that the company commander may have proper knowledge of the situation and of impending operations, he must keep in close contact with the army Ordnance officer. With information obtained from this source, he can dispose his platoons so as to give the maximum support where it is needed the most. In an active engagement the company commander must keep in close touch with his platoons and shift their zones of action as may be necessary to equalize the evacuation loads. Company headquarters should keep an operations map showing the salient features of the tactical situation and the location and area assignments of each platoon. An additional advantage of this map is its use in preparing overlays which may be used as movement orders for the reassignment of spheres of action for the platoons. Platoon headquarters will maintain a situation map showing the last reported position of each of their operating squads.

Company HEADQUARTERS

The company headquarters consists of one or more officers and the required number of enlisted men.

The organization shown by the accompanying chart may be used by the company commander as a guide in organizing the office.

The vehicles assigned to company headquarters include the following:

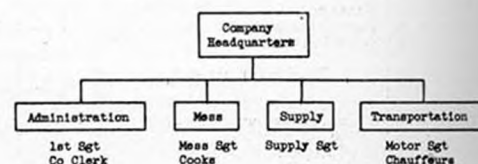
Truck, 1/4-ton, 4 x 4. - This vehicle is used primarily for general messenger service.

Truck, 3/4-ton, 4 x 4. - This vehicle is usually assigned to the company commander for his use or to be used as he may direct.

Truck, 2-1/2-ton, 6 x 6. - One of these vehicles is used as the kitchen truck. It carries the range, icebox and kitchen utensils.

Other trucks of this type are used as company supply trucks. When the company moves, these trucks will carry office equipment and other company impediments.

ORGANIZATION OF COMPANY HEADQUARTERS



Organization. - The company headquarters carries out the general military administrative functions of the company. In order to facilitate the division of responsibility, this section is divided into the following subsections:

Administrative. - This subsection is headed by the first sergeant. It is responsible for:

The training and administration of the company.

The maintenance of personnel records.
The maintenance of the company council book.

The preparation of training programs and schedules for the military and technical training of the company.

The supervision of all training in the company.

The maintenance of the correspondence files and the correspondence book, and the preparation of such records and reports as may be directed by the company commander.

The preparation of all necessary plans covering the changes in the location of the company, and the maintenance of a situation map showing the locations of the various components of the company.

The conduct of periodic scheduled or unscheduled inspections of all phases of the activities of the company.

Mess. - This subsection is headed by the mess sergeant and is responsible for:

Securing, transporting, preparing, and serving rations.

The preparation of all menus whenever the variety of the ration will permit.

Supply. - This subsection is headed by the supply sergeant and is responsible for:

The maintenance of the stock record covering all company property.

The maintenance of all records of individual equipment, and of files of memorandum receipts of property held by members of the company.

The maintenance of files of all vouchers to the stock record account.

The preparation of requisitions of all items required by the company.

The preparation of all property forms - such as reports of survey; statements of charges; inventory and inspection reports; over, short and damaged reports; etc. - required in the property administration of the company.

Transportation. - This section is headed by a motor sergeant. It is responsible for traffic control within the company.

Company Commander. - The company commander is responsible for all phases of the operations of the company. He should require the heads of all sections to keep him informed at all times of any changes in the status of matters pertaining to the operation of the company. He should establish the major policies and routine of procedure governing the operation of the company, but should delegate the responsibility for the performance of specific duties to the proper subordinates. Such subordinates should be held strictly responsible for the results. He is solely responsible for the administration of disciplinary action under the 104th Article of War, and he cannot delegate this authority. He is also responsible for planning for future requirements and inspecting the units of the company. He should actively participate in personnel administration. He should from time to time reassign officer and noncommissioned officer personnel in the company to different sections or duties. Such a practice will assist in preparing the company to meet emergencies. He should endeavor to insure continuity of policy within the company by the maintenance of policy books by each section.

Company Executive. - In general, the senior lieutenant of the company will be designated as the company executive. In addition to his normally assigned duties, he will keep himself informed of matters affecting the entire company, and he will be prepared to act for the company commander in his absence.

Property, mess and liaison officer. - Has the usual functions of such an officer.

First Sergeant. - The first sergeant is the company commander's senior representative in matters pertaining to company administration. He is specifically responsible to the company commander for:

Maintenance of all records and reports pertaining to company administration.

Preparation of purely military training programs and schedules.

The enforcement of discipline.

The preparation and issuing of company orders as directed by the company commander.

The preparation of routine correspondence.

The supervision of formations.

Supply Sergeant. - The supply sergeant is responsible to the supply officer for the security, proper storage, and administration of the company property. He should understand thoroughly all property regulations and must keep accurate and complete records and inventories.

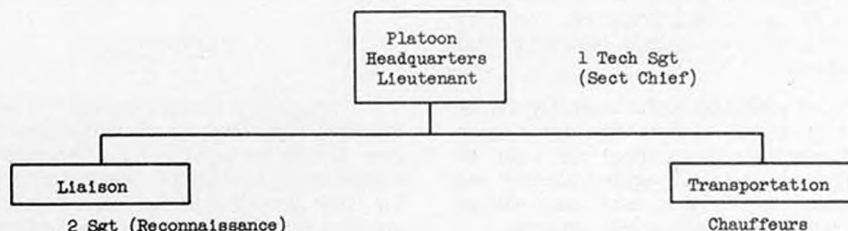
Mess Sergeant. - The mess sergeant is responsible to the mess officer for all matters pertaining to the administration, obtaining, preparing, and serving of the company mess and the care and maintenance of all mess property.

Motor Sergeant. - The motor sergeant is responsible for the dispatching and maintenance of company vehicles.

Company Clerk. - The company clerk is responsible to the first sergeant for the typing of all necessary correspondence of the company office and the maintenance of the necessary files and records kept by that office.

The EVACUATION PLATOON

ORGANIZATION OF PLATOON HEADQUARTERS



The evacuation platoon is organized with a platoon headquarters, headed by the platoon commander, who is assisted by eleven enlisted men, and 6 heavy and 1 light squads, each of which consists of an evacuation unit and its crew.

The major items of equipment assigned to the evacuation platoon are shown in the Table of Organization.

The general picture of the problem confronting the evacuation platoon is discussed at the beginning of this study. In this connection it should be clearly understood that the ultimate responsibility of the evacuation platoon falls on the company commander, to whom the platoon commander is in turn responsible.

Control of the units of the evacuation platoon will normally be effected through platoon headquarters. The platoon will be assigned a specific mission and will be given any general instructions necessary by company headquarters. Within the limitations imposed by these instructions, the full responsibility for the accomplishment of the mission falls on the platoon commander. Through platoon headquarters the platoon commander will control the dispatching of vehicles from the platoon area and the movements of these vehicles in the field.

In order to maintain the close control specified above, it is imperative that the platoon commander maintain close contact both with evacuation units in the field and with company headquarters.

Careful consideration should be given to recognition signals between ground and air forces. These signals will be prescribed by higher headquarters. All evacuation units in the field should be kept informed of any changes of such recognition signals and carefully instructed in their use. This is particu-

larly important for such units, since their size and slow speed make them excellent targets for both aircraft and artillery. It may sometimes happen also that they will be transporting captured enemy equipment, in which case they might be mistaken for enemy units.

Platoon HEADQUARTERS

Platoon headquarters has two distinct functions - namely, liaison and transportation. A suggested organization of the platoon headquarters to carry out these functions is shown in the accompanying chart.

The control of the platoon is administered from the platoon office. This office maintains a situation map showing the location of the various evacuation squads, will prepare and maintain files of trip tickets for missions of the squads, and will prepare reports required by company headquarters. The platoon office is also responsible for maintaining liaison with collecting points or the combat units supported. These functions are carried out by reconnaissance noncommissioned officers, who go forward to collecting points or other places where damaged materiel may be found and keep platoon headquarters informed as to routes to such places, as well as the number, types, and conditions of materiel to be evacuated. These liaison agents should cooperate closely with other Ordnance representatives at collecting points. In the absence of directives, these agents should be prepared to make a cursory inspection of damaged materiel with a view to recommending the proper destination for evacuation.

The EVACUATION SQUAD

The heavy evacuation squad consists of an evacuation transporter unit with its crew. It is in command of a sergeant, and the crew consists of five additional men.

The primary function of an evacuation squad is to go forward to the location of damaged Ordnance materiel, load it on the transporter vehicle and carry it to a maintenance shop for repair.

Squads should keep in close contact with platoon headquarters, keeping it informed of their location and of any other pertinent data in which it may be interested. The squad will be trained in the use of, and prepared to use, the prescribed recognition signals between ground and air forces.

Heavy evacuation units normally will be protected by armor against fire from small arms. They will also be equipped with a cal. .50 machine gun for protection against aircraft and enemy raids. In addition, each man will be equipped with a carbine or a cal. .30 rifle.

The light squad is essentially the same as the above except that it is equipped with a heavy wrecker in place of the transporter unit referred to above.

The operations of the evacuation squad are of a highly specialized nature. Since they will operate fairly close to the front lines, where they may be subject to enemy attack, it is essential that they be welded into a smooth-working, highly efficient team in order that they may accomplish their mission in the most expeditious manner. The training of these squads should include the efficient use of camouflage and the proper use of individual cover. These men should also be well trained in detecting and neutralizing booby traps. A security plan should be worked out in detail, and the squad drilled in its execution, so that proper protection may be maintained at all times.

The sergeant in charge of the squad acts as its commander at all times. He acts as foreman during evacuation operations. He is responsible for the training and efficiency of his crew.

The driver operates the vehicle on the road and operates the winches during loading and unloading operations. He is responsible for the mechanical condition of the vehicle and the maintenance of the motor book. He also acts as gunner when the mechanic is otherwise employed.

The mechanic assists the driver in keeping the equipment in good mechanical condition. He also assists in loading and unloading, especially where mechanical ability is required. It may sometimes happen that a small amount of mechanical work on the damaged vehicle will make it easier to handle in loading operations. A few minutes spent in such preparations may save hours in loading time. The mechanic acts as gunner when the need arises and will man the

cal. .50 machine gun when required both on the march and during loading operations.

The riggers handle the ropes and cables under the direction of the squad leader and perform any other duties as he may direct. They should be capable of driving tanks and other automotive equipment so as to assist in loading operations where the automotive power of the damaged vehicle may be used. These men should be fully conversant with ropes, knots, and other rigging equipment, and should exercise great care not to injure the disabled or damaged materiel further in loading and unloading operations.

DEFINITIONS

Recovery is the removal of disabled or damaged materiel from the battlefield or wherever it may be found, and its transportation to a point which is readily accessible to transporting units traveling to the rear. Recovery is sometimes used as a generic term to combine recovery and evacuation operations. In this sense the term means the acquisition of damaged or abandoned materiel with the purpose of preparing it for reissue.

Salvage, as used in this study, refers to unserviceable equipment which is beyond repair. After cannibalization of such equipment, it may be turned over to the quartermaster salvage service for disposition.

Evacuation is the transportation of recovered materiel from collecting points or from maintenance shops to the proper maintenance echelon for repair. It is also used in a general sense to denote the movement to the rear of any and all types of personnel and materiel.

A recovery collecting point is an area located in the vicinity of the combat troops and near the axis of supply and evacuation. Disabled, abandoned, captured, and salvaged materiel recovered from the battlefield will be brought to this area for evacuation. The location of collecting points is specified in administrative orders of divisions and larger units.

A contact party is a detachment of Ordnance personnel sent from an Ordnance field shop to units requiring assistance. It may consist of as many men and as much equipment as are considered necessary for the mission.

Cannibalization is the stripping from damaged materiel of serviceable parts which are required for maintenance operations. This will always be performed on nonrepairable items in all echelons and may be performed on repairable items which must be evacuated to a higher echelon if stocks of the component parts are depleted in the lower echelon.

A booby trap is an explosive device arranged on abandoned materiel by a combatant for the purpose of wounding or killing careless or thoughtless opponents. These traps may be con-

nected to doors, windows, furniture, and souvenirs, such as helmets or parts of uniforms or rifles, and they may be attached to weapons or vehicles which have had to be abandoned. (See another article in this issue.)

The axis of supply and evacuation is a principal route (or routes, in the event one-way traffic is necessary), following the main line of advance, over which supplies are brought forward to the troops and over which damaged and/or salvaged materiel is moved to the rear echelons. Whenever possible, the axis of supply and evacuation will be along main highways.

YOU SHOULD KNOW ABOUT----

-----FIELD RIGGING

On the next page you will find the beginning of a study of field rigging. This is a subject of special interest to recovery personnel, and of general interest to all Ordnance personnel. In this article you will find discussions and directions for tying all the principal knots, bends and hitches which you will use in the field, as well as information regarding hoisting devices, etc.

-----CAMOUFLAGE

On page 538 a discussion of some of the principles of camouflage begins. Camouflage will often be of vital importance to a recovery unit if it is to operate successfully in the field. The subject is of general importance for the personnel of all units located in the theater of operations.

-----BOOBY TRAPS

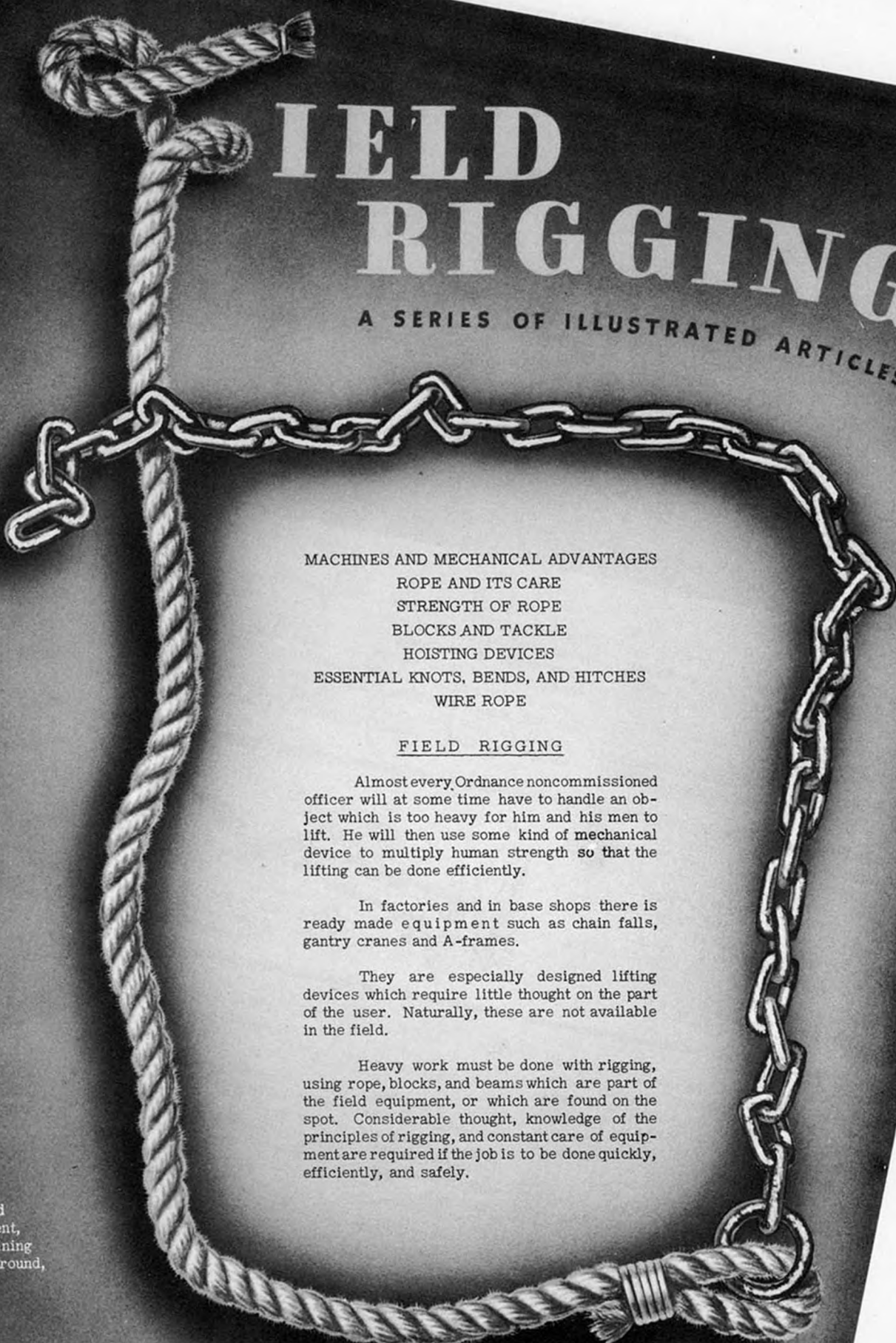
Don't overlook the short article on Booby Traps which begins on page 543. It may not look important to you, because you are not a "booby", but it is very important, and maybe you are a "booby".

Some strange stories have been coming from the war zones. They indicate, as we should always expect, that the enemy carries with him a bag full of surprises, even when he is being defeated and is in reckless retreat.

We must never underjudge the cunning of an enemy. We must expect to encounter many little tricks, often to our sorrow, if we live to think about it afterward.

It is said that during the Axis retreat from Egypt across Lybia during November, the pursuing British troops often found what appeared to be small notebooks on the desert. Too many times British soldiers stopped to retrieve these lost articles, or "souvenirs". When picked up they exploded in the hands of the man who had more curiosity than sense. In some cases the injuries were fatal. In the remainder, the curious received one or two "souvenirs" which he will carry with him the rest of his life. He ceases to pursue the retreating enemy, with stubs of arms where hands should be.

DON'T TOUCH ANYTHING UNLESS YOU KNOW POSITIVELY WHAT IT IS.



FIELD RIGGING

A SERIES OF ILLUSTRATED ARTICLES

MACHINES AND MECHANICAL ADVANTAGES

ROPE AND ITS CARE

STRENGTH OF ROPE

BLOCKS AND TACKLE

HOISTING DEVICES

ESSENTIAL KNOTS, BENDS, AND HITCHES

WIRE ROPE

FIELD RIGGING

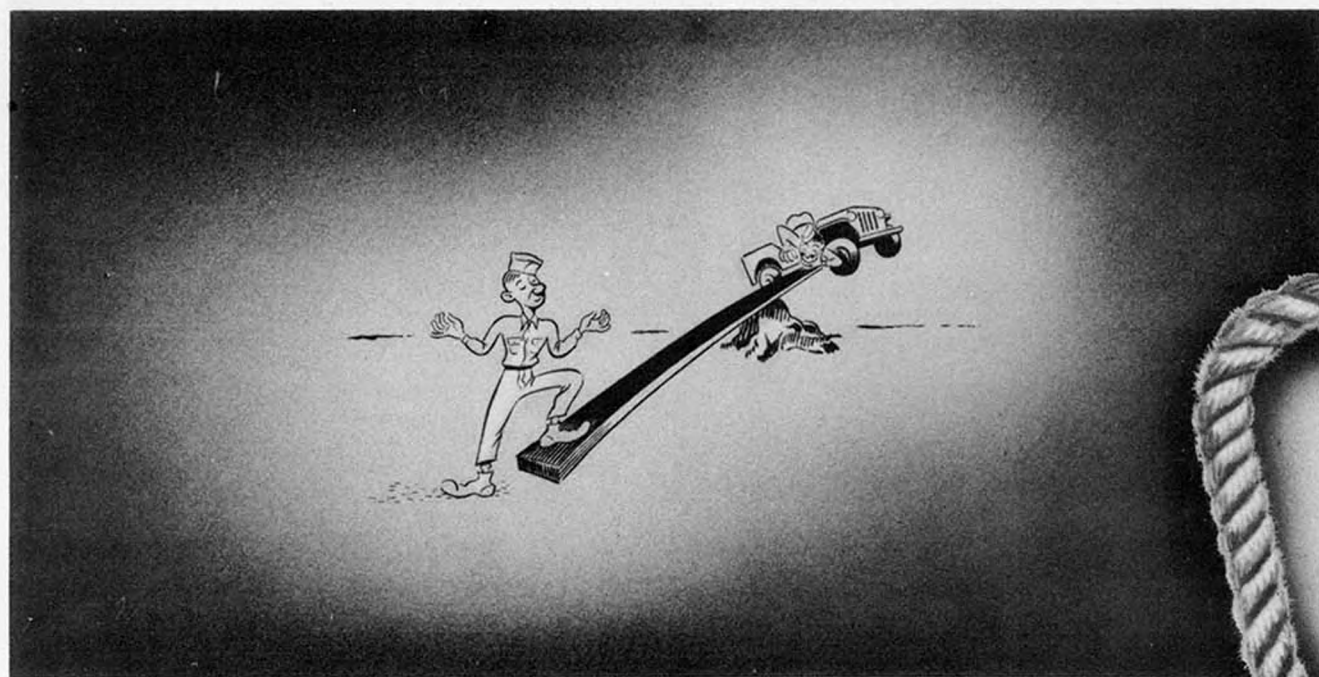
Almost every Ordnance noncommissioned officer will at some time have to handle an object which is too heavy for him and his men to lift. He will then use some kind of mechanical device to multiply human strength so that the lifting can be done efficiently.

In factories and in base shops there is ready made equipment such as chain falls, gantry cranes and A-frames.

They are especially designed lifting devices which require little thought on the part of the user. Naturally, these are not available in the field.

Heavy work must be done with rigging, using rope, blocks, and beams which are part of the field equipment, or which are found on the spot. Considerable thought, knowledge of the principles of rigging, and constant care of equipment are required if the job is to be done quickly, efficiently, and safely.

Based on a text titled
"Field Rigging" prepared
by the Training Department,
Ordnance Replacement Training
Center, Aberdeen Proving Ground,
Maryland.

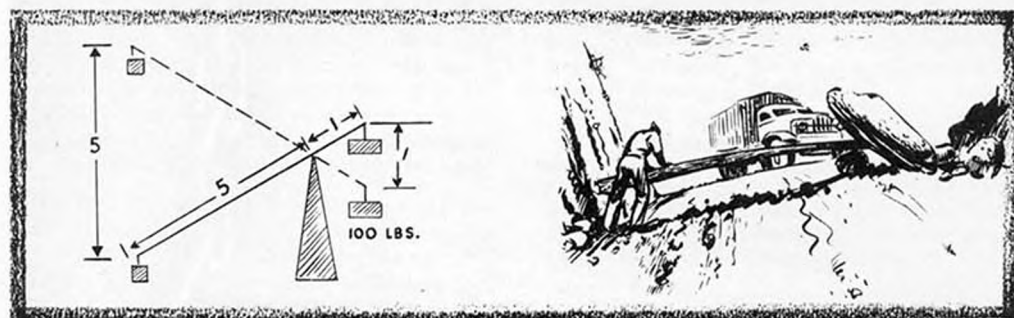


Field rigging makes use of various devices which increase the force that a man can exert, but in all these only one basic principle is involved.

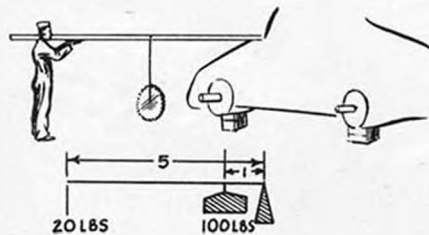
This principle is:

A small force applied over a great distance will move a great load a short distance.

Thus we see that 100 pounds times 1 foot (short lever arm) equals 20 pounds times 5 feet (long lever arm). In other words, the small weight times its lever arm equals the large weight times its lever arm. No energy has been gained, but one change has been made. With a small weight we have been able to balance a large weight; MECHANICAL ADVANTAGE has been



This is shown by the lever. The small weight on the long end of the lever can move a great distance and exactly balance the large weight which moves a short distance. The work done — the weight times the distance it moves — is the same in both cases. Therefore there is no energy gained.



We see in the sketch that a weight of 20 pounds exactly balances another which is 5 times as heavy, or 100 pounds, on the lever. This is true because the small weight moves 5 times as far as the large weight. We also notice that the long lever arm is 5 times as long as the short and that the small weight is on the long arm.

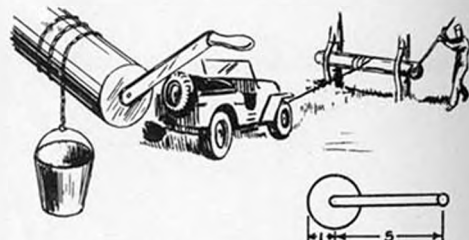
gained. MECHANICAL ADVANTAGE is the proportion between the large weight and the small weight which balanced it.

The value of this thing called Mechanical Advantage is readily seen, of course. A great deal of lifting and moving must be done in the performance of Ordnance Maintenance, and much of this work requires muscles, or some substitute for muscles.

Never fail to take advantage of mechanical devices if the materials required for their use are at hand. Personnel is the most valuable item used in our maintenance work. A man who is weakened or broken unnecessarily is an inexcusable loss of our most valuable maintenance tool. A man in the hospital can perform no maintenance work, and in addition he requires care from other personnel.

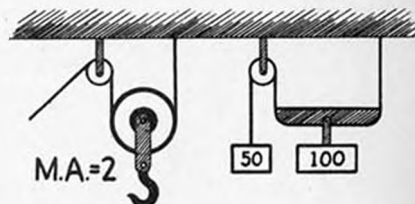
The idea of Mechanical Advantage, therefore, cannot be given too much emphasis. The use of so simple a principle as that of the lever should be used whenever possible.

The same principle is applied in the use of the windlass, which is a sort of continuous



lever. The increase in force is equal to the length of the handle divided by the radius of the drum.

The pulley is another form of lever, as can be shown by cutting out a part of the pulley and imagining it as operating alone. For every two feet of rope pulled the weight moves only

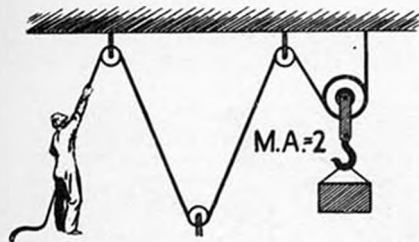


one foot. This makes it possible for a force of 50 pounds to balance a weight of 100 pounds. Therefore the M. A. (Mechanical Advantage) of this pulley system is 2, since a weight of 50 pounds is able to balance a weight twice as heavy.

The fixed pulley is used only to change the direction of the pull and does not change the M. A. The M. A. is the important factor to be studied, however, for in addition to helping prevent injury and unnecessary fatigue of personnel the principle involved serves to magnify

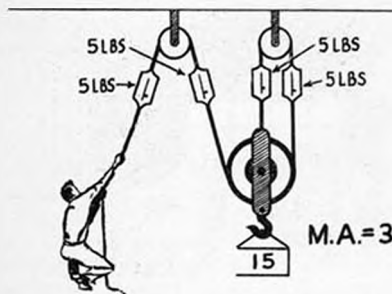


many times the power which the personnel available could otherwise afford. Note the use of block and tackle in the lifting apparatus of the



Heavy Wrecker, which magnifies greatly the lifting power which would otherwise be available.

The more ropes there are supporting the load the more slowly it moves, and the greater the M. A. This can be shown by placing a scale



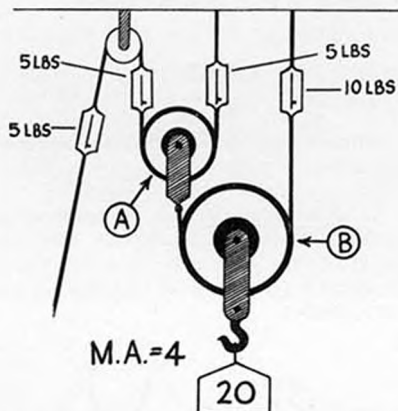
in each strand of the supporting rope. The strain is equal on each part of the rope because the rope passes over the wheels easily, and

makes the strain on each strand equal to the strain on the pulling rope. The M. A. of a simple pulley system is equal to the number of supporting ropes.

Saying that the load moves more slowly does not of necessity imply any disadvantage in the use of the principle involved. While speed is almost always essential in maintenance work, it must often be subordinated to other considerations. Being sure, and being safe, are also important considerations, and often they add to the actual speed with which the entire task is accomplished.

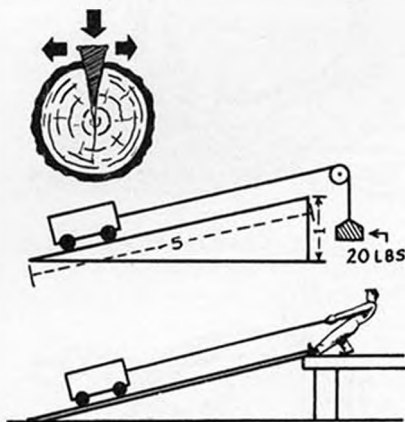
In the efficient use of block and tackle, as in all adaptations of rigging principles to the tasks at hand, a high degree of ingenuity is a necessity. It is often possible to do a job in a number of different ways, possibly with equally satisfactory results. It is just as easy, however, to select a wrong method, or at least one which would consume more time or energy.

Compound systems result when one system is connected as a part of another. Pulley "A" moves one-half as fast as the pulling rope.



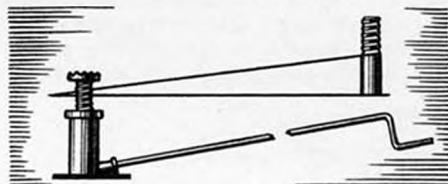
Pulley "B" and the load move one-half as fast as pulley "A" and one-fourth as fast as the pulling rope. Therefore the M. A. of the compound system is obtained by multiplying the M. A. of the two systems.

The wedge or inclined plane is another familiar device. This is the principle used in splitting a log with a wedge, or cutting with sharp



instruments. It is also involved when a sloping surface is used to raise heavy objects. The M. A. of this device is equal to the distance the object moves divided by the height it is raised.

We realize without stopping to think that it is easier to move a heavy object up a ramp or a sloping incline than to lift it bodily. It may



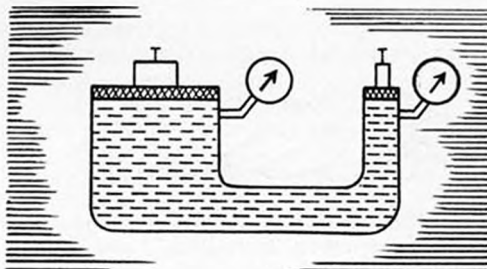
also be much safer, and therefore quicker in the end. We know, certainly that it reduces the probable fatigue of personnel, which in itself is an advantage always to be considered.

A screw is nothing more than a "rolled up" inclined plane. It is used in doing work in



the form of mechanical jacks, nuts and bolts, and turn buckles.

Another useful principle is that of the hydraulic jack. If a small force is exerted on a



small piston a pressure is set up, and this pressure is carried by tubes to a large cylinder.



Since the same pressure is exerted on every part of the system, the large piston can support a greater force, as it has more area upon which the pressure acts. As in the other



devices, however, the small piston must move through many strokes in order to raise the large piston a short distance.

Rope is by far the most important single item in field rigging. It is made up of many fibres of hemp or similar material which are twisted into yarns. The yarns have a right-hand twist (or lay). Many yarns are placed together and twisted to the left to form a strand. Several strands, usually three, are laid up right-



handed to form a rope. The rope does not untwist when a strain is applied to it because the strands have a strong left-hand twist which balances the combined right-handed twist of the yarns of the rope.

Ropes used in the army will usually be three-strand, right-laid. Other types of rope are made in different ways.

Cable-laid is another term which means the same as right-laid.



Shroud-laid rope is composed of four strands laid up right-handed around a core rope.



Marline is creosoted twine which is used for lashing, whipping, or seizing. It may be two or three-strand and is left laid.



Nothing can be done to increase the strength of rope, but many things may happen to decrease its strength. It is necessary to inspect it frequently to guard against wear or damage. Be sure to test it whenever there is any doubt as to its strength.



The inner surfaces of the strands should be inspected frequently. This can be done by opening the jaws (point at which the strands press against one another), with a strong twist against the lay. Special note should be made of:

1. Broken Inner Fibres caused by sand or sharp particles which cut the fibres when the rope is flexible as it is when passing over a sheave (wheel of a block or pulley).

2. Discoloration caused by action of acid or strong caustic. This will appear as a reddish-brown stain which is much darker than the natural color of the rope. If the discoloration is due to acid the fibres will break when scratched with the thumb nail. Remove the damaged portion and splice the rope.

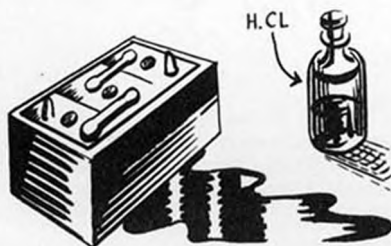
3. Mold, usually caused by damp storage, can be recognized by its musty odor. It may appear as a green, white or black dust in the jaws of the rope. Rope that is damaged by mold should not be used until its strength is tested.

(TEST: The tackle you are to use should be formed with the rope to be tested. Fasten it between two fixed objects and apply force stronger than that to be used in actual lifting.)



When storing or handling rope be sure to guard against:

1. Commercial Acids: A common acid (Sulphuric) is found in automobile batteries. Because it is very strong, never allow rope to come in contact with batteries that may be lying about unprotected.



2. Uric Acid: This is found in urine.



3. Sand: This may be picked up almost anywhere. It cuts the inner fibres. Wash the rope frequently.



4. Commercial Caustic: This weakens the rope as does acid.



5. Mold: This will attack any wet rope, especially if it is dirty. Store rope in a cool dry place.



6. Dry-Rot: Storing in a hot dry place for long periods causes rope to become weak and limp, because of dry-rot. Avoid storing in attics or furnace rooms.

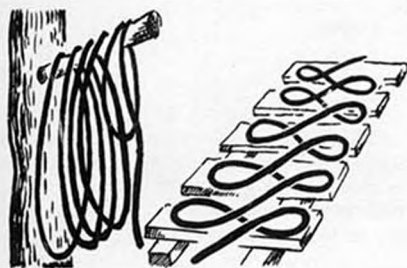


New rope should make a creaking sound when it is tied or twisted. If it does not do this there is reason to doubt its strength. It should be tested before being used.

Rope should be stored in a cool dry place. When it becomes wet it should be thoroughly dried before being coiled and placed in storage. Rope should be dried in the shade and away from artificial heat. If possible it should be hung on a peg or beam in such a way that air can circulate around all parts of it. If the rope is



heavy it may be placed on a wooden rack on the floor in such a manner that air can circulate around it.



Rope should be washed regularly, especially if it has become covered with sand, sap from green timbers, or other dirt which might cut the fibres or mold. A strong spray of water played on the rope is a very effective method of washing. Another method is to place the rope in a barrel of clear water and work it up and down with a forked pole.

Care must be taken to avoid twisting the rope during handling. A twisted rope will not pull straight but will kink or snarl. A snarled or twisted rope will cause a rig to twist and bind when used. Rope is likely to become twisted when it is coiled or uncoiled by inexperienced personnel. Experiments show that when rope is coiled to the right (in clock-wise direction) it twists to the right; but when coiled to the left it twists to the left. It is desirable to harden the twist of a rope while it is coiled, rather than unlay it; thus right laid rope should always be

coiled to the right. The rope should be uncoiled in the reverse direction, i.e., to the left. This



will remove the twist placed there when coiling. If uncoiled in the same direction, an additional twist will be put in the rope and it will kink badly.

The rule to follow for right-laid rope is: COIL TO THE RIGHT—UNCOIL TO THE LEFT

New rope is wrapped in burlap and bound with cord. If the rope is uncoiling to the right,



turn the coil over and pull the end through the

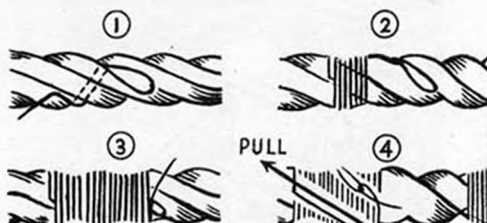


core and the rope will UNCOIL TO THE LEFT as it should. Continue uncoiling until the desired amount is removed.

When rope is cut, the portion of the strands near the ends are freed and lose their strength. Since it was the twist of the strands that held the rope together, it now begins to loosen and unlay. To avoid this, the rope is "whipped" with twine, yarn or marline. Wire or marline is best for whipping heavy rope.

Whipping is done as follows:

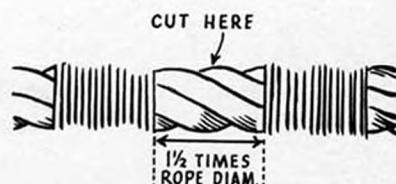
1. Form a bight in the marline and lay it in a jaw of the rope.
2. Begin wrapping tightly about the rope against the lay.
3. After a length 1-1/2 times as long as the diameter of the rope has been covered, pass the end through the bight.
4. Draw the bight under the whipping by pulling on the first end laid down. Draw halfway through and remove the free ends of the marline.
5. Repeat the process, leaving about one and one half rope diameters between whippings. Cut the rope neatly between the whippings.



Rope is cut easily when under tension. Bend it sharply at the spot to be cut and use a sharp pocket knife on the outside strand. When



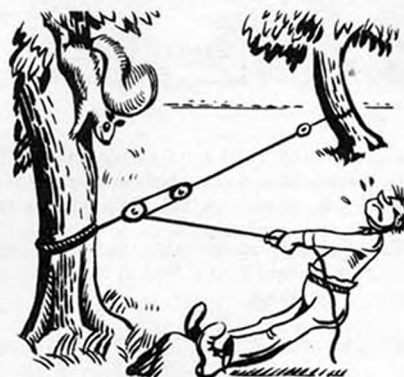
a rope is to be cut it should be whipped on either side of the place to be cut.



Do your whipping carefully. Carelessness in such work may cause disastrous inconvenience and delay later. As already mentioned, be sure, be safe, and thereby add to your eventual speed.



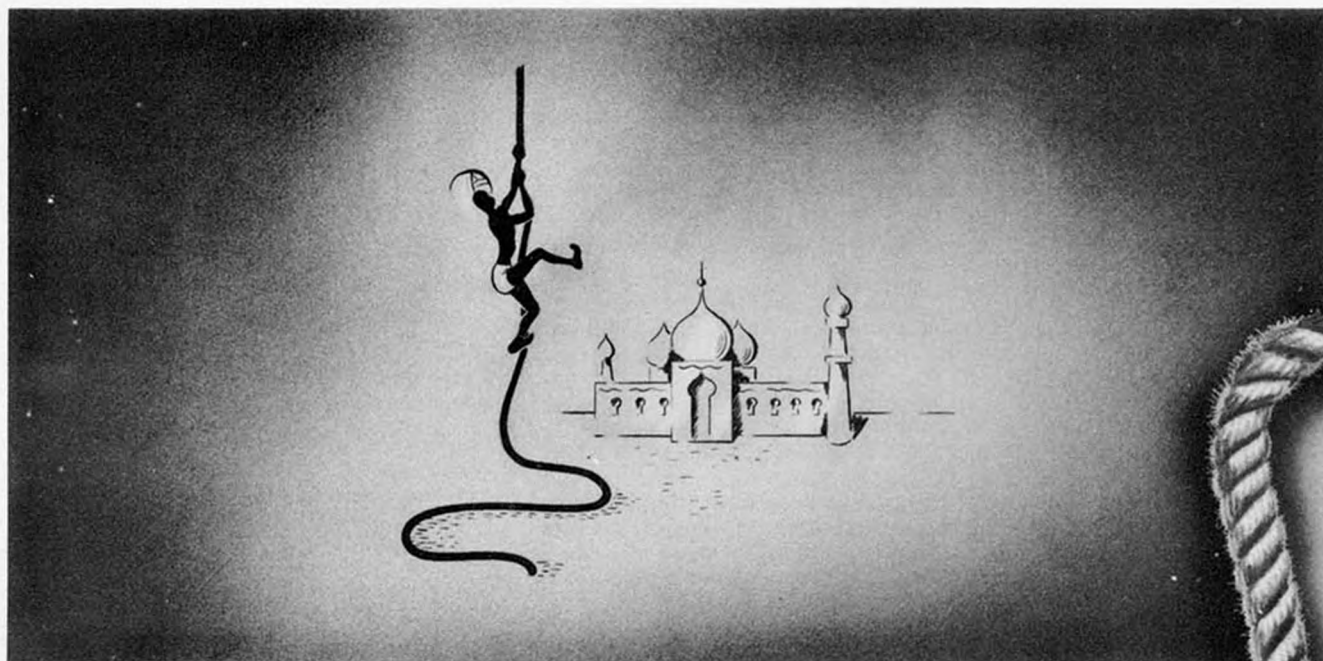
New rope may have a slight twist the first time it is uncoiled. To remove this twist, fasten one end of the rope to a snatch block (or swivel block) and fasten the snatch block to a fixed object several feet from the ground. Stretch the rope to its full length and pull it taut with a block and tackle held by another fixed object. (Or simply fasten it to a truck and pull.) If there is time to do so, hold it taut for an hour to allow the fibres to set against one another. Rope that has become kinked and snarled may be stretched in the same way but it is usually not necessary to hold it taut for a long time.



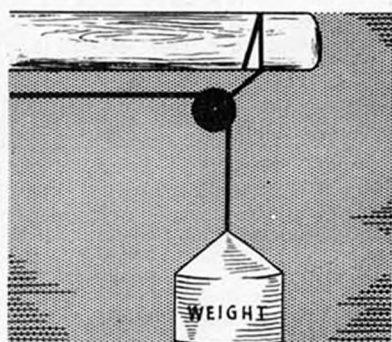
All personnel involved in the use of rope should be thoroughly trained in its care as well as in its use.

An hour spent in the care of rope, or in preparing it for efficient use, is always a good investment. It will pay dividends in the quality of work performed with it, in safety, in the temper and fatigue of personnel, and in final results.

Nothing will tend to increase the confidence of personnel in rope to be used than the knowledge that it is in good condition for use, and that knowledge is best obtained if the men who are to use the rope care for it when it is not in use. This does not mean, of course, that other personnel should not also be well informed.



Rope has only one kind of strength. It resists being pulled in two. It will not resist a force in any direction except along its length. Therefore rope is said to be flexible. Its strength is called tensile strength.



New hemp rope and flexible steel cable usually found on army vehicles have tensile strengths as shown in the following table:

(NOTE: Flexible steel cable has a strength approximately eight times that of hemp rope of the same diameter.)

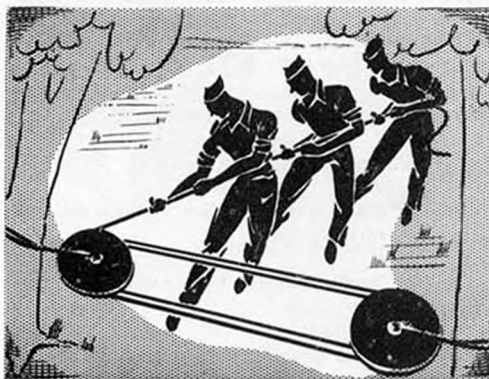
DIAMETER	STANDARD HEMP ROPE	BREAKING LOAD FLEXIBLE STEEL CABLE
1/2	3200 lbs.	25600 lbs.
5/8	4920 lbs.	39360 lbs.
3/4	5910 lbs.	47280 lbs.
1	10020 lbs.	80160 lbs.
1-1/4	12340 lbs.	98720 lbs.
1-1/2	15160 lbs.	121280 lbs.

The safe workingload that can be put on a rope is very much less than the breakingload. It should not be more than one-third of the STANDARD BREAKING LOAD. For example - the safe workingload of a rope 1/2" in diameter is one-third of 3200 pounds, or about 1066 pounds.

Special care must be exercised when using old or worn rope. Exposure and use weakens rope so that it may lose 1/4 or 1/2 of its original strength in a few months. Tarring a rope will decrease its strength but make it more durable and more weather-proof.

This justifies repeating the statement that the confidence of using personnel is increased by familiarity with rope which is to be used.

Rope should be tested whenever there is any doubt about its strength. The tackle should



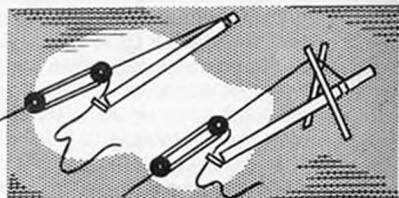
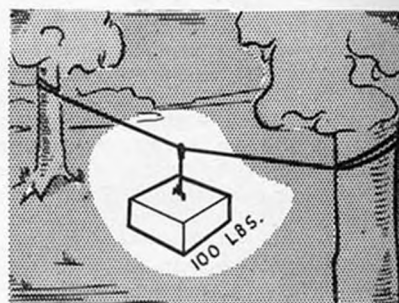
be fastened between two trees or other fixed objects. If it is known that two men can operate the tackle, three or four men should be used to test it.

It is wise to test the complete rig because the timbers may contain hidden failures



or the wood may be weak and allow the timber to break, causing damage to personnel and equipment. A truck or tractor is usually heavy enough to remain on the ground while the tackle is being tested.

The weight of the object to be lifted does not always indicate the strain that will be put on the rope. The rigger must look out for cases in which ropes are made to pull against one another or to pull at too sharp an angle such as



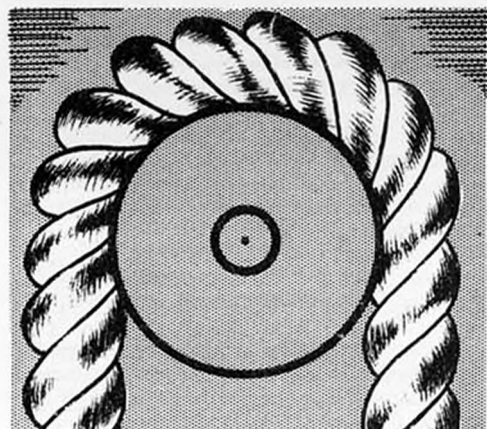
would occur while raising a pole or by using too short a sling. Try to place the rig so that the ropes may pull straight up, or as nearly straight as possible.



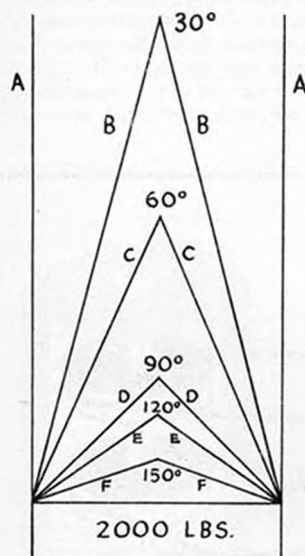
As the sling is made shorter the ropes begin to compress the load as well as hold its weight. When the sling makes an angle of 120 degrees each rope is actually under 2000 pounds stress, or twice as much as when it was pulling straight up. When a rope is bent at a sharp angle such as



over the corner of a square beam, its strength is decreased. The strands that are on the short or inner side of the bend are compressed while the strands on the long or outer side are under tension and carry the entire load. This explains why a rope usually breaks where it is knotted. If the curve is long and even as around a sheave, each strand, because of the lay of the rope, has a chance to be both an outside and inside strand, thus equalizing the stress on each strand. The



The effect of a short sling in increasing the strain on a rope is shown in the accompanying figure. If the ropes come straight down, the

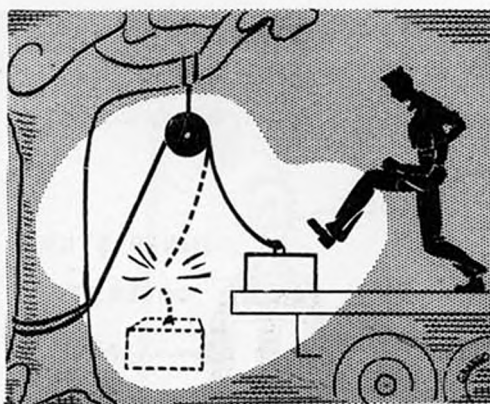


- A — 1000 pounds
- B — 1035 pounds
- C — 1154 pounds
- D — 1414 pounds
- E — 2000 pounds
- F — 3864 pounds

pull is exactly opposite to the pull of the 2000 pound weight, and each rope carries 1000 pounds.

creasing noise that a rope makes going over a sheave is caused by the strands moving from the part of the curve where they are compressed to the part where they are stretched, and back again. If the curve is long enough so that all 3 strands touch it at least once, it is safe to use.

After calculating weights, allowing for angles and eliminating sharp bends, the rope may still fail due to a sudden "snap". This occurs when the weight is allowed to fall for a distance and is



stopped suddenly. The force, like the striking force of a hammer, cannot be figured accurately, but it is very great. The same effect results from a faulty knot or hitch that slips and seizes.



SISAL ROPE

As a wartime measure a substitute material, sisal, is being issued in some cases instead of the usual manila rope. Sisal is safe. But all personnel using it should remember that it has limitations. It has only about 80% the breaking strength of manila.

Circumference Nominal Inches	Breaking strength in Lbs.	
	Standard Rope (3 strand)	Sisal Rope (3 strand)
5/8	450	360
3/4	600	480
1	1000	800
1-1/8	1350	1080
1-1/2	2850	2120

Use sisal with sensible recognition of its limitations and it will be found an excellent substitute.

No separate set of rules need be set up for the care and use of Sisal rope except the warnings regarding comparative strength given above.

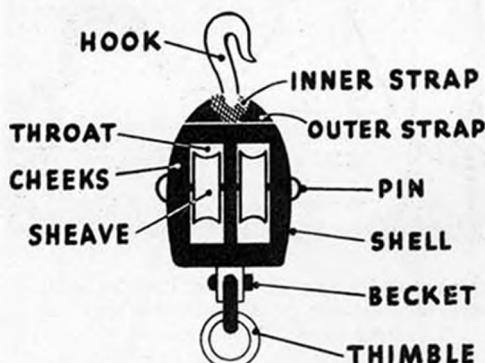
So far as physical appearance is concerned it is put together in the same manner as Manila hemp rope. It is packed in the same manner, and must be unpacked in the same manner.

The same things which damage Manila hemp also damage Sisal. Acids, caustics, sand and grit, dry rot, and mold have the same effects. In other words, Sisal must be given the same treatment as that customarily given to your rope.

Its limitations must be borne in mind both by supervisory and by using personnel. Every effort must be made to prevent any loss of confidence in the use of this substitute. The two types, if possible, should be segregated, so that a crew using Manila rope may not suddenly learn, by its failure, that they have been using Sisal. This could easily happen in night operations unless something is done to prevent it.

This gets back to the idea already mentioned, but worthy of repetition. Be sure, be safe, and then get the job done. This requires a high type of supervision and constant care on the part of all personnel concerned.

A block consists of a shell or frame housing containing one or more grooved pulley wheels or sheaves giving support to the ends of a pin upon which the sheaves revolve. A hook is attached to one end of the block and a becket to the other end.



Blocks are used to change the direction of ropes, and to multiply power at the expense of distance and time. Blocks are designated by the length of the shell in inches, and by the number of sheaves.

Blocks with 1, 2, 3, and 4 sheaves are called single, double, triple, and quadruple blocks, respectively.

SNATCH BLOCK

Another type of block used in rigging is the snatch block or swivel block. Its primary use is to change the direction of pull. In order to accomplish this mission, the snatch block is so constructed that one side may be opened, and a line passed through this opening and on to the sheave. This opening is called the "gate". The advantage of the gate is that a rope can be placed onto its sheave without having a free end of the rope available. The gate is locked while the block is working.

To open the gate it is only necessary to tip the block at the point where the hook is attached and the gate will come free. The snatch block is usually a single sheave block, and it has a swivel hook. This is necessary because the

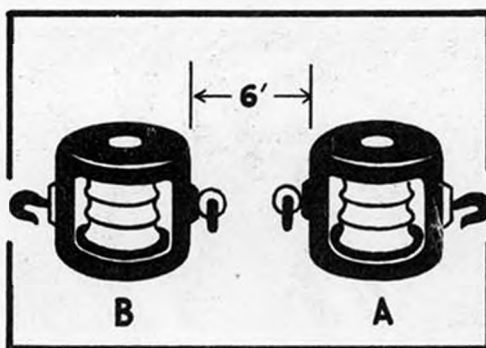


block must be slowed to conform to the direction of the pull.

Blocks come in various sizes, and they will take different sizes of rope. A common size is the block with the eight inch shell. It is best to use a 3/4 or 1 inch rope for the eight inch block. If we use too large a rope the result will be a loss of power due to friction, and also an unnecessary wearing of the rope.

HOW TO REEVE A SET OF TRIPLE BLOCKS

1. Set the blocks down on their sides, with the hooks outward, and the becket facing each other.



2. Two men, one for each block, straddle the blocks with their backs to each other. The men and blocks should be approximately six feet apart.

3. Pass the rope through the center sheave of block A, from right to left.

4. Next, pass the rope through the bottom sheave of block B, from right to left.

5. Then pass the rope through the bottom sheave of block A, again from right to left.

6. At this point pass the rope through the center sheave of block B from left to right.

7. From here, pass the rope through the top sheave of block A, from left to right.

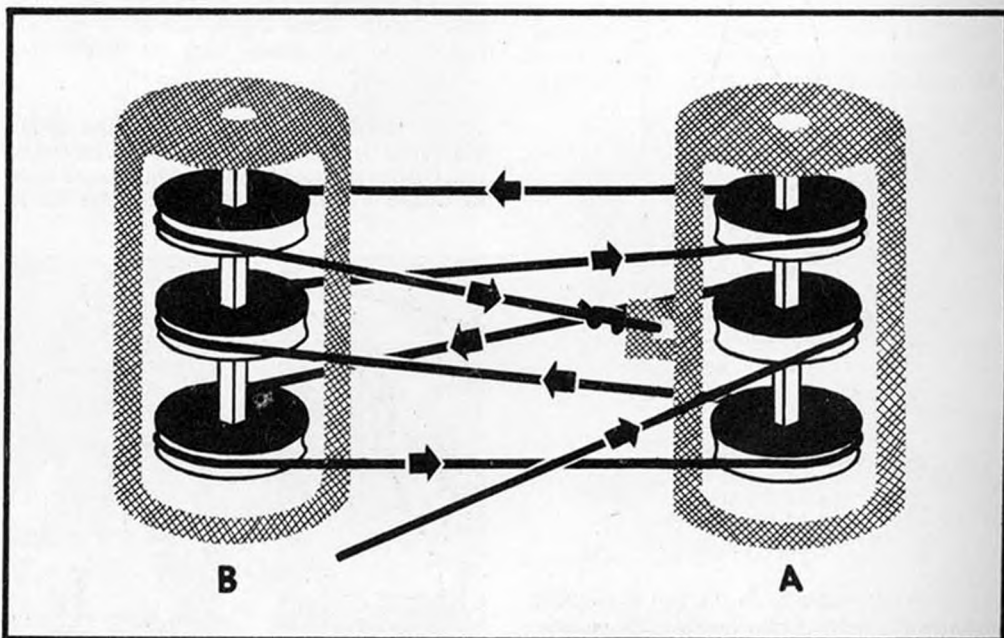
8. Next pass the rope through the top sheave of block B, again from left to right.

9. The last step is to bring the running end up to the becket of block A, making certain that you pass the rope under the only line that crosses the blocks.

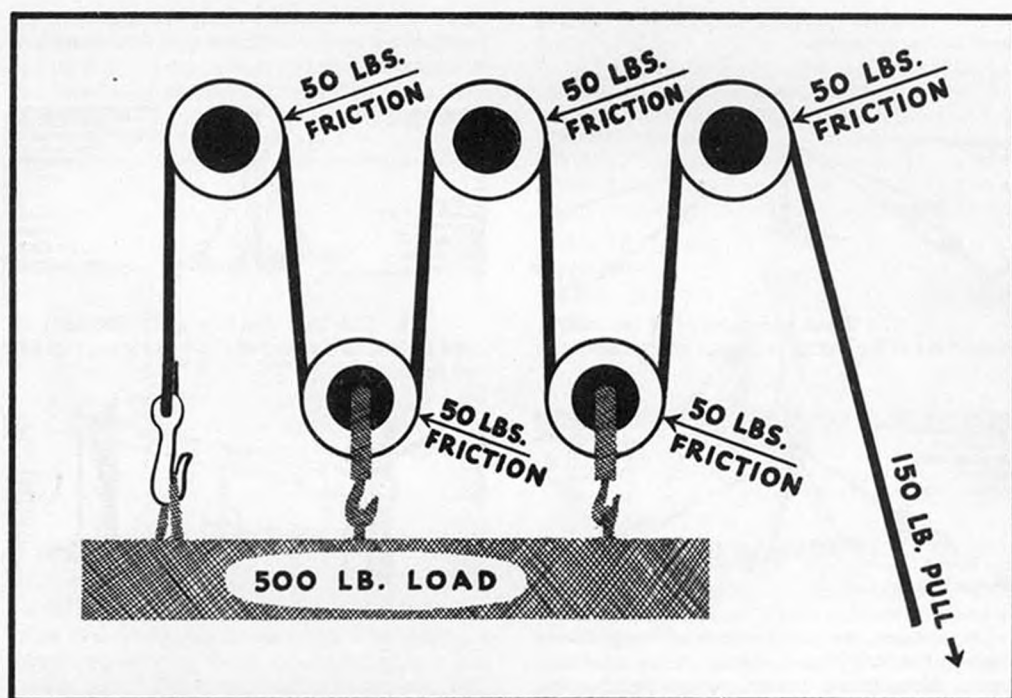
10. Pass the rope through the becket, fasten it with two half hitches and seize the end.

Whenever reeving a set of blocks that have unequal numbers of sheaves, the block having the greatest number of sheaves is always reeved first. All blocks are reeved through the mouth of the sheave nearest to the hook. In the

event that a set of blocks have the same number of sheaves, it makes little difference which of the blocks is reeved first. However, it should be remembered that the block through which the rope is first passed is to be considered the top block, or the stationary block when hoisting.



It is best to have the pull line running over the center sheave. In this way there will be a minimum of friction due to tipping of the blocks.



unnecessary delay in the accomplishment of the task, and it encourages the forming of a bad habit by personnel. Instruct all personnel so that they will understand how to evaluate each job to be done, and determine sensibly the rig required to do it.

This is even more important when we consider friction. In simple tackle arrangements we have stated that the mechanical advantage is equal to the number of supporting ropes. However, it must be remembered that each pulley increases the friction and for this reason no more pulleys than are necessary should be included in the system. Friction is found around the sheaves and pins and also where the ropes rub against each other. For the average size block a safe rule is to allow a 10% friction loss for each sheave in the block.

EXAMPLE:

Tackle: One double and triple block; a total of five sheaves or five supporting ropes. This should give a mechanical advantage of five.

Load: 500 pounds. This should mean that a pull of 100 pounds would lift the load.

Friction: Five sheaves at 10% each give a 50% friction loss. Thus an additional 250 pounds (50% of 500 pounds) is added to the load.

Total load to be lifted: 750 pounds. Thus a pull of 150 pounds (750 pounds divided by 5) is needed to lift the 500 pound load.

From this example it can be seen that friction plays an important part in rigging.

MECHANICAL ADVANTAGE

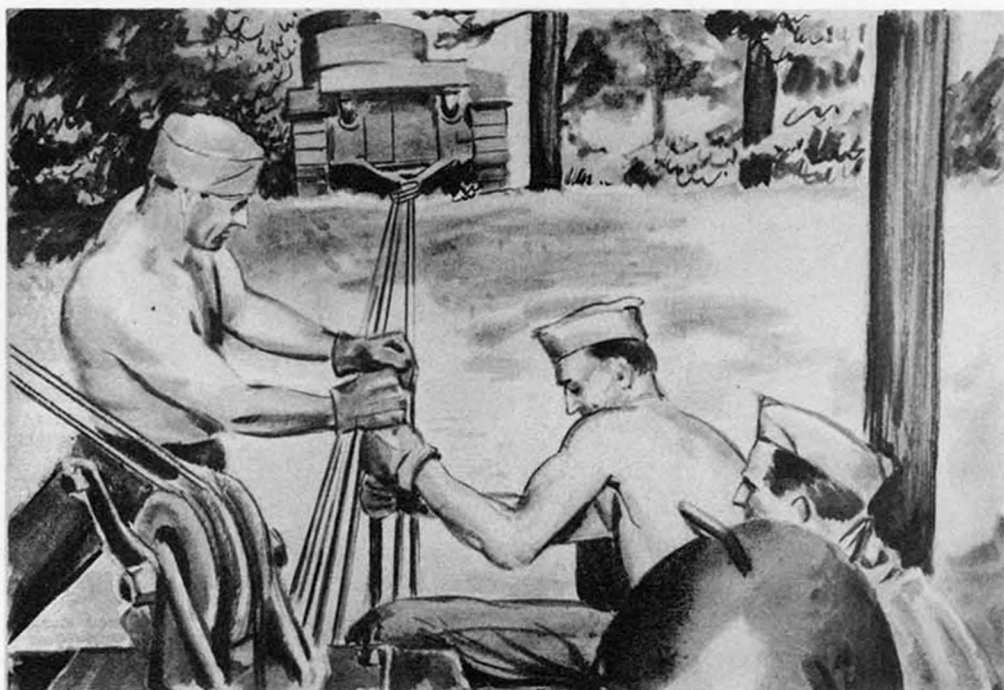
The mechanical advantage is the proportion of the load to the power necessary to raise the load.

In moving loads with block and tackle it may or may not be desirable to obtain a great mechanical advantage. The greater the mechanical advantage, the greater will be the amount of rigging required as well as the time to prepare it.

Too much rigging causes waste of time and material. Therefore, the mechanical advantage of a rig should be no greater than is actually necessary in view of the pull to be applied and the power available.

If eight men are available it would be unwise to rig a combination that would enable one man to do the task.

Remember that the most simple rig which will get the job done is the ideal rig to use. Time wasted in the preparation of complicated rigging is faulty for at least two reasons. It causes an



There are four types of hoisting devices used in field rigging.

1. The Gin Pole is a single pole or spar.



2. The Shear is composed of two spars, separated at the butts, and lashed together at the tip ends.



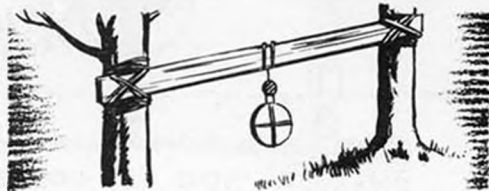
These are constructed of timbers and spars. Not every type of tree can be used as a spar. Some trees, due to the nature of wood, are not well suited for the purpose.

In the group of "recommended types",

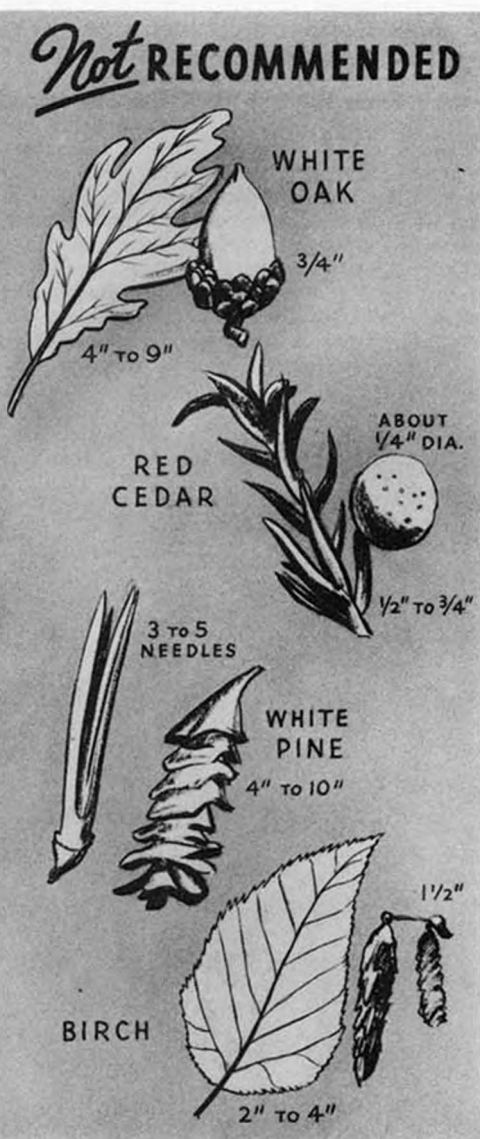
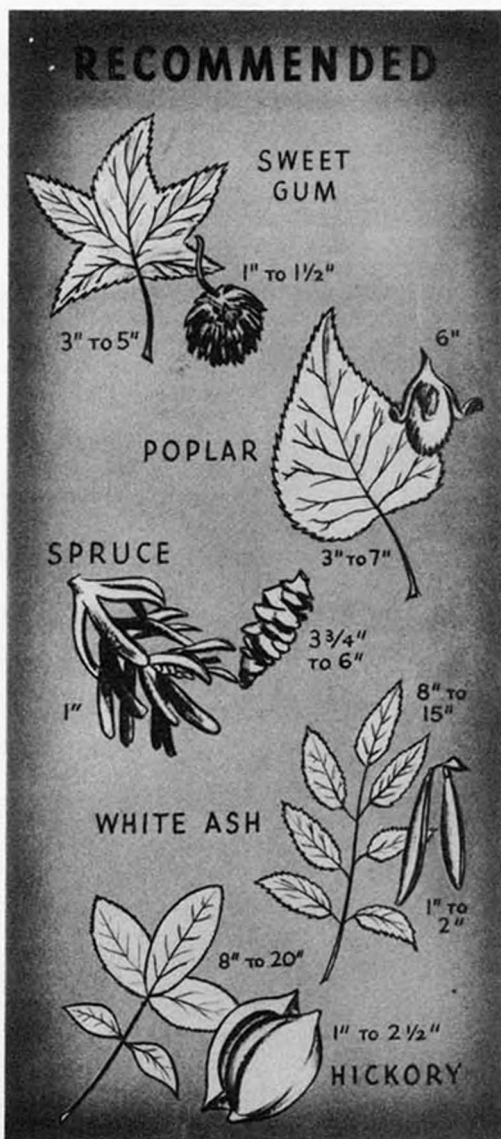
3. The Tripod is composed of three spars (legs), separated at the butts and lashed together at the tip ends.



4. The Transom is a horizontal spar or rope lashed or tied across two uprights, usually two trees.



the best and safest type is that which will without snapping if placed under very heavy stress. The non-recommended types will snap without warning because of the presence of numerous knots, and the rigidity of the wood. Their use should be avoided.



Usually but three rigging problems are met in the field. First; the mounting and dismounting of heavy pieces; second, the loading or unloading of materiel; and third, the handling of disabled materiel. The first is usually accomplished with permanent rigging. In the second case, too, more or less permanent rigging is us-



It is not advisable to employ a spar which does not measure at least 8 inches in diameter at its butt end. Nor is it necessary to use a spar that measures over 12 inches in diameter. The characteristics of a good spar are these:

1. Straight grain of the wood.
2. Must be flexible.
3. Must be straight.
4. Should have a minimum of knots.
5. Must be free of splits.
6. Should be well seasoned (not green).

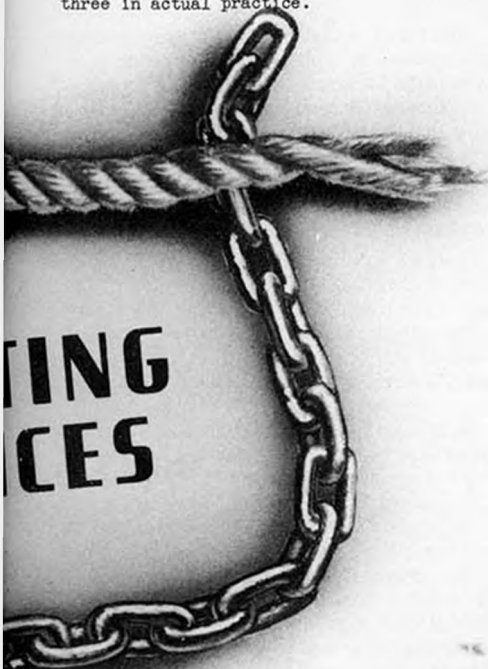
Unless spars which have already been prepared for use are available, experienced personnel should be assigned to the task of procuring them, as, for example, when they must be cut from standing timber.

First of all, due care should be used in the selection of the tree or trees to be cut. Attention must be paid to the variety of timber available, and to the sizes required.

The cutting of timber, too, if necessary safety precautions are to be taken and if the work is to be done without considerable waste of time, requires experience. Really useful experience in such work can be gained only by practice.

Safety must not be overlooked in the cutting of timber, especially when the personnel assigned to such work is not thoroughly experienced.

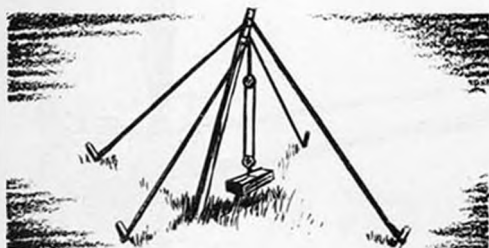
usually available. It is the third case which is apt to test fully the knowledge and ingenuity of personnel. This brief discussion is published to provide the fundamentals of this subject. Remember, however, that the first and cases listed here very often approach the conditions of case three in actual practice.



THE GIN POLE

The gin pole is the simplest of the hoisting devices constructed in the field. Only one spar or pole is required.

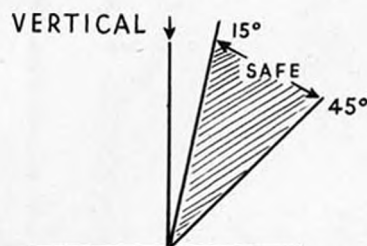
The gin pole must have both back and side guys in order to maintain it at the angle which is required. The guys are those ropes which must be secured to the spar to be used, and also to some kind of suitable anchorage, for the purpose of holding the spar in the desired position.



The back guy on a gin pole is usually more satisfactory if it is a block and tackle. It is thus easily used to raise the gin pole from the ground to the desired angle. After the spar is in place this back guy may also be used for the adjustment of the spar backward and forward as may be required by the task being performed.

There is a limit to the angle at which a Gin Pole may be set and used. Any angle between 15 and 45 degrees from the vertical is considered

safe. More than 45 degrees is considered unsafe, because leverage produced by the load will unduly tax the back falls and back anchorage. On the other hand an angle of less than 15 degrees



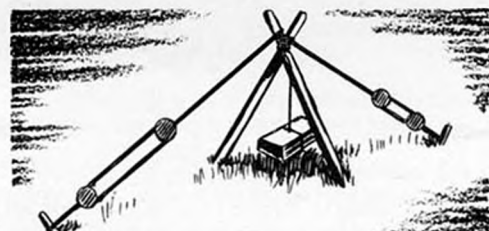
may cause the load to swing into the Gin Pole, causing the blocks to jam against the pole, thus creating friction which may have serious results such as the cutting of the running line.



THE SHEAR (THE "A" FRAME)

The Shear (or "A" Frame) differs from the Gin Pole in that it is possible to move it from an angle of 45° on one side to an angle of 45° on the opposite side of the vertical.

The shear does not require the use of side guy lines, and this is often a convenient factor since it reduces the need for so much rope, cable, or other material used for guy lines.



The moving ability of the shear is made possible by taking up the slack on one set of blocks, either front or rear, while the slack on the opposing set of blocks is lessened.

When the shear has passed the vertical position, the front falls thereby become the back falls, while the back falls then become the front falls.

Because of this action, it is possible, by use of the shear, to raise an object on one side of the shear and, while holding it in a raised position, move it to the other side and then let it down.

Great care, however, should be exercised in using the shear in this manner, especially when objects of considerable weight are being moved. The shear must have solid footings, the movement to be made with the object being lifted should be carefully studied before the operation begins, and the personnel involved should pay close attention to the work as it progresses.

APPROXIMATE SIZE AND LENGTH OF SPARS REQUIRED FOR SHEARS

Weight to be Lifted	Mean Diameter	Length
3 to 5 tons	8 to 11 inches	30 to 40 feet
5 to 12 tons	11 to 14 inches	40 to 50 feet
12 to 25 tons	16 to 20 inches	50 to 60 feet

THE TRIPOD

The tripod is a more permanent type of lifting device. It is usually used where the rigging required is of a more permanent nature. It is not movable. It must be built of long and heavy spars, if it is to be able to accommodate a bulky object between its spars. Usually, a tripod is so large that it requires a Gin Pole to lift it into position.



To secure the tops of poles in making a tripod, lay the two legs parallel with tips on a skid. Place the pry pole between them with butt in opposite direction. Make a clove hitch on one outer spar, take eight or ten loose turns around all three spars, with a couple of frapping turns around the lashing between each leg and the pry pole. Finish with a clove hitch on the pry pole above the lashing.



ROPE AND LOG TRANSOMS

In considering the erection of a lifting device, the following three factors must be taken into consideration.

1. Time available.
2. Labor available.
3. Natural facilities available.

Time which is available is, of course, an important consideration, since an unreasonable portion of the time available cannot be spent in preparing to do maintenance work if the actual work itself is to be accomplished.

In stable situations, however, the time required to make completely adequate arrangements for the hoisting of heavy objects may prove to be a very good investment. If the hoisting device is to be used for a considerable period of time, the use of ample time to prepare it for use may be justified.

The question of time required, however, must be determined by the personnel involved, and is dependent entirely upon the situation.

The amount of labor available, too, is an important consideration, both in the erection of the hoisting device and in the use to which it can be put. The manual which the personnel available will be called upon to perform without the aid of a hoisting device must be considered. If but little time is available, and if the personnel present is adequate to perform a small required amount of lifting, the erection of a transom may be a waste of time and effort.

It is the last factor which suggests the erection of a transom. Ordnance companies often are located in heavily wooded areas for the purpose of camouflage, where there are plenty of sturdy trees which can be used in the construction of a transom. Two trees about 15 to 20 feet apart should be selected.

ROPE TRANSOM

The rope transom is the type which can be erected most rapidly. If the rope is available (1-1/2" or 1-1/4" in diameter), a rope transom should be erected instead of a log transom. The fact that the strength of a rope is a known quantity, while the strength of a log is usually not known, makes the rope transom a safer device.

When rope is used, care should be taken that enough slack is left in the rope to lessen the strain on the rope. This is the same principle

that exists in a sling. However, the rope should be placed high enough that the slack in the rope and the slight bending of the trees will not place the upper block too low and prevent raising the load to the desired height.

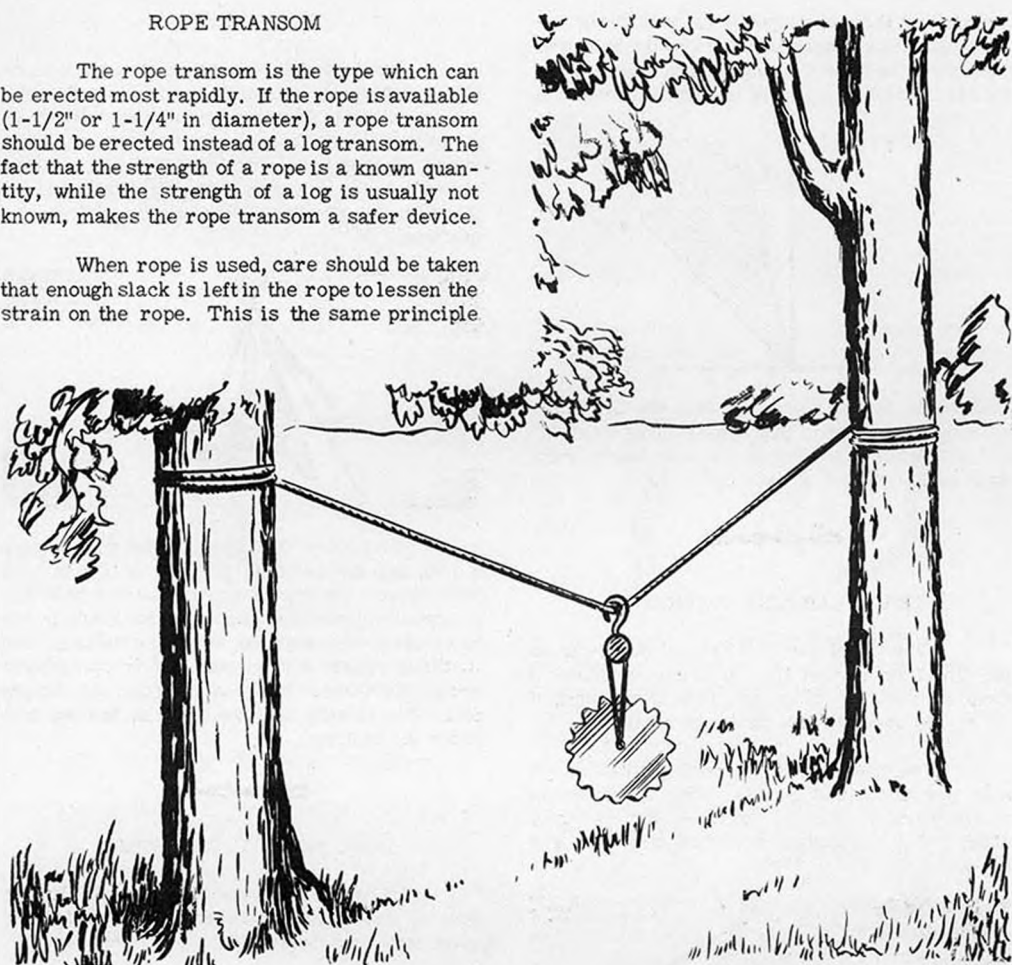
The trees can be prevented from bending too much toward the center either by tying each tree back to the base of another tree, or by using a log stiffener. This can be accomplished by lashing a log across both trees above the points where the cross rope is tied. Not only will the log serve as a brace between the two trees, but it also can be used as a means of raising the block and tackle to the rope transom.

In the establishment of a bivouac to be used for field maintenance work, proper consideration should be given to the selection of trees which will be suitable for the erection of transoms, if such hoisting devices are to be used.

It is even possible that this consideration will materially influence the making of a choice between two or more conveniently located sites.

It should be noted that trees a convenient distance apart should be selected. The span must not be too great, nor too little. If the area is heavily wooded, consideration must be given to the possibility of moving large vehicles or other material between the two trees easily. Obviously considerable time might be required for the clearing of other trees or underbrush if a site so encumbered were to be selected.

Unless the site was especially suitable for other reasons, such a waste of time might not be worth while.



LOG TRANSOM

The log transom requires less rope than the rope transom. It consists of nothing more than a log lashed across two trees. A sling is thrown over the log and the upper block hooked to this sling. The log can be hoisted into position, preparatory to being lashed in place, by means of a single block and a light line. The block is lashed to the tree just above the point where the log is to be lashed.

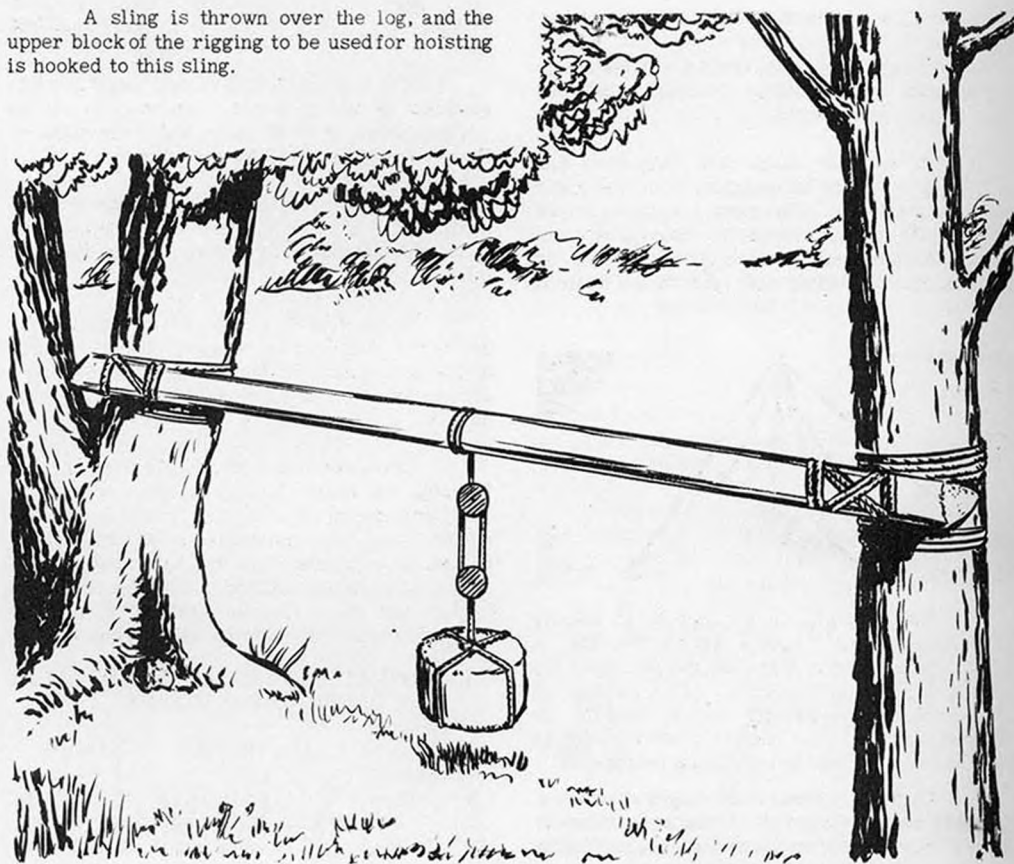
The fact that a log transom requires less rope than a rope transom may at times be a distinct advantage, especially if the required log of suitable variety can be obtained nearby.

The log transom consists of nothing more than a log lashed across two trees. It is important, however, that it be constructed properly. It must be substantial enough for the lifting of any heavy object for which it is intended.

The log can be hoisted into place preparatory to being lashed to the two trees by the use of a single block and a light tackle. The block used should be lashed to first one tree and then the other, just above the points where the ends of the log are to be lashed.

All lashing should be done carefully. The proper knots for the particular condition existing should be used, and they must be properly and securely tied. Care must be given, of course, to their untying when the transom is dismantled.

A sling is thrown over the log, and the upper block of the rigging to be used for hoisting is hooked to this sling.



A knowledge of the knots, bends, and hitches described in this article will fully equip a rigger to perform any type of rigging job.

Before going into the subject, a few definitions should be learned.

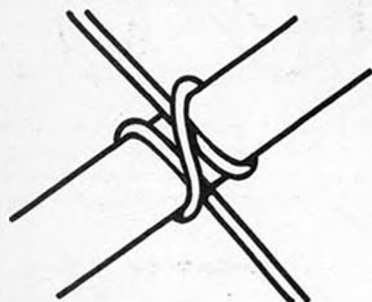
A **KNOT** is formed by rope twisted about itself.



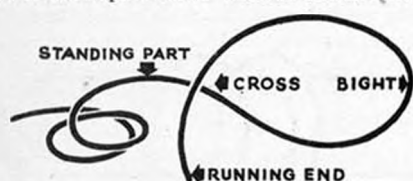
A **BEND** is formed by one rope fastened to another rope.



A **HITCH** is formed by a rope fastened to a beam or other object.



The **RUNNING END** of a rope is that part of the rope used to work in and around the



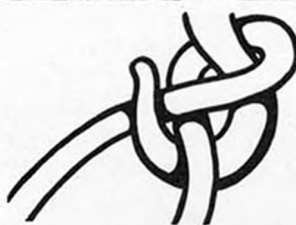
standing part to form a knot. The running end is the free end.

The **STANDING PART** of a rope is that part around which the knot is tied.

The **BIGHT** is a loop formed in a rope by doubling itself back along its own parallel.

A **CROSS BIGHT** is a loop formed in a rope by doubling the running end back and across the standing part.

BEARING SURFACE or **PURCHASE** is



that portion of the rope which is in contact with an object or another rope; it is that portion of

the ropes in a knot, bend, or hitch, that binds and creates the friction which holds the fastening together.

(CAUTION: Putting an average knot, bend, or hitch, in a rope decreases the strength of a rope approximately 25%. This is not caused by the fact that the fastening will slip, but in forming the fastening the rope has been bent and twisted. This bending and twisting causes some fibers to be stretched and some fibers to be compressed, creating stresses which will weaken the rope.)

There are three qualities to look for in judging the usefulness of a knot. It is well to keep these in mind while learning and using knots.

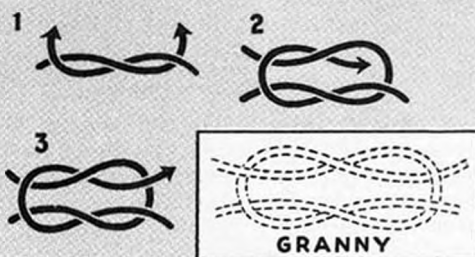
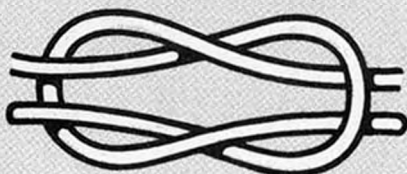
1. It will hold; it is dependable and slip-proof.
2. It is easy to tie.
3. It is easy to untie.



SQUARE KNOT

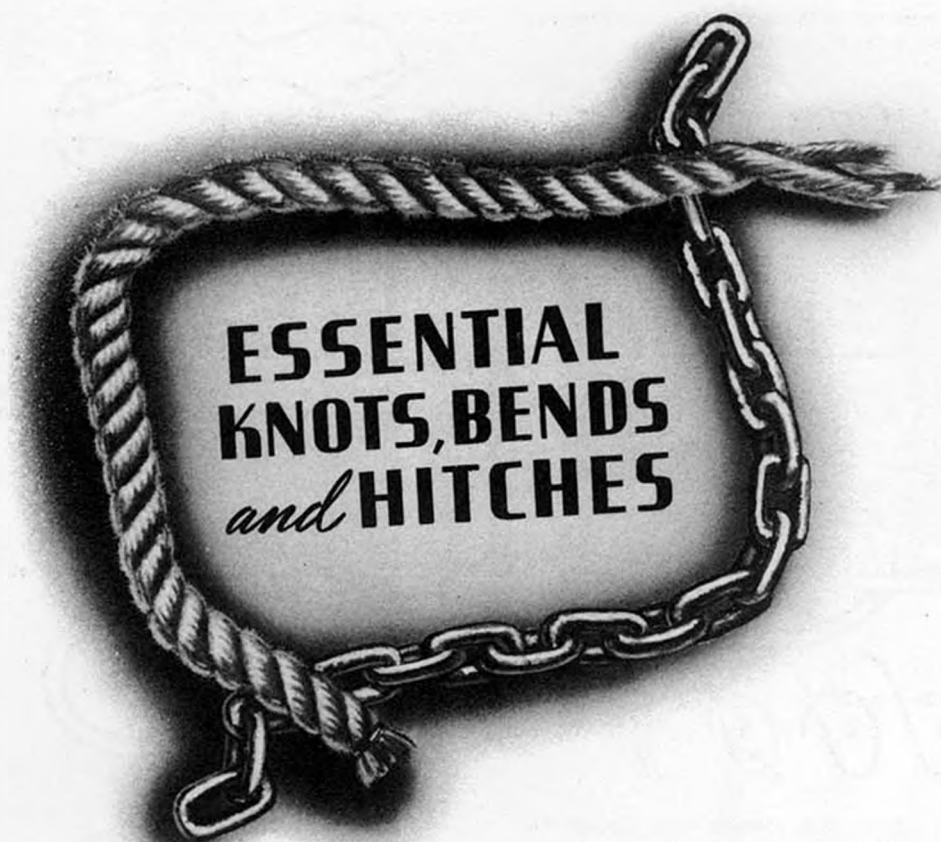
A square knot is sometimes called a Reef Knot. Its holding qualities are very good. It is used to join two ropes of equal diameters, or ends of the same rope. There are two methods of tying this knot, both of which are shown here.

Take care that when the knot is completed

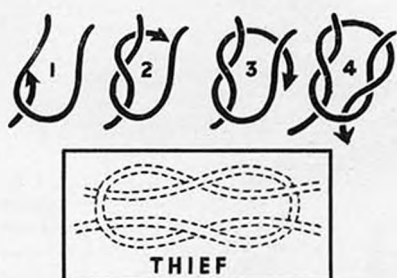


the running end and standing part of each rope both come out on the same side of the loop; otherwise you will have a Granny. This knot is unsafe!

Make sure that the running ends of both

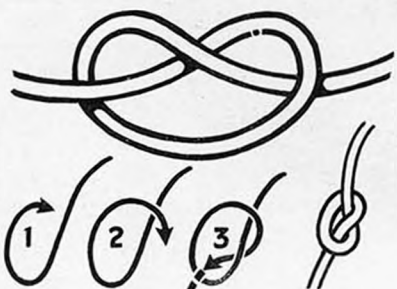


ropes come out on the same side; otherwise you will have a Thief Knot, also unsafe.



OVERHAND KNOT

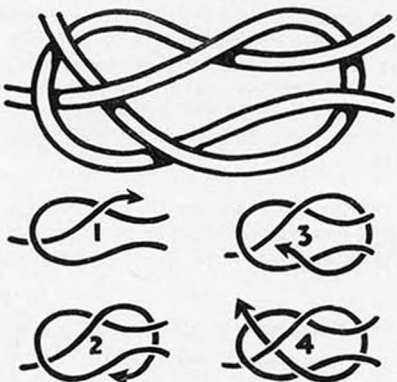
The overhand knot is used to prevent the end of a rope from unraveling, or to prevent the



end of a rope from passing back through the sheave of a block.

SINGLE SHEET BEND

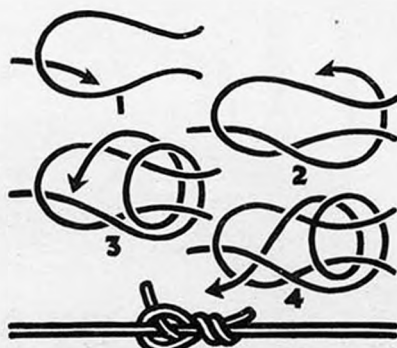
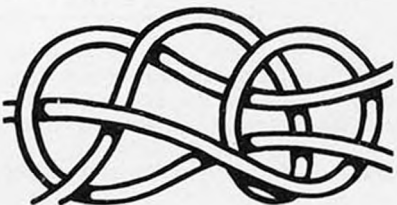
The single sheet bend is used to join the ends of two ropes of different diameters. Its tying is very similar to that of the square knot.



Note that in forming the sheet bend the first bight should be made with the heavier rope, completing the bend with the lighter rope.

DOUBLE SHEET BEND

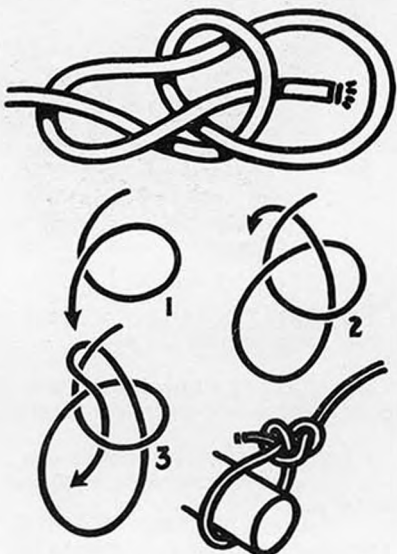
The double sheet bend is similar to the single sheet bend, except that double purchase is obtained around the neck of the bight. It is used to join two wet ropes of different diameters.



Note that in contrast with the single sheet bend, the first bight of the double sheet bend should be made with the lighter rope.

BOWLINE

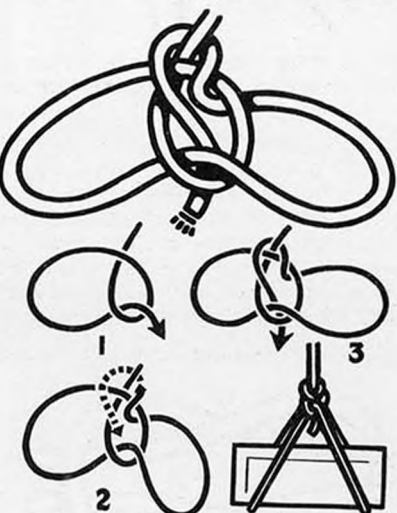
The bowline is often called the king of knots. It is simple to tie and untie. It will



never jam. It is used to form a loop of any desired size which will not slip.

DOUBLE BOWLINE

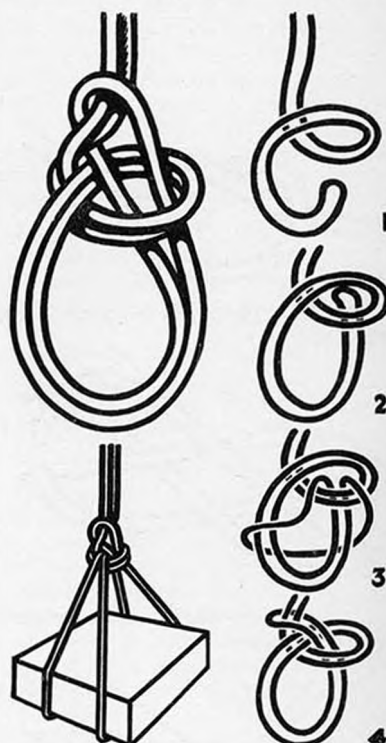
In cases where a double bearing surface is required, the double bowline replaces the



single bowline for by its use double purchase is obtained.

BOWLINE ON A BIGHT

When a loop with a double purchase is required, when it is necessary to form a sling for a man such as in a boatswain's chair, or when it is necessary to form a loop in a rope



when the ends are not available, the bowline on a bight is used. Remember in practicing this knot that the two single ends of the rope are not available to the tier; only the doubled or loop end is available.



CLOVE HITCH

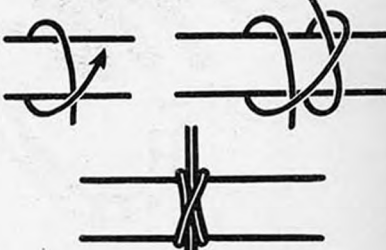
The clove hitch is the most widely used hitch in field rigging. Its main quality is that it



FIRST METHOD



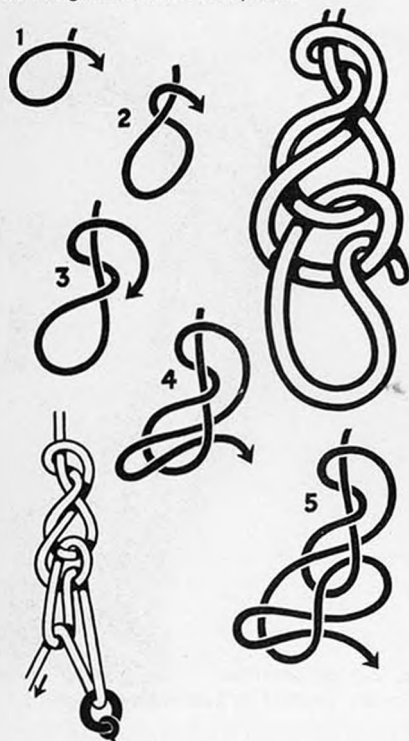
SECOND METHOD



will tighten as tension is put on it, also this tightening will occur no matter which end of the hitch is pulled on. It is used to fasten a guy line to anchorages and spars. Two methods of tying this hitch are shown here. The first is used when the free end of the spar is available, and the second when it is not. Note that the second method actually is nothing more than two half hitches formed back to back.

DUTCHMAN

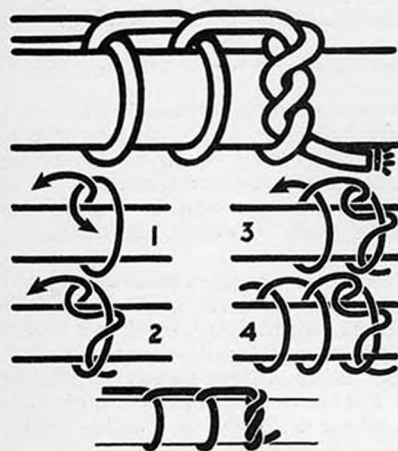
The hitch known as the dutchman gives us a mechanical advantage which can be used to tighten guy lines, fastenings on picket stakes, fastenings on truck loads, etc.



To use the dutchman, pass the running end around the anchorage and through the third bight. Now by pulling on this running end, mechanical advantage will be obtained and the guy line will be tightened. The running end can be secured to the anchorage with a clove hitch.

TIMBER HITCH WITH TWO HALF HITCHES

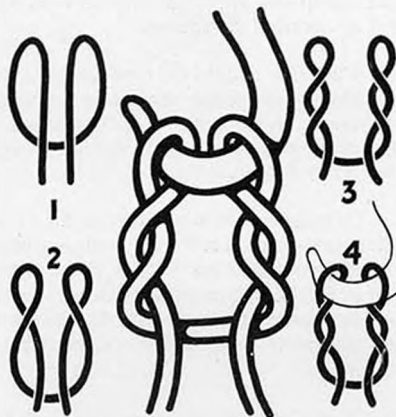
This method is used to haul a log, spar, gun tube, or any long cylindrical object with the pull line parallel to the object being drawn.



Note that the two half hitches should always be between the timber hitch and the pull.

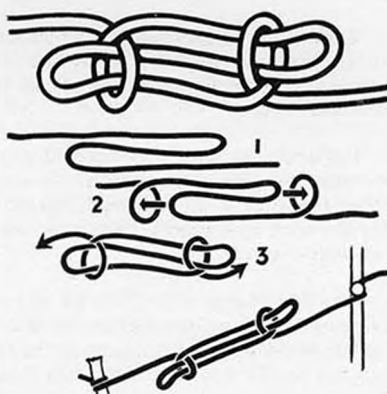
CATSPAW

The catspaw is used to obtain a double bearing surface on a hook.



SHEEP SHANK

A sheepshank is used to shorten a rope when the ends are not available, or, it may be used to by-pass a weak portion of a rope when the ends are not available. In the latter case,

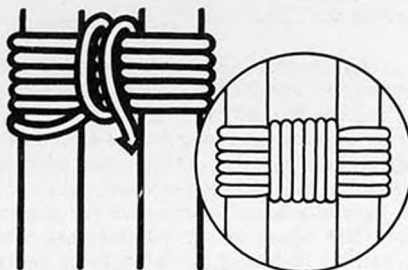


be certain that the weak portion of the rope is in the center of the three parts.

Extreme care should be exercised in the use of this knot, as it will not hold unless stress is maintained.

FRAPPING

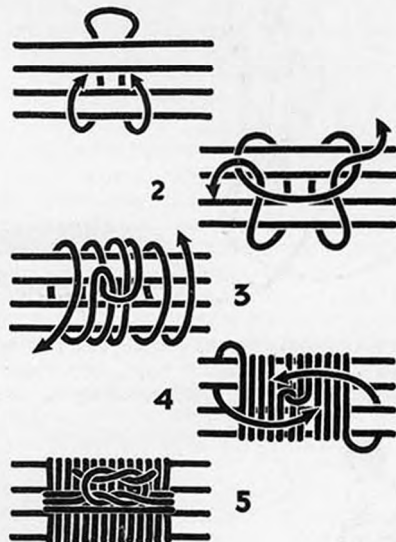
Frapping is the process of taking several turns of a rope about a lashing in a direction which cuts across the turns of the rope. This helps to tighten the lashing and to keep these



ropes from slipping apart, this may best be shown by the accompanying drawing.

SEIZING

Seizing is used to secure the running end of a rope to its standing part. This is necessary both to prevent the jamming of bends and

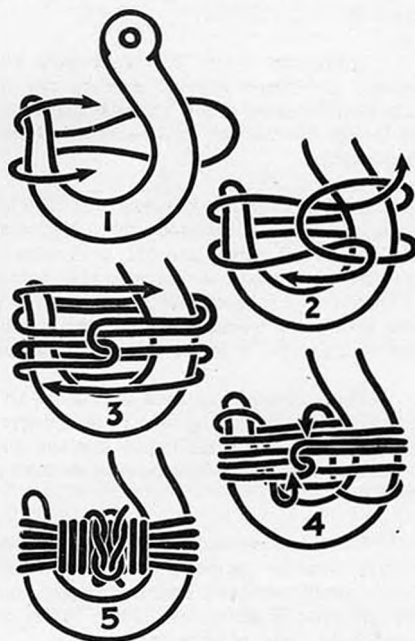


hitches and also to make some bends and hitches more secure.

MOUSING A HOOK

Mousing is used to close off the mouth of a hook so that any rope in the hook will not fall out. Mousing also strengthens a hook since it ties the short side to the long side.

Both of these considerations may be of distinct advantage at times. It may easily happen that the rope, cable, or other material being used for hoisting heavy objects, may be slackened considerably while attaching or unfastening the ends from the object to be lifted. Mousing prevents this. The strengthening of a hook, which often is subjected to severe strain, is, of course, a safety measure of importance.



All of the knots, hitches, bends, and other rigging principles outlined herein should be mastered by all personnel. The efficiency of both individuals and organizations is thus increased.

Instructions have already been given for removing rope from the coil. DO NOT USE THE SAME METHOD WITH WIRE ROPE. If a coil of



wire rope is laid on the ground, and one end is pulled out, as with hemp rope, only kinks and unsatisfactory results will be obtained. Set the



roll or coil on edge and roll it like a hoop or a wheel. Roll along a straight line, or too many coils may be unrolled at one turn.

Two preliminary steps should be taken when new wire rope is placed in service: (1) saturate it thoroughly with fresh motor oil, Grade 30, and (2) operate it without load for a while to "limber" it. Only when protected by lubrication (which retards corrosion) will wire rope give the best possible service. Today, when we must all conserve what we have, such protection is doubly important.

Corrosion is one of wire rope's worst enemies. It strikes without warning and often reaches an advanced stage before being noticed. Even though checked, it still leaves its imprint of destruction.

Probably the most severe type of deterioration, corrosion is the most difficult to evaluate. Ordinarily, when internal corrosion has taken place, external corrosion is also present. It is impossible to estimate accurately by any known means the remaining strength or safety factor of the rope, once corrosion has set in.

The dictionary defines corrosion as "an action of eating or wearing away by slow degrees; a gradual decay by crumbling or surface disintegration; a gradual breaking down of the material attacked."

There are two distinct types of corrosion, acid and alkaline (or salt) corrosion. Water, which is composed of hydrogen and oxygen, comes under the head of acids and is one of the chief causes of this type of rope destruction.

In the case of acid corrosion the wire becomes pitted and stress concentrates at the reduced cross-sections where pits are located. This causes premature failure of the rope.

In the case of alkaline, or salt corrosion, the wires become encrusted with a layer of the products of corrosion. The rope becomes rust bound. For example, alkaline corrosion increases the size and weight of the steel wires.

Acid and alkaline corrosion both may occur when ropes are operating in (or subjected to) ordinary atmosphere or weathering, or to special conditions which subject the rope either to acid or alkaline substances.

When this occurs the rope loses its flexibility. Then some of the wires are overloaded, which causes them to break. This is the "beginning of the end" for the entire rope. It starts to wear away rapidly.

Corrosion starts as soon as the strands and wires are exposed to the elements and usually starts before one is aware of it. Carelessness, neglect in the handling and storing of wire rope, is the real cause of corrosion. In other words, proper attention will almost always prevent corrosion.

In its early stages corrosion is difficult to detect. The first signs are general discoloration of the wires of the rope. As corrosion progresses, the wires will become either pitted or covered with a reddish brown substance, depending upon whether the corrosion is of an acid or alkaline type. Even worse, the exterior may be nice and bright, while the inside is being eaten away.

Prevention of corrosion is an important part of the program which the Army has undertaken to preserve such vital materials as steel, gasoline and rubber.

Inspection of wire rope is probably one of the most overlooked ways of increasing its life. The tendency is all too much toward discarding the wire line when it begins to look bad or have wickers in it.

The life of wire rope could be increased if a systematic inspection program were developed which would detect troubles when they first develop and would not wait until they become obvious.

Methods of inspecting wire rope can be fairly well standardized, although inspection practices must necessarily vary to allow for the peculiarities of the individual installation. Evidences of deterioration in wire rope will, within fairly wide limits, be the same, regardless of where and how the rope is used.

Deterioration of wire rope will be evidenced by: (1) broken wires; (2) worn wires; (3) pitted or corroded wires; (4) drastic reduction in rope diameter and excessive lengthening of lay; (5) marks of mechanical abuse, such as flattening and distortion.

To inspect wire rope properly is to discover its worst spot. Thus, an inspection must include the entire length of the rope. If the rope is covered throughout its length with a heavy lubricant that obscures a view of the broken wires and of the abrasion-worn surfaces of the wire, provision must be made for the inspector to ascertain where the wire breaks are occurring, and the degree of abrasion abuse the rope has suffered. In many cases it will be possible to ascertain the section of rope showing the most deterioration simply by looking at it.

If a casual inspection will not disclose the worst portion of the rope, the matter is so important that it cannot be overlooked. Any effort required to make a careful inspection of the rope will be a worth while investment, for once the rope is allowed to become useless in the field,



it may not be possible to repair it. Proper care in the present is better than regret in the future.

Inspection should include:

1. A quick check of the number of broken wires by rope lays, so that the worst lay may be selected. One rope lay (see Figure 1) is the distance in which one strand makes one complete revolution around the rope.

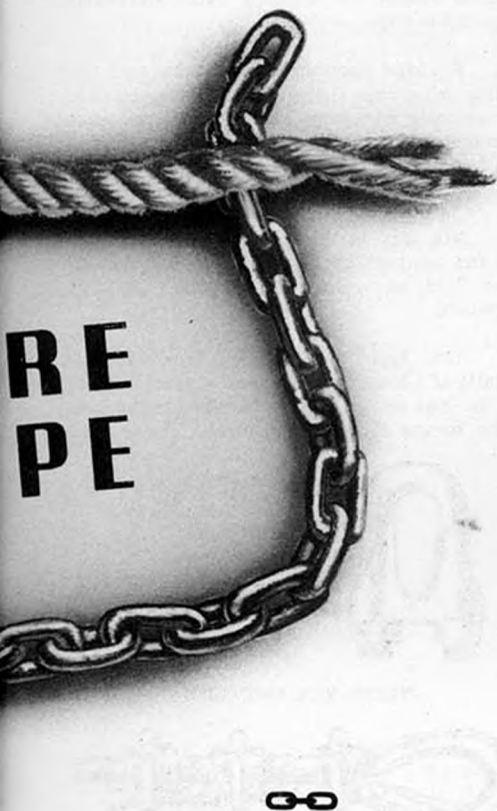
The worst broken-up lay should be selected for accurate counting of broken wires, since that lay constitutes the weakest point in the rope.



Note whether the majority of these wire breaks are occurring in one or two strands, rather than being fairly evenly divided among all strands. If they are concentrated in one or two strands, the rope will be considerably weaker than if they are evenly distributed.

It should also be noted where the majority of wires are breaking in relation to their position on the strand, whether they are crown breaks occurring on the top side of the strand, or whether they occur in the valleys between adjacent strands. If they are crown breaks they probably indicate normal deterioration; if valley breaks, they may be an abnormal condition.

An effort must always be made to determine the causes of breaks as the inspection progresses, for causes must be removed, if possible, in order to prevent recurrence of damage. Neglect or failure to remove causes of damage is just as inexcusable as any other neglect or failure in the care of wire rope.

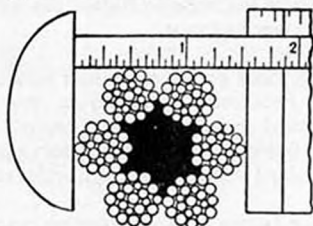


Wire breaks in a rope occur from a number of different causes, of which the most common are shown in Table No. 1.

TABLE 1 -- TYPICAL CHARACTERISTICS AND CAUSES OF BROKEN WIRES IN WIRE ROPE

Type of Break	Characteristics	Cause
Fatigue	Wire break will be transverse; cross-sectional view of broken ends will show granular structure. (See Figure 7.)	Where fatigue breaks occur, rope has been bent around too small a radius too often, or it has been subjected to vibration or whipping. Fatigue also often occurs after wire has been damaged by corrosion.
Tension	Wire break will show one side of broken wire coned, the other cupped. (See figures 4 and 5.) This type of break also can develop on wire showing abrasion.	Where tension breaks are found, rope has been subjected to too great a strain, either for its original strength or for the strength remaining in it after other factors of deterioration have weakened it. Frequently tension breaks are caused by suddenly applying a load to a loose rope, thereby setting up incalculable impact stress.
Abrasion	Wire break will show broken ends worn smooth to knife-edge thinness. (See Figure 6.) Wire broken by abrasion in combination with another factor will show a combination of characteristics. Figure 7 shows combination of abrasion and fatigue.	Abrasion wear obviously will be concentrated at points at which the rope is rubbed most constantly. These points are usually the grooves of sheaves and drums and any other object with which the rope comes into contact. Unwarranted abrasive wear indicates improperly grooved sheaves and drums, or other localized abrasive condition.
Corrosion	Can easily be noted by pitted surface of wire, with break usually showing evidence of one of the three foregoing factors.	Indicates improper lubrication. Extent of damage by corrosion to interior of rope is extremely difficult to determine; consequently, corrosion is one of the most insidious and dangerous causes of rope deterioration. If hemp center of wire rope is not lubricated and is allowed to dry out, it will collapse and fail to afford proper support for strands, thereby causing marked reduction in rope diameter and extreme external wear.
Cutting	Wire will be pinched down and out at broken ends or will show evidence of a shear-like cut. (See Figure 8.)	These conditions are evidence of mechanical abuse caused by agents outside the installation or by something abnormal or accidental on the installation itself.
Torsion or twisting	Wire will show evidence of twisting and corkscrew effect at broken ends.	
Machining	Wire will be flattened and spread at broken ends.	

2. A check of the diameter of the rope (see Figure 2) throughout its length should disclose any drastic reduction from the catalog



diameter at any point. Such reduction will indicate that the hemp center has dried out and collapsed, the rope has been stretched unduly, or internal corrosion is present.

3. Inspect the degree of abrasion wear occurring on the wires. Either the length of the wear should be discovered or an actual diameter check of the individual wires should be made. It is difficult to measure this wear accurately, especially in a rope of small-diameter wires; but some check must be made.

4. Note carefully, not only in the most broken-up section of the rope, but in its entire length, whether any signs of rust are appearing. Internal corrosion in a rope may be evidenced by a showing of rust in the valleys between the strands. Pittings also will usually be discovered more rapidly in the valleys. It is possible to have internal corrosion, however, with no external signs.

5. Note whether wire breaks and abrasion occur in one short section, or whether they are distributed throughout the length of the rope. Usually wire breaks will be concentrated in the portion of the rope which passes most frequently over the sheaves during normal operation; in sections of rope that wind onto drums most frequently; or in sections where wear is concentrated either by mechanical abuse or other factors.

6. Note carefully the condition of the rope near attached fittings.

In addition to the number of breaks, the amount of stretch in a line also indicates the approach of the end of useful life. Applying loads to a 6 by 19 rope up to about one-half the rated breaking strength of the rope will show a total stretch equal to 0.2 to 0.3 percent. For correctly preformed ropes this stretch will be from 30 to 50 percent less.

In actual service the history of rope stretch is always a guide to tell when ropes absolutely must be removed from service. In the initial stages of rope life, rapid stretch always occurs, then a long period of negligible but rather constant stretch occurs, and finally when the core starts to deteriorate rapidly and the wires within the rope start to break rapidly the rate of stretch again becomes more rapid. When this latter stage of stretch begins the rope should immediately be taken out of service.

Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used.

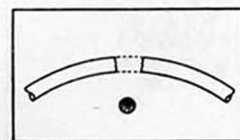
It would seem most foolish for personnel to overlook the maintenance of equipment on which wire rope is being used.

Just as any tool is important to the workman, so is every piece of equipment to the maintenance individual and his organization, whatever its size. In order to give the best service, and the best service possible is a definite requirement on the battlefield, all equipment must be kept in such a condition that it not only operates, but that it operates with complete satisfaction.

With this thought in mind all personnel should be constantly on the alert, such alertness itself constituting a continuous inspection.

The principal items to be checked are:

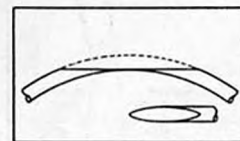
1. Sheaves.
2. Drums.
3. Reeving.
4. General operating conditions.



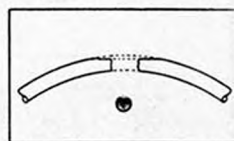
Fatigue-type break, no abrasion



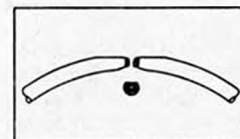
Cup-and-cone break, no abrasion



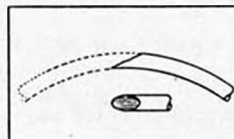
Worn through by abrasion



Fatigue-type break, with abrasion



Cup-and-cone break, abrasion



Cut or gouged wire

SHEAVES

Points to be checked on sheaves are:

1. **Size.** - Measure the diameter of a sheave from bearing surface to bearing surface, not from flange edge to flange edge, because it is the radius of the bearing surface that governs the degree of bending to which the

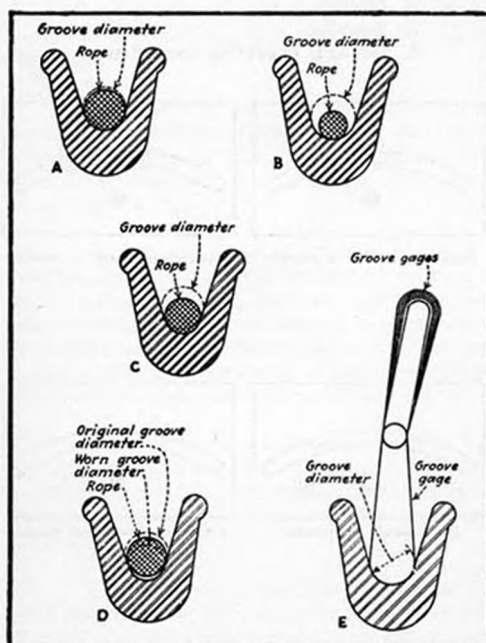
TABLE 2 -- RECOMMENDED AND MINIMUM DIAMETERS FOR SHEAVES

Rope	Recommended diameter; number times rope diameter	Minimum diameter; number times rope diameter
6x7	72	42
6x19	45	30
6x30	45	30
6x37	27	18
8x19	31	21
18x7	51	34

rope is subjected as it travels over the sheave. Table 2 gives the recommended diameters for various constructions of rope.

These recommendations apply to drums as well as sheaves. Since the rate of fatigue of wire rope is governed largely by the radii of the bends which it must take in normal operation, it is extremely important that the recommended diameters be equalled or exceeded. A large amount of internal wear is caused by improper sheave and drum diameters.

2. **Sheave grooves.** - The diameter of the bearing grooves of sheaves and drums must bear a certain definite relation to the diameter of the wire rope used on them. (See Figure 9.) As a rope passes constantly over the sheave, the



groove is worn deeper and its diameter becomes constantly smaller until it is less than that of a new rope or listed diameter. When a new rope is placed in such a groove it will be forced down into the groove and be pinched out of shape.

On the other hand, a rope placed in a sheave groove of too great a diameter will not be afforded proper support. Such a condition tends to allow the rope to flatten out as radial pressure is applied to it.

The ideal condition is that in which the wire rope receives support from the sheave groove around just less than one-half of its diameter. Gages for measuring sheave grooves can be obtained from any wire manufacturer.

Table 3 gives the tolerances recommended for sheave grooves.

TABLE 3 -- TOLERANCE BY WHICH GROOVE DIAMETER SHOULD EXCEED ROPE DIAMETER

Nominal rope diameter, inches	Recommended tolerance, inches
1/4 - 5/16	1/64
3/8 - 3/4	1/32
1 3/16 - 1 1/8	3/64
1 9/16 - 2 1/4	3/32
2 5/16 and larger	1/8

3. **Sheave materials.** - Sheaves of too soft material will be cut by wire rope, and their bearing surfaces will become corrugated to fit the contour of the rope used over them. This contour will not exactly conform to that of the next rope to be used over them, therefore the new rope will be cut and worn by the corrugations. Such sheaves should be remachined or replaced with sheaves of harder material.

4. **Sheave operation.** - Defective bearings will cause sheaves to wobble or to revolve eccentrically and will thus set up a whipping action in the wire rope.

Such a condition should be corrected at once. It not only induces wear on both the wire rope and the sheaves, but it is a hazard which might otherwise cause great damage to both personnel and materiel.

5. **General sheave conditions.** - A sheave that is out-of-round or has a flat spot on its bearing surface will also cause whipping of the rope and must be repaired immediately. This is another of the things which should be watched constantly by using personnel.

DRUMS

Recommendations for drum diameters are the same as those for sheaves, given in Table 3 for sheave groove diameters. Three checks are to be made on drums.

1. **Contour.** - With plain-faced drums corrugations on the face will cause the same damage to rope as discussed under sheave materials. Drums that have become corrugated should be remachined. Where the drum shell is too thin it may be lagged with steel plate.

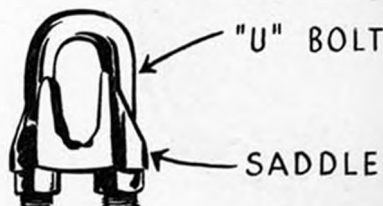
2. **Symmetry.** - If the drum face is low at one spot the rope will tend to pile up at this point. The rope coming onto this part of the drum first will wind in too open a wrap, whereas that on either side of the low spot will wind too tightly, thus causing undue scrubbing of adjacent wraps.

3. **Winding.** - Where grooved drums properly designed for the rope to be used upon them are employed, no winding difficulties are usually encountered when the fleet angles are satisfactory. Where plain-faced drums are used, care must be taken to see that the wire rope winds onto the drum evenly in a continuous loosely closed helix so that one wrap just touches the adjacent wraps. Too tight winding of rope will cause one wrap to scrub unduly against adjacent wraps, and thereby cause excessive abuse of the rope.

Perhaps something should be said regarding wire rope fittings. Cable clamps used in connecting wire rope have been in existence for more than forty years, and for as long a time these clamps have been improperly handled in many instances.

Not only is this method of attachment light and compact, but it may be applied quickly in the field, and requires no special skill or equipment.

This type of connection consists essentially of a loop formed around a steel thimble with the free end of the line fastened to the load line by means of wire rope clips. These clips



APPLYING WIRE ROPE CLIPS



CORRECT METHOD: U-Bolts of Clips on short end of rope.



CORRECT METHOD (Clips removed): No distortion on live end of rope



WRONG: U-Bolts on live end of rope.



WRONG: Staggered Clips; two correct and one wrong.

are composed of a specially formed saddle and one or two U-bolts, depending upon the size of the wire rope. The seat of the saddle is formed to fit over the strands of the wire rope which prevents cutting the outer rope strands when a load is applied.

Always place the saddle on the load line, with the U-bolts around the free end. The distance between clips should not be less than six times the diameter of the wire rope.

When making the connection, tighten securely all nuts on clips before and after the load is applied. After the rope has been in service for an hour or two, check the clips again; periodically thereafter.

Always insert a thimble into the looped end of a clip attachment, otherwise the rope will flatten out of shape, displacing the strands and decreasing the efficiency of the attachment.

The disadvantages of clips are that they frequently allow the rope to slip. Be sure you do not place the U-bolts over the load-holding end of the wire connection, as this causes concentration of pressure at the inside crown of the U-bolt, resulting in severe cutting of the rope.

The number of clips for each connection are indicated in the following table:

Diameter of rope, inches	No. of clips
1/4" to 3/8"	3
7/16" to 5/8"	4
3/4" to 1-1/8"	5
1-1/4" to 1-1/2"	6
1-5/8" to 1-3/4"	7



Sketch A in the accompanying group of illustrations shows the first steps in attaching a wire rope socket.

Because of the inconvenience and difficulties, as well as the need for special training and considerable actual experience, in splicing wire rope, it is often desirable to find some other means of joining lengths of wire rope.

The wire rope socket is one means of accomplishing this. It must be borne in mind, however, that a rope fitted with sockets cannot be passed over drums or sheaves, since the socket itself is of considerably greater diameter than the wire rope.

As shown in sketch A in the accompanying group of illustrations, the rope is securely bound with wire at a distance from the end of the rope equal to the length of the barrel of the socket.



Then the rope is opened and the hemp core cut out. The wires are next cleaned well with kerosene or turpentine and wiped thoroughly dry.

The cleaning of the wire rope ends must be done carefully and thoroughly, since the remainder of the process depends upon a good adhesion between the wire rope strands and the metal to be used to hold them in the socket. Good results cannot be obtained if dirt or foreign matter is present on the wire rope strands.

B shows the next step of separating the wire in the strands, which can be conveniently done by using a small piece of pipe.



Then straighten the wires, and soak them in a solution of one-half muriatic acid and one-half water for five minutes. Then clean them off.

The wire ends are next dipped into a solution of one-third muriatic acid and two-thirds water.

C is an illustration of the wires that have been brought together and bound with a single wire at the extreme end so that the socket



will easily slip over all the wires. To ready the socket, the inside of the barrel must be cleaned with kerosene or turpentine and wiped dry.

Next, the inside of the barrel is coated with a solution of one-half muriatic acid and one-half water. Allow this to dry thoroughly.

After it is dry, heat the socket until it becomes warm. Then apply a second solution consisting of one-third muriatic acid and two-thirds water. The socket is forced over the wires until they are even with the end of the socket barrel.

D shows the socket ready for spelter or melted zinc. The small wire binding at the end

of the rope is removed to allow the wires to spread in the socket bowl.

Use pure spelter, free from dross. Either place fire clay or wrapping paper around the rope at the base of the socket to prevent the spelter from running out.



Hold the socket and rope vertical and pour the melted zinc into the barrel of the socket until the tops of all wires are covered.

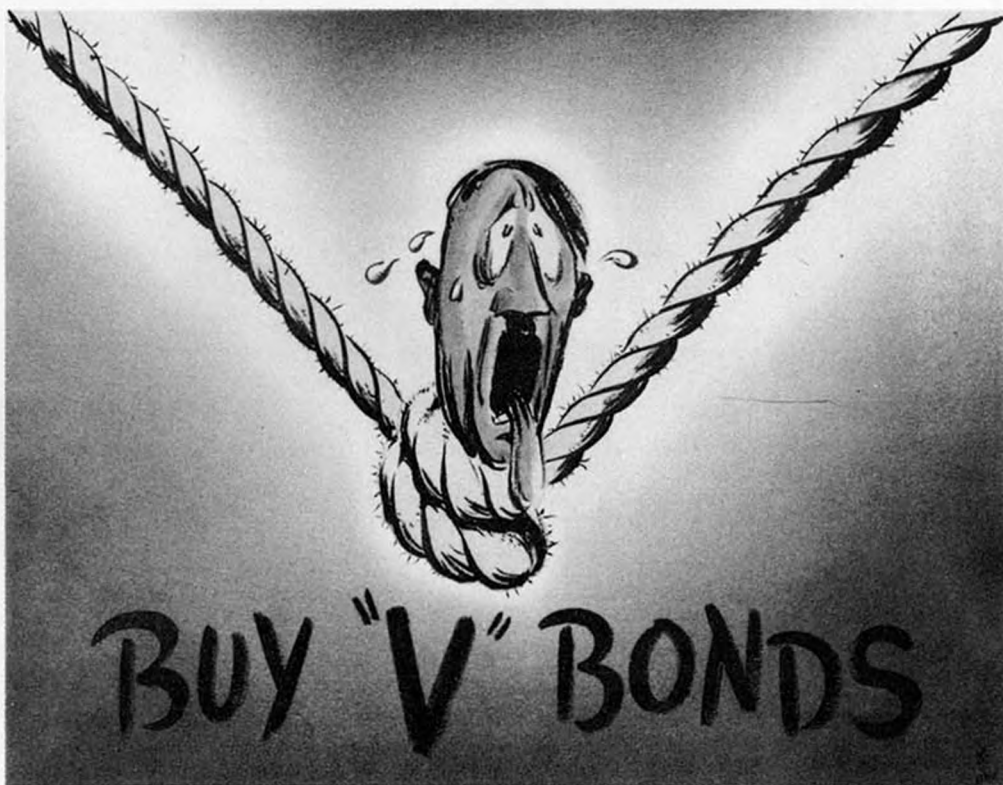
Probably a perfect fitting of a wire rope socket at the first attempt for a beginner would be expecting too much. Although the directions for performing this operation seem simple, experience should be gained under good supervision.

Proper cleaning of the wire rope strands is most important if good results are desired. Proper separation of the strands, too, as well as their proper positioning in the base of the socket will add to the efficiency of the work.

E shows the finished socket, ready for service. The finished socket will now be found



to constitute a rapid and convenient method of connecting wire ropes, as well as an efficient one.



WHILE THEY FIGHT WE SERVE THEM



Photos by
U. S. Army
Signal Corps

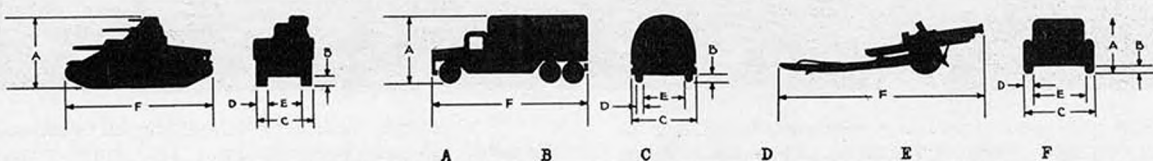
DATA ON MATERIEL

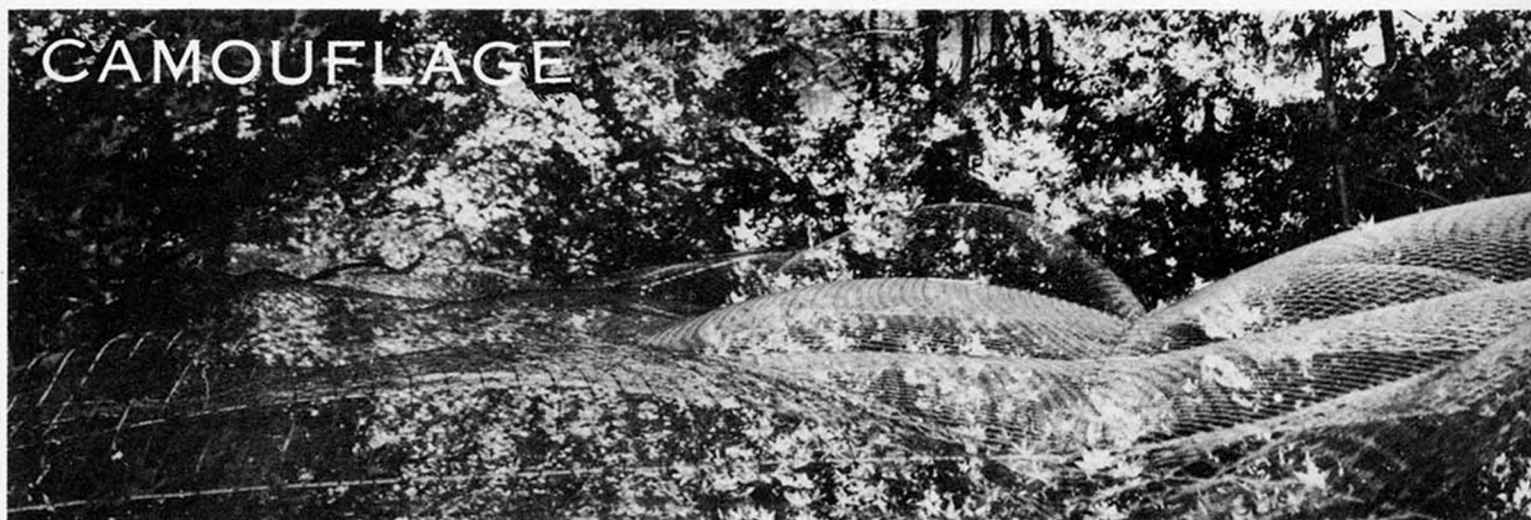
The material given in the accompanying table is to allow the Ordnance soldier in the evacuation company to have a knowledge of the dimensions and weights of the materiel which he may be called upon to handle. The data given are not a complete compilation of all Ordnance items. However, it is felt that sufficient information has been given to be useful in the field in judging weights and measures of similar vehicles or weapons.

Wherever possible, the data given have been extracted from technical manuals and similar sources. Where the information could not be found elsewhere, the dimensions given were actually measured on the item itself. Such measurements are denoted with the symbol \$.

The clearance between tracks or tires may be obtained by subtracting the track or tire width from the tread, and noting that the width of a track or tire is slightly greater than the size of shoe or rated size of tire. A reasonable allowance should be made for clearances when using the dimensions given. Measured dimensions are correct to approximately 1/2".

Net weights given for vehicles are without personnel, fuel, armament and ammunition. Other weights given are gross weights and include an allowance for the crew.

							
Weapon or vehicle	Height overall	Road Clear	Width overall	Track or tire width	Between tracks (or tires)	Length overall	Wt. tons
Gun, 37mm, AT, M3, Car M4	3'-2"	9"	5'-4"	6"	50"	12'-11"	.46
Gun, 37mm, AA, M1A2, Car M3	6'-9"	11"	5'-10"	5.5"	Tread 58"	20'-1"	2.50
Gun, 40mm, AA, M1, Car M2	6'-8"	14"	6'-0"	6.0"	Tread 55"	18'-10"	2.15
Gun, 57mm, AT	4'-2"	10"	6'-3"	8 1/2"	50"	15'-2"	1.4
How., 75mm, M1A1, Car M3A1	3'-8"	9"	5'-8"	5.5" 6"	51"	12'-9"	1.04
Gun, 75mm, M1897A4, Car M2A2	4'-8"	15"	7'-0"	7 1/2"	62 1/2"	18'-4"	1.84
How., 105mm, M2A1, Car M2	5'-0"	16"	6'-10"	7.5" 8"	Tread 70" 62"	19'-10"	2.13
How., 155mm, M1918, Car M1918A3	11'-6"	20"	7'-10"	13.0"	75 1/2"	21'-0"	4.53
Gun, 155mm, M1A1, Car M1	9'-1"	12"	8'-3"	2x11.00 24"	51 1/2"	34'-6"	15.50
Gun, 3", AA, M3, Mount M2A2	10'-0"		6'-11"	10"	Tread 66"	25'-0"	8.40
Gun, 90mm, AA, Mount, M1A1	9'-4"	11"	8'-5"	2x10	53"	20'-8"	8.63
Car, Scout, M3A1	6'-7"	15"	5'-11"	8 1/4"	Tread 63" & 65"	18'-5"	4.40
Car, Armored, M5, Ford	7'-10 7/16"	13.5"	8'-6"	12.00x20		18'-1 1/2"	19.0
Car, Half-track, M2	6'-1"	17"	6'-5"	8 1/4"	Tread 64"	19'-7"	7.10
Tank, light, M3	8'-8"		7'-4"	7 5/8" shoe	Tread 73"	14'-10"	14.0
Tank, Light, M5	8'-5"	16 1/2"	7'-4"	11 5/8" shoe	Tread 73"	14'-7"	15.5
Tank, Medium, M3	10'-3"	17"	8'-11"	16" shoe	Tread 83 1/2"	18'-6"	30.0
Tank, Medium, M4A1	8'-11"	17"	8'-7"	16" shoe	Tread 83"	18'-6"	31.5
Gun, 3", M7, Med Tank Chass M4	8'-11"	17"	8'-7"	16"	7'-11"	18'-6"	32.5
How, 75mm, SP, Track Car M8	7'-6 1/2"	16 1/2"	7'-4"	11 5/8"	6'-1"	14'-7"	15.5
How., 105mm, SP	8'-2"	15 1/2"	8'-0"	11 5/8"	6'-1"	14'-6"	23.3
Gun, 37mm, AT, SP, Car M4A1	3'-2"	10"	5'-3 1/2"	6" tires	4'-2"	12'-10 1/2"	.9
Gun, 75mm, AT, SP, M1897A4, Half-T Car M3	6'-3"	17 1/2"	6'-0"	11"	5'-5"	20'-0"	6.5
Tractor, Light, M2	5'-4"	13 1/2"	4'-9"	12" shoe	Tread 42"	9'-1"	3.4
Tractor, Medium, M1	6'-2 1/2"	13"	5'-6"	16" shoe	Tread 50"	13'-3"	6.5
Tractor, Heavy, M1	7'-6"	14 1/2"	9'-10"	20" shoe	Tread 74"	15'-1"	14.0
Truck, 2 1/2-ton, Prime Mover (GMC)	9'-2"		7'-4"	7.50x20	49"	19'-2 1/4"	5.0
Truck, 4-ton, Prime Mover (Diamond T)	9'-6 1/2"		8'-0"	9.00-20	50 3/4"	24'-0"	9.4
Truck, 7 1/2-ton, Prime Mover (Mack)	9'-4 3/4"		8'-5 3/4"	12x24	50 3/4"	23'-1 1/4"	13.9
Truck, machine shop	9'-10"	9"	7'-10"	7.50"	54 1/2"	19'-10 1/2"	6.5
Gun, M5, 3", AT	4'-10 1/2"	16"	6'-10"	6"	5'-2"	23'-1"	2.45



Camouflage is work done to provide protective concealment of materiel, troops, or military works from enemy observation from airplanes, captive balloons, and ground observations posts.

We are not so much concerned with the methods of observation as with those of concealment. We must realize, however, that efficient processes of observation are constantly in operation on behalf of our enemy, and that the slightest relaxation of vigilance or care on our part may prove to be our undoing. Ordnance troops, as a rule, have but little reason to fear direct observation, which means the use of direct vision which may be aided by field glasses or telescopes. This does not mean that direct observation can be entirely forgotten. On the contrary, it must always be regarded as being possible, and when operating near the battle front Ordnance troops must give it consideration.

Much more important, however, to Ordnance troops, such as an evacuation unit operating behind the actual combat zone, is indirect observation by the enemy. Indirect observation, provided by aerial photographs, is very effective. The skill of the expert photograph interpreter in translating apparently insignificant details into important military intelligence can hardly be realized by one who has not specialized in it.

The roads, paths, houses, towns, etc., in peace appear in certain fixed patterns on aerial photographs. The pattern may be large and simple as in a farming district, or it may be intricate or confused as in broken, wooded areas. In war these peacetime patterns are disrupted. War requires new roads, new paths, etc., and rarely will these fail to register on an aerial photograph as separate and distinct from the normal pattern of the terrain unless properly camouflaged. An intricate terrain pattern makes the work of the photograph interpreter more difficult and the work of camouflage easier.

Camouflage can be accomplished by any one or more of the following methods:

Hiding. - Completely concealing an object by constructing overhead cover or lateral screening.

Blending. - Making an object indistinguishable from its surroundings by breaking up its form and shadow. This method is particularly valuable where the terrain pattern is intricate.

Deceiving. - This method includes --

Making an object appear to be something else, for example, constructing a shop so that it appears like a barn, or

Using dummies to mislead the enemy and draw his attention away from actual installations.

The requirements for successful camouflage, listed in the order of their importance, are:

- Proper choice of position.
- Good camouflage discipline.
- Proper erection of camouflage material.
- Proper choice of camouflage material.

A position satisfactorily fulfilling all conditions is seldom found. However, adequate reconnaissance, and proper consideration of all requirements of the situation, will help in the selection of the best position available. The location should be such that occupying troops can successfully accomplish their mission. Ease of access should be possible, without making telltale tracks either during installation, delivery of necessary supplies, or movements of personnel. Consideration must be given to the natural concealment or the ease of concealment by camouflage, and to the prevention of enemy ground or balloon observation. Suitable locations for necessary auxiliaries, if any, must be available. At the same time they must be easily camouflaged and easily accessible, yet not so close as to give away the main installation. The discovery of one accessory may draw attention to the area and force the removal of the entire installation.

If possible THE LAY-OUT SHOULD BE PLANNED IN DETAIL BEFORE THE POSITION IS OCCUPIED. The best way to choose a position is to use an aerial photograph to supplement the necessary ground reconnaissance. Maps are often helpful, especially in determining whether or not the mission can be accomplished from a given location. Ground reconnaissance should determine the availability of local materials for use in camouflage purposes.

Camouflage discipline is intended to attain two objectives. Of first importance, possibly, is the prevention of any visible appearance in the terrain of change caused by personnel, for example, making paths or tracks, cutting trees or sod, or leaving any foreign objects exposed in the vicinity of the position. Possibly of equal importance is the maintenance of camouflage material, for example, repairing it when damaged, and keeping it up to date by changing its appearance or color as that of the terrain changes with the season.

Camouflage material should be so erected that it does not have a regular form or cast either a regular or well-defined shadow. It must conceal the form and shadow of the object camouflaged, and hide the tracks of constructing personnel.

The materials chosen should match the surrounding terrain in color and texture, and should be easy to maintain, considering the length of time the position will be occupied.

The effectiveness of camouflage may be checked by examining an aerial photograph of the camouflaged position. Even in good positions, some minor changes will probably be necessary. Where flagrant mistakes have been made, it may be advisable to move to an entirely new position. In this case the original position might well be maintained as a dummy, in order to deceive the enemy as to the dispositions in the area as a whole. Maintenance requirements may be determined by rephotographing the position at appropriate intervals.

Camouflage materials are of two classes - natural and artificial. Natural materials include green vegetation such as fresh grass and foliage, branches in leaf, sod, etc.; dry vegetation, such as dead leaves, bare brush, etc.; and debris natural to a shell-torn village, battlefield, or similar locality.

Artificial materials include fishnets garnished with oxburg, burlap, or like material; chicken wire garnished similarly; and garlands.

Natural materials are advantageous in that they match the color and texture of the locality more easily when properly used; that they are effective against all types of aerial photographs, particularly the infrared and color photographs; and that they reduce the quantity of camouflage supplies to be furnished from the rear. Natural materials are disadvantageous in that they cannot be prepared in advance for quick erection, it being necessary to do all work at the site; and that green vegetation must be renewed frequently to replace wilted material, requiring exceptionally strict discipline of maintenance personnel to prevent making visible tracks.

In general, natural materials give the best results, and artificial materials are used mainly for positions of a more or less permanent nature when maintenance of natural materials would be difficult; in situations in which time and labor are not available for gathering and erecting natural materials; or in localities where suitable natural materials are difficult to obtain in sufficient quantities.

USE OF NATURAL MATERIALS

Vegetation, either green or dry, can be placed directly on and around an object or can be supported over an object to form an overhead cover. Green vegetation must be placed in its natural position, otherwise it will reflect the light differently and show up in aerial photographs. For example, leafy branches thrown upside down photograph too light, because the under side of a leaf is a different color from the upper side. Dry vegetation can be placed in any position, although it is generally better to place it as naturally as possible. With both green and dry vegetation the density of cover must be such as to match the texture of the locality.

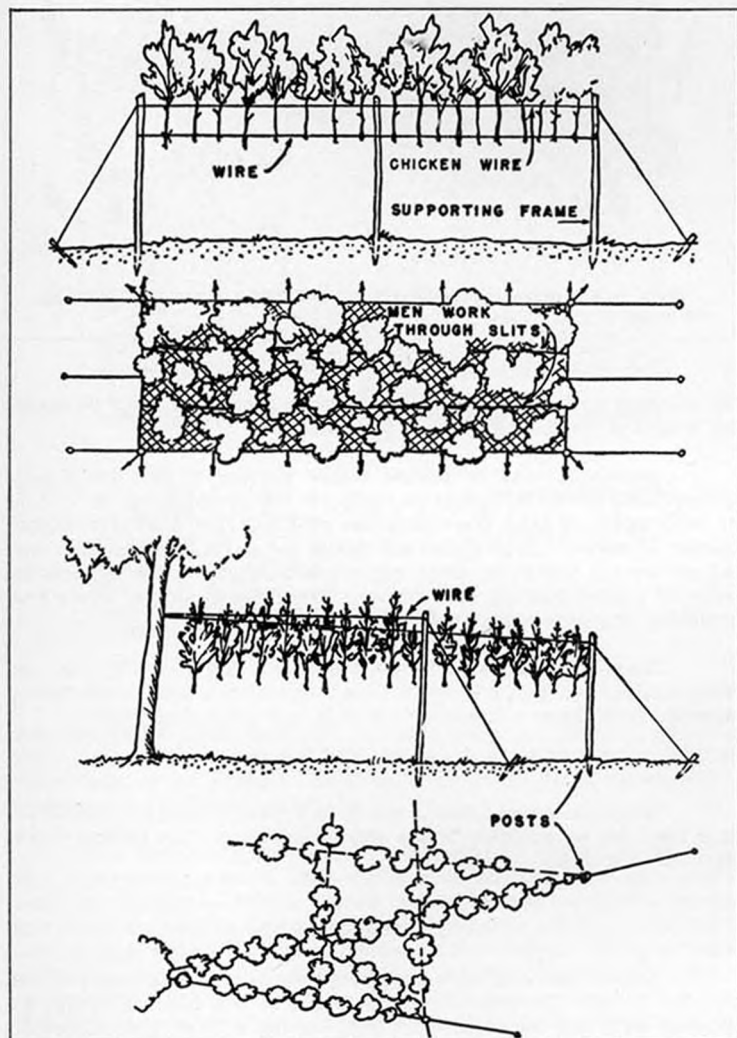
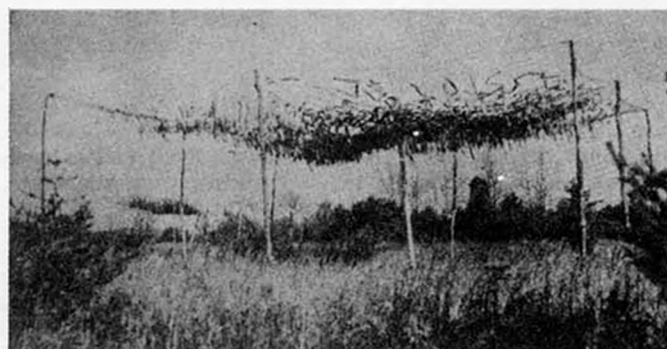


Fig. 1 -- Overhead covers of natural materials

In making an overhead cover of green vegetation two methods are successful. (See Figure 1.)

Stretch wires overhead at different heights and in several directions, fastened to trees or posts. Suspend small trees, branches, or shrubs by their tips from these wires.

Stretch strips of chicken wire on a suitable supporting frame, placing the strips side by side without overlap and without fastening the adjacent edges together. Men work from underneath through the slits between the strips and stick out branches, shrubs, etc., in the chicken wire so that the butt ends project down 8 to 12 inches. The butt ends are then wired so as to hold the branches upright.



FLATTOP

DRAPE

Fig. 2 -- Uses of fishnets

Dry vegetation used for overhead cover can be thrown on the supporting frame in any position. The proper texture is secured by varying the density of material.

Debris suitable for camouflage usually occurs only in localities where the terrain pattern is very intricate and confused, with many irregular forms and shadows. Debris is placed over and around an object in such a locality as to break up its form and shadow into an irregular pattern. Debris requires no renewal and little maintenance, but its use is limited to suitable localities.

USE OF ARTIFICIAL MATERIALS

Fishnets, because of their portability, are used principally in mobile situations for artillery, tanks, trucks, etc., and are issued in the following standard sizes, all with 2-1/2-inch mesh:

Size of fishnet (feet)

Machine guns and mortars	12 x 12
Antitank guns and their prime movers	22 x 22
Light tanks	30 x 30
Medium tanks	45 x 45
Field and antiaircraft artillery, and trucks	36 x 44

Fishnets are used to provide overhead cover for an object in either of two ways: As a "flat-top", supported on a wire frame above the object,

or as a "drape", placed over and around the object. In either case, a fish-net must be tied in with some natural feature, such as a clump of trees or brush, to be effective. (See Figure 2.)

Fishnets shrink when they get wet and expand as they dry out; hence when used as flat-tops they must be adjusted with each change in weather conditions. They deteriorate more quickly than chicken wire and should therefore be used for the more temporary installations. When fishnets must be installed initially on positions which will be occupied for a long time, they should be replaced with chicken wire at the first opportunity.

Chicken wire is issued for use in standard strips 6 feet wide by 30 feet long, having a 2-1/2-inch mesh. It is normally used, in more or less stable situations, for over-head flat-top covers supported on wire frames. Compared to fishnets, chicken wire can bridge longer gaps between supports without sagging, is more permanent, and will not shrink or expand due to moisture conditions, and in case of fire will not drop the whole fabric on men and materiel underneath. It is more bulky, less easily handled, and is too stiff for use as a drape.

Garlands are made by doubling a 40-inch length of oznaburg or burlap and knotting the double length in the center. These knots are then secured to a light wire framework at 8-inch intervals in such a way that they will not slide on the wire. Garlands are useful for thickening overhead cover, whether natural or artificial, and for extending irregularities in the edges of nets. (See Figure 3.)



GARNISHING

The standard material for garnishing is 7-ounce, 40-inch wide oznaburg, a cotton cloth something like unbleached muslin. Burlap may also be used.

Both fishnets and chicken wire are garnished by weaving strips of oznaburg, about 5 feet long and 2-1/2 inches wide into the net along irregular lines. Each end of each strip is allowed to dangle about 8 inches from the under side of the net.

In garnishing fishnets, the strips of oznaburg are woven close together in the center of the net so that about 70 percent of the mesh openings are covered. The garnishing is thinned out gradually at the edges of the net. Garnishing should be very irregular in outline. (See Figure 4.) The thickly woven central portion serves to conceal what may be under it, and the thinned edges cast a faint, indeterminate shadow which, merging into the inequalities of the terrain, renders it unnoticeable in aerial photographs. Since the thinned edges allow objects under them to show, the cover must be much larger than the object over which it is placed.

Each standard strip of chicken wire is garnished throughout in one of two ways, either thick for use in center portions or thin for use at edges.

COLOR OF NETS

Garnishing for nets must be colored to fit the locality where the net is used. In a stable situation, nets may be furnished to the using units already garnished and colored to fit the particular sites. In mobile situations, garnishing or garnished nets may be furnished in a neutral color but must be finally colored on the site. In any case, coloring must be checked by air observation to prove its effectiveness. Nets colored in one solid color throughout generally give as good results as nets with mottled patterns of several colors and are easier to prepare.

Garnishing may be colored either by paint or dye. Paint is the more satisfactory material as most dyes fade rapidly. A casein-bound color-water paint, furnished in paste form, is the standard material. It is furnished in a variety of colors, including burnt umber, burnt sienna, yellow ochre, green, golden yellow, ultramarine blue, black, white, and red.

To match a particular piece of terrain, any two or more of these colors can be mixed to form a new color. The proportions of basic colors to be used must be determined by trial and error for any given locality.

Paint can be applied by means of a paint brush, which requires excessive labor; or by use of a spray gun, which is especially useful for correcting colors in the field; or by dipping in a vat of paint, which is

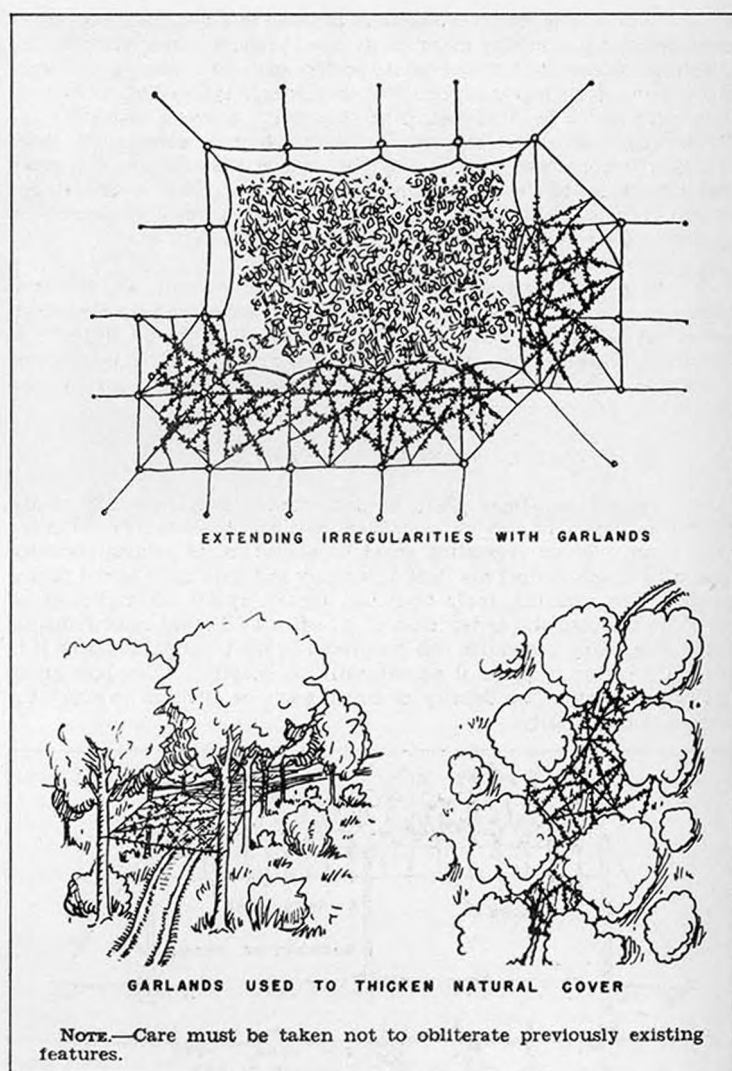


Fig. 3 -- Garlands

the quickest method, but requires much more paint and thereby increases the weight of the finished product materially.

Garnishing may be painted before weaving, in the form of large pieces (bolts or rolls) or of strips ready for use. Painting before weaving is economical of paint but makes the material stiff and hence slightly harder to weave. Large pieces are easier to paint than strips, but when strips are cut therefrom their edges are unpainted which changes the color of a garnished net appreciably. This is unimportant where final matching of colors is done in the field.

Garnishing may also be painted after being woven into the net. This method is particularly useful when the garnished nets are painted by dipping. Both upper and under sides of the net must be painted.

FOLDING OF FISHNETS

When not in use, fishnets should be folded carefully in such a way that they can be unfolded for use without confusion. The best method is shown in Figure 5.

SNOW CAMOUFLAGE

Camouflage when snow is on the ground is much more difficult than at other times. The following points should be kept in mind. Trails get tracked with mud and melt out early, leaving a black line; snow falls through camouflage material and the holes show dark; the warm roofs of dugouts, etc., cause early melting of snow.

When the snow first falls keep activity at a minimum. Snow often melts quickly in places and it is only on the first clear morning that an unbroken white sheet exists. Enemy air observation is intensified at this time.

Cover trails, dugout roofs, etc., with fresh snow. Renew this covering as often as needed. Cover camouflage with something to hold snow and then scatter snow thereon. The entire surface need not be covered, but the form should be broken up with the snow.

Use white cloth in patches to cover the camouflage. Cloth in the quantities necessary would probably only be furnished for areas where snow lies unbroken on the ground for long periods.

TYPICAL CAMOUFLAGE PRACTICE

Roads and paths. - Existing roads and paths should not be camouflaged, as they will normally have been photographed by the enemy and

the vicinity of a camouflaged position. In wet weather the best way to keep a path from spreading wide is to lay down trench boards or cover it with cinders.

Bivouacs. - Shelter tents can usually be hidden by placing them irregularly among bushes and trees and by covering them over with brush and grass. Out in the open they may be grouped irregularly under a single cover of artificial camouflage material or of brush supported on wire. Large tents can be treated in a similar way. The irregular grouping of the tents to fit in with existing concealment is the most essential feature.

The concealment of bivouacs is much simpler in woods and villages than in the open. In thin woods use overhead cover of proper color, or cover tents with branches or brush, and avoid all regularity in placing tents or shelters. In villages utilize existing buildings, walls, basements, etc. A shelter in a tumble down or roofless enclosure may be disguised by leaning broken timbers against the wall above the shelter to represent fallen rafters, and scattering dirt, dust, brick, or debris over the shelter. In yards, shelters should be placed near fences, hedges, or trees, and disguised with paint splotches, mud, brush, or grass.

When necessary to conceal a bivouac in the open, cover the area with camouflage material on a standard wire frame. About 5 square yards of cover per man is sufficient. In covering any large area, care should be taken to come exactly to the existing edge of a field. Partly

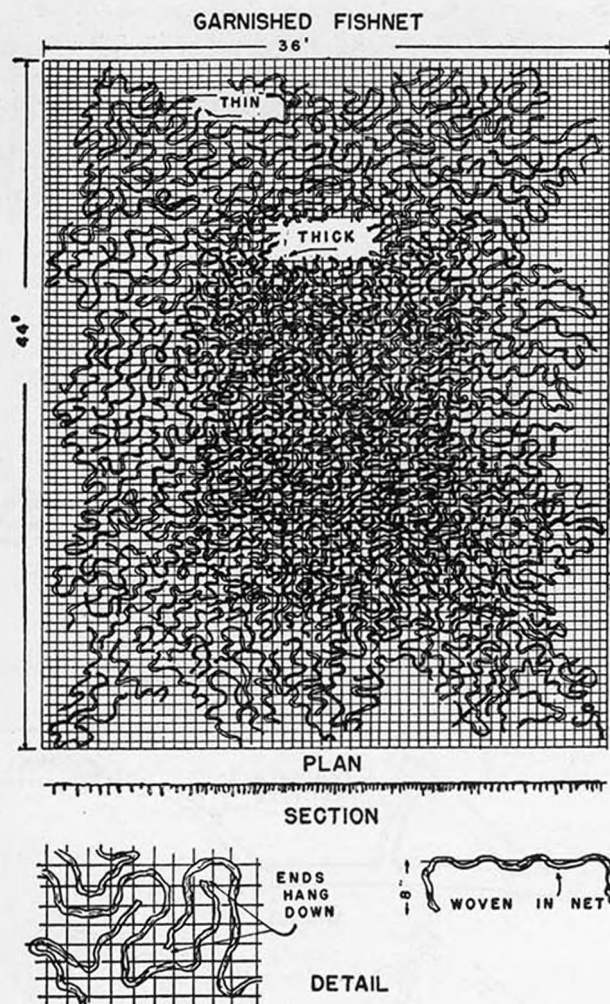
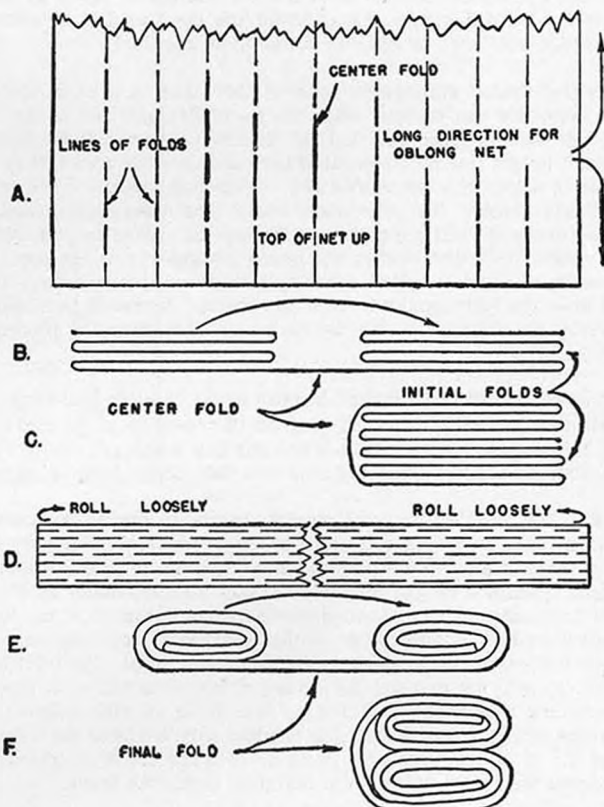


Fig. 4 -- Garnishing

any attempt at hiding them will attract attention. Where practicable, their use should be regulated by traffic routing and control so that their appearance is not changed due to widening of the traveling surface or destruction of bordering vegetation.

New roads and paths can be concealed for short distances only. For ease of concealment, choose routes which afford as much natural cover as possible. Where natural cover is scarce, follow existing surface lines, such as fence lines and ditch banks, keeping on the north side of such objects to take advantage of the shadows. When artificial cover is necessary, use chicken wire or stretched wires on which camouflage material is placed in irregular patches. Never hide a road or a path under a solid blanket of one material; break it up with irregular patches of different materials. These patches need not be contiguous. (See Figure 6.)

Concealed roads and paths MUST be wired in along both sides so that vehicles or personnel cannot make wide places or shortcuts which are not concealed. In many cases similar wiring is necessary for roads and paths not concealed, in order to prevent changes in their appearance in



PROCEDURE

1. SPREAD FLAT. (A) AND FOLD TOWARDS CENTER. (B. AND C.) TO FORM LONG FOLDED STRIP (D.)
2. ROLL LOOSELY FROM BOTH ENDS. (E.) AND FOLD ROLLS TOGETHER. (F.)

Fig. 5 -- Folding of fishnets

covered fields, or those where edges of cover do not exactly coincide with existing boundaries, are very evident in photographs. When a cover occupies exactly the same area as the field underneath it, even if the color is not exactly the same, it appears in photographs as though some normal agricultural development had taken place.

Buildings. - Buildings, on account of their height, always cast strong shadows, and as they have rectangular forms are easily picked out on aerial photographs. It is difficult to conceal a building, except a very small one, so that it will not show in a photograph.



Eighty percent of the value of the camouflage of buildings lies in their correct location. Woods should be used for locations of buildings to the utmost possible extent. If scattered clumps of trees or bushes exist, tie the buildings into them; avoid the open as far as possible. Never arrange buildings in rows or space them regularly.

A flat-roofed building is less visible than a peak-roofed one, because, with the sun on one side, the hard straight line in the latter between the side in light and that in shadow is very conspicuous. If new boards, bright tin, or corrugated iron are used for roofs, they must be painted in a flat color or daubed with tar or mud to remove the shining or conspicuous color. Old boards are better than new; rough boards are better than dressed. Tar paper is a good covering. After any conspicuous color is neutralized, pile bushes and brush irregularly on the roof. It is not necessary to cover it entirely, but by letting some brush extend beyond the roof lines the rectangular form is broken up. Increase this breaking up of form by placing bushes or brush on the ground, extending irregularly from the building.

Dumps. - For large dumps in rear areas, scatter buildings irregularly in and around woods and clumps of trees so as to make poor bombing targets. A dump should not be near any landmark easily visible at night, such as a large white building or a distinctive body of water.

For the smaller forward dumps, locate in places favorable for concealment such as woods, scattered brush or trees, or villages. Avoid important crossroads, lone buildings, or groups of buildings, or the immediate vicinities of gun batteries. Lay out the dump so that the material is scattered and fits in with the natural features of the terrain as far as possible. Cover piles of material with sufficient screening to prevent the enemy from seeing the quantity on hand. Restrict traffic so that tracks will not indicate the nature of the installation. If possible, provide return routes for vehicles so that their turning will not mark up the area. In heavy woods, stretch chicken wire between the trees at a height of 12 to 15 feet above the ground and place brush on this wire so as to conceal the roads and piles of material under the trees.

Trucks and tanks. - Trucks and tanks should use their mobility to get under natural cover wherever possible. They should always park in scattered, irregular formations. They are best concealed under heavy natural cover as in dense woods. In partly open country, they should be run into thin woods or a clump of trees or brush and either covered with brush, weeds, etc., or preferably draped with standard garnished fishnet (see Figure 2.) In open fields, their identity can be hidden by a fishnet drape but they cannot be concealed. When used as a drape, the fishnet must be propped off the tank or truck by brush or poles so that the shape of the object will not show through. The edges of the net should be held away from the tank or truck by being pegged to the ground or tied to bushes or trees.

Except on hard roads, trucks and tanks make characteristic tracks which are quite visible to aerial observers. These tracks should be effaced, particularly at the entrance to the woods or other localities where the trucks or tanks are halted.



Both trucks and tanks should be dark in color rather than light. When not in motion, all shiny parts such as headlights and windshields should be covered or obscured as by mud.

After camouflaging trucks or tanks, care should be taken not to make unconcealed paths leading to the place where they are located.

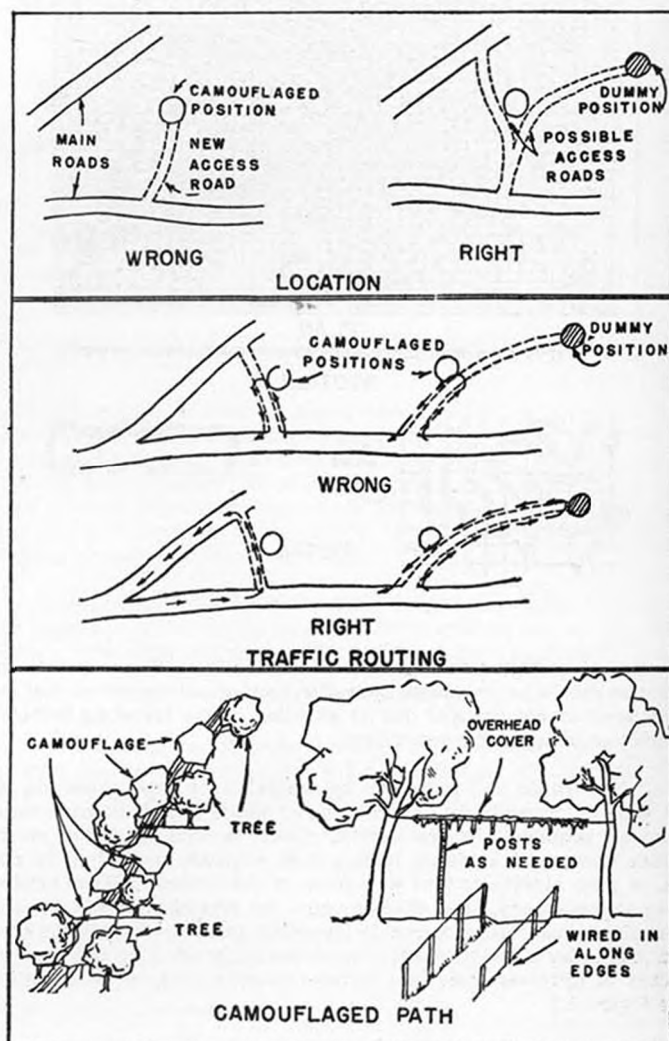


Fig. 6 -- Access roads and paths

"Booby trap" is the name given to devices used by an enemy to wound or kill careless or thoughtless opponents. As the name indicates, only a "booby" will be injured by such a trap. You must always be watchful for them in areas which have been in the possession of the enemy. They may be connected to doors, windows, furniture, and souvenirs, such as helmets or parts of uniforms or rifles, and they may be attached to weapons or vehicles which have had to be abandoned.

The elementary booby trap usually consists of a small charge of explosive, either in slabs or in a cartridge, with an igniter worked by either the push or the pull method, or both. A wire or cord may be attached to the igniter and to another object, or the trap may be placed beneath a loose board.

The following are examples of places in which booby traps may be used:

Doors. - Traps are placed inside houses, over doors, in door frames, or against the wall behind the door when wide open. Doors in such cases are rarely locked, and are sometimes left ajar.

Windows. - Traps are placed on inside sills of ground floor windows, or connected to closed or half-open shutters with a wire in tension.

Barn doors. - Traps, usually of heavier charge than referred to above, may be placed on the ground or between battens at the height of a man. They may be placed under a loose board in the floor.

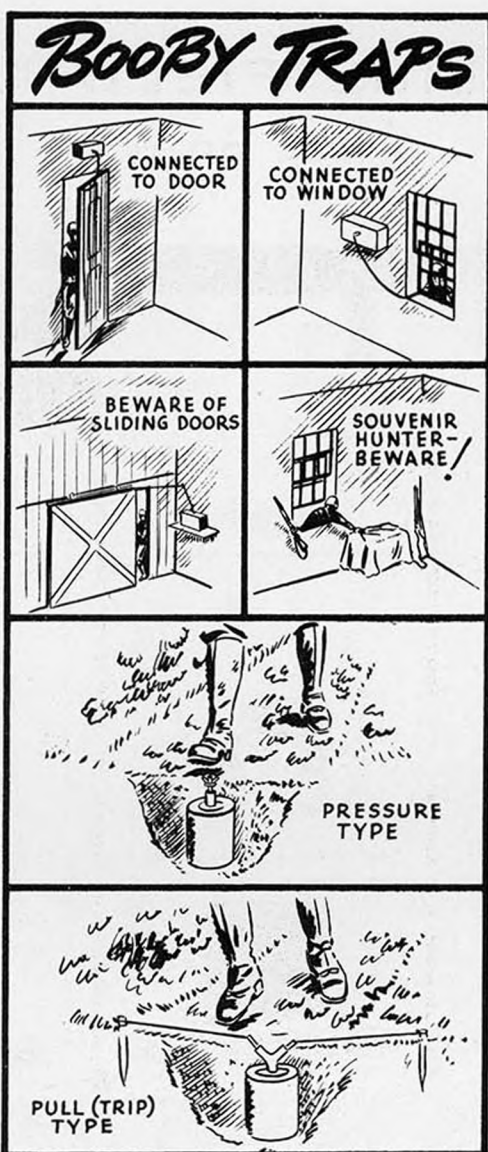
Vehicles. - Traps may be placed inside the cabs of vehicles, attached to the doors or brake handles, or placed under the seats. They may be found under the closed or half-open hood of the vehicle.

Souvenirs. - A helmet, pair of boots, blouse, rifle, or pistol, or other piece of equipment, particularly when left in a building or other confined space, may be connected with a booby trap. This is a particularly useful type against an opponent with the habit of collecting souvenirs.

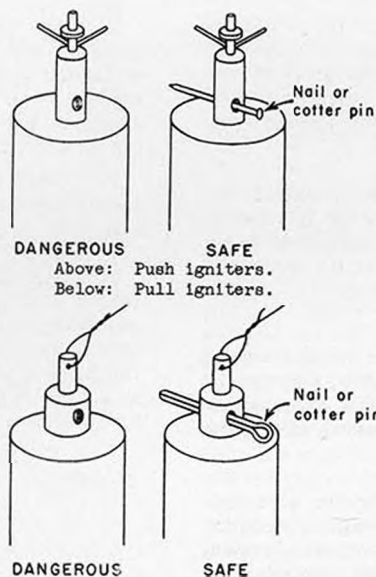
Miscellaneous. - Traps may be used in cellar entrances, inside doors, cupboards, chests of drawers, and farmyard vehicles. In fact the only limitation of the uses of such devices is the extent of the ingenuity of the person planning their use.

ANTIPERSONNEL MINES

Antipersonnel mines work with shrapnel effect, that is, use a casing containing hundreds of bullets or other missiles which are blown through the air by the explosion of the mine. Like booby traps, they may work on either the push or the pull method. They are particularly useful in woods where they are more easily camouflaged. Mines with pull igniters are usually worked by a simple trip wire but may be



fixed in loose branches and other minor hindrances to advance which an unsuspecting person is liable to move. A mine with a push igniter is generally used in combination with an obstacle,



Neutralizing a trap

being placed in the middle of the obstacle itself or in the approaches to it. Antipersonnel mines may frequently be employed to protect barbed wire, antitank minefields, and other installations from clearing operations.

ANTITANK MINES

Antitank mines may be found in small fields blocking roads or approaches to important weapons or positions or in larger fields used as a part of a continuous obstacle against tank movement. Many antitank mines operate only under pressure of 300 pounds or more, but others may operate under the weight of a man or may be fitted with special means of detonation when tampered with. These mines should be neutralized and disarmed by specially trained individuals. If you encounter an area where you suspect their presence, avoid it and report it to your commander.

PRECAUTIONARY MEASURES

When you suspect the presence of a booby trap or of mines you must take great care before moving. You should examine outdoor areas for trip or tension wires or disturbed surfaces of the ground. In buildings nothing should be moved until it has been thoroughly examined. If you must enter a building, try to get a view of the inside of the door through a window before you enter. If you can't do that, open the door with a long pole from a sheltered position. Even if you thus detonate a mine, be careful that there isn't a second one which will explode when you close the door. Sometimes a double booby trap has been used to take advantage of such carelessness.

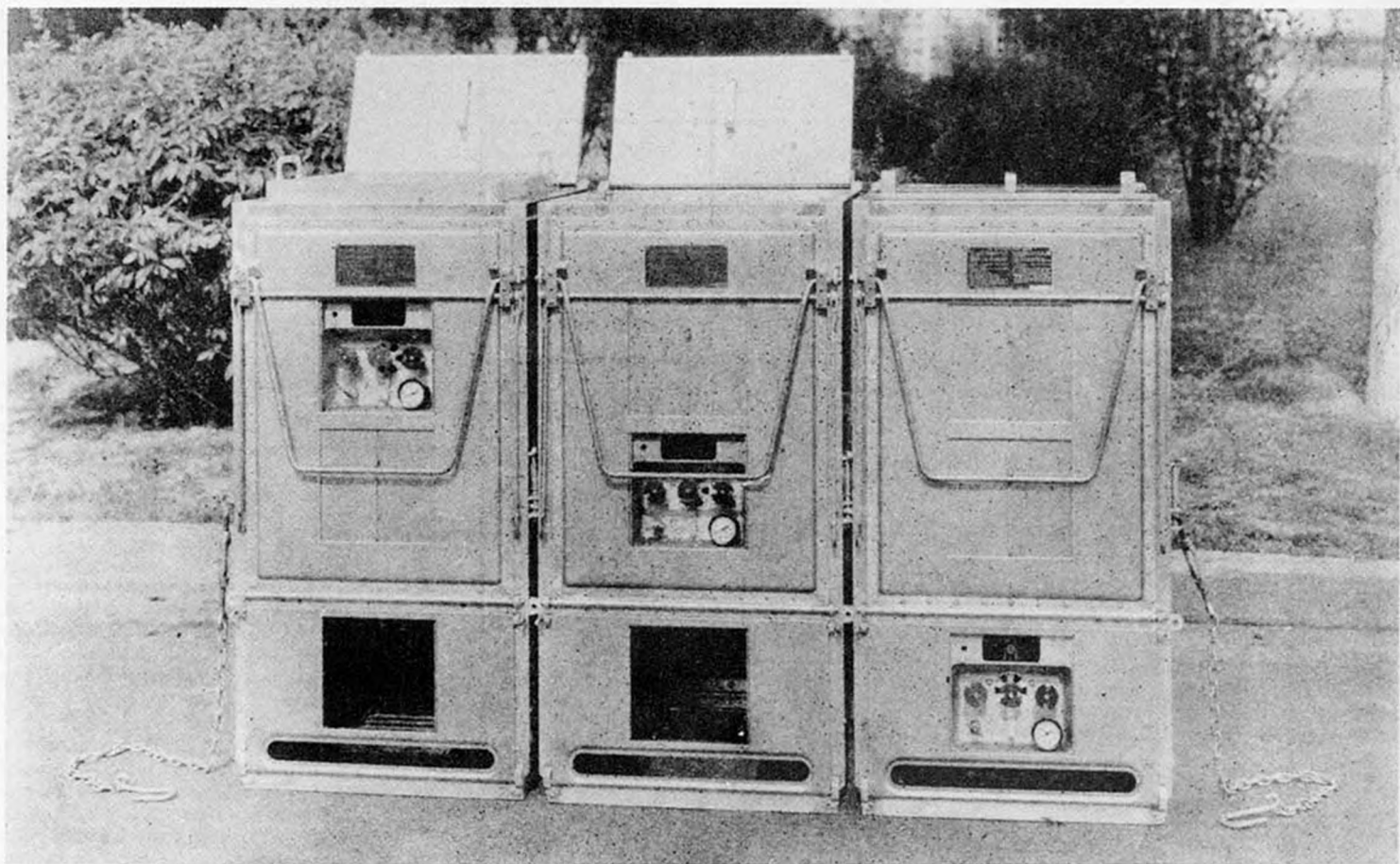
When any wire or cord is found you should follow it up, WITHOUT TOUCHING IT, to make certain that it is not connected to a trap. Any igniter which you find must be neutralized before any wires are cut or any unnecessary movement is made. If you cut a cord or wire, it should be done with scissors or pliers, not with a knife, so that no pull will be produced while cutting. If the wire or cord is stretched tight, it must not be cut, as that will detonate the mine. If you cannot easily neutralize a mine or trap, mark it to protect others until it can be dealt with by specially trained men.

NEUTRALIZING A TRAP

The first and most delicate operation is to find out where the trap is and how it is fired. Having discovered the charge, all igniters must be neutralized. Push and pull igniters have a safety device consisting of a metal key which passes through a hole in the stem. The last step in the placing of the mine is the removal of this key. When you have found the igniters, you must neutralize them by pushing a split pin or nail in this hole. Until this has been done you should exercise great care to avoid compressing the igniter in any way or pulling any wires or cords in the vicinity. Once split pins are in position you should unscrew the igniter from the charge. Do this with care, as a detonator may be in the igniter tube and, if so, it is liable to fall out. If you cannot unscrew the igniter by hand, leave it for a trained man. DO NOT ATTEMPT TO DISARM A MINE UNLESS YOUR MISSION DEMANDS IT.

GASOLINE FIELD RANGE

MODEL OF 1937



Three units of the range latched together for cooking in transport, showing the tie-chains for anchoring the range in a truck or railway car. The right hand unit is set up for boiling and roasting, the middle unit is set up for frying, and the left hand unit is set up for griddle cooking.

The Range, Field, M1937, a new responsibility of the Ordnance Department, so far as maintenance is concerned, was developed at Jeffersonville Quartermaster Depot. Although it is designed to use gasoline as a fuel for performing a variety of cooking operations, it is also provided with a collapsible grate which may be used for burning wood in emergencies.

The range is constructed in small units to make it suitable for small organizations, but these units may be combined for the use of larger units. One, two or three units may be installed across the front end of the 1-1/2-ton truck, opening toward the rear of the truck. If necessary, the fire unit may be operated outside the cabinet.

The fire unit produces a green flame at the burner surface without preheating the generator. It is intended to use either white or ethyl gasoline. Reports from the field, however, indicate that white gasoline has proven much more satisfactory than ethyl, the latter tending to clog the burners, as will be explained later.

The cabinet is made of aluminum angles for the frame, aluminum sheets for the outer shell, stainless steel sheets for the lining and stainless steel sheets for doors. All walls and doors have a closed air space between outer sheets and inner sheets for insulation. The cook pot cradle and all supporting rails are of soft steel. Steel rivets, hot tinned, are used to attach the parts together. The valve stems are made of stainless steel.

The cooking vessels for each unit of the range are an aluminum roasting pan with four lifting handles, holding ten gallons; a heavy aluminum roasting pan cover that may be turned over and used as a griddle; a cake pan that may be placed inside of the roasting pan; a heavy aluminum cook pot holding fifteen gallons, and an aluminum insert holding ten and one-half gallons.

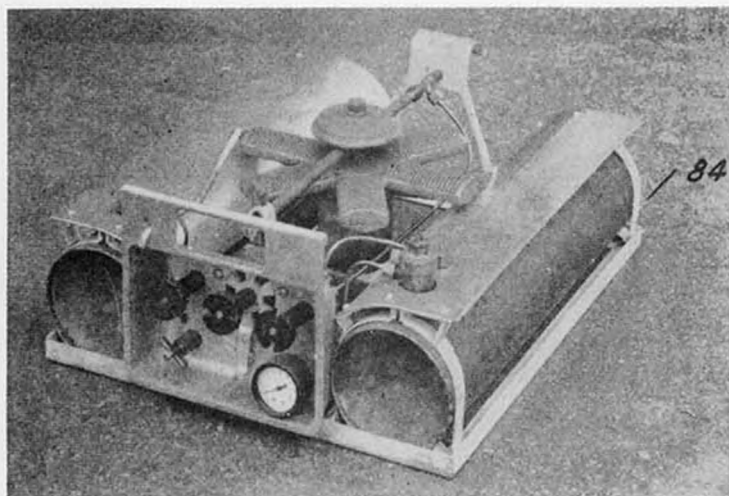
When the units of the range are installed in a truck they are attached together with the upper latching pins and are anchored to the truck body with tie-in chains.

The use of heavy valves, seamless copper silicon tubing with brazed connections, ground joint unions and steel parts throughout the generating system, makes failure of these parts unlikely when the fire unit is handled properly. The copper silicon alloy tanks are tested at two hundred and fifty pounds per square inch. The fuel output valve has an automatic shut off check that will close automatically if a break in the fuel line should occur.

The range will function equally well in moving vehicles or on the ground.

RECENT MANUFACTURE

In ranges produced since March 1, 1942, soft steel has been substituted for stainless steel and aluminum in the cabinets, and for stainless steel and copper silicon alloy sheets in the fire units.

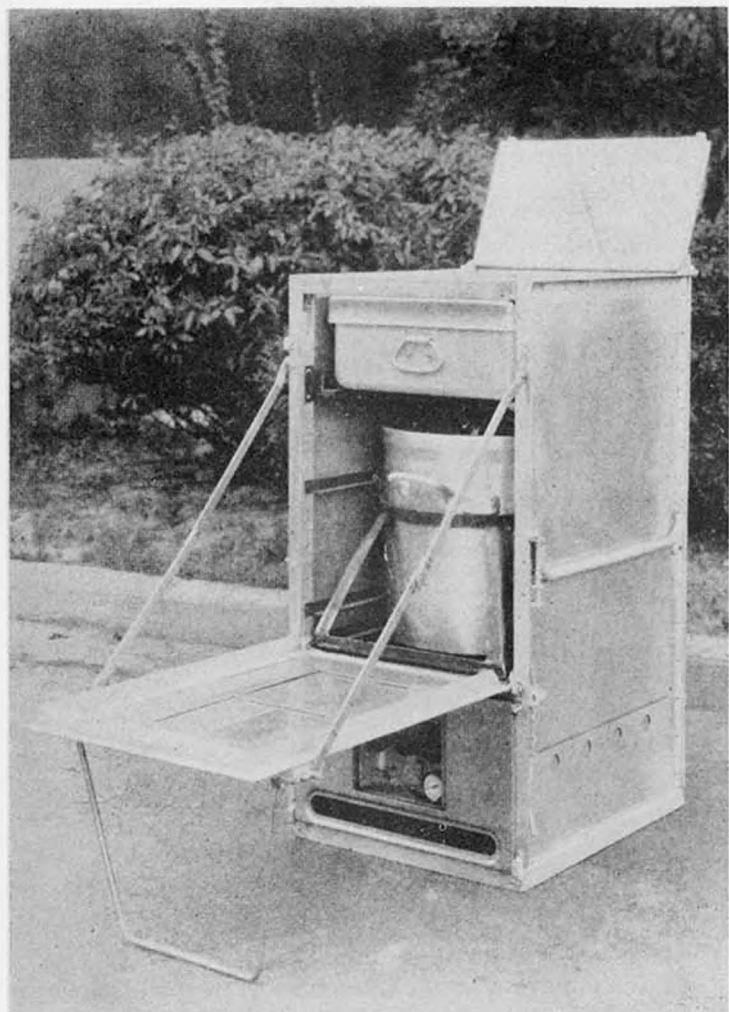


The gasoline fire unit

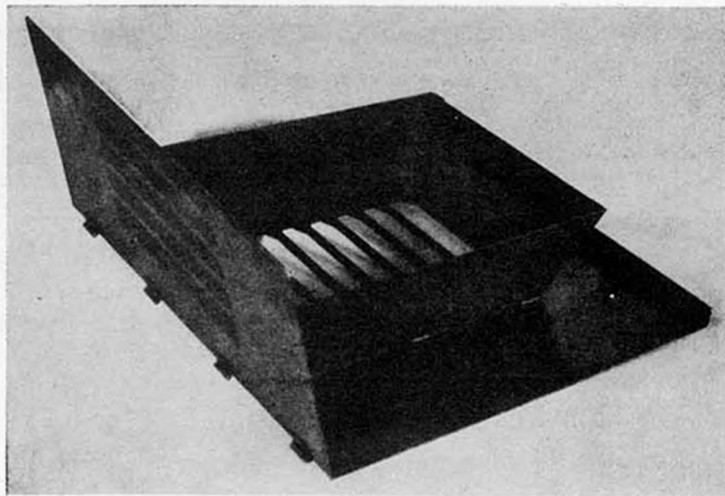
TO CLEAN THE FIRE UNIT

To get the proper performance from the fire unit it is necessary to keep the vital parts of it clean. This applies especially to the generator, the flame valve, the burner slots, and the mirror.

Clean the mirror with a wet rag. Do not use any scouring material on the mirror surface. Best results can be had with the fire unit when the proper type of flame is maintained. A clean mirror is essential to this control. KEEP THE MIRROR CLEAN.



One unit of the range with the cooking equipment in place



The wood burning grate set up for use

Clean the surfaces of the burner with the wire brush. If food particles have become lodged in the burner slots, clean the slots with the burner slot cleaner. KEEP THE BURNER SLOTS CLEAN.

The generator in this fire unit is operated at a temperature high enough to break down into solids the lead compounds in ethyl gasoline. The asbestos filter disc used in the generator removes most of the solids from the vaporized fuel, but there is a slow choking of the generator and flame valve passages by these solids when ethyl gasoline is used as a fuel. If the passages are allowed to choke tight the cleaning operation is extremely difficult. But if attended to at the proper intervals cleaning of the passages is very easy.

It is recommended that when ethyl gasoline is used a new filter disc be put in and the fuel jet be cleaned after each tank of gasoline has been burned, and that the generator passages be cleaned after each day of cooking operations.

If white gasoline is used less frequent cleaning will be required.

To put in a new filter disc —

Remove the filter case cap screw. Lift off the filter case cap and throw out the dirty filter disc. Remember that the dirty filter disc is charged with lead compounds. Dispose of it so as to prevent any chance of food contamination.

Clean the inside surfaces of the filter case with the wire brush and put a new filter disc into the filter case cap. Press it down firmly and be certain that both ground joint surfaces are entirely free from dirt particles. Put the cap back on the filter case body. Apply a small amount of graphite grease to the threads near the end of the filter case cap screw and to the surface of the copper gasket on the screw.

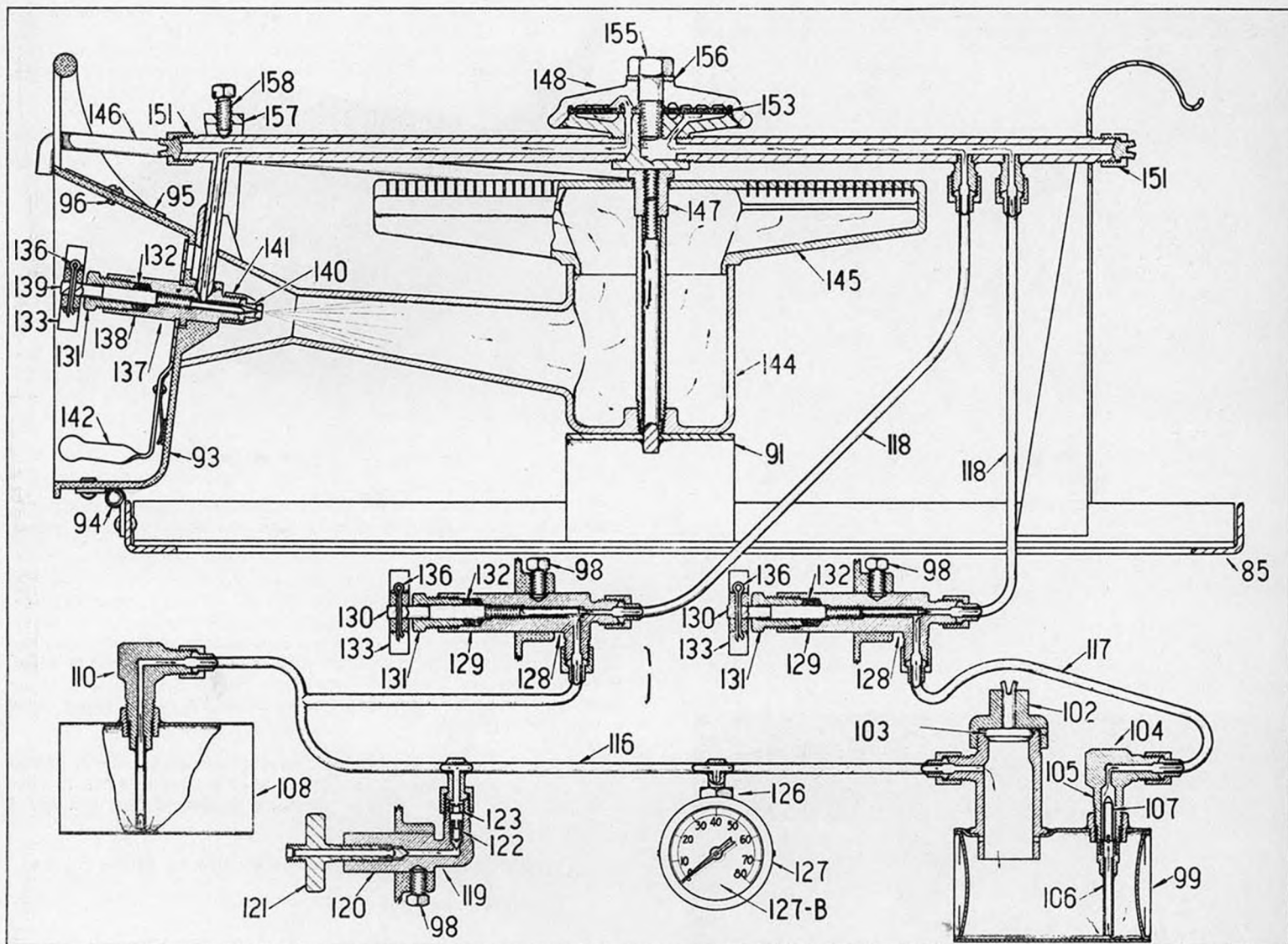
DO NOT PUT ANY GREASE IN THE GROUND JOINT OR ON THE ASBESTOS FILTER DISC.

Replace the filter case cap screw, pulling it down firmly with the wrench. Do not kick or drive this wrench to tighten the screw cap. Pull it down firmly with the hand only.

To clean the fuel jet and flame valve stem, loosen the generator yoke set screw and unhook the yoke. Raise the front end of the generator and pull out the flame valve. Take off the air shutter. Open the flame valve about one turn of the knob. Hold the flame valve body with the five-eighths-inch wrench and remove the flame valve nut with the nine-sixteenths-inch wrench. Remove the fuel jet from the nut and clean the jet with the jet reamer. Be certain that the reamer enters the jet clear up to the shoulder on the reamer. This will remove all dirt from the jet and will not enlarge the aperture.

Use only the jet reamer to clean the jet. Do not insert any tool or wire into the front end of the jet.

The flame valve stem should be cleaned once each day. If the stem needs cleaning perform this operation before replacing the jet. The packing



LIST OF PARTS

- | | | | | | |
|-----|---------------------------------|------|------------------------------------|-----|-------------------------------|
| 85 | Frame, fire unit | 118 | Tube, fuel or air, long | 138 | Body, flame valve |
| 93 | Panel, fire unit front | 119 | Valve, air input | 139 | Stem, flame valve |
| 94 | Hinge, fire unit front panel | 120 | Body, air input valve | 140 | Jet, fuel |
| 95 | Mirror, fire unit front panel | 121 | Stem, air input valve | 141 | Nut, flame valve |
| 96 | Screw, self tapping | 122 | Check, air input valve | 142 | Shutter, air |
| 98 | Screw, set | 123 | Retainer, air input valve check | 144 | Chamber, mixing |
| 99 | Tank, fuel | 126 | Elbow, air gauge | 145 | Burner, fire unit |
| 102 | Cap, fuel tank filler tube | 127 | Gauge, air pressure | 146 | Rod, burner control |
| 103 | Plug, fuel tank filler tube cap | 127B | Glass, air pressure gauge | 147 | Nut, burner |
| 104 | Valve, fuel output | 128 | Valve, (without knob), air or fuel | 148 | Generator |
| 105 | Body, fuel output valve | 129 | Body, air or fuel valve | 151 | Cap, generator tube |
| 106 | Tube, uptake | 130 | Stem, air or fuel valve | 155 | Screw, filter case cap |
| 107 | Check, fuel output valve | 131 | Gland, packing | 156 | Gasket, filter case cap screw |
| 108 | Tank, air | 132 | Packing, valve stem | 157 | Yoke |
| 110 | Elbow, air output | 133 | Knob, valve stem, air | 153 | Disc, filter |
| 117 | Tube, fuel, short | 136 | Pin, cotter | 158 | Screw, set |
| | | 137 | Valve (without knob), flame | | |

gland must be screwed out with the valve stem. Clean the valve stem with the wire brush. Be careful not to injure the point of the stem. Replace the stem and the gland, being certain the stem stays ahead of the gland so the gland will not lock against the shoulder on the stem. Pull the gland in moderately tight.

Place the jet on the point of the valve stem, and be certain the stem is backed out so the jet will seat tight against the valve body when the nut is tightened.

Tighten the flame valve nut moderately.

Replace the air shutter. See that the socket in the flame valve body is clean. Lift the front end of the generator and insert the flame valve, being sure that the small pin enters its slot in the front panel. Push the valve home and hold the generator down tight with the hand while

the yoke is hooked on and the set screw is run down with the fingers. Tighten the set screw very moderately with the set screw wrench.

If a leak occurs where the generator fits into the flame valve socket, it may be caused by dirt in the joint or by an injured surface. Clean the joint if dirt is the cause of the leak, and grind the parts together if a surface is injured.

Do not tighten the yoke screw excessively.

To clean the generator passages, loosen the filter case cap screw. With the five-eighths-inch wrench remove the generator tube caps and disconnect the fuel and air tubes at the rear end of the generator. Loosen the generator yoke screw and unhook the yoke. Lift out the generator and remove the filter case cap.

Under no conditions should the generator tubes be removed from the filter case body. Throw out the dirty filter case. Clean the filter case and the burner top with the wire brush.

Using the generator cleaner, clean all passages in the generator. Be sure that the cleaner reaches the bottom end of every generator passage. Remove all loose dirt from the passages after using the cleaner.

If this cleaning is done each day as directed no trouble will be experienced in getting the cleaner all the way in, but if cleaning is neglected until the passages choke tight it is very difficult to get the cleaner to reach the bottom of the passages.

After cleaning all passages, place the generator back in position, put in the flame valve, hook up and tighten the yoke. Replace the generator tube caps, being sure the surfaces are clean, and pull down moderately tight with the wrench.

Ordinarily no other parts of the fire unit need removing or cleaning.

The fuel and air tubes may be tested before connecting them to the generator by opening the fuel and air valves when there is pressure in the tanks.

If gasoline flows when the fuel valve is opened very slightly the fuel tubes are open. Note that if the fuel valve is opened very much the fuel output valve will close and the tube may appear choked. Open the fuel valve very slightly for this test.

Opening the air valve will cause a distinct outrush of air when the air tube is clear.

Remember that the air and fuel tubes contain only air or liquid gasoline and the danger of their choking is very remote.

Connect the air fuel tubes to the generator, being sure not to pull the nuts too tight. Insert a new disc and close the filter as described above.

Valve stem packings will need only infrequent replacing. The packing glands should be kept only tight enough to prevent leakage. Application of graphite grease to the valve stem bodies will keep them working free.

If a valve or the manifold needs to be removed from the front panel, the panel may be dropped forward by disconnecting the tubes and removing the mixing chamber screws.

Be certain that all parts of the fire unit that have been cleaned are free from dirt or sand before being reassembled.

GENERAL CARE

Handle the range cabinet carefully. There is little danger of breaking it, but the walls may be dented if it is treated roughly.

Spilled food and grease should be removed promptly. Cleaning may be done with Bon Ami and a rag, or with steel wool and gasoline or cleaning fluid.

Do not allow water to enter the fuel tank. A very small amount of water will stop the flame. Invert the fire unit to remove water from the fuel tank.

If the burner slots become choked with rust, it may be removed by pickling for a few minutes in a fifty percent solution of muriatic acid, used hot. Do not leave the burner in the pickling solution longer than is necessary to remove the rust. A burner with much widened slots should be replaced.

Apply graphite grease to the cook pot cradle rails occasionally.

Be certain not to leave the cook pot over the fire without water in the pot.

Protect the filter case ground joint. A dent in this part is very difficult to repair. Avoid dropping objects on the copper tubing.

Every fire unit has been tested under flame before being shipped.

The range is a piece of mechanical equipment that should be cared for and kept in good condition. Study it carefully and you will soon master the method of correct handling.

Use only the wrenches supplied with the range. Do not use pliers on any of the nuts.

Remember that gasoline is dangerous if spilled near the fire.

TROUBLES AND THEIR TREATMENT

A leak at the filter case ground joint, indicated by a yellow flame at the point of leakage, may be caused by an injured ground joint surface or by a loose cap screw.

Tighten a loose screw, though not excessively. Tapping the filter case cap right over a leak may stop a small leak. Re-grinding will be necessary when the ground joint surfaces have been injured. Grind only enough to reseal the joint.

Much trouble is caused by tightening the filter case cap screw too tight. If the ground joint surfaces are clean, moderate tightening is sufficient. Use the hand only on the wrench.

A leak at the flame valve socket may be caused by dirt in the socket, or by improper placing of the flame valve when the generator yoke is tightened. Be very careful to put the generator tube into its socket just right before the yoke screw is tightened. An injured socket joint may be repaired by grinding in with valve grinding compound.

Excessive tightening of the generator yoke screw may fracture the front panel.

Very moderate pressure will make this joint tight.

Unions on the tubing fittings should be set up moderately tight.

A yellow flame may be caused by dirt at the point of the flame valve stem. This may be removed by turning the valve stem back and forth while the flame is in operation.

If the flame valve jet is not cleaned frequently the opening will be reduced by dirt. This condition may be remedied by closing the flame valve tight and reopening. Keep the fuel jet clean.

A dirty filter disc reduces the passage of fuel through the disc, and is indicated by a weak flame. Replace the dirty filter disc.

If the passages in the filter case body and in the generator tubes are allowed to go too long without cleaning they will choke and stop the flame.

These passages are very difficult to clean if they are allowed to choke tight. Cleaning the passage once each day will prevent this trouble.

REPAIR TRAILER

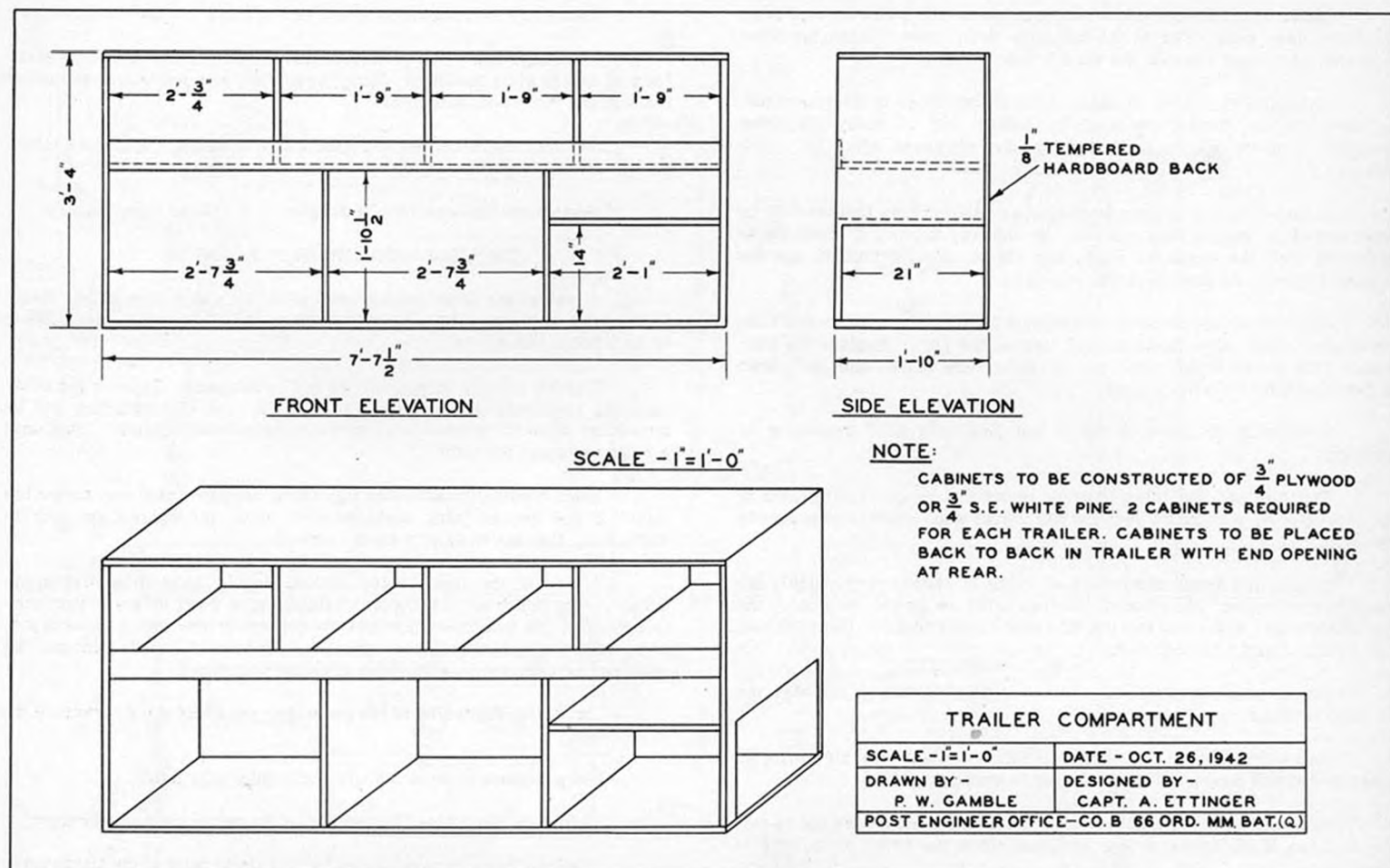
A mobile service unit for repairs and replacements on gasoline ranges, in the field, has recently been developed at Madison Barracks, New York, by Captain Arthur Ettinger, of Company B, 66th Ordnance Medium Maintenance Battalion (Q).

Two (2) cabinets, constructed of 3/4-inch plywood or other suitable material, are mounted back to back in a standard one-ton cargo trailer.

Overall dimensions of the cabinets are 7' 7-1/2" long, 1' 10" wide, and 3' 4" high. Hinged sides permit access to cabinet compartments from the sides of the trailer.

In addition to spare parts and tools, provision is made for carrying two complete range burners. Exchange of complete units will avoid delay when extensive repairs are necessary.

The trailer is attached to a weapons carrier, equipped with a work bench, vise, and an air compressor with long hose. Compressed air facilitates the testing of the various units.



Rear view showing mechanic making repairs using tail gate as a work bench

The stock of parts that this trailer is capable of carrying is sufficient to handle the number of ranges a crew of two (2) men can repair in several days.

The plans for construction of this equipment have been submitted to the Office of the Chief of Ordnance, and have there been deemed worthy of use by Ordnance units which may be interested. It is interesting to note that during recent maneuvers of the Second Army in Tennessee, observers reported that Ordnance organizations were being called upon to repair and overhaul large numbers of these ranges. Be ready for them when they reach your shop.

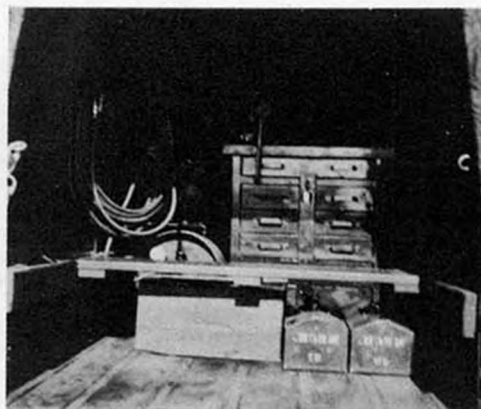
Instructions for the operation and care of this range, in the form of a booklet from which much of this article was extracted, are distributed by the Jeffersonville Quartermaster Depot, Jeffersonville, Indiana. The booklet also contains a list of parts which may be required to make repairs, showing part numbers, correct nomenclature, composition of groups of parts, etc.



Rear view showing storage compartments for two (2) complete burners



Left side



Interior view of setup in $\frac{1}{2}$ -ton weapon carrier



Right side

IT'S AN IDEA!

As proof that ideas which may prove helpful to Ordnance personnel may sometimes originate in non-Ordnance sources, the Editor offers an idea received recently from Lt. Alexander L. Mackintosh, Assistant Automotive Officer, Seventh Air Force, A.P.O. 953. Lt. Mackintosh, whose idea is illustrated on this page, writes:

"Not having read anything about adapting an assembly tent for the use of a repair shop for second, third, or fourth echelon work on vehicles, I am taking this opportunity to write about the success that we had in the 5th Bombardment Group (H) by the adaption of same.

"It was necessary for us to service about 110 vehicles in all categories. This was a pretty big and uncomfortable assignment, without adequate protection from sun, rain, wind, mud, etc.

"Therefore, I drew a regulation assembly tent from the Quartermaster, and had it erected. Then, by substituting three (3) eleven-foot poles in place of the regular side poles on one side, it was possible to raise the edge of the tent top so that a 2-1/2-ton GMC cargo truck, with canvas top in place, could be driven in with ease.

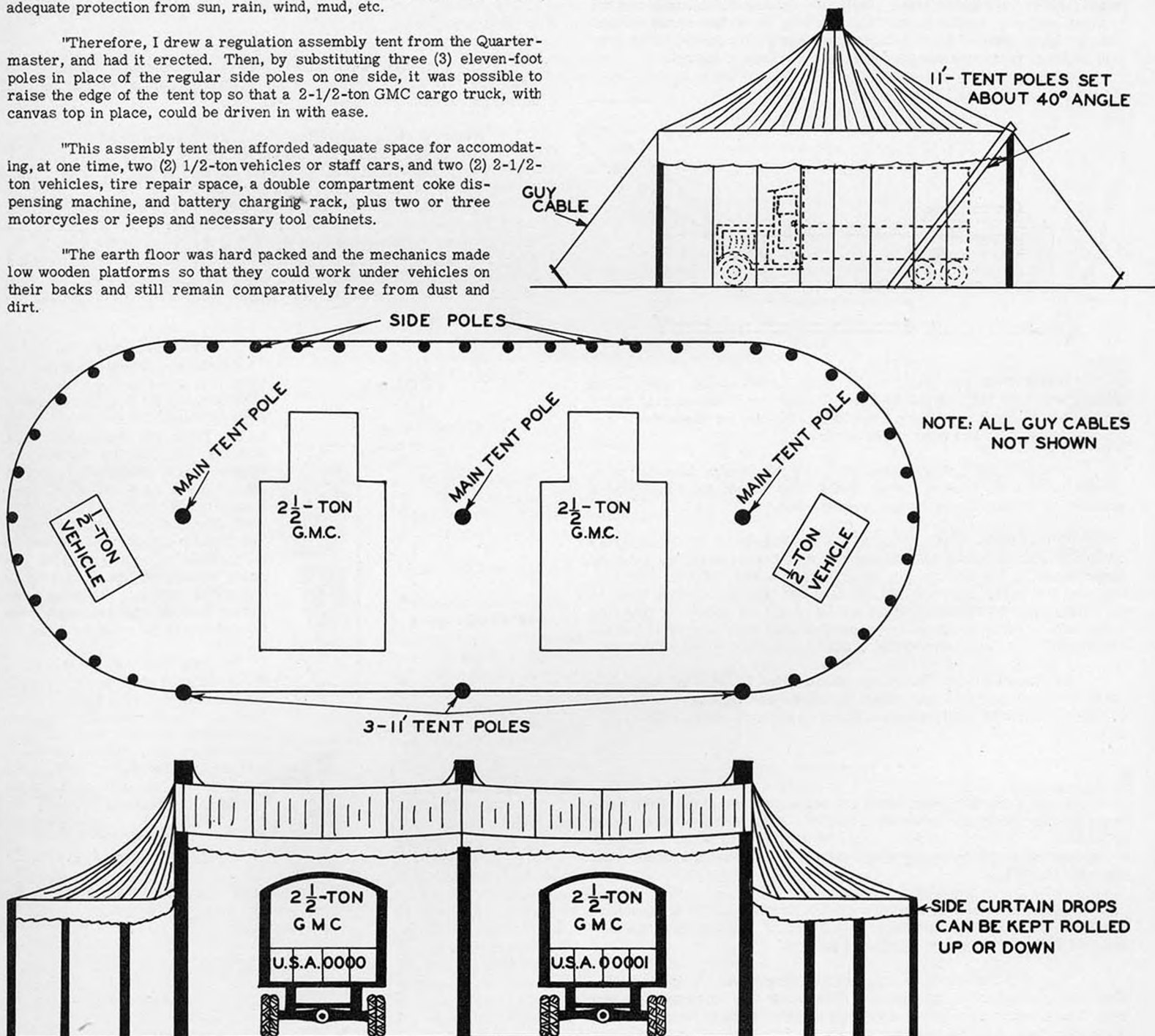
"This assembly tent then afforded adequate space for accomodating, at one time, two (2) 1/2-ton vehicles or staff cars, and two (2) 2-1/2-ton vehicles, tire repair space, a double compartment coke dispensing machine, and battery charging rack, plus two or three motorcycles or jeeps and necessary tool cabinets.

"The earth floor was hard packed and the mechanics made low wooden platforms so that they could work under vehicles on their backs and still remain comparatively free from dust and dirt.

"I am submitting this bit of information and attached drawing in the hope that you might see fit to publish it in THE ORDNANCE SERGEANT for the benefit of organizations that are "on the spot" for proper maintenance shop buildings.

"Even though our creation resembled a small two-ring circus tent, many compliments and expressions of envy were expressed. This adaption served us for three or four months in a highly satisfactory manner until a proper garage building was finally erected for our organization."

It may be possible that Ordnance organizations will find themselves in a similar spot, and this idea may offer a solution. Good fortune, how-

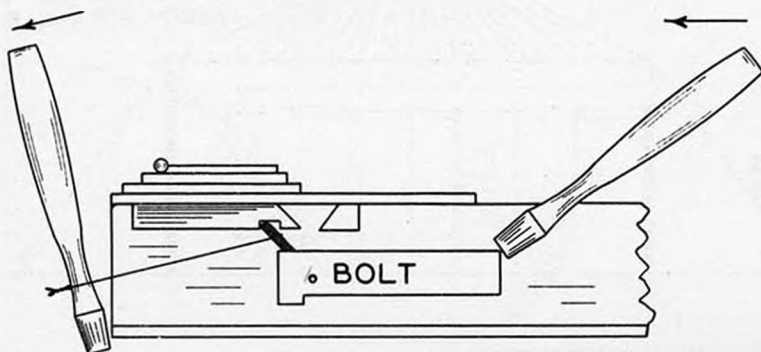


ever, may not always provide a hard packed ground surface. Straw, gravel, grass, or a number of things might be used to cover the ground if necessary, for almost any ground covering might be better than that afforded by a shop exposed to the elements.

Lt. Roy T. Huntington, of the Ordnance Office, Camp Pendleton, Virginia, has submitted a useful idea. He says that "recently a Browning Machine Gun, Cal. .50, M2, came into our shop for repair. Examination disclosed that the bolt had been inserted with the cocking lever pointing to the rear, and the cocking lever had become jammed in a recess in the top plate bracket, preventing movement of the bolt in either direction.

"We finally solved the difficulty with a simple expedient.

"With the back plate and recoil spring removed, a piece of steel piano wire about twenty inches long was inserted from the rear of the receiver, and worked around the cocking lever to form a loop, with the two ends of the wire protruding from the rear of the receiver. These ends were twisted together around a hammer handle so that a pull could be exerted on the cocking lever. Sufficient pressure was applied to the hammer handle to spring the tip of the cocking lever free of the recess. With the lever clear of the recess, the bolt was gently pushed to the rear with another hammer handle placed against the face of the bolt.



"Aside from two small burrs which were easily removed, no damage was done to the parts involved. Comparison of the cocking lever, with a new one from our stock, revealed no bending or distortion. The gun was assembled and returned to service.

"It was found that soft steel wire of small enough diameter to be passed around the cocking lever would snap under the considerable pressure necessary to spring the cocking lever."

Commenting on this idea, Lt. Joe W. Simpson, of the Small Arms Section of The Ordnance School, remarked that some difficulty had been experienced by his section with the bolt of the Cal. .50, M2 Browning Machine Gun being inserted into the receiver with the cocking lever to the rear, thereby becoming jammed. It might be expected that this might happen often in classes composed of men with somewhat limited experience. Men who learn by doing often learn also by misdoing.

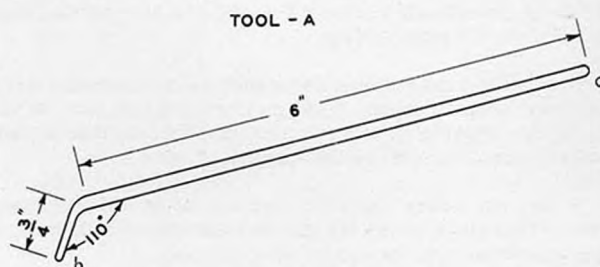
Lt. Simpson adds, "The idea submitted by Lt. Huntington is very good, in that it is simple and effective. Many methods have been tried by this section with vary degrees of success, but none were as good as this."

From Tech. 4th Grade Steve Schultz, a member of the 858th Ordnance Service Company stationed at Kearns, Utah, comes another small arms idea. Schultz has made a couple of simple tools which he uses in the disassembly of the recoil spring from the Thompson Submachine Gun, Cal. .45, M1928A1.

Tool A is made from a steel rod 6-3/4" in length, 3/16" in diameter. The b end of the rod is cut down to less than 1/8" in diameter for a distance of 3/4", and is bent to a 110° angle.

Tool B is made from a steel rod 6" in length and 1/4" in diameter. The c end of the tool is flattened to 1/2" in width for approximately one inch. The d end is also flattened slightly in order to have three (3) small holes into the rod to pin it to the handle. In this case a 3-inch piece of

broom handle was used. A hole 1/4" in diameter was drilled into one or the ends of the handle for 2-1/2". The d end of the rod was inserted. Three (3) holes were drilled into the side of the handle and aligned with the three (3) holes in the rod. (Holes in the handle are the same size as those in the rod.) Three (3) pins were made and driven into place to hold the handle and rod together. (Pins were made from 8-penny nails.) The c end of the rod has a rounded slot 3/8" in width and 5/16" in depth cut out by a round file. The length of the tool is 6-1/2".

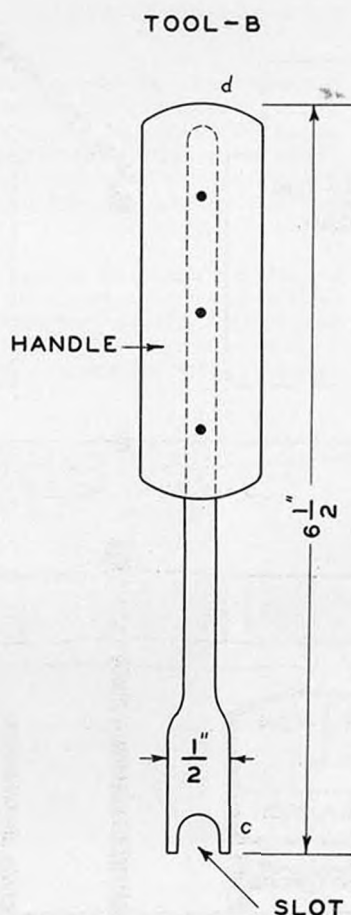


The purpose of these tools is to save recoil springs. They prevent wear and tear in the process of disassembling during instruction, and during actual repair of these weapons.

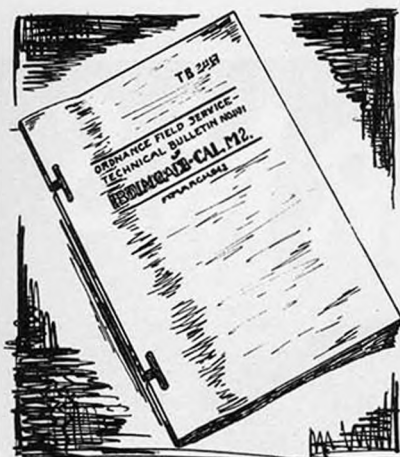
When the stock and frame groups are removed from the receiver the recoil spring, buffer pilot and buffer disc next have to be removed. Place the slotted end of tool B between the coil of the recoil spring at the far end of the buffer pilot, draw back on the tool and compress the recoil spring against the rear of the buffer pilot. Insert the b end of tool A into the hole at the forward end of the buffer pilot. If need be, the same process can be repeated, compressing the recoil spring even more. When removing the recoil spring, buffer pilot, and buffer disc from the receiver, leave tool A in place until these parts are removed. Thus this becomes a simple operation with simple tools made at practically no cost.

The Small Arms Section of The Ordnance School does not believe it is necessary to make up any special tools for use in disassembling or assembling the recoil spring in the Thompson Submachine Gun, pointing out that "by forcing the spring against the buffer pilot with the fingers of one hand, and inserting a small drift punch into the hole in the buffer pilot, holding the spring in this slightly compressed position, it is possible to easily remove the group without bending or stretching the recoil spring. The same procedure may be used to reassemble the group into the receiver."

Take your choice, readers. It's an idea, anyway, and something to think about. What ideas do you develop in your thinking? Maybe you uncover an idea now and then which helps you. If so, the same idea would help others. Let's have them, so we can pass them on to thousands of Ordnance readers.



DEPTH OF SLOT - $\frac{5}{16}$ "
WIDTH OF SLOT - $\frac{3}{8}$ "



Ordnance Field Service
Technical Bulletin

War Department,
Ordnance Office
Washington

GUN, AUTOMATIC, 20MM, M1;
LOOSENING OF BUSHING
IN REAR BUFFER HOUSING

1. Bushing (A25562) has been found to work loose in the rear buffer housings of 20mm automatic guns, M1. The existence of this defect will not impair the functioning of the gun but will make it difficult to disengage the rear buffer housing plunger from the receiver when removing the buffer group. When a loose bushing is encountered, it should be tack welded to the housing.

2. This information is published pending revision of and publication of:

By order of the Chief of Ordnance:

H. R. KUTZ
Brig. General, Ordnance Department
Chief of Field Service



FSMW0 A47-W1,
ORDNANCE DEPARTMENT,
Washington, 1942.

FIELD SERVICE MODIFICATION WORK ORDER

1. Major Item Affected:

Name	SNL	TM
Gun, Automatic, 20MM, M1 & M2	A-47	9-227

2. Part Modified:

Name	Drg. (dated)	SNL
MECHANISM, feed, 20MM, M1		
Right Hand	D36371 6/27/42	A-47
Left Hand	D36370 6/27/42	A-47

a. New design or modified part:

Name	Drg. (dated)	SNL
HUB, R. H., assembly	A207169 7/29/42	A-47
HUB, L. H., assembly	A207170 7/29/42	A-47
SHAFT AND BUSHING, assembly	B163916 7/29/42	A-47

NOTE: The following drawings have been superseded by the drawings listed above:

Drawing No.	
B163516A	by A207169
B163516B	by A207170
B163523	by B163916

3. Purpose of Modification: To install self-lubricating type bushings to prevent binding of the shaft in bearings.

4. Drawings Required to Apply Modification: None.

5. Parts Affected by Modification:

- a. New parts required: None.
b. Replacement parts required: None.
c. Substitute parts required:

Name	Pc. Mk. or Drg. No.	Qty.
For Right Hand Feed		
HUB, R. H., assembly	A207169	1
SHAFT and BUSHING, assembly	B163916	1
For Left Hand Feed		
HUB, L. H., assembly	A207170	1
SHAFT and BUSHING, assembly	B163916	1
d. Discarded parts:		
Name	Pc. Mk. Or Drg. No.	Qty.
Right Hand Feed		
Hub	B163516A	1
Shaft	B163523	1
Left Hand Feed		
Hub	B163516B	1
Shaft	B163523	1

e. Procurement of parts required:

- (1) Where procured: Chicago Flexible Shaft Co. and/or Hurley Machine Division
(2) Date available: Now.

6. Special Tools, Jigs and Fixtures: None.

7. Special Instructions:

- a. Applied by: Ordnance Machinist.
b. Time required: 1 hour
c. Procedure of operation:
(1) Disassembly and assembly of the feed mechanism is covered in TM 9-227.
(2) In the righthand feed replace hub B163516A with hub assembly A207169. In the lefthand feed replace hub B163516B with hub assembly A207170.

- (3) Replace shaft B163523 with shaft assembly B163916 in both feeds.
(4) The key A25942 should be shortened to 4.82 inches.

d. Arsenal or field operation: Field

e. Comment with reference to published FSMWO's: None.

f. Disposal of discarded parts:

- (1) Shafts B163523 will be returned to Watervliet Arsenal for reworking.
(2) Hubs B163516A and B163516B will be scrapped.

g. This Work Order is to be completed by December 1, 1942. If it is not complete by this date, it will be reported to the Office of the

Chief of Ordnance, Attention of the Field Service, Maintenance Branch, Small Arms Section, with a satisfactory reason for delay.

8. Remarks: This Work Order pertains to the following feed mechanisms:

Mechanisms manufactured by Chicago Flexible Shaft Company:

Right Hand - Nos. 1 - 1823 inclusive.

Left Hand - Nos. 1 - 1821 inclusive.

Mechanisms manufactured by Hurley Machine Division of Electrical Utilities Corporation:

Right hand - Nos. 101, 103, 104, 105, 106, 109, 110, 112, 113, 114, 115, 117, 120, 121, 122, 123, 128, 130, 131, 135, 138, 139, 140, 141, 143, 144, 145, 146, 148, 149, 150, 151, 152, 153, 157, 159, 162, 164, 168, 176, 177, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 191, 193, 194, 196, 197, 198, 199, 200, 201, 203, 204, 209, 210, 211, 212, 213, 214, 216, 217, 220, 221, 222, 223, 225, 229, 230, 232, 233, 236, 240, 241, 242, 245, 247, 248, 249, 252, 253, 255, 256, 257, 258, 259, 260, 261, 262, 264, 265, 267, 268, 269, 270, 271, 272, 273, 274, 275, 277, 278, 279, 280, 284, 286, 287, 288, 290, 292, 293, 296, 297, 298, 299, 301, 302, 304, 305, 306, 308, 312, 313, 314, 315, 323, 328, 331, 332, 333, 334, 336, 338, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 461, 484, 485, 487, 488, 489 and 491.

Left hand - Nos. 102, 103, 105, 109, 111, 112, 113, 114, 116, 117, 118, 120, 124, 126, 129, 132, 136, 139, 141, 142, 143, 144, 145, 147, 149, 152, 156, 157, 159, 161, 162, 169, 170, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 196, 197, 199, 201, 203, 204, 205, 206, 207, 209, 210, 212, 213, 214, 215, 217, 220, 225, 226, 229, 231, 232, 233, 234, 235, 238, 239, 240, 241, 242, 244, 246, 248, 249, 250, 251, 253, 255, 259, 261, 262, 263, 265, 266, 268, 269, 270, 271, 274, 276, 277, 278, 280, 282, 289, 290, 291, 292, 293, 294, 295, 311, 312, 314, 320, 322, 324, 325, 326, 327, 328, 329, 332, 333, 338, 339, 340, 341, 342, 343, 348, 349, 361, 430, 431, 432, 433, 434, 435, and 323.

Total: 1,971 Right Hand Mechanisms
1,967 Left Hand Mechanisms

9. Date Approved for Publication:

BY ORDER OF THE CHIEF OF ORDNANCE:

H. R. KUTZ
Brig. Gen., Ordnance Department
Chief of Field Service

FSMW0 B3-W8
ORDNANCE DEPARTMENT,
Washington, 1942

FIELD SERVICE MODIFICATION WORK ORDER

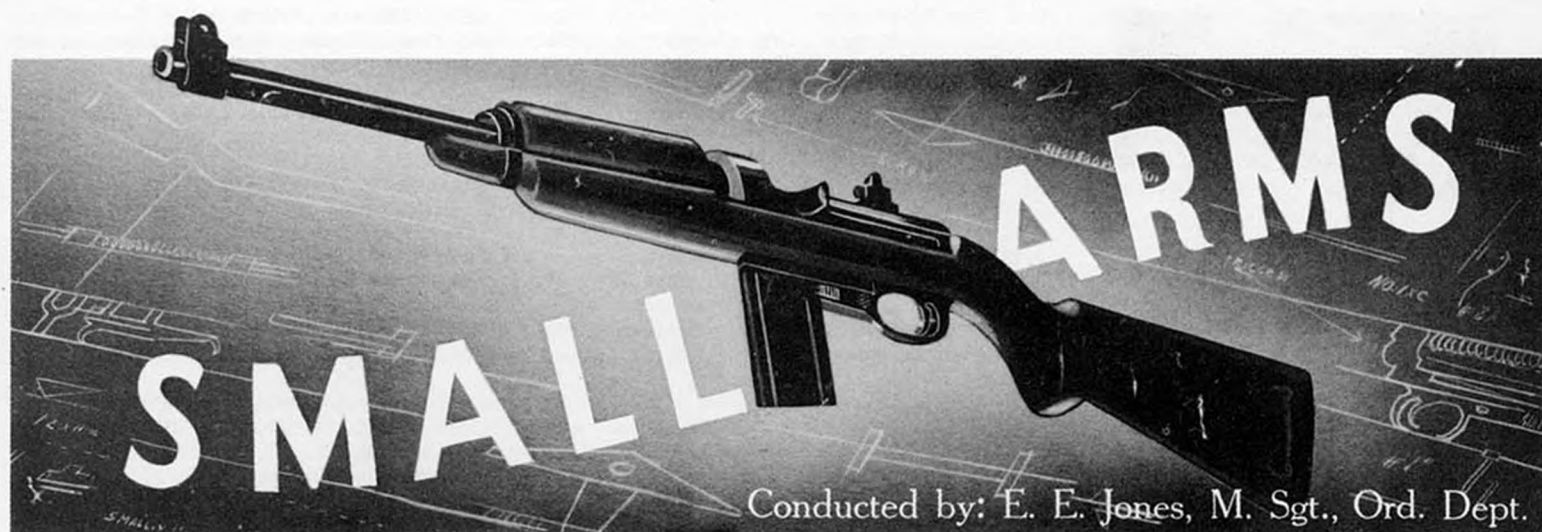
1. Major Item Affected:

Name	SNL	TM
RIFLE, U. S., Cal..30, M1903	B-3	9-1270

2. Part Modified:

Name	Drg. (dated)	SNL
Bolt Group	-- --	B-3

(Continued on page 597)



Conducted by: E. E. Jones, M. Sgt., Ord. Dept.

Vickers Machine GUN, Caliber .303, Model of 1915

by Pvt. CHARLES E. DU CHARME, Ord. Dept.

Part III

CAUSE, EFFECT AND REMEDY OF MALFUNCTIONS

MALFUNCTIONS

Malfunctions cause uncontrolled fire, resulting in the gunner's inability to cease fire in the normal manner, creating a hazard that endangers the lives of friendly troops, particularly those advancing under the protection of a barrage. Immediate action is imperative.

Other malfunctions cause unintentional cessation of fire which create a hazard that involves the loss of life and of advantage, the latter by permitting enemy advances resulting in the capture of personnel and the taking of armament, ammunition and terrain. Immediate action, in this case, is equally imperative.

Malfunctions are, largely, attributable to lack of proper care and handling, mechanical causes which are likely to occur in any piece of mechanism and to faulty ammunition. The first of these can be avoided, the second reduced with proper attention to the first, and the third is, perhaps, inevitable under war time production conditions and, in any event, beyond control in the field.

When such stoppages occur, and the necessity for quick action arises, the nature of the malfunction to be dealt with is generally indicated by the position of the handle.

1. If the weapon stops with the handle close to the dead stop MISFIRE is indicated. THE CAUSE: (a) bad primer; (b) broken firing pin; (c) weak or broken main spring; (d) dirty lock. THE REMEDY: Turn the handle over once, pull the belt once and resume firing. If the weapon continues to misfire, change lock, load and resume firing.

NOTE: When a temporary stoppage necessitates the employment of the spare lock, or feed box, repair the one replaced at the first opportunity to assure its being available, in working condition in reserve.

2. If the handle is vertical INCOMPLETE RECOIL ACTION is indicated. THE CAUSE: (a) light charge, (b) recoil spring too strong, (d) broken gib or gib spring. THE REMEDY: Help the handle over, release it to return, resume firing. If the stop recurs in a few rounds, help the handle over and release it to return. Then ease the tension of the recoil spring with three turns of the tension screw and resume firing. If on assisting the handle over it returns to the vertical position, instead of to the dead stop, change the lock, load and fire.

3. If the handle is at an angle of forty-five degrees a RUPTURED CARTRIDGE is indicated. THE CAUSE: (a) broken cartridge case, (b) damaged cartridge. THE REMEDY: Raise the rear cover, draw back the lock; if the broken case is on the next round clear the carrier, load and fire. If the broken case is not on the next round, insert the defective cartridge extractor, in place of the next round, press it home with the lock, draw the lock to the rear, remove the defective cartridge extractor with the obstruction, load and resume firing.

4. If the weapon stops firing with the handle nearly down — RECOILING PARTS HOME — INCOMPLETE COUNTER-RECOIL ACTION is indicated. CAUSE: (a) recoil spring too weak. (b) a thick rimmed cartridge. REMEDY: strike the handle downward; if it goes strengthen the recoil spring three turns, if the handle will not go down, raise the front cover, press down the carrier, draw back the lock, remove the thick rimmed cartridge, load and fire.

NOTE: A succession of stops with the handle nearly down can result from insufficient head space. However, it is assumed here that the head space was checked and found to be correct, or was corrected, before firing was begun.

CAUTION: Striking the handle downward should be performed by striking a glancing blow with the heel of the palm, rather than by direct pressure, to avoid injury to the hand should the weapon fire accidentally.

5. Should the weapon stop firing with the handle nearly down — RECOILING PARTS NOT HOME — FAILURE TO FEED is indicated. CAUSE: (a) incorrectly loaded belt. (b) loose

bullet left in the belt. REMEDY: turn handle to vertical position, hold knob in left hand and the tail of the handle in the right hand, draw back the recoiling parts and "hang the lock", press upon upper and bottom feed box pawls and withdraw belt, then allow the recoil parts to go forward. Reload and fire.

6. If the weapon fires prematurely FAULTY ACTION OF THE SAFETY SEAR is indicated. CAUSE: (a) a badly worn or damaged tumbler can reduce the movement of the firing pin so that it is not drawn back sufficiently to be held by the safety sear. (b) the projection, or bent, on the firing pin may be so worn or damaged that the safety sear can not retain it.

NOTE: A firing pin can be broken through the faulty action of a worn or damaged safety sear allowing the firing pin to go forward before the carrier is fully up.

REMEDY: Open the rear cover, slowly operate the mechanism by hand several times, at the same time observing the action of the safety sear. When the lock is being withdrawn a distinct "click" will be heard as the firing pin is engaged by the safety sear. The "click" will be repeated when it is being released, just as the roller handle comes to rest on the dead stop.

CAUTION: Care must be taken to see that the carrier is in its highest position, should it ever be necessary to release the main spring while the lock is out of the weapon, otherwise the firing pin may be damaged if released in any other position other than opposite the firing pin hole in the carrier.

If, when the rear cover is opened to ascertain the cause of an unintentional cessation of fire, it is seen that the carrier is not completely up, no attempt should be made to raise it. It should, on the contrary, be pushed down. If necessary a small screw driver may be used to clear the gib, while the roller handle is turned down to draw back the lock. Thus, danger of firing the cartridge accidentally while the cover is open is avoided.

WARNING: Keep fingers away from the tail of the tumbler when the lock is fired, to avoid injury.

DISASSEMBLING AND REASSEMBLING

TO STRIP GUN

REMOVE:

Locking pin of muzzle attachment.
Muzzle attachment sleeve with front disc and cap.

UNSCREW:

Barrel disc (with combined spanner).
Follower.

RAISE:

Front cover and remove feed box.
Rear cover and remove lock.

REMOVE:

Recoil spring box with recoil spring.
"T" pin and turn down handle block.

outer steam tube, does not work freely. Make certain, when replacing it, that the steam tube plug enters the steam tube socket in the trunnion block. The steam tube socket is visible when the water plug group is removed. And make certain that the front plug screw is replaced.)

TO ASSEMBLE GUN

ATTACH:

Right recoil plate barrel.
Left recoil plate to barrel.

INSERT:

Fuzee which must be pushed home and turned slightly to lock. It is impossible to incorrectly insert the fuzee.
Barrel, with recoil plates, in gun.

REPLACE:

Feed box.

CLOSE:

Front cover.

REPLACE:

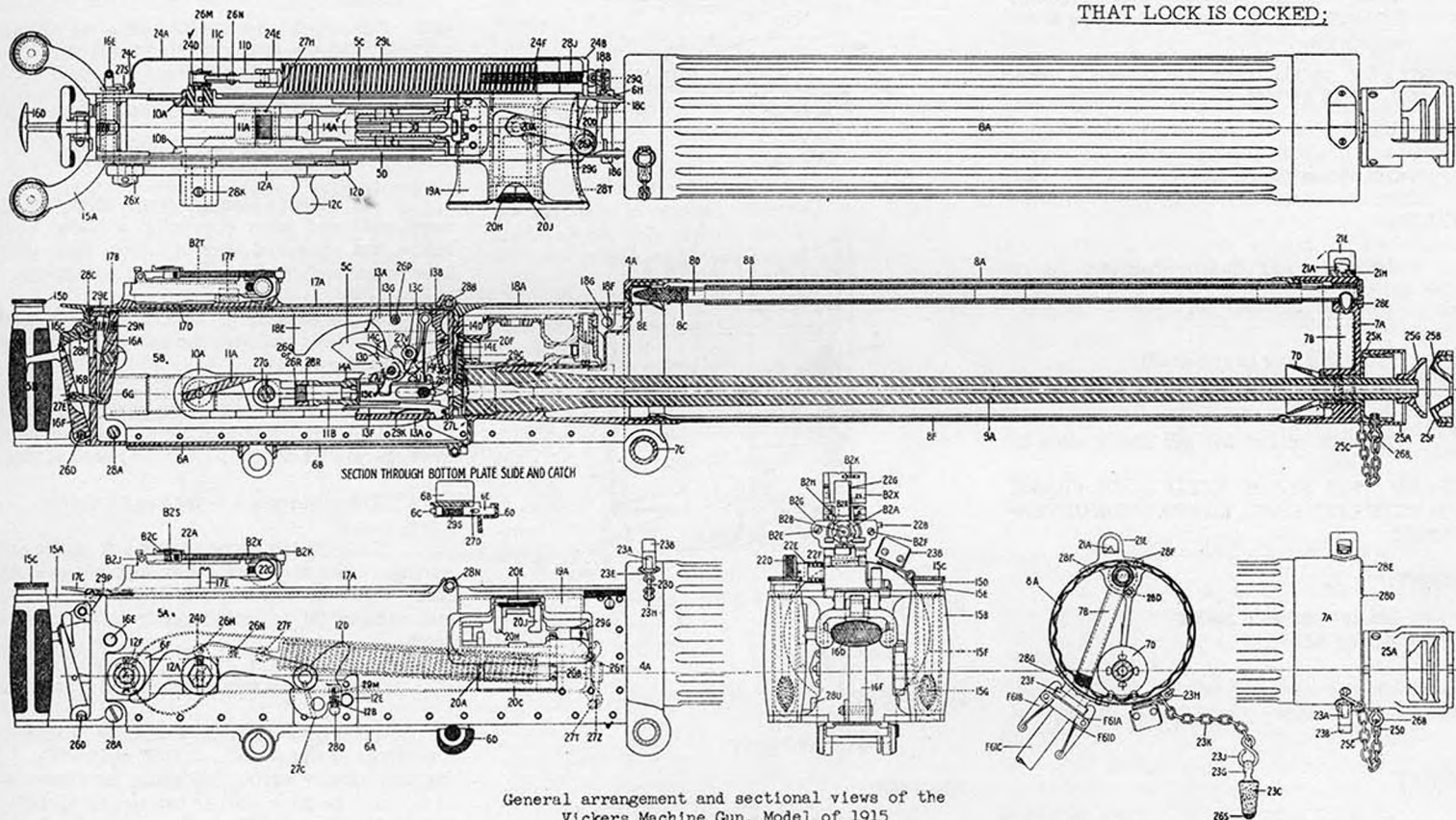
Follower and barrel disc, screw tight.
Muzzle attachment sleeve, with front disc and front disc cap.
Locking pin of muzzle attachment.

COMMENT: It is essential that the follower, barrel disc and front disc are tightly screwed in at all times. They are liable to work loose, during firing, and become damaged. Screw these parts as tightly as possible by hand, using a spanner wrench, then give the spanner a final tap with a lead hammer.

TO STRIP LOCK

ASCERTAIN:

THAT LOCK IS COCKED:



General arrangement and sectional views of the
Vickers Machine Gun, Model of 1915

WITHDRAW:

Roller bracket and left filling pieces.
Recoil plates with barrel.

DETACH:

Fuzee and recoil plates.

DO NOT

DETACH: Roller handle from crank.

REMOVE:

Dead stop.
Bottom slide.
Front or rear cover.
Front cover catch.
Handle block.
Steam tube (Unless the slide valve, or

REPLACE:

Roller bracket and left filling piece.

CLOSE:

Handle block and secure with "T" pin.

REPLACE:

Recoil spring box with recoil spring.
Lock.

CLOSE:

Rear cover.

PRESS OUT:

Side levers pin and bushing.

REMOVE:

Side levers.

DETACH:

Lifting levers.

SLIDE OFF:

Carriers.

DEPRESS:

Safety sear and fire lock.
(KEEP HAND CLEAR OF THE FIRING
PIN HOLE AND FINGERS CLEAR OF
TUMBLER.)

PRESS OUT:

Tumbler pin.

REMOVE:

Tumbler.

PRESS OUT:

Hand sear pin.

REMOVE:

Hand sear and main spring.

DEPRESS:

Safety sear and allow firing pin to drop out.

UNHOOK:

Safety sear and remove it with its spring. DONOT separate safety sear spring from safety sear.

COMMENT: The safety sear pin is not a removable part, being riveted to the lock frame.

PUSH OUT:

Gib spring plate.

REMOVE:

Gib spring and gib from carrier.

TO ASSEMBLE LOCK

(No tool is required)

REPLACE:

Gib, gib spring and gib spring plate in carrier.

FROM THIS STAGE; HOLD LOCK FRAME FLAT IN LEFT HAND, KEYWAY SIDE UPPERMOST.

INSERT:

Safety sear with spring.
Firing pin.

PLACE:

Tumbler.

INSERT:

Tumbler pin.

SLIDE ON:

Carrier. (Firing pin being in cocked position.)

PUT ON:

Lifting levers.
Side levers.

SECURE WITH:

Side levers bushing and side levers pin.

(WITH FIRING PIN FORWARD, IN FIRED POSITION:)

INSERT:

Main spring by pushing it into place.

FULL COCK:

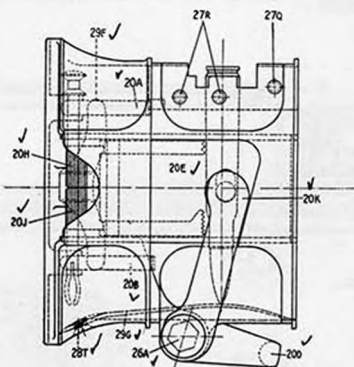
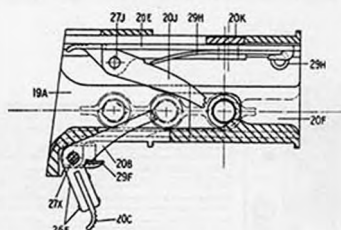
Lock.

NOTE: Should the key pin in the tumbler pin be broken, the tumbler pin may be used temporarily until a new one is available, by filing off the broken ends of the key pin so as to prevent any damage to the hole in the lock frame.

TO STRIP FEED BOX

NOTE: The feed box, being readily accessible for cleaning and oiling, should not be stripped unless repairs and replacements necessitates it. After the feed box has had considerable service the bullet guide spring may require adjustment or replacement. To remove it, take out the bullet guide spring screw and slide the spring out of its dovetailed slot.

VICKERS MACHINE GUN
MODEL OF 1915
FEED BOX



PUSH OUT:

Lever pin.

DRIVE OFF:

Lower feed lever.

REMOVE:

Upper feed lever.

DRAW OUT:

Feed box slide.

UNHOOK:

Top pawls from slide.

REMOVE:

Top pawl spring.

DRAW OUT:

Bottom pawls pin.

REMOVE:

Bottom pawls.
Bottom pawls spring.

DO NOT REMOVE BULLET GUIDE SPRING, EXCEPT FOR REPAIR, ADJUSTMENT OR REPLACEMENT.

TO ASSEMBLE FEED BOX

PLACE:

Bottom pawls.
Bottom pawls spring.

INSERT:

Bottom pawls pin.
Top pawls on feed box slide.
Feed box slide.

PLACE:

Upper and lower levers and drive home.

INSERT:

Lever pin.

NOTE: Cartridges of maximum length may project slightly from the feed box, but will not affect the functioning of the weapon.

HEAD SPACE ADJUSTMENTTO ADJUST HEAD SPACE

All Vickers Machine Guns, when issued, work well and have correctly adjusted head space, but wear and tear of firing may alter head space and render adjustment necessary.

A succession of broken or separated cartridge cases indicates the necessity of taking up the head space.

Frequent stops with the handle not quite down on the dead stop indicates either too tight head space, or lack of tension in the recoil spring.

The adjustment is made as follows:

Take off the recoil spring box and recoil spring. Open the rear cover and remove the lock. With the combination spanner, unscrew and remove the adjusting nut from the cross-head.

In case of the first malfunction described:

Insert the suitable washer or washers. Two sizes are provided003" and .005" . . . , the thin washer having one small hole punched in it while the thick washer has two small holes punched in it, to facilitate size determination.

In case of the second malfunction:

Assuming that the tension of the recoil spring is sufficient, the removal of a washer, or washers, is necessary.

Replace lock keeping it in its rear position and, in the absence of a head space gauge, test as follows:

Push carrier to its highest position against the stop on the lock frame and place a dummy cartridge in the carrier grooves opposite the firing pin hole. With the barrel home, turn the roller handle slowly over on to the dead stop, guiding the dummy cartridge into the chamber.

If the correct head space has been obtained a slight check will be felt as the roller

handle comes to rest on the dead stop. When correct head space has been obtained remove the dummy cartridge and replace the recoil spring box with the recoil spring.

NOTE: When ascertaining the thickness of the washer required to be added, do not, at first, remove the adjusting nut. Place the washer, or washers, on the cross-head, between the adjusting nut and the face of the side levers. When the correct adjustment of head space has been determined, unscrew the adjusting nut, place the washers in their correct positions and replace the adjusting nut, screwing it tight with the spanner wrench.

RENEWAL OF PACKING

TO RENEW PACKING

(At breech end of barrel)

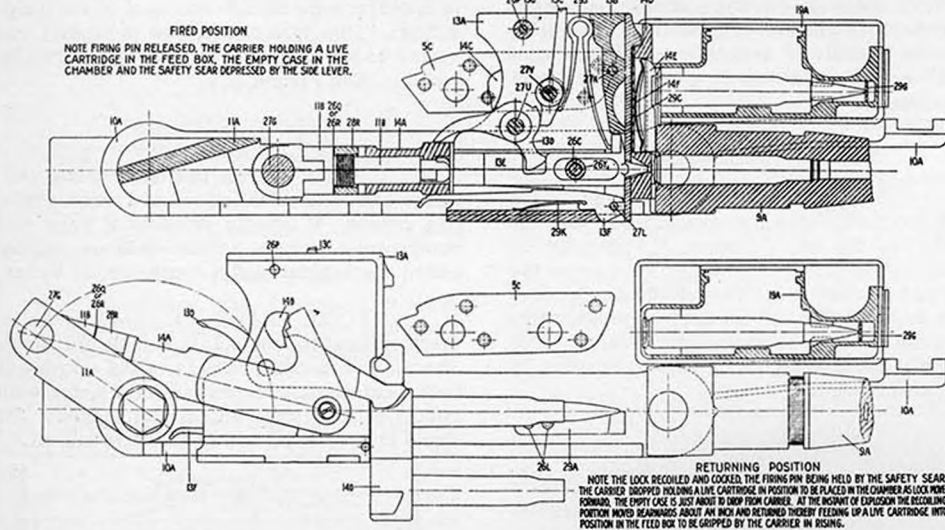
Lubricate approximately fourteen inches of heavy asbestos and wind it around, in the cannellure of the barrel, pressing it together with a thin piece of wood, or the point of a screwdriver or knife until the cannellure is filled.

NOTE: When the barrel is removed for the renewal of the packing at the breech end, it may be necessary to adjust the packing at the muzzle end, necessitating the unscrewing of the follower.

(At muzzle end of the barrel)

Approximately eleven inches of heavy asbestos is required to pack the muzzle end. Push it in, as it is being wound, with a thin piece of wood or the point of a knife or screw driver.

VICKERS MACHINE GUN MODEL OF 1913 POSITIONS OF THE GUN MECHANISM



NOTE: Excessive packing at the muzzle end will prevent the follower tightening up against the face of the water jacket cap. Loss of the complete attachment can result from breakage due to improper adjustment. The follower should be screwed tightly home, but care must be taken that the asbestos packing does not press too tightly against the barrel, causing it to jam.

Test the recoiling portion of the weapon to see that it works freely and that the asbestos packing is not so tight as to cause excessive friction. To do this, remove the recoil spring from the fuze links, take out the lock, turn the roller handle upward and, holding it with the right hand and the fuze with the left, slide the recoiling portion backward and forward to see that it moves easily and that the barrel goes home. The weight necessary to move the recoiling parts should not exceed four pounds.

CARE AND HANDLING

PREPARATION, BEFORE FIRING

1. Draw back slide of bottom plate.
2. Fill water jacket.
3. Place sufficient water in condensing device to cover end of steam escape hose.
4. Remove the steam outlet cork plug group.
5. Attach the hose connection group and immerse the end of the flexible hose in the water contained in the condensing unit.
6. Examine the feed box. Test upper and bottom pawls and springs and oil parts of the feed box.
7. Examine the lock and oil all working parts. Test main spring, gib spring and firing pin.
8. Open rear cover, remove lock and examine bore of the barrel, from the muzzle end.
9. Oil the working parts of the weapon: the barrel at front and rear bearings, recoil plates, cams, lock guides, crank bearings, dead stop and roller and the guides on the cover.

NOTE: Effective oiling of the barrel bearings is done as follows: Open the front cover and remove the feed box. Draw back the lock, allowing the carrier horns to hang on the steps of the outside plate cams. This is referred to as "hanging the lock". Place thumb behind the roller handle and with the first two fingers on the tail of the handle, rotate the handle. This rotation will cause the barrel and recoil plates to move backward, making the front and rear bearings accessible for oiling.

If it is seen that water leaks at the breech, it is indicated that there is insufficient packing in the cannellure of the barrel and the barrel must be removed and asbestos packing added.

If water leaks at the muzzle the follower must be unscrewed and more packing inserted: then the follower must be replaced and screwed tightly with the spanner wrench, to which a final tap with a lead hammer should be given.

Weigh the recoil spring in the following manner: Remove the lock from the gun, place the ring of a spring balance over the roller handle and pull upwards, vertically, and the weight indicated on the scale, when the roller handle COMMENCES to move, will be the weight of the recoil spring. This should be between seven and eight pounds, but tension should be kept as high as possible, consistent with maintaining the normal rate of fire. If the spring tension is over or under the required weight, adjust it by turning the tension screw handle.

In adjusting the weight of the recoil spring, it will be found that six "clicks" (or three complete turns) of the tension screw will increase, or decrease, the weight of the recoil spring about one (1) pound.

Make certain that spare parts and tools are immediately available for use if required, particularly a spare lock, spare feed box, spare barrel, screw driver, spanner wrench, defective cartridge extractor, oil can, cleaning rod and patches.

CARE DURING FIRING

1. Constant care that a sufficient supply of water is present in the water jacket, to assure that the barrel is at all times immersed, is essential.
2. Make certain that the ammunition belt is not pulled out of alignment while the weapon is firing.
3. During every cessation of fire, oil the lock and all frictional parts and replace a partly used belt with a full one.
4. Keep a watch on the various clamps of the tripod and on the muzzle attachment which have a tendency to work loose during firing.
5. Keep the ammunition belt always in line with the feed box and the top of the ammunition box up to, but not above, the cross head joint pin. Use other ammunition boxes, or any other available means, to elevate the ammunition box to this position.
6. Refill empty belts without delay and replace in ammunition boxes.

NOTE: It is advisable, though not absolutely essential, that the belt is placed in the box so that the end of the belt having the single long brass strip enters the weapon first. The other end of the belt will be found to have two long strips, one on each side of the last cartridge.

WARNING: Keep hands away from the roller handle while the weapon is firing to avoid risk of injury. (Continued on page 600)

11. Adjust the sight.

12. Check that ammunition is correctly loaded in the belts.



Conducted by: W. C. Minshaw, Major, Ord. Dept.

FUNDAMENTALS OF ARTILLERY WEAPONS

by D. A. WERBLIN
2nd Lt., Ord. Dept.

PART III

CARRIAGES

A carriage is an assembly which furnishes a support for a cannon in firing and, in the case of mobile artillery, enables the weapon to be moved readily from one position to another. A carriage may consist of a combination of several or all of the following major components: recoil system, equilibrator, sleigh, cradle, top carriage, bottom carriage, elevating mechanism, traversing mechanism, axle, trail, equalizer, firing support.

TYPES OF CARRIAGES (OR MOUNTS)

There are two main classifications of carriages, namely: fixed carriages and mobile carriages. Fixed carriages include the barbette and disappearing types. Mobile carriages are classified as railway, self-propelled, and towed carriages.

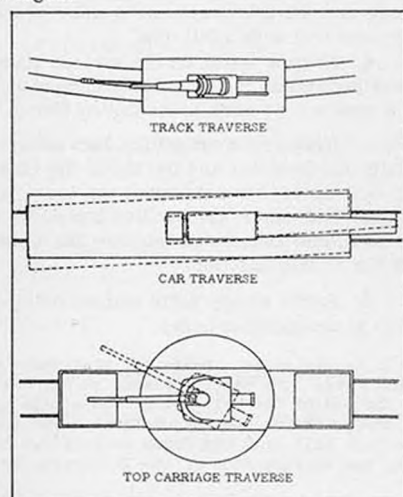


Fig. 25 -- Traverse methods for railway artillery

Barbette Carriages

According to a strict definition, a barbette carriage is a stationary carriage on which a cannon is mounted to fire over a parapet. Today, however, the term barbette carriage is used in a broader sense to refer to a stationary carriage, regardless of whether it fires over a parapet, which is capable of traversing through large angles except as limited by a protecting turret or casemate.

Disappearing Carriages

A disappearing carriage is one which holds the cannon behind a parapet during loading and raises the cannon above the parapet for firing. When fired, the cannon recoils to the rear and downward, pivoting about a lever axle. When fully recoiled the cannon is approximately horizontal, and the counterweight is raised. The cannon is returned to its in-battery position by the counterweight.

Railway Mounts

Railway mounts are classified generally according to the methods by which traverse is obtained and recoil is taken up.

Traverse is accomplished by one of the following methods. (See Figure 25.)

- (a) By moving the mount along a curved track or epi (track traverse).
- (b) By rotating the entire car (car traverse).
- (c) By rotating a top carriage with respect to the car (top carriage traverse).

(2) Recoil is taken up by allowing the mount, or some part thereof, to be displaced to the rear. There are four systems of recoil, namely: cradle recoil, top carriage recoil, sliding recoil, and rolling recoil. (See Figure 26.)

d. Self-propelled mounts. - A self-propelled mount is one which serves as a car-

riage for a cannon and has its own engine for providing motive power.

e. Towed carriages. - A towed carriage is one which is mounted on wheels and is towed by some outside source of power (prime mover). This type of carriage is usually connected to its prime mover through a trail and lunette. (See Figure 27.)

RECOIL SYSTEMS

A recoil system is a mechanism which limits and controls the recoil and counterrecoil of a cannon. It usually consists of three main components: namely, a recoil brake, a counter-recoil mechanism, and a counterrecoil buffer.

RECOIL BRAKE. - A recoil brake is a mechanism which controls the recoil of a cannon. The modern recoil brake is called a hydraulic brake and consists essentially of a piston which moves in a cylinder filled with a fluid. This liquid is usually oil and is called recoil oil.

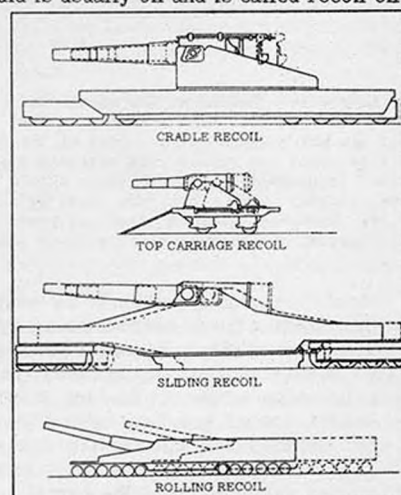
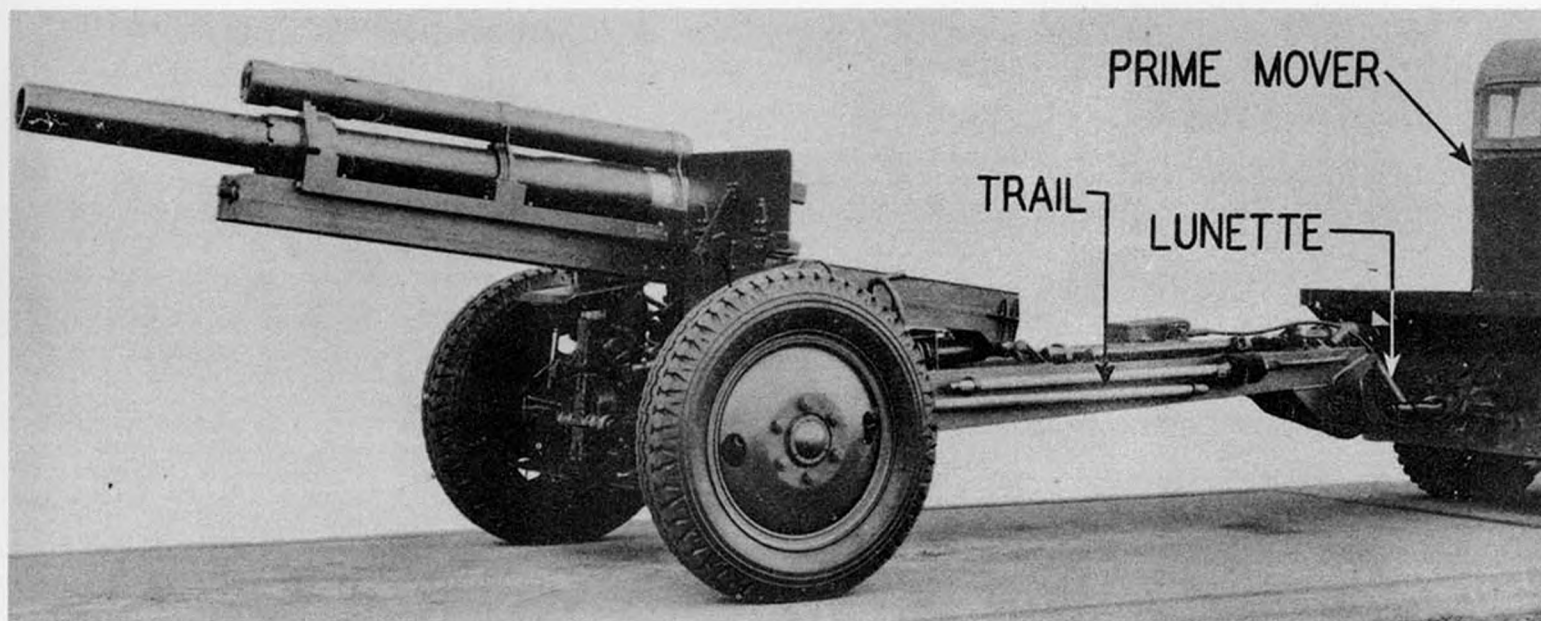


Fig. 26 -- Recoil methods for railway artillery



The hydraulic brake is attached to the weapon in either of two ways:

The cylinder is attached to the cannon and moves with it during recoil and counter-recoil, while the piston is fixed to the carriage.

The piston is attached to the cannon and moves with it during recoil and counter-recoil, while the cylinder is fixed to the carriage. (See Figure 28.) For the purpose of subsequent discussion, this particular arrangement will be assumed.

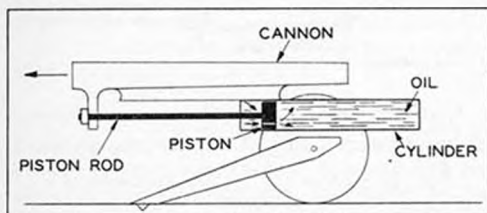


Fig. 28 -- Recoil brake

In either case, when the cannon recoils, there is relative motion between the piston and the cylinder, and the operation in both cases is fundamentally the same.

Operation. (See Figure 28.) - When the cannon recoils, it pulls the piston with it to the rear. The oil to the left of the piston is under pressure and is forced through holes provided in the piston. The resulting resistance retards

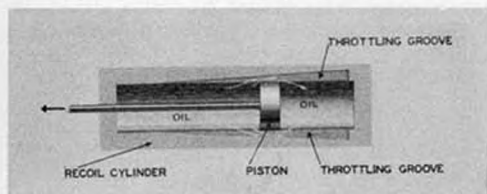


Fig. 29 -- Throttling grooves

the recoil and brings the cannon to a stop. With this arrangement of oil flow, the velocity of recoil would not decrease uniformly and would result in unbalancing the cannon and carriage. To effect a uniform recoil, the rate of oil flow must be varied, or throttled, by varying the size of aperture through which the oil flows. Several devices for throttling the oil flow are described below.

Fig. 27 -- Towed carriage

Throttling grooves. (Figures 29 and 30.)

Throttling grooves are tapered slots or grooves cut into the recoil cylinder walls. In this arrangement, the piston has no holes in it, and hence the passage of oil is through the throttling grooves. These grooves are cut in a manner such as to have the greatest depth at the beginning of recoil, the depth tapering to zero at the end of recoil. Thus, the oil flows freely at first, allowing the cannon to recoil (Figure 30, A). As the piston moves in the cylinder, the depth of groove is decreased (Figure 30, B), resulting in a corresponding decrease in oil flow and retardation of recoil. At the end of recoil (Figure 30, C) the piston completely seals the cylinder, thereby stopping the passage of oil and bringing the cannon to rest.

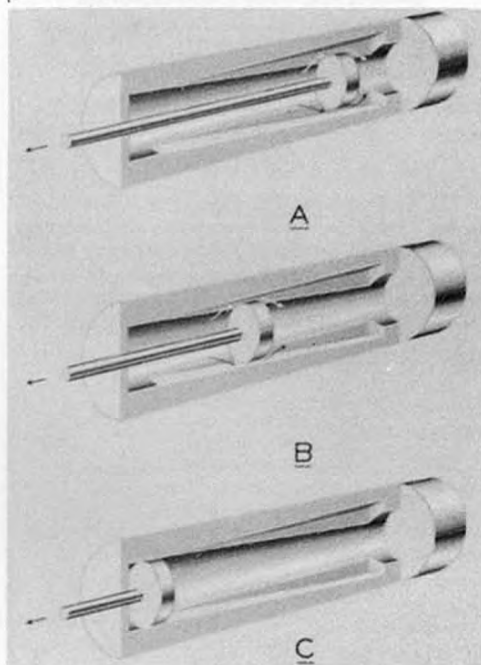


Figure 30 -- Throttling grooves

Throttling bars. (Figure 31.) - Throttling bars are wedge-shaped bars attached to the recoil cylinder walls. Rectangular notches are provided in the piston so that it slides on the throttling bars as the gun recoils. At the start

of recoil, the notches form apertures through which the oil can flow (Figure 31, A). The size of aperture decreases as the cannon recoils further (Figure 31, B), until, at the end of recoil, the apertures are completely sealed by the throttling bars (Figure 31, C), thus stopping the flow of oil and bringing the cannon to rest.

Throttling rod. - In this system, a tapered throttling rod is attached to the recoil cylinder. The piston rod is hollow to receive the throttling rod during recoil, and orifices are provided in the piston to allow oil flow. The progressive throttling of the flow of oil is shown in figure 32. At the start of recoil, the smallest section of the throttling rod is opposite the orifices, and hence the oil flows freely, allowing the cannon to recoil. As the cannon recoils further, the opening through which the oil can flow is decreased, until at the end of recoil, the tapered rod completely seals the piston orifices, thereby stopping the flow of oil and bringing the cannon to rest.

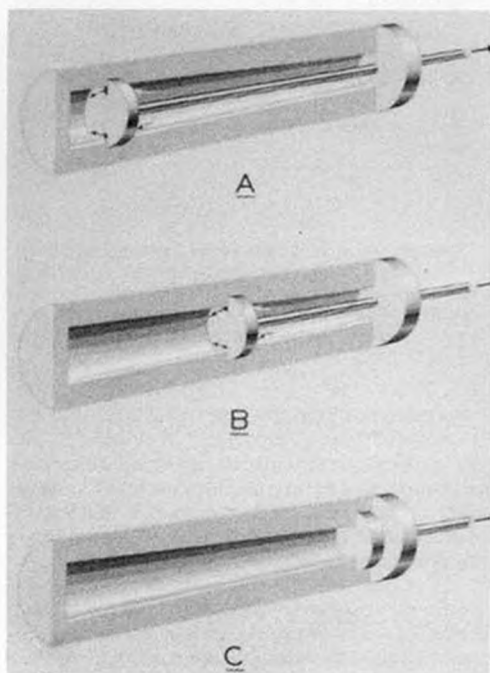


Fig. 31 -- Throttling bars

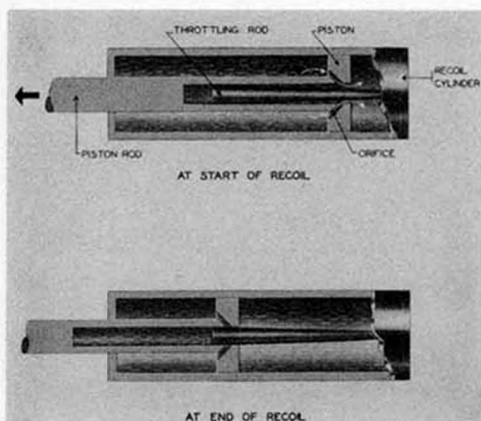


Fig. 32 -- Throttling rod

Variable recoil. - In certain heavy mobile weapons, a variable length of recoil is employed, permitting long recoil at low angles of elevation to insure stability, and short recoil at high elevation to prevent the cannon from striking the ground. (See Figure 33.) One type

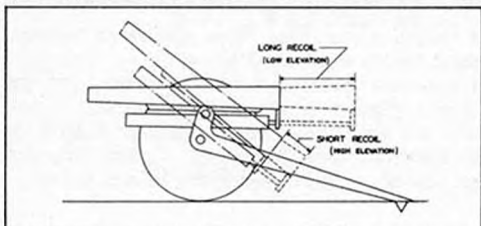


Fig. 33 -- Variable recoil

of variable recoil mechanism is illustrated in Figure 34. A hollow piston rod slides on a control rod which has throttling grooves cut in it. Maximum recoil is attained when these grooves line up with ports in the piston head, since a maximum flow of oil is then possible. To reduce the length of recoil, the control rod is rotated, moving the throttling grooves out of line with the ports. (For the purpose of illustration only one port and one throttling groove are shown in Figure 34.) This action reduces

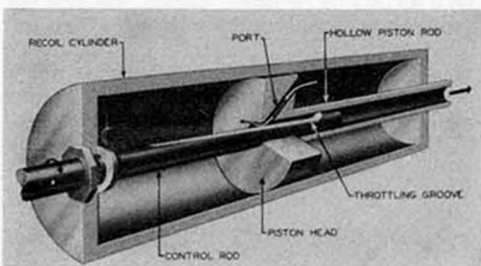


Fig. 34 -- Variable recoil mechanism

the aperture through which the oil can flow, and the increased resistance results in a shorter recoil.

COUNTERRECOIL MECHANISMS

A counterrecoil mechanism is a device which returns a cannon from its recoiled position to its in-battery position and holds it there until fired again. The different types of mechanisms are described below.

Gravity type. - When the cannon is fired, it recoils rearward to its loading position, and a counterweight is raised by the energy of recoil. After the cannon is loaded, the counterrecoil mechanism is tripped, and the counterweight

moves downward and raises the cannon back into battery.

Spring type. (Figure 35.) - The essential components of this type of mechanism are a cylinder, spring, and rod. With the cannon in battery (Figure 35, A) the spring is under initial compression and hence holds the cannon in

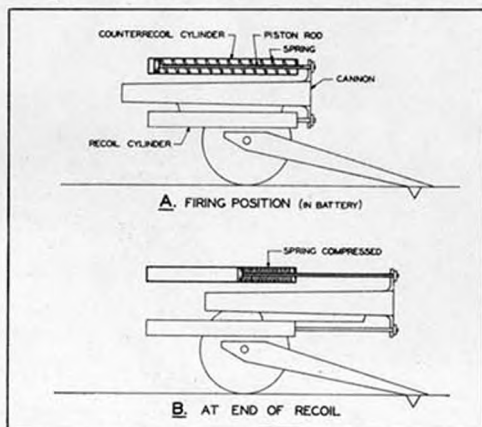


Fig. 35 -- Spring counterrecoil mechanism

place until fired. When fired, the cannon recoils, pulling the counterrecoil rod with it to the rear, and further compressing the spring as seen in Figure 35. The spring assists in checking the recoil. At the end of recoil, the spring expands and pushes the rod forward, thus pulling the cannon back into battery and holding it there.

Hydrospring recoil system. - In this recoil system, recoil is taken up by a hydraulic brake, and counterrecoil is controlled by a spring-type concentric grouping of brake, spring, and buffer as shown schematically in Figure 36.

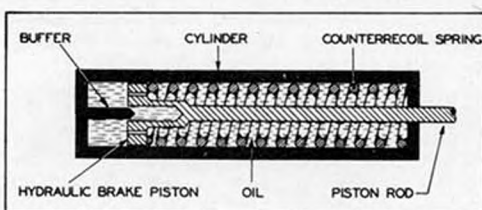


Fig. 36 -- Hydrospring recoil system

Hydropneumatic type. - As described below, a hydropneumatic counterrecoil mechanism employs the force of compressed gas - usually nitrogen - to return a cannon to its in-battery position from its recoiled position. There are two general types of hydropneumatic recoil

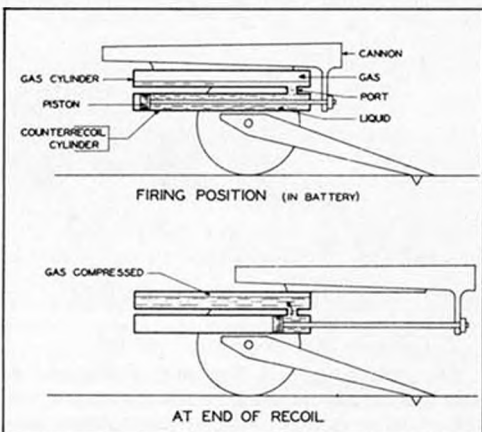


Fig. 37 -- Direct-contact counterrecoil mechanism

mechanism, namely: the direct-contact type and the floating piston type.

Direct-contact counterrecoil mechanism. (Figure 37.) - In this type, a counterrecoil cylinder is provided with a liquid-tight piston and is connected, by a port, to a cylinder above it which serves as a reservoir for liquid and gas. The system is provided with liquid, sufficient to fill the counterrecoil cylinder completely and the other cylinder about one-half. In the case illustrated, the piston is connected to, and recoils with, the cannon. When the cannon is fired, liquid is forced by the piston through the connecting port into the reservoir cylinder. This further compresses the gas which was under sufficient pressure to hold the cannon in battery. At the end of recoil, the gas pressure, acting in the opposite direction, forces the oil back through the port against the piston, thereby returning the cannon to its in-battery position and holding it there.

Floating-piston counterrecoil mechanism. - A floating-piston type of counterrecoil mechanism is shown schematically in Figure 38. This is a dependent type of counterrecoil mechanism, i.e., there is a connection between

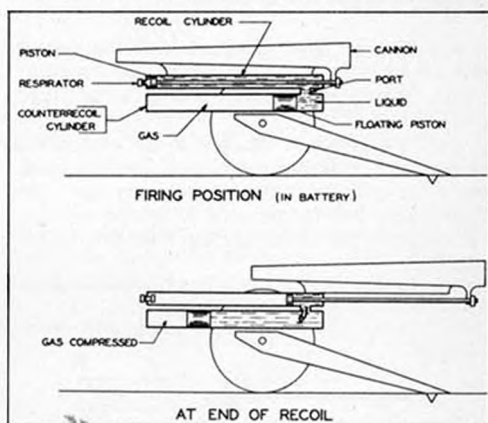


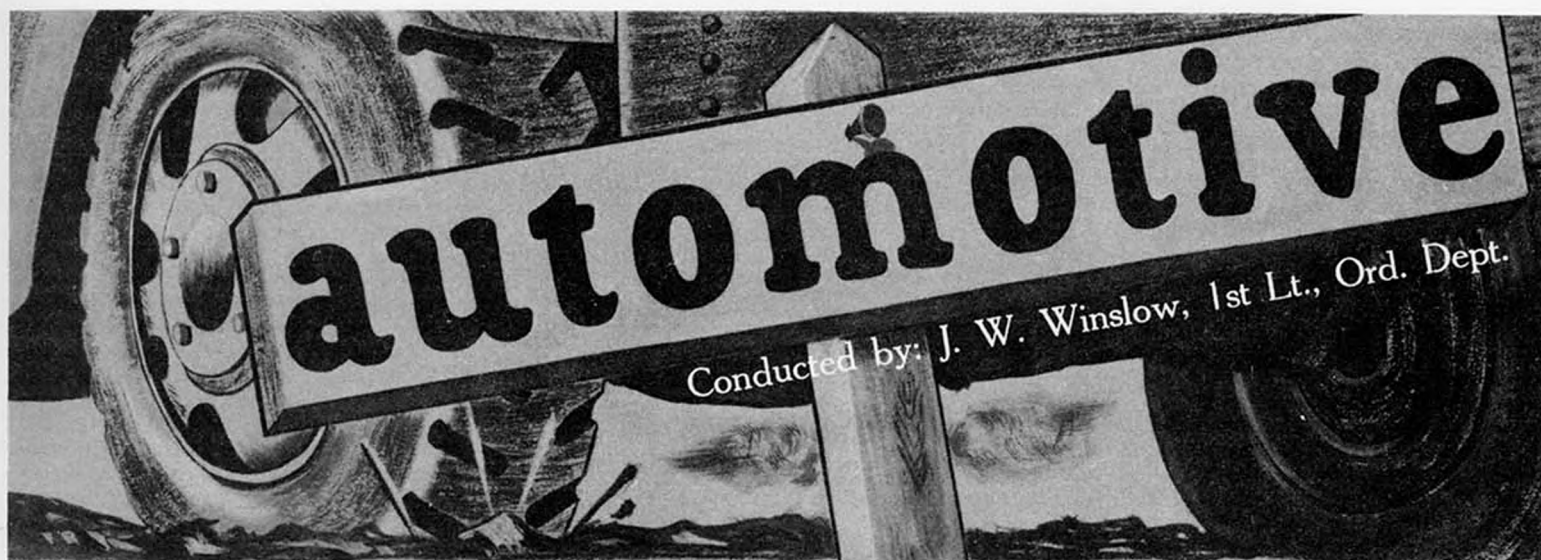
Fig. 38 -- Floating piston counterrecoil mechanism

the hydraulic recoil brake and the counterrecoil cylinder. A floating piston forms a tight seal between the fluid at one end of the counterrecoil cylinder and the gas at the other end. As the cannon recoils, carrying the recoil-brake piston with it, the liquid is forced through the port into the counterrecoil cylinder, thus forcing the floating piston forward and further compressing the gas. The gas pressure assists in checking the recoil. At the end of recoil, this pressure forces the floating piston back to the rear, driving the fluid back through the port and against the recoil-brake piston. This pushes the piston, and hence the cannon, back into battery. The initial gas pressure is made great enough to hold the cannon in battery until it is fired again.

COUNTERRECOIL BUFFER. - A counterrecoil buffer is that part of a recoil system which controls the last movement of a cannon in counterrecoil. Its purpose is to prevent shock as the cannon returns to its firing position.

Dash-pot buffer. (Figure 39.) - A dash-pot counterrecoil buffer consists of a tapered rod (buffer rod) which is attached to the counterrecoil cylinder and which slides in and out of a cylindrical cavity, or dash pot, in the end of the piston rod. In this particular case, the counterrecoil cylinder is attached to the cannon and recoils with it, while the piston rod is attached

(Continued on page 601)



GENERATOR CONTROL SYSTEMS

Control systems are all of a kind. In the generator, the generated voltage depends on three things:

1. The speed of rotation
2. The strength of the field
3. The physical dimensions of the generator.

Recall that the speed of rotation is fixed by the speed at which the engine is running. Also, that the physical dimensions of the generator are fixed when the machine is designed and built. Thus the only factor useful for control of generated voltage is field strength.

Get in mind the fact that the control of charging current is always accomplished by control of generated voltage. (Current flow can be controlled by variable resistance in the circuit. This method (variable resistance) is not used in the automotive generator control system).

Also, always keep clearly in mind that the current output of a generator, as long as it is below the maximum imposed by the current limiter, is determined by the loads the generator must supply. For example, if the equivalent resistance of all the devices (battery, lights, ignition, radio, etc.) is low, the generator will supply a high current. If the equivalent resistance is high, the generator output is low.

If control of the generator had to be done manually, an assistant driver would have a full time job merely keeping proper current and voltage relations. Fortunately we have automatic control systems to do away with this would-be rough assignment.

Control is either "internal" or "external." Internal indicates that the control of the generator is accomplished WHOLLY INSIDE THE GENERATOR CASE. External control means that the control system is entirely outside the generator-case. Both systems operate on the fundamental principle of controlling the field strength. Some vehicles are equipped with a system that uses some internal and some external control. Such systems will not be directly treated in this discussion.

by **W. J. SEVERINGHAUS**
1st Lt., Ord. Dept.

Internal control saw its hey-day in the years previous to 1933. Since then external control has been used in varying degrees and the mechanism constantly improved. By 1940 all American cars and most trucks had adopted the THREE ELEMENT CONTROL BOX.

Since all recent Army vehicles (tank and wheeled vehicle) use the three element control box this discussion will be devoted to showing what the units are, how and why they operate, and how to check and adjust them.

THE THREE UNITS

1. Reverse current cut-out or cut-out relay	Automatic switch. Protects generator when generator armature from burn-voltage exceeds ing out due to excess-battery voltage; live current flow when opens when gen- armature is stopped erator voltage is (or slowed) less than battery voltage.
2. Current Limiter	Limits the current output of the generator to a safe maximum. Protects the armature from overheating and generator to a burning out due to excessive current.
3. Voltage Regulator or Voltage Limiter	Limits the generated voltage to a safe maximum. (A) Protects all units of fixed resistance (such as light bulbs) from burning out. (B) Acts to taper off charge rate to battery as battery comes up to full charge.

The names of the units require no explanation. The functioning of the units is given as follows:

HOW THE REVERSE CURRENT CUT-OUT FUNCTIONS

As the generator builds up voltage more current is forced through the voltage winding (fine wire) on the RCC core. This increasing current produces an increasing electromagnetic field tending to pull the soft iron RCC armature toward the core. The pull of the electromagnet is opposed by the tension of the spring tending to hold the armature in its posi-

tion away from the core. By adjusting the spring, or the magnetic air gap, or the point gap, the points may be made to close at any desired voltage. SEE FIGURE 1. For the six volt system this is 6.4 volts; for the twelve volt system about 13.5 volts.

Where is the reverse current used? The heavy winding (current winding) about the reverse current cut-out core is not effective until the points close. Then while the generator charges the battery (and supplies other loads) the heavy coil current helps hold the points tight together by adding to the strength of the electromagnet. When the generator slows down and the voltage falls below battery voltage, current will reverse in direction through the current winding of the RCC. This current (about 3 to 4 amperes) reverses the polarity of the core of the RCC and repels the armature. SEE FIGURE 2. It is evident that the spring tension plus the repulsion of the reverse current electromagnet are jointly useful in opening the cut-out points. CAUTION: If the cut-out is closed manually it will remain closed, allowing excessive current to flow from the battery to the generator. This will burn out the armature.

HOW THE CURRENT LIMITER FUNCTIONS

The generator in the sketch (FIGURE 3) has, let us assume, a safe maximum current of 35 amperes. The parallel resistances marked "loads" in the diagram represent lights, radio, heater, etc. While generator current is being supplied to all these and the battery, the demand may exceed 35 amperes. The generator voltage is between 6.4 (cut-out closing voltage) and 7.5 (limit imposed by the voltage regulator) — for example, 7.0 volts. The cut-out points are closed and the voltage is not high enough to cause the voltage regulator points to open. The only way to keep the current from exceeding 35 amps is to reduce the voltage of the generator below 7.0 volts. (This example assumes the resistance of the connected load to be low enough that at 7.0 volts the resulting current will exceed 35 amperes.)

In order to reduce the generator voltage, (1) the current flowing in the winding around the core of the C.L. increases the strength of the

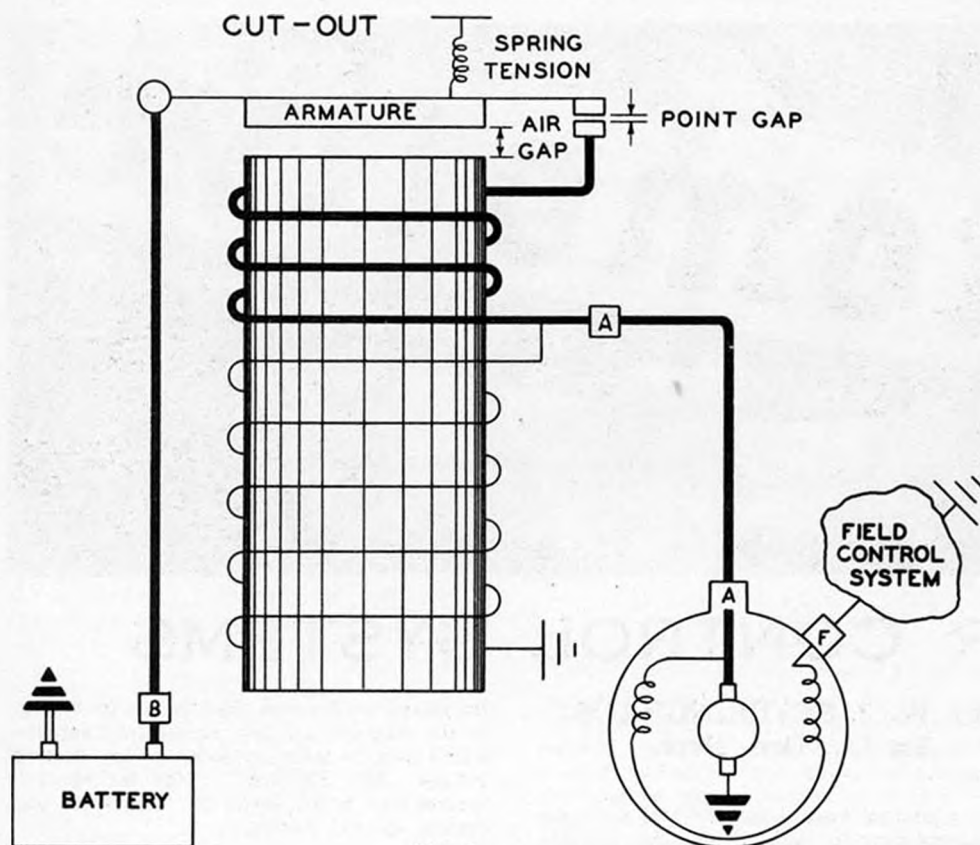


Fig. 1

electromagnet as the current increases. (2) At 35 amperes this magnetic pull is sufficient to overcome the spring tension on the armature and the armature moves toward the core. (3) This opens the C.L. points. The field current previously flowing through the points is interrupted. The diagram (FIGURE 3) shows the full field current as 4 amperes. With the points open 2 amperes remains, flowing through the leakage resistance.

Now consider that the strength of an electromagnet (such as the generator field) varies with the current flowing in the winding. If the field current is reduced from 4 to 2 amperes, the field strength is reduced in the same proportion. In this example, the field strength is cut in half. Since the generated voltage varies with field strength, cutting the field strength in half also cuts the generated voltage in half. The original generator voltage (7.0) is thus reduced to 3.5 volts.

The resistance of the connected load (battery, lights, radio, etc.) has not changed so, according to OHM'S LAW, the current will decrease proportionately with the voltage and the current should fall from 35 amperes to 17-1/2 amperes. This would so decrease the strength of the current limit or electromagnet that the points would close again, full field current would flow, and the generated voltage would build up and increase the current output again.

Now carefully consider that the points vibrate between 50 and 200 times per second. While it takes time to describe what happens, it actually occurs in a very brief period of time. Let me make clear that the figures used to illustrate what happens are exaggerated. The current is not really reduced from 35 amperes to 17-1/2 amperes. First learn the principles of operation and the relations of the various factors in this simple example. The actual

change in current looks something like the picture given in FIGURE 4.

At (A) FIGURE 4, closing the headlight switch increases the current demand from 20 amperes up to the safe maximum value. The vibration of the current limiter is shown by the way the current fluctuates. Note the current rises a little above 35 amperes then falls a little below 35 amperes before rising again. BUT THE AVERAGE VALUE IS 35 AMPERES. At the beginning of this discussion it was emphasized that control of charging current is always accomplished by control of generated voltage. To see how this is done, assume that before point (A) FIGURE 4, the generator was supplying 20 amperes to the load at the limited maximum of 7.5 volts. When the headlights were turned on the current supplied by the generator

at 7.5 volts would have gone up to point (B) FIGURE 4. But at 35 amperes the C.L. operates to reduce the average voltage sufficiently to keep the average current at 35 amperes. A very possible value for the new average voltage would be 7.0 volts. Of course, the lights are not as bright at 7.0 volts as they would be at 7.5 BUT the generator will not overheat at 7.0 volts, whereas it will by supplying excessive current at 7.5 volts.

THE LEAKAGE RESISTANCE

Why is it necessary to use a resistance of this nature? Why is it not permissible to open the current limiter points and decrease the field current to zero? To get at the answer to this problem remember that any electric current flowing in a coil in such a manner as to set up a magnetic field, has the property of inductance. This is similar to inertia in the field of moving objects. The electric inertia of a current flowing in a wire tends to keep that current flowing even when some means (such as opening the points of the current limiter) is employed to stop it. This field current has large electrical inertia which would cause the current to flow across the points as they open in the form of an electric arc. This arc will remove metal from one point to another and due to the large amount of heat liberated in the high resistance of the air gap across which the arc is formed, will tend to fuse the metal of the points. With the leakage resistance in parallel with the points the arcing and burning is nearly eliminated in a well designed system. This result is obtained in two ways:

- (1) The value of the field current is not reduced to zero since some of the field current flows at all times through the leakage resistance.
- (2) The surge due to the electrical inertia of the generator field takes the path of least resistance and flows through the leakage resistance instead of arcing across the points.

The arguments set forth above for the current limiter will also apply to the leakage resistance used with the voltage regulator. Indeed, in the complete control box one leakage resistor serves both devices in the very simple circuits given here.

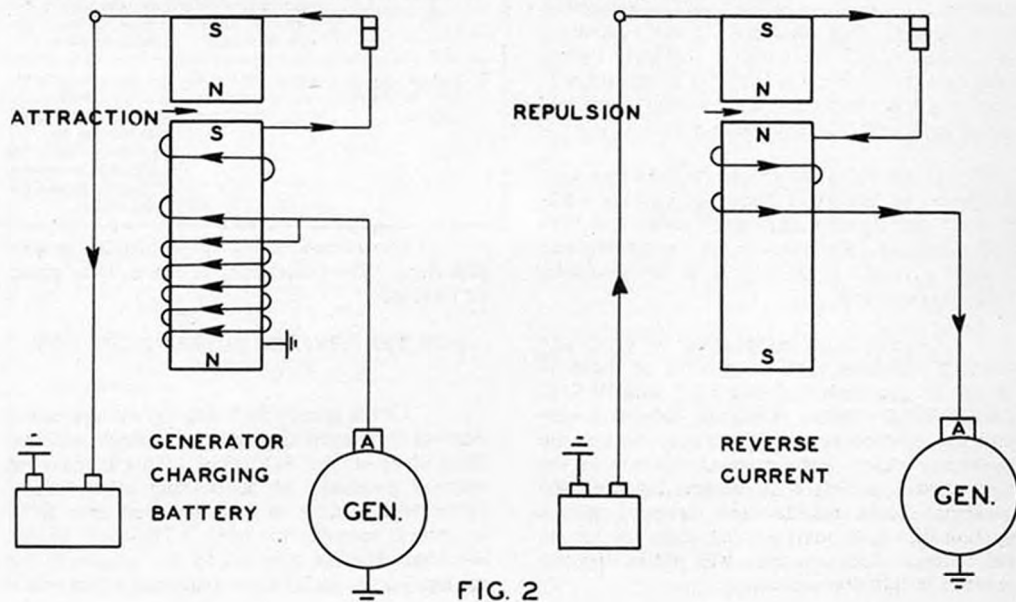


FIG. 2

HOW THE VOLTAGE REGULATOR FUNCTIONS

This device is in operation almost continuously. Any time the speed of the armature tends to raise the generated voltage above a safe value, the voltage regulator must operate. The winding on the core of the voltage regulator is made of fine wire of quite high resistance in order to use relatively little current. This "voltage winding" uses many turns of wire to obtain electro-magnetic strength as opposed to the current limiter winding which uses few turns carrying a high current (hence "current winding") to obtain electromagnetic strength.

However, as the generator voltage builds up, the current through the voltage regulator winding increases proportionately. At the safe maximum voltage the electromagnet of the voltage regulator is strong enough to attract the V. R. armature, and open the points. In sequence, the action of the several factors involved is listed below:

1. Generator voltage increases
2. Current in voltage regulator winding increases
3. Electromagnet strength of V.R. increases
4. V.R. armature is pulled toward core, opening points
5. Field current decreases
6. Field strength of generator decreases
7. Generator voltage decreases
8. Current in voltage regulator windings decreases
9. Electromagnet strength of V.R. decreases
10. V.R. armature is pulled away from core, closing points
11. Field current increases
12. Field strength of generator increases
13. Generated voltage increases

Note that step 13 is the same as step 1, completing the cycle. As with the current limiter the cycle is of very short duration and the points vibrate between 50 and 200 times a second. The similarity in action of the CL and the VR is marked. BUT it is excessive current that causes the current limiter to operate; whereas it is excessive voltage that causes the VR to operate.

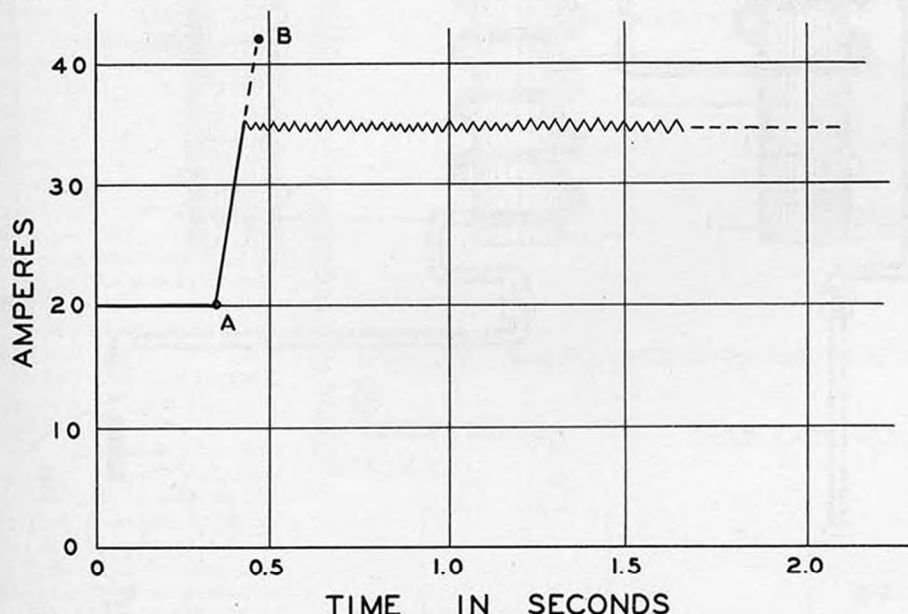


Fig. 4

CURRENT REGULATOR

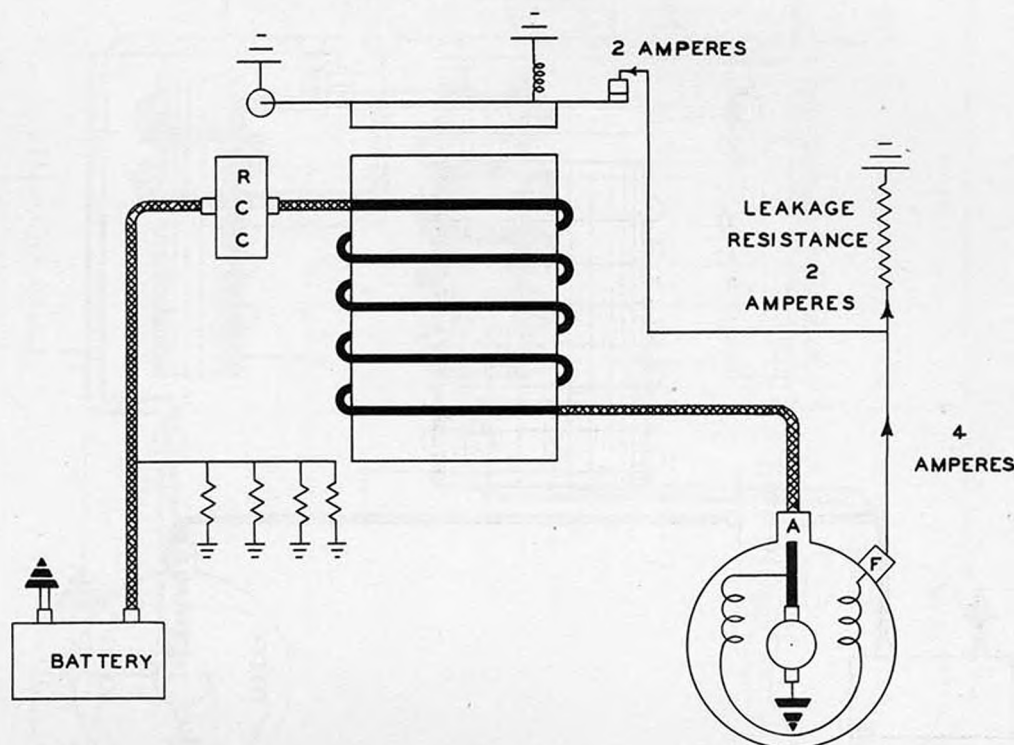


Fig. 3

COMBINING THE RCC, THE CL, and VR

It is necessary, in combining the functions of the CL and VR, that the contact points of both units be connected in series in the generator field circuit. This provides for interruption of part of the field current if either the CL or the VR points are opened. The three units combined to control the type of generator having the field grounded in the control box are shown in FIGURE 6. Observe that in FIGURE 6 only one resistor is used in conjunction with the CL and the VR. Also observe that the field current flows from the "high" brush of the generator, out the (F) terminal on the generator case to the (F) terminal on the control box. Inside the control box the field current normally divides, the larger part flowing through the VR and CL points to ground, the smaller part flowing through the leakage resistance to ground.

If the generator field is grounded inside the generator case, the control box is similar to FIGURE 7. Field current is taken from the windings carrying the full output current, flows through the CL and VR points, is joined and increased by the smaller current flowing through the leakage resistor. This junction is inside the control box. The full field current flows out the (F) terminal of the control box, in the (F) terminal of the generator, through the field windings and to ground inside the generator.

THE TANK CONTROL BOX

There is a great similarity between the type of control box shown in FIGURE 7 and the control box found on tanks. The tank uses the two wire system, rather than the grounded system. The control box, reduced to its simplest terms, is shown in FIGURE 8. The tank generator corresponds to the wheeled vehicle generator with the field grounded in the generator. Field current flows from the current winding of the current limiter through the CL and VR points. Before the field current leaves the control box the current through the field leakage resistor is added and the full field current flows out the control box (F plus) terminal into the generator (F plus) terminal through the field windings to the negative or "low" brush of the generator. On some two wire control boxes the (A plus) and (A minus) terminals are marked (G plus) and (G minus).

It is extremely important to grasp the principles already presented. A thorough understanding of the operation of each unit is necessary to the development of skill and speed in checking, adjusting and repairing control boxes. These circuits are simplified to show the fundamentals of external control. All the necessary windings, cores, springs, and resistance units needed to make a workable control system are shown. Actual control boxes are equipped with additional windings and more complex circuits because experience has shown that these modifi-

VOLTAGE REGULATOR

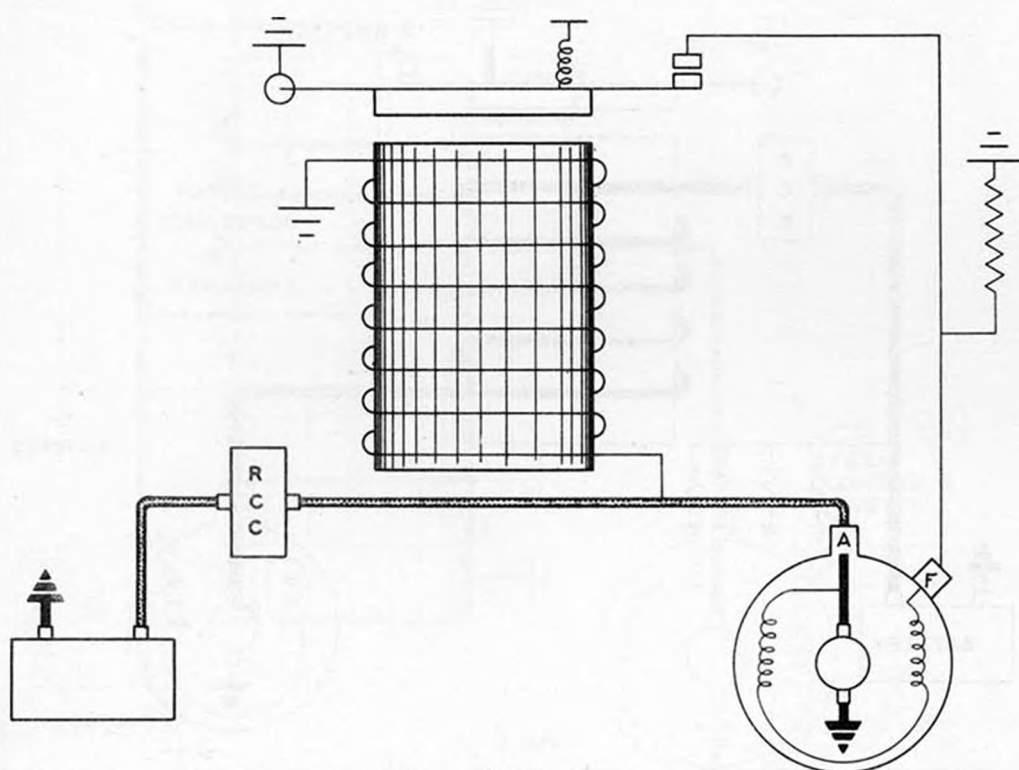


Fig. 5

cations give better control and lengthen the life of the control system.

CHECKING AND ADJUSTMENT

Barring extreme cases, all checking and adjustment of control boxes can be accomplished with an ammeter and voltmeter connected as shown in FIGURE 9 for the grounded system, and FIGURE 10 for the two wire system. The generator may be mounted on the vehicle or driven by an electric motor (as on a test bench).

GENERAL RULES

(1) Never race the vehicle engine while checking or adjusting the control system. It is not necessary to do so; it is hard on the engine; it demonstrates lack of skill and workmanship on the part of the mechanic.

(2) It is never necessary to exceed one and one-half times the VR setting (for example — about 12 volts for a 6 volt system with the VR setting at 7.5 volts). To do so endangers all fixed resistance across which the voltage is thrown; particularly those in the control box.

(3) If adjustments can be obtained by changing spring tension alone never change air gap and point gap settings. However, if the spring tension is not sufficient follow the manufacturer's recommendations in setting the air gap and point gap.

(4) Be extremely careful not to close the points of the reverse current cut-out accidentally. If this is done the generator armature and most of the charging circuit wiring will burn out. Take special caution when replacing the cover on the control box.

(5) Do not be too ready to condemn contact points which are a little pitted. Very often they will afford better contact if left alone than would result if you try cleaning them by filing.

(6) Keep in mind that increasing spring tension:

- a. Increases RCC closing voltage
- b. Increases CL maximum current
- c. Increases VR maximum voltage

(7) BEFORE CONCLUDING THAT THE CONTROL BOX IS OUT OF ORDER MAKE A CAREFUL CHECK OF:

- a. The fan belt tension
- b. Drive pulleys
- c. All wiring and connections
- d. The generator

(8) Adjustments must be made with the system at normal operating temperature. Settings must be rechecked with the covers on to insure accurate results.

(9) Changing engine speed can best be done with the throttle linkage, NOT WITH THE FOOT FEED. This will give close control of engine speed and insure against racing the engine.

(10) NEVER LET AN INEXPERIENCED MECHANIC SERVICE CONTROL SYSTEMS WITHOUT CLOSE AND COMPETENT SUPERVISION. IT IS A SIMPLE JOB ONLY IF YOU THOROUGHLY UNDERSTAND IT.

SPECIFIC PROCEDURE

To adjust the reverse current cut-out:

1. Slowly increase engine speed, bringing up generator voltage.

2. Observe voltage at which cut-out closes (this may be done by listening for the click of the points; by watching the points; or by observing the kick of the ammeter hooked into the charging circuit on the battery side of the control box.)

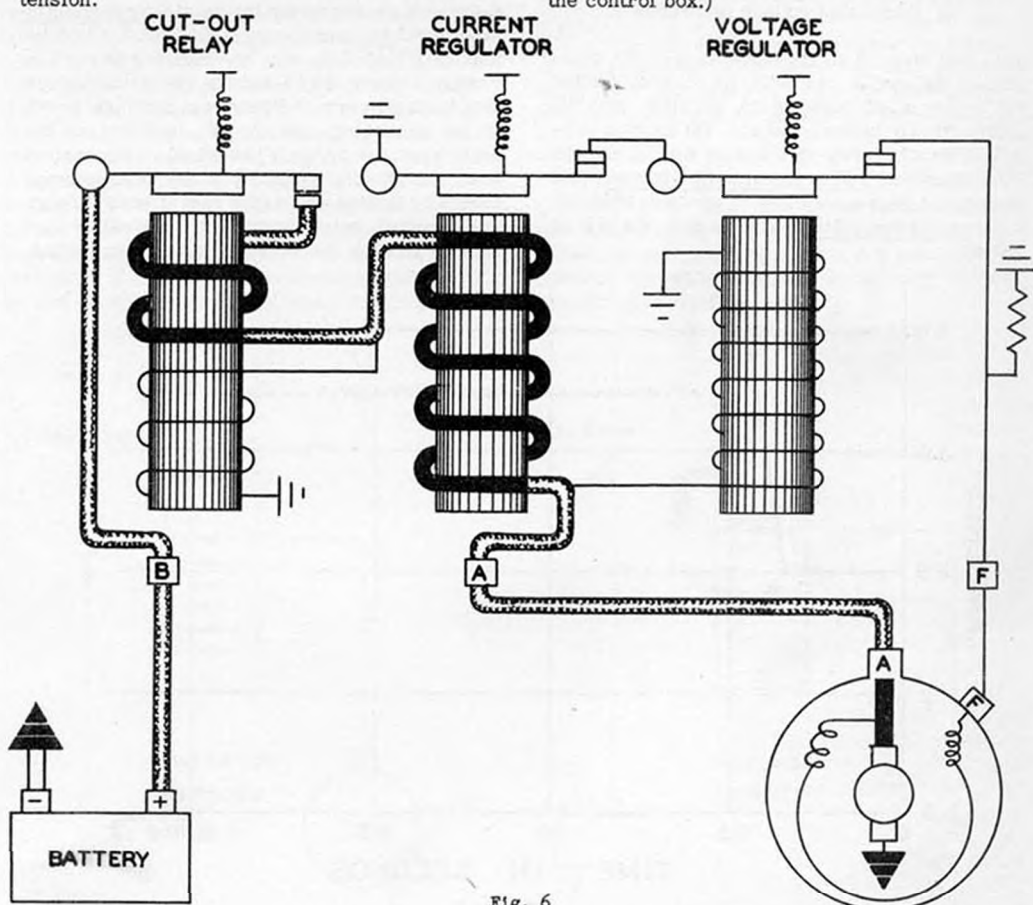


Fig. 6

3. Adjust spring tension to give proper closing voltage.

To adjust the current limiter:

1. Short circuit the voltage regulator points. (Tie a piece of small wire — one end to the fixed point, one end to the moveable point.)

2. Bring up engine speed to increase generator voltage.

3. Loosen CL spring tension so maximum current is less than the normal CL setting.

4. Increase spring tension to increase setting to the normal maximum. This procedure will insure that it is the current limiter that is limiting the current and NOT poor generator performance.

NOTE: If with a fully charged battery the specified charging rate cannot be reached as described above, discharge the battery by stopping the engine and using the starter (ignition off) for thirty seconds. Cranking can be continued longer if necessary. (Remove short circuit wire from VR points when CL is properly set.)

To adjust the voltage regulator:

1. Disconnect wire leading to BATTERY (B) terminal in control box. With this done the generator will operate on open circuit.

2. Increase engine speed and adjust spring tension of VR to obtain proper limiting voltage.

IN FOLLOWING THE PROCEDURES FOR SETTING THE CURRENT LIMITER ON ANY BUT HEAVY DUTY EQUIPMENT, EXTREME CARE MUST BE TAKEN NEVER TO EXCEED 1-1/2 TIMES THE VR SETTING. Wiring in the light control box is not sturdy enough to withstand overload current resulting from excessive voltage.

INTERNAL REGULATION

THE NOW OBSOLETE, BUT STILL IN MUCH USE, THIRD BRUSH GENERATOR

The principle of operation is again control of generator voltage by control of field strength. In the third brush generator no abrupt change in field current is used to change field strength as with external control. No mechanism is used: the third brush is the only device necessary to effect control of the generator output. The reverse current cut-out is necessary in any vehicle generator system. The third brush, in its peculiar manner, functions as CL and VR.

The third brush generator has only one terminal; this terminal is marked (A). The lead from this terminal carries the charging current out to the RCC and then on to the battery. The generator case is grounded. FIGURE 11 shows the arrangement of

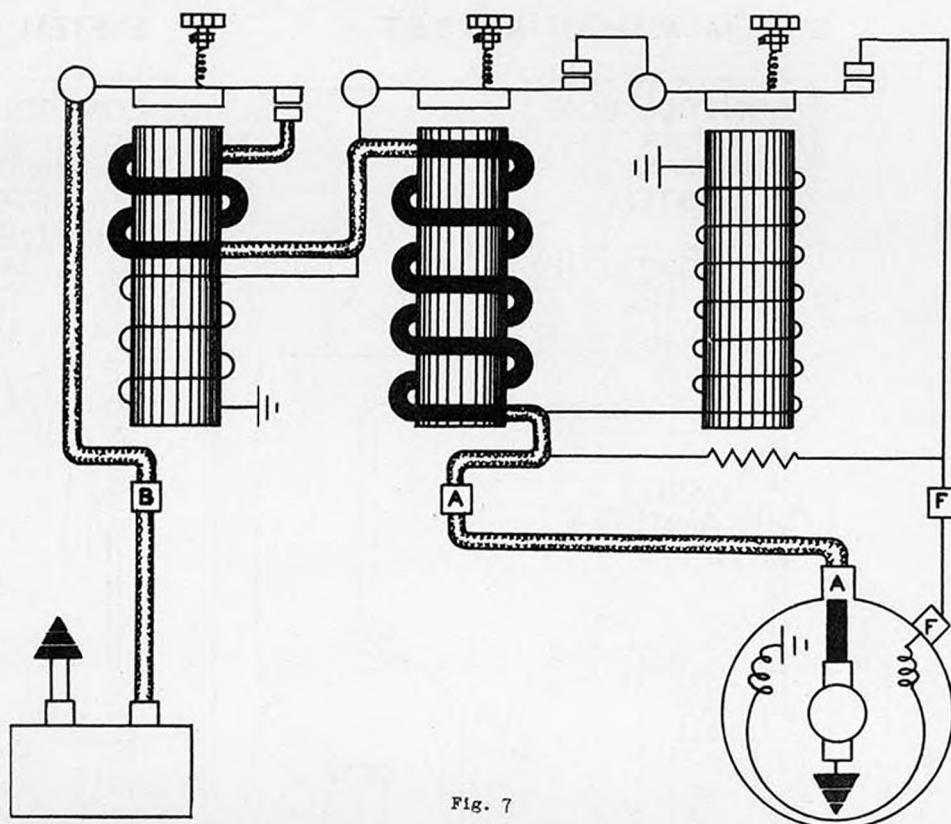


Fig. 7

armature, brushes, field, and case. The third brush can be rotated toward brush No. 1 (to raise output) or toward brush No. 2 (to lower output). But the brush is not moveable while the vehicle is in operation. What, then, is the action of the third brush in any one position?

If an electromagnet is placed in the field between the poles of a permanent magnet (as in

FIGURE 12) the flux is distorted to follow the path indicated. FIGURE 13 shows the distribution of field flux when practically no current is flowing through the armature. This field is nearly uniform. But as the armature delivers more current it acts in a manner very similar to the electromagnet in FIGURE 12. Although the armature is rotating, the conductors on the right side of the brushes carry current into the

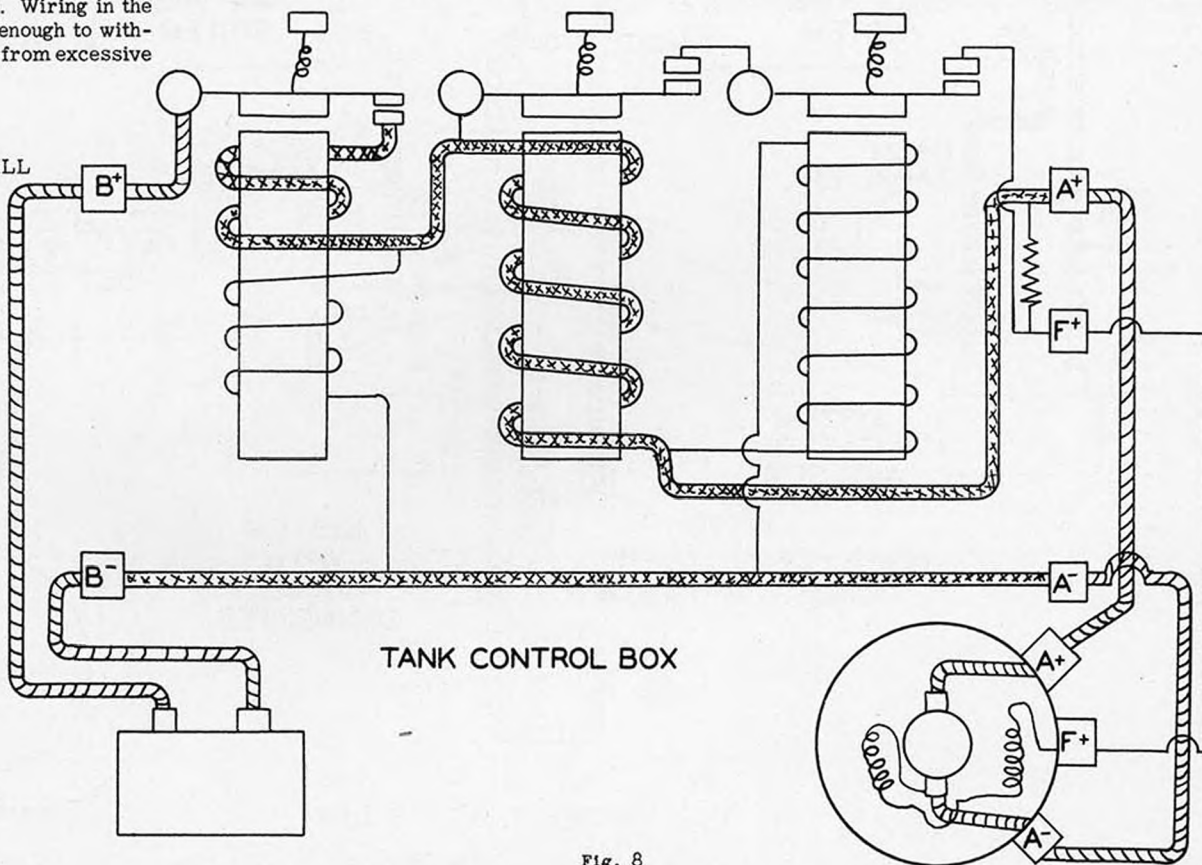


Fig. 8

SYSTEM WITHOUT AVR SET

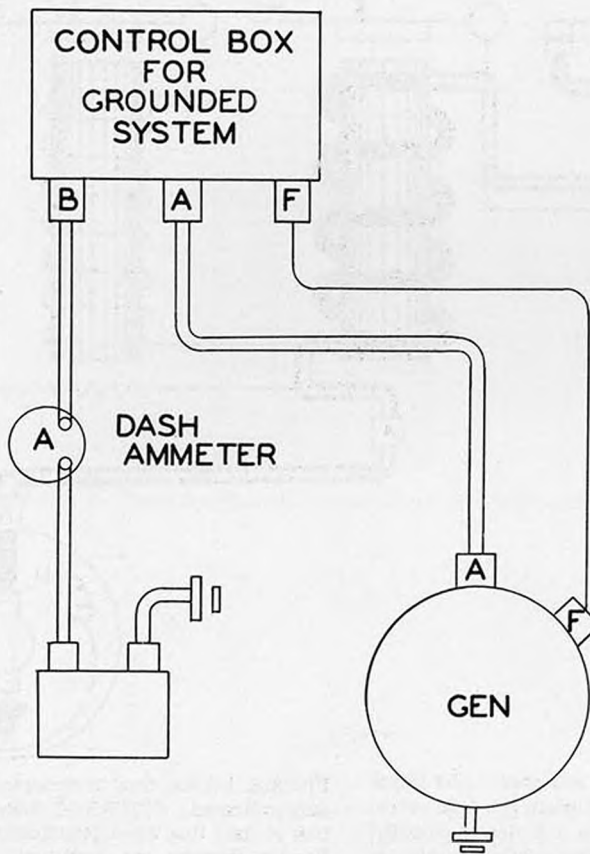
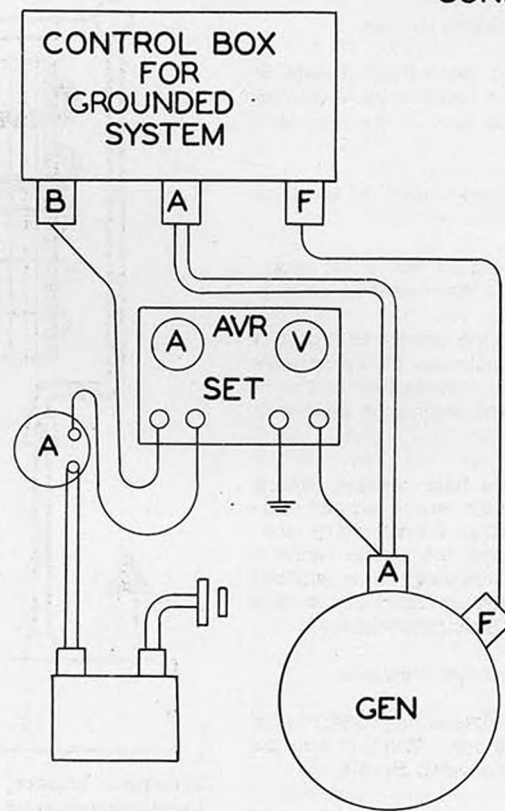
SYSTEM WITH AVR SET
CONNECTED

Fig. 9

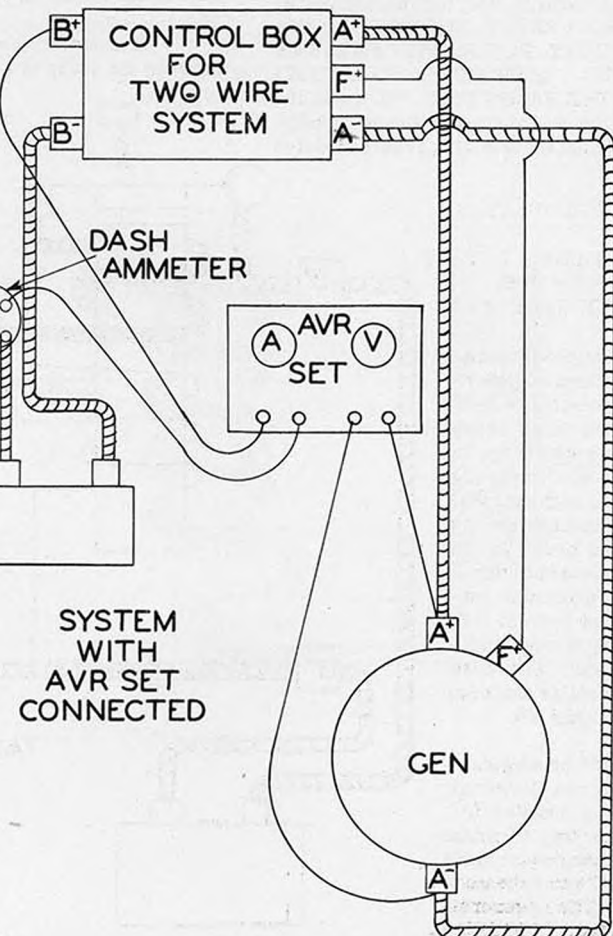
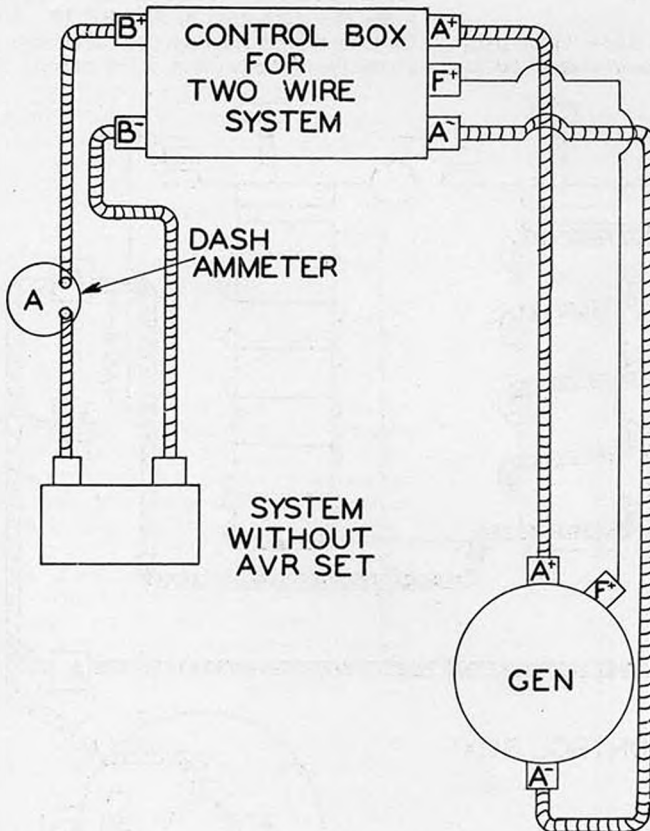


Fig. 10

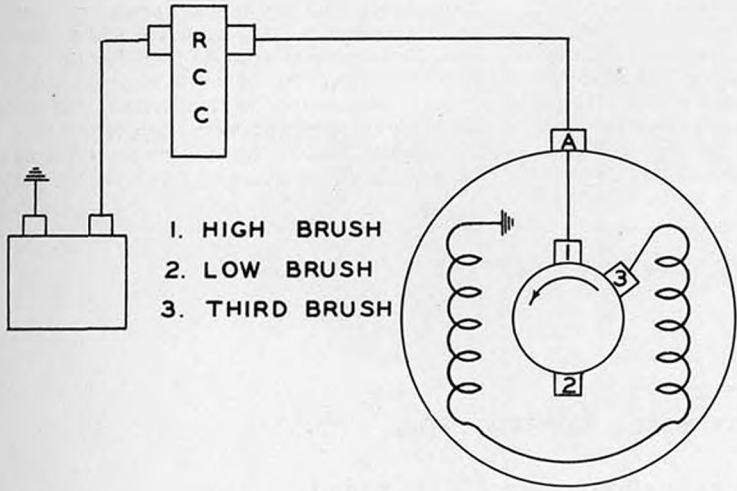


Fig. 11

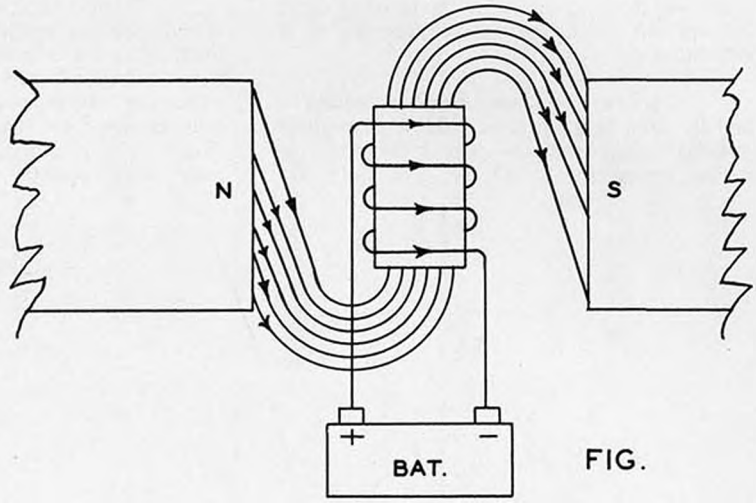


Fig. 12

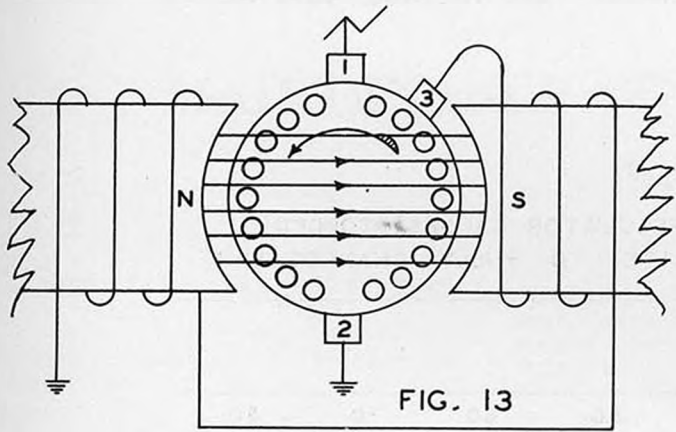


Fig. 13

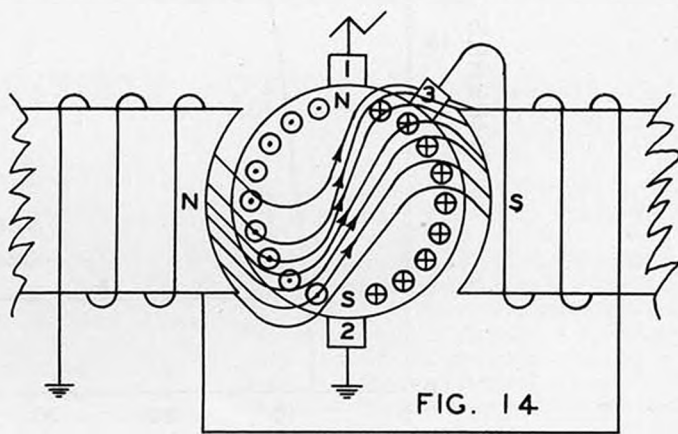


Fig. 14

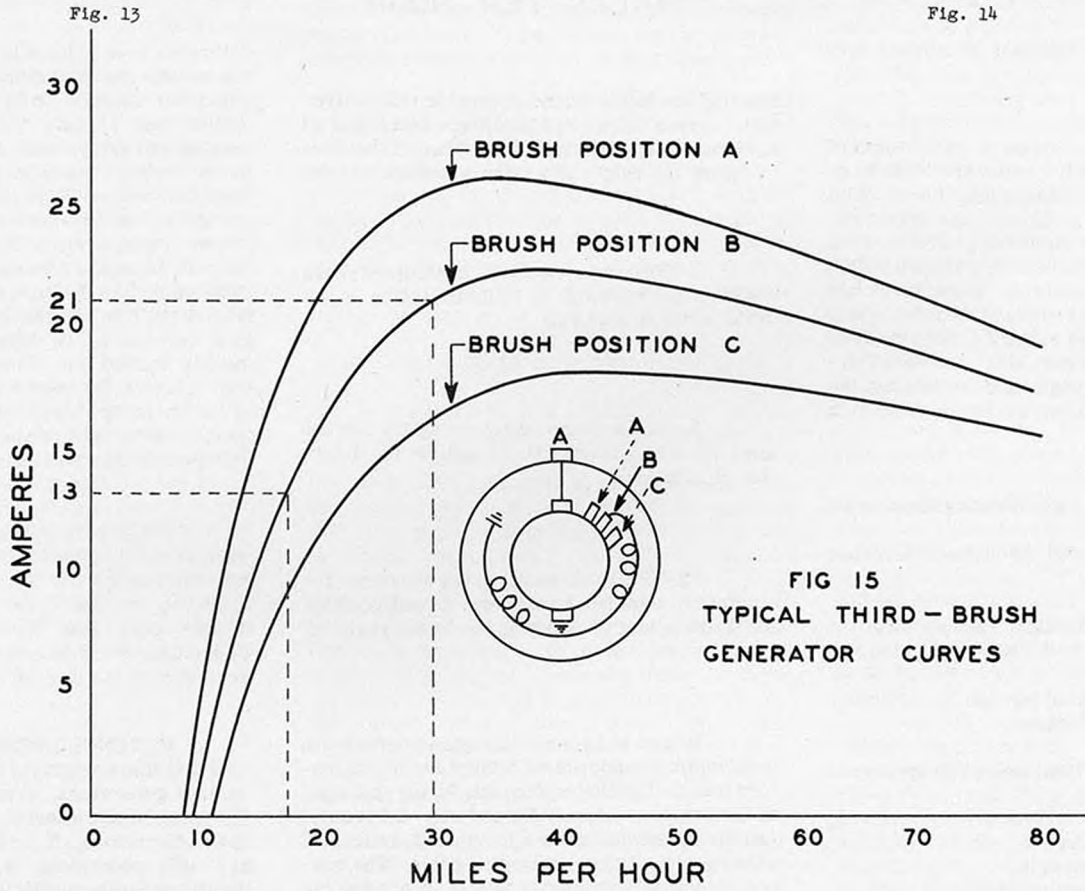


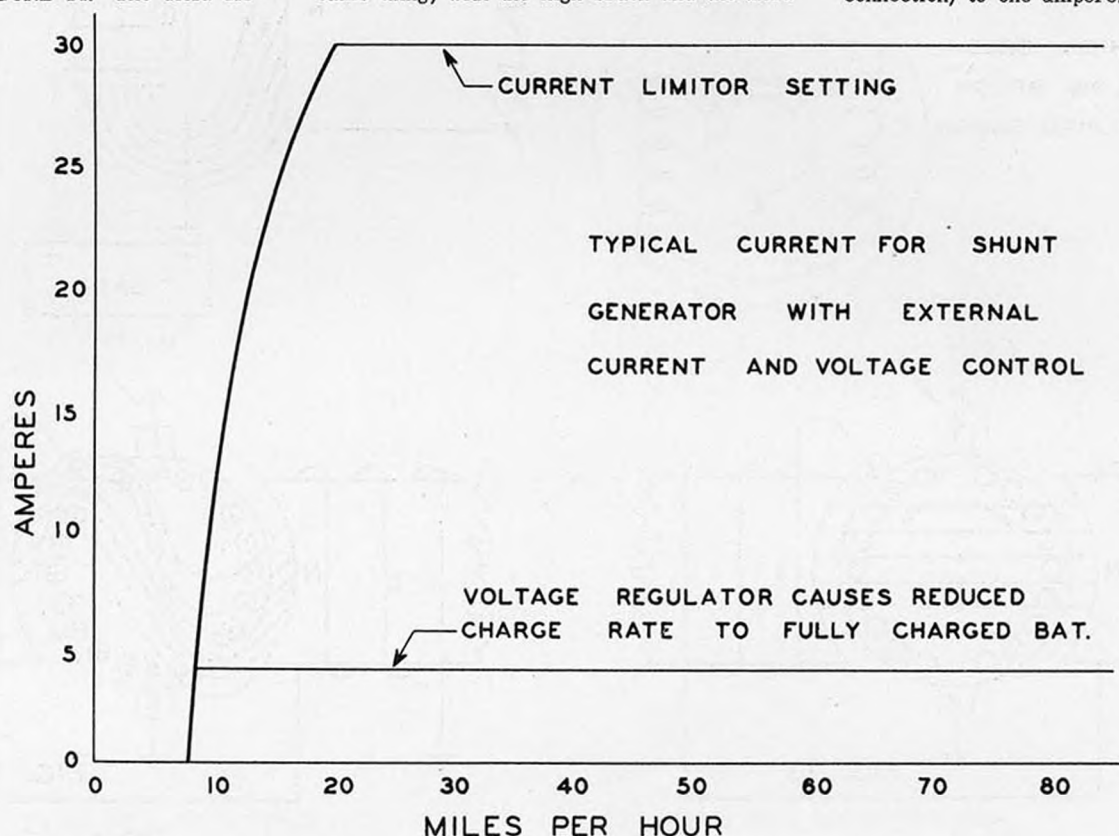
Fig. 15

paper and those on the left of the brushes carry current out of the paper (as represented in FIGURE 14.)

This causes a new magnetic field to be set up. The original field plus the new field created by the armature causes the field distortion shown in FIGURE 14. The field dis-

The next thing to understand is the effect of changing the position of the third brush. If the third brush is moved very close to the high brush, extreme field distortion will be needed to effect any current regulation. In order to get this extreme field distortion the armature must deliver a high current. Another way to say the same thing; with the high brush and the third

current regulation; not voltage regulation. Note that the system in good condition will deliver about 21 amperes at 30 MPH. (SEE FIGURE 15, BRUSH POSITION B). Of this 21 amperes, about 12 is supplying the lighting system, and the balance is charging the battery. Suppose the battery load is reduced (by a loose ground strap connection) to one ampere. The total current



tortion increases with increase of current flow through the armature.

The voltage generated in each length of wire laying in a slot on the armature depends on the rate of cutting lines of magnetic force. With a large current flowing through the armature, most of the field flux is distorted to flow between the "high" (No. 1) brush and the third brush. This reduces the voltage generated in the wires between the "low" (No. 2) brush and the third brush. With the lowering of the voltage across the field windings the field current will decrease, decreasing the field strength and decreasing the voltage generated between the low and the high brush.

The action of the third brush generator is:

1. Higher speeds tend to generate higher voltage.
2. Higher generator voltage tends to deliver more current to the battery, lights, etc.
3. Higher current through the armature causes more field distortion.
4. Field distortion lowers voltage across generator field

lowers field current
lowers field strength
lowers generated voltage
lowers generator current

brush close together, the generator will deliver high current before any limiting effect (control) is obtained through field distortion. Therefore to adjust the output of a third brush generator:

1. To increase output: move third brush toward high brush (this is in the direction of rotation of the armature.)
2. To decrease output: move third brush away from high brush (this is against the direction of rotation).

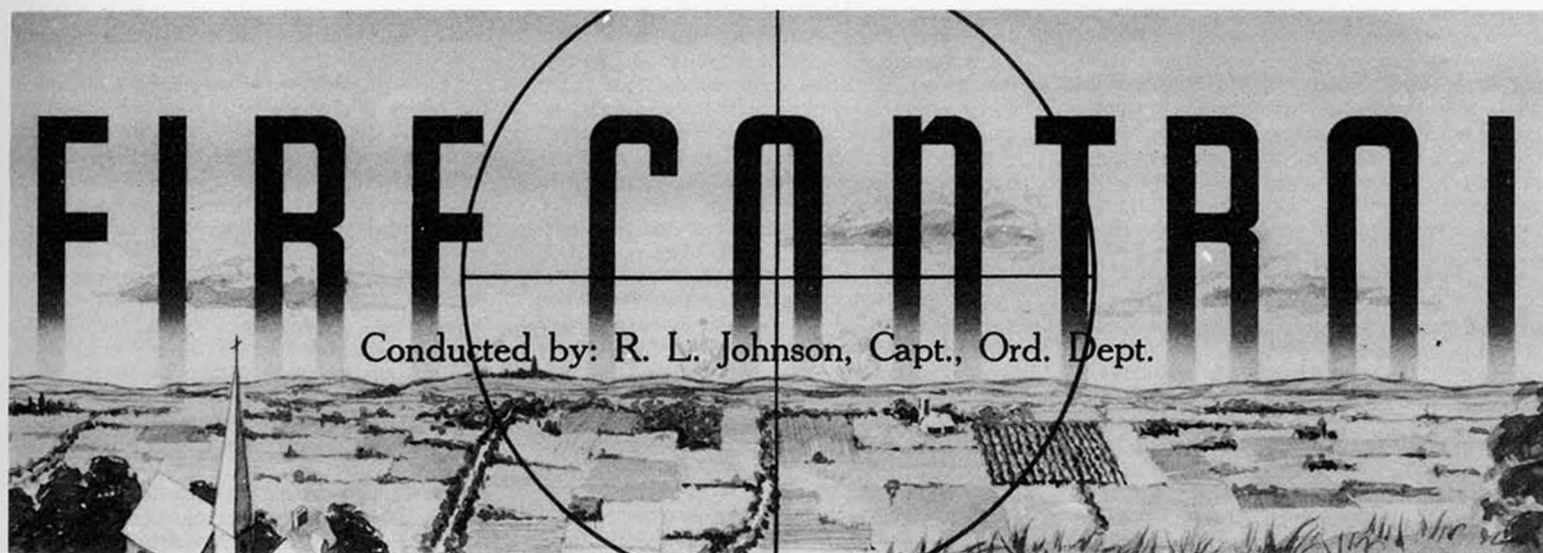
FIGURE 15 shows (1) on any one curve the regulation obtained by any one brush position and (2) the effect of changing the brush position.

It used to be a not infrequent experience with vehicles equipped with third brush generators that the lighting equipment, during operation of the vehicle, suddenly burned out. Subsequent examination would show a loose or disconnected battery ground strap or starter cable. The reason behind this trouble is useful in proving the peculiar fact that third brush regulation is

delivered now is 12 plus 1 or 13 amperes. If the vehicle were running at about 18 MPH the generator voltage would be only sufficient to deliver this 13 amperes. BUT, the vehicle is running at nearly double this speed and the generator voltage tends to go higher, limited by field distortion. BUT, the field is not distorted enough by the 13 ampere current and the generator voltage rises rapidly until sufficient current is again flowing (largely through the light bulbs) in the armature to cause enough field distortion to again limit the voltage. This new current is so high the light bulbs are quickly burned out. The moral to be found in this incident is: never allow high resistance in the charging circuit of a third brush generator; to do so will cause increase of generator voltage sufficient to overload the lighting system.

FIGURE 16 shows the result of external current and voltage control. So long as the current limiter and the voltage regulator are operating properly the generator can never deliver more than the amperage determined by the CL setting, nor can the generator voltage ever exceed the limit at which the VR is set.

IN CONCLUSION: further study will reveal that there are many circuits used to control various generators. Some are combinations of the external and internal control systems shown in this discussion. If the fundamentals of control are well understood it is an easy matter to quickly grasp the modifications and combinations found in particular generator control systems.



MAINTENANCE OF DIRECTOR, M5 AND M6

The following notes on adjustment are a continuation of those given in the November issue of THE ORDNANCE SERGEANT.

CHECKING BACKLASH IN ELEVATION

Turn the range handwheel until the range dial indicates datum line range. Align the vertical zero deflection marks and pull out the clutch knob.

Locate several objects which are about 30° apart in elevation. These objects should include angles from 0° to 90°. Turn the elevation handwheel to increase elevation until the horizontal reticle line of the elevation telescope intersects the first reference point, without overrunning. Note the reading on the quadrant elevation dials. Continue to turn the handwheel in the same direction for about 10°, then reverse direction until the horizontal reticle line again intersects the reference point. Do not overrun. Again note the reading of the quadrant elevation dials. The difference between these two readings must not exceed six minutes. The width of the line graduation is roughly three minutes.

Any adjustment necessary will require a complete check of the gear train in elevation. Note particularly the differential mechanisms and replace them with serviceable parts if they are worn. Pay particular attention to the pinion of the quadrant elevation mechanism. It should be meshed tightly with the segment gear. If the mesh appears loose, check the tension of the anti-backlash spring, also check whether the shaft of the pinion, clamped in place by four screws, is too far down. If this shaft is improperly adjusted, loosen the four screws and shift the pinion up as necessary.

ADJUSTING SPRING TENSION OF VARIABLE SPEED DRIVE

The spring tension of both lateral and vertical variable speed drives is adjusted in a similar manner. This adjustment should be made prior to assembly of the mechanisms in the director.

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Obtain a spring balance (household scale) which reads from 0 to 10 or 12 pounds. Place the hook of the scale around upright arm of the rocker assembly near the spring and pull until the balls are cleared by the cylinder. At this point note the reading of the scale. It should be between 7 and 8 pounds. If it is not, an adjustment must be made. Tighten the nut to increase the spring tension. It may be necessary to loosen the guide screw before making this adjustment.

The spring tension of the variable speed drives may be checked while they are in the director by placing one end of a rod, which is about 2 feet in length, against the center of the rocker assembly, the hook of the scale against the other end, and pulling towards the director. This will tend to force the cylinder away from the balls and the tension may be checked as before. The precaution of maintaining a straight pull on the scale must be observed at all times.

ADJUSTING THE RATE MOTOR GOVERNOR

The azimuth and elevation rate motor governors are adjusted in a similar manner.

Before turning on power, ascertain that the governor will not strike the governor guard. If it does, shift the position of the guard and/or motor until the necessary clearance is obtained.

Turn on power. On the elevation side it is well to set in a slight increasing deflection in order to prevent the limit switch operating and turning off the motor. Use a stop watch and time the rotation of the worm gear which drives the disk of the variable speed drive. This gear should rotate in the direction of the arrow at a speed of 20 revolutions per minute. The allowable tolerance is 1/2 second.

If an adjustment is necessary, remove the governor guard. In order to do this it will be necessary to remove the two screws holding the guard to the base. Turn the governor to a

2 o'clock position then lift the guard up and out with a twisting motion. Do not damage the gear.

Rotate the governor until the nuts are in a convenient position, then turn each of the adjusting nuts until each screw extends through by the same number of threads. It will be necessary to hold the screw by a pair of needle nose pliers in order to prevent it slipping when the nut is turned. Now turn each nut in the desired direction by the same amount. Thus, if one nut is tightened one turn, then each of the other three nuts must be tightened a like amount. One complete turn of the nuts will change the time about 3 seconds. One flat on each nut is equivalent to about 1/2 second change in time. Recheck until the results are satisfactory.

CHECKING THE DYNAMIC OPERATION OF THE TORQUE AMPLIFIER

Dynamic operation of the azimuth and elevation torque amplifiers may be checked in the same manner. Tests and adjustments for static operation of the torque amplifier were covered in the October issue of THE ORDNANCE SERGEANT. These should be checked prior to assembling a torque amplifier in the director.

Set deflection to zero and pull out the rate setting clutch knob. Turn the handwheel slowly and rotate the director through 360° azimuth or elevate and depress the telescopes from minimum to maximum. The torque required to accomplish this should not be excessive. The motion through the gear train should be smooth, without chatter or jerk. If these conditions are not met the load imposed by the gearing may be too great and should be corrected by a thorough cleaning and relubrication of the gear train.

Set in datum line range. Push in the rate setting clutch knob. Turn on power. Slowly set in decreasing and increasing deflection rates from minimum to maximum. The deflection rate should be set in smoothly. The director should traverse or the telescopes should elevate or depress smoothly without hesitation. The dials should register all movements without chatter or jerk. If the dials

appear jerky, check the orienting clutch, worm drive assemblies, rate motors, and tension of flat spring supporting ball carriages. This spring should be firmly against the ball carriage. As an aid to checking smoothness of operation in azimuth, note the reaction of the level bubbles. Check also by observing an object through the telescopes. Any tendency to jerk or chatter will be especially noticeable at low deflection rates. However, it must be remembered that the director will rarely be used at low deflection rates.

If the requirements indicated above are not satisfactorily met, the torque amplifier should be removed and rechecked. It may also be removed and rechecked. It may also be necessary to remove and clean the differential mechanisms.

CENTRALIZING BALL CARRIAGE OF THE LATERAL VARIABLE SPEED DRIVE

Align the zero deflection marks and pull out the clutch knob. Turn on power and observe the fine firing azimuth dial. If there is any movement it must not exceed 1° per minute. If the movement is excessive recheck the adjustment of the stationary collar of the rate setting clutch. If this adjustment is correct, loosen the locking screw on the bracket of the bar assembly and turn the adjusting screw in the proper direction until the motion ceases. Caution: Support the ball carriage with the finger during this adjustment in order to prevent breaking or otherwise damaging the flat spring. Check that the two screws holding the flat spring are fully home and the spring is against the ball carriage.

ADJUSTING SUPERELEVATION MECHANISM AND CENTRALIZE THE BALL CARRIAGE OF THE VERTICAL VARIABLE SPEED DRIVE

Check the speed of the elevation rate motor.

Align the vertical zero deflection marks, then pull out the clutch knob. Turn the elevation handwheel until the telescope is at 90°.

The maximum radius of the superelevation cam should now extend towards the base of the director. If it does not, loosen the lever on the telescope shaft slightly and rotate the cam until the maximum radius is down. This is done by rotating the lever in relation to the shaft. Check that the rod will clear the grease cups on the torque amplifier in all positions. Tighten the lever. Check that the two screws are holding the flat spring against the ball carriage with noticeable pressure.

Place a jumper across the limit to prevent its cutting out the motor. This may be done by placing a conductor from the orange terminal on top of the elevation switch to the orange ribbed terminal on the rate motor, and a conductor from the pink terminal on top of the elevation switch to the pink ribbed terminal on the rate motor.

Check the range scale on the director for the superelevation setting which is to be made on the micrometer. In order to make this setting it will first be necessary to loosen the nut on the superelevation mechanism. To facilitate this, push in the clutch and turn the elevation handwheel until the ball carriage of the vertical variable speed drive moves about one inch from the edge of the disc. Support the ball carriage with the finger and loosen the nut, using the

special offset wrench, about 1/4 turn. Use a screw driver and turn the micrometer until the index line in the center of the roller is opposite the .05 setting on the scale and the zero mark on the micrometer is opposite the lower edge of the scale. Caution: The scale must be parallel with the micrometer screw. If it is not bend the scale slightly until it is in proper alignment. Check the table below for the instructions for making any setting of the micrometer from this position. In the event an .058 setting is to be made, turn the micrometer clockwise 6 complete turns. This will bring the zero mark on the micrometer opposite the edge of the scale again. Now continue to turn the micrometer in a clockwise direction for 13 divisions on the micrometer. Tighten the nut. Align the vertical zero deflection marks and pull out the clutch knob. Do not change position of clutch throughout adjustment.

Turn on power. In the event the telescope tends to move away from the 90° position turn the elevation handwheel to bring it back. This condition merely means that the ball carriage is not centralized when the deflection is set to zero. To correct it, loosen the locking screw in the bracket on the superelevation mechanism and turn the adjusting screw in the proper direction until the motion ceases. Caution: Support ball carriage to prevent damage to flat spring. Observe the fine quadrant elevation dial as a final check for any movement. When the telescope is at 90° the fine dial should not move more than 1° per minute. It is possible to centralize the ball carriage at this position of the telescope

until no motion of the dial occurs and the adjustment should be made until this condition exists.

Having obtained the preceding adjustment, the action of the superelevation cam may be checked. The cam should cause the telescope to depress at any position other than 90°. In order to save time, turn the handwheel until the telescope is at about 10°, then release the handwheel and allow the cam to cause the telescope to depress. Use a stop watch and determine the time necessary for the telescope to move from 5° to 0°. Check the table below for the correct time and tolerance for this movement.

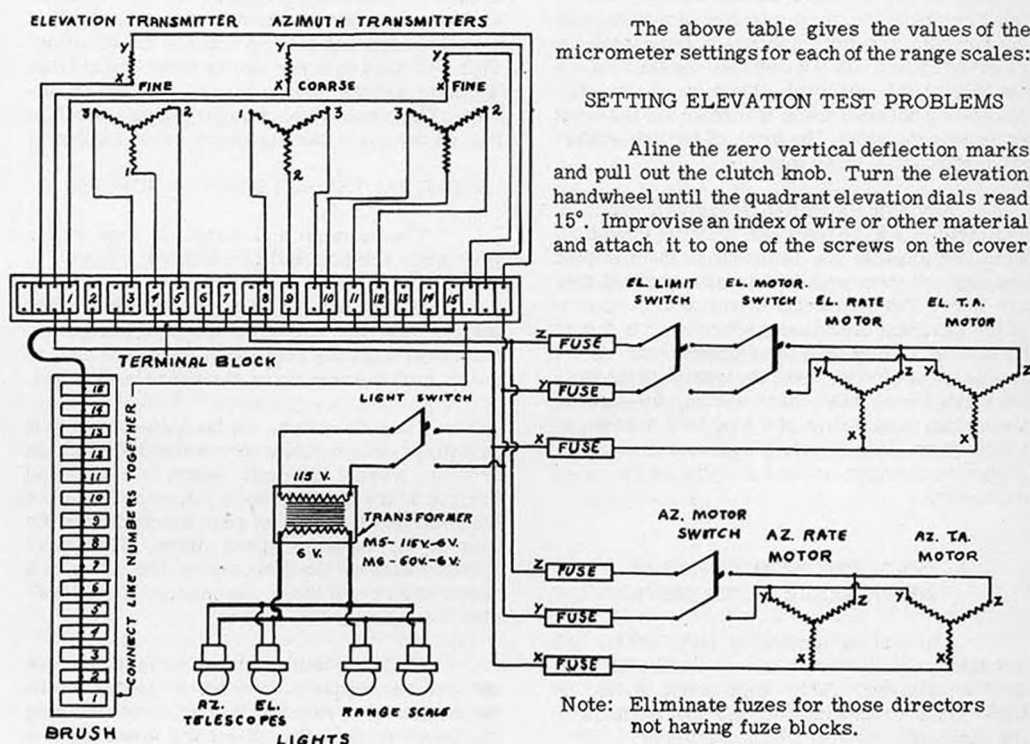
If the time is not within tolerance turn the adjusting screw, which moves the ball carriage, until the time is correct. If no adjustment is necessary the next paragraph should be omitted.

Turn the telescope back to 90°. Turn off power. Loosen the lever on the telescope shaft. Turn on power. Change the position of the cam until there is no movement of the dial. Tighten the lever. Recheck the time from 5° to 0° and continue the adjustments until it is correct.

Turn the telescope to about 70°. Check the time required for the telescope to depress from 65° to 60°. Check the table below for the correct time and tolerance. If the time is not within tolerance, turn the adjusting screw until it is correct. If any movement of the screw is necessary it will be extremely small. In the event any adjustment is necessary it will be necessary to completely recheck the times from 5° to 0° and

Muzzle vel.	Dial number	Value of K	Clockwise from .05 Turns	Divisions	5° to 0°	+ - 65° to 60°	+ -
2400	A	.0762	16	12	9.8 sec.	0.5	22.9 sec
2450	B	.0750	16	0	10.0	0.5	23.2
2500	C	.0729	15	3	10.3	0.5	23.9
2550	D	.0713	14	10	10.5	0.5	24.4
2600	E	.0694	13	9	10.8	0.5	25.1
2750	F	.0580	6	13	12.9	0.5	29.1

WIRING DIAGRAM



65° to 60°, as well as the movement of the dial at 90°. Remove the jumper.

The above table gives the values of the micrometer settings for each of the range scales:

SETTING ELEVATION TEST PROBLEMS

Align the zero vertical deflection marks and pull out the clutch knob. Turn the elevation handwheel until the quadrant elevation dials read 15°. Improvise an index of wire or other material and attach it to one of the screws on the cover

Note: Eliminate fuses for those directors not having fuse blocks.

of the upper bracket of the quadrant elevation mechanism. Mark the segment gear so that the mark and the index are in line. Mark the segment gear again when the quadrant elevation dials read 75°.

Check the superelevation setting indicated on the range scale. Check the appropriate list of problems for range and deflection to be set in. Set the required range on the range dial. If a decreasing deflection is to be set in, turn the elevation to about 85°, if an increasing deflection is to be set in, turn the elevation to about 0°.

Turn the elevation handwheel until the sliding dog of the clutch can be engaged with the gear without changing its position, then push in the clutch knob. Turn the handwheel to set in the desired deflection.

Turn on power. Use a stop watch to record the time required for the segment gear to move from 15° to 75°, or vice versa. Reverse the deflection immediately after the mark on the segment gear has passed the timing index, align the zero deflection marks, pull out the clutch knob, and turn off power.

The correct time for the movement is indicated in the problem. If this time is in error, check the trouble shooting chart for the cause.

SETTING AZIMUTH TEST PROBLEMS

Check the list of problems for the range and deflection setting which is to be made.

Align the lateral zero deflection marks. Pull out the clutch knob. Turn the azimuth

handwheel until the fine firing azimuth dial reads zero. This is for convenience only. Tighten the locking device (small knob) and disengage the orienting clutch by loosening the large knob.

Improvise an index attached to the base of the director and a mark on the support housing or the tripod as a reference for timing one revolution of the director.

Set in the required range. Turn on power. Turn the azimuth handwheel until the desired deflection is set in. Time one complete revolution of the director. Do not set in deflection before power is turned on because the initial torque required to start the director is quite high and may result in damage to the torque amplifier.

The correct time for the movement is indicated in the problem. If this time is in error, check the trouble shooting chart for the cause.

TROUBLE SHOOTING CHARTS

DIRECTORS, M5, M6

Trouble shooting on Directors, M5, M6, is a process of orderly analysis of the symptoms indicating faulty operation due to improper setup adjustments or damaged or worn parts. Troubles can be positively and quickly located if a regular procedure is followed. The information contained here is a guide to orderly analysis of troubles that may develop in these instruments. As the user gains experience in trouble shooting, this guide will not be necessary.

TEST PROBLEMS

CONTINUITY TEST

Note: Disconnect director from power source. Set present angular height to 45° by means of elevating handwheel. (This will prevent elevation limit switch from breaking circuits.)

- Terminal block #1 to X on elevation motors - Elevation switch on - off.
Terminal block #1 to X on azimuth motors - Azimuth switch on - off.
- Terminal block #15 to Y on elevation motors - Elevation switch on - off.
Terminal block #15 to Y on azimuth motors - Azimuth switch on - off.
- Terminal block #8 to Z on elevation motors - Elevation switch on - off.
Terminal block #8 to Z on azimuth motors - Azimuth switch on - off.
- Terminal block #1 to X on all transmitters.
- Terminal block #15 to Y on all transmitters.
- Terminal block #4 to #1 on Elevation fine transmitter.
- Terminal block #5 to #2 on Elevation fine transmitter.
- Terminal block #3 to #3 on Elevation fine transmitter.
- Terminal block #8 to #1 on Azimuth coarse transmitter.

Range Scale E, MV2600F.S. S.E. Setting .0694					
Time in seconds required for Telescopes to Elevate or Depress between 75° and 150°					
Range Yards		500	1000	1500	2000
ELEVATION DECREASING					
Deflection Degrees -5	Given Time	9.6 ± 0.8	17.4 ± 1.2	26.0 ± 1.6	35.5 ± 2.1
	Obs. Time				
	Error				
-10	Given Time	4.8 ± 0.5	9.0 ± 0.7	13.7 ± 1.0	19.3 ± 1.3
	Obs. Time				
	Error				
-15	Given Time	3.1 ± .5	5.9 ± 0.6	9.2 ± 0.8	13.0 ± 0.9
	Obs. Time				
	Error				
-20	Given Time		4.3 ± 0.5	6.7 ± 0.6	9.7 ± 0.8
	Obs. Time				
	Error				
-30	Given Time				6.0 ± 0.6
	Obs. Time				
	Error				
ELEVATION INCREASING					
Deflection Degrees 5	Given Time	10.6 ± 0.8	21.1 ± 1.4	35.3 ± 2.1	55.6 ± 3.1
	Obs. Time				
	Error				
10	Given Time	5.1 ± 0.6	9.8 ± 0.8	16.0 ± 1.1	23.9 ± 1.5
	Obs. Time				
	Error				
15	Given Time	3.2 ± 0.4	6.3 ± 0.6	10.1 ± 0.8	15.0 ± 1.0
	Obs. Time				
	Error				
20	Given Time		4.5 ± 0.5	7.2 ± 0.7	10.7 ± 0.8
	Obs. Time				
	Error				
30	Given Time				6.4 ± 0.6
	Obs. Time				
	Error				

Range Scale E, MV2600F.S. S.E. Setting .0694					
Time in seconds required for the Director to turn one complete revolution in Azimuth					
Range Yards		500	1000	1500	2000
AZIMUTH - CLOCKWISE					
Deflection Degrees 5	Given Time	50.0 ± 1.8	103.9 ± 3.4	169.0 ± 5.4	248.5 ± 7.7
	Obs. Time				
	Error				
10	Given Time	24.2 ± 1.0	50.9 ± 1.8	83.2 ± 2.8	122.6 ± 4.0
	Obs. Time				
	Error				
15	Given Time		32.7 ± 1.3	54.0 ± 1.9	79.9 ± 2.7
	Obs. Time				
	Error				
20	Given Time		23.3 ± 1.0	38.9 ± 1.5	58.0 ± 2.0
	Obs. Time				
	Error				
30	Given Time				34.8 ± 1.3
	Obs. Time				
	Error				
AZIMUTH - COUNTERCLOCKWISE					
Deflection Degrees -5	Given Time	50.0 ± 1.8	103.9 ± 3.4	169.0 ± 5.4	248.5 ± 7.7
	Obs. Time				
	Error				
-10	Given Time	24.2 ± 1.0	50.9 ± 1.8	83.2 ± 2.8	122.6 ± 4.0
	Obs. Time				
	Error				
-15	Given Time		32.7 ± 1.3	54.0 ± 1.9	79.9 ± 2.7
	Obs. Time				
	Error				
-20	Given Time		23.3 ± 1.0	38.9 ± 1.5	58.0 ± 2.0
	Obs. Time				
	Error				
-30	Given Time				34.8 ± 1.3
	Obs. Time				
	Error				

RANGE SCALE F
 S.E. Setting .058

Time in seconds required for telescopes to elevate or depress between 75° and 15°				
RANGE YARDS	500	1000	1500	2000
ELEVATION DECREASING				
Deflection	Given time	9.4+- .8	16.9+- 1.1	25.1+- 1.6
degrees	Obs. time			33.8+- 2.0
-5	Error			
	Given time	4.7+- .5	8.7+- .7	13.1+- 1.0
	Obs. time			18.0+- 1.2
-10	Error			
	Given time	5.7+- .6	8.7+- .7	
	Obs. time			
-15	Error			
	Given time			8.9+- .7
	Obs. time			
-20	Error			
	Given time			5.5+- .6
	Obs. time			
-30	Error			

ELEVATION INCREASING

Deflection	Given time	10.2+- .8	19.9+- 1.3	32.0+- 1.9	47.6+- 2.7
degrees	Obs. time				
5	Error				
	Given time	4.9+- .5	9.4+- .8	14.7+- 1.0	21.3+- 1.4
	Obs. time				
10	Error				
	Given time		6.0+- .6	9.4+- .8	
	Obs. time				
15	Error				
	Given time				9.7+- .8
	Obs. time				
20	Error				
	Given time				5.8+- .6
	Obs. time				
30	Error				

 RANGE SCALE F
 A. E. Setting, .058

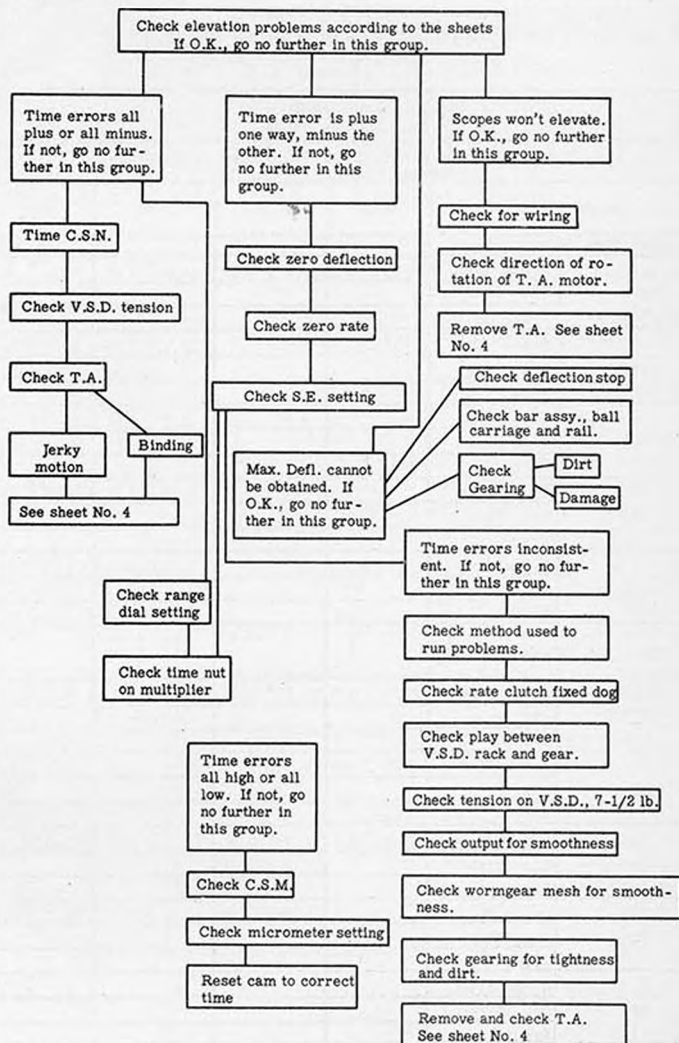
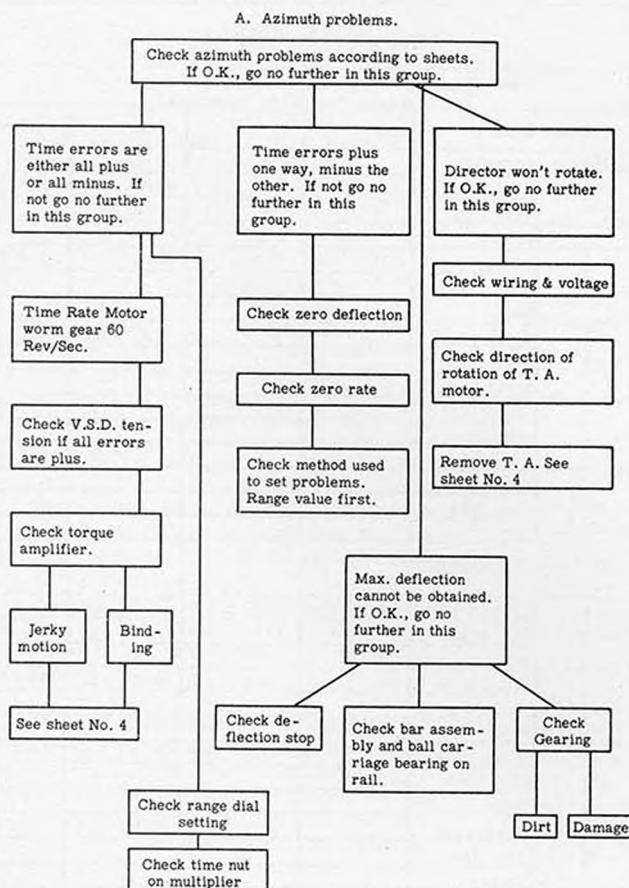
Time in seconds required for the Director to turn one complete revolution in Azimuth				
RANGE YARDS	500	1000	1500	2000
AZIMUTH - CLOCKWISE				
Deflection	Given time	48.9+- 1.9	99.2+- 3.3	158.1+- 5.0
degrees	Obs. time			226.0+- 7.1
5	Error			
	Given time	23.6+- 1.0	48.6+- 1.8	77.8+- 2.7
	Obs. time			111.5+- 3.6
10	Error			
	Given time		31.2+- 1.2	50.4+- 1.8
	Obs. time			
15	Error			
	Given time			52.6+- 1.9
	Obs. time			
20	Error			
	Given time			31.5+- 1.2
	Obs. time			
30	Error			

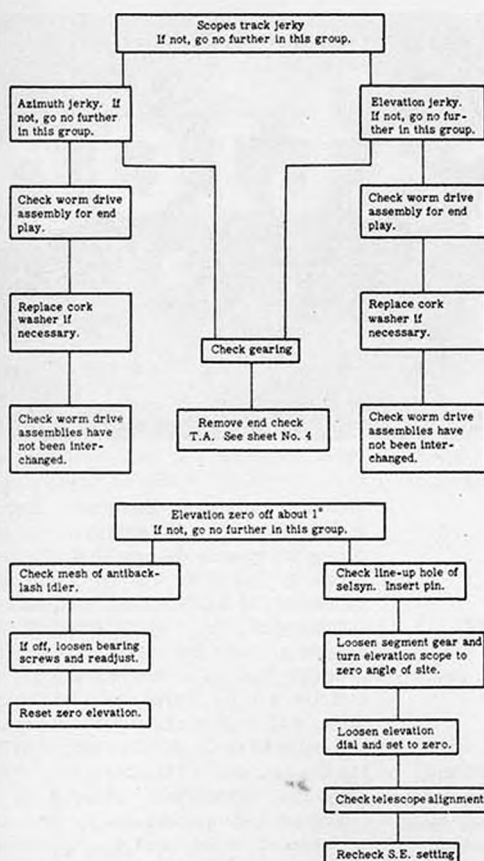
AZIMUTH - COUNTERCLOCKWISE

Deflection	Given time	48.9+- 1.9	99.2+- 3.3	158.1+- 5.0	226.0+- 7.1
degrees	Obs. time				
5	Error				
	Given time	23.6+- 1.0	48.6+- 1.8	77.8+- 2.7	111.5+- 3.6
	Obs. time				
10	Error				
	Given time		31.2+- 1.2	50.4+- 1.8	
	Obs. time				
15	Error				
	Given time				52.6+- 1.9
	Obs. time				
20	Error				
	Given time				31.5+- 1.2
	Obs. time				
30	Error				

TROUBLE SHOOTING CHARTS

B. Elevation problems.





10. Terminal block #9 to #2 on Azimuth coarse transmitter.
11. Terminal block #10 to #3 on Azimuth coarse transmitter.
12. Terminal block #11 to #1 on Azimuth fine transmitter.
13. Terminal block #12 to #2 on Azimuth fine transmitter.
14. Terminal block #10 to #3 on Azimuth fine transmitter.

INSULATION TEST

1. If a megger is available, terminal blocks #1-5 incl. will be "meggered" to director frame. Minimum acceptable resistance value is one (1) megohm.

2. The six (6) volt terminals on the illumination step-down transformer will be "meggered" to director frame. Minimum acceptable resistance value is one (1) megohm.



The October and November issues of THE ORDNANCE SERGEANT contained a series of articles pertaining to various types of vehicles. In connection with these articles the following letter has been received from the Office of the Chief of Ordnance.

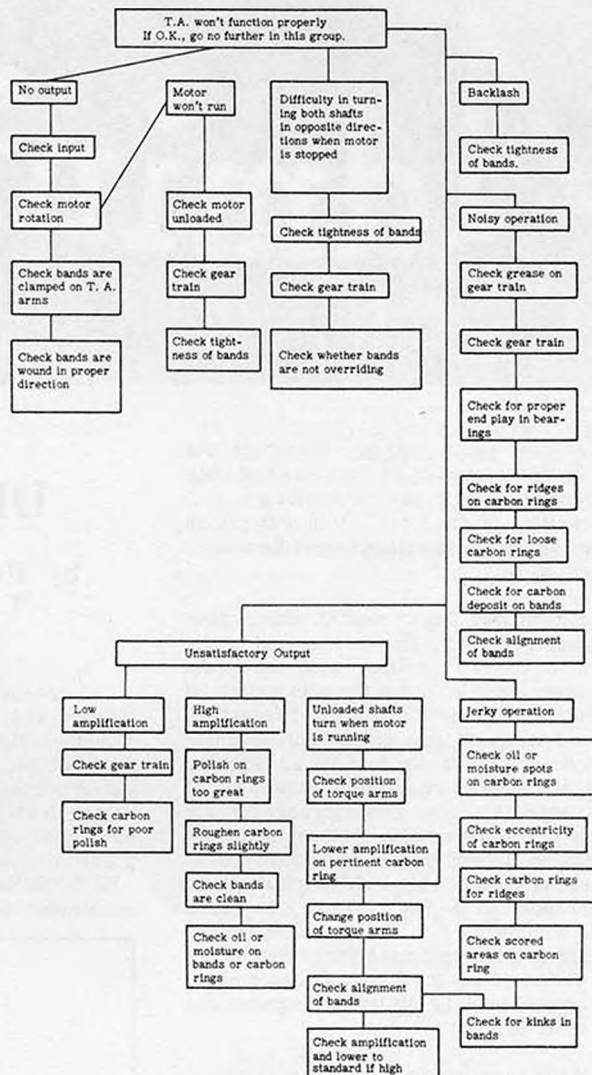
Editor, THE ORDNANCE SERGEANT
The Ordnance School
Aberdeen Proving Ground, Maryland

Dear Sir:

The October, 1942, issue of THE ORDNANCE SERGEANT, has very excellently prepared articles on several of the Ordnance Mobile Shop Trucks. In some cases it is noted that the writers referred to the facts that the trucks being described were in the limited standard classification, but in some instances this was not done. As far as the majority of these trucks are concerned, this isn't of great consequence, in the case of the Emergency Repair Truck, though, this can be misleading.

There was only a limited number of the Emergency Repair Trucks issued when they were placed under the limited standard classification. In

The Torque Amplifier.

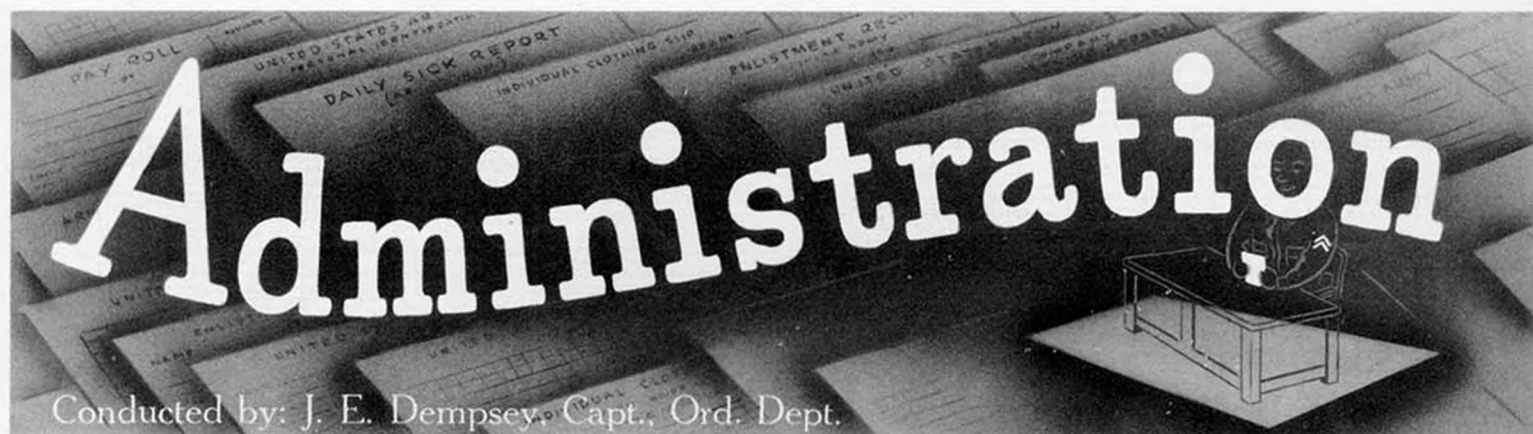


their stead, there is now being issued Ordnance Maintenance Sets A and B. These sets constitute essentially the same tools and equipment originally furnished in the Emergency Repair Trucks Load A and Load B, respectively, with the exception that they are furnished in a standard carrying case. The carrying case is then to be mounted in the body of a standard 3/4-ton Weapons Carrier.

In view of these facts, it is recommended that your next issue of the magazine make special mention of the fact that these trucks, including the Emergency Repair Trucks, are being placed in the limited standard classification, and that additional articles will be forthcoming in the near future on the newer type trucks which, it is believed, will be far superior to anything yet used in the field of maintenance work.

HOWARD W. KIZER
Colonel, Ord. Dept.

A study of the new type trucks has been begun, and articles describing them may be expected in early issues of THE ORDNANCE SERGEANT.



Conducted by: J. E. Dempsey, Capt., Ord. Dept.

A little over a year ago an article was written on this same subject but since that time so much has changed so as to necessitate a complete rewriting of the topic. It is with this in mind that we shall conduct the present discussion of desertion.

Recent War Department Circulars have emphasized repeatedly the seriousness of the military offense of desertion. Men who desert are severely punished under the 58th Article of War. Upon conviction of the charge of desertion, a soldier forfeits all pay and allowances which have accrued to his credit; forfeits all deposits; forfeits the rights of citizenship as well as the right to become a citizen. Deserters are forever incapable of holding any office of trust under the United States. Deserters can, when convicted of the charge of desertion occurring during time of war, be sentenced to death. Thus it behooves company commanders to impress upon the enlisted men of their command the gravity of the offense of desertion. In any case of desertion, a prompt repentance is no defense against the charge of desertion.

When an enlisted man goes absent without leave, his organization commander will immediately notify his nearest relative by telegraph or mail that he is absent without leave and that if he does not return he will be dropped as a deserter from the Army of the United States with the resultant disastrous consequences. The organization commander must also make a searching inquiry as soon as possible after the absence has been reported so as to discover any evidence which might point to the probable cause of the man's absence. Any evidence as to attempt to desert must be carefully preserved. Troubles in and out of the service should be noted and recorded. The facts developed, with names of competent witnesses will be carefully recorded in substantiation of intent, to be used when charges are required. Such evidence as debts owed, knowledge of marital difficulties, trouble with non-commissioned officers, and the like will be carefully investigated. There is no set form for recording this data, therefore it is suggested that the form as shown by Figure 1 be used.

In the event the organization is served by a Unit Personnel Section, the above form will be forwarded by the organization commander to the Unit Personnel Officer with the Morning Report on the date the man's status is changed from AWOL to desertion. If the organization performs their own personnel administration, the form will be forwarded with other reports to the station commander.

DESERTION

by HOWARD B. SCHOR
T. Sgt., Ord. Dept.

At the same time the organization commander will have an officer of his command, capably assisted by the Supply Sergeant, search for, secure, list, and properly safeguard all public property and clothing for which the absentee is responsible, including that which may have been left with the laundry or any other government agency. This list will be compared with the Enlisted Man's Individual Clothing and Equipment Record (W.D., A.G.O. Form No. 32)

and his Individual Equipment Record (W.D., A.G.O. Form No. 33) so that in case of desertion it may be readily determined whether any such property has been lost in consequence of his desertion. If any has been lost, the organization commander will, upon dropping the man in desertion, take the usual action in the case of property lost or destroyed and the value of the articles will be charged against the deserter on W.D., A.G.O. Form No. 36 (Statement of Charges) and entered on the Supplemental Pay Roll covering the accounts of the deserter. If it is necessary the appropriate affidavit by the Supply Sergeant and certificate by the organization commander to be used as supporting evidence to a Report of Survey (W.D., A.G.O. Form No. 15) will be executed. The organization commander will prepare a list of clothing left at the post by the deserter which may be in the form as shown in Figure 2.

COMPANY "A",		Fort Blank, Illinois,	
84TH ORDNANCE MAINTENANCE BN,		October 2, 1942.	
<u>EVIDENCE GATHERED AT TIME OF DESERTION</u>			
NAME:	Arthur C. Abernathy	GRADE:	Pvt
ASN:	363845670		
* DEBTS: _____ MARITAL DIFFICULTIES: ☒ TROUBLE WITH NCO's: _____			
** REMARKS: After a thorough investigation, it is believed by the undersigned that this man's absence is due to his difficulties with his mother and father-in-law. This man has been married only a short time and it seems that his wife's parents are continually mistreating her since her marriage to him. It was evidently his idea to get away from the Army and try to make a new home for his wife so as to get her away from her old home.			
 J. R. BURNS, Captain, Ord. Dept., Commanding			
(*) Place "X" in the appropriate space. (**) Give brief explanation of item marked "X".			

Fig. 1

The aforementioned list and the original W.D., A.G.O. Form No. 32, Individual Clothing and Equipment Record (a true copy of Form 32 is prepared and filed with the records of the organization) will be disposed of as directed for the Report of Evidence Gathered at Time of Desertion.

All issue clothing and individual equipment abandoned by a deserter will be immediately turned in to the Quartermaster for renovation and reissue when the enlisted man is dropped in desertion on the Morning Report. All other effects will be retained for six months by the post commander of the post from which the man deserted, unless he is returned to military control within that period and then the effects will be returned to the deserter at his expense. After that time they will be disposed of as stated in paragraph 8d, AR 615-300.

COMPANY "A",
84TH ORDNANCE MAINTENANCE BN,

Fort Blank, Illinois,
October 2, 1942.

I certify that the following is a list of the clothing left at this post by Private Arthur C. Abernathy, 363845670, Company A, 84th Ord. Maint. Bn., upon absents himself without leave from this station on October 1, 1942:

- 2 Ea Cap, Garrison, Khaki
- 1 Ea Cap, Herringbone twill
- 1 Ea Coat, Wool, Serge
- 5 Ea Drawers, Cotton, Shorts
- 2 Ea Handkerchief, cotton, white
- 1 Ea Jacket, Field
- 1 Pr Leggings, Canvas, Dsmtd, M-1938
- 1 Ea Necktie, cotton, khaki
- 1 Ea Raincoat
- 1 Ea Shirt, Cotton, Khaki
- 1 Ea Shirt, Flannel, OD
- 1 Pr Shoes, Service
- 1 Pr Trousers, Wool, OD
- 2 Pr Trousers, Cotton, Khaki

J. R. Burns
J. R. BURNS,
Captain, Ord. Dept.,
Commanding.

Fig. 2

In what instances will the enlisted man's status of "AWOL" be changed to that of "desertion"? This will occur when: (1) the enlisted man AWOL fraudulently enlists in one of the armed forces of the United States or in a foreign army; (2) the company or detachment commander after a thorough investigation believes that the absentee does not intend to return to his organization or that he quit his organization to avoid hazardous duty or to shirk important service; (3) the enlisted man has been AWOL for 20 days unless there is good reason to believe he intends to return; (4) the enlisted man goes AWOL while at a port of embarkation awaiting shipment overseas, or when he goes AWOL from his organiza-

tion after orders for its movement overseas have been published in the organization.

The effective date of desertion in these cases is the first day of unauthorized absence and NOT the day that the enlisted man's status is changed to desertion in the Morning Report. Thus, a man who is carried in a status of "AWOL" on October 1st and then dropped in "desertion" on October 20th, is considered to have deserted on October 1st - this being the effective date of desertion.

Within two (2) days after an enlisted man has been dropped on the Morning Report as a deserter, W.D., A.G.O. Form No. 44 (Report of Desertion) will be prepared in triplicate and the two carbon copies thereof forwarded direct to The Adjutant General, Washington, D.C., and the original copy securely fastened in the Service

To be forwarded in triplicate

No.

REPORT OF DESERTION

(See AR 615-300)

ABERNATHY, Arthur C. 363845670
(Last name) (First name) (Middle initial) (Army serial number)

Private, Co. A, 84th Ord. Maint. Bn.
(Grade) (Company, regiment, and arm or service)

absented himself without proper leave on 10/1/, 1942.

and is on this 20th day of October, 1942.
dropped as a deserter.

Witnesses as to charge of desertion:

Captain J. R. BURNS, Ord. Dept.
1st Sgt. PAUL C. JONES, 6456864, Co. A,
84th Ord. Maint. Bn.

Age at Enlist: 22 years; Rate of Pay:
\$50.00 per mo; Allotments: None.
Prior Service: None.

The soldier is also charged with additional offenses as follows (give a summary only; if none, so state):

None.

Witnesses as to additional offenses:

None.

J. R. Burns
J. R. BURNS, Capt., Ord. Dept.,
(Signature with grade and organization)

Commanding Company "A".

Place Fort Blank, Illinois.
W. D., A. G. O. Form No. 44
January 15, 1937

Fig. 3

essary for action upon charges, including age at enlistment or induction, rate of pay, allotments and insurance deductions and prior service. See Figure 3.

The remainder of the report will be completed to show the records transmitted and will also contain extracts from the Morning Report affecting the individual concerned. These extracts from the morning report will include the complete date of each and the initials of the officers authenticating the remark.

When the individual is brought to trial for desertion, Page No. 3, of the Report of Desertion will be detached from the rest of the report and presented in evidence before the court martial.

Within five (5) days after the man is dropped in desertion, the following records required in case of deserters will be completed and forwarded to the Commanding Officer of the station from which the enlisted man absented himself without leave. These records will be retained by the station commander for a period of six (6) months. If after six months the deserter has not returned to military control, these records will be forwarded to The Adjutant General, Washington, D.C.

Record W.D., A.G.O. Form No. 24). In units that are served by a Unit Personnel Section (Regiments, Separate Battalions, etc) the report will be prepared by the Unit Personnel Officer for the signature of the organization commander and then proper distribution made by the Unit Personnel Officer. When organizations perform their own personnel administration, this report will be prepared and distributed by the organization commander.

In the preparation of the Report of Desertion (W.D., A.G.O. Form No. 44), Page No. 1, will, in addition to other information required thereon, show all pertinent information nec-

a. **SERVICERECORD, W.D., A.G.O. Form No. 24.** - The Service Record will be forwarded by filling in the next unused numbered indorse-

REPORTS AND RECORDS FORWARDED		THESE COLUMNS ARE FOR A.G.O. USE ONLY	
Name	Number	Missing papers called for	Receipt and disposition in A.G.O.
Service Record	1		To File
Individual Clothing Record	1		
List of clothing left at post	2		
Evidence gathered at des.	2		
Soldier's Qual. Card	1		

Reason for not forwarding a required paper will be stated below:

* In this column will be entered the number of copies of each report or record forwarded, using pencil if desired.

3-5171

Fig. 4

ment. This indorsement will show The Adjutant General, Washington, D.C., as the recipient and not the commander of the station to whom the records are originally forwarded after desertion. This eliminates the necessity of preparing another indorsement in the event the man does not return to military control within the period of six months. The fact of desertion will be shown in the indorsement by amending so much of the indorsement as reads "This soldier was transferred to" by deleting the words "was transferred to" and adding the words "deserted" together with date and place of desertion. The entry in the indorsement under "and left this organization" will be the effective date of desertion which is the first date of unauthorized absence as shown in the Morning Report and not the date his status was changed from AWOL to desertion. The indorsement will also include a statement of the deserter's accounts at time of desertion. In some units it is a common practice to show in the indorsement that the man's accounts have been stated on the required Supplemental Deserter's Pay Roll and the disbursing officer to whom such pay roll was submitted. See Figure 6.

b. **DESCRIPTIVE LIST OF DESERTER, W.D., A.G.O. Form No. 45.** - Regulations prescribe that the Post Commander distribute this form to police officials, post offices, etc., in or near the vicinity of the deserter's home or any other place that it is believed that the man might visit. This form will be prepared by the office preparing other records in as many copies as

* EXTRACT COPY OF MORNING REPORT OF—

Company "A", 84th Ord. Maint. Bn.,
(Company, troop, battery, or detachment) (Regiment or other organization)

Oct 1/42 Pvt Abernathy duty to
MCB AWOL 6:00AM. JRB

Oct 20/42 Pvt Abernathy AWOL to des. JRB
MCB

Co A, 84th Ord Maint Bn Ft Blank, Ill, 10/20/42
(Complete designation of command) (Station) (Date)

I, J. R. BURNS, Capt., Ord. Dept., certify
(Name, grade, and arm or service)

that I am the commanding officer of Co A, 84th Ord
(Complete designation of command)

Maint Bn and official custodian of the morning reports of said command, and that the foregoing is a true and complete copy (including any signature or initials appearing thereon) of that part of the morning report of said command submitted at Fort Blank, Illinois
(Station)

for the dates indicated in said copy which relates to Arthur C. Abernathy, 363845679 Pvt., Co A,
(Full name, Army serial number, grade, and organization of person referred to in extract copy)

J. R. BURNS
J. R. BURNS,
Captain, Ord. Dept.
(Grade and arm or service)

* In case the Extract Copy of Morning Report is offered in evidence before a court martial, it must be detached from pages 1 and 2.

3-5171

Fig. 5

may be deemed necessary and forwarded to the station commander with other records for proper disposition. See Figure 7.

c. **SOLDIER'S QUALIFICATION CARD, W.D., A.G.O. Form No. 20.** - The Soldier's qualification card will be forwarded with other records to the station commander from which the deserter first absented himself without leave for file and subsequent disposition.

In preceding paragraphs have been discussed all reports and records required to be completed and forwarded to the station commander from which the deserter first absented himself without leave. A recapitulation of these froms is as follows:

- Evidence Gathered at Time of Desertion.
- List of Clothing Left at Post.
- Individual Clothing & Equipment Record (WD AGO Form No. 32).

d. Report of Desertion (WD AGO Form No. 44).

e. Service Record (WD AGO Form No. 24).

f. Descriptive List of Deserter (WD AGO Form No. 45).

g. Soldier's Qualification Card (WD AGO Form No. 20)

The records and reports previously discussed are only part of the records and reports required in cases of deserters. In following paragraphs, we will discuss a number of other

2 Ind.

Hq. 84th Ordnance Maintenance Bn.,
Fort Blank, Ill., October 21, 1942
The Adjutant General, Washington, D.C.
This soldier ~~XXXXXXXXXX~~ Deserted Oct. 1, 1942 at
~~Fort Blank, Ill.~~ this organization October 1, 1942
He was last paid to include September 30, 1942
by C. H. Cohen, Capt., F.D.
(Name and grade of finance officer or agent officer, if any)
Due United States: ~~XXXXXXXXXX~~ \$8.76 overpayment mo
of Sept/42 on Vou #320, accts of C. H.
Cohen, Capt., F.D., Sept/42. Accounts
stated on Supplemental Deserter's Pay
Roll and forwarded to Capt. C. H. Cohen,
F.D., Fort Blank, Ill., Oct. 21/42.

Due soldier at date of des: \$15.00 deposited with
Capt. C. H. Cohen, FD, Aug. 2/42.

This soldier ~~has the~~ a Class E allotment running which has been deducted from his
pay to include 19...
This soldier ~~has the~~ not authorized a Class D deduction for Government insurance which has
been deducted from his pay to include 19...
His character is ~~Good~~ *Poor* JRB
Efficiency rating as soldier ~~is satisfactory~~ *is unsatisfactory*
have personally verified all entries in this indorsement.
A. R. COMPTON
1st Lieut., Ord. Dept.
(Grade and organization)

This soldier reported 19... (Organization to which transferred)
and was assigned to (see page 5).

* Here enter any amounts due soldier and not paid to date, such as monetary allowance in lieu of quarters and subsistence; if nothing, so state.
(Strike out words not applicable.)

3-5555

Fig. 6

reports and records required to be prepared for deserters:

a. **EXTRACT FROM SERVICE RECORD, W.D., A.G.O. Form No. 25.** - The extract from the Service Record contains pertinent information concerning the individual taken from the Service Record to be used for future reference. This form includes a facsimile of the forwarding indorsement in the Service Record. See Figure 8.

This form when completed, is filed in the office of preparation.

b. SUPPLEMENTAL DESERTER'S PAY ROLL. - The Supplemental Deserter's Pay Roll is prepared in triplicate on W.D., Form No. 366 and 366a. This pay roll contains a statement of the accounts of the deserter from the date of last full payment to include the date preceding the first day of unauthorized absence. The original and first carbon copy of the roll are forwarded immediately to the disbursing officer designated to pay the command to which the individual belonged. The triplicate copy is filed by the office preparing the pay roll. See Figure 9.

c. NOTIFICATION OF DISCONTINUANCE OF ALLOTMENTS, W.D., A.G.O. Form No. 30.

DESCRIPTIVE LIST OF DESERTER OR ESCAPED MILITARY PRISONER FROM THE ARMY OF THE UNITED STATES

(See AR 615-300)

The man described below is a (deserter) ~~from the Army of the United States~~ and his return to military control is desired. If apprehended by you, either deliver him to the nearest military post, camp, or station or hold him and inform the nearest military post, camp, or station that he is in your custody.

For payment for expenses and services, see paragraph 2 on the reverse side of this form.

ABERNATHY, Arthur C., 36845670
(Last name) (First name) (Middle initial) (Army serial number)

Private, Co A, 84th Ord. Maint. Bn.
(Grade) (Company, regiment, and arm or service)

Accepted for enlistment at Chicago, Illinois
Enlisted May 22, 1941

at Chicago, Illinois
Deserted October 1, 1942

at Fort Blank, Illinois
Born in Calhoun, Illinois

(Town or city) (State or country)

Age 22 years; occupation Farmer
Eyes Blue; hair Brown; complexion Ruddy

Height 5 feet 9 inches
Residence Route #6, Calhoun, Illinois

(Name and address of nearest relative as given by soldier)
Alton B. Abernathy (Father)

(Name and degree of relationship)
Route #6, Calhoun, Illinois

(Address)
Name and address of person to be notified in case of emergency as given by soldier:

Alton B. Abernathy (Father)

(Name and degree of relationship, if friend, so state)
Route #6, Calhoun, Illinois

(Address)
REMARKS.—Prominent scars and marks; also any peculiarities in appearance, clothing worn at desertion, or any other information which may aid in apprehension.

None.

A. R. Compton
A. R. COMPTON, 1st Lt., Ord. Dept.
Personnel Officer.

Fort Blank, Illinois
(Station)

October 21, 1942
(Date)

W. D., A. G. O. Form No. 45
Sept. 18, 1941

*Strike out words not applicable. 10-24061-1

Fig. 7

(1) Class "E" Allotments. - If the deserter had a Class "E" Allotment, this form will be prepared in duplicate and the original forwarded to the Chief of Finance, Allotment Division, Washington, D.C., and the duplicate filed with the retained records of the deserter. See Figure 10.

(2) Class "D" or "N" Allotments. - In the event the deserter had a Class "D" or "N" Allotment, this form will be prepared in triplicate. The original will be forwarded to the Chief of (Continued on page 601)

RECORD OF IMMUNIZATION

(Type of vaccination or diptheria susceptibility test)

SPECIFY	DATE	RESULT

If carrier examination, show parasite examined for, and kind of specimen.

Blood type

2nd Ind.

Hq. 84th Ordnance Maintenance Bn.,

Fort Blank, Ill., October 21, 1942

The Adjutant General, Washington, D.C.

This soldier deserted Oct. 1/42 at Fort Blank,

xx Illinois and left this organization Oct. 1, 1942

He was last paid to include September 30, 1942

by C. H. Cohen, Capt., F.D.

(Name and grade of financial officer or agent, if any)

Due United States; if nothing, so state Due US \$8.76 over-

payment mo. of Sept/42 on Vou. #320

accts. of C.H. Cohen, Capt., FD, Dept/42

Due soldier at date of des: \$15.00 deposited with C

C.H. Cohen, FD, Aug. 2, 1942 Capt

This soldier (has not) a Class E allotment running which has been deducted from

his pay to include 19

This soldier has authorized a Class D deduction for Government insurance which

has been deducted from his pay to include 19

This soldier has authorized a Class N deduction for Government insurance which has

been deducted from his pay to include 19

His character is

Efficiency rating as soldier

I have personally verified all entries in this endorsement.

A. R. Compton
A. R. COMPTON,

1st Lt., Ord. Dept.,

Personnel Officer.

REMARKS

Here will be shown such other entries not set forth elsewhere as may be required to

make the extract complete as in the case of a soldier finally separated from the

service.

Report of Desertion, WD AGO Form #44

Soldier's Qualification Card

Descriptive list of Deserter

List of Clothing Left at Post

Evidence gathered at time of desertion

Service record with inclosures transmitted to CO, Ft. Blank, Ill.

by A. R. Compton, 1st Lt. Ord. Dept., 10/21/42

6. Inc. (Individual clothing record) *Strike out words not applicable

(See Remarks) 10-25078-2

Fig. 9

EXTRACT FROM SERVICE RECORD

(See AR 345-125)

OF

ABERNATHY, Arthur C., 36845670

(Last name) (First name) (Middle initial) (Army serial number)

Home address Route #6

(Number and street or rural route; if none, so state)

Calhoun, Illinois

(City, town, or post office) (State or country)

Name and address of nearest relative Alton B. Abernathy

(Father) Route #6

(Relationship) (Number and street or rural route; if none, so state)

Calhoun, Illinois

(City, town, or post office) (State or country)

Person to be notified in case of emergency Same as above

(Degree of relationship) (Number and street or rural route; if none, so state)

Same as above

(City, town, or post office) (State or country)

Age at enlistment 22 yrs. 3 mos. Rate of pay per mo. \$50.00

Accepted for service at Chicago, Illinois

Enlisted or inducted at Chicago, Illinois

on the 22nd day of May 1941

in grade of Pvt. by J. J. JOHNSON, Capt.,

for Ordnance Department FA

(Company, regiment, arm or service) (Words and figures)

to serve Three (3) years.

Completed years months days for longevity pay,

at enlistment or induction. Has over years' service.

Grade Pvt. Specialist rating

Time lost prior to the normal date of expiration of term of enlistment to be made good

under 107th Article of War (here give inclusive dates of absence, number of days, and cause):

No time lost under 107th AW.

Sentences by courts martial:

Confinement None

Forfeitures None

Detained pay None

Deduction for Class E allotment, \$None per month.

Deduction for Class D insurance, \$None per month.

Deduction for Class N insurance, \$None per month.

PRIOR SERVICE

None from 19 to 19

(Co. regt., arm, or service) (Grade)

Discharged as character

By reason of from 19 to 19

(Co. regt., arm, or service) (Grade)

Discharged as character

By reason of from 19 to 19

(Co. regt., arm, or service) (Grade)

W. D., A. G. O. Form No. 25 April 25, 1942

10-25078-4

Fig. 8

Fig. 9

PAY ROLL

OF

COMPANY "A" 84th ORDNANCE MAINTENANCE BN.

FORT BLANK, ILLINOIS

For month of OCTOBER 1942

Page 2

NAME, PRESENT AND ANCESTRAL GRADE, AND SERIAL NUMBER

SELECTIVE TRAINING

PRIVATE

1. ABERNATHY, Arthur C., 36845670

2. Last pd to include Sept. 30, 1942, by

3. Captain C. H. Cohen, FD, Fort Blank, Ill. Due

4. \$8.76 overpayment mo. of Sept/42 on Vou. #320

5. accts. of C.H. Cohen, Capt., FD, Sept/42. Due

6. sol for dpt made with Capt. C. H. Cohen, FD, Aug. 2, 1942 \$15.00.

7.

8.

9.

10. "I further certify that the payment to the enlisted man named on the within

11. payroll is not prohibited by any provisions of law limiting the availability of the

12. appropriations involved."

13.

14.

15.

16.

A. R. Compton
A. R. COMPTON,
1st Lt., Ord. Dept.,
Personnel Officer.

Voucher No.

Fort Blank, Illinois Oct. 21, 1942

I certify that this roll is made out as required by Army Regulations, that entries pertaining to such names are correct; that where postal or enlistment allowance is due, the soldier was not furnished ration for the period that quarters allowance is due, he or she was actually occupied quarters at the address shown. Except otherwise stated each man was last paid to Sept. 30/42.

C. H. COHEN, Captain F.D., U.S.A.

A. R. Compton
A. R. COMPTON,
1st Lt., Ord. Dept.,
Personnel Officer.

I certify that I witnessed the payment of this roll and that prior to the issuing of this certificate each man received the amount not applicable his name, with the exception of those men marked "Not paid."

Note.—This certificate will be signed only on the copy of the pay roll which bears signatures of the men for payment to mail.

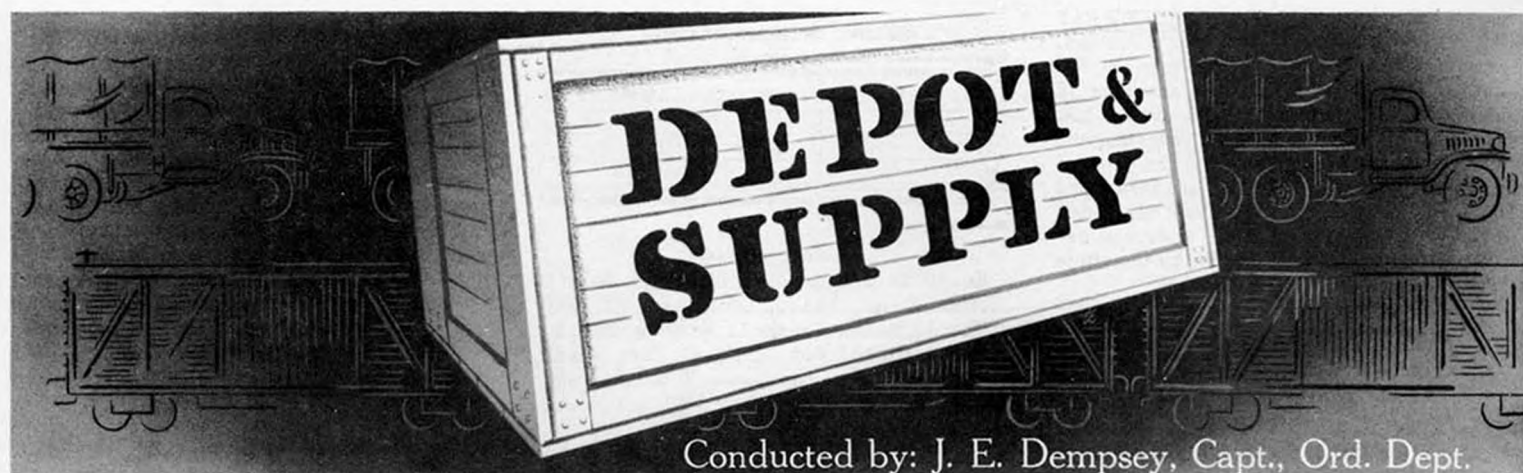
Note.—This certificate will be signed only on the copy of the pay roll which bears signatures of the men for payment to mail.

Note.—This certificate will be signed only on the copy of the pay roll which bears signatures of the men for payment to mail.

Post Exchange; Co. Fund and Collections paid by check on Treasurer U.S.

Date 19

PAYEE CHECK NO. AMOUNT



In a preceding article in this section, the preparation and purpose of an Inventory and Inspection Report (W.D., I.G.D. Form No. 1) was discussed. You will recall that there are two classes of unserviceable property, namely Class I property — that is property that has been worn out through fair wear and tear in the public service, or property that has been declared obsolete, and Class II property — that is, property that has become unserviceable through causes other than fair wear and tear. The Inventory and Inspection Report is most frequently used for the disposition of Class I property. This is the only purpose of an Inventory and Inspection Report. A Report of Survey (W.D., A.G.O. Form No. 15) may also be used for the disposition of Class I property, but is most commonly used for the purpose of fixing responsibility for the loss or damage to public property (Class II Property), and for the disposition of the property when disposition is involved. With this distinction, the writer believes that the article on the Report of Survey that follows will be more clearly understood.

Whenever a Report of Survey is required, it should be prepared by the responsible officer as soon as practicable and in any event within 30 days after discovery of such loss or damage. In the event that the Report of Survey is not prepared within 30 days, the responsible officer must attach a certificate to the report indicating his reasons why he had not prepared this report within the prescribed period. The Report of Survey is usually prepared in triplicate and forwarded to the commanding officer. There are a few mechanics in the actual preparation of the report that should be strictly observed by the responsible officer. Separate reports are to be prepared for property pertaining to the different supply arms and services. The money total on each sheet must be initialed by the responsible officer. Care should be exercised to avoid alterations such as erasures, interlineations, etc., and whenever it occurs, the officer making it should initial the change. Under the date and circumstances, the officer should give a brief and clear statement of all facts in the matter and, whenever supporting documents are being submitted, reference them separately and alphabetically as Exhibit "A", "B", "C", etc., pertaining to the Report of Survey being prepared. See Figure 1. The certificate and affidavit on the form should be properly subscribed to but the certificate may be omitted if the oath is signed by the responsible officer and his signature properly acknowledged. See Fig. 1. When the Report of Survey covers damaged or unserviceable property of a value not exceeding \$500.00 (at depots and arsenals

Report of Survey

by ABRAHAM RESNEK
Sergeant, Ord. Dept.

the limitation of \$500.00 is waived) and in the opinion of the responsible officer all concerned should be relieved from responsibility, he will also include under date and circumstances a recommendation for the disposition of the property.

The responsible officer will attach to the original copy of the Report of Survey all documentary evidence in his own behalf as may be available. He will also attach any supporting papers on the behalf of anyone else who may be involved in the Report of Survey. Documentary evidence may be in the form of certificates, affidavits, Over, Short, and Damaged Reports, Bills of Lading, etc. Affidavits from enlisted men used in support of a Report of Survey may be in the form indicated in Figures 2 and 3.

Each item of documentary evidence will bear a notation in the lower left corner so as to properly identify it with the Report of Survey to which it pertains, e.g., "Exhibit A" — R/S 10/17/42 — \$2.59". See Figures 2 and 3.

The "Findings" in each case are indicated by the Surveying Officer. Here should be indicated all information relative to the report as determined by the data submitted, and where oral testimony has been considered the name of each witness and a concise statement of the testimony is entered. Immediately after the "Findings", without loss of space, a caption entitled "Recommendations" should follow, and these recommendations by the Surveying Officer should cover completely all subjects or articles investigated. If additional space for the findings and recommendations is necessary, additional sheets may be attached. The station, date, and signature of the Surveying Officer will follow the recommendations. See Fig. 4.

It is interesting to note that under certain conditions, the commanding officer must appoint a surveying officer to investigate and report on shortages in shipment before the Report of Survey can be considered valid. In several instances, the appointing authority can act on a Report of Survey without the appointment of a Surveying Officer, and for convenience when this is done, the survey is referred to as a "short form" Re-

port of Survey. However, although authority is delegated in these several instances for the commanding officer to approve Reports of Survey without a Surveying Officer, he may under any circumstances, if he desires, appoint a Surveying Officer.

One of the most frequent uses of a Report of Survey is when shortages or damages occur in shipment and a common carrier or the shipping officer is involved. In such cases, the first action by the receiving officer is to immediately make a notation of the shortage or damage on the "property received copy" of the Bill of Lading. This is important so that the finance officer can make a proper adjustment before payment is made on the original copy of the Bill of Lading to the carrier.

When a common carrier accepts responsibility for a loss or damage in shipment, the receiving officer should immediately obtain from the carrier's agent a written acknowledgement of the responsibility. If the value of the articles involved does not exceed \$10.00 and if this written acknowledgement is not readily obtainable, it may be omitted. Under these circumstances, a Report of Survey will be initiated by the receiving officer and this written acknowledgement of the carrier, if obtained, together with the following information and evidence will be included in or submitted with such report:

- A brief statement of the circumstances, including a reference to the serial number and date of the Bill of Lading involved.
- An accurate listing of the quantity, value and weight of the property lost or damaged beyond repair, and a recommendation as to disposition of damaged property.
- In case of reparable damage, as itemized statement as to cost of repairs.

If the value of the property involved does not exceed \$10.00, the first step by the receiving officer would be to prepare a Report of Survey. In all instances, except if definitely indicated to the contrary, a Report of Survey is prepared in triplicate. Upon return by the commanding officer of an approved copy of the Report of Survey, the receiving officer will file it with his retained copy of the corresponding shipping ticket and will execute on the copy of the shipping ticket returned to the shipping officer the following certificate:

**"NO ACCOUNTABILITY"
REPORT OF SURVEY**

ORDNANCE Property 150th Ordnance Company (MM), Fort. Blank, Illinois
(Class of property, ordnance, medical, etc.) (Stock record account and station)

Accountable officer WILLIAM G. BURTE, Captain, Ord. Dept. Date October 17, 1942

STOCK NO.	ARTICLES	QUANTITY	TOTAL COST	DISPOSITION		
				DESTROY	SALVAGE	OTHER
	GROUP B-6					
	BARREL	1	\$2.59			
Grand total			\$2.59			

DATE AND CIRCUMSTANCES

On October 3, 1942, PISTOL, automatic, Cal. .45, M1911A1, serial number 146250, was issued to Private William Jones, 31496850, 150th Ord Co (MM). Examination of pistol on Oct. 15, 1942, by inspecting officer disclosed that the barrel of said pistol was so pitted and rusted as to be beyond further use or repair. Statement of Charges were prepared and cost of pistol barrel entered on payroll against Private Jones for the month of Oct. 1942. He refused to acknowledge the charge and demands a R/S under Par. 2b (3), AR 35-6640. (See Exhibits "A" and "B" attached hereto.)

AFFIDAVIT

I do solemnly swear that the articles of public property shown above and/or attached sheets were lost, destroyed, damaged, or worn out in the manner stated, while in the public service.

William G. Burte
WILLIAM G. BURTE,
Captain, Ordnance Dept.
(Grade and organization)

Subscribed and sworn to before me at Fort. Blank, Illinois

this 17th day of October, 1942.

Roger Bacon
ROGER BACON
Captain, Inf., Adjutant.
(Grade and organization or title; if notary public, affix seal)

W. D., A. G. O. Form No. 15
July 15, 1935

CERTIFICATE

I certify that the ~~loss~~ destruction, damage, or unserviceability of the articles of public property shown above, and/or on attached sheets, was caused in the manner stated and without fault or neglect on my part, and that each article listed with a view to elimination by destruction has been examined by me personally, has never been previously condemned, and is, in my opinion, worthless for further public use.

(Signature)
(Grade and org., accountable or responsible officer)

Hq. FORT BLANK,
Station Fort. Blank, Illinois
Date October 17, 1942

To R. B. Conley, Captain,
Infantry

who is appointed surveying officer.
By order of Colonel SMITH,
Roger Bacon
ROGER BACON, Capt., Inf. Adjutant.

Fig. 1

"I certify that the articles designated by # above were not received by me, that the value of the articles short is \$ _____ and in accordance with the provisions of paragraph 4c, AR 35-6640 have not been taken up on the stock record account."

In the event this certificate covers damaged property, the above certificate will be modified accordingly.

Quite often a loss, damage, or shortage in shipment occurs when the value of this shortage or damage exceeds \$10.00 and the common carrier refuses to accept responsibility. Aside from the notation by the receiving officer on the Bill of Lading which should always be his first step in every case of discrepancy, the receiving officer should modify the shipping ticket accordingly by adding the words "Except as noted" to the acknowledgement of receipt on the shipping ticket, and initiate in triplicate an Over, Short, and Damaged Report (W.D., Q.M.C. Form

No. 445). One copy of this report will be filed with his retained copy of the shipping ticket, and the other two copies of the Over, Short, and Damaged Report will be forwarded to the shipping officer with the modified shipping ticket. If the shipping officer accepts responsibility for the shortage, he will approve the Over, Short, and Damaged Report. The shipping officer will retain one copy of the OS&D Report for his records, and return the other copy to the receiving officer. The receiving officer will attach the approved OS&D Report to his retained copy of the shipping ticket and this will terminate the matter.

However, if the shipping officer is unwilling to accept responsibility for the shortage and this will in most instances be the case, the procedure on the part of all concerned becomes involved. The shipping officer would in the first instance indicate "Disapproved" over his signature on both copies of the OS&D Report. He will retain one copy and return the other copy to the receiving officer. The shipping officer will prepare for his side of the case all certificates and affidavits that he thinks essential and necessary to show that he should be relieved from all responsibility. These certificates and affidavits will be attached to the "Disapproved" copy of the OS&D Report being returned to the receiving officer. Upon receipt of the Disapproved OS&D Report, the receiving officer will initiate a Report of Survey in triplicate. He will attach to the original copy of the Report of Survey the affidavits and certificates of the shipping officer and also all affidavits and certificates he wishes to present on his own behalf. In addition, all documentary evidence and data such as a true copy of the Bill of Lading, an itemized statement of the cost of repair when

STATE OF ILLINOIS)
COUNTY OF CARROLL) ss

Fort Blank, Illinois,
October 17, 1942.

Before me, the undersigned, authorized by law to administer oaths in cases of this character, personally appeared Private William Jones, 31496850, 150th Ordnance Company (MM), Fort Blank, Illinois, who being duly sworn according to law, deposes and says:

"On October 3, 1942, PISTOL, automatic, cal. .45, M1911A1, serial number 146250, was issued to me by Sergeant John Smith, Supply Sergeant, 150th Ordnance Company (MM). I did not inspect this pistol at the time it was issued to me. From the date I received the pistol until it was inspected, I kept this pistol in the rack in my barracks as ordered. There was no occasion during this period, October 3, 1942 to October 15, 1942, to use said pistol for practice at the range or duty of any kind. Under the circumstances, I feel that I am in no way responsible for the pistol barrel becoming rusted and pitted, and in my opinion, this pistol was issued to me in this condition."

Further deponent sayeth not.

William Jones
WILLIAM JONES, 31496850,
Pvt., 150th Ord. Co. (MM).

Subscribed and sworn to before me at Fort Blank, Illinois, this _____ day of October, 1942.

Roger Bacon
ROGER BACON,
Captain, Infantry,
Adjutant.

Exhibit "A" - R/S 10/17/42 - \$2.59.

Fig. 2

STATE OF ILLINOIS)
COUNTY OF CARROLL) ss

Fort Blank, Illinois,
October 17, 1942.

Before me, the undersigned authorized by law to administer oaths in cases of this character, personally appeared Sergeant John Smith, 31168440, 150th Ordnance Co (MM), Fort Blank, Illinois, who being duly sworn according to law deposes and says:

"I am the Supply Sergeant of the 150th Ordnance Company (MM). My records indicate that on October 3, 1942 I issued PISTOL, automatic, cal. .45, M1911A1, serial number 146250 to Private William Jones, 31496850, 150th Ordnance Co (MM). The said pistol was examined by me before issue and found to be in good condition. This pistol was received from the Ordnance Property Officer, Fort Blank, Illinois, on September 25, 1942, and was in good condition at the time received. Private Jones received the first issue of the pistol. At no time while this pistol was in the possession of Private Jones did he report any defect in the barrel."

Further deponent sayeth not.

John Smith
JOHN SMITH, 31168440,
Sergeant, 150th Ord. Co. (MM).

Subscribed and sworn to before me at Fort Blank, Illinois, this 17th day of October, 1942.

Roger Bacon
ROGER BACON,
Captain, Infantry,
Adjutant.

Exhibit "B" - R/S 10/17/42 - \$2.59.

Fig. 3

damaged property is involved, copy of the "Disapproved" OS&D Report, etc., should be attached to the original copy of the Report of Survey. It is also imperative, that a certificate be attached to the original copy of the Report of Survey by the receiving officer stating whether the circumstances indicate that a common carrier was or was not liable. This certificate should be followed by a recommendation of the receiving officer if unserviceable property is involved as to its disposition. Upon completion of all action by the receiving officer in this matter, all papers will be submitted to the commanding officer.

If the value of the property concerned does not exceed \$20.00, the commanding officer may dispose of the report without appointment of a Surveying Officer. He may hold the carrier liable or relieve all concerned.

When the value of the property exceeds \$20.00 but not over \$500.00, the commanding officer may approve the report to relieve all concerned without the action of a Surveying Officer. To hold the carrier liable when the amount is over \$20.00, he must appoint a Surveying Officer. If the amount involved in any instance is over \$500.00, the commanding officer is compelled to appoint a surveying officer.

Upon return to the receiving officer of an approved Report of Survey when an OS&D Report is involved, he will notify the shipping officer by sending him a true extract copy of the findings of the Surveying Officer.

As indicated previously in this article, the appointing authority under any circumstances may appoint a surveying officer. However, the

appointment of a Surveying Officer is compulsory in the following cases:

a. Property of a value greater than \$20.00, lost, destroyed, or damaged in transit, when responsibility for the loss, destruction, or damage is not accepted by the shipping officer, or by the carrier, and the commanding officer does not approve the report as submitted to relieve all concerned.

b. Property of a value greater than \$500.00 when ordered to be abandoned.

c. Property lost, destroyed, or damaged through the fault or neglect of an officer or enlisted man, and for which he declines to accept a charge against his pay.

d. Property found to be short or damaged upon transfer of accountability from one individual to another, when controversy arises as to the liability for such shortage or damage.

e. When survey is directed by the commanding officer or higher authority.

f. When the value of property short, damaged, or otherwise unserviceable exceeds \$500.00 or when in the judgement of the commanding officer all concerned should not be relieved from responsibility. At depots and arsenals the limitation of \$500.00 is waived.

FINDINGS.—I have examined all available evidence as shown in exhibits A to B and as indicated below have personally investigated the same and it is my belief that the articles listed hereon and/or on attached sheets, total cost \$2.59 was pitted and rusted through the fault and neglect of Private William Jones, 31496850, 150th Ordnance Company (MM). That the present condition of the barrel, alleged by Private Jones to have existed at time of issue to him, was never reported by him to anyone in authority. That the pistol, of which said barrel was a part, was received from the Ordnance Property Officer, Fort Blank, Ill., on September 25, 1942, and was inspected by Sergeant John Smith, 31168440, Supply Sergeant, 150th Ordnance Co (MM), and found to be in excellent condition. That said pistol, at time of issue to Private Jones on October 3, 1942, was again inspected and found in excellent condition. Exhibits "A" and "B" considered. **RECOMMENDATION:** That cost of barrel listed on this R/S, in the full amount of \$2.59, be charged against the pay of Private William Jones, 31496850, 150th Ordnance Company (MM).

Fort Blank, Illinois,
October 20, 1942.

R. B. Conley
R. B. CONLEY,
Capt., Inf.,
Surveying Officer.

I have witnessed the destruction of the articles to be destroyed and/or received the articles to be turned in to salvage.

Date
(10) Hq. FORT BLANK,
Station Fort Blank, Illinois.
Date October 20, 1942

APPROVED: Any damaged property shown above and/or on attached sheets has been inspected by me, or by a disinterested officer of suitable grade and arm or service, and the disposal indicated is in the best interests of the public service.

John Smith
JOHN SMITH
Col., Inf., Commanding.
(Appointing authority)

(11) Officer witnessing destruction, or salvage officer
Hq.
Reviewed for corps area commander
Date
Number Finance officer.

Fig. 4

When damaged property is involved in a Report of Survey, the appointing authority must inspect the property or delegate the inspection to a disinterested officer of suitable grade and arm or service, and approve the disposition as indicated in the report. The Commanding Officer may permit the carrier to retain the damaged property when responsibility has been assumed by the carrier, and full compensation has been made to the Government. However, if the articles consist of secret, confidential or restricted property, or technical supplies and equipment manufactured exclusively for the Government, the Commanding Officer will dispose of it in accordance with announced policies of the Chief of the supply arm or service. A credit for the value of this damaged property will in all cases be passed to the carrier whenever under these conditions property is retained by the Government.

Damaged or unserviceable property except as indicated above will be recommended for disposition by the Surveying Officer in one of the following ways:

- a. To be continued in service.
- b. To be turned in to depot or arsenal.
- c. To be turned in for reclamation of component parts.
- d. To be sold.
- e. To be turned in for salvage.
- f. To be destroyed.
- g. Announced policies of Chiefs of Supply Arms or Services.

To indicate on the Report of Survey the disposition recommended, the Surveying Officer will enter an abbreviated entry, e.g., "S" — "To be turned for Salvage"; "D" — "To be destroyed", etc., under the column "Disposition" on the face of the Report of Survey.

As the above dispositions are self-explanatory, no further amplification is presented herewith with the exception of g. Generally, the authority for the disposition of "supervised" property is delegated by the Chiefs of Supply Arm or Service to the Service Command, and commanding officers and surveying officers should take cognizance thereof. Sometime, in the matter of "supervised" property, certain items may be reserved for approval by the War Department before disposition can be made. The Chief of Finance in such instances will usually act for the War Department. The advice and opinion of the Chiefs of Supply Arms and Services will be requested, but the final determination as to the disposition of these special items remains with the Chief of Finance. Therefore it is important when "supervised" property is involved and when the disposition has not been delegated to the Service Command, the Commanding Officer should submit all copies of the Report of Survey through channels for approval of the disposition recommended.

The Commanding Officer after careful examination of the Report of Survey will, if found to be satisfactory, indicate his approval on all three copies. He will send a copy to the accountable officer, and the original and one copy will be transmitted to the Commanding General of the Service Command. If the report

is approved by the Commanding General of the Service Command, the original copy will be filed in the office of the Adjutant General of the Service Command, and the duplicate filed in the office of the Finance Officer of the Service Command (Property Auditor's File). However, if the disposition of the property has been reserved by the Chief of the Supply Arm or Service, or should the amount of the property involved exceed \$500.00, or if the commanding officer for any reason so desires, he may submit all three copies to the Service Command. In such cases, the copy to the accountable officer will be delivered to him when returned by the Service Command.

There are Reports of Survey, the final action of which is reserved to the Secretary of War, and action is taken for him by the Chief of Finance. The following are some of the classes of Reports of Survey for which final action is reserved to the Chief of Finance:

- a. Those involving the disposition of "supervised" property when authority has not been delegated to the Service Command.
- b. All those where the value of the property lost, destroyed, or unaccounted for or the amount of damage to be inquired into exceeds \$1,000.00.
- c. Those covering shortages or damages noted on Government Bills of Lading or incident to shipment thereon.

Under W.D. Circular 105, dated April 10, 1942, in order to facilitate the preparation of Reports of Survey at posts, camps, and stations and to simplify the procedure, several changes have been made. Where two or more regiments are quartered or where the total strength of the command exceeds 5,000, the post, camp, or station commander may designate a "Board of Officers for Property Adjustment". On this board will be one or more officers of suitable grade and experience assigned to the Service Command together with such enlisted assistants as may be necessary. It is the duty of this board to act as Surveying Officer on Reports of Survey as prescribed in AR 35-6640. In addition, when an organization is not provided with a supply officer, the board will assist in the preparation of Reports of Survey. Paper work should be reduced to the barest essential; statements and affidavits should be brief. When accountability for property has been terminated, and the commanding officer is authorized to take final action on Reports of Survey (Short Form) falling within the provisions of paragraph 9a, AR 35-6640, the appointing authority will distribute the approved Report of Survey as follows:

- a. Original to the organization commander.
- b. Duplicate copy filed with the Regimental Supply Officer for the appropriate company's jacket file.
- c. The triplicate copy will be destroyed.

All Reports of Survey prepared by a company where accountability has terminated, i.e., the property was dropped from accountability by the property officer upon issue and picked up on the "Company Property Book", the Report of Survey will be plainly marked "No Accountability".

After final action is taken on a Report of Survey, it can be reopened, corrected, or canceled, provided that additional evidence of a material nature is uncovered. The survey can be reopened by a letter addressed to the Commanding General, Service Command, stating the additional evidence. The letter will be forwarded through the same channels as the original Report of Survey, and intermediate officers will indorse thereon their recommendations as to any action deemed advisable. When an approved Report of Survey is reopened, the original copy will be returned by the office in which it is filed. Any action taken thereon, will be indicated on all copies and distributed as before except where the amended action has so changed the report as to require final action by the Chief of Finance.

Where property was believed lost and dropped from accountability as a result of an approved Report of Survey, if subsequently found, the accountable officer will pick this property up on his stock record account by the use of an OS&D Report. A notation will be placed on the Report of Survey referring to the OS&D Report by serial number. A notation will also be placed on the OS&D Report referring to the Report of Survey concerned. In the event that responsibility had been placed on an individual in the above instance, and payment made, the individual will secure reimbursement after the reopened report of survey has been approved.



In a Bulletin published by the Training Methods Branch of The Ordnance School we find a few rather pertinent extracts from an article published in the Militar-Wochenblatt, a German Army publication.

"To train others successfully, the officer must himself first master the subject he wishes to teach, then he must learn sound methods of instruction by which he can transmit his knowledge to others. THE ONE IS AS IMPORTANT AS THE OTHER."

"Too often, there is a lack of preparation by the officers. There is a mistaken notion prevalent that after one has gained the right to wear shoulder straps he no longer needs preparation. Preparation should not be limited to a knowledge of the subject to be taught, but should extend to a study of the best methods of presenting it."

We've heard a great deal about the very obvious fact that an instructor is a leader, but how about looking at the same idea the other way around? When you get right down to it, isn't a man a leader BECAUSE he is an instructor? The widespread misconception that a leader is a man who knows how to give commands is based upon the erroneous and even dangerous assumption that the giving of commands is the hardest part of a leader's work. Actually, it is the easiest. What really distinguishes a leader from other men is not that he is a person who has developed an ability to give commands. Rather it is the highly significant fact that he is a person who has trained other men to carry out (instead of merely "obey") commands when the time comes to give them. After all, isn't it true that one of the outstanding characteristics of men who are well led is the fact that they know what to do even in the absence of commands or of the commander?

THE MACHINE SHOP

Conducted by: F. P. Bingert, M. Sgt., Ord. Dept.

MECHANICAL DRAWING

by HARRY F. ZAHLER, Tech. 4th Gr., Ord. Dept.

INTRODUCTION

Drawing is portrayal or delineation through use of lines. It is an art that began more than 50,000 years ago, when man of that day carved crude pictures of his daily and ceremonial life in rock. From those pictures, we have been able to piece together the story of his existence and to fit that story into its chronological place in the History of all life on earth.

The urge to draw is instinctive with man. Take for example, any child at play. Without being prompted, he will draw lines on paper, walls, or anything handy. Outdoors, a favorite medium is the earth, on which he traces lines with his finger. Soon he draws something like this  and shouts, "Ooh, look Mommy, a Horse!"

"Mommy" may smile at the crudity of such drawings, but actually they are almost identical with carvings that exist today in caves 50,000 years old.

Man's submission to his urge to draw was the beginning of written language. He drew a crude picture of an object. Soon it was used by others, each user leaving off a bit more of its detail, until finally, after thousands of years, these pictures developed into the letters of our modern day alphabets.

Chinese, the language of Confucius, who said, "One picture is worth a thousand words", still uses line drawings of objects, as letters of its alphabet.

The important thing about all of this is, that in each case, drawings tell a story, and in many cases, far more effectively than words.

And so with Mechanical Drawing. It, too, tells a story — but of things mechanical. A mechanical drawing is created mainly because the man who has a valuable creative mind, should not be required to use his time merely for making the item he conceived. Instead, he should be able to devote his energy to creating new ideas. Through a mechanical drawing, he enables some-

one other than himself to construct the item he has in mind.

In the early days of our present highly developed industrial era, an inventor after working for a month might have developed the details of an idea for a labor saving machine. Then would come a complete mental halt. He would have to stop his creative thinking for, maybe, six months in order to stay constantly alongside of the mechanic who would do the actual building of the machine.

This was a wasteful practice and might have gone on indefinitely, were it not for the fact that rapid expansion of the use of machines, made it necessary for one inventor's idea to be duplicated simultaneously by 50 mechanics, located in shops that were far apart. It was thus physically impossible for the inventor to be with each mechanic every minute of every day to interpret his original intentions regarding construction. This meant that unless some other method was found to bring the exact wishes of the inventor to the mechanic, the tremendous potential of mass machinery would be forever stalemated.

The first steps in this direction were represented by the sketch which contained lengthy notes describing, in minute detail, everything the inventor wished done. In these notes the inventor also tried to anticipate every point of doubt that might arise in the mind of the mechanic, who would be working on the item.

Here, again, is a prime consideration, even today. Before releasing a mechanical drawing, an inventor, or draftsman, tries to anticipate every possible point of uncertainty, and to clarify it.

When an inventor wished to portray the object he had in mind, he searched for ways and means of making a portrayal that was both accurate and easy to understand. Words alone were out of the question, so pictures came into use. Photographs were considered but dismissed at once, for the simple reason that you can't photograph a thing that exists only in a man's mind.

Thus, the only alternative was found to be line drawings. Through constant use, they underwent considerable development until in the present day, carefully made line drawings, laid out according to certain, simple, universally understood rules, act as our basis for transmitting precise information between the various echelons of production.

The following paragraphs give in condensed form, some of the basic principles underlying the universally accepted rules of mechanical drawing.

ORTHOGRAPHIC PROJECTION

a. Description

The basis of engineering drawing is orthographic projection, which may be defined as the method of representing the exact shape of an object by two or more views on planes at right angles to each other, dropping perpendiculars from the object to the plane. (See Figure 1.)

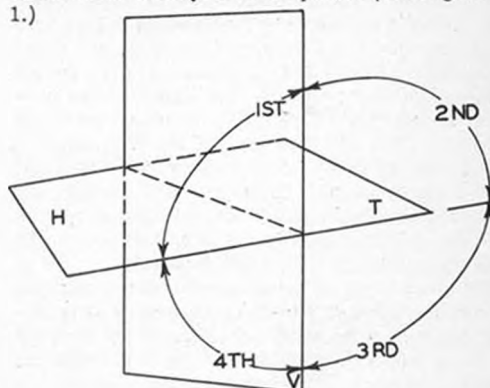


Fig. 1

b. Third Angle Projection

Figure 2 represents a horizontal plane and a vertical plane intersecting at right angles, forming four quadrants of angles. In the United States objects to be drawn are always thought of as placed in the third angle. Lines or projectors from the object, perpendicular to the planes, will form views. Orthographic Projection from the third angle is known as third angle projection.

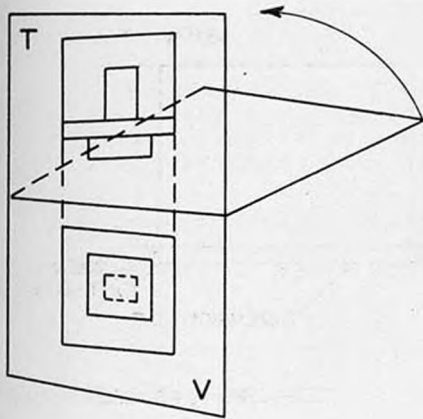


Fig. 2

c. Two and Three Views

Figure 3 shows the relative positions of the views on the paper. Two views may be sufficient to show the exact shape of the object with its three dimensions — length, width, and thickness. If the object is complex a third view is necessary and a side view is projected.

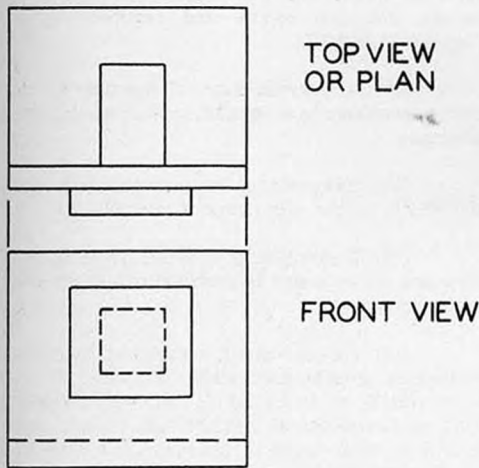


Fig. 3

d. Position of Views

The top view is directly above the front view; the bottom view is directly below the front view and the side views are either side of and on the same level with the front view. The rear view is on the same level with the side views. (See Figure 4.)

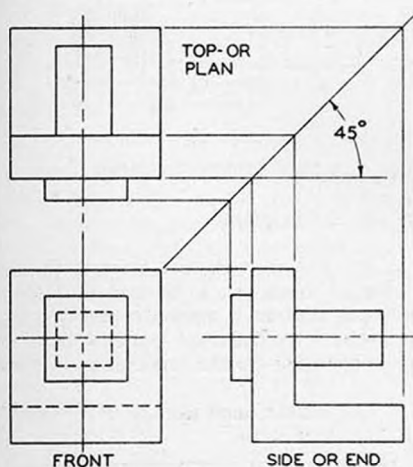


Fig. 4

PICTORIAL DRAWINGS

a. There are three types of Pictorial drawings:

- (1) Cabinet Drawing, or sometimes called "Oblique Angle Projection".
- (2) Isometric Drawing.
- (3) Perspective Drawing, or sometimes called "Vanishing Point Projection".

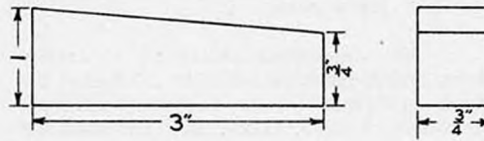


Fig. 5

b. There are four types of perspective drawing.

- (1) One Point Projection
- (2) Two Point Projection
- (3) Three Point Projection
- (4) Four Point Projection

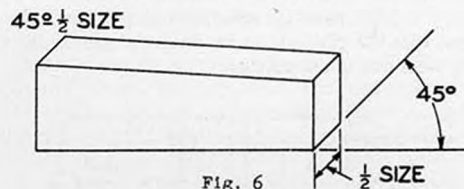


Fig. 6

CABINET PROJECTION

a. Description

(1) Cabinet drawing lines on the oblique angle are shown one half size when the angle is 45 degrees (see Figure 6) and 3/4 size when the angle is 30 degrees. (See Figure 7.)

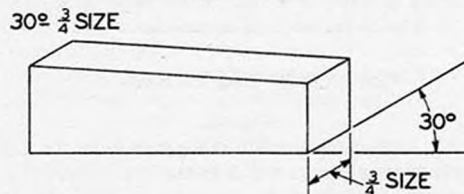


Fig. 7

(2) In both oblique and cabinet projection, the largest side of the object should be parallel to the picture plane to reduce distortion.

(3) To simplify construction, circular and irregular surfaces should be shown in the vertical plane. (See Figure 8.)

ISOMETRIC DRAWINGS

a. Description

Isometric Drawings have three axes 120 degrees apart. All measurements are made

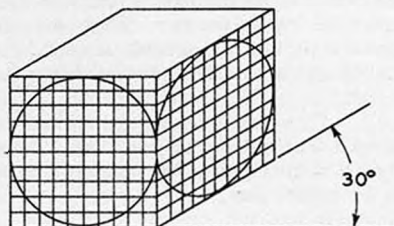


Fig. 8

along or parallel to these axes in their true lengths. (See Figure 9.)

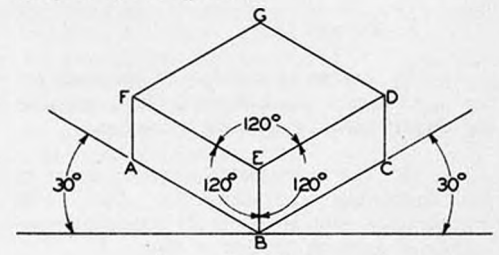


Fig. 9

PERSPECTIVE DRAWING

a. Description.

Perspective drawing is a true drawing, drawn from one or more points outside of the drawing to a center or vertical line, measured from the horizontal plane. (See Figures 11 to 14.)

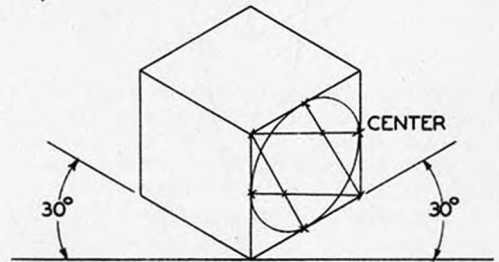


Fig. 10

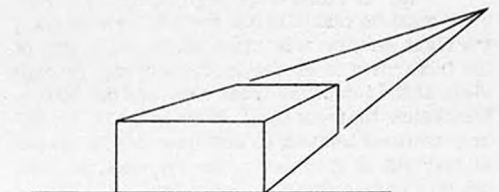


Fig. 11

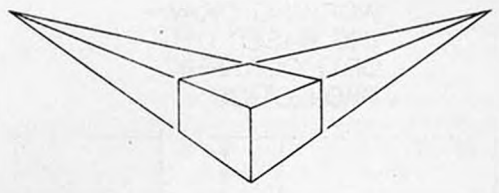


Fig. 12

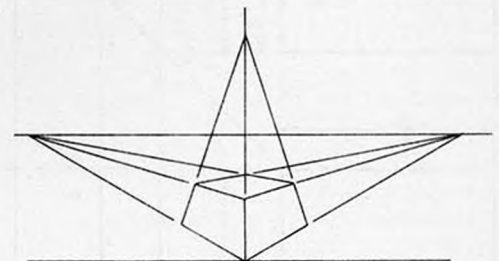


Fig. 13

WORKING DRAWINGS

a. Description

When dimensions and information are added to the drawing for the manufacture of the object, it becomes a working drawing. This type of drawing is based on orthographic projection. (See Figure 15.) Working drawings are made mostly of separate parts known as Details and Castings. A Detail is identified by a number,

and a Pattern, by a letter within a circle. Example ②

b. Purpose

(1) A working drawing is one made for use in a workshop, an industrial plant, in building construction, or erecting in the field.

(2) The representation of an object by such a drawing must follow the principles of orthographic projection. In all standard drawings third-angle projection is used.

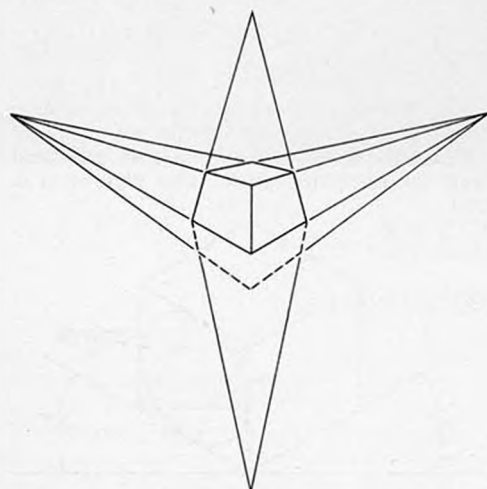
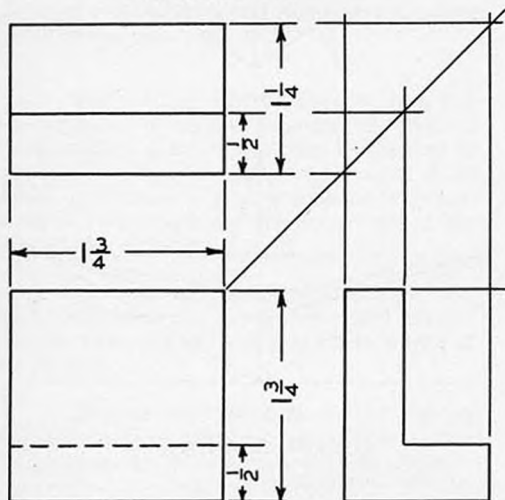


Fig. 14

(3) In Third-angle Projection, the front view must be placed below the top view or plan; the right end, or side view, at the right side of the front view or elevation, the left end, or side view, at the left of the front view, and the bottom view below the front view. If the space is limited or conditions demand, an end view may be placed at the right or at the left of the top view, or plan, but this is an exception.

WORKING DRAWING BASED ON ORTHOGRAPHIC PROJECTION



DET. I-BLOCK
I-MACHINE STEEL
STK. $\frac{1}{4}$ X $\frac{1}{2}$ WT. 77LBS.

Fig. 15

(4) A sufficient number of views and sections should be shown to give all necessary information regarding the size and shape of the part.

(5) Two views are generally needed to represent an object. Three views are often required, while more may be necessary.

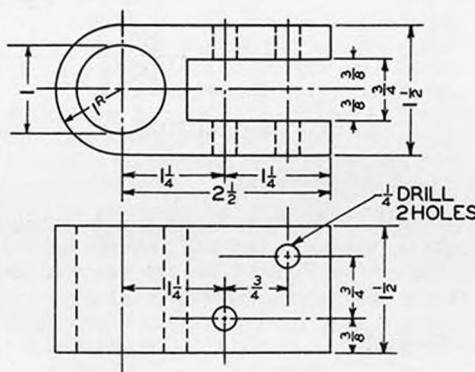
DIMENSIONS

a. Introduction

All dimensions should be accurately shown and it must be borne in mind, that the dimensions given are those necessary and most convenient for the workman who is to make the piece. Therefore, the draftsman must put himself in the place of the pattern maker, blacksmith, or machinist, and must mentally construct the object represented. He must foresee whether the object can be cast or forged practically and economically and must know which dimensions would best give the information required.

b. How used

(1) Drawings are dimensioned the exact size that the piece is to be made, regardless of the scale of the drawing.



EXAMPLE OF DIMENSIONING

Fig. 16

(2) Dimensions and notes must be $\frac{1}{4}$ inch or more from the drawing.

(3) Dimensions are so placed as to read in the direction of the dimension lines, either from the bottom or from the right of the sheet. All figures and notes should read easily from the lower right-hand corner.

(4) All notes are preferably placed parallel to the bottom of the sheet, to read horizontally, never at an angle.

(5) Dimension figures must be made $\frac{1}{8}$ inch high. Fractions are to be made $1\frac{1}{2}$ times the height of the whole numbers, with division line in line with the dimension line.

(6) Place the dimension figures near the center of the dimension line, in a convenient space left for the purpose. Where the dimension space is limited, the arrowheads and figures are placed on the outside of the extension lines.

(7) Arrowheads always are made narrow, about $\frac{1}{3}$ as wide as they are long. They should show a slight curve in the outline from the point to the widest part.

(8) General practice in most industries, such as automotive, machine tool, and allied in-

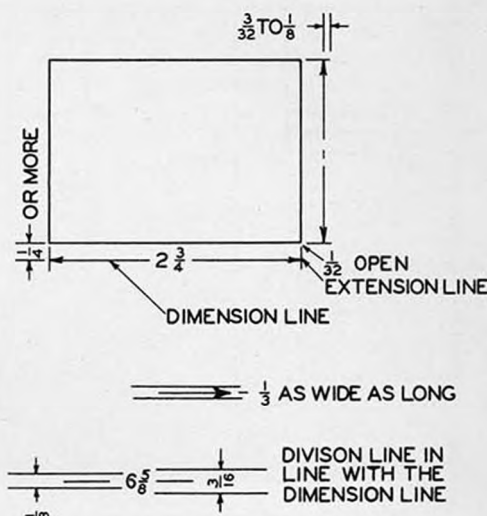


Fig. 17

dustries, is that all dimensions be given in inches only — Ordnance work is expressed in inches up to 100 inches; over 100 inches in feet and inches. Where all dimensions are given in inches, the inch marks are omitted. (See Figures 16 and 17.)

(9) Keep dimensions off the figure, except where there is a possibility of confusing the workman.

(10) Keep related dimensions, i.e. Length and Width, on the same view if possible.

(11) Dimension of a detail given in one view are not repeated in another, unless clearness requires.

(12) Circles are dimensioned by their diameters, arcs by their radii. All radii should be marked R. or Rad., and all Diameters, either Dia., or Ream, Bore, Drill, Core, Grind, etc. A drill or bolt circle is dimensioned either by its diameter or its radius. Give radius where radius will be used, diameter where diameter will be used by the worker.

(13) Where there are several diameters in a given length, it is better to give them across the length rather than in an end view. (See Figure 18.)

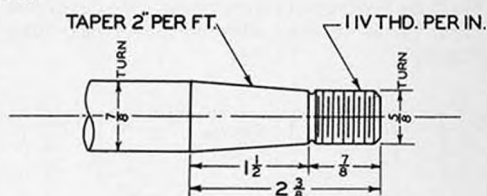


Fig. 18

CONVENTIONAL LINES

a. Description

(1) The conventional lines of the kinds and weights shown are to be used as required. When made in pencil a marked contrast must be made between the different types of lines. The beginner should be careful to make such contrast.

(2) Border lines shall be very heavy full lines, $\frac{1}{32}$ inch wide.

(3) Visible edges or outlines of objects are the most prominent part of a drawing and

shall be shown by heavy full lines of medium width.

(4) Hidden or invisible edges of objects shall be represented by short 1/8 inch dashes. Somewhat lighter than visible lines, separated by spaces equal to the width of the lines.

(5) Dimension Lines shall be fine, light, solid lines, drawn parallel to the direction of measurement and 1/4 inch or more from the

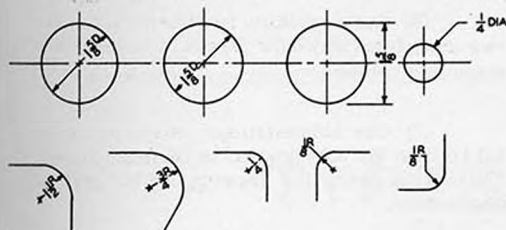


Fig. 19

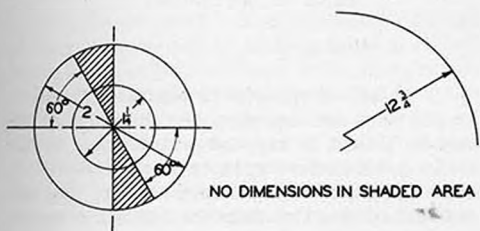


Fig. 20

outline of the view. These lines are broken near the center for the dimension figures, and are terminated at the extension lines by small arrowheads. (See Figure 21.)

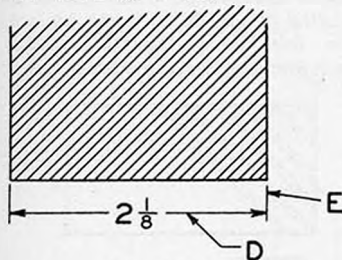


Fig. 21

(6) Extension or Witness Lines shall be fine, light, full lines drawn at right angles to the dimension line, from a point 1/32 inch from the outline and extended 1/8 to 3/32 inch beyond the dimension line.

(7) Center lines shall be fine, light, broken lines, consisting of uniform dashes 5/8 inch or more in length, separated by single, uniform dashes (1/16 inch) and spaces of the same length.

(8) The trace of a cutting plane, to show where a sectional view is taken, is made the same width as visible outlines and consists of uniform dashes. Arrowheads placed at right angles to the trace of the cutting plane show in which direction the section is viewed. (See Figure 22.)

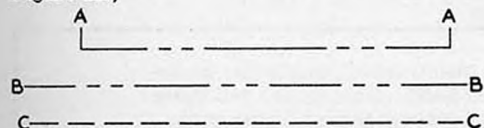


Fig. 22

(9) Section, Projection, and Construction Lines. Lines in pencil, including all lines not

essential outlines or edges of the object represented, shall be very fine, full lines.

(10) Section or Cross-Hatch lines are fine, full lines, generally drawn at 45 degrees and spaced evenly to give a shaded effect and to show the location of material in a sectional view.

LETTERING

a. Introduction

Lettering is of great importance to mechanical draftsman. Skill is essential. Many otherwise well-executed drawings are not only disfigured, but are made useless by poor, illegible lettering. Every draftsman must be able to letter a drawing neatly and rapidly. Any system of letters suitable for drawings must not only be neat in appearance but well proportioned. Artistic finish is secondary to plainness and speed. A simple form is necessary: First, that dimensions and notes may be easily read by the workman so that he may have no excuse for making a mistake; second, that the letters may be easily and rapidly made in order to keep the cost of the drawing low. While artistic lettering requires a particular aptitude and a natural fitness for the work, a simple style is within the reach of any earnest draftsman, and laxity upon this important subject is inexcusable.

Since it is the almost universally accepted practice to use only capital letters upon working drawings, the entire attention should be given to the making of capitals only. It is evident that, if the time allowed, much better results can be obtained through practice upon this one type of letter.

Either inclined or vertical lettering is acceptable in industry. Inclined lettering only is used in about 40 percent of the industrial drafting rooms on machine drawings. The indications show a tendency toward vertical lettering. Vertical lettering has many advantages, namely:

- It conforms to the outlines and style of type in printed title strips.
- It forms the basis of architectural lettering.
- Basically vertical and inclined lettering are the same in form, in proportion, and in the order and direction of strokes.

It seems especially suitable in early mechanical drawing in schools because of its fitness of design in many situations.

Care should be taken to group the letters closely together into words, leaving sufficient space between the words to make them easily recognized. The space between the letters in a word should be kept uniform in apparent area. The space between words should be equal to the height of the letters. The beginner must copy from good models all the different kinds of characters, and thus acquire a perfect knowledge of the proper proportions of every letter. Skill can be gained only by careful observation and right practice, with improvement in technic and speed as the goal.

b. How used

Lettering is used on drawings because it is more legible than writing. Letters and figures are printed between light guide-lines

drawn horizontally 1/8 of an inch apart. (See Figure 23.) The slope is about 22 degrees and the lettering is alternately spaced. Care should be taken in forming words. Letters that form words are not equally spaced but arranged so that the space between them appears equal. To become proficient in lettering, the shape and proportion of letters must be studied and much time spent in practice.

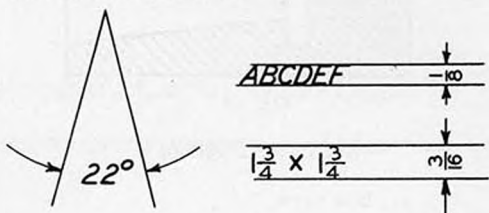


Fig. 23

FINISH

a. Definition

Machine-finished surfaces are such as are made with the cutting tools, and are indicated by the finish mark. The form of the finish mark which has had nearly universal use is that of a modified italic made with the bar crossing the line at an angle; the line represents the finished surface.

b. Ground finish.

Ground-surfaces are such as are made with the use of a grinding wheel. With a sufficient amount of stock left for grinding. The form of a grind mark which is used is a capital G, through the center of the line, of the surface to be ground, or a note could be placed alongside of the object, to state "Grind Finish".

SCREW THREADS

a. How used

(1) Screw threads should be indicated by alternate light and heavy lines.

(2) Either of the simplified methods, may be used. The diameter, pitch, type of thread, and fit should be designated. The note taking the form 1"-8-NC-2, or 1"-14-NF-2. (See Figure 24.)

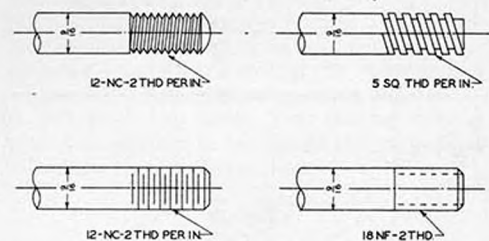


Fig. 24

(3) Any other than the standard threads should be stated in a note. If a screw has a left-hand or multiple thread a note should call attention to the fact, thus, 1/2"-13-NC-2-L.H.

(4) A tapped hole should be shown by a circle indicating the size of the drill, and a larger concentric circle in a hidden-edge line, indicating the size of the tap. A note should state the diameter and number of the tap, thus: 1"-8 Tap NC-2.

(5) Never make detail drawings of standard screws, bolts, and other fastenings. However, these are listed in the Bill of Material.

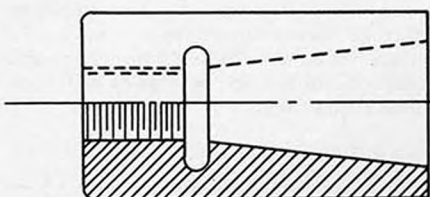


Fig. 25

SECTIONAL VIEWS

a. How used.

(1) A sectional view shows the form of a piece as made by a cutting plane at the place where the plane has cut through. A portion of the piece is imagined cut away to expose the hidden parts. The purpose of a section is to show the shape of cores, thickness of stock, interior mechanism, and assembly.

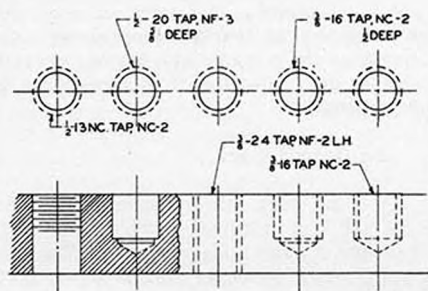


Fig. 26

(2) The place at which a section is taken is indicated by the trace of a cutting plane. If the section is not symmetrical, or if something behind the cutting plane is shown, arrows should be added indicating in which direction the section is viewed. Section letters are placed behind the arrow heads to show a sectional view of a broken line. (See Figure 28.)

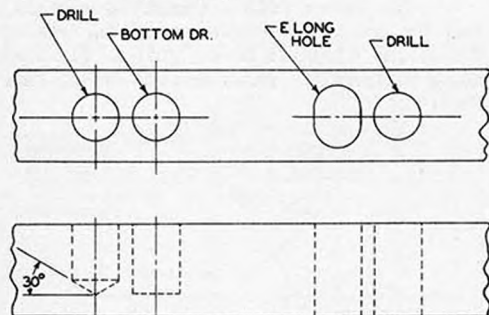


Fig. 27

(3) The surface cut by a plane is indicated by cross-section lines at 45 degrees, spaced in proportion to the size of the drawing, usually about 1/16 inch apart. Practically all cross sectioning is done in fine, light lines.

(4) On all detail drawings, sectional views should be cross sectioned as for cast iron; cross-section lines for cast iron are fine. The material of which the part is made is stated in a note near the right-hand corner, or in connection with the name of the part.

(5) When a sectional view is made of an assembly, the accepted conventions for the

material may be used, the adjoining cross-sectioned areas having the lines in opposite directions. Some firms use uniform cross-hatching for all materials, but many use the conventional symbols for various materials.

(6) Cross-Hatching showing section views of metals, drawn at 45 degree angle with a note of the name of the metal are shown in Figure 29.

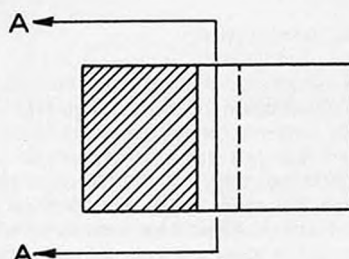


Fig. 28

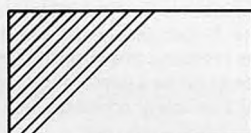
NOTES

a. How used.

(1) Use explanatory notes, freely. Clearness is all-important.

(2) Notes that apply to the part in general should be placed in the lower right-hand corner. Notes applying to local operations are performed. The following forms of notes are recommended:

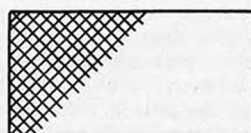
7/16 Drill - 2 holes	1/4 x 45° Chamfer
3/8 Punch - 2 holes	1/2-13 NC-2 Tap
5/8 - 18 Tap NF-2	1/2-13 NC-2 Thd.
#12 Drill (0.1890)	70° C Sink x 3/8 Dia.
Taper 1-1/2 per ft.	3/4 Drill - 5 holes
	equally spaced.



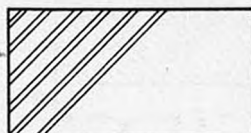
CAST IRON



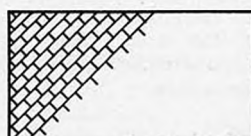
BRONZE, COPPER



BABBITT, LEAD



STEEL



ALUMINUM



GLASS, MARBLE

Fig. 29

A series of articles on "Shop Mathematics" will begin in the January issue of THE ORDNANCE SERGEANT. This series will begin at the very beginning of mathematics and proceed toward higher mathematics, paying particular attention to the application of mathematics to shop work.

(3) Greater prominence may be given a note by underlining it with a line as heavy as the visible edges.

(4) All left-hand threads should be plainly marked, L.H.

(5) Handed pieces should be marked, "Right or Left", R.H.; L.H.

(6) On tool details, the dimensions of the raw stock from which the part is to be made are sometimes given.

(7) Use abbreviations where possible, but be sure the abbreviation is commonly used. The worker reads the drawing, not the draftsman's mind.

BILL OF MATERIAL

a. How used.

A bill of material is generally placed on all drawings for shop purposes and erecting. It may be placed in any convenient space on the drawing, but preferably just above the title block and adjacent to the right-hand border. The Bill of Material must contain the number of parts, the material of which they are made, the name of the part, the reference number on the drawing and, if a pattern is required, the pattern letter.

The listing of the parts begins at the bottom, a few spaces being left at the top for the listing of additional parts as occasion demands. Such standard parts as bolts, machine screws, washers, etc., are listed but not drawn.



Conducted by: W. G. Sylvester, Capt., Ord. Dept.

TYPES OF WELDING JOINTS

The properties of a welded joint depend largely upon the correct preparation of the metal edges being welded. All mill scale, rust, oxides and other impurities must be removed from the joint edges or surfaces in order to prevent their inclusion in the weld metal. The welding heat cannot be used to the greatest advantage unless the edges to be welded are so prepared as to permit easy fusion without excessive heating. Care should be taken in order to keep the heat loss due to radiation and conduction into the base metal from the weld down to a minimum. The type and position of the joints, when they are properly prepared, will reduce the amount of expansion on heating and contraction on cooling that occurs in the parts being welded.

grease or other foreign matter. The flanged butt joint shown in Figure 3 (a) is used for welding sheet metal up to 0.0625 in. in thickness by the oxyacetylene welding process. The plain square butt joint shown in Figure 3 (b) is used for welding sheet metal up to 1/8 in. in thickness by the oxyacetylene and electric arc welding processes. These thin sections should be spaced in jigs to allow for weld shrinkage along the seam. In arc welding, back-up or quench plates made of copper or cast iron are necessary on light sheets to control the warpage or distortion. Welding should be done by the back step welding method to prevent the thin sections from buckling.

the edges of the plates from both sides as shown in Figure 3 (d) and 3 (f). The U - shaped type of joints are more satisfactory and require less filler metal than the V type for welding heavy sections and for welding in deep grooves. The double - V bevel joint requires approximately one-half the amount of filler metal that the single - V bevel joint requires for the same plate thickness. In general, butt joints prepared from both sides permit easier welding, obtain less distortion, and insure better weld metal qualities in heavy sections than joints prepared from one side only.

The included angles of bevel for arc welding range between 60° and 75°, whereas

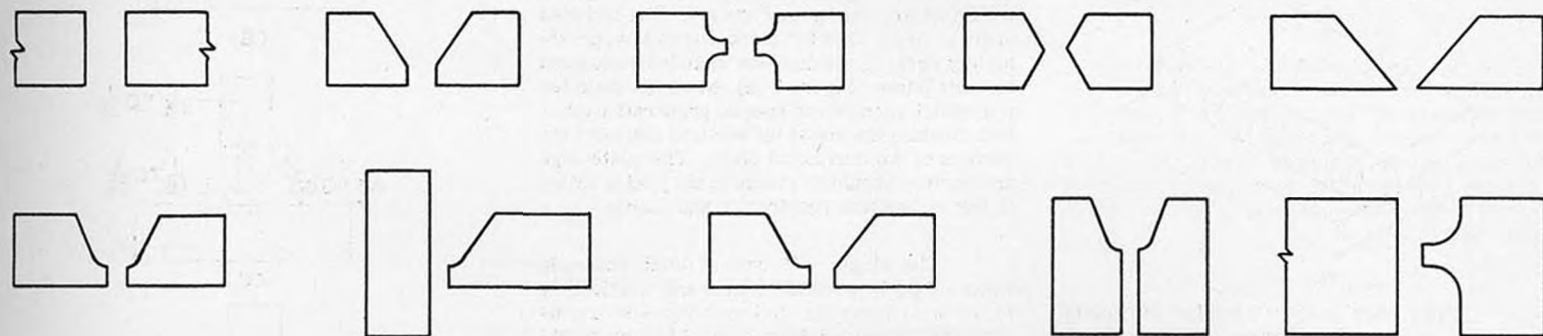


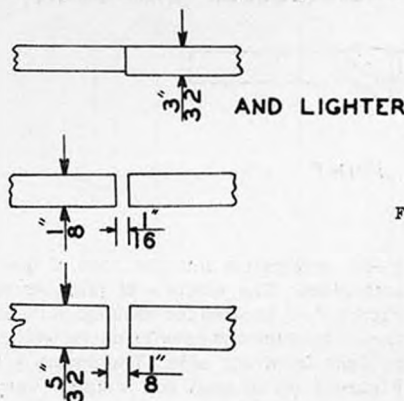
Fig. 1

The preparation of the metal is governed by the form, thickness, and kind of metal, the available methods for preparing the edges to be joined, and the load which the weld will be required to support. Some of the more important and more common methods used for preparing plate edges and joints for welding are shown in Figure 1. There are five basic types of joints used to weld the various forms of metal. These are the butt, lap, tee, corner and edge joints.

BUTT JOINTS

This type of joint is used to join the ends or edges of two plates or surfaces located approximately in the same plane with each other. Plain square butt joints on light sections are shown in Figure 2. Several types of edge preparations used for making butt welded joints on various thicknesses of metal are shown in Figure 3. These can be prepared by flame cutting, shearing, flame grooving, machining, chipping or grinding. The edge surfaces should in each case be clean of oxides, scale, dirt,

Plate thicknesses 3/8 to 1/2 in. can be satisfactorily welded from one side only by either the oxyacetylene or electric arc welding process, using the single - V or single - U joint types shown in Figure 3 (c) and 3 (e) respectively. Heavier sections should be welded by preparing



included angles ranging between 75° and 90° are required for oxyacetylene welding. Where arc welding must be done from one side on heavy sections from 1- 1/2 to 2 in. in thickness, a single - V bevel with an included angle of 40° to 45° should be used. The spacing between plates or sections is increased with increasing thickness of metal being welded.

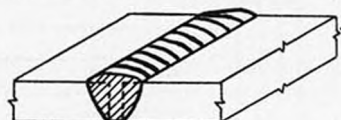


Fig. 2
SQUARE BUTT
JOINT - WELDED

LAP JOINTS

This type of joint is used to join two overlapping plates, so that the edge of each plate is welded to the surface of the other. Figure 4 shows this type of joint. These joints can be made by welding from one side only where the

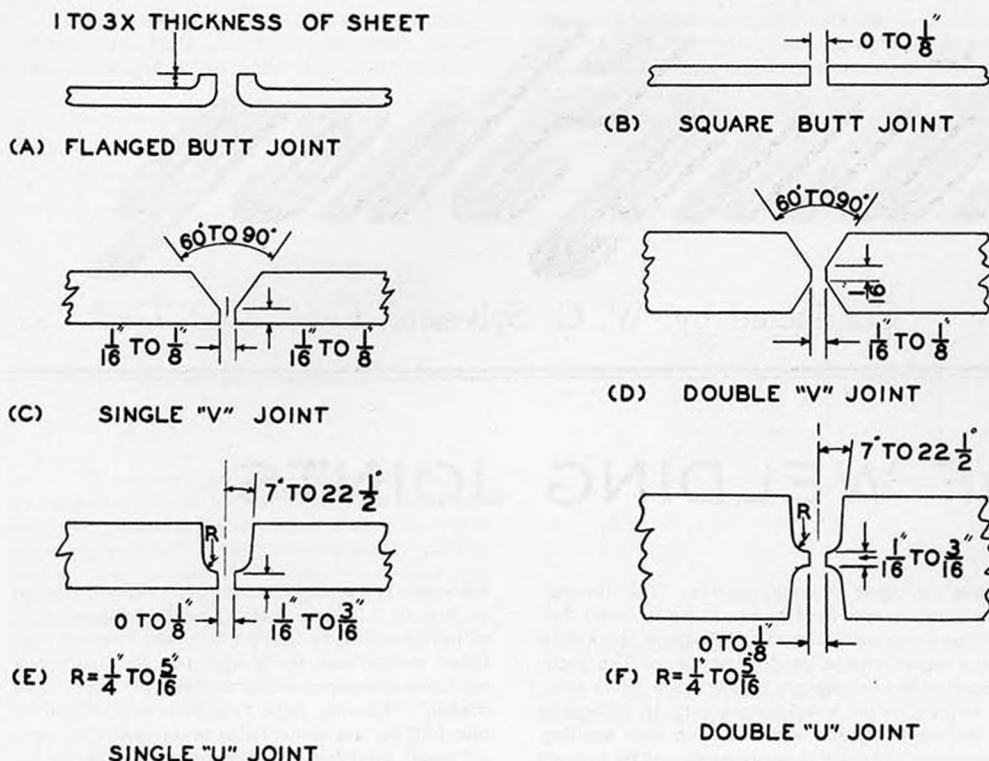


Fig. 3

design of the joint does not permit welding from both sides. However, when so welded, the joint does not develop its full strength but is stronger than a butt weld for some applications. Tubing or frames that overlap or telescope together are cases where the lap joint gives better properties than the butt joint.

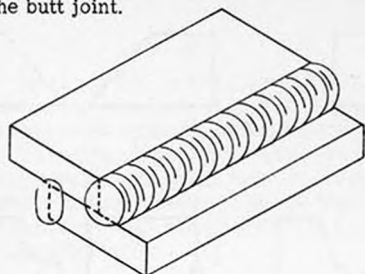


Fig. 4

Other edge preparations for lap joints are shown in Figure 5. Figure 5 (a) is known as a single lap joint and is used where welding must be done from one side. Figure 5 (b) is a double

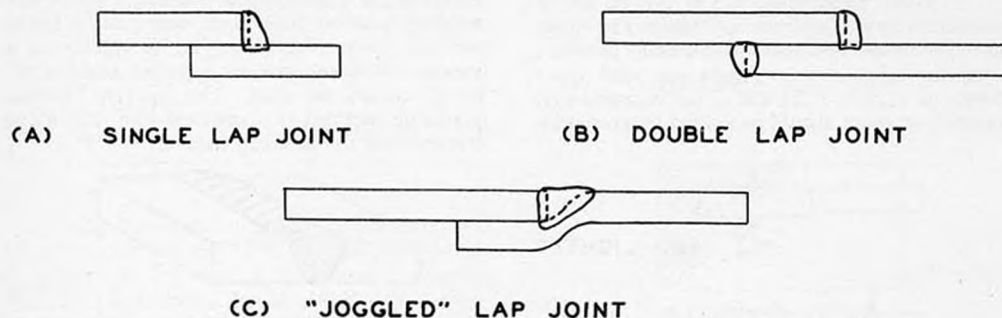


Fig. 5

lap joint which will develop the full strength of the sheet or plate being welded. Figure 5 (c) is an offset or "joggled" lap joint and is used where two overlapping plates must be joined and the welded plates must be kept in the same plane. This lap joint is stronger than the single lap type but is more difficult to prepare.

TEE JOINTS

Tee joints are used to weld two plates or sections whose surfaces are located at approximately 90° to each other at the joint. Figure 6 shows a typical plain tee joint welded from both sides. Other edge preparations used for making tee joints are shown in Figure 7. The included angle of bevel used for these joints is approximately equal to one-half the included angle used for butt joints. Figure 7 (a) shows the plain tee joint which requires no special preparation other than cleaning the end of the vertical plate and the surface of the horizontal plate. The plate edge and surface should fit evenly at the joint in order to insure uniform penetration and fusion.

The single - V type of joint shown in Figure 7 (b) is used for plates and sections up to 1/2 in. in thickness. In heavy plates where the joint can be welded from both sides the double bevel tee joint shown in Figure 7 (c) is used. Care should be taken to obtain complete weld

be taken to obtain full penetration into the root of the weld from each side. As in butt welding, less filler metal is required for making either the single - J tee joint than for the single - V tee joint, and the same is true for the double joints.

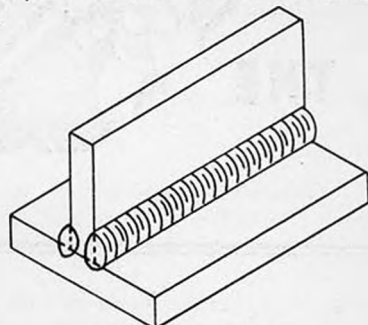
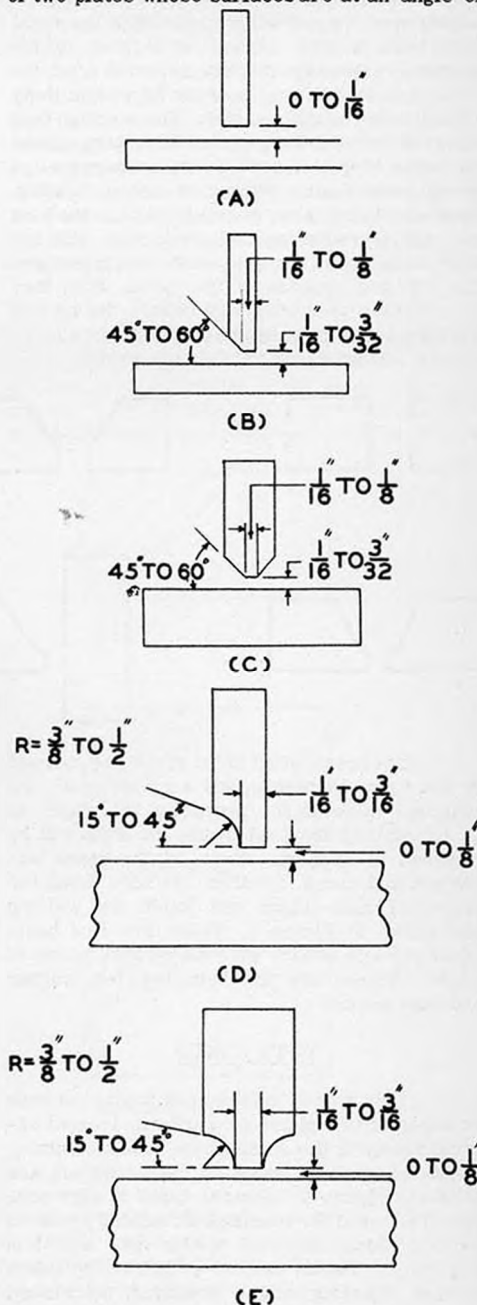


Fig. 6
CORNER JOINTS

This type of joint is used to join the edges of two plates whose surfaces are at an angle of



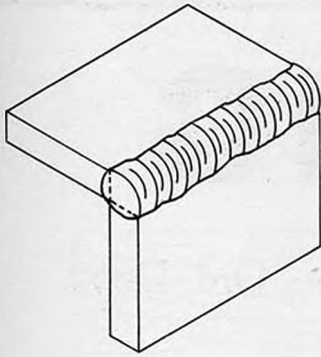


Fig. 8

approximately 90° to each other. It is shown in Figure 8 and is used in the construction of box frames, tanks, boxes and similar articles. Welding can be done from one or both sides depending upon the position and type of corner joint used. Figure 9 shows some of the more

melted down with an oxyacetylene flame with little or no filler metal being added. In arc welding, only a very light bead is required to make the joint. In welding heavy sections the lapped plate is V-beveled or U-grooved as shown in Figure 9 (d) through (e) to enable penetration to the root of the joint.

Figure 9 (b) shows an open type corner joint and is used on heavier sheet and plate. The two edges of the plate are melted down and sufficient filler metal is added to build up the corner from one side.

Heavy plate is welded from both sides as shown in the open corner joint Figure 9 (c). The joint is first welded from the outside, then reinforced from the back side by means of a seal bead.

EDGE JOINTS

Two parallel plates are joined together as shown in Figure 10 by means of a weld on an

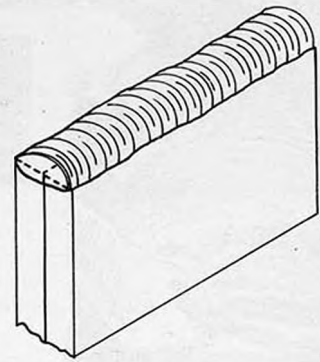


Fig. 10

each edge and to reinforce the joint. Two common types of edge joints are shown in Figure 11. Thin sheets are welded by using the joint types in Figure 11 (a), (b), and (c) with no special preparation being necessary except to clean and form the edges and tack weld them in position for

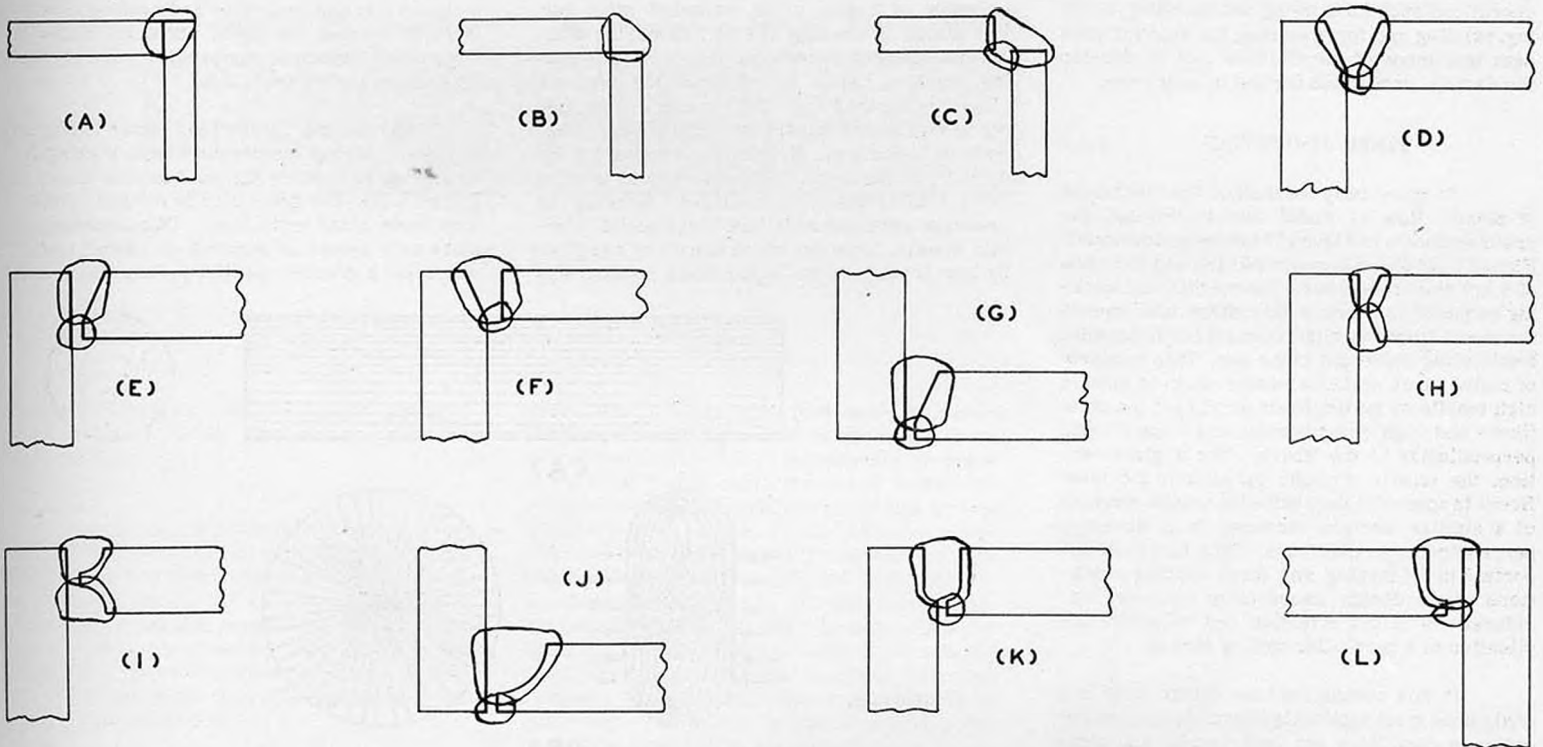


Fig. 9

common joint types used for making corner joints. Figure 9 (a) is a closed type corner joint used on lighter sheets and plates where the strength required at the joint is not too high. To make the joint the overlapping edge is

edge joint. This joint is not very strong and is used principally for joining the edges of sheet metal, and for welding reinforcing plates on flanges of I-beams or edges of angles. Sufficient filler metal is added to completely fuse or melt

welding. The joints shown in Figure 11 (d) and (e) are used for welding heavy plates and require that the edges be bevelled in order to secure good depth of penetration and fusion of the sidewalls.

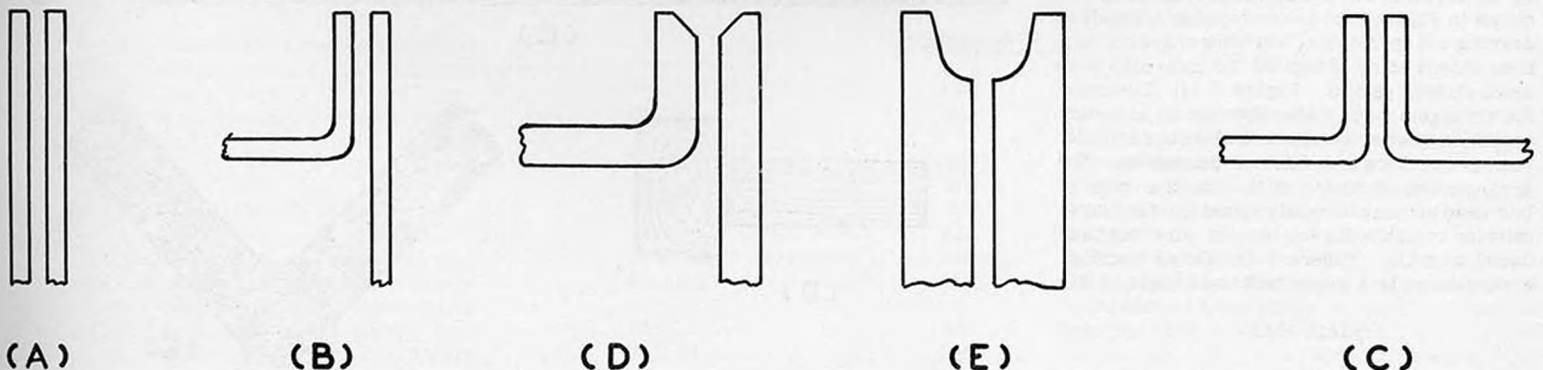


Fig. 11



FORGING

Conducted by: W. G. Sylvester, Capt., Ord. Dept.

TOOL FORGING

The problem of tool forging involves not only the combination of several basic forging operations such as drawing out, upsetting, bending, twisting and forge welding but also includes heat treatment of the finished tool to develop the desired properties for the intended use.

FIBER STRUCTURE

To more fully understand the mechanics of plastic flow of metal due to forging, the sketches shown in Figure 1 have been developed. Figure 1 (a) shows a cross section and end view of a hot rolled steel bar. The mechanical working required to produce this shape also caused the metal fibers to align themselves in parallel bands along the length of the bar. This property of rolled steel sections enable them to sustain high tensile or pulling loads parallel to the steel fibers and high compression and impact loads perpendicular to the fibers. For a given section, the tensile strength parallel to the steel fibers is approximately twice the tensile strength of a similar section stressed in a direction perpendicular to the fibers. This factor is important in all forging and forge welding operations where design necessarily involves considerations of the direction and selective application of a particular type of stress.

In this connection, the design used in a chain hook most applicably illustrates design for optimum conditions for both tensile and compression forces. Figure 1 (b) illustrates the manner in which metal fibers are deformed and upset by a typical upsetting operation. The nature of the final disposition of the metal fibers is such as to enable the piece to withstand high compression loads applied in the direction shown by the arrows. The arrangement of metal fibers shown in Figure 1 (c) is developed as a result of drawing out operations. The fibers have not only been stretched or elongated but have also been more closely packed. Figure 1 (d) illustrates the arrangement of metal fibers in an upsetting operation on a bolt the shank of which had initially been drawn down to a desired dimension. The arrangement of fibers at the junction point of bolt head to shank is ideally suited for the transmission of tightening-up tension stresses produced in bolts. Figure 1 (e) shows the fiber arrangement in a piece bent to an angle of 90°.

GRAIN SIZE

Another important consideration from the standpoint of hardness and strength is the

size and uniformity of the grains making up the metal. Figure 2 (a) shows the uniform distribution of grains in an annealed steel bar. The action of drawing out by hammering without the application of heat, that is, cold working, tends to flatten and elongate the grains as shown in Figure 2 (b). Cold working increases the hardness and tensile strength of steel; however, it reduces the plasticity and therefore the ductility of the metal. Excessive cold working results in brittleness, localized "checking" or cracking and eventual failure of the metal. Certain metals, however, which cannot be hardened by heat treatment can be hardened considerably

by cold working. This applies principally to non-ferrous metals such as pure copper, brass, bronze and the like.

Steel bars which have been cold worked can be restored to their initial structure by annealing. This process consists of heating the metal to a bright red color and cooling slowly. When so treated the metal structure shown in Figure 2 (b) can be restored to its original grain size as shown in Figure 2 (a).

By heating the steel bar shown in Figure 2 (a) to a forging temperature and drawing out by forging to produce the section size shown in Figure 2 (c), the grain size is refined, that is, it is made smaller in size. This action takes place as a result of working on heated metal, which has a greater plasticity than cold metal.

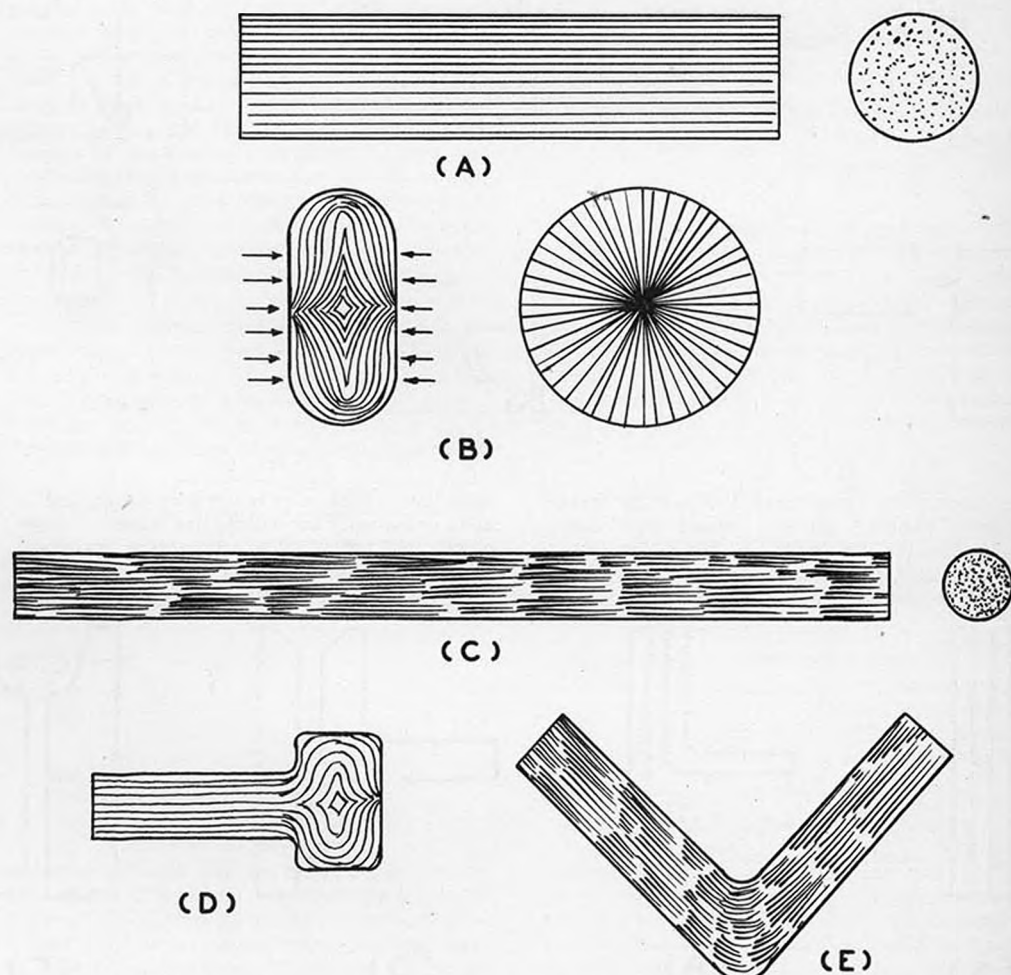


Fig. 1

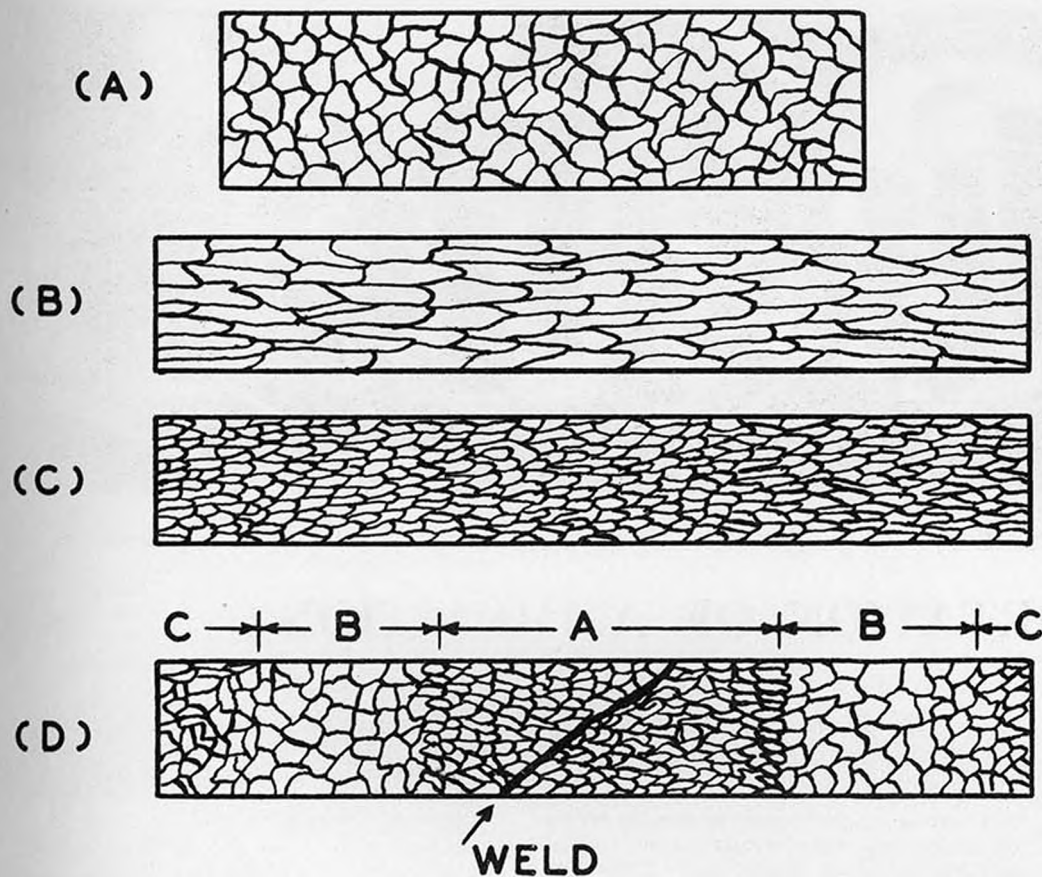


Fig. 1

Fig. 2

Hammering breaks down the larger grains to produce the relatively smaller size shown in Figure 2 (c).

The grain refinement produced by forge welding is shown in section A of Figure 2 (d). Metal which has been heated to a forging temperature but which has not been subjected to hammering retains an annealed structure shown in the sections marked B. Previously forged metal which has not been heated to forge welding temperature retains the refined grain shown in the sections marked C.

In order to eliminate the discontinuity produced by the forging and forge welding operations the entire structure should be annealed to produce a uniform grain size similar to that shown in Figure 2 (a).

It can be seen that both mechanical working and heat treatment have a definite influence on the grain size in a piece of steel and therefore on its hardness, strength, ductility and other physical properties.

HEAT TREATMENT OF TOOLS

The plain carbon steels used for forging tools such as chisels, punches, etc. have a carbon content of approximately 0.90%. These steels are forged to the desired shape before heat treating to develop the required hardness. Figure 3 (a) shows a cold chisel forged from heat-treatable steel stock ready for hardening. The point

of the chisel included in the section A-C is heated in a forge to a cherry red temperature just above its critical point (1420° F) and quenched in water to the level B until cold. The chisel is then removed and the point quickly polished with a piece of emery cloth to remove any adhering scale. The heat bank remaining in the unquenched section B-C is gradually conducted to the point of the chisel and tempers it. The tempering action can be controlled by noticing the colors of the thin oxide films forming on the surface. Tempering promotes some toughness at the chisel point and removes some of the brittleness produced by quenching. The fine grain size produced by the hardening operation is not disturbed.

By this procedure only the chisel point is hardened and tempered. Tools requiring com-

Two new departments will be added to THE ORDNANCE SERGEANT in the February issue.

The Base Shop is becoming more and more important in modern Ordnance maintenance. The Base Shop School will be explained in the February issue and a technical article from that source will appear in each later issue.

In the past a few articles telling about Foreign Materiel have been reproduced in THE ORDNANCE SERGEANT. The February issue will contain the first of a series on this subject which will continue indefinitely. These articles will cover such items as small arms, artillery, fire control, etc.

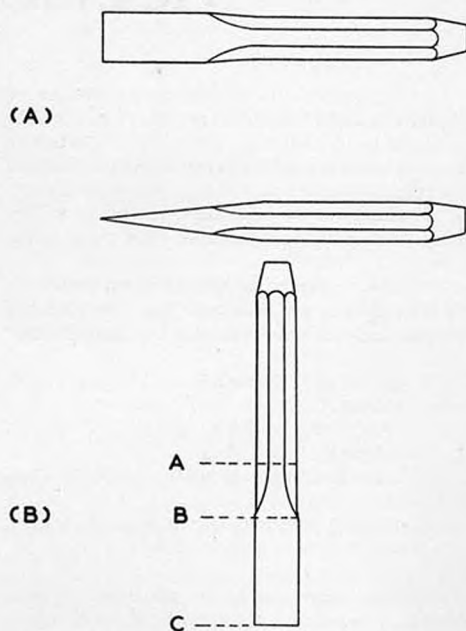


Fig. 3

plete hardening and tempering are more effectively handled in a furnace. In order to more clearly define the relationship between temperature and temper colors used for carbon steel tools the chart shown below should be consulted for the particular applications noted.

TEMPER COLORS

Color	Temperature °F.	Uses
Faint Straw	400	
Straw	440	Scrapers, hammer faces, lathe, shaper and planer tools.
Dark Straw	480	Milling Cutters, taps and dies.
Very deep straw	480	Punches and dies, knives and reamers
Brown Yellow	500	Stone cutting tools, twist drills
Bronze or Brown Purple	520	Drift pins
Peacock or full purple	540	Augers, cold chisels for steel
Bluish purple	550	Axes, cold chisels for iron, screwdrivers, springs.
Blue	570	Saws for wood.
Full Blue	590	
Very dark Blue	600	
Light Blue	640	



Conducted by: R. J. Russo, Capt., Ord. Dept.

TRANSPORTATION OF AMMUNITION

Somewhere in the European theater of operations, there is a direct need for ammunition for heavy field weapons. The Chief of Ordnance has been notified of this need through command channels, and has issued shipping orders directing the shipment of this ammunition to an arsenal, prior to export from an East coast port.

The commanding officer of an Ordnance Depot located in the midwest has received one of these shipping orders calling for the following:

80,000 rds. of Shell, H.E., M101, unfuzed, 155mm Gun
20,000 rds. of Shell, smoke, FS, M104, unfuzed, 155mm Gun.
100,000 Charge, propelling, 155mm Gun, M1 and M1A1
110,000 Primer, percussion, 21-grain, Mk. IIAI.

This shipment is to be made by rail freight. Inter-State Commerce Regulations classify explosives for freight shipment as forbidden and acceptable. Acceptable explosives are divided into three classes according to the hazards involved in handling.

Class "A" includes those dangerous explosives which have a detonating or maximum hazard, such as ammunition for cannon. The high explosive and chemical ammunition contained in this particular shipment fall into this classification. A Class "A" shipment requires a certified car, which must meet the following requirements.

1. Closed car of not less than 80,000# capacity.
2. Steel underframe and friction draft gear.
3. Airbrakes and handbrakes in proper condition.
4. Solid floors without holes.
5. Doors which can be securely locked.

The following information concerning the preparation of car certificates is taken from Paragraph F, Section 525, of Inter-State Commerce Commission Regulations. The following certificate, printed on strong tag board measuring 7 by 7 inches, or 6 by 8 inches, must be

by P. H. STAUFF
S. Sgt., Ord. Dept.

duly executed in triplicate by the carrier, and by the shipper, if he loads the shipment; the original must be filed by the carrier at the forwarding station on a separate file; and the other two must be attached to the outside of car doors, or to the sides of car, one on each side, the lower edge of the certificate not less than 4-1/2 feet above the floor level:

CAR CERTIFICATE

No. 1 Station, 19

I hereby certify that I have this day personally examined car No. ; and that the roof, sides, and ends have no loose boards, holes, or cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the kingbolts and draft bolts are properly protected and that there are no uncovered pieces of metal or nails projecting from the floor or sides of the car which might injure packages of explosives; also that the floor is in good condition and has this day been cleanly swept before the car was loaded; that I have examined all the axle boxes and that they are properly covered, packed, and oiled, and that the air brakes and hand brakes are in condition for service.

Railway employee inspecting car.

CAR CERTIFICATE

No. 2 Station, 19

I hereby certify that I have this day personally examined the above car; that the floor is in good condition and has been cleanly swept and that the roof, sides, and ends have no loose boards, holes, cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the kingbolts and draft bolts are protected, and that there are no uncovered pieces of metal or nails projecting from the floor or sides of the car which might injure packages of explosives;

that the explosives in this car have been loaded and stayed and that the car has been placarded according to the regulations for the transportation of explosives prescribed by the Interstate Commerce Commission; that the doors fit or have been stripped so that sparks cannot get in at the joints or bottom.

Shipper.

Railway employee
inspecting loading and staying.

Note. - Both certificates must be signed; certificate No. 1 by the representative of the carrier. For all shipments loaded by the shipper he or his authorized agent must sign certificate No. 2, and the representative of the carrier must certify as to loading and staying and general conditions. When the car is not loaded by shipper, certificate No. 2 must be signed only by the representative of the carrier. A shipper must decline to use a car not in proper condition.

Class "B" includes those less dangerous explosives, which have an inflammable hazard, such as smokeless powder. The 100,000 propellant charges in this shipment will fall into this classification. A certified car is not necessary for a Class "B" shipment, although the requirements for a certified car should be maintained, with particular attention to protection against sparks.

Class "C" includes those relatively safe explosives, which have a minimum hazard, such as primers. The 46 boxes of primers in this shipment could be shipped under Class "B", but will be shipped in a separate car.

Loading is usually accomplished by the shipper, in this instance the Ordnance Depot. Following the spotting of the cars for loading, all cars in which Class "A" and Class "B" shipments will be made must be properly placarded. All placards are furnished by the shipper, and must be displayed on all sides of the car for protective security during loading and transporting. A car containing a Class "A" shipment requires "Explosive" placards. A car contain-

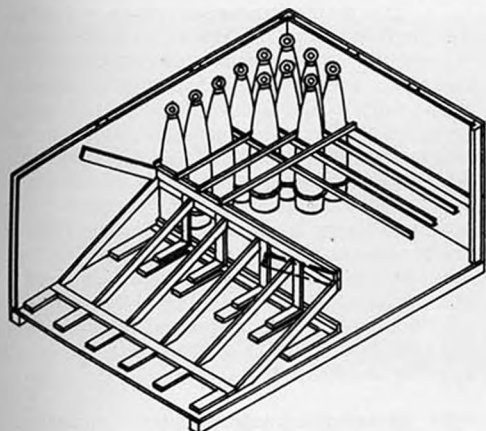


Fig. 1 -- Method of packing 155mm projectiles in car

ing a Class "B" shipment requires "Dangerous" placards. No placards are necessary on a car containing a Class "C" shipment. Prior to loading, each car must have its wheels chocked and brakes set. The immediate vicinity should be cleared of all inflammable materials, that fire hazard may be minimized. Loading operations should be suspended, and all car and magazine doors closed, when engines are passing. It is necessary that all cars be carefully swept and metal projections removed or covered.

All bracing and staying materiel must be furnished by the shipper, and care must be taken that the shipment be properly braced and stayed in accordance with Inter-State Commerce Commission Regulations. The proper methods of loading and staying carload, and less than carload shipments of explosives, are adequately illustrated in the Bureau of Explosives Pamphlet No. 6.

155mm projectiles are stored on their bases, in an upright position. Braces are placed parallel and laterally with the sides of the car, thus immobilizing each projectile. (See Figure 1). The importance of using braces of sufficient

size and strength cannot be stressed too much. Improper bracing would cause considerable damage to rotating bands and shell bodies, resulting in unserviceable ammunition.

Propellant charges for the 155mm Gun are packed 3 per cloverleaf bundle. The bundles are placed on their sides parallel to the car sides, and stacked as high as the inside boarded walls permit. The "stepdown" method of stacking can be effectively used. (See Figure 2.)

The primers for this shipment of ammunition will make up a "less than carload" shipment. There are 48 boxes, which will be placed in one end of a car. The "stepdown" method of stacking will be used, and the shipment braced with the "Special L.C.L. Shipment Brace". (See Figure 3.)

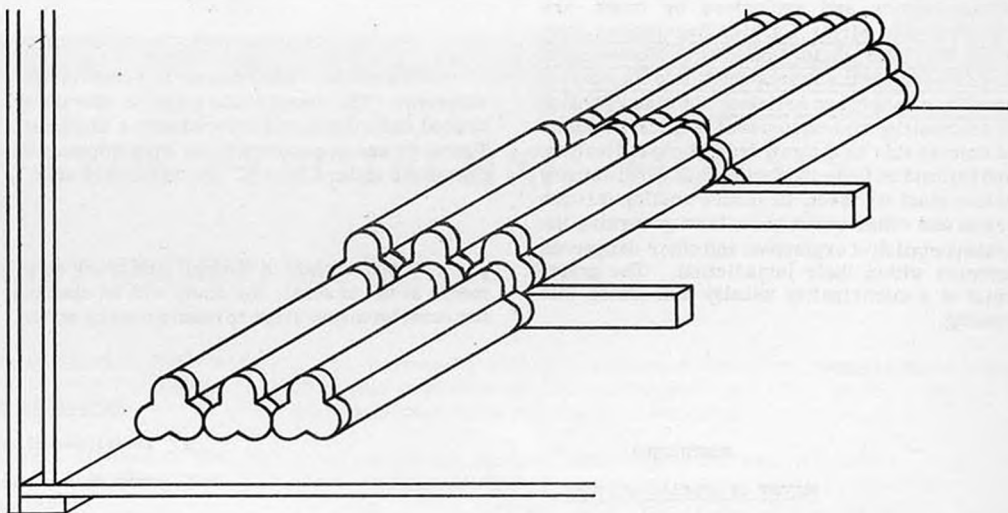


Fig. 2 -- "Stepdown" method of packing propellant charges in car

The following paragraph is taken from Ordnance Department Order No. 333, and concerns reports of special shipments. As soon as

a shipment has been consigned to a Port, to a Regulating Station, or to a representative of a foreign government, the consignor will immediately prepare the Shipping Ticket, containing details covered on the "Report of Special Shipment". (See Figure 4.) It will not be necessary to fill out the "Report of Special Shipment", if legible copies of the Shipping Tickets are dispatched within eight hours of departure of materiel. If however, it is not possible to dispatch a copy of the Shipping Ticket, to comply with the

above, then a "Report of Special Shipment" form will be filled out immediately and the Shipping Tickets will be sent as soon thereafter as possible. In case the Shipping Ticket must be prepared at an office (such as the District Office) other than the actual shipper, the "Report of Special Shipment" will be prepared and sent by the government representative at the facility from which shipment is made. A copy of the

"Report of Special Shipment", unless Shipping Tickets can be dispatched as described above, will be distributed, as follows by the most expeditious mail. When the shipment is consigned to United States forces overseas, one copy will be forwarded to the Port Ordnance Officer.

The transportation of government property by rail freight or express, water, or highway carrier operated as a part of rail or water carriers, or express companies, must be accomplished through the use of Government Bills of Lading. Supplies turned over to a transportation officer for shipment must be accompanied by three copies of a memorandum shipping ticket. The memorandum shipping ticket will contain the necessary information to enable the transportation officer to make out the bills of lading. This information includes the shipping names, consignee, consignor, package weights, gross weight of the shipment, appropriation chargeable, and authority for the shipment. One copy of the memorandum shipping ticket will be receipted by the transportation officer, and returned to the supply point, in this case the Ordnance Depot. Another copy will be sent to the consignee, who will be the transportation officer at the arsenal nearest the intended port of export. The remaining copy will be filed with the "Property Shipped" copy of the bill of lading, by the transportation officer. As this shipment consists of more than two carloads, a written routing order must be obtained from the Quartermaster General. Before this shipment of am-

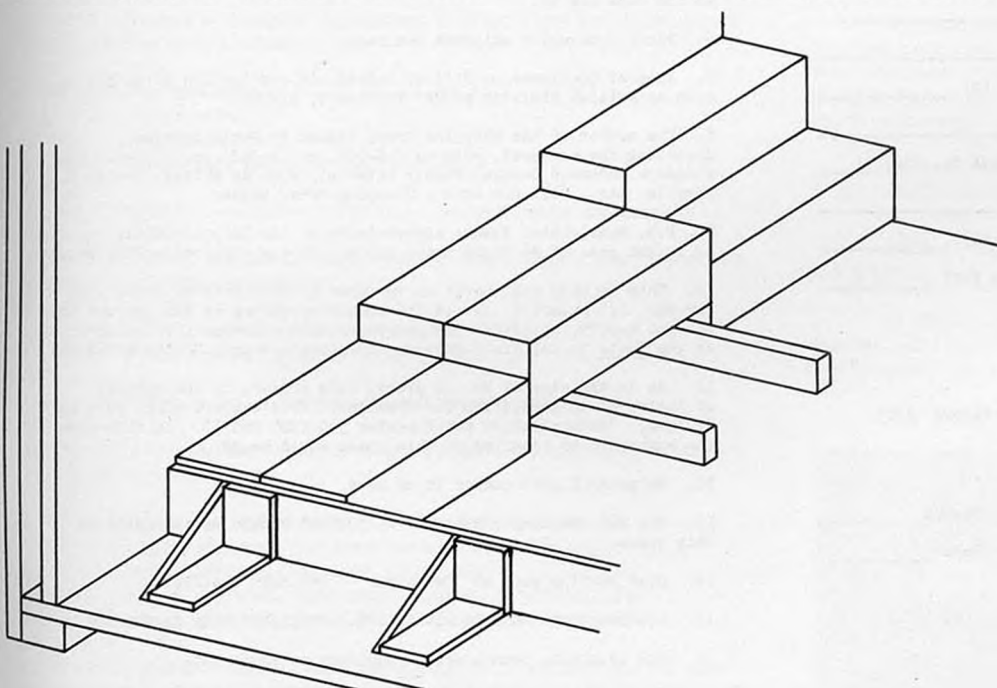


Fig. 3 -- "Stepdown" method of stacking boxes of primers in car and use of the "Special L.C.L. Shipment Brace"

munition can get under way, a request for release will also have been sent to the Quartermaster General. This request will indicate the nature of the ammunition, weight, cubic measurement, location, consignee, and the importance and urgency of the shipment. Only upon receipt of the necessary release and shipping instructions can the shipment be moved.

The scene shifts to an arsenal in the East, where a shipping order has been received for 100,000 Fuze, P.D., M51, w/Booster, M21, to be shipped to an arsenal nearest the intended port of export on the East Coast. This shipment of fuzes is related to the rail shipment of projectiles, propellants and primers, and will complete the assembling of 100,000 complete rounds of high explosive and chemical ammunition.

This shipment is to be made by motor truck. Regulations governing the transportation of ammunition and explosives by truck, are prescribed in Motor Carrier Regulations, Part 7, of the Inter-State Commerce Commission Regulations for the Transportation of Explosives and Other Dangerous Articles. The classification of ammunition and explosives for truck shipment is comparable to the rail freight classification, and is found on Page 10, Section 7.2. Preliminary action must be taken to insure routing through towns and cities which have laws governing the transportation of explosives and other dangerous articles within their jurisdiction. The police chief of a municipality usually authorizes this routing.

Trucks used in the transportation of ammunition and explosives should be inspected daily for defects in electric wiring, lights, brakes, gasoline tanks, and lines. The engine must be cleaned of accumulated grease, oil and dirt. Care must be taken that any oil or grease splashed on the truck body from moving parts, be removed daily. Smoking on, or near a truck-load of ammunition or explosives, is forbidden. Safety matches are carried in a metal container in the tool box. Proper fire fighting equipment, including fire extinguisher, must be carried in every truck. The driver of the truck must have had previous instruction in fighting gasoline fires. In the event that a loaded truck breaks down, it should be towed to its destination by another of the convoy trucks. If this is impossible, two guards will be posted, and the consignee notified of the breakdown, that a truck and personnel may be sent to transfer the load from the disabled truck.

There are 4000 boxes of fuzes in this shipment. The truck loads must be effectively braced and stayed, and covered with a tarpaulin. Placards are unnecessary, as this shipment is classified under Class "C", or relatively safe.

Upon arrival of the rail and truck shipments at the arsenal, the loads will be checked for completeness, prior to reshipment by water.

Due to the dangerous nature of ammunition and explosives, port authorities designate an explosive anchorage at a safe distance from the regular port facilities. At this point, supplies of ammunition and explosives are transferred to, or discharged from cargo ships, by means of barges and lighters. All shipments of ammunition and explosives consigned for export, must be shipped to the arsenal nearest the port of export, as pier consignments are prohibited. The arsenal to which this particular shipment has been consigned, prior to export, is located on a navigable river. At this point the shipment will be transferred to barges and lighters, move down the river to the "Explosive Anchorage", and there be transferred to a ship.

Ammunition and explosives intended for shipment by water, are divided into 12 storage groups. This grouping allows for previous planning of storage space, as regards a particular shipment, and obtains the best safety factors in handling and storing. A ship's master is responsible for the loading of the vessel, and at times when large quantities of ammunition and explosives are involved, an Ordnance expert will be available to help lay out a proper cargo plan. The ship's master is supplied with two copies of the manifest, or list of the ships cargo, and two copies of the cargo loading plan. Regulations governing the transportation by water, of explosives, inflammables and chemical warfare materials, are found in A.R. 30-1270.

"Happy landing on the Nazi."

EXPLANATION OF FORM FOR REPORT OF SPECIAL SHIPMENT

RESTRICTED

REPORT OF SPECIAL SHIPMENT

To: (3) _____ Station (1) _____
 _____ Date (2) _____

Shipment was made at (4) _____, _____ by means of
 (5) _____ Time _____ Date _____
 _____ Means of Transportation _____

Shipment was made from (6) _____

Shipped to: (7) _____

Shipping Order No. (8) _____ F.S. Req. (9) _____

Foreign Country Req. and S. R. No. (10) _____

Auth. for Transfer (11) _____ Shipping Ticket No. (12) _____

QMR No. (13) _____ Routing (14) _____

Approx. Value for Export Declaration (on War Aid only) (15) _____

Gross Weight (16) _____ Cubic Feet (17) _____

Car Number (18) _____ B/L Number (19) _____

Items Shipped (Use back of Page if list cannot be given below) (20)

Signed _____
 Rank _____

RESTRICTED

1. Establishment making the Report.
2. Date that the Report is made out and sent forward.
3. Name of recipient of report, such as Port Ordnance Officer, N. Y. Port of Embarkation or British Ministry of War Transport, Insert address of recipient.
4. Time and date material delivered to transportation agency.
5. Insert, Carload freight, L.C.L. freight, air express, Railway express, Commercial truck, Parcel post, Army truck, or Army plane, as the case may be.
6. Place from which shipment was made.
7. Name of Consignee on Bill of Lading and destination of material, such as British Ministry of War Transport, N.Y.C.
8. The number of the Shipping Order issued by Field Service, directing the movement, such as 3-G-504, or DA-392, or 146-S-2. Non-standard Ordnance General Supply material, such as British design 3.7 barrels, etc., will not have a Shipping Order Number.
9. F.S. Requisition Number appertaining to the Shipping Order. As in the case of #8 above there may not be any applicable F.S. Req. No.
10. This is only applicable in the case of shipments of Lease Lend (or War Aid) material. It is the number appearing in the subject of General Supply, Field Service letter of Authorization for Transfer, or as the Basis in all Field Service, ammunition Supply Shipping Orders.
11. As in the case of No. 10 above, this appears in the subject of letter of Authorization for Transfer. This subject might read as follows, "Authorization for Transfer 3-G-(BSC 2657)". In this case the number to be inserted in this space would be 3G.
12. Shipping Ticket number to be used.
13. The ODT QMR number such as "WI 302014" should be indicated in this space.
14. Give routing such as "Bamberger -- Southern Pacific".
15. Accuracy need be only within 10%. Furnished only on War Aid.
16. The weight in pounds within accuracy of about 10%.

Fig. 4 -- Report of special shipment



AVIATION ORDNANCE

Conducted by: Ordnance Section, Army Air Forces

THE "FINAL" TYPE PYROTECHNIC SIGNALS

by HENRY WEIMER, 2nd Lt., Ord. Dept.

Pyrotechnics are modifications of fireworks designed to produce a brilliant light for illumination or colored lights and smokes for signaling.

Some types of pyrotechnics are projected from or used on the ground; others are released or fired from airplanes. Depending upon where they are functioned, pyrotechnics are classified as:

1. Ground types.
2. Aircraft types.

They are further classified according to the purpose for which they are used:

1. Flares — designed to produce a bright light for illumination. Illumination may be necessary for:

- a. Reconnaissance.
- b. Observation.
- c. Bombardment.
- d. Emergency landings of airplanes.

2. Signals — designed to produce colored lights and smokes.

The use of signals depends upon a prearranged code. Signalling may involve sending messages:

- a. From aircraft to other aircraft or to ground units.
- b. From ground troops to other ground units or to aircraft.

This article will consider aircraft signals only.

Prior to 1942 the Army Air Forces used the following pyrotechnics for signalling from planes.

- a. Signal, aircraft, white star, parachute, M10
- b. Signal, aircraft, red star, parachute, M11
- c. Signal, aircraft, red star cluster, M14
- d. Signal, aircraft, white star, blinker, parachute, M15
- e. Signal, aircraft, green star, blinker, parachute, M16

This group of signals were designed to be fired from the M2 pyrotechnic pistol. Figure 1 shows a typical signal of this group which has recently been standardized as the AN-M11. The remainder of the signals in this group are now limited standard.

In January, 1942, the Ordnance Department standardized a series of signals now referred to as the "Interim" type. This series consisted of six double star and three single star signals.

- a. Signal, aircraft, double star, Red-red, AN-M28
- b. Signal, aircraft, double star, Yellow-yellow, AN-M29
- c. Signal, aircraft, double star, Green-green, AN-M30
- d. Signal, aircraft, double star, Red-yellow, AN-M31
- e. Signal, aircraft, double star, Red-green, AN-M32
- f. Signal, aircraft, double star, Green-yellow, AN-M33
- g. Signal, aircraft, single star, Red, AN-M34
- h. Signal, aircraft, single star, Yellow, AN-M35
- i. Signal, aircraft, single star, Green, AN-M36

These signals consisted of a star composition loaded in an aluminum cup and contained within an aluminum barrel, 3.02 x 1.56 inches. They were designed to be fired from the M2 Pyrotechnic pistol. Each star composition burned for seven seconds with the candlepower depending upon the color of the star.

- a. Red — 9000 candlepower minimum
- b. Yellow — 2000 candlepower minimum
- c. Green — 6000 candlepower minimum

Figures 2 and 3 show cross sectional views of a typical double star and a typical single star respectively.

In April, 1942, the "Interim" type signals were declared limited standard, and the "Final" type series signals were standardized to replace the "Interim" type.

The "Final" type signals closely resemble British Aircraft Signals.



Original type aircraft signal

SIGNAL, AIRCRAFT, DOUBLE STAR, AN-M37 to AN-M42

These signals are assembled in a shotgun-type shell of cartridge paper with a brass head. The signal cartridge is 3.85 inches in length by 1.537 inches in diameter. They are designed for use in the breech loading, Pistol, Pyrotechnic, AN-M8. Upon firing, the propelling charge ignites and projects two freely falling stars of the same or different colors, which burn from 7 to 13 seconds. The color and intensity of the stars are as follows:

Red — 25000 candlepower minimum
 Yellow — 12000 candlepower minimum
 Green — 20000 candlepower minimum

The following signals are provided:

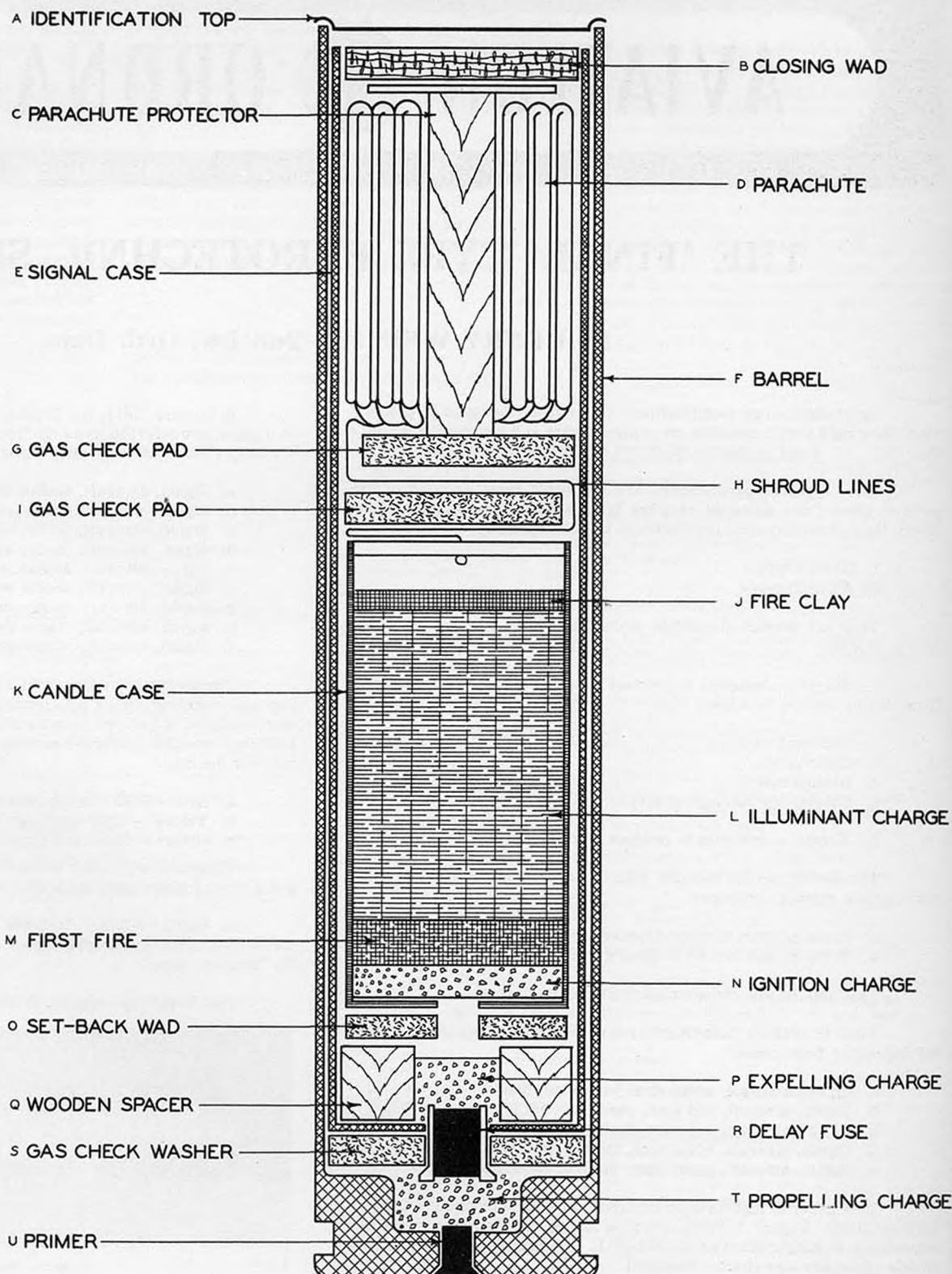
Signal, aircraft, double star, Red-red, AN-M37
 Signal, aircraft, double star, Yellow-yellow, AN-M38
 Signal, aircraft, double star, Green-green, AN-M39
 Signal, aircraft, double star, Red-yellow, AN-M40
 Signal, aircraft, double star, Red-green, AN-M41
 Signal, aircraft, double star, Green-yellow, AN-M42

The cartridge case is natural colored, marked in black with the type and model of the signal, the Ordnance insignia, lot number, manufacturer's symbol, and date of loading. Around the cases of the double star signals two 1/4-inch bands are marked, each the color of one of the stars. The

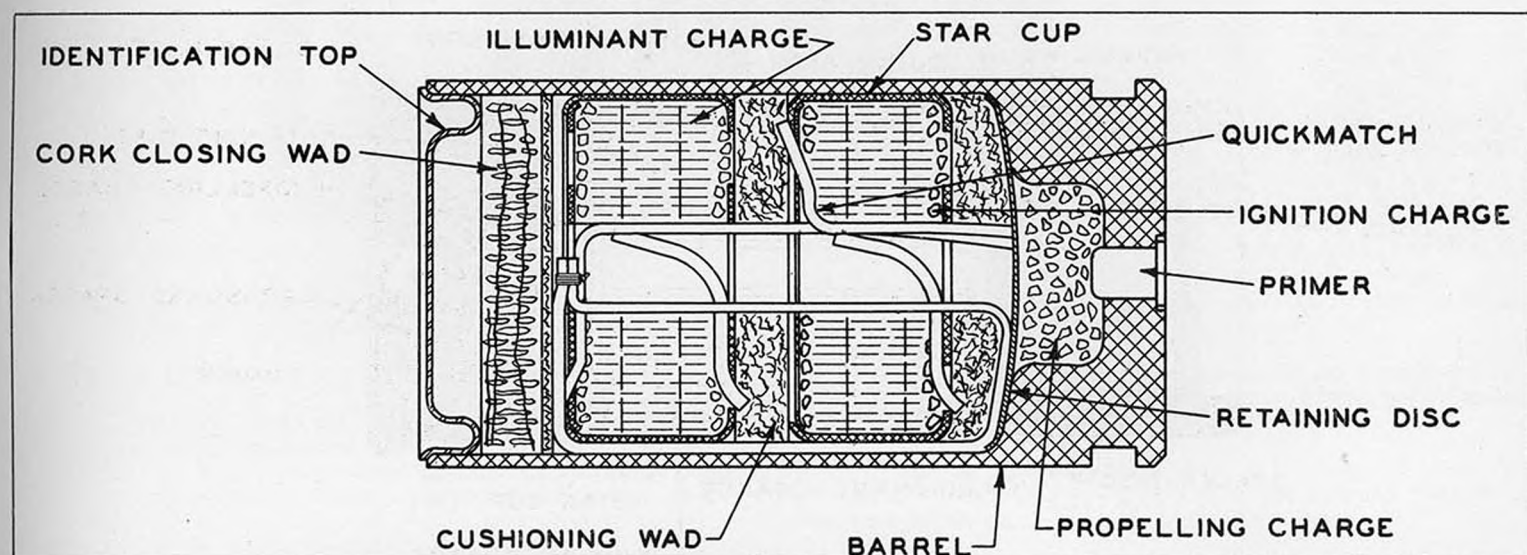
SIGNAL, AIRCRAFT,
RED STAR,
PARACHUTE,
M11

The M10 and M11 pyrotechnics differ only in the composition of the illuminant charge. The M10 burns with a white light, while the M11 gives off a red light. The identification top of the M10 is painted white and has the letters WP stamped into it, the M11 is painted red with the raised letters RP. Both signals are fired from the pyrotechnic projector, M2, and are fired only from aircraft EXCEPT THE M11 FIRED FROM THE GROUND MEANS "DISTRESS".

On pulling the trigger of the projector, the primer (U) is functioned, igniting the black powder propelling charge (T). The signal case (E) with its contents is projected 150 to 200 feet before the 2 to 3 second delay fuse (R) functions the expelling charge (P). The gas check washer (S) helps to prevent the escape of gases between the barrel (F) and the signal case. The identification top is pushed out by the signal case as it is projected. The wooden signal case spacer (Q) protects the expelling charge from being crushed by the candle assembly on set-back and the set-back wad (O) cushions the shock on the candle assembly. The expelling charge propels the contents of the signal case, including the candle and parachute, from the signal case. The case check pads (G) and (I) help prevent the escape of the gases between the signal case and the candle case (K), protect the parachute (D) from fire, and cushion the upward thrust on the parachute and the wooden parachute protector (C). The parachute protector pushes out the cork closing wad (B), and the parachute and candle assembly follow. The parachute is either cloth or paper about 24" in diameter, with shroud lines (H) from which the candle assembly is suspended. The candle is functioned by ignition of a black powder priming or ignition charge (N) by the propelling charge. This in turn ignites the first fire (M) which functions the illuminant charge (L). The candle burns for about 30 seconds with 30,000 C.P. The fire-clay layer (J) protects the suspension cords from heat.



SIGNAL, AIRCRAFT, DOUBLE STAR (Interim type)



There are six of the signals, aircraft, double star of the so-called "interim type". They are similar to each other, varying only in the color and candlepower of the stars. The assembly consists of a pair of stars housed in an aluminum barrel (H), tied together with a length of quickmatch, and separated from each other by a cushioning wad (E). The aluminum barrel is notched at the base to fit in the M2 pyrotechnic pistol, and contains in its base a primer (K) and a propelling charge of black powder (J), which is held in place by an onion skin retaining disc (I). Each of the stars consists of an aluminum cup (D) filled with illuminant charge (C) coated top and bottom with a layer of black powder ignition charge (G). The top and bottom of the star cups are perforated with six holes, in addition to the large central hole running entirely through the stars, and through these holes are threaded lengths of quickmatch (F) running from the ignition charge on the face of each star to the top of the propelling charge. The stars are held in the barrel by the cork closing wad (B) and the identification top (A). This identification top is made from thin metal sheet, and has embossed into it two

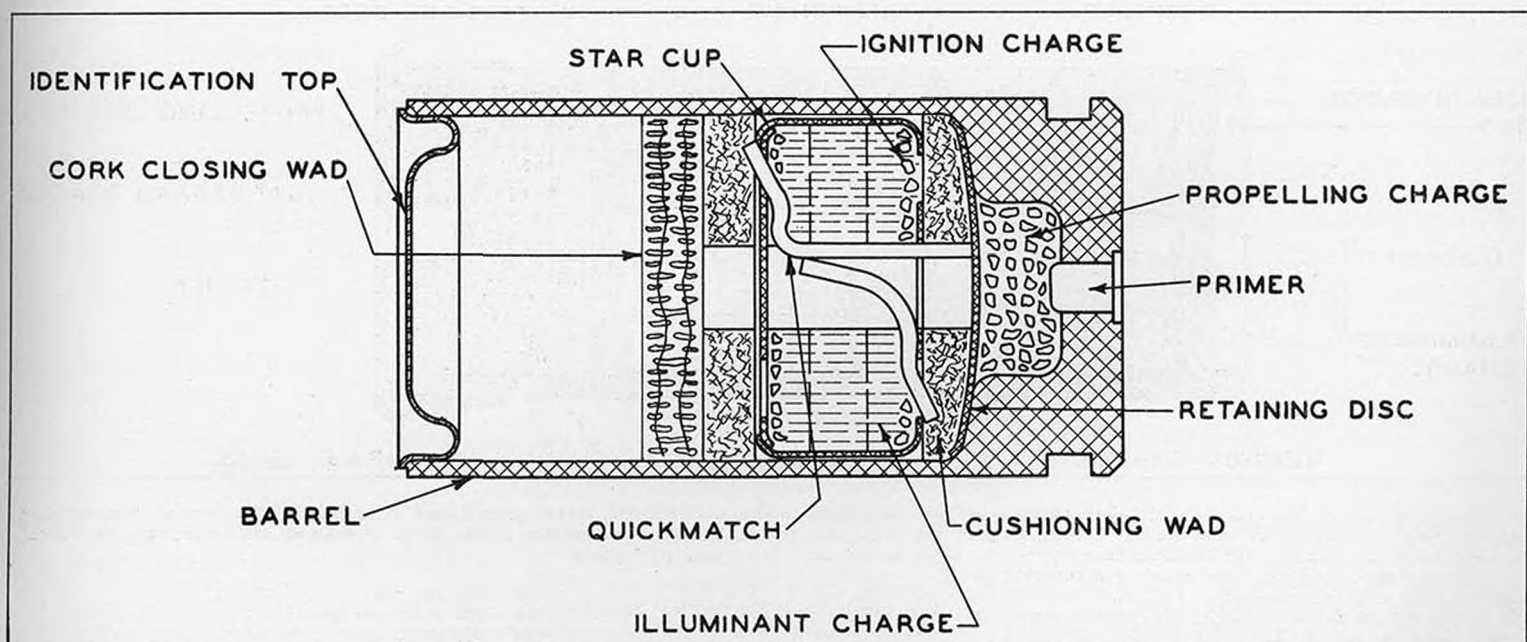
letters which describe the color of the stars; it is painted correspondingly.

The six signals are:

AN - M28 red-red	9000 cp.
AN - M29 yellow-yellow	2000 cp.
AN - M30 green-green	6000 cp.
AN - M31 red-yellow	
AN - M32 red-green	
AN - M33 green-yellow	

OPERATION: When the pistol is fired, the primer functions the propelling charge which ignites the quickmatch and propels the stars from the barrel. The flaming stars fly through the air, burning about seven seconds apiece.

SIGNAL, AIRCRAFT, SINGLE STAR (Interim type)



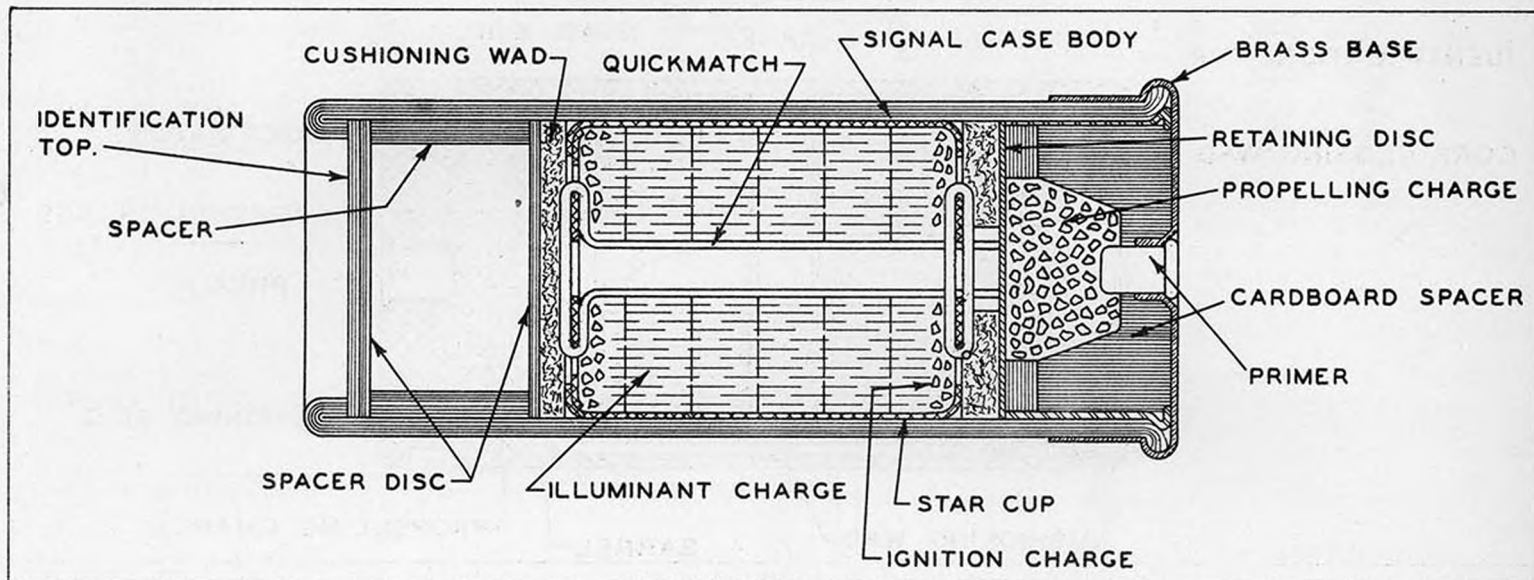
There are three of the signals, aircraft single star of the so-called "interim type". They are similar to each other varying only in the color and candle-power of the star. The assembly consists of a star housed in an aluminum barrel (C), protected by cushioning wads (E), and held in place by the cork closing wad (B). The star consists of an aluminum cup (D) filled with illuminant charge (F) coated top and bottom with black powder ignition charge (G). The top and bottom of the star cup are perforated with six holes, in addition to the large central hole running entirely through the star, and through these holes are threaded lengths of quickmatch (E) running from the ignition charge on the face of the star to the top of the propelling charge (J). The propelling charge consists of black powder and is housed in the barrel underneath the onion skin retaining disc (I) in contact with the primer (K).

The top of the barrel is closed by an identification top (A) which is painted the same color as the signal and which has a corresponding letter embossed in it as follows:

AN - M34 R red	9000 cp.
AN - M35 Y yellow	2000 cp.
AN - M36 G green	6000 cp.

OPERATION: When the pistol is fired, the primer functions the propelling charge which ignites the quickmatch and propels the star from the barrel. The flaming star flies through the air, burning about seven seconds.

SIGNAL, AIRCRAFT, SINGLE STAR (Final type)



There are three of the signals, aircraft single star of the "final type". They are similar to each other, varying only in the color and candlepower of the star. The assembly consists of a star housed in a cardboard signal case (G), protected by cushioning wads (D) and held in place by a spacer (B) and spacer disc (C). The star consists of an aluminum cup (H) filled with illuminant charge (F) coated top and bottom with black powder ignition charge (I). The top and bottom of the star cup are perforated with six holes, in addition to the large central hole running entirely through the star; through these holes are threaded lengths of quickmatch (E) running from the ignition charge on the face of the star to the top of the propelling charge (K). The propelling charge consists of black powder, and is housed in a cardboard spacer (L) inside the signal case underneath an onionskin retaining disc (J) and in contact with the primer (M). The bottom at the signal case is reinforced

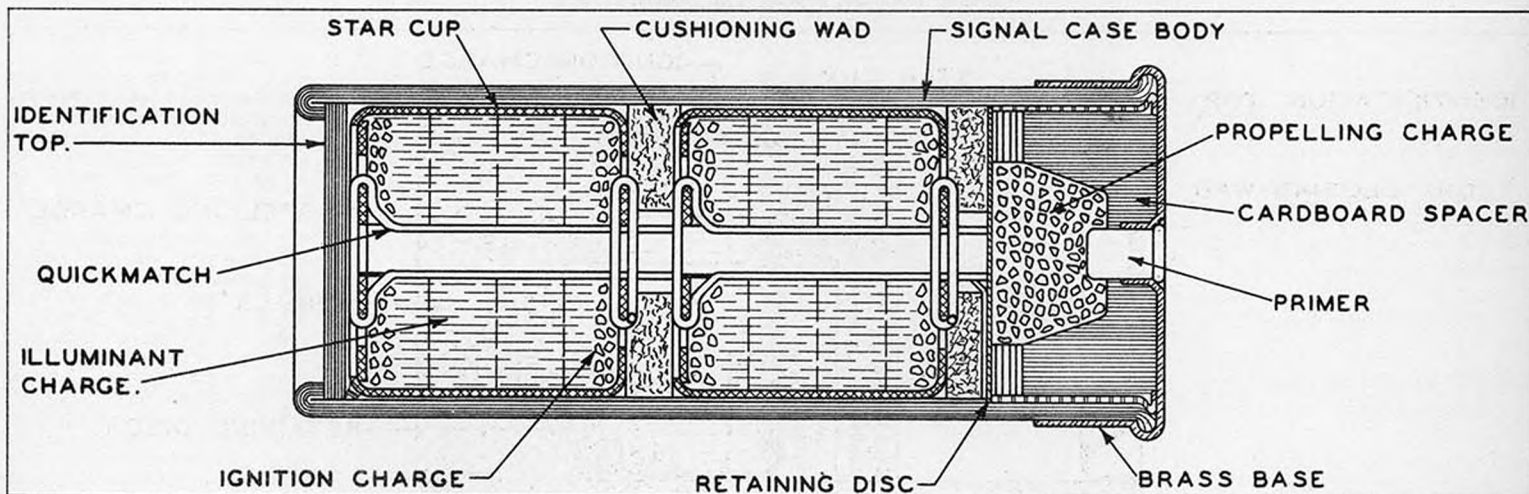
by a thin brass base (N) which provides a rim for seating the signal in a projector.

The top of the signal case is closed by a 360° crimp-fastened, cardboard identification top (A) which is colored correspondingly to the signal as follows:

AN - M43 red	25,000 cp.
AN - M44 yellow	15,000 cp.
AN - M45 green	30,000 cp.

OPERATION: When the pistol is fired, the primer functions the propelling charge which ignites the quickmatch and propels the star from the barrel. The star flies through the air, burning 7 to 13 seconds.

SIGNAL, AIRCRAFT, DOUBLE STAR (Final type)



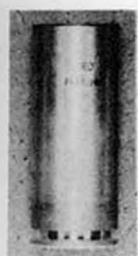
There are six of the signals, aircraft double star of the "final type". They are similar to each other, varying only in the color and candlepower of the stars. The assembly consists of two stars housed in a cardboard signal case (G), protected by cushioning wads (F), and tied together with a tying string (B). Each star consists of an aluminum cup (E) filled with illuminant charge (D) coated top and bottom with black powder ignition charge (H). The top and bottom of each star cup are perforated with six holes, in addition to the large central hole running entirely through the star; through these holes are threaded lengths of quickmatch (C) running from the ignition charge on the face of the star to the top of the propelling charge (J). The propelling charge consists of black powder and is housed in a cardboard spacer (K) inside the signal case underneath an onionskin retaining disc (I) and in contact with the primer (M). The bottom of the signal case is reinforced by a thin brass base (L) which provides a rim for seating the signal in a projector.

The top of the signal case is closed by a 360° crimp-fastened, cardboard identification top (A) which is colored correspondingly to the signal, as follows:

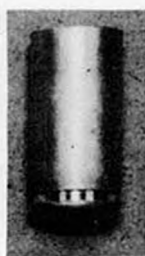
AN - M37 red-red	25,000 cp
AN - M38 yellow-yellow	12,000 cp
AN - M39 green-green	20,000 cp
AN - M40 red-yellow	
AN - M41 red-green	
AN - M42 green-yellow	

OPERATION: When the pistol is fired, the primer functions the propelling charge which ignites the quickmatch and propels the stars from the barrel. The stars fly through the air, burning 7 to 13 seconds apiece.

IF YOU BELONG TO AN ORDNANCE SECTION ASSIGNED TO THE
ARMY AIR FORCES SEE NOTICE ON PAGE 601



Interim type aircraft signal



Final type aircraft signal



British type aircraft signal



color of the stars is also marked on one-half of the identification top and the name of the color is stenciled thereon in black.

SIGNAL, AIRCRAFT, SINGLE STAR, AN-M43 to AN-M45

The single star signals are similar to the above except that each cartridge produces one star instead of two. The cartridge is of the same size, and is for use in the same pyrotechnic projector. The stars have the same burning time, but differ in candle power from the double star signals as follows:

Red — 25000 candlepower minimum
Yellow — 15000 candlepower minimum
Green — 30000 candlepower minimum

The following signals are provided:

Signal, aircraft, single star, red, AN-M43
Signal, aircraft, single star, yellow, AN-M44
Signal, aircraft, single star, green, AN-M45

Figures 4 and 5 show cross sectional views of typical single star and double star signals of the "Final" type, respectively.

The markings on the single star are the same as on the double star, except for the means of identification. The identification band is 1/2-inch wide and the identification top is solid color.

The "Final" type signals are packed 12 per carton, 12 cartons per box, 28-1/8 x 13-9/16 x 12-19/32 inches. The weight of the box with signals is as follows:

Signal aircraft, double star, Red-red, AN-M37, 87.5 pounds.
Signal, aircraft, double star, Yellow-yellow, AN-M38, 87.5 pounds.
Signal, aircraft, double star, Green-green, AN-M39, 98.3 pounds.
Signal, aircraft, double star, Red-yellow, AN-M40, 87.5 pounds.
Signal, aircraft, double star, Red-green, AN-M41, 92.9 pounds.
Signal, aircraft, double star, Green-yellow, AN-M42, 92.9 pounds.
Signal, aircraft, single star, Red, AN-M43, 78.5 pounds.
Signal, aircraft, single star, Yellow, AN-M44, 74.6 pounds.
Signal, aircraft, single star, Green, AN-M45, 83.4 pounds.

Field Service Modification Work Orders

(Continued from page 551)

- a. New design or modified parts:
- | Name | Drg. | (dated) | SNL |
|------------------------|--------|---------|-----|
| LOCK, safety, assembly | B8759 | 5-1-42 | B-3 |
| SLEEVE, bolt, assembly | C46049 | 4-12-35 | B-3 |

3. Purpose of Modification: To replace un-serviceable safety lock assemblies and bolt sleeve assemblies manufactured by Remington Arms before August 21, 1942.

4. Drawings Required to Apply Modification: None.

5. Parts Affected by Modification:

- a. New parts required:
- | Name | Pc. | Mk. | Qty. |
|--|-------|-----|------|
| LOCK, safety, assembly (Re-worked part or part manufactured by Springfield Armory or by Remington Arms after August 21, 1942). | B8759 | | 1 |

SLEEVE, bolt, assembly (Re-worked part or part manufactured by Springfield Armory or by Remington Arms after August 21, 1942).

SLEEVE, bolt, assembly (Re-worked part or part manufactured by Springfield Armory or by Remington Arms after August 21, 1942).	C46049		1
--	--------	--	---

b. Discarded parts:

Name	Pc.	Mk.	Qty.
LOCK, safety, assembly (Manufactured by Remington Arms before August 21, 1942).	B8759		1

SLEEVE, bolt, assembly (Manufactured by Remington Arms before August 21, 1942).

- c. Procurement of parts required:
- (1) Where procured: Raritan Arsenal
 - (2) Date available: Now.

6. Special Tools, Jigs, and Fixtures: None.

7. Special Instructions:

- Applied by: Using Arm
- Time required: 5 minutes
- Procedure of operation: Remove bolt from rifle. Disassemble bolt as described in Field Manual 23-10 and replace defective bolt sleeve assembly and safety lock assembly with serviceable assemblies. Reassemble rifle.
- Arsenal or field operation: Field.
- Comments with reference to published FSMWO's: None.
- Disposal of discarded parts: Parts replaced should be shipped to Raritan Arsenal to be forwarded to Remington Arms Company for reworking.
- This Work Order is classified in the RED Group, and therefore will be completed at the earliest practicable date. A monthly Progress Report should be forwarded to this Office listing the number of the Field Service Modification Work Orders classified in the RED Group applied during the current month and the number yet to be applied in your Service Command.

8. Remarks: This modification is to be applied to all U. S. Rifles, Cal. 30, M1903, manufactured by Remington Arms in which difficulty is encountered. In determining whether the safety lock assembly is properly retained on the bolt sleeve assembly the bolt should be retracted sharply and stopped by the cut-off. The safety must not be dislodged from the rifle. When conducting this test, the safety should be in the "ready" position. In no case should the test be conducted with the safety in an upright position

since in this position the inertia of the firing pin, striker and cocking piece will be thrown against the safety lock assembly and will result in damage to the rifle.

9. Date Approved for Publication:

BY ORDER OF THE CHIEF OF ORDNANCE:

H. R. KUTZ
Brig. General, Ordnance Dept.
Chief of Field Service

YOUR CHANGE OF ADDRESS!

The editor of THE ORDNANCE SERGEANT hears that same sad story every month. Some unit moves. It falls to report a change of address. The next issue of THE ORDNANCE SERGEANT is returned, unclaimed. A few weeks pass. Then a letter complains that THE ORDNANCE SERGEANT hasn't been received since such-and-such an issue. Back issues are requested in order to complete the organization file. But the back copies are no longer available, and another file which might have been complete is broken, never to be complete again.

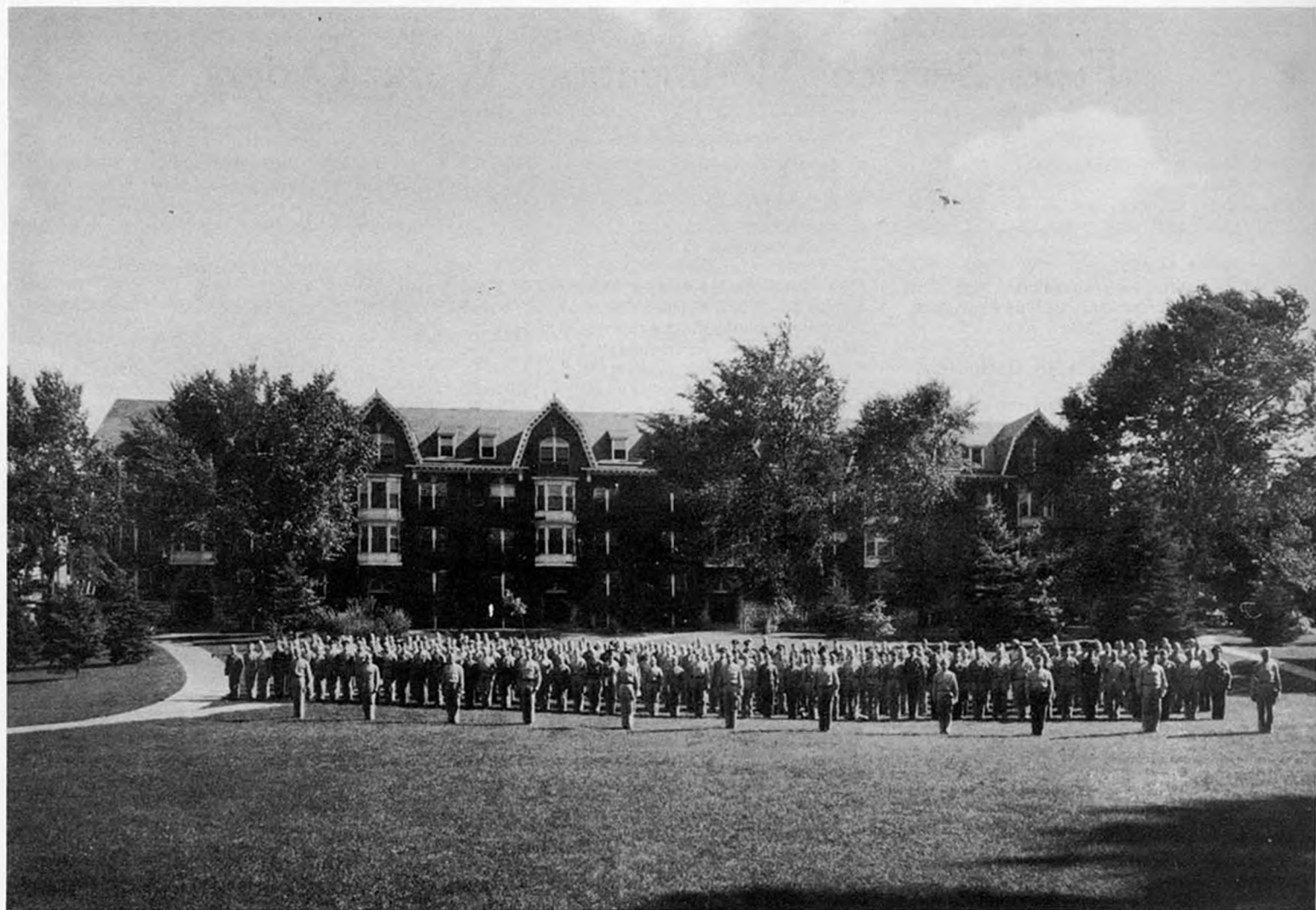


Conducted by: G. D. Meixel, 1st Lt., Ord. Dept., Secretary, The Ordnance School

LANSING SECTION, THE ORDNANCE SCHOOL

The Lansing Section of the Ordnance School, located at Lansing, Michigan, has experienced the greatest growth since its establishment last February, of any similar school in the country. The first class consisted of 25 armorers. Currently the classes have an enrollment of 450 officers and men representing the Army, Navy, Air Corps and Marine Corps.

All instruction is given at the School's headquarters on the top floor of the Engineering Building of Oldsmobile Division of General Motors. The School is operated on a 24-hour basis with classes convening at 7:00 A.M. and 4:00 P.M. Study periods are conducted after the close of instruction sessions.





Complete instruction is given in the assembly, disassembly, maintenance and repair of 20 and 37mm cannon manufactured by Oldsmobile and calibre .50 machine guns produced by another Division of General Motors. Since all of these weapons are used on certain types of aircraft, the training equipment includes, in addition to the guns themselves and the various equipment necessary to servicing and maintaining them, a complete fighter plane, an extra fuselage and various wing sections.

The student armorer whose duty it is to service and maintain this armament, requires specialized knowledge in many technical subjects - all of which are taught at the school. These include machine gun synchronization, bore sighting, operation and repair of numerous gun accessories such as chargers, feeds, magazines, solenoids, adapters and mounts.

Graduates are required to assemble and disassemble the various weapons in specified times while blindfolded. The record for this operation is three minutes and nine seconds on the calibre .50 machine gun and on the 20 mm cannon (a much more complicated weapon) it is 16 minutes and 55 seconds. The obvious reason for this blindfold training is to equip men to perform their tasks under difficult circumstances, approaching as nearly as possible actual combat conditions.

The course is of 28 days duration. The faculty consists of 50 men of Oldsmobile's engineering and production staffs, each of whom is an outstanding authority on the production, operation and maintenance of all weapons utilized in the classes.

Not only are students given thorough training in the manipulation and repair of the weapons themselves, but likewise they are carefully schooled in manufacture and test-firing. They follow the weapons from their arrival at the plants in the form of raw steel through the various phases of construction until they emerge finished cannon and are test fired on the company ranges.

Personnel of the Lansing Section of the Ordnance School are quartered at the Olds Hotel in Lansing and at Wells Hall on the campus of Michigan State College in East Lansing. The latter are transported to and from classes by bus, as the College is more than five miles from the school. Men at the Olds Hotel march to and from classes, weather permitting. Otherwise they also are transported by bus.

Commanding the school are: 1st Lt. L. W. Jackson, Officer in Charge, assisted by Staff Sgt. P. H. Webb, Sgt. Kenneth D. Eagle, Cpl. L. M. Cusick, and Cpl. Donald A. Fox.

Buy War Bonds

Vickers Machine Gun

(Continued from page 555)

CARE AFTER FIRING

1. Unload the weapon. Unloading is accomplished by turning the roller handle to the rear twice. **DONOT TOUCH THE AMMUNITION BELT.** After doing this press upon the upper and bottom pawls of the feed box and remove the ammunition belt.

2. Oil the chamber and the bore immediately and thoroughly.

3. See that the main spring is released.

4. Empty the water jacket, remove the hose connection group and insert the steam outlet cork plug group.

5. Close the bottom plate slide.

6. See that no live cartridges are among the empty cartridge cases.

7. Examine the lock carefully, particularly the carrier, the firing pin and springs, to make certain that they have not been damaged. It is not necessary to strip the lock to make this inspection.

8. **THOROUGHLY CLEAN AND OIL THE WEAPON AT THE FIRST OPPORTUNITY.**

NOMENCLATURE

Alphabetical List of Component Parts of the

VICKERS MACHINE GUN

(Model of 1915)

(Numbers after the components refer to numbers shown on Plates to identify the various parts.)

Adjustment nut (28R)
Adjusting washer, thin (26R)
Adjusting washer, thick (26Q)
Aperture disc (B2A)
Barrel (9A)
Barrel disc (25G)
Base spring (B2T)
Bottom pawl, left hand (20A)
Bottom pawl, right hand (20B)
Bottom pawl connecting plate (20C)
Bottom lever (20D)
Bottom pawl pin (27X)
Bottom pawl rivet (26E)
Bottom pawl spring (29F)
Bottom plate (6A)
Bottom plate slide (6B)
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 Windage screw collar (22E)
 Windage screw knob (22D)
 Windage screw spring (22F)



Fundamentals of Artillery Weapons

(Continued from page 558)

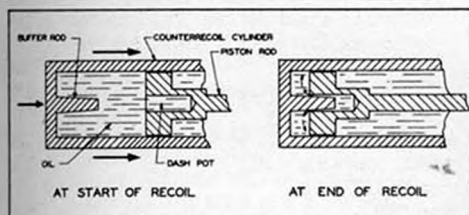


Fig. 39 -- Dash-pot buffer

to the carriage and does not move. As the cannon recoils, the buffer rod is withdrawn from the dash pot, which then fills with oil. During the latter part of counterrecoil, the buffer rod enters the oil-filled cavity, and the escape of oil from inside the dash pot is permitted only through the narrow clearance between the rod and the dash pot. The progressively closer fit of the rod in the dash pot allows the oil to flow out through only a small orifice, and the motion of the buffer rod in the last few inches of counterrecoil meets with great resistance. The cannon thus is eased into battery without jarring the carriage.

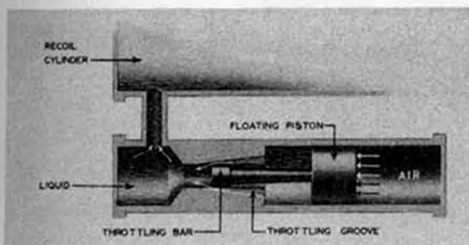


Fig. 40 -- Internal-rod buffer

c. Internal-rod buffer.—Figure 40 shows one design of an internal buffer. Essentially, it consists of a tapered rod (throttling bar), which is attached to a floating piston and which moves relative to a sleeve, the interior of which has tapered throttling grooves. When recoil has been completed, the floating piston has been pushed to the right, and the air has been compressed. Then during counterrecoil the air pressure acts on the floating piston which moves to the left, forcing the oil through the throttling grooves as indicated. As counterrecoil progresses, the head on the throttling bar gradually diminishes the area of the throttling grooves through which the oil flows. The resulting re-

sistance eases the cannon into battery without shock.

Respirator (Schindler Buffer). (Figure 41) — Though not a true counterrecoil buffer, a respirator may assist buffer action. This device is employed in a hydropneumatic recoil system as indicated in Figure 41. The respirator is

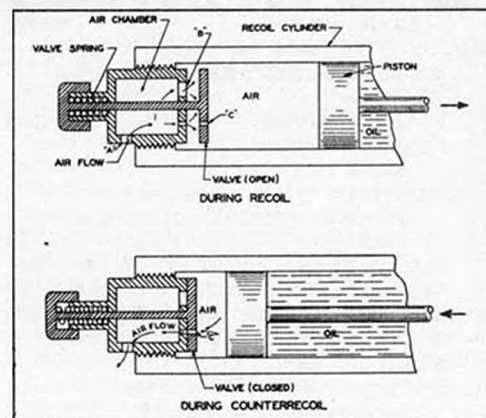


Fig. 41 -- Respirator "Schindler buffer"

screwed into the front end of the recoil cylinder. It contains a one-way air valve which opens to pressure from the outside only. During recoil, the rearward movement of the piston causes air to be drawn into the respirator through a hole "A" and then into the recoil cylinder through a hole "B", the valve opening to permit this passage of air. During counterrecoil, the internal air pressure closes the valve. The air, now compressed by the returning piston, is permitted to escape only through a hole "C" of a predetermined size. The resulting resistance to the escape of air produces a buffer action.



DESERTION

(Continued from page 575)

Finance, Allotment Division, Washington, D.C., the duplicate forwarded to the Veterans Administration, Washington, D.C., and the triplicate copy filed with the retained records of the deserter. See Figure 10

Chief of Finance, Allotment Division, Washington, D.C.

Forward directly to ~~FORWARD TO THE DESERTER~~

NOTIFICATION OF DISCONTINUANCE OF ALLOTMENT

(See AR 35-5520)

ABERNATHY, Arthur C. 363845670, Pvt., Co. A, 84th Ord Maint Bn.
 (Last name) (First name) (Middle initial) (Army serial number) (Grade) (Company, regiment, or arm or service)

The Class E allotment of the ~~enlisted man~~ named above in the amount of \$3.86 per month commencing June 1, 1941, to National Life & Accident Insurance Co., Nashville, Tenn.
 (Name and address of allottee)

entered on pay rolls of Co. "A", 84th Ord Maint Bn. is hereby discontinued, effective Sept. 30, 1942
 (Company or detachment)

because of Desertion of Soldier Date of separation October 1, 1942

† Address for future reference (Number and street or rural route) (City, town, or post office) (State)

Place Fort. Blank, Illinois (Signature of allottee)

The ~~enlisted man~~ was last paid to September 30, 1942 and allotment deducted to September 30, 1942

† Detachment for whom allotment was discontinued (Signature of commanding officer or personnel officer, with grade and representation)

Date October 5, 1942 A. R. COMPTON, 1st Lt., Ord. Dept. Personnel Officer.

* Strike out words not applicable.
 † Give address in case of discharge only.
 ‡ When discontinuance is due to cause other than death or desertion, the allottee's signature will be affixed, or reason given why he did not sign.
 W. D., A. G. O. Form No. 99
 March 1, 1941

Fig. 10

10-5500

d. DISCONTINUANCE OF CLASS "A" PAY RESERVATION, W.D., A.G.O. Form 30-5.—If the deserter had a Class "A" Pay Reservation for the purchase of War Bonds, the above form will be prepared in quadruplicate and the original and duplicate copies forwarded to the Chief of Finance, War Bond Division, Washington, D.C. The two remaining copies will be retained by the office preparing the form. The quadruplicate copy, normally delivered to the subscriber, may be eventually destroyed.

There may be some question of the effect that desertion has on the payment of the family allowance. First of all, immediately upon desertion, the Allowance and Allotment Branch, A.G.O. Washington, D.C., will be notified by the Unit Personnel Officer or organization commander as the case may require. The payment of the family allowance will continue until notification is received by the Allowance and Allotment Branch, A.G.O., of the man's conviction of desertion or when he has been absent in desertion for 3 months, whichever occurs first.

It is very evident from the above article that the act of desertion not only places the individual concerned in a critical situation but constitutes an enormous increase in work for all concerned.



NOTICE! Ord. Sect., AAF

This is the first issue of THE ORDNANCE SERGEANT being received by a considerable number of Ordnance Sections assigned to units of the Army Air Forces serving overseas. The Ordnance Section, Army Air Forces, is anxious to receive any information of a technical nature which will be useful to that section, or to other similar units serving elsewhere. If you have in mind any advice, praise, criticism, or any information of a technical nature you can add to the great part you are already playing in the war by sending it THROUGH TECHNICAL CHANNELS to the Ordnance Section, Army Air Forces, Washington, D. C.

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