SAPPER!

SAPPER: a military specialist who lays, detects and disarms mines.

The following is a series of lectures by a WW II British training officer with an expertise in mines. They were hand-written and unsigned. Ordinarily, I would have passed them over but the hand-drawn illustrations were so precise and beautiful I knew the author had a more than dutiful knowledge of his subject.

As I waded through his stylized handwriting I knew I had discovered a genius. He gives an overview of the craft which lends much beauty and majesty to possibly the most horrible segment of modern warfare.

There are gaps in the series, due to the fact that there was obviously no intent to publish. But the interested reader will gain much insight into both the philosophy and mechanics of this martial art. This insight cannot help but give a clearer understanding to other lesser works in this field.

Mines and booby traps have been of utmost importance but have seldom been given the recognition they deserve as one of the most effective adjuncts of anti-personnel warfare.

Eighty percent of the U.S. casualties in Vietnam were caused by mines and booby traps. The average G.I. never saw a VC but was demoralized by the knowledge that they were ever-present. Moreover, he knew that no matter how well trained and courageous he might be, he was most likely to lose a limb, or his life, to some gadget set out by a non-soldier, or even a child.

The Russian G.I.s were likewise demoralized by Afghan irregulars to

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EXPLOSIVES THEORY

(OPENING LECTURE)

An explosive is a substance, made up up of various nitrates and chemicals, and when suitably stimulated, decomposes rapidly from a solid into a gas with the liberation of intense heat, resulting in a sudden and intense pressure causing violent disruption of the air and its immediate surroundings. I.E , one slab of TNT expands in the form of gas, in one second, approximately 18,000 times its own size in space.

This rate of change, from a solid to a gas, is worked out in meters per second and is known as the violence figure of the explosive, i.e., rate of change. For instance, TNT is approximately 18,-000 miles per hour.

THE CLASSIFICATION OF EXPLOSIVES can be divided into three groups.

(a) Speed of Reaction (MPS)
(b) According to its Sensitivity.
(c) Service Classification.

The speed of reaction can also be divided into three groups:

(a) Combustion
(b) Explosion
(c) Detonation

Combustion. This is a chemical reaction in which oxygen from the air is embodied, usually accompanied by heat and there is always a liberation of gasses, i.e., as in a petrol engine. The violence figure on speed of reaction is up to a third of a meter.

Explosion. This is a rapid form of combustion. The heat is intense and large quantities of gasses are produced suddenly, causing intense pressure and disruption, i.e., gunpowder, cordite and ballistite, etc. The violence figure is up to 3,000 meters per second. Both combustion and explosion can be produced by means of flash (spark flame), match, etc., and is mainly the expansion of burning gases, which rapidly requires room to expand and therefore gives a pushing or lifting effect to achieve this object.

Detonation. This is the ultra-rapid breaking down of a substance, proceeding through the explosive in the form of a wave, known as the "detonating wave". Detonation creates a cutting and shattering effect and depends on continuity. Therefore it will be halted by an air space. In detonation there is complete disintegration of any close object, so rapidly does it need to expand that it will cut through a substance or completely destroy it, in preference to moving it. Violence figure: 3,000 meters per second and upwards.

Up to 4,000 meters per second - Low Explosive
From 4,000 to 8,000 - High Explosive
From 8,000 and upwards - Very High Explosive

According to their sensitivity explosives are divided into three groups:

(a) Initiators
(b) Intermediaries
(c) Bulk Explosives

Initiators. An initiator represents a detonator or equivalent, such as fulminate of mercury.

Intermediaries. These are primers for boosting the detonating wave once it has been created, such as any of the sensitive explosives which can be initiated by detonator direct. (Gelignite or Nobel's 808).

Bulk Explosives. These are main charge or fillings, representing a bulk explosive such as TNT or Wet Gun Cotton, etc. These are of the non-sensitive variety, which must have a primer to initiate them, and any of the above intermediaries can be used for doing this. It will be noted that all intermediary explosives (sensitive) should also be primed to obtain the best results and power. An example; Gelignite initiated by detenator alone has a violence figure approximately 3-4,000 meters per second, but when primed, will be raised in the region of 8,000 mps.

Service Classification. This can be divided as:

(a) Propellence.
(b) High Explosives.
(c) Miscellaneous.

The power of explosives is judged by two standards:

(a) The rate of combustion upon detonation (violence figure).

(b) The volume of gas produced in relation to an explosive such as Lyddite (power figure 100).

Sensitivity. This is the term used to determine the ease with which an explosive can be detonated; high sensitivity naturally involves danger.

Stability. All explosives, to a certain degree, are unstable, otherwise they would not explode. Most explosives used in military services are relatively safe, but under certain conditions some tend to break down and decompose, resulting in deterioration in efficiency and safety in handling. For instance, Gelignite is affected by heat and cold. Obviously, bulk explosives cannot be manufactured or transported safely if they have a high rate of sensitivity. Therefore, in order to initiate bulk explosives, a number of accessories are necessary, such as initiators and intermediaries.

Initiators. First, of combustion or flash:

(a) safety match, (fuzee match).
(b) igniferous or percussion cap (flash cap).
(c) ampule or miner's igniter (chemically produced flash).
(d) friction igniter (German equivalent to a fuzee match).
(e) electric flash.

To prolong and carry the flash, giving a delay, safety fuse is used.

(a) fuse, safety. No. 2 MK II, (black). Burns under water.
(b) S.A. Commercial Safety, misc. packing. 24 ft. lengths.
(c) Bickford's Blue. Commercial Safety.

Burning speed of all three fuses, 2 ft. per minute.

Booby traps need no delay, consequently, instantaneous Orange fuse is used and is lighted with a naked flame (but never should be). Burning speed; 90 ft. per second.

More on Detonators: - three main types.

(1) No. 27 packed 25 to a tin, complete with rectifier. (8 tins to a box).

Rectifier: A device for converting alternating current to direct current.

(2) No. 8 commercial packed 100 per tin.
(3) No. 33 electric, packed 100 per

tin.

No 24 detonator is a service detonator and consists of a solid drawn-out aluminum tube 1 3/4" x .26" in diameter. To use with safety fuse, the fuse is inserted into the open end of the detonator, which is crimped, attaching both firmly to each other. The detonator consists of .35 grammes A.S.A. (lead azide, lead stypnate and aluminum powder) which is a very sensitive mixture, and which detonates .55 grammes of tetryl. The tetryl has the effect of amplifying the effect and power of the detonating wave set up by the A.S.A. From the open end inwards is a space of 7/8 c. which the fuse fits in, then comes the A.S.A mixture and lastly the tetryl (tetra. nitro-methyl analine). Very sensitive, the detonator is sensitive to friction and it supercedes the previous type, which was filled with fulminate of mercury. The commercial equivalent of the No. 27 detonator is the No. 8 Commercial and in

prene plug (rubber) seals the electric firing head in position and prevents moisture from entering and the electric firing head is a filament terminal of two wires. Lowest current fire is 8 amps and a 4.5 volt hellicon lamp is normally used.

Electric Fuse No. 31 is an independent firing head supplied for use in conjunction with a No. 27 or No. 8 detonator, by insertion in the end which normally receives the safety fuse. It is painted brown and one end is closed with a cork disc secured by shellac and between the cork disc and the filament is a small amount of guncotton. This is ignited by electricity and in turn ignites the A.S.A. which detonates the tetryl.

Commercial No. 8 submarine electric detonator is equivalent to the commercial No. 33, the detonating end (really a No. 8 A.S.A.) is exactly the same dimension as a No. 27 service detonator

was used. Of course, the surface area of the lid, which pivots on the fuse, has a large bearing on the subject. For the blast can only affect the fuse if the lid offers sufficient surface area. But this was remedied by the introduction of a spider, more of which will be explained further on.

Sympathetic Detonation occurs only between explosives and is caused by the passage of the detonating wave, which is only effective within a certain radius. Thus, an air space can break the continuity of a detonating wave, the radius of which depends on (1) its speed and (2) the amount of explosive.

When an explosion occurs, the blast is felt for some distance around the explosion. But the farther one is away from the spot, the weaker the blast. When the detonating wave originates, its speed is a thousandth of a meter per second.

For instance, a mine filled with TNT radiates detonating waves at a speed of 7500 meters per second. This represents almost 4 3/4 miles per second. But the further the waves travel, the weaker they become, until they are ineffective in their ability to initiate other explosives, but still retain sufficient blast power to smash that explosive. Therefore, Sympathetic Actuation is a mechanical action involving two armed mines, wheras Sympathetic Detonation occurs between explosives and can be rendered harmless by an air space.

(9) When moving through a minefield, it is best to take long strides on tip-toe, treading as lightly as possible. Panic in a mined area must be avoided at all costs. The slightest movement increases the weight of the individual ans a running man almost doubles his own weight. Consequently, it is possible for a man to actuate an anti-tank mine by accident, which is normally safe under his own weight, if he loses his head and runs blindly. The fact can easily be proven that a man's weight is considerably "increased" in this respect:-

(a) Casting one's mind back to days when it was possible to record one's weight on the weighing machine in Woolworth's, the weight was actually recorded when the needle was stationary. But the movement of the individual in stepping off the machine caused the pointer to move forward, showing an increased weight.

(b) If a person treads on a chap's toe, it is not as bad as if he is running clumsily by and lands on that unfortunate individual's foot. Also, if a man is running blindly, he cannot possibly avoid trip-wires, etc., which are definitely anti-personnel in nature.

(10) When lifting mines, each man should be in possesion of at least 24 safety-pins: These can be wire or nails, being of 12 guage in thickness or more and not less than 1 1/8" in length.

(11) Never cut a trip-wire without first acertaining whether it is tight or slack. Safety-pins should always be inserted. Always remember to trace trip-wires to both ends. A taut trip-wire is naturally holding something, and if cut, it will release it. The moral is "never cut a taut trip-wire and never pull a slack one".

(12) Always check fuses for tightness in fitting to mines and never force a tight fuse into a mine.

(13) Check all mines with removable covers, to insure they fit correctly.

(14) Don't bunch together; one man, one mine, one chance the first and last.

(15) Here are nine examples of famous last words:-

(1) Come and watch me lift this one.
(2) Let's cut the wire.
(3) Throw me a tin of fuses.
(4) These mines don't seem to be booby-trapped.
(5) These mines don't seem to go off when you walk on them.
(6) That looks a good billet, electric light and all.
(7) Nice bit of loot, this.
(8) This lid and fuse are jammed, throw me a hammer.
(9) I always smoke on the job.

The enemy, having captured a large number of British mines in the early years of the war, have made good use of them in recent months. In one sector, it was found that a large percentage of captured mines were used along with German mines. Thus, British mines laid by the Germans must be treated as enemy mines. No provision for booby-traps has been made on British mines. But the enemy has made that provision, and, because "familiarity breeds contempt", Allied troops have overlooked the possibilities of booby-traps, and have not exercised sufficient care in lifting, resulting in casualties.

Casualties have also occured through carelessness, caused by individuals rushing to view damaged vehicles or to render aid to injured comrades. This must be prevented at all costs, and persons concerned ordered to proceed in an orderly manner, systematically clearing a way to their objective.

Methods of mine detection and lifting.

Bayonets.

This is the slowest, by far, but certainly the surest method of detecting all mines, except Plastic Mines. When prodding with a bayonet it should be held at an angle of 45 degrees with the bevelled edge underneath, so that the bayonet will glance off a mine. There is one correct way to hold a bayonet and that is to grip the handle tightly, for a slack grip will cause friction between the handle and the palm of the hand, resulting in a blister in one of the worst places possible.

The correct drill is to prod every 3" in a line to the left and right, and linking up with the man on either side. The prodders should then move forward 3" each time. Average speed forward over a yard frontage is 1 1/2 yards per minute.

Detector.

There are several types of detectors, each based on the original, produced in October, 1941. They each have different standards of accuracy. But the biggest drawback is the inability to detect any mine other than one with a metallic container.

Americans, however, have invented a "Homogenous" detector, capable of locating any object in the ground which is not consistent with the true nature of the ground. Therefore, rocks, metal rods planks of wood, bottles and even air cavities are located and consequently so much time is wasted.

Mine destroying tanks.

These have developed rapidly in the past 12 months, but are not 100% perfect as deeply laid mines are often dormant for some considerable time, unless the earth is packed down hard enough to set them off.

Dogs.

It has recently been revealed that dogs have been trained to locate mines, adding one more laurel to their already large bouquet. These animals move forward with the Sappers, etc. When they locate a mine, some sit stock still, others whine, whilst some emit a low growe. But they do not touch the ground covering the mine, which is then marked

When the mines are located, various methods of removal are employed. The most common is the use of a 50 yard length of cable, which is attached to the mine, and the mine removed by the "Lifter" from under cover.

It is necessary to allow 30 seconds delay before approaching the mine after removing it, in case a delay action fuse is fitted and is set into operation, when the mine is moved.

During these lectures, you will see how easy it is to make mistakes by curiosity, ignorance, over-eagerness and anxiety to complete the job. You will realize how great the debt is, that the Army owes the R.E.s (?), for their work arlier in the war. Too late, it has been realized that the Army needs training in mines and booby-trap warfare. Not to do the R.E.'s job but to safeguard themselves from injury in ignorance of the mines with which they may be confronted.

This course is similar to arms drill. You were taught to fire a rifle when you first joined up. Not to engage the enemy as front-line troops, but to protect yourselves should you suddenly find yourselves without any other support. So it is with mine warfare. This training is designed to give you sufficient knowledge to avoid danger from mines and not to make you "Mine Lifting Personnel".

Methods of mine destruction.

This is rather a bigger subject than first thought. For the majority of persons are totally ignorant of the various methods by which mines can be destroyed. Asked how they would destroy a mine, or mines, the majority suggest small arms fire, others say to pour some petrol on it and set fire to it. A small minority who sense the danger in the previous suggestions admit they don't know.

Well, the suggestion of small arms fire is a foolish one and here's why. First. a rifle bullet will not detonate bulk explosives. But even if a marksman can see the mine, there is a very slim chance of him striking the fuse or igniter and operating it so the mine is destroyed. Ofttimes the mine is riddled with bullets without setting it off, but unfortunately the fuse is damaged and the mine is ultimately pronounced a dud by the cocksure marksman. Then it goes off as soon as some unfortunate person moves it.

The small arms fire suggestion can only be effective if (10 the mine is in full view, and the fuse also, so the marksman who must be (2) a skilled shot. To think of trying to set off a mine which is below ground level, is ridiculous. If the mine is in the shooter's full view, that man is in grave danger from shrapnel splinters.

Next comes the suggestion to destroy

the mines with fire. Experience has proven this is very wrong, indeed. In one incident, a pit was dug and a number of mines placed in it and liberally covered with petrol and lit. Once again it proved 75% ineffective for two reasons. (1) The explosive was partly protected by the metal bodies, sensitive detonators packed in the centers of the mines, in the fuses. The result was that one of the fuses was damaged and when the debris was turned over the mine went off and the metal casings became dangerous shrapnel.

These practices are very dangerous and must not be entertained at any cost. It is far better to stack mines requiring destruction, marking them as such and reporting them to the proper authorities.

The easiest way to destroy mines, or one mine, is by using a primer, detonator and a substantial length of Safety Fuse to give a delay. When dealing with one mine, uncover without disturbing it, and place sandbags around it. Finally, place a primer in the center of the lid, complete with detonator and fuse. Carefully cover with loose earth, leaving the fuse showing. When the primer is initiated it supplies sufficient blast to actuate the mine, just as if a vehicle had passed over it.

This method applies to single mines requiring on site destruction, but where mines can be moved, they should be carefully stood on one end, in a shallow trench 18" deep, with the lids towards the center. A primer, detonator and a length of safety fuse is then placed in between the center mines, the lids of which should be facing each other. The primer provides sufficient blast power to actuate these mines, which in turn, set off the remainder.

Various other methods were devised to clear mined areas in the early stages of the desert war. Among them was one which entailed the use of a "mat" or "net", woven with primacord and unrolled over a mined area and then initiated simultaneously at several points. This proved almost useless, because the blast power was insufficient to actuate a deeply laid mine.

Recently, a device known as the "Conger" was tried out. This consists of a length of 2" canvas hose, which is projected empty over a minefield by means of a 5" rocket and subsequently filled with a liquid explosive known as 822. It is capable of clearing a 25 foot lane through a field of TMI 42 & 43s and it promises to be very effective.

The mine sweeping tank was very successful in clearing paths through minefields in Normandy. But it is not an entirely new idea. Originally a vehicle was used, with two steel girders projecting in front and a roller, fixed so that its protruding steel spikes dug into the ground as the vehicle moved forward and the weight of the roller actuated the mines.

Unfortunately, the roller, being made of concrete, could not withstand the continuous blasts of the mines and it was soon shattered. Consequently, the idea was temporarily abandoned, until the "flail mechanism" was thought of some time afterwards. The first model, called the "Scorpion", was constructed by fitting the flail mechanism to the "Matilda Tank", the mechanism being driven by an auxilary engine.

Further types were the Baron Marquis and Crab. The latter drives the cylinder by the tank engine, and as it rotates, lengths of heavy chain attached to it act as flails. They beat the ground with considerable force, exploding the mines in its path.

The latest type is fitted with a Sherman chassis, shortened in length and breadth. Its main armament is a 75 mm gun. It has "feelers", which give warning of obstacles and Bangalore Torpedo ejectors, which eject the torpedos to destroy the obstacles and clear a path.

The drawbacks to this type of mine clearance are few. But one was found to be the fitting of a thicker shear-pin to the TMI Z .42, so that the flails failed to shear it and operate the igniter. Consequently, the tank tracks were shattered by the mine, disabling the mine-clearance tank.

A second idea, very uncommon, was to link a Tellermine by a detonating fuse to a charge, so that when the mine was actuated by the flails the charge was set off, disabling the tank once more.

These special devices to defeat the purpose of this special tank, requires special preparations, also. And in the present stage of the war on the continent, owing to the mobility of the troops, it is not possible to anticipate any move with a sufficient margin of time to lay counter-measures against the use of the "Crab" tank.

This method is not in full use in the Far East. The country does not lend itself to mine warfare, except of course, anti-personnel mines. But nevertheless, personnel undergoing training in methods of mine clearance should anticipate the Japanese use of mines whenever the opportunity presents itself.

METHODS OF GERMAN MINE LAYING.

The object is not to teach actual laying and lifting of German minefields. It is to teach general recognition and warn you of methods employed to defeat detection and lifting. It is generally understood that the Germans are a thorough and methodical race, but also prone to repetition and, in spite of their thoroughness, sometimes fail to carry out their original intentions, leaving tell-tail clues which are equally as important as mines, fences and warning boards themselves.

Although his minefields are ofttimes fenced in, when he retires, he removes all traces possible and one has to rely on mines-signs to detect their presence. There are however, two types of minefield marking recently discovered:- The first is the more common of the two and consist of two rows of warning boards, the outer, black & white lettering and the inner, white and black lettering.

The space in between the rows of boards is normally clear of mines. The second consists of lengths of barbed wire wound around the post. A/P mines are indicated by a 3" length projecting from the top of the post, wheras A/T mines are indicated by two dome-like hoops on the top of the posts, giving an appearance similar to a mine marker. Ofttimes it has been found that the front edge of the minefield has been left entirely unmarked, and if marked, false gaps and deceptive wire has been found or encountered. There may also be scattered groups of mines laid haphazardly in front of the minefield, which are entirely unmarked.

Belts of mines, laid close to our own forward defense localities may also be seen, as they are often hastily laid. Ofttimes machinegun and listening posts are placed well forward of main minefields, and are covered by automatic sentries, consisting of Very lights operated by trip-wire. Naturally A/P mines are laid to the best advantage, this being mainly in front of the minefield, although it is common to find them in the field itself.

To give the minefield an appearance of depth, shallow mine belts are sometimes employed, with considerable gaps in between, and consisting of 2-5 rows each. Normal distance between mines and rows is 5-10 yards. These narrow belts help to hide gaps. They are normally up to 270 yards long by 20 yards deep.

Booby-traps, connected to wire obstacles, are operated by the movement of the obstacles. Or else, by movement of some other object in the field to which they may be attached and which is in range

The entire layout of a prepared minefield is coordinated with a fire plan of defense, so that a deficiency in mines is made up by firepower.

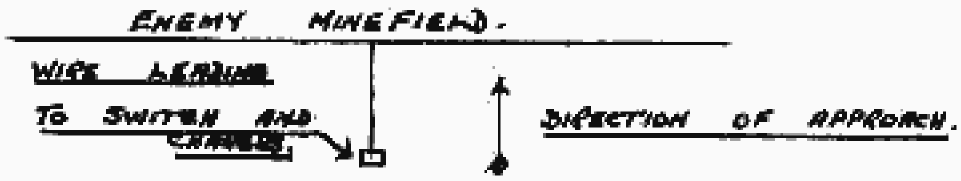
Approximately 25% of the Tellermines laid are booby-trapped. Occasionally, during retreats, additional charges were laid under the Tellermines. These were attatched to the anti-lifting devices. These charges were either 75 lb. boxes of TNT or 200 gram blocks of Penthrite or Tolite. As much as three 75 lb. boxes have been laid under a treble Tellermine making a total charge of 261 lbs., capable of completely destroying vehicles.

Tellermines have also been found laid at 2 yards spacing, closely spaced deliberately to cause "Sympathetic Actuation". No cases of "dummy" minefields have been reported to date. But there was one instance where a field of "Holtz" mines (German wooden box mines) were found to be dummies, as these mines were found to be filled with sand. This, however, was thought to be sabotage.

Very few patterned minefields were found, but A/P minefields were found on hill terraces, accessable normally only to personnel. High grass or grainfields afford excellent covers for breast-high trip-wires or lever actuated mines, besides the normal pressure-operated mines.

To defeat the detector, A/T mines have been found laid as deep as 2'6" so that vehicles will eventually compress the earth hard enough to actuate the mines. One instance of mines laid below their normal depths revealed that groups of six were laid 18" to 24" deep spaced approximately one yard from the road centers and where single mines were laid deeply, they were spaced 20-50 yards apart. Holes in the roads, which ran through or near a mined area, were sometimes filled with scrap metal, and other times a mine was laid deeply, with scrap metal on top to cause a delay. Other cases revealed an unbroken road surface, but mines had been laid under the tarmac surface from the side of the road, so that the passage of vehicles would cause the surface to crumble.

When approaching a minefield, remember that it is very easy for the enemy to trip the outer from your side without causing any damage to enemy troops who may advance through their own minefield. This is done by running a wire from the outer wire to a pull action switch outside the minefield so that the leading elements of your own troops who are advancing towards an enemy position, set the trap off and it kills or injures others behind:



The only snag to this type of boobytrap is that enemy troops returning from patrol activity in our lines, may accidently operate it and suffer casualties- "Serves them right".

Here is some information recently obtained from Italy.

A/P Fields.

In theory, mines are always laid in regular patterns by a pacing drill, evenly spaced so that alternative rows cover off the spaces left by other rows. Density for shrapnel mines: 1 mine per meter. Minefields with a density of 1 mine per meter were never deeper than 25 meters (approx. 27 yards) and with a density of 1/2 mine per meter, maximum depth is 40 meters.

Spacing.

Between mines, 4 meters maximum 10 meters, with never less than 4 rows or more than 7 rows at 8-10 meter intervals.

Mixed Fields.

There was a tendency to lay pairs of rows of one type alternately with pairs of others.

Marking.

A german A.P. minefield always has a trip-wire on its enemy side (facing us), which should be 2 meters from the nearest row of mines. Back corners are always marked with stone cairns (mud piles otherwise) in line with the trip-wire with no other signs to indicate A.P. mines.

Gaps.

Personnel gaps (1/2 meter wide) marked with extra signs such as white tape, handkerchief, white paper or a cross-piece of wood. A single low wire running transverse to the line of the field is the boundary between "blocks" laid by different units. 1/2 meter on either side of these wires is always safe.

The ends of the minefield are unmarked unless close to a road or track, and then by a trip-wire along the road. These observations do not apply in all instances, or when mines are laid in haste.

Anti-tank mines.

In theory, these are laid out in regular patterns and staggered from row to row. The density is 1-5 mines per meter of front, and the spacing and interval not less than 10 meters: Anti-tank mines, as previously remarked are sometimes separated from A/P only by the boundary trip-wires. But there are normally no markings left except a fence or wire by the road.

One instance was recorded where holes had been dug and filled in again, giving the appearance of a minefield. But this could hardly be called a dummy minefield, but a decoy minefield.

Anti-tank ditches, although deep and wide, can be crossed by personnel and to prevent this, shrapnel mines are laid in the bottom, also the bottoms of slit trenches.

Another instance of an anti-personnel minefield found is as follows:-

Bayonets were driven in the ground so that they protruded six inches aboveground. Fine trip-wires ran to mines midway between bayonets. Concrete picket mines were used in bush or scrub, with the concrete cylinders one inch above ground-level. There was very little attempt at concealment, either in this case or in the following one:-

Trip-wires led to a ZZ .35 igniter screwed in a 200 gram block in company with two others, buried 2" to 3" below ground-level. Neither of these instances was classed as successful.

So ends my course on methods employed by Germans in laying their mines. It must be understood that the subject is one upon which it is possible to continue investigation indefinitely, as these methods change daily as different types of country are encountered. But remember, "Forewarned is Forearmed", and by keeping your eyes open you may save your life and others.

To gain further expertise in the deadly skill of mines and booby-traps, study THE IMPROVISED MUNITIONS HANDBOOK, PMJB 2, page 282; MINES AND BOOBY-TRAPS, PMJB 3, page 11, BOOBY-TRAPS, page 235 and INCENDIARIES, page 274.

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the extent that they also packed it in.

The Germans in their Russian campaign were similarly demoralized by partisans who cared less than nothing for German military prowess or technology. Aside from pitched battles with Russian regulars or siege tactics around major cities, the German soldier was helpless and alone outside his encampment. Most towns on the route were either destroyed or bypassed. They were too dangerous to occupy.

The French partisans were so effective at sabotage and the murders of German personnel as to necessitate vast amounts of extra manpower and equipment throughout France. And the French government had capitulated and promised its people would be nice!

Our own ancestors probably killed more British regulars by ambush and sniping than in pitched battles.

Over the ages, irregular warfare has advanced from sniping, ambush and simple sabotage to refinements undreamed of by our ancestors. But the end purpose has remained the same. That is, to so harrass, confound and confuse an enemy that he can't function. And wheras former irregular warfare has been only a complement to regular troops, the Viet Cong and the Afghan Freedom Fighters won their wars with it.

As world civilization degenerates and the mass dieoffs accelerate, we will face a series of invasions. Possibly by Russians but certainly by hordes of Latin-Americans, fleeing starvation and plague as their own countries cease to be nations. Then the U.S. will become a vast battleground of urbanites fighting each other for another day of life

Towns will be ringed with defenses against refugees and renegade military units.

No one can really know what will actually happen, but if you prepare for the worst you can defend your own against all comers. And in preparing, you must drop the macho fantasies and study the martial art of improvised weaponry.

Of course, a basic part of your study must be conventinal light weaponry. The 1883 gunsmithing course in PMJB 3 is something to cut your teeth on. You can also make money reconditioning antique guns.

Clyde Baker's 1933 gunsmithing course will update your skills. You will also be surprised at how the science of ammunition in Earl Naramore's 1937 HANDLOADER'S MANUAL will enlarge your expertise on explosives.

By reading every paragraph in all four volumes of THE POOR MAN'S JAMES BOND, you will absorb knowledge subconciously, even though you might not fully understand it all at the first reading. Then, when you are most needed, you will be one of the most important men in your territory.

FM 21-105

BASIC FIELD MANUAL

ENGINEER SOLDIER'S HANDBOOK

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BASIC FIELD MANUAL

ENGINEER SOLDIER'S HANDBOOK

(This manual supersedes FM 21–105, March 12, 1941.)

CHAPTER 1

THE ENGINEER SOLDIER AND THE CORPS OF ENGINEERS

■ 1. WHAT IT MEANS TO BE AN ENGINEER.—You are an engineer. You are going to build bridges and blow them up. You are going to stop tanks and destroy them. You are going to build roads, airfields, and buildings. You are going to construct fortifications. You are going to fight with many kinds of weapons. *You are going to make sure that our own troops move ahead against all opposition, and you are going to see to it that enemy obstacles do not interfere with our advance. You are an engineer.*

■ 2. YOU AND YOUR JOB.—*a*. You have been chosen to be trained to do a man-sized job for the Army and for your country. To do it well you must keep your eyes and ears open, your mind alert, and be always on your toes. You must keep yourself in top-notch condition. You must become physically tough and an expert at your job. Whether or not our Army succeeds depends a lot on how much better *you* are at *your* job than the *enemy* engineer is at *his*.

b. That's a large order. The Army knows it is; but the Army also knows that if you give the best that is in you, you will do the job well. You will build, tear down, and fight better than any other soldier in the world. You will be an *American* engineer.

■ 3. THE CORPS OF ENGINEERS AND THE FIGHTING TRADITION.—*a*. *The beginnings of the Corps of Engineers*.—(1) The Corps of Engineers to which you belong has a long record of courage

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and of jobs well done. The early engineers set high standards of achievement; the engineers who came later in our history not only maintained those standards, but even improved upon them. Today you and your fellow engineers are carrying on that record; you are going to make the history of the Corps of Engineers even more brilliant.

(2) The first engineers were three small companies organized in the Revolutionary War with the help of French officers. The job of engineers then consisted mainly of constructing field fortifications. The act of the Continental Congress which created the engineers stated that its commissioned officers were "to be skilled in the necessary branches of mathematics; the noncommissioned officers to write a good hand." Those requirements are a long way from the numerous skills our soldiers must have today, let alone our officers and noncommissioned officers.

(3) In 1802 an act of Congress created the present Corps of Engineers. Until the Civil War there was only a handful of engineer troops in our Army. Even during the Civil War the largest number of engineers was four companies. But engineers performed valiant tasks. They fought as infantry in courageous fashion. The engineering jobs of that little body of men should make us proud to carry on their tradition; for example, they threw a 2,000-foot ponton bridge across the James River in a few hours. That's a mark for us to shoot at.

b. *The development of the Corps*.—(1) Engineers continued to play important roles in every military campaign in our history. It wasn't until the first World War, however, that the great force of engineer troops was really felt. In that war the Corps of Engineers grew from 2,500 men to almost 300,000. The way they fought and did engineer work at Cantigny, St. Mihiel, and Meuse-Argonne is one of the magnificent traditions of the Corps.

(2) Today you are part of hundreds of thousands of troops who make the Corps of Engineers a constructive and destructive fighting force. The chapters which follow will tell you something about the numerous jobs of engineers; they will help prepare you to carry on the important missions of the Corps of Engineers.

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CHAPTER 2

ENGINEER TOOLS AND COMMON ENGINEER TASKS

SECTION I

ENGINEER TOOLS

■ 4. IMPORTANCE.—*a*. The engineer soldier is an expert in many things. One of his most important skills is the use of many kinds of tools; some, hand tools, others, power tools. Tools are the basic implements of the engineer. They go along with his unit and are always at hand. With tools the engineer accomplishes many tasks. How well and how quickly he does his job depends upon—

(1) His skill.

(2) His physical condition.

(3) The condition of his tools.

b. All of these are the responsibility of the individual soldier. His own life and the lives of his fellow soldiers depend upon the tools and the skill with which they are used.

■ 5. CARE.—Mainly upon you, the soldier who uses these tools, depends the condition of the tools. When the supply sergeant or his assistant issues tools to you, you become responsible for them. Clean and oil them before you return them. If you are careful in the use of your tools, if you use them in the correct manner, if you are quick to notice and report such things as dullness, battered heads, and rough spots on handles, the job of keeping tools in good condition is easy.

■ 6. SAFETY.—Your tools are sharp. If they are handled improperly you or a comrade may be hurt. Learn to use your tools correctly; the correct way is both the easiest and

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the safest way. Here are a few general safety rules. Do not forget any of them.

a. Carry your tools properly. (See fig. 1.)

b. Do not lay sharp tools, such as axes, adzes, and peavies, on the ground where they can be stepped on, fallen on, or run into.

c. When swinging a tool, make sure all others are a safe distance away.

d. Make sure all tool heads are tight on their handles.

e. Do not get in the way of another soldier who is using a tool.

■ 7. USE.—Tools are designed to do work with a minimum of effort. The untrained man tires himself by forcing his tools, gripping them too hard, or using an improper position. The trained man is relaxed, lets his tools do most of the work, and uses his mind, eyes, and hands to guide the tools.

■ 8. ENGINEER TOOL SETS.—Each engineer organization is equipped with the hand tools needed for accomplishing the work usually assigned to it. For convenience in selecting tools for a particular job, they are grouped into sets, such as carpenter, blacksmith, pioneer, and demolition sets. Learn to know the contents of the various squad and platoon sets.

■ 9. HAND TOOLS.—Most of the tools you use are hand tools, the most important of which are discussed below. These discussions are only a guide, however; they are not a substitute for actual training and extensive practice. Apply the things you read here at the first opportunity.

a. Ax (see fig. 2).—Before starting to swing the ax, make sure that there is no interference in any direction. If there are overhanging limbs or undergrowth in the way, clear them out first. Make sure of a firm footing and see that no one is dangerously close. In swinging the ax, be especially careful to stand so that if the mark is missed, or if the ax glances off, it will not strike you. (See figs. 3 and 4.) Keep your eyes on the point to be struck. Never throw the ax or leave it lying on the ground; instead, drive it into a log or stump, or put it in its box. Never use the ax to drive metal stakes.

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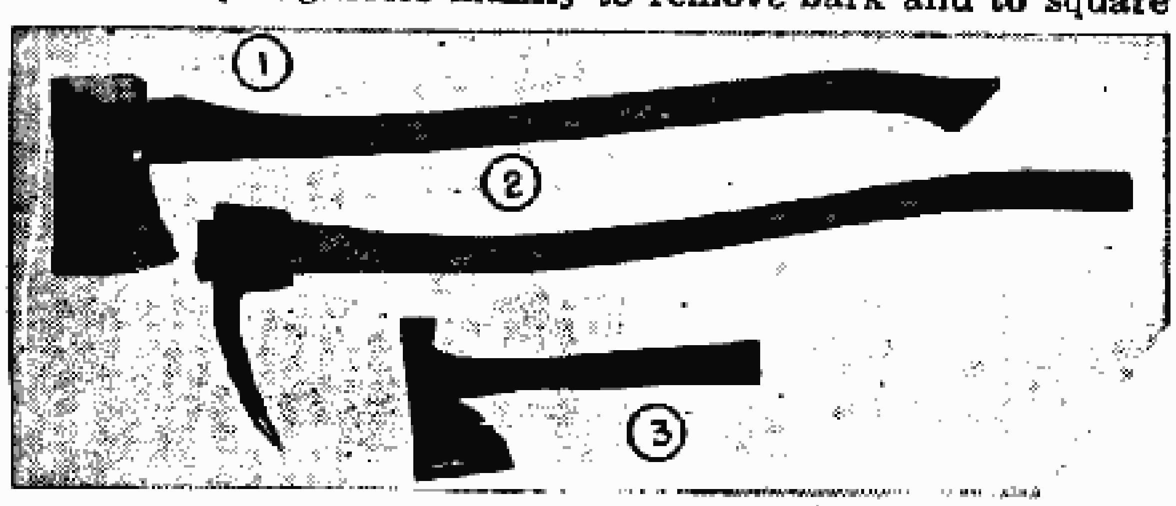
① ③

FIGURE 1.—Proper way to carry ax, adz, and two-man crosscut saw.

b. Hatchet (see fig. 2).—The hatchet is used for light trimming work such as framing timber, sharpening stakes, or splitting wood. The position of the hand depends upon the desired blow. Hold it near the end of the handle to strike a heavy blow for heavy cuts and near the head for light trimming strokes. The hatchet has a hammerhead which may be used for driving medium-size nails.

c. Adz (see fig. 2).—The adz is a hewing and smoothing tool used by engineers mainly to remove bark and to square



① Ax. ② Adz. ③ Hatch

FIGURE 2.—Hewing tools.

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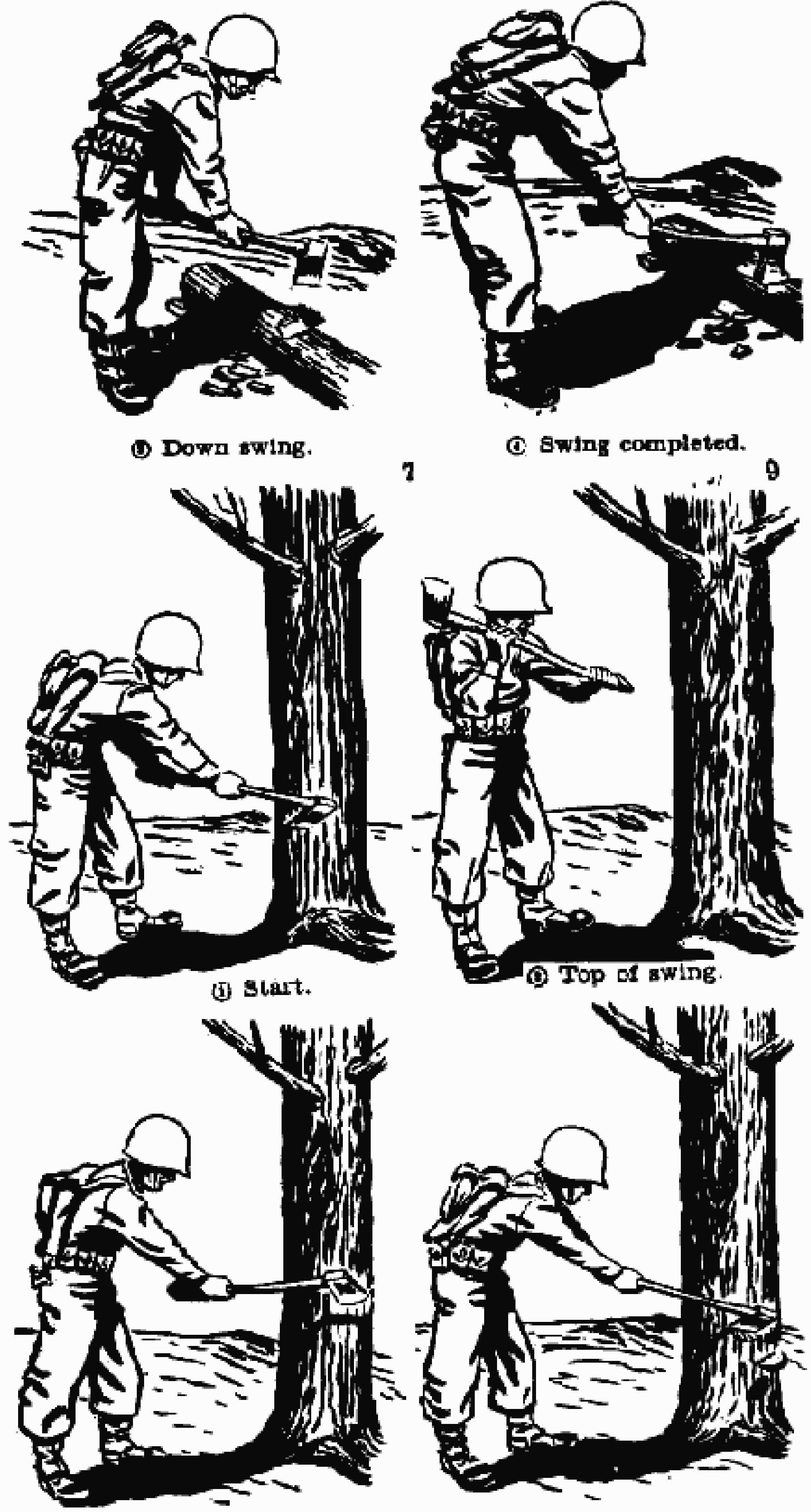
① Start. ③ Top of swing.

FIGURE 3.—Using the ax on horizontal timber.



③ Down swing. ④ Swing completed.

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① Start. ③ Top of swing.

③ Down swing. ④ Swing completed.

FIGURE 4.—Using the ax on standing timber.

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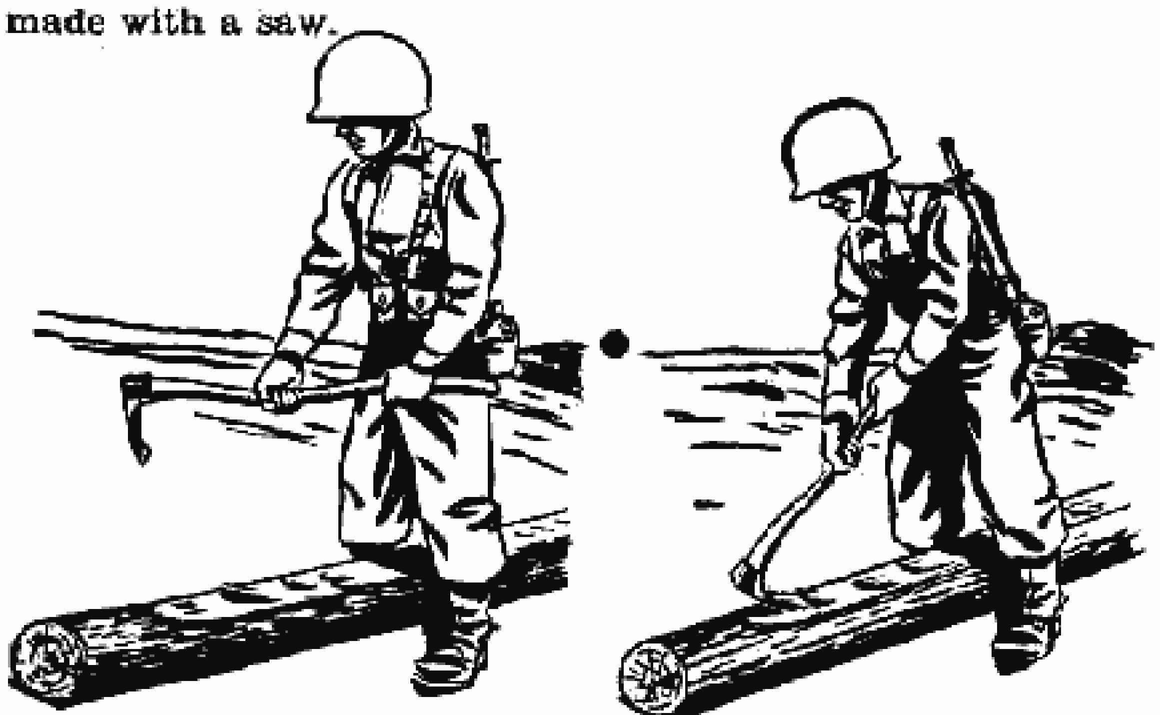
round timber. It must be used carefully or the user may be injured. The correct way to use the adz is to stand astride the log and take short hewing strokes. (See fig. 5.) The log is first scored with chopping strokes, or with shallow cuts made with a saw.



① FIGURE 5.—Using the adz. ②

FIGURE 6.—Pick.

d. Pick and pick mattock (see fig. 6).—You should be able to use the pick or pick mattock with either the right or left hand leading. The pick is swung in a manner similar to that used in swinging the ax. (See fig. 3.) To use it with the right hand leading, stand with your feet comfortably placed, left hand at the handle end, right hand near the

9 9

pick head, body bent slightly forward, and arms hanging naturally. Carry the pick head behind and above your right shoulder without changing the position of your hands. Swing the pick head forward, allowing the handle to slide through your right hand until your hands meet, and continue the stroke downward. Keep your eye on the point to be struck.

e. Shovels (see fig. 7).—You should be able to use the shovel with either a right- or left-hand swing. After filling it by one of two methods (fig. 8 ① or ②), press the handle down and back to free the shovelful from the rest of the material. Then hold the handle down while raising the weight of the full shovel with the other hand. In casting, allow the handle to slide through the lower hand in the most convenient manner. Do not use a shovel as a pry.

f. Saws.—Saws are of various design, depending upon the kind of work required.

(1) *Hand saws* (fig. 9①).—There are two kinds of hand saws—crosscut and rip. A crosscut saw has knifelike teeth and is used to cut wood *across* the grain. A ripsaw has chisellike teeth and is used to cut wood *with* the grain. The hand saw is used in most common carpentry work. A saw cut should be started by guiding the blade against the thumb of the left hand and drawing the saw backward (fig. 10). Extending the forefinger along the handle aids in guiding the blade. Hold the saw lightly and do not try to push it into the wood; move it back and forth with a full, long stroke, letting it do its own cutting.

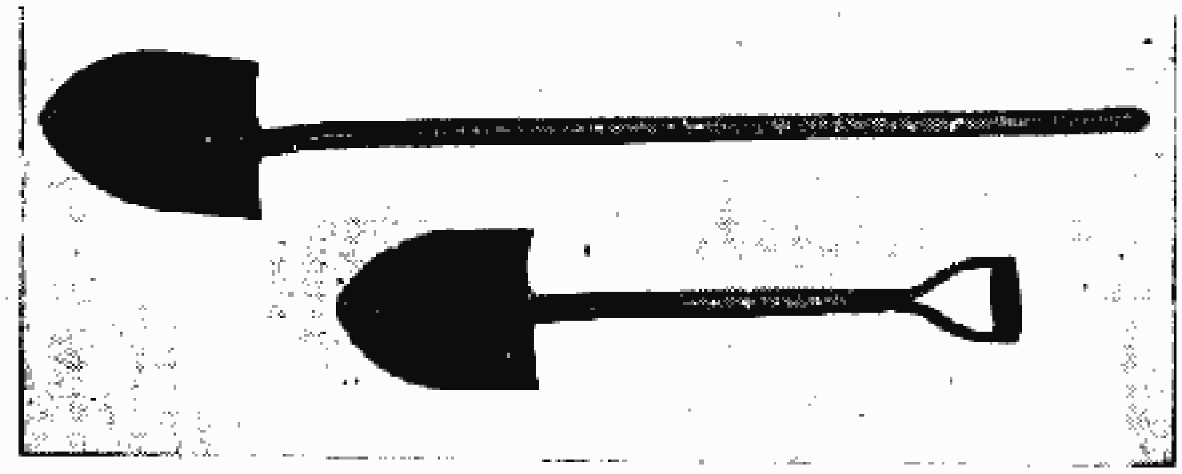


FIGURE 7.—Long-handled and D-handled shovels.

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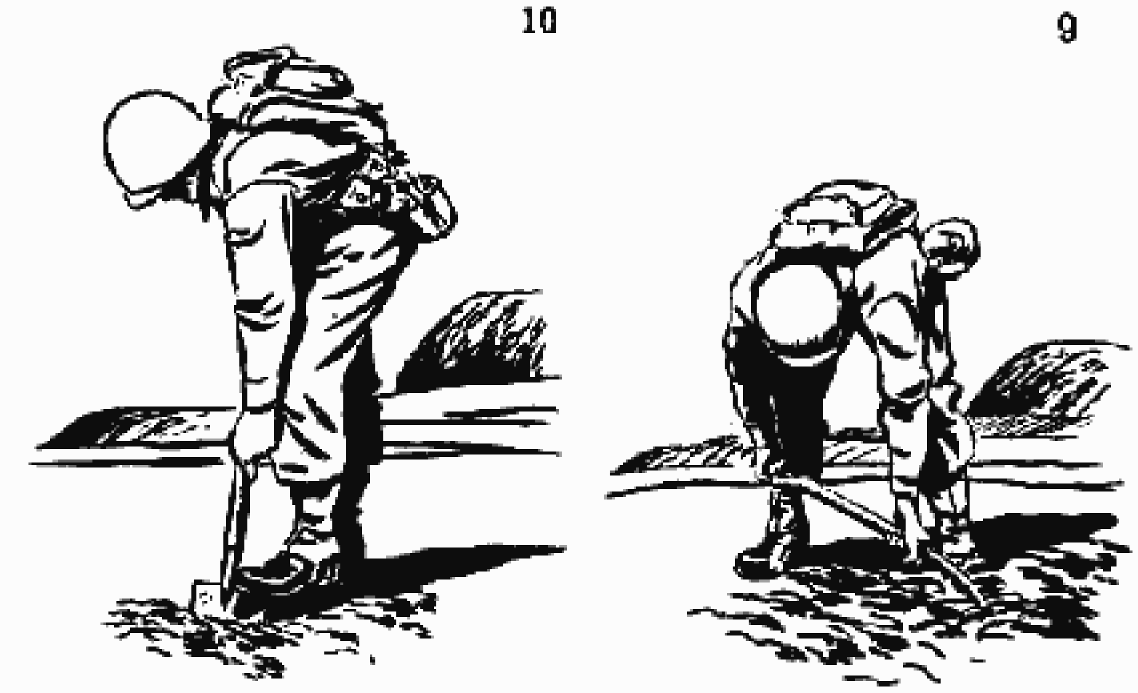
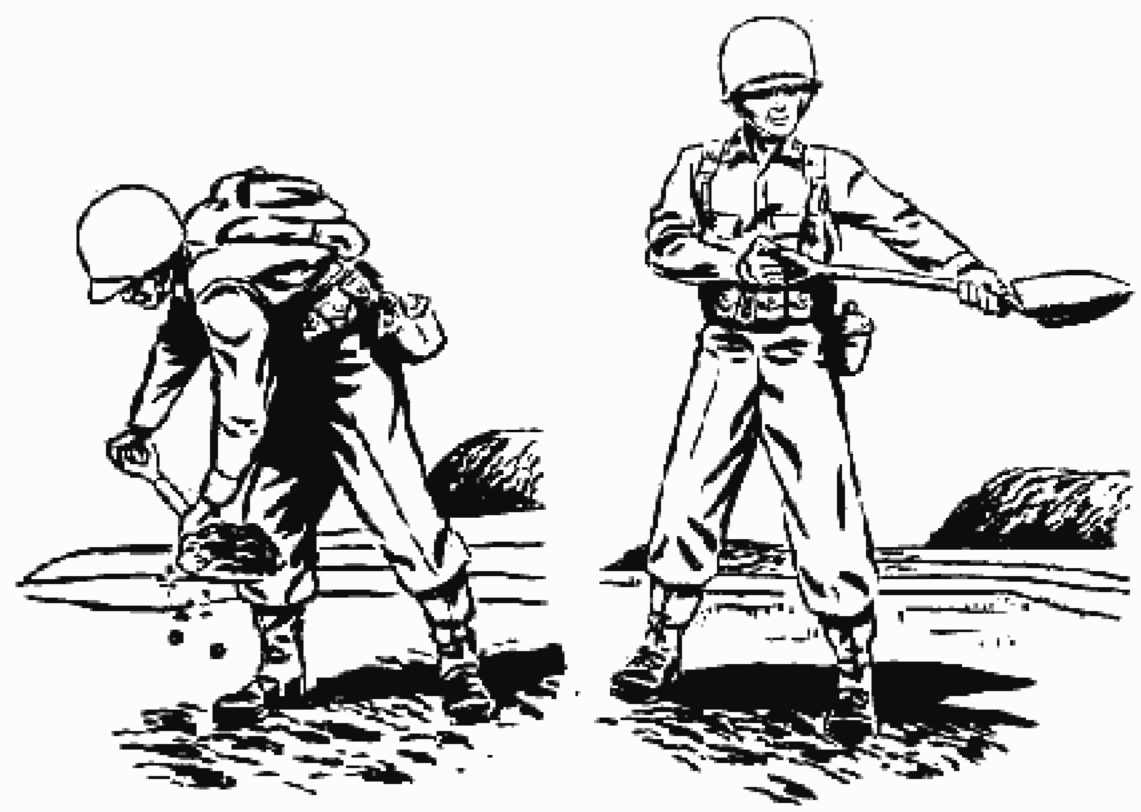


① Filling shovel. ② Filling shovel (alternate method).



③ Start of throw. ④ End of throw.

FIGURE 8.—Using the shovel.

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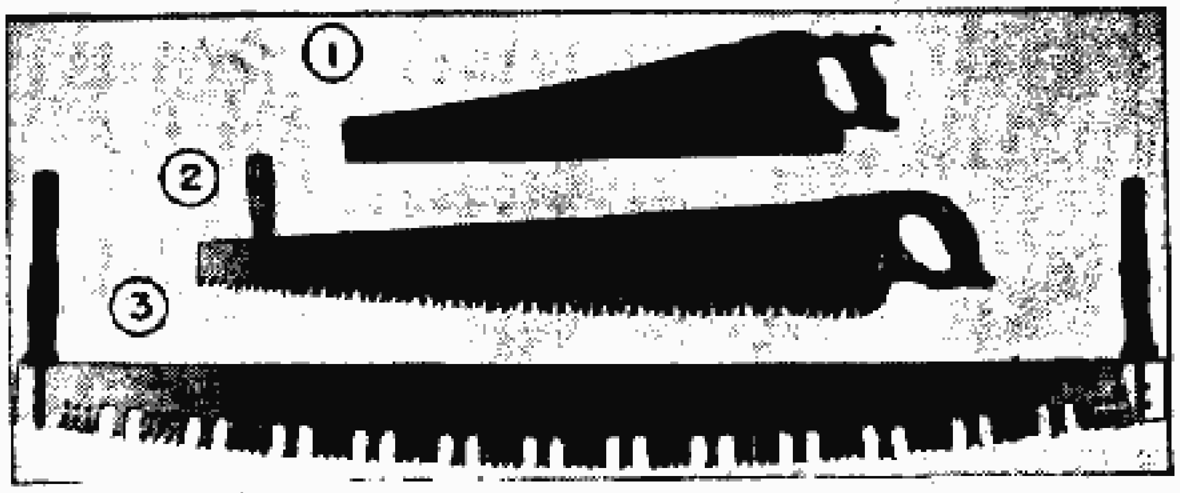
(2) *One-man saw* (fig. 9 ②).—This saw is equipped with cutting and drag teeth and an extra handle so that, if desired, two men (one at each end) can use it. This saw is used on fairly heavy and rough timberwork where speed is more important than close fits or exact measurements.

(3) *Two-man crosscut saw* (fig. 9 ③).—This saw has two removable handles and is used for cutting standing trees or for heavy framing or cutting. Two men operate it by pulling alternately. Do not push or "ride" the saw; one man's straight pull does the work while the other man relaxes but keeps his hand on the handle.

g. Clawhammer.—The clawhammer is used to drive and draw nails. In driving nails, the hand should be at the level



① Hand saw.
② One-man crosscut saw with supplemental handle.
③ Two-man crosscut saw.
FIGURE 9.—Saws.

of the nailhead at the moment of impact so that the nail is hit squarely and the force of the blow travels directly along the nail. (See fig. 11.) Similarly, in drawing nails, the force should be directly along the nail, as shown in figure 11.

h. Sledge (see fig. 12).—The sledge is used for heavy driving, rock-breaking, striking rock drills, and for shop and general construction work. It should be swung like a pick. A full stroke gives best results.

i. Maul (see fig. 12).—The maul is a heavy, wooden driving tool, and should be used only to drive wooden stakes and posts. It is swung like the sledge.

j. Peavy (see fig. 13).—The peavy is a gripping and level-action tool, used to roll, haul, or carry heavy timber. To

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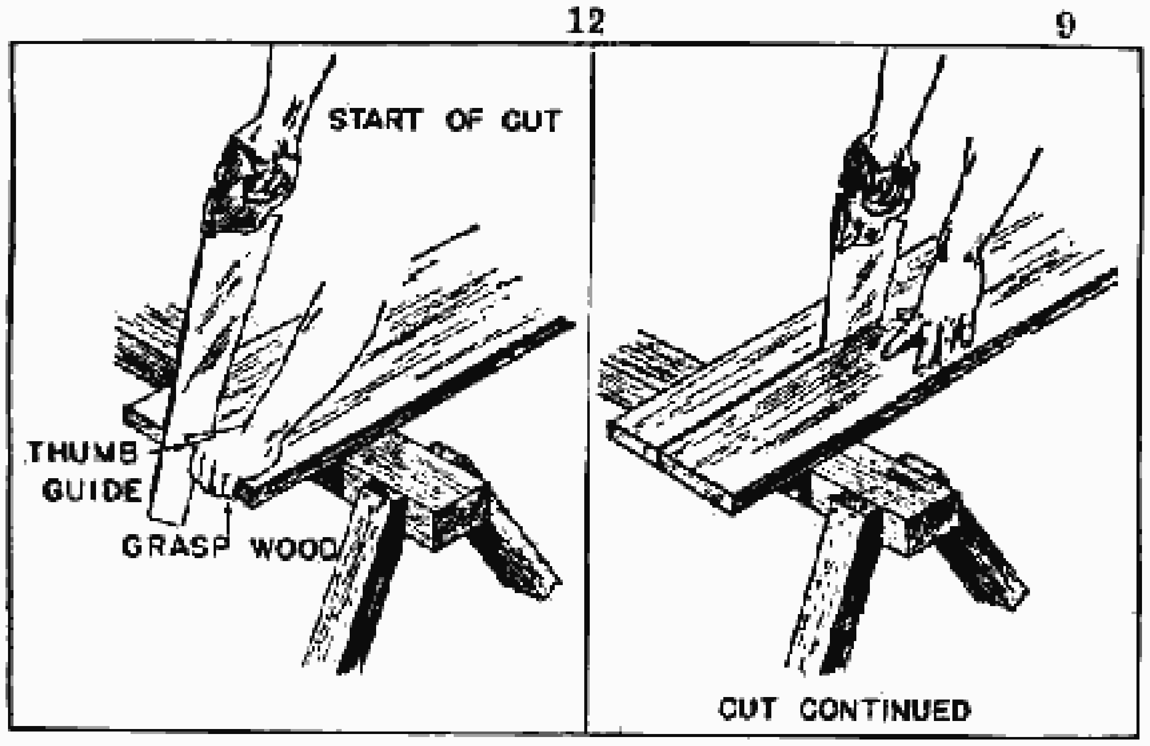

FIGURE 10.—Using the saw.

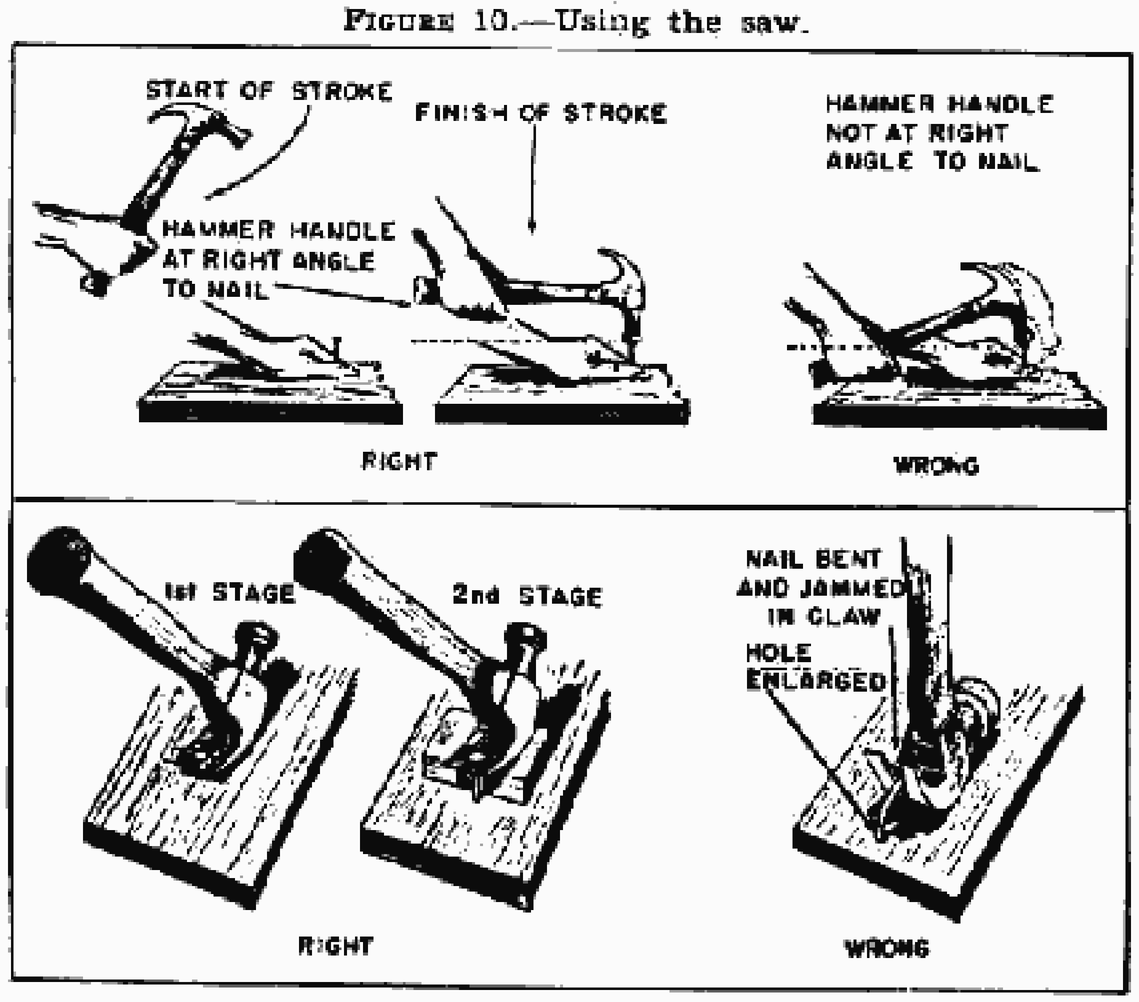

FIGURE 11.—Using the hammer.

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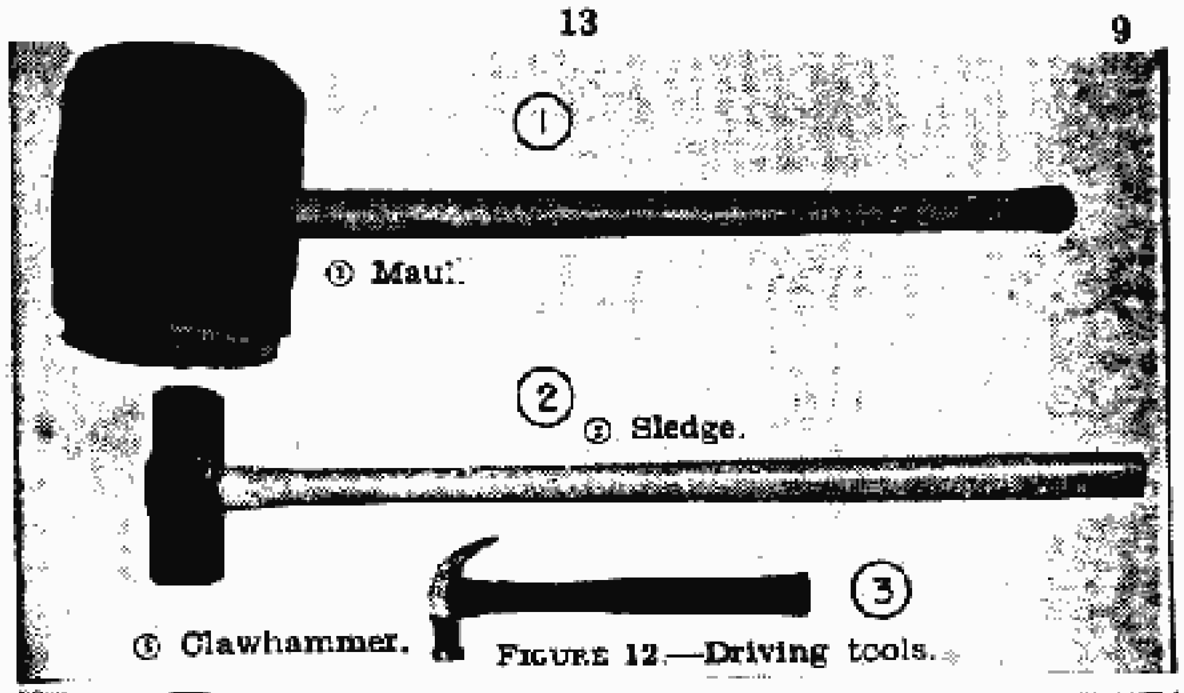


① Maul. ② Sledge. ③ Clawhammer.
FIGURE 12.—Driving tools.

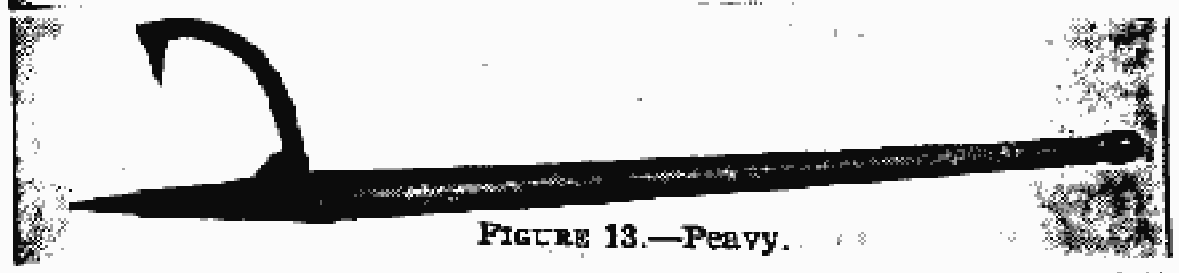
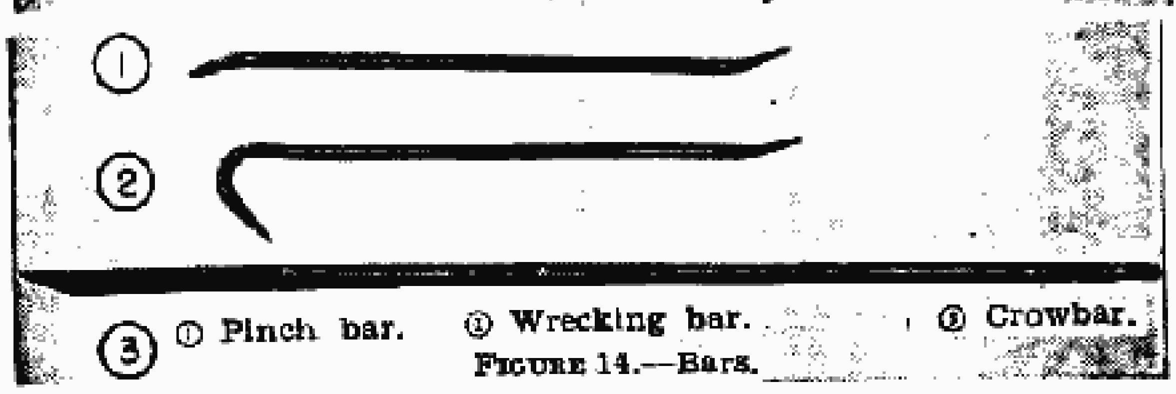


FIGURE 13.—Peavy.



① Pinch bar. ② Wrecking bar. ③ Crowbar.
FIGURE 14.—Bars.

14 9

carry heavy logs with peavies, men should be distributed equally on each side of the log. (See fig. 40.)

k. Bars (see fig. 14).—There are several kinds of bars, of varied shapes: crowbar, wrecking bar, pinch bar. These are prying tools and are used as levers. In using these bars, secure as much leverage as possible and take small "bites" each time. Be satisfied with relatively small movement at the cost of little effort, instead of doing excessive work to make a large move.

l. Brush hook (see fig. 15).—The brush hook is a sharp, curved cutting tool used to clear underbrush and to trim branches. It should be swung with both hands at the handle end.

m. Machete (see fig. 16).—The machete (pronounced muh-SHAY-tay, muh-SHET-ee, muh-SHET) has a long, extremely sharp blade with a wooden handle. It is used to clear underbrush and trim small branches. It is swung with one hand. Keep it in its sheath when not in use.

n. Earth auger (see fig. 17).—The earth auger is an extremely useful hole-boring tool for the engineer. The 6- and 10-inch sizes are most commonly used. As far as possible, keep the cutting blades out of contact with rocks; use it with care in rocky ground.

o. Wire cutters (see fig. 18).—Wire cutters are especially designed to cut barbed wire. The rubber-covered handles are insulated against live wires. The bent hooks on the searching nose are used to pull the wire toward the operator. The cutters are used with two hands.

p. Side-cutting pliers (see fig. 18).—Side-cutting pliers are used both for holding and cutting, essentially with one hand.

q. Pocketknife (see fig. 19).—The pocketknife has four blades, which include a combination reamer and leather punch blade, a screw driver and bottle-opener blade, a can-opener blade, and a cutting blade. It is equipped with a clevis for attachment to a carrying chain, thong, or cord.

r. Wrenches (see fig. 20).—The two chief adjustable wrenches are the monkey wrench for angular bolts or nuts, and the pipe wrench for round fittings. Note the differences between them.

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s. Brace and bit (see fig. 21).—The brace and bit is a boring tool with a variety of bit sizes. It has different bits for wood-boring and for metal-boring. Make sure the wood drills do not come into contact with foreign material such as rocks and nails.

t. Ship-ring auger (see fig. 22).—The ship-ring auger is a long boring tool used to bore holes deeper than those made with the bit and brace.

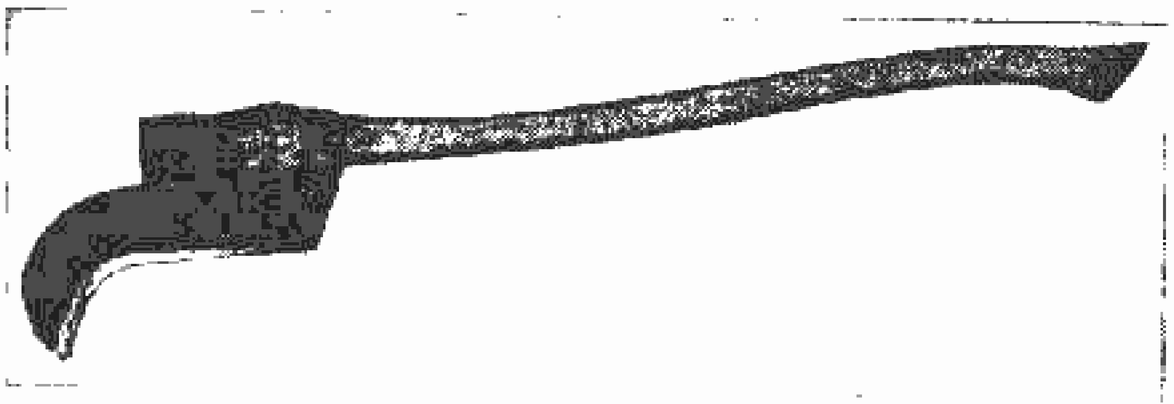

FIGURE 15.—Brush hook.

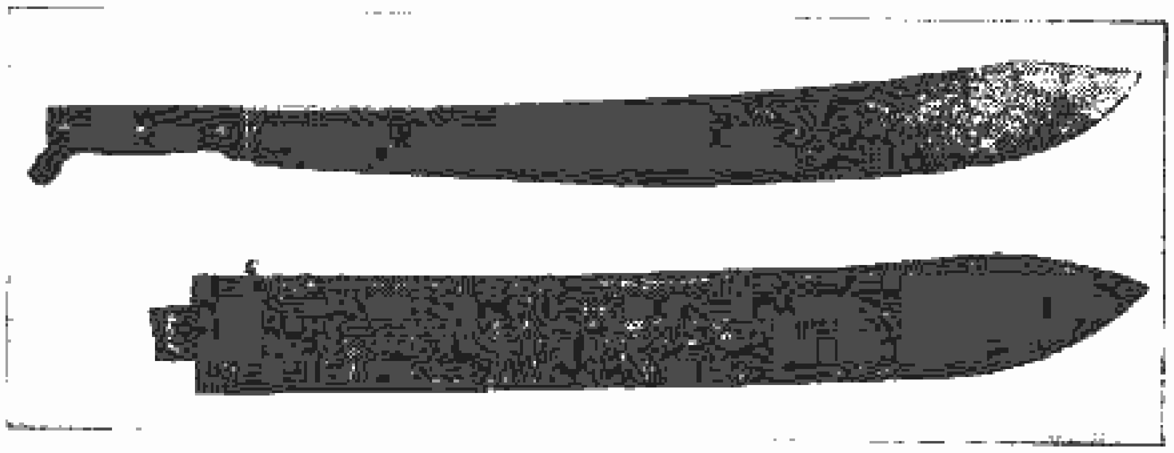

FIGURE 16.—Machete and sheath.

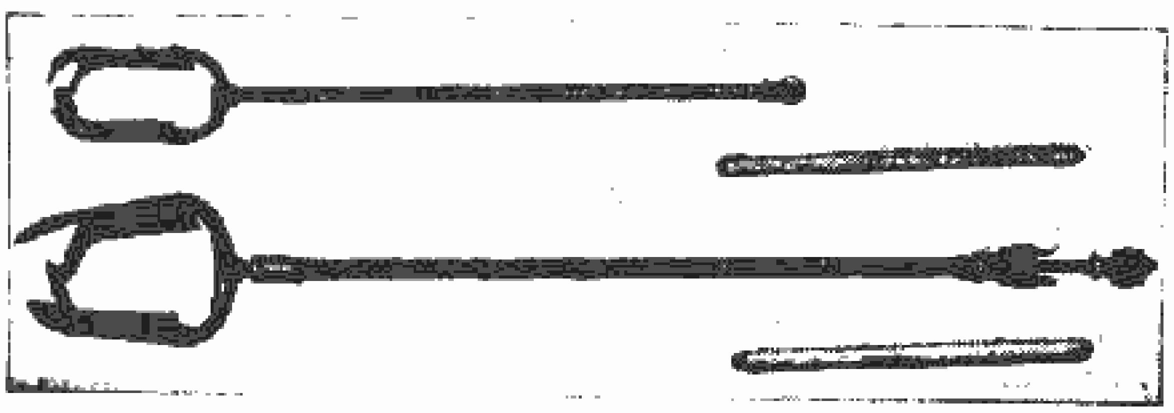

FIGURE 17.—6- and 10-inch earth augers.

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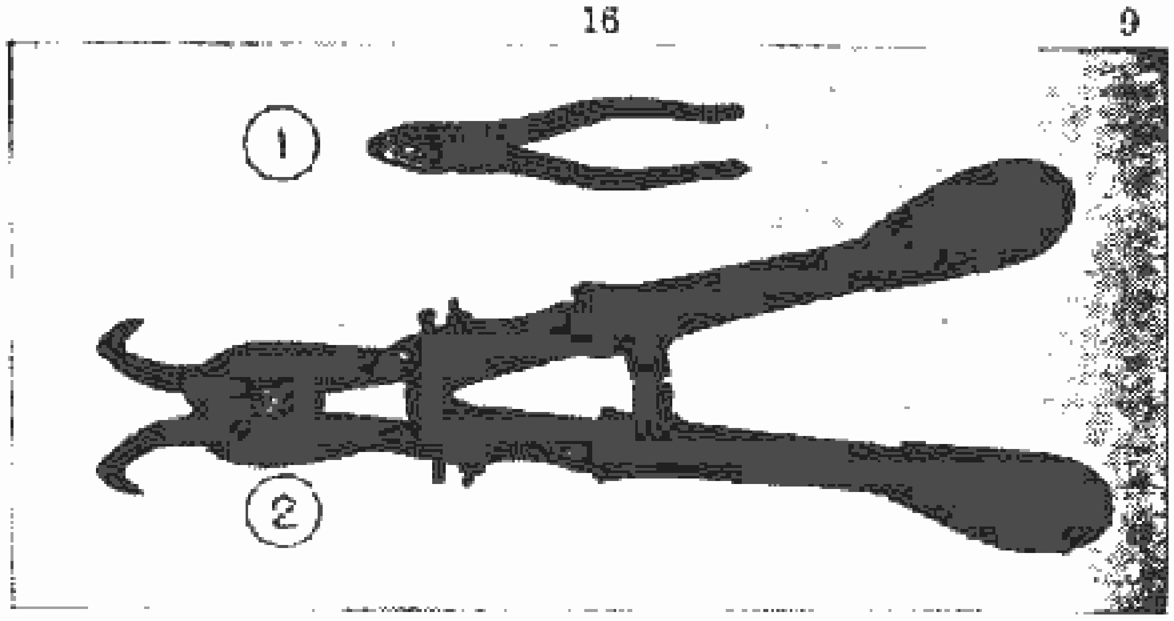

② Wire cutters. ① Side-cutting pliers.

FIGURE 18.—Wire-cutting tools.

u. Plane (see fig. 23).—There are several kinds of planes used for various kinds of work, but the working principle of all is the same. It is a smoothing tool with a fine cutting blade. It should be used with both hands guiding the stroke. Take long easy strokes with the grain of the wood, short strokes against the grain. Be especially careful that the blade is not nicked by nails or other obstructions in the wood.

v. Chisels (see fig. 24).—(1) Wood chisels are struck with a wooden mallet, never with a metal hammer.

(2) Cold chisels for cutting metal are struck with metal sledges and hammers.

w. Measuring tapes (see fig. 25).—The standard engineer measuring tape is a metallic, linen-fiber tape, rolled in a leather case. Keep it in its case when not in use. Since the

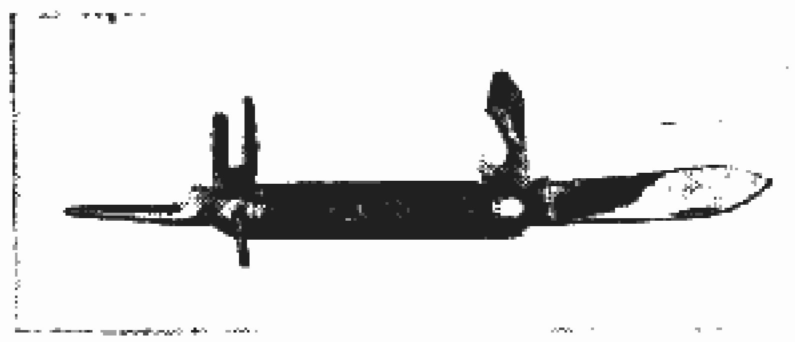

FIGURE 19.—Pocketknife.

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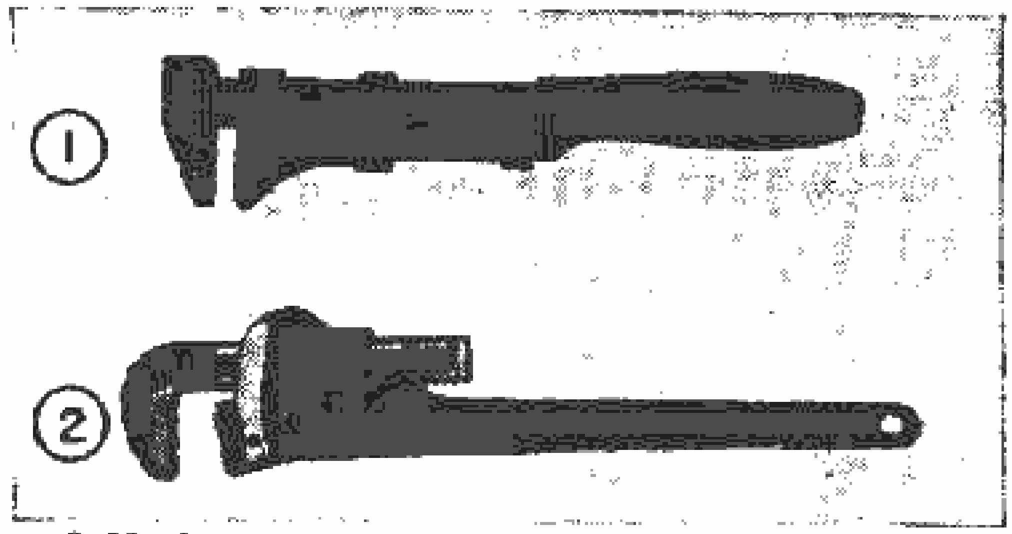
metallic tape stretches slightly, the 6-ft. steel rule should be used for exact measurements.



① Monkey wrench. ② Pipe wrench.

FIGURE 20.—Wrenches.

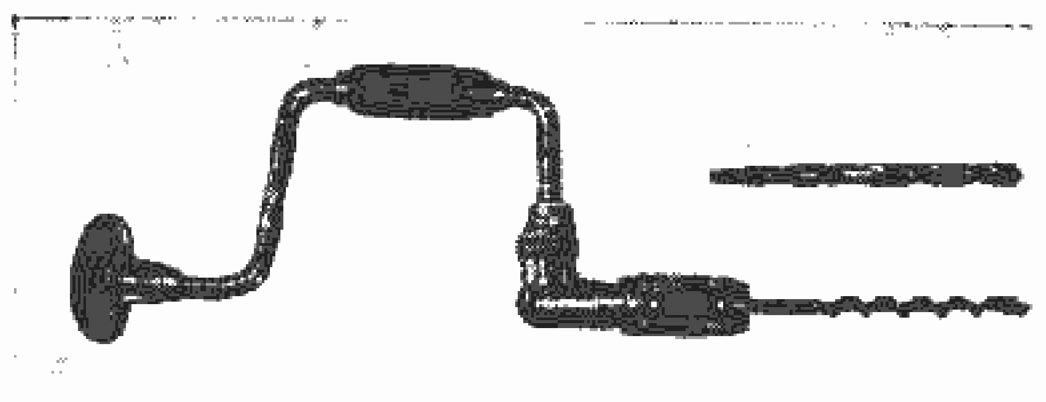


FIGURE 21.—Brace and wood bit, with detached steel-cutting bit.

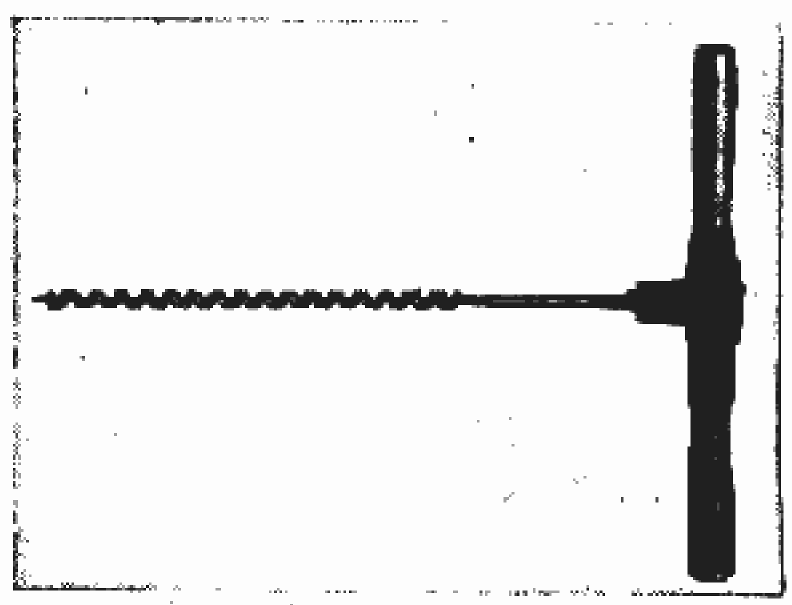


FIGURE 22.—Ship-ring auger.

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FIGURE 23.—Jack plane.

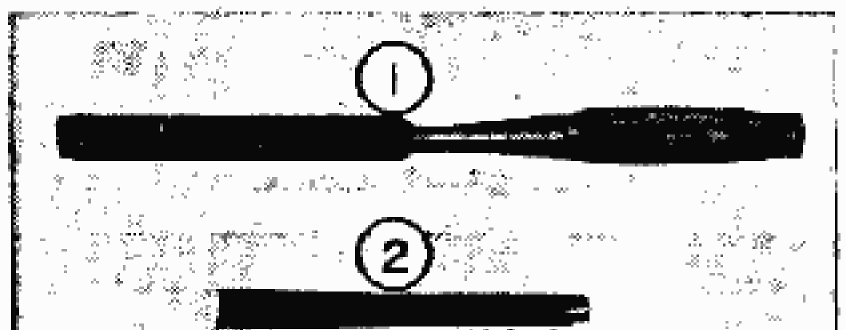
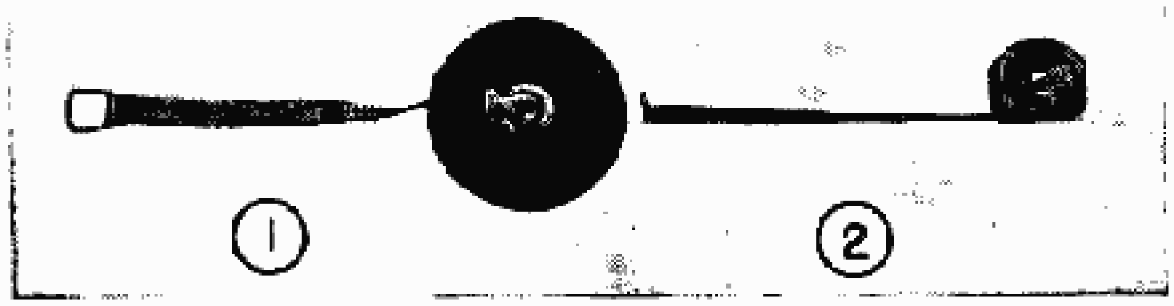


FIGURE 24.—Chisels.

① Wood chisel. ② Cold chisel.



① Metallic tape. ② Steel rule.

FIGURE 25.—Tapes.

x. Squares (see fig. 26).—The try square is used to test square edges and surfaces. The steel framing square is used to measure angles and to draw the various lines needed by a carpenter.

y. Level (see fig. 27).—The level is a precision instrument. By means of the bubble (bead) in the phials in the level, the engineer can determine whether or not a surface is horizontal or vertical. When the level rests on a surface and the bead is centered in the tube, the surface is level.

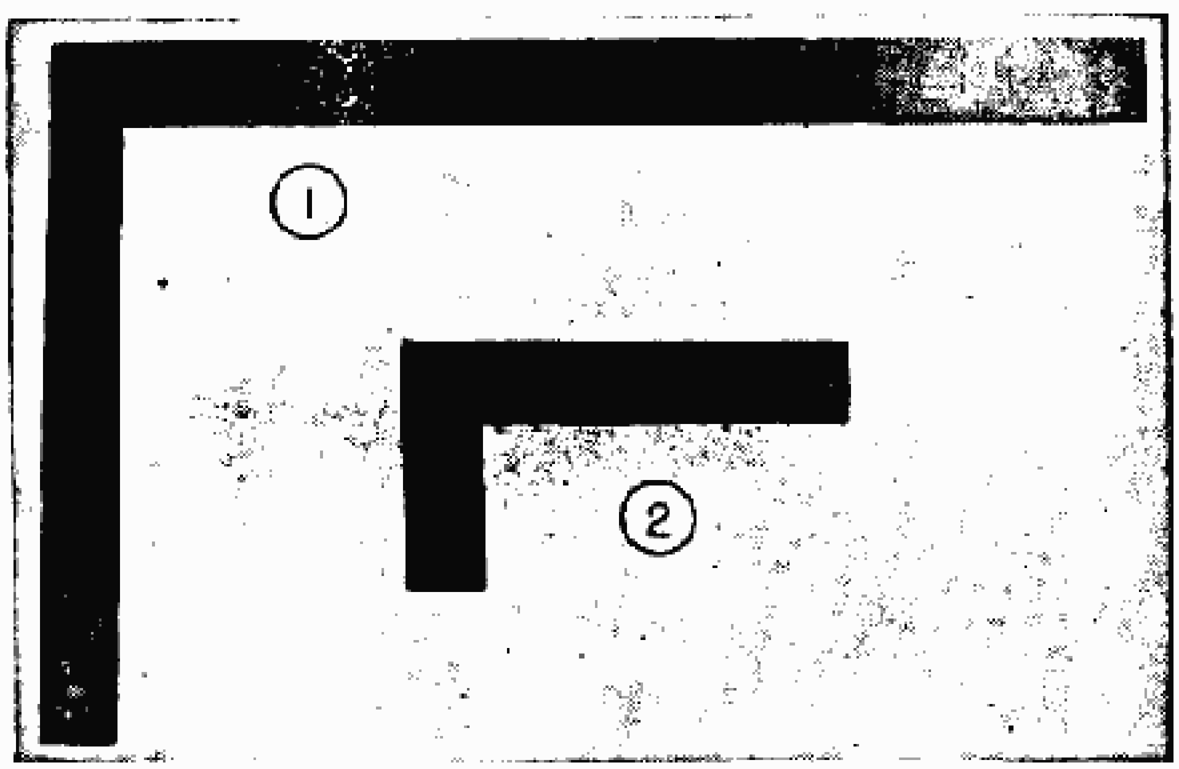
19 10–11

■ 10. POWER-DRIVEN TOOLS.—The power-driven tools used most frequently by the engineer are tools driven by compressed air from the mobile air compressor unit. These tools save much time and labor, and each engineer soldier should know how to use them. The tools most commonly used are clay diggers, wood and rock drills, pavement breakers, hammers, and wood saws. (See figs. 28 to 34, inclusive.) Figure 35 illustrates the gasoline timber saw.

SECTION II

COMMON ENGINEER TASKS

■ 11. MATERIALS.—Certain prepared building materials, such as standard-size lumber, are available to engineers at supply depots. However, very often the engineers must build their bridges, emplacements, etc., out of local materials found at the site of the work. Therefore, an engineer soldier must be always alert to note local materials, resourceful in his use of these materials, and quick to use them whenever he can.



① Carpenter steel square. ② Try square.

FIGURE 26.—Squares.

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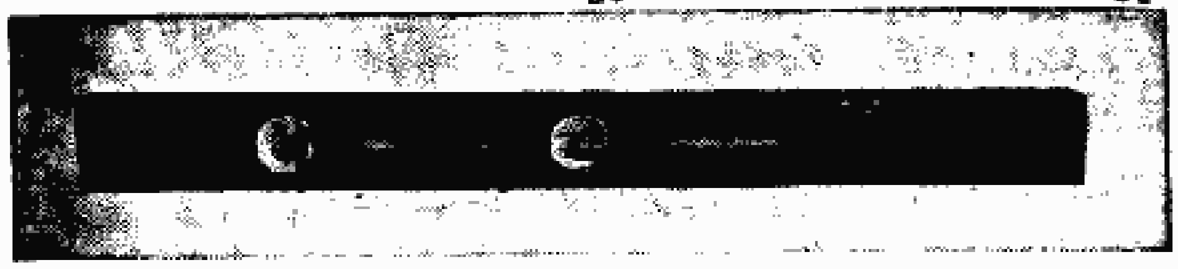

FIGURE 27.—Carpenter's level.

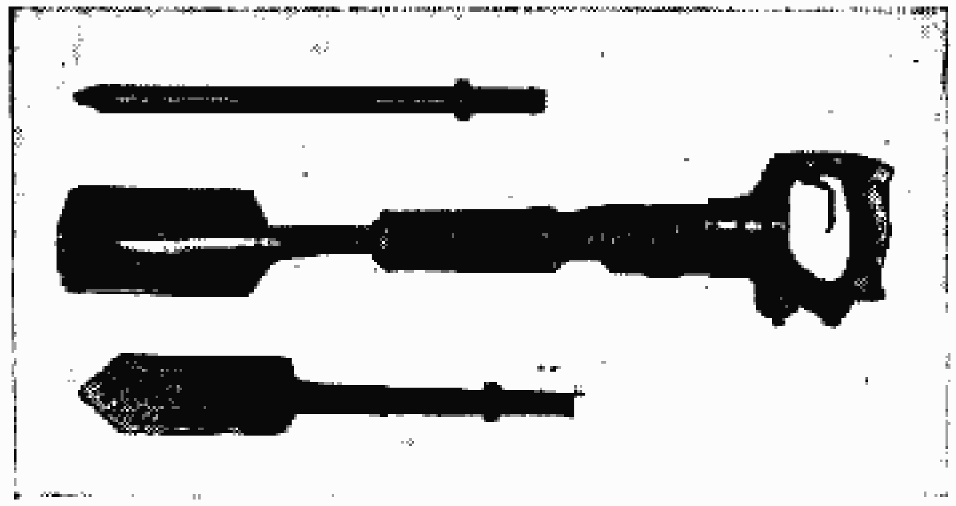

FIGURE 28.—Pneumatic clay digger with spade and moil-point attachments.

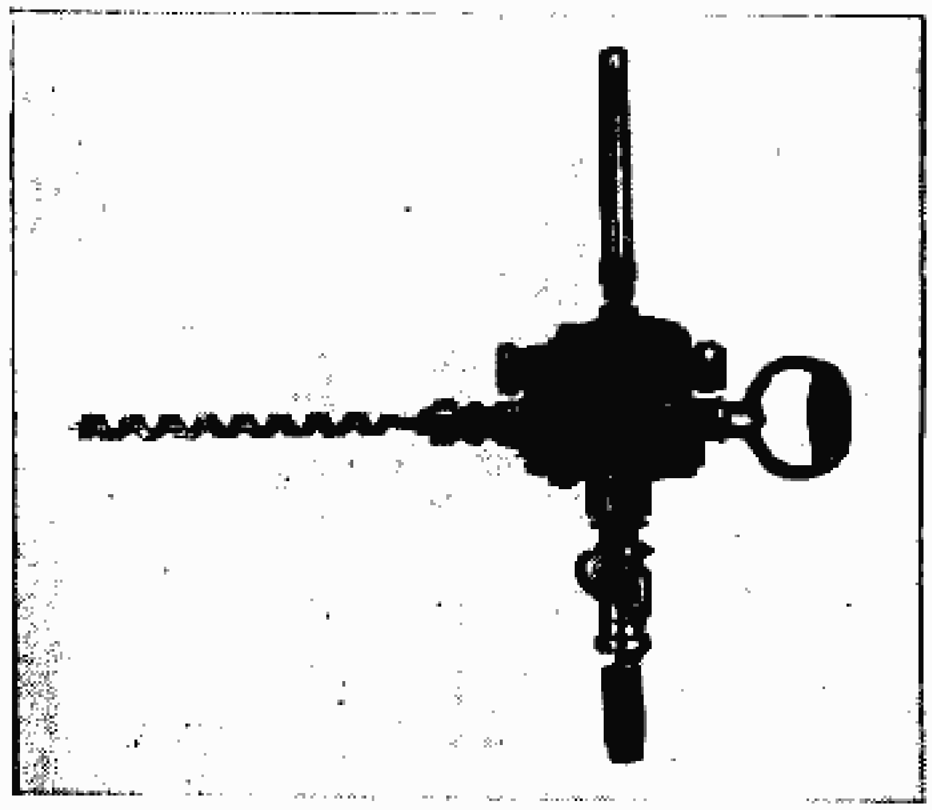

FIGURE 29.—Pneumatic wood drill.

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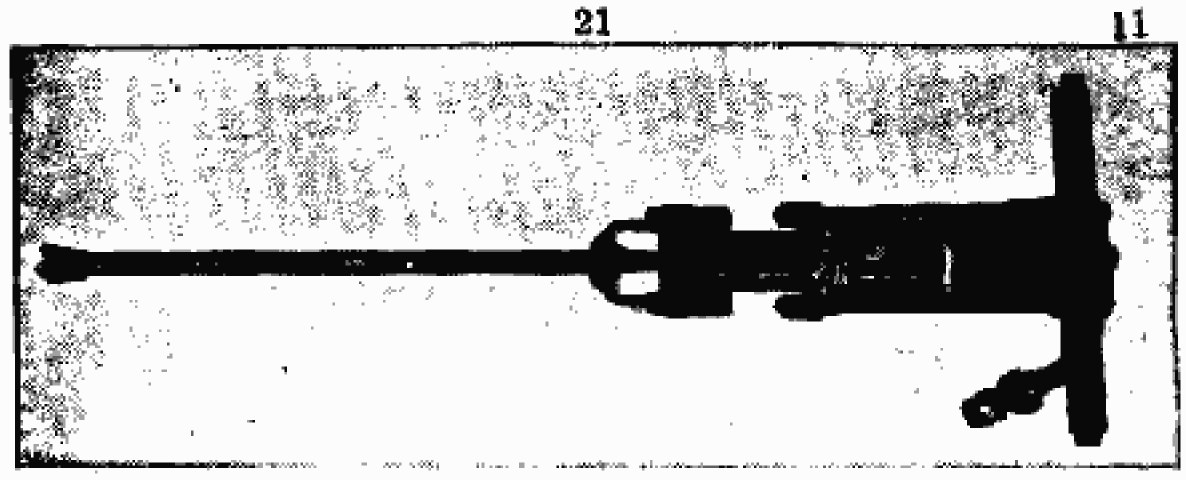

FIGURE 30.—Pneumatic rock drill.

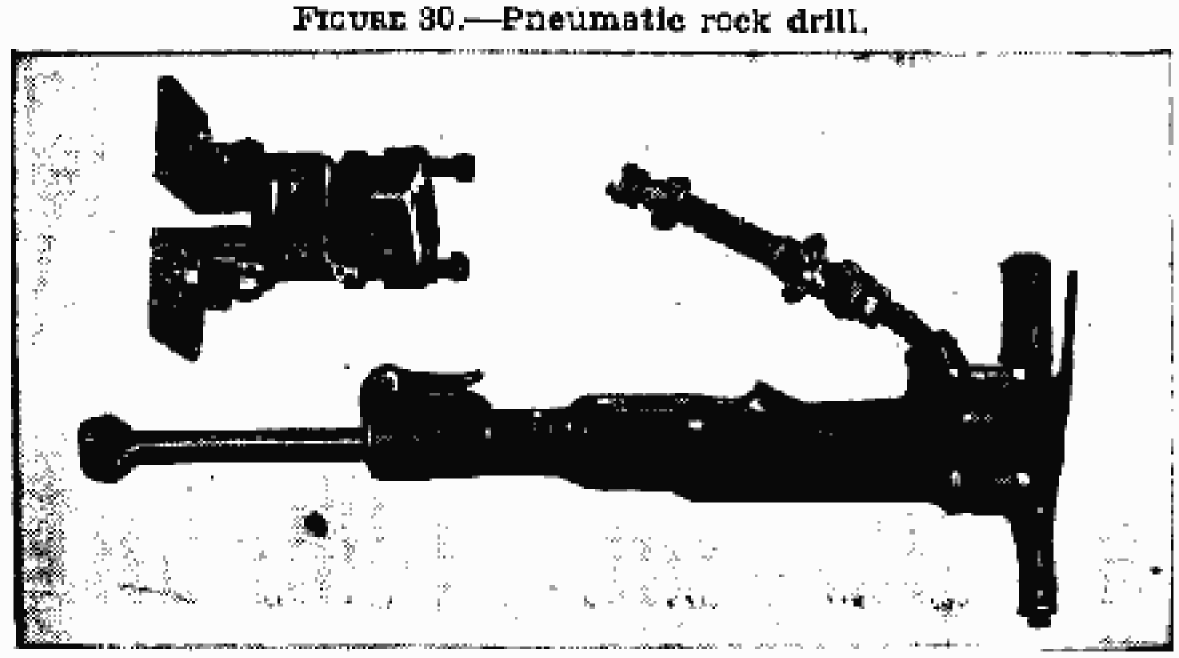

FIGURE 31.—Pneumatic pavement breaker with sheathing-driver attachment.

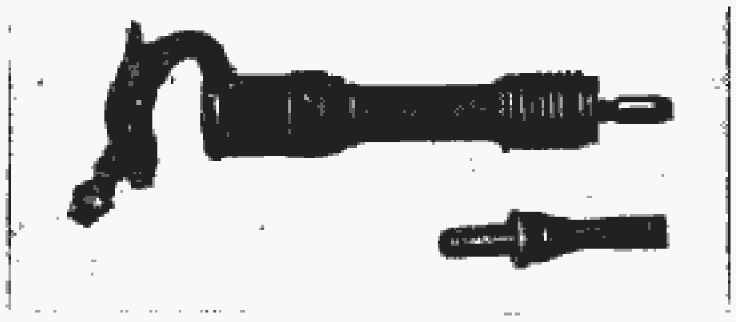

FIGURE 32.—Pneumatic nail driver with chisel attachment.

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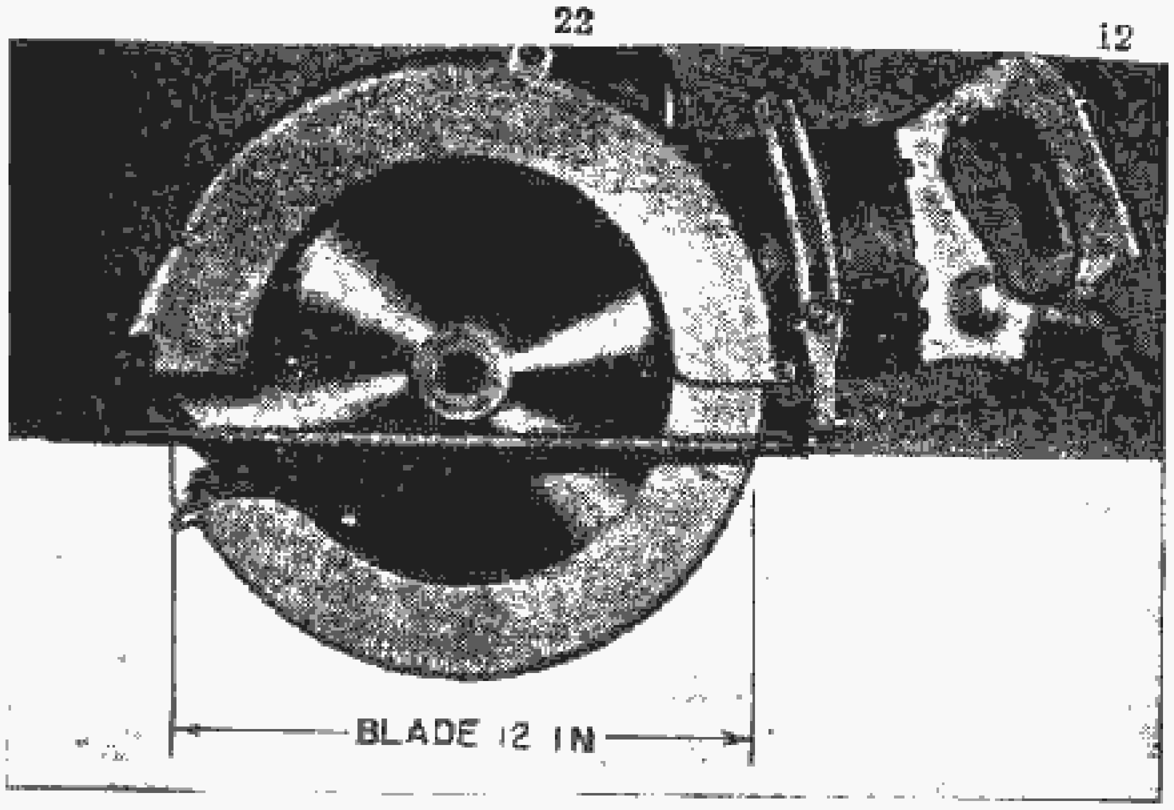

FIGURE 33.—Pneumatic circular timber saw.

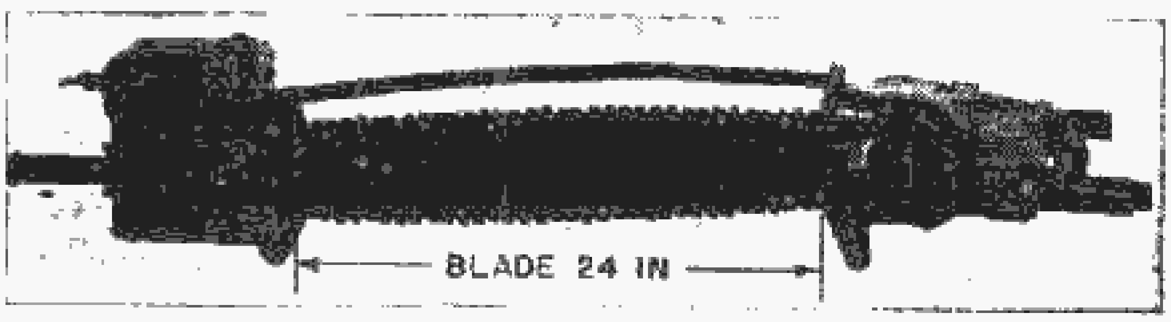

FIGURE 34.—Pneumatic chain saw.

■ 12. FELLING TREES.—With an ax, cut a deep notch near the base of the tree (see fig. 36) on the side toward which the tree is to fall. Then saw the tree on the opposite side to cut the remaining fibers, using steel wedges, if necessary, to keep the saw from binding. To cut the trunk clear of the stump, the saw cut should be started opposite the point of the notch. Where it is desired to keep the base of the tree firmly attached to the stump after felling, as in making a tree road block, the saw cut should be made considerably higher than the notch, so that all fibers will not be severed when the trunk falls. It is often advisable to use guy lines

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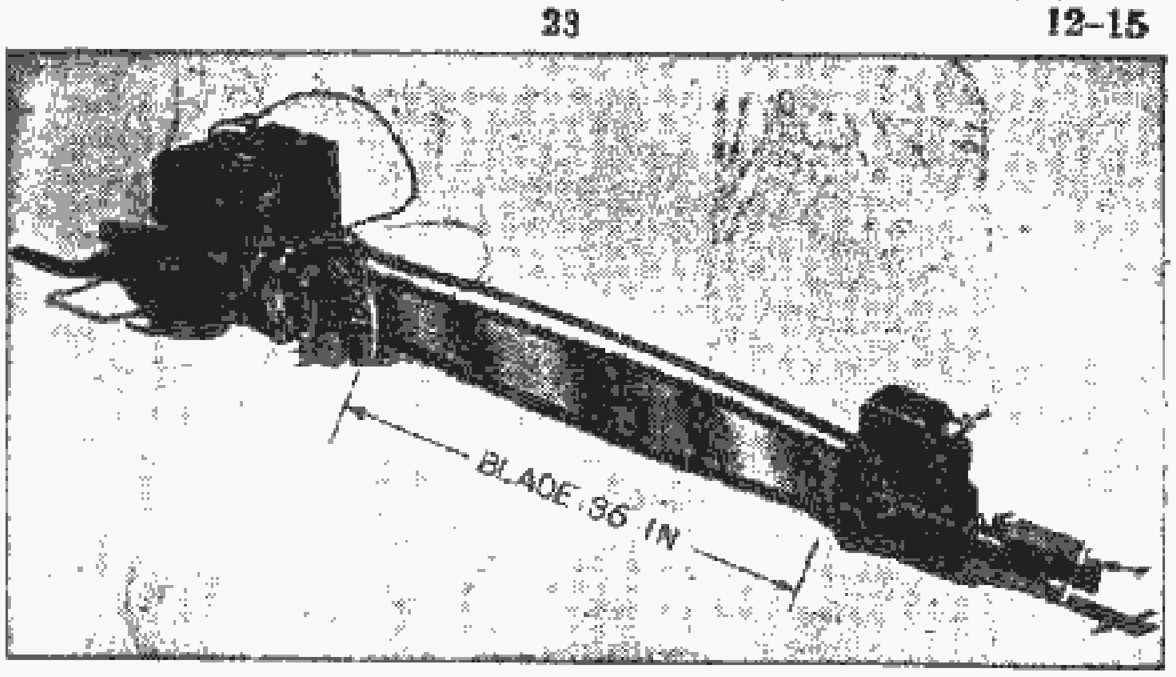

FIGURE 35.—Gasoline-driven chain saw.

to guide a tree in falling and sometimes to use hand or motor power to pull a tree in a desired direction.

■ 13. MAKING TIMBER JOINTS.—In rough carpentry work, the butt joint and the lap joint are used to join or splice two pieces of wood so that they form one continuous piece. (See fig. 37.) The butt joint requires the use of fishplates to hold the ends together. The lap joint is made by overlapping the ends of two timbers and nailing them together. This is the simplest and quickest splice for bracing and like uses.

■ 14. DRIVING DRIFTPINS.—Driftpins (heavy iron spikes) are used to fasten large timbers together. Since driftpins are made of relatively soft iron, holes must first be bored in the wood before the pins are driven. These holes should be slightly smaller in diameter than the pin itself; for example, the hole for a ½-inch driftpin should be made with a 7/16-inch bit.

■ 15. HANDLING LOADS.—*a. Heavy lifts.*—The proper method of lifting heavy loads is to make the legs do the work. (See fig. 38.) Do not bend over from the waist and throw all the strain on the groin and back muscles. Improper methods of lifting often cause a hernia (rupture).

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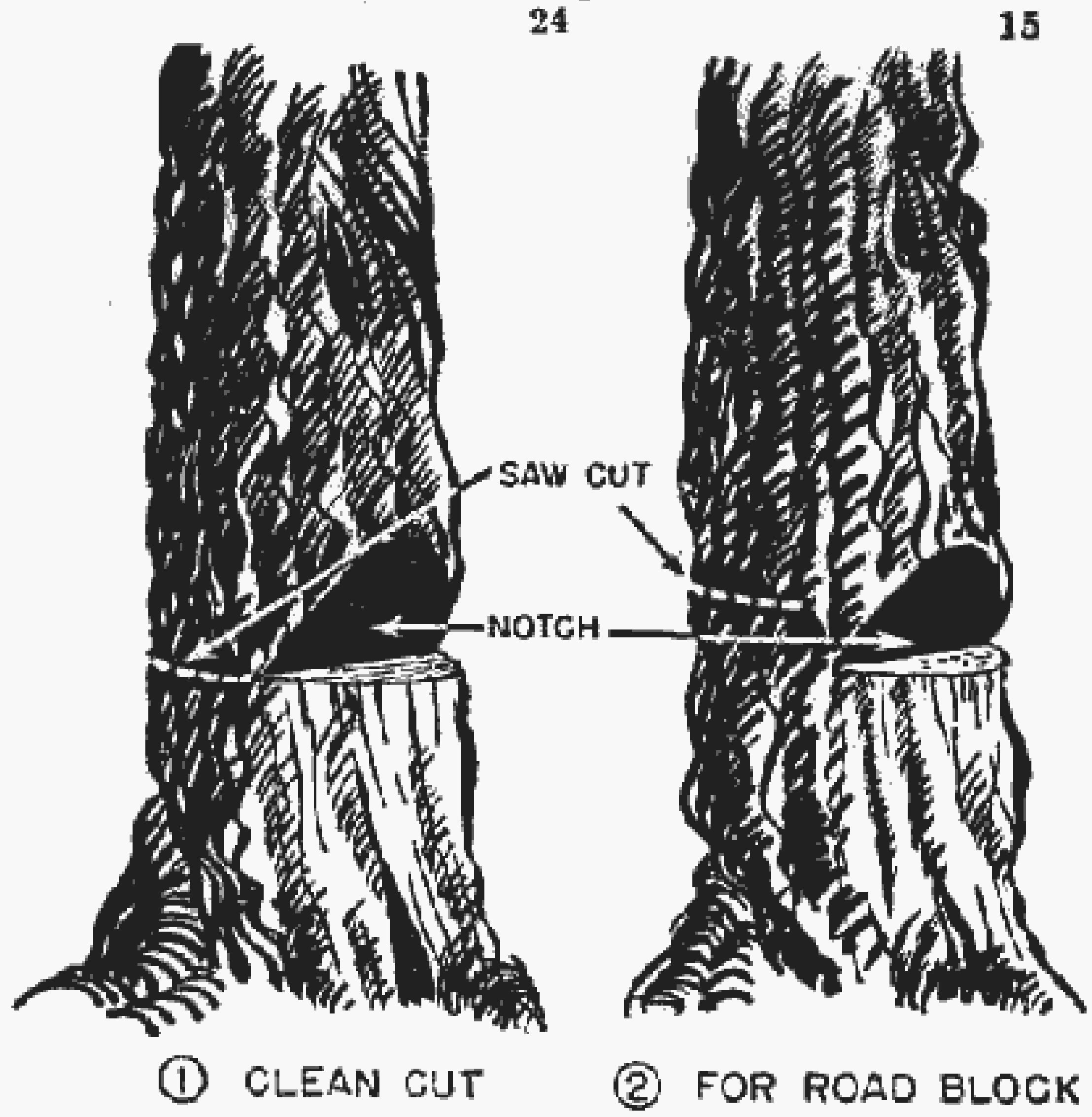

FIG. 36.—How to fell trees.

b. Carrying long or heavy loads.—(1) For long, fairly light objects, such as timber beams or ponton balk, one man takes each end; to keep it from tipping over, the load rests on the right shoulder of the man in front and on the left shoulder of the man in the rear. (See fig. 39.)

(2) For carrying somewhat heavier objects, more men may be used in a similar manner, but it is better to use pick handles, pipes or bars of ample length placed underneath. Two men (on opposite sides of the load) carry each handle. Timber and rail tongs, if available, should be used in the same manner, except that the load hangs below the handles. Figure 40 illustrates the use of the peavy to carry timber. Extremely heavy loads should be handled on pipe rollers, wheeled dollies, block and tackle, or by machines.

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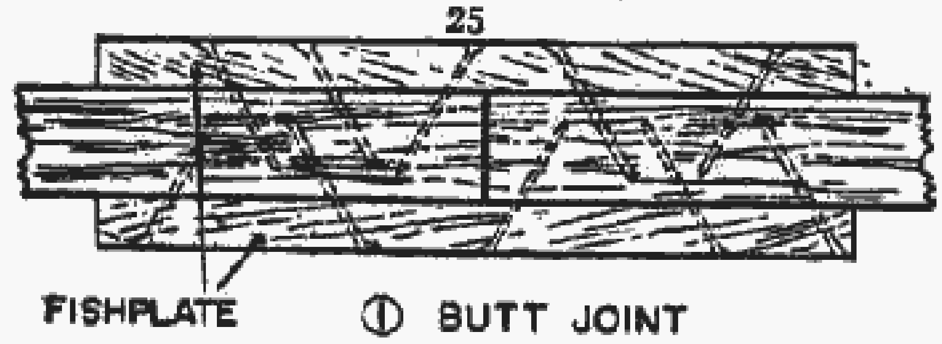

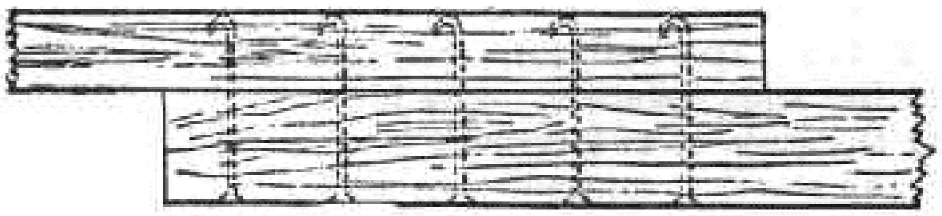

② LAP JOINT

FIG. 37.—Simple timber splices.

① Right. ② Wrong.

FIG. 38.—How to lift heavy objects.

26 15–16

(3) For small but heavy loads, a wheelbarrow should be used with the load placed evenly as far forward as practicable.

c. *Carrying chess.*—A wide one-man load, such as plank or 10-ton ponton chess, is carried on edge, rear end down, next to the body, with the right hand underneath, near the middle or balance, and the left hand on top steadying and guiding the load. (See fig. 41①.) Sometimes, when the chess is unusually muddy and slippery, or when fatigue necessitates the use of two supporting hands, the chess may be carried with both hands underneath. (See fig. 41②.) When this is done, however, special care must be taken to control the plank so that no one is hit by the ends. For carrying 25-ton ponton chess, two men are needed.

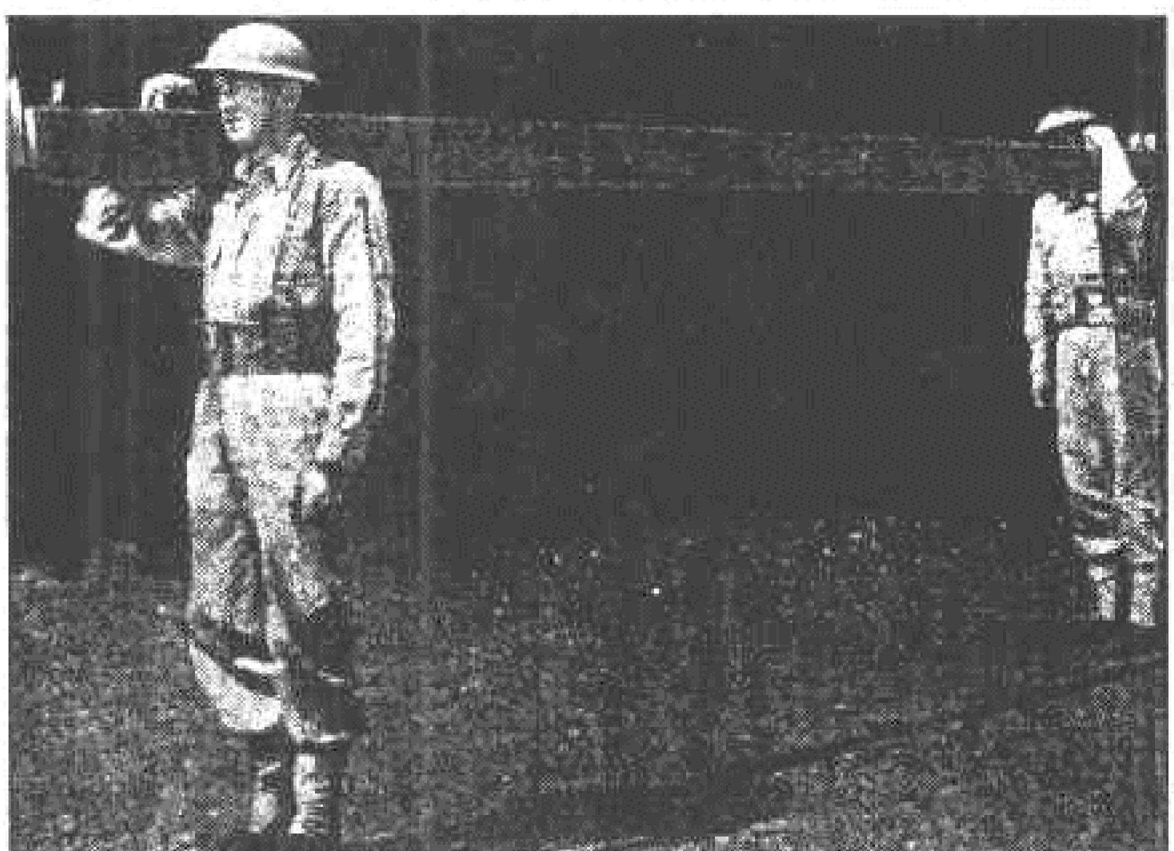

FIGURE 39.—Carrying balk.

■ 16. USING SANDBAGS (see fig. 42).—Sandbags are always laid with the chokes (mouths) tucked under and the side seams and tied ends inside. Grain, cement, and similar

27 16

bags can be used, but they should not be more than half-filled or they will be too heavy for a man to handle. Sandbags are used frequently as reveting material to bolster the sides of holes in the ground. Figure 42 shows various ways to use sandbags for revetments. To lay sandbags properly, they must be shaped so that when in place they are roughly half as wide as they are long.

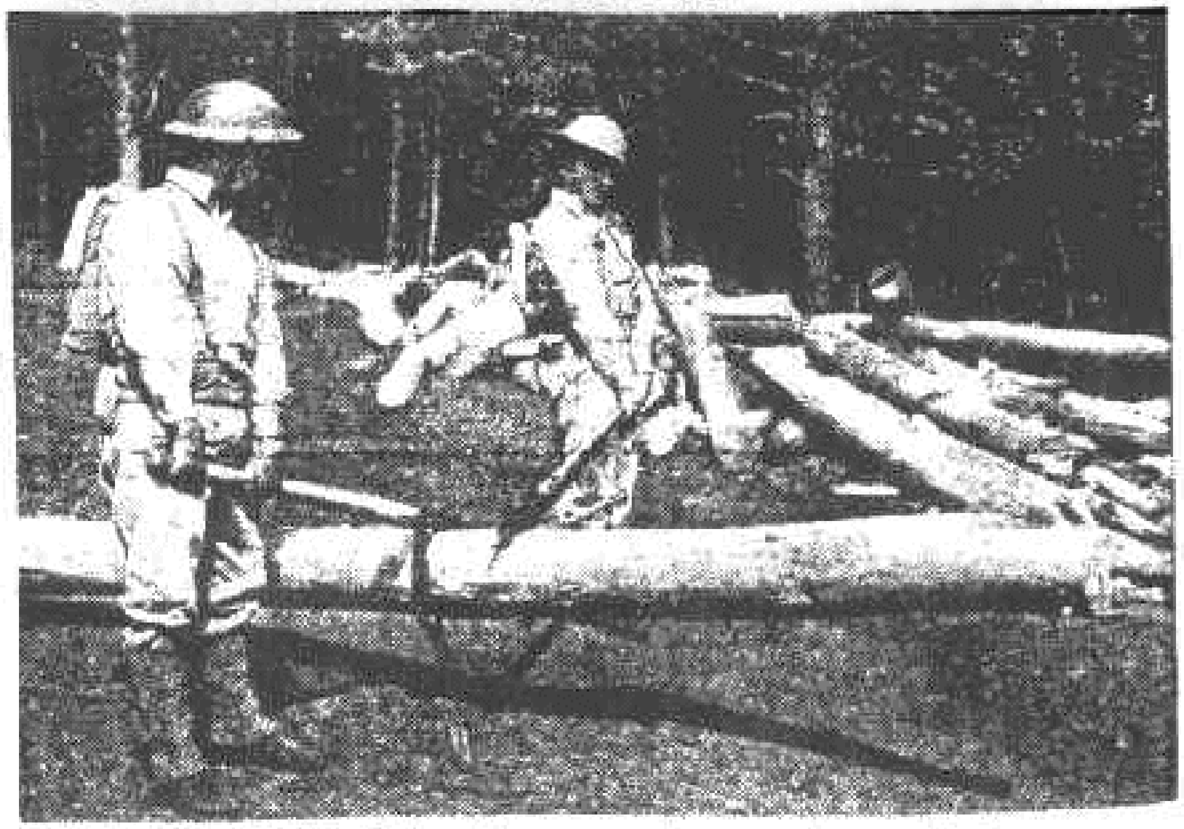

FIGURE 40.—Using the peavy to carry heavy timber.

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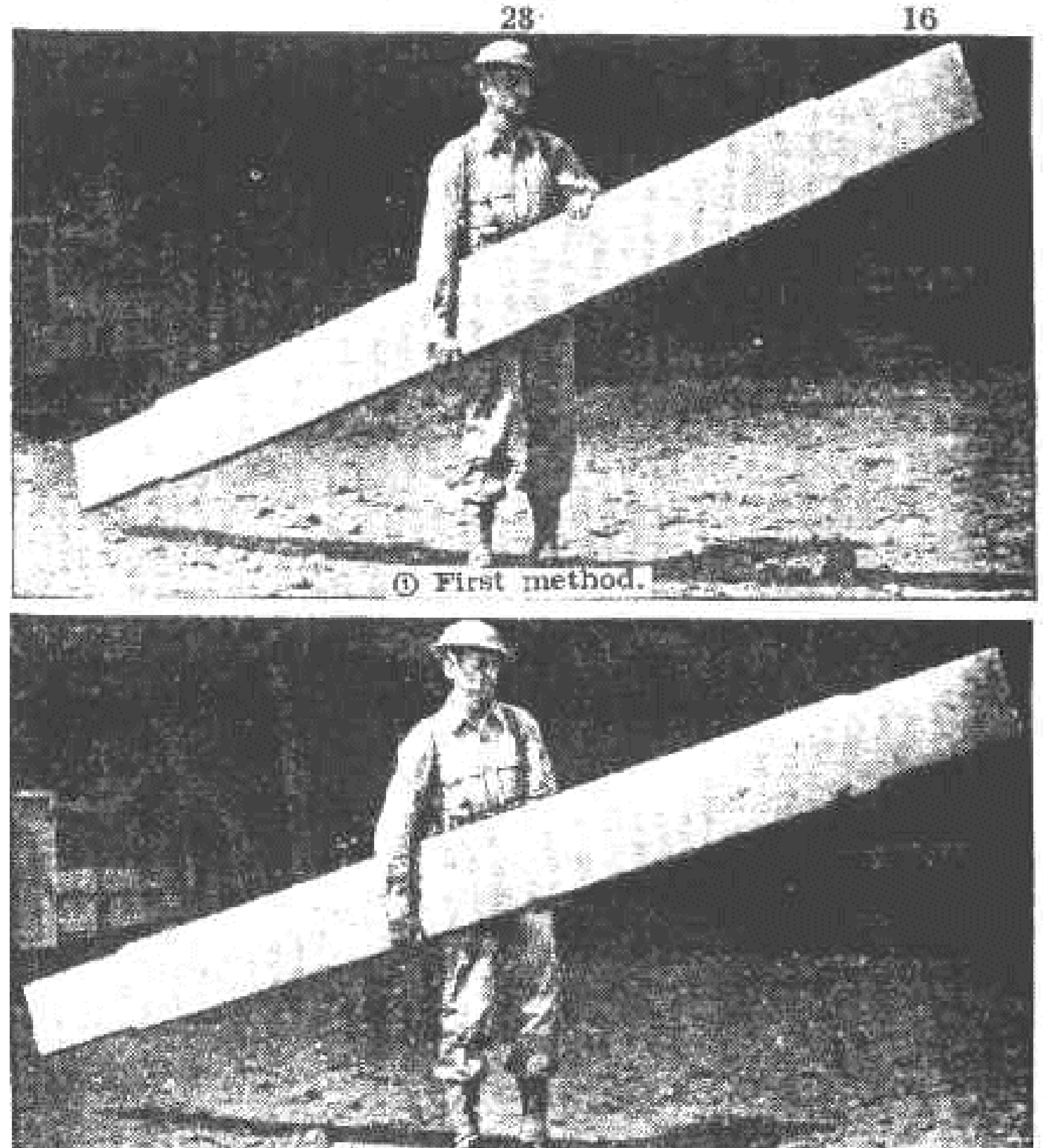

① First method.

② Alternate method.

FIGURE 41.—Carrying 10-ton ponton chess.

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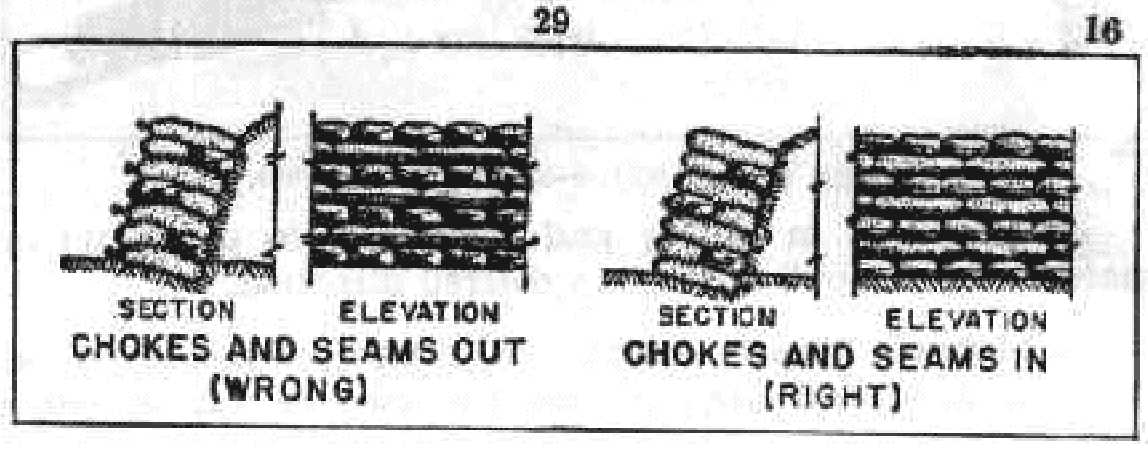

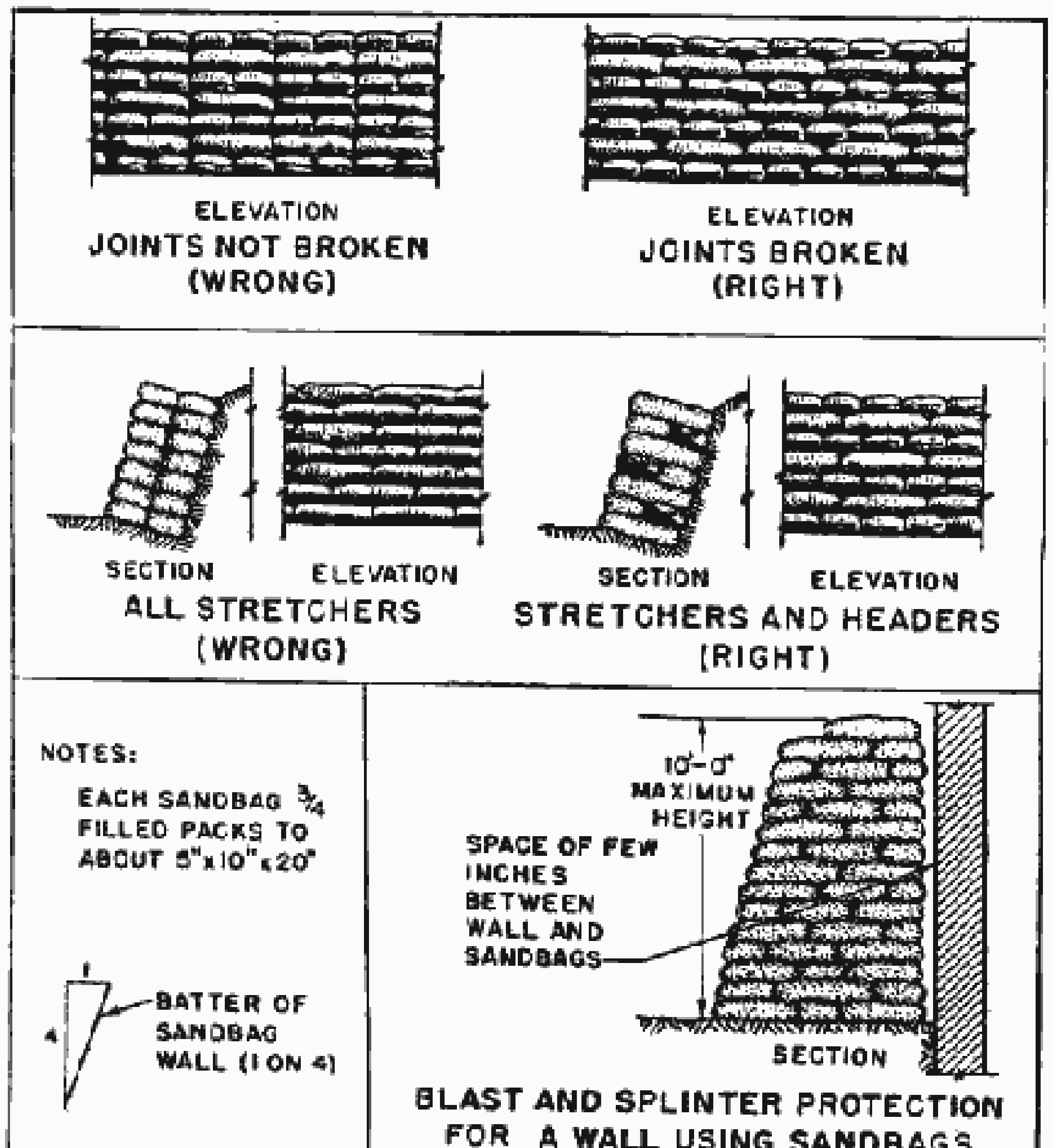

FIGURE 42.—Using sandbags as revetment.

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CHAPTER 3

ELEMENTARY RIGGING

■ 17. IMPORTANCE.—The engineer often makes his own machines for use in heavy work and as substitutes for tools and machines that are unavailable. The machines are simple, but they save much labor. By "rigging" is meant the handling of rope (manila or wire) and chains with blocks and tackles to raise, move, or hold heavy loads. The combinations which the engineer rigs up with rope are really simple machines. This chapter explains the principles and methods of rigging, which will be one of your most valuable skills as an engineer. Make a thorough command of this skill a part of your personal Army knowledge.

■ 18. CARE OF ROPE.—Proper care of rope lengthens its usefulness. Observe the following precautions:

a. Do not store in wet, damp, or hot places.

b. Clean muddy rope by washing in water.

c. Dry before storing, but do not use artificial heat.

d. Avoid pulling over sharp edges.

e Avoid dragging rope through sand or dirt. Sand has an abrasive action on the inner fibers.

f. Keep rope free of contact with acid, alkali, or other damaging chemicals.

g. Use knots that can be untied and will not have to be cut.

h. Repair broken strands as soon as possible.

i. Slaken dry, taut lines when exposed to rain or damp weather.

j. Always whip loose ends of rope, and when cutting a length of rope put on two whippings and cut between them.

k. Inspect rope frequently.

■ 19. UNCOILING AND COILING ROPE.—*a*. New rope is coiled into bales usually containing 1,200 feet each. To uncoil, begin with the end in the center of the coil. The rope should

31 19-20

uncoil in a left-hand (counterclockwise) direction. If it uncoils in the wrong direction, turn the bale over, pull the end through the center, and uncoil from the opposite side. (See fig. 43①.)

b. Coil rope in a right-hand (clockwise) direction (see fig. 43②). Mark the end of the rope that will enter the coil last; this is helpful in uncoiling.

■ 20. DEFINITIONS.—*a*. *Knot*.—A knot is a tie or fastening made with a rope or cord. Types of knots include the following:

(1) *Bend knot* which fastens one rope to another or to a ring or loop.

(2) *Hitch knot*, a temporary knot used to fasten one rope to another, or to spar or post, so as to be readily undone.

NOTE.—These terms are often loosely applied; the same tie, for example, is called a sheet bend, weaver's knot, or weaver's hitch.

(3) *Splice*, a knot joining two ropes, or parts of same rope, by interweaving strands of two parts.

(4) *Lashing*, a knot which ties together objects such as spars or poles by means of a rope. The individual ropes used in this knot are also called "lashings"; rope of this kind, used to lash pontons, is about 18 or 20 feet long and ½ inch in diameter. It has an eye splice at one end and is whipped at the other end.

b. *Special terms*.—(1) *Anchorage*.—Any means, natural or improvised, for securing guys, ropes, struts, etc.

(2) *Bight*.—Loop formed on rope so that the two parts cross (or lay alongside) each other.

(3) *Chock*.—Bring blocks together until they touch each other.

(4) *Frapping*.—Several turns of rope taken around lashing turns, used to keep the lashing tight and in place.

(5) *Guy*.—Rope, chain, or spar attached so as to steady an object.

(6) *Lay*.—The twist of a rope.

(7) *Mousing*.—Closing mouth of hook by lashing to prevent rope or load from becoming dislodged.

(8) *Overhaul*.—To separate the blocks in block-and-tackle rigging.

32 20-23

(9) *Reeve*.—Thread blocks with rope in assembling block and tackle.

(10) *Return*.—Each part of rope between blocks or between either end and a block.

(11) *Round (run) in*.—Bring blocks closer together.

(12) *Running end (part)*.—Free end of rope.

(13) *Seizing*.—Lashing the running end to the standing part of rope.

(14) *Standing end (part)*.—Whole rope less running end.

(15) *Tackle*.—Assembly of ropes and blocks.

(16) *Transom*.—Horizontal spar.

(17) *Unlay*.—Untwist rope.

(18) *Whipping*.—Binding or lashing end of rope to prevent unlaying.

■ 21. KNOTS AND THEIR USES.—For any one job a particular knot is the best to use; that is why there are so many knots an engineer must know. Learn to tie all the knots and learn to use them at the proper time. Figures 44 to 48, inclusive, illustrate the most common knots.

■ 22. SPLICES.—The three principal steps in splicing a rope are unlaying the strands, placing the ends together, and tucking the ends of the strands. No attempts should be made to learn to splice without having rope in the hands and actually executing the operations. Marlinespikes or ten pins are desirable, but no special tools are necessary.

■ 23. SHORT SPLICE (fig. 49).—*a*. Short splicing is the best method to join two ropes when an appreciable increase of rope diameter at the splice is not objectionable. A short splice should not be used when the rope will be passed over a pulley.

b. To make the short splice.—

(1) Unlay the strands of each rope for at least five turns.

(2) Bring the ends of the rope together so that each strand of one rope rests between two consecutive turns of the other rope.

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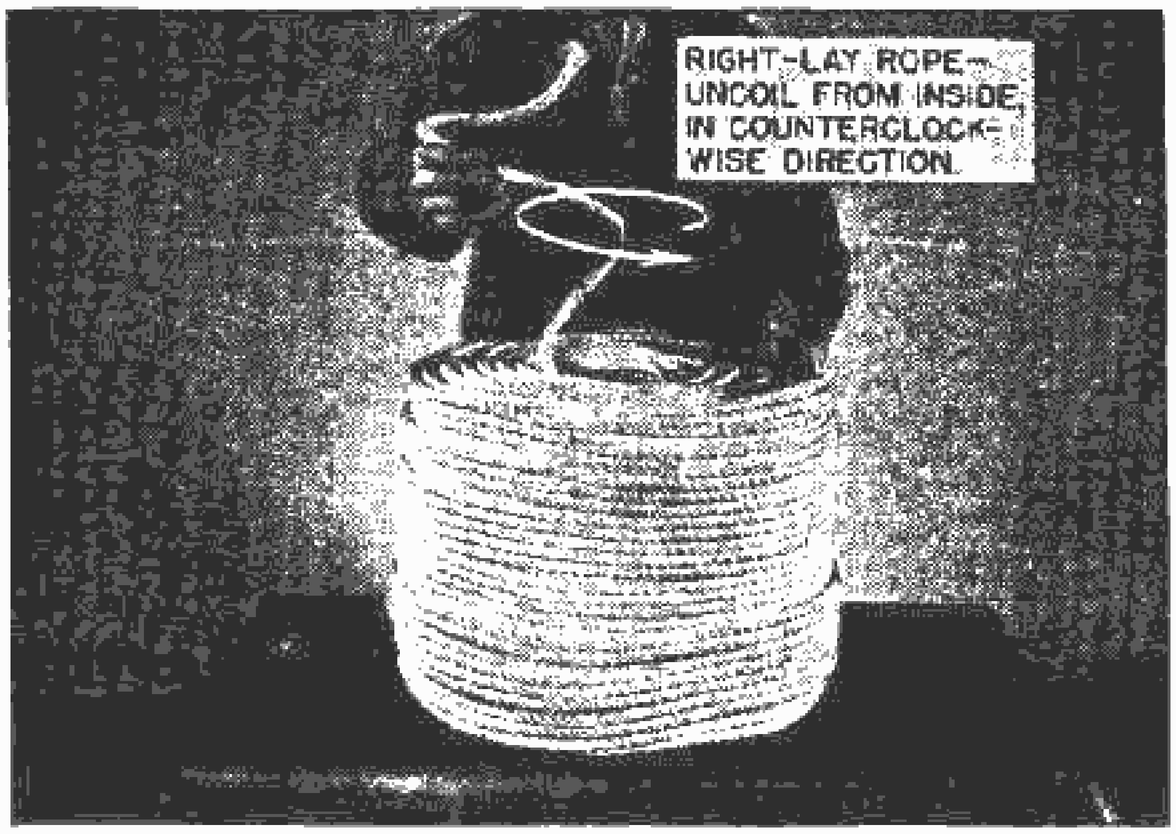
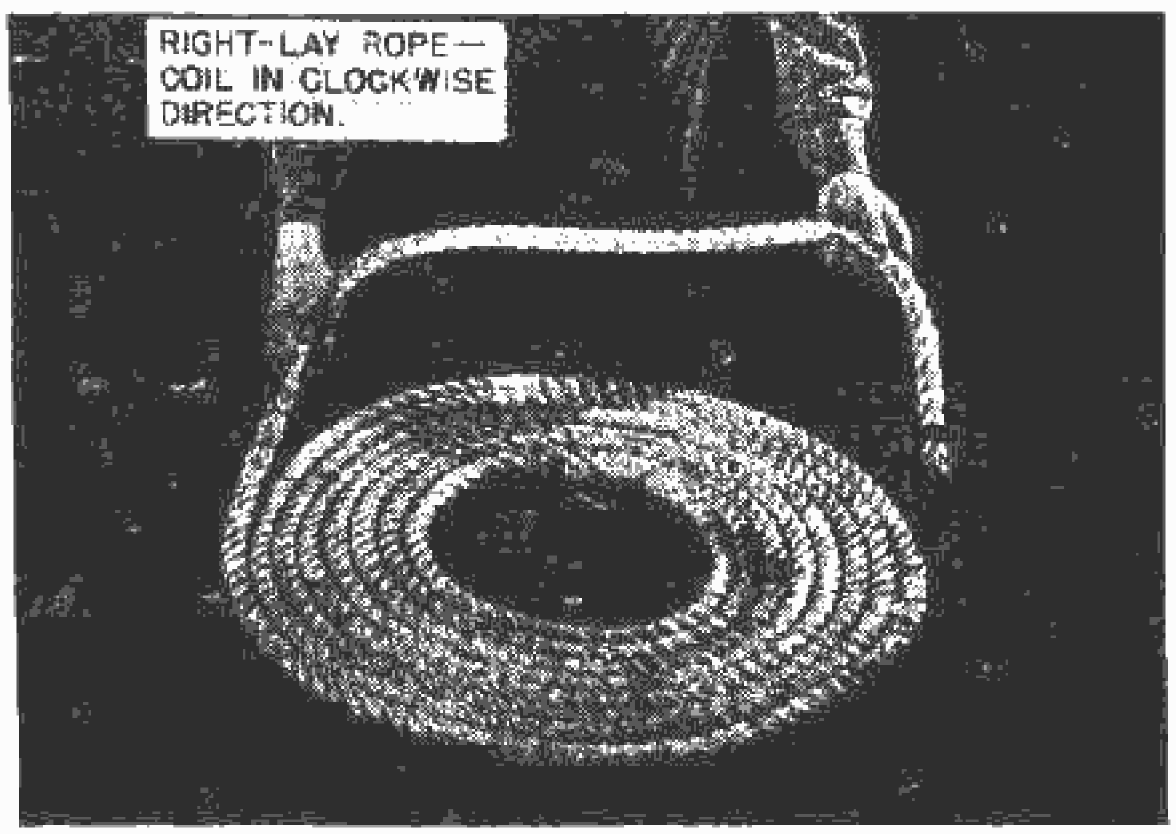


Ⓒ Uncoiling.



Ⓓ Coiling.

Figure 43.—Coiling and uncoiling right-lay rope.

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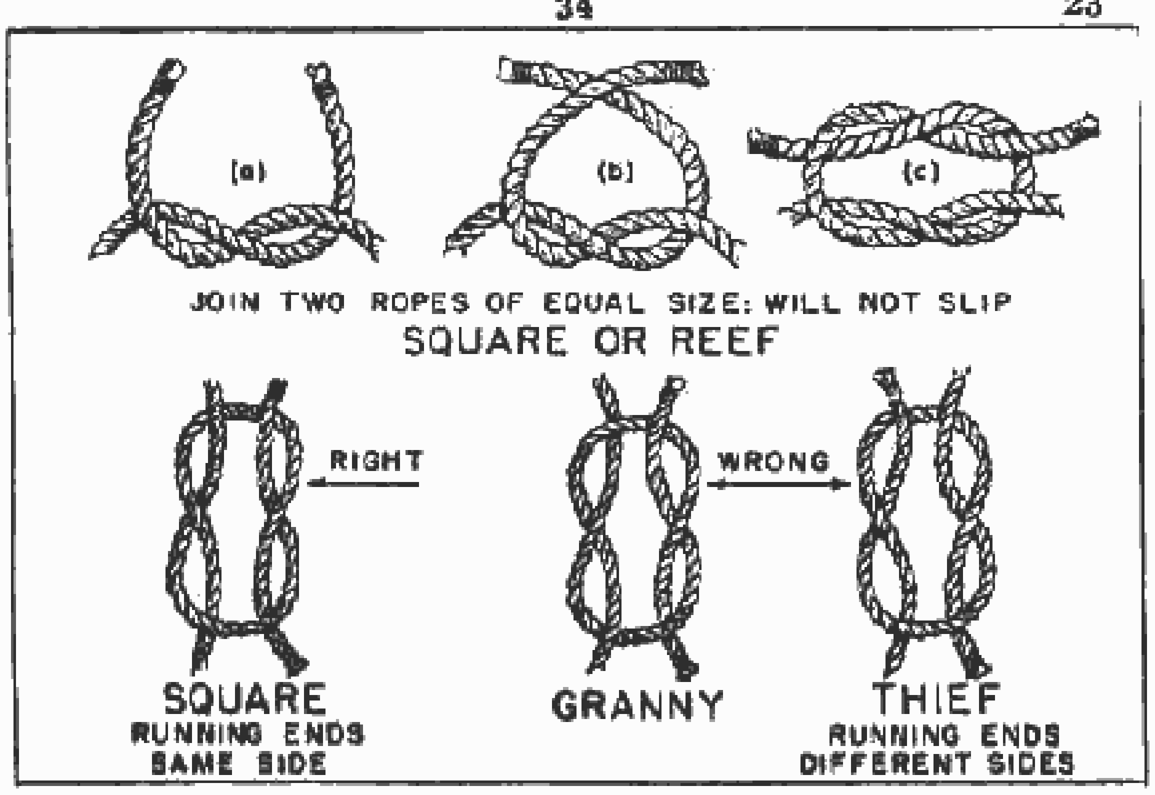

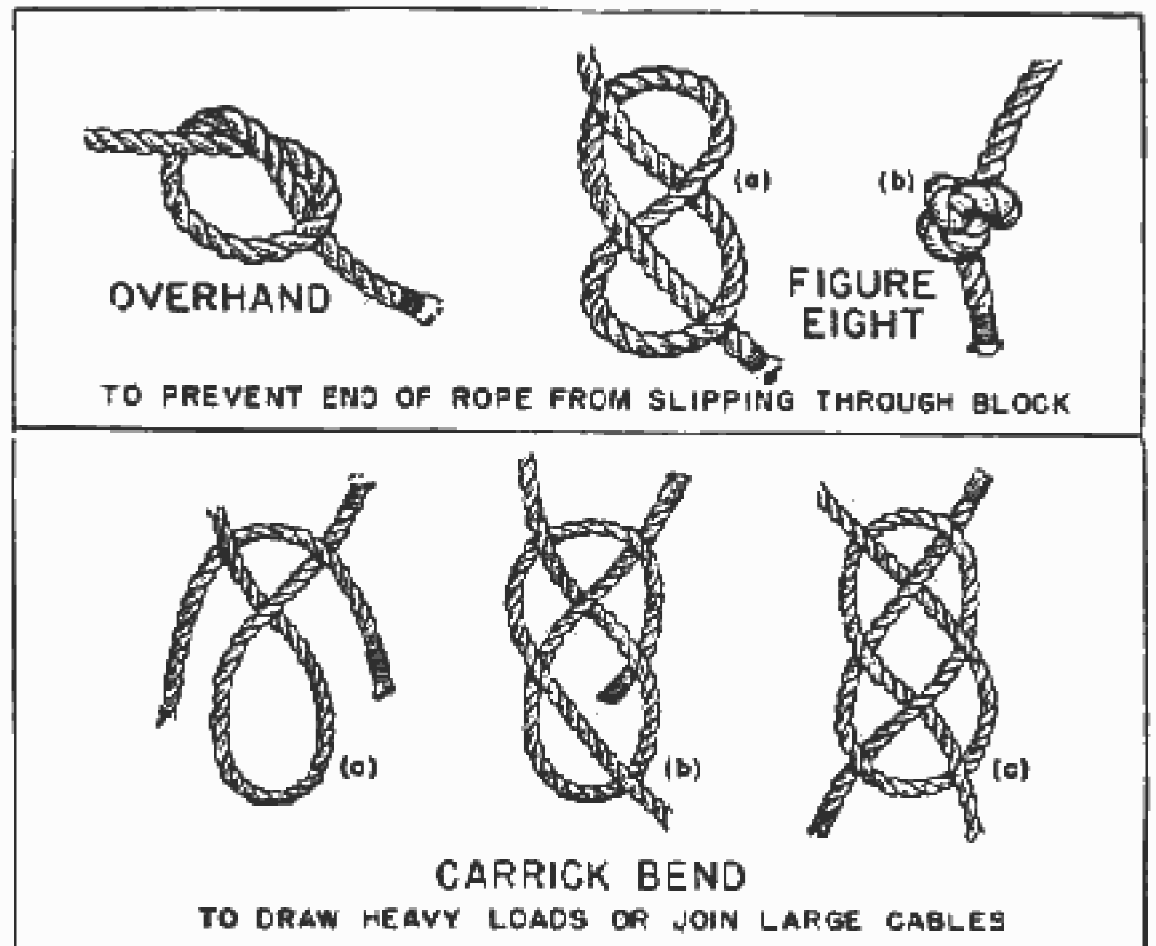

Figure 44.—Knots.

(3) To prevent unraveling as the splice is begun, tie a piece of twine around the dark rope at the beginning of the un-

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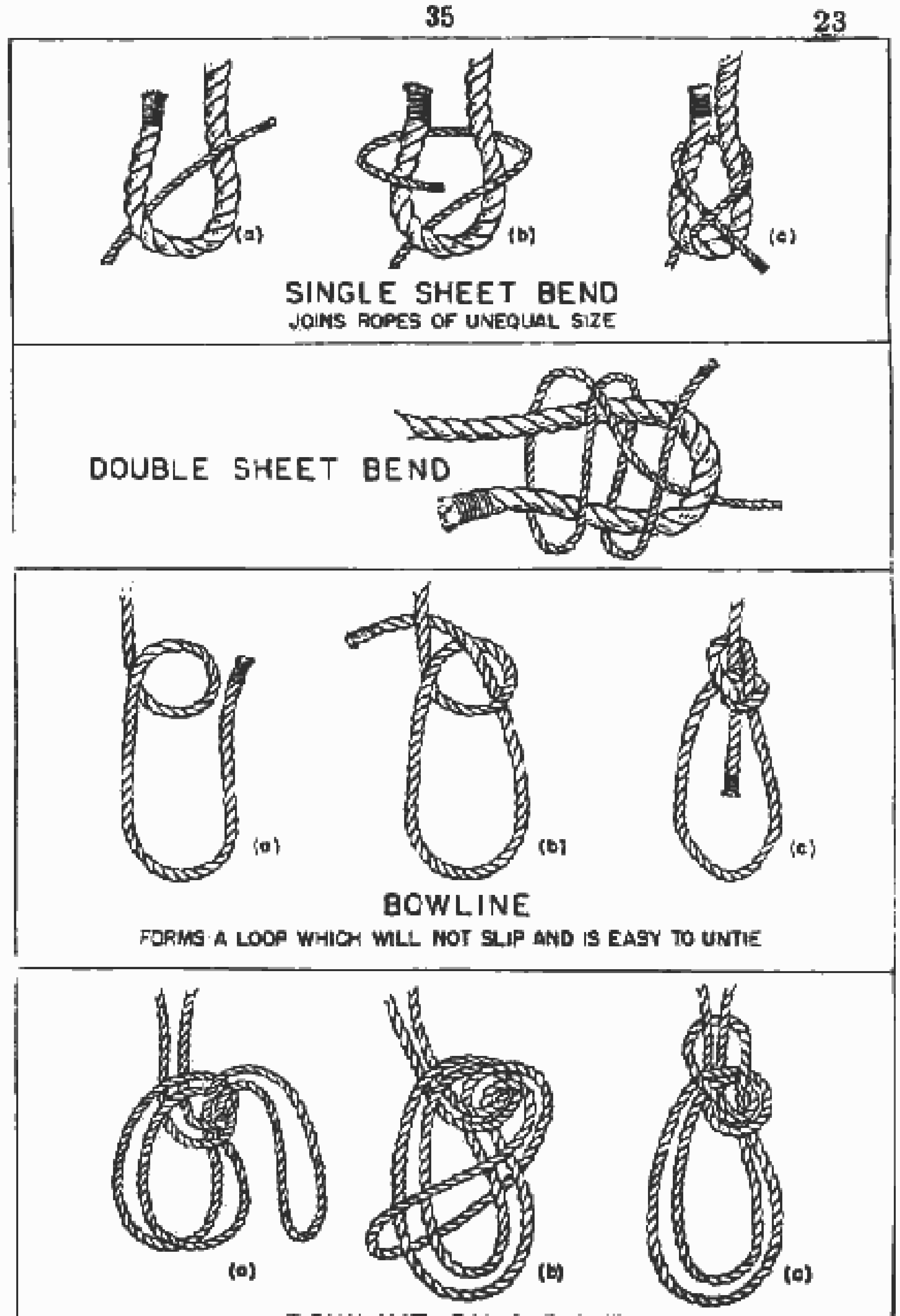

Figure 45.—Knots.

raveling; tuck each of the dark strands by passing over one strand and under the next of the white rope.

(4) Remove the twine and tuck the free strands of the white rope over and under the strands of the dark rope in

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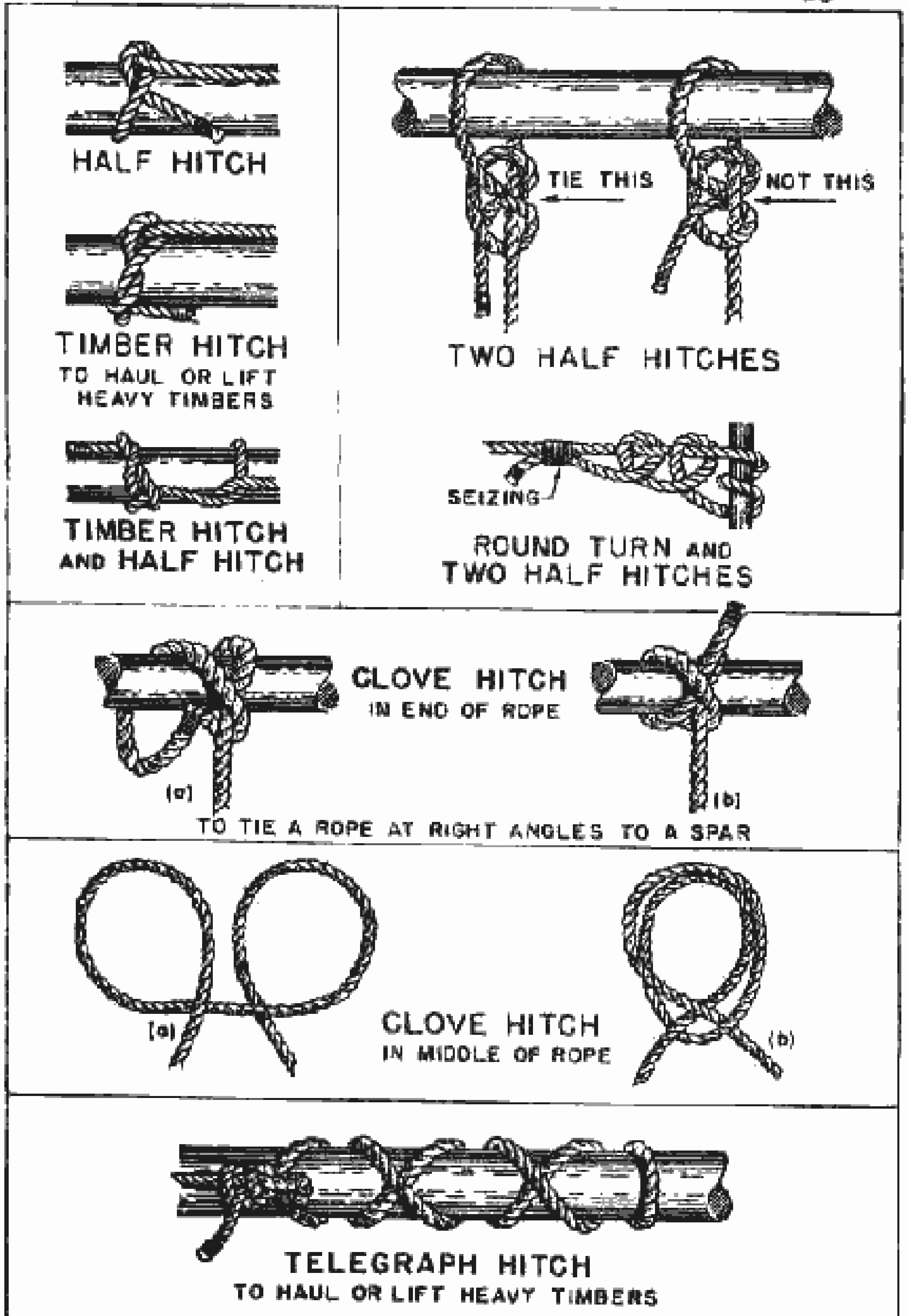

FIGURE 46.—Knots.

the same manner.

(5) Make at least three more tucks with the first rope, repeat for the white rope, and cut off the loose ends. The

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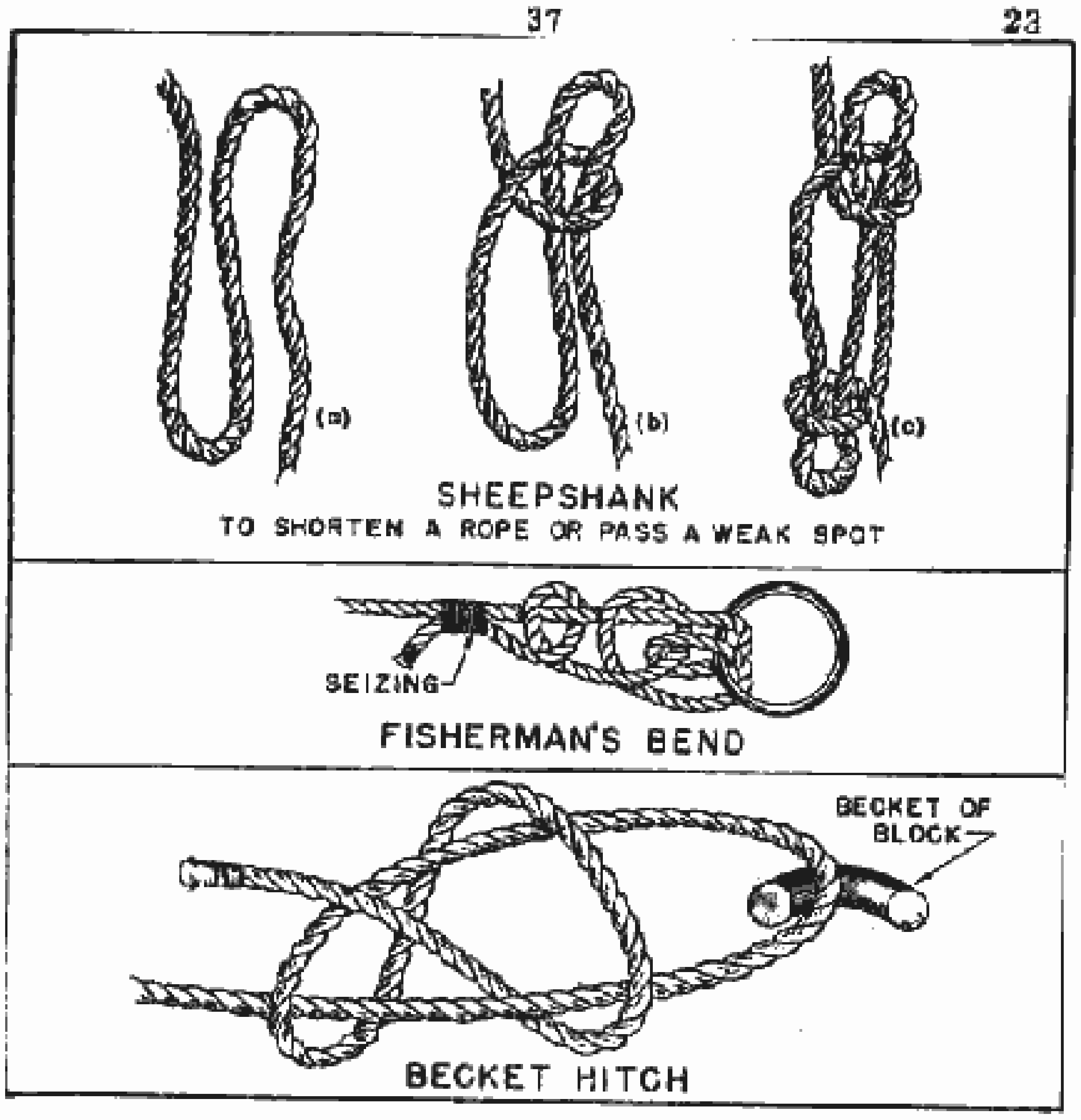

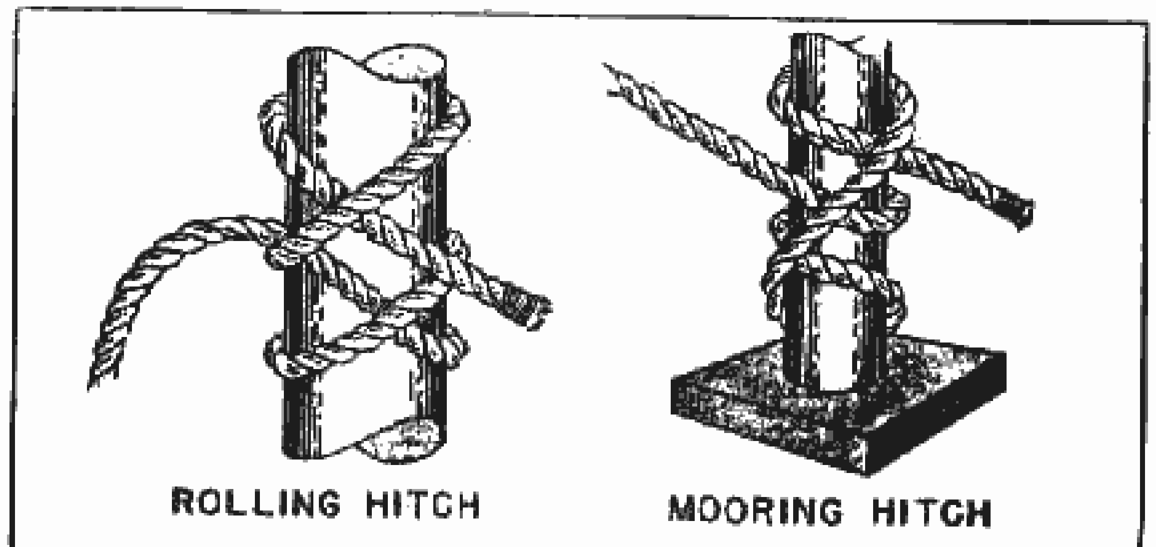

FIGURE 47.—Knots.

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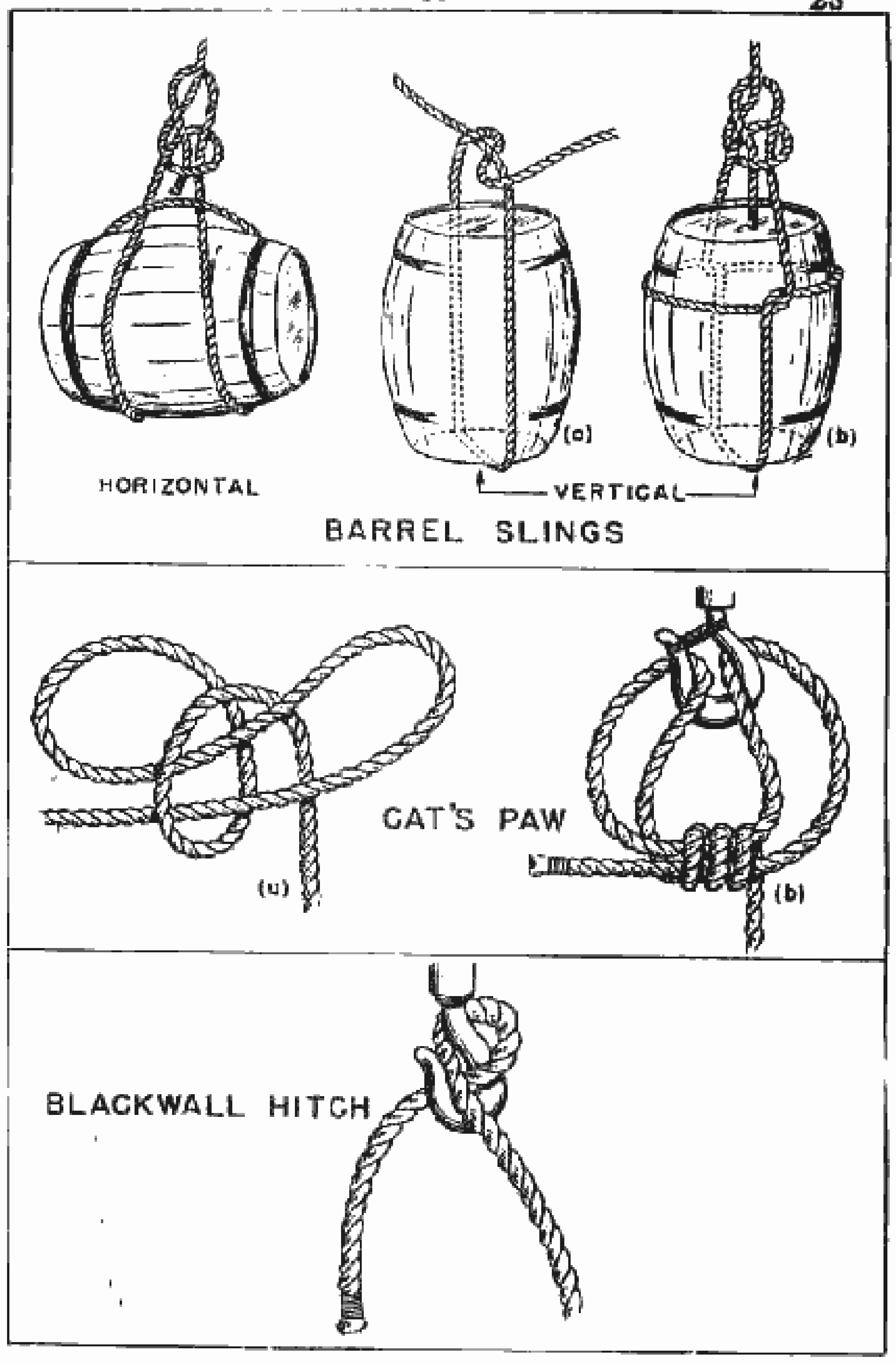

FIGURE 48.—Knots.

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ends of the splice may be tapered by continuing the tucking process for two or three tucks, cutting out a few fibers from each strand after each tuck. Rolling the splice (under the foot or under a board) will make it compact and smooth.

■ 24. LONG SPLICE.—The long splice must be used where it is necessary to keep the increase in diameter to a minimum. It also has a neater appearance. The long splice is used to join ropes of equal size when the rope is to run through a block.

a. Stage 1: Unlaying.—To make a long splice in a three-strand rope (see fig. 50)—

(1) Unlay 15 turns from the ends and tie strings about one

of the ropes at these points.

(2) Bring the two parts together in the same manner as for the short splice.

(3) Beginning at the point where the two parts are placed together, unlay one of the strands to the right, and lay carefully in its place all but the last five turns of the corresponding strand from the left. This latter operation should follow closely the unlaying of the strand to the right. There are still two pairs of strands left at point *A* where the ends were placed together.

(4) Remove the piece of string and run one of these pairs to the left in the same manner as the first pair to the right; cut off the long ends of the strands (including the two remaining at *A*) about five turns from the main rope.

b. Stage 2: Tucking.—The next part of the splicing consists in tucking the ends of the three pairs of strands. All are tucked in the same manner, as follows: being sure that the ends of the strands pass each other as illustrated in (a) (fig. 50) and not as in (b). As shown in (c), bring the strand from the right up over the nearest strand from the

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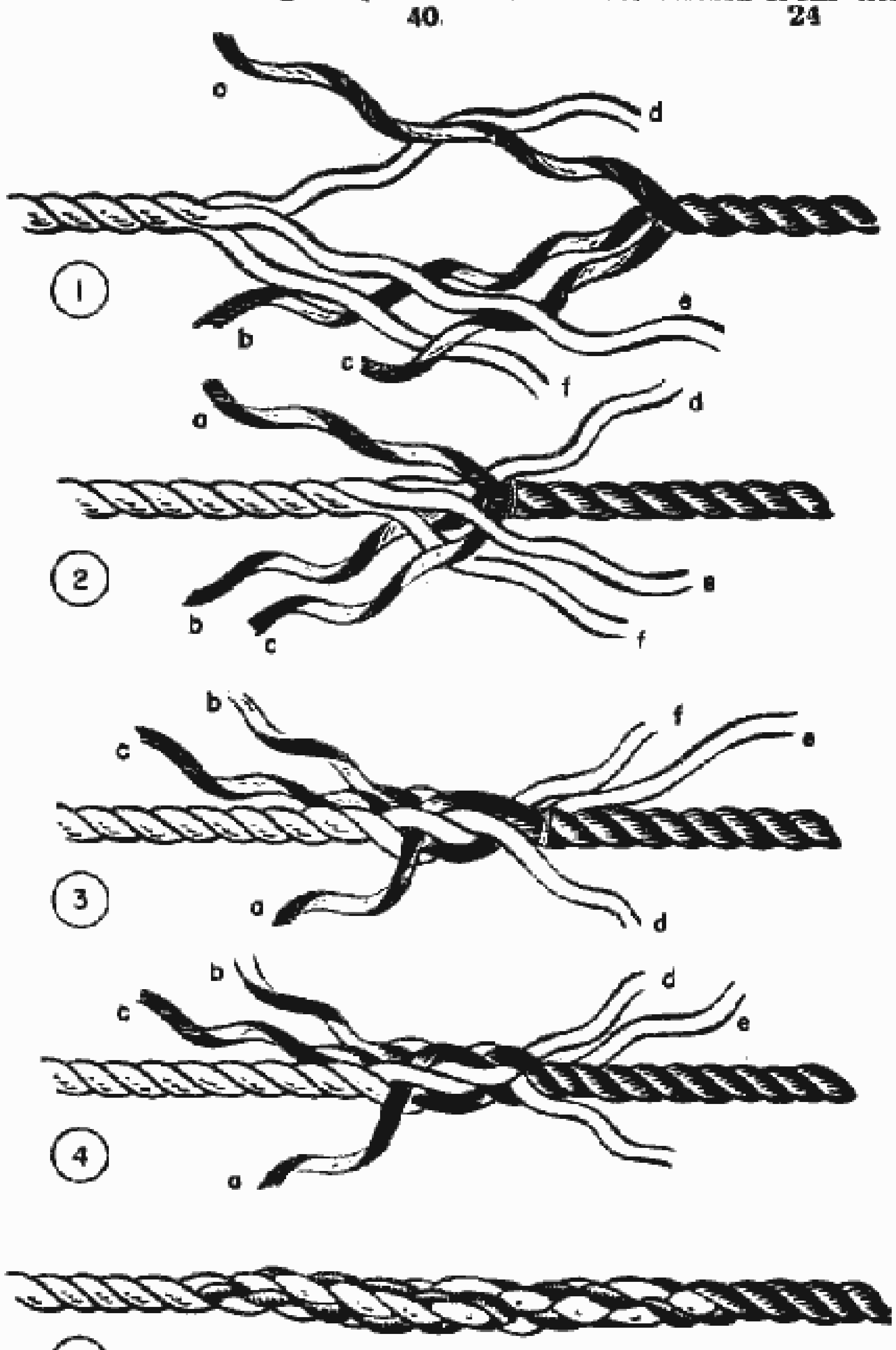

FIGURE 49.—Short splice.

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left and under the next strand (d), and (e) give the strand from the left one tuck (f). (g) Each strand should now be given two more tucks in a direction almost at right angles to the direction of twist. When all three pairs of strands have been tucked, cut off the ends and make smooth by rolling.

■ 25. EYE SPLICE.—The eye splice is used to secure a rope permanently to a ring or becket and for making a permanent loop in the end of a rope. To make an eye splice (see fig. 51).—

a. Unlay about five turns on the end of the rope and pass the middle free strand (b) under a strand of the rope so as to form a loop of the desired size.

b. Pass a second free strand (a) under the next strand of the rope.

c. Pass the third free strand (c) under the third strand of the rope as shown in "inset A"; tuck the free strands into the rope (over one strand and under the next) in the same manner as the short splice.

d. Draw all the strands taut and cut off the loose ends.

■ 26. RENEWING A BROKEN STRAND.—Unlay each broken end for about 10 turns; secure a strand of the same size rope about 20 turns in length and lay all but about 5 turns at each end of it into the broken rope in place of the broken strand; join the new strand at each end with an overhand knot with the end of the broken strand; cut the ends of the broken strand to 5 turns and tuck the ends as in the long splice.

■ 27. CARE AND USE OF WIRE ROPE.—Correct handling of wire rope at all times is essential to maximum service. The following precautions should be observed:

a. Reels of wire rope should not be dropped. Weight of rope may break reel, permitting rope to become kinked.

b. Prying with bars should be done on flanges of reel, not on rope.

c. Wire rope should be stored in a dry place and away from corrosive fumes. Outside layer of reel or coil should

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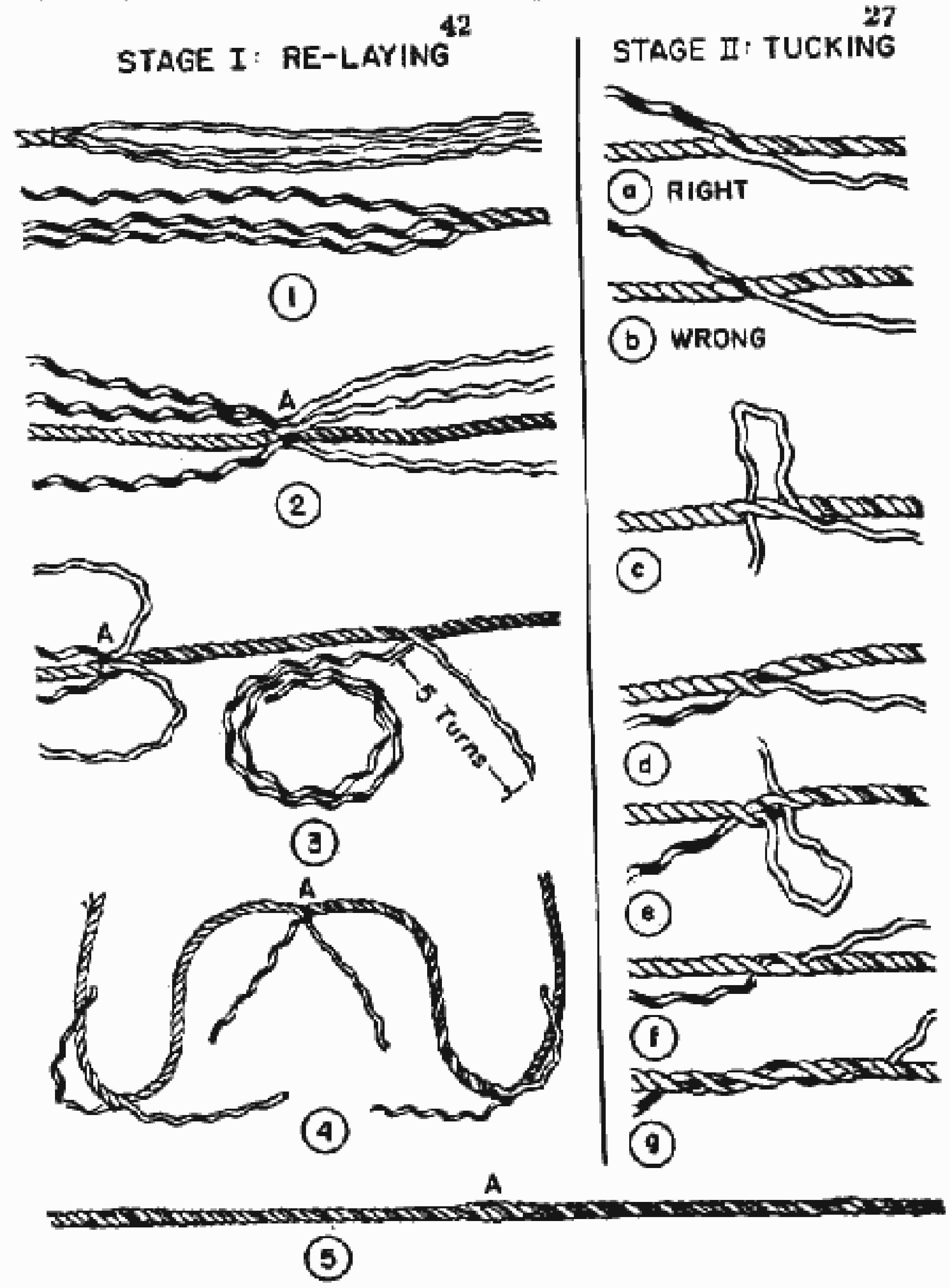

FIGURE 50.—Long splice.

be protected by a coating of lubricant. Wire in use should be well lubricated.

d. Newly installed wire rope should be worked for a while without load to enable rope to adjust itself to working conditions.

e. To avoid sharp kinks, all loops in slack rope should be straightened before load is applied. To remove a kink, wire

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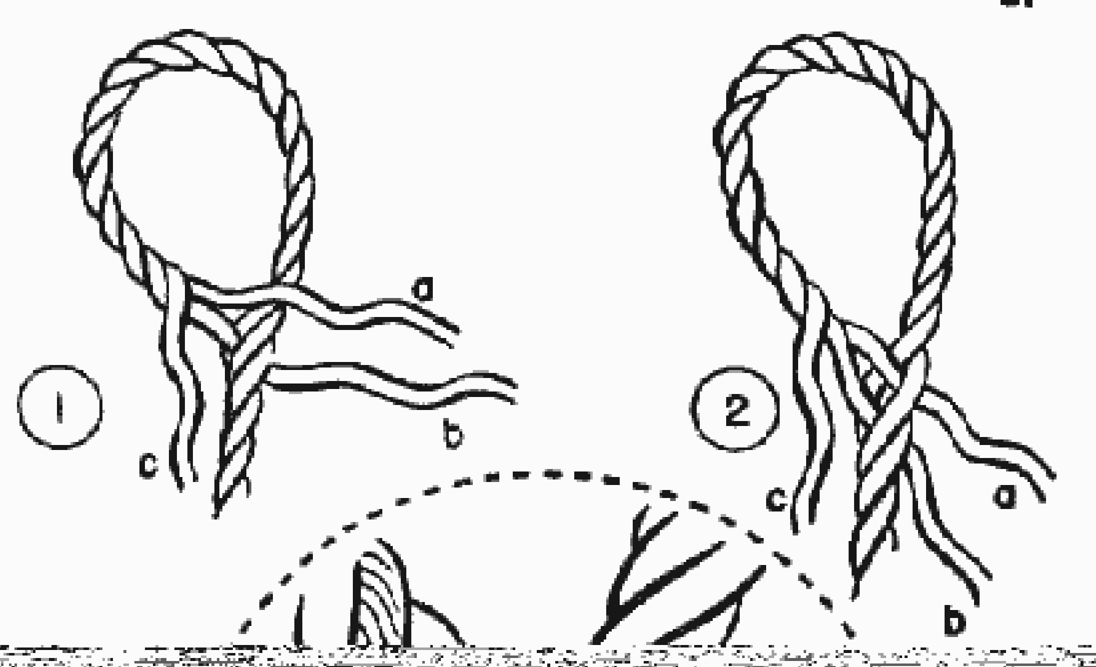

k. When removing wire rope from reel or coil, reel or coil must rotate as the rope unwinds. Attempts to unwind rope from stationary coils will result in kinking.

(1) A correct method for unreeling wire rope is to mount reel on a shaft supported at each end. Rope is then pulled off, permitting reel to rotate. When spooling wire rope from reel to drum, rope should travel from top of reel to top of drum, or from bottom of reel to bottom of drum. This prevents reverse bends which make rope difficult to handle.

(2) To uncoil wire rope, end is held stationary while coil is rolled out on ground. This method prevents kinks.

l. When coiling wire rope loose as it comes from drum, determine lay of rope; if left lay, coil to left (counterclockwise), or if right lay, coil to right (clockwise). When finished, ends of rope should be tied to coil, and top or end should be marked to aid in uncoiling.

m. To wind wire rope on reel or drum, the following rule is convenient to determine proper starting flange; the left

45 27–28

hand is used for left-lay rope, and the right hand for right-lay rope; back of the hand is up for overwinding and down for unwinding. Standing behind and facing drum, the

grits, at prices from 60 cents to $1.50 each. They are useful for dressing up and reshaping hardened parts that cannot be filed, and should be bought as needed. Pike India Oil Stones can be had in many odd sizes and shapes, and should be bought as required, the purchaser selecting them from illustrations in any large tool house catalog. The No. 27 stone, known as a "point" is round in section, 3 inches long, 5/16 inch diameter, and tapering to a very sharp point. It is indispensable for getting into small corners and grooves, when a file will not cut. The No. 58 is larger, being 4 inches long, ½ inch diameter at one end and ¼ inch at the other. A very useful stone in reshaping parts of sears, triggers, etc., when the file will not cut. Last but not least, the stones for easing trigger-pulls. There are two kinds of Arkansas stone, known as "Hard Arkansas" and "Soft Arkansas." Specify the hard and refuse the soft. Slip stones for trigger work should be about two inches long, 3/16 inch thick at one edge and tapering to a knife edge on opposite side. This material is also available in round, square and triangular "sticks" the last two shapes being most useful. Buy them only as the need arises.

I hesitate to bring this chapter to a close. Already it has taken more than its rightful share of space, and has named so many tools, etc., that the reader may have gained the impression that even a small tinkering shop is beyond his financial statement. Time after time I have checked over my own tool equipment, in an effort to miss nothing essential, nor to include nothing that might not be definitely useful or necessary. My own work has covered a wider field, perhaps, than the average amateur will cover in a few years of tinkering his guns; and he should therefore discard at once the idea that it is necessary for him to have everything mentioned or to be mentioned later before he can restock his pet rifle or put on a new sight. Far from it! Start with the fewest possible number of tools—you'll be surprised how rapidly they will accumulate, as your hobby grows and develops.

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Chapter 4

SPECIAL AND HOME-MADE TOOLS AND EQUIPMENT

HAVING rigged up a place to work, and assembled a few of the most essential tools, the amateur gunsmith will next consider certain other equipment, some of which is necessary to certain jobs, while other items may be dispensed with, but will nevertheless add both to the pleasure, speed and convenience of the work. For the gunsmithing trade calls at times for tools not regularly listed or manufactured, and which if ordered specially from a tool maker, would cost a great deal. Fortunately, most of them can be easily made by the amateur.

Before going into details of these special tools, let's consider a few of the non-essential but worth while ones.

The first is a high grade MOTOR GRINDER. When I first started tinkering with guns I had no grinder—and now I wouldn't know how to get along without one. Many long hours of filing have been reduced to a pleasant few minutes work; to say nothing of the advantage of being able to buff and polish parts quickly and more perfectly than by hand.

There are three well known makes of grinders of the type I am going to recommend—the Black & Decker, the U. S. Electric Company, and the Van Dorn. Possibly there are others I have not seen. Of the three named, I believe one to be about as good as another. The first two are somewhat heavier, and might stand up better under long hard usage. They cost about $60 and $50 respectively, while the Van Dorn, a trifle lighter machine, costs about $40. All three are ball bearing, with an automatic built-in starting rheostat, rubber covered connection cable, and socket plug, operating on any ordinary lighting circuit. The grinder is small and compact, and sets conveniently on the bench, or may be had with a cast iron floor pedestal at an additional cost. The shaft is 1/2 inch diameter, and has a

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6 inch Aloxite wheel 1/2 inch thick on each end—one coarse, and one fine. Other wheels of various sizes, shapes and thicknesses not exceeding these dimensions may be added as needed. The wheels have removable guards and tool rests adjustable for height and cutting angle. With the wheels removed, you can use wire or cloth buffers, wood wheels faced with abrasive cloth, sandpaper wheels for dressing down butt pads—new uses will be continually occurring to the owner of one of these splendid machines. By using Aloxite wheels with thin, rounded or beveled edge you can get into places in shaping up parts that would ordinarily call for a milling machine or shaper. Hours of filing can be saved when making barrel bands, sight bases, ramps, and similar jobs. Tools can be sharpened—although these wheels are too hard and fast (3000 to 3600 R.P.M.) for carving chisels and plane bits which are best ground on an old fashioned grindstone.

Soft steel wire buffers are splendid for carding off the rust during the bluing process, and, with light pressure, for burnishing a barrel after it is blued. A separate wire buffer should be kept for carding off rust, and this must be boiled in lye or sal soda to remove all grease, then rinsed in clean boiling water. If the bristles should rust a bit, that is the best evidence that there is no grease or oil on them to spoil the bluing job.

You will want two or three cloth buffing wheels 4 inches in diameter, and two or three 6 inch ones. These are not much good until worn down to an even surface on the edge. Start the motor and hold a sharp chisel against the cloth until all loose edges, threads, etc., are worn off and the surface is smooth and compact.

Keep one cloth wheel clean and dry, for final polishing; keep another for use with Tripoli rouge; another, perhaps, for fine jeweler's rouge. Others may be surfaced with a little fine emery or carborundum in heavy grease for preliminary polishing of parts.

Wood wheels can be made as needed. Scribe a circle the required size with dividers on a piece of clear soft pine; bore a half inch hole through the center for the shaft, and saw and file the wheel to shape on the outline. Set it on the shaft, tighten up the nut to hold it, then start the motor and turn the wheel true by holding a slightly curved very sharp chisel against it, then finish with sandpaper.

Coat the edges of these wheels lightly with glue or very thick shellac, then roll them in fine emery, carborundum, pumice, etc., as needed. On some, glue thick felt weather-stripping to the edge, letting the ends of felt meet evenly. The felt may be used dry for final polishing, or may be coated, either dry or with heavy grease, with various abrasives.

Make, or have made, some hardwood (preferably maple) spindles which will screw onto the end of motor shaft instead of the nut, and projecting from two to four inches beyond the end of shaft. The projecting ends may be shaped as desired, to reach through trigger

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guards and other places for inside polishing. Coat them with glue and wrap on felt to hold the abrasives.

Special wheels of compressed felt are fine for polishing, but very expensive. If you can afford a few of them they will make a hard job easy. They are used both dry, and with abrasive pastes.

Very fine polishing wheels are made by cementing together several thicknesses of heavy leather—sole leather or saddle skirting. Bore the shaft hole and saw them round with a coping or scroll saw, then turn them true on the shaft with a chisel. Edges may be made square, round, V-shaped or beveled as needed. Rub valve grinding compound on some and keep others for use dry in final polishing.

You can get a drill grinding attachment for use with your grinder for about $12.00. Many mechanics scoff at these attachments, considering themselves competent to hold the drill in their fingers and grind it true. Grinding a drill is about the most particular job you will find, and one of the hardest to learn. The attachment will soon pay for itself in drills saved or reclaimed—for be it known that a dull drill, or one ground off center is useless. Off center grinding of the point causes a drill to cut a hole larger than itself—a serious matter when a certain screw is to be tapped into the hole. Accurate grinding of very small drills is almost impossible without the attachment.

Another useful accessory is a chuck, made to either screw on end of motor shaft instead of the nut, or else to be slipped on and held by a set-screw. Drills may be held in the chuck for boring; small pieces of drill rod may be turned to size for pins by holding a file against the rod while motor is running; often a new firing pin can be turned out with only this chuck and a file for a tool. Round parts may be chucked for cutting down slightly, or for polishing. Finally, a pully may be placed on one end of the motor shaft, and belted to a bench drill, small bench lathe, drill press, or to another grinder, in case you want one slower running than the motor itself.

The best substitute for a small motor grinder, is a GRINDING HEAD which can be purchased from the mail order houses for four to ten dollars. This can be belted up to a 1/4 h.p. motor, a fan motor, gas engine, or even the old flivver. The lad on the farm, where electricity is not available, will connect up his grinder to the tractor, milking machine, log saw or washing machine. Leave it to him—he'll get power to it. A grinding head, belted for a speed of 1500 to 2500 R.P.M. is better for some work than the high speed grinder—but the latter is supreme when roughing off a lot of surplus metal in making parts from rough stock.

The amateur gunsmith should manage if possible to have some kind of a motor, even if nothing better than a fan motor is available. Small cloth and steel wire buffers are almost indispensable at times, any investment you make in this direction will quickly pay for itself.

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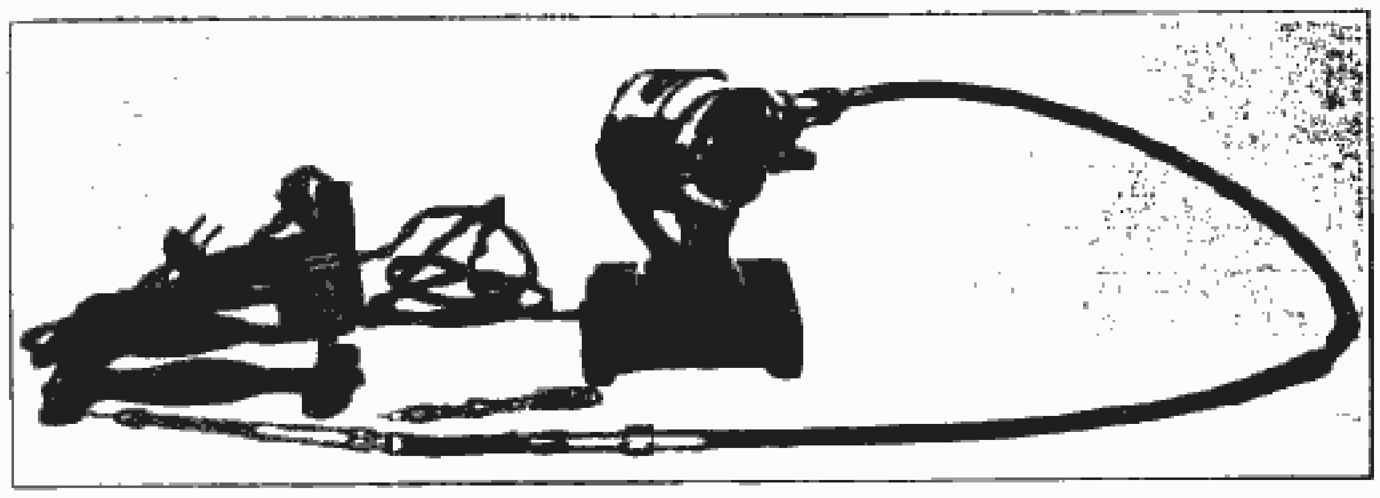
THE DENTAL ENGINE. Now for another suggestion, for which I am deeply indebted to the dental fraternity. This will not be new to some people, but will be to many. When you sit in the dentist's chair inwardly cursing the fiend as he drills into the old molars with such keen delight, probably you paid little attention to the makeup of the principal tools he was using. Yet if you had that "dental engine" of his in your shop, you would find a million and one uses for it on every job, big and little.

Dentistry and gunsmithing are two widely separated professions but the professional gunsmith will do well to investigate this piece of dental apparatus and learn of its daily application to his business.

The old time dentist used a villainous arrangement on a tall stand, with wheels and string belts, operated by a treadle which he worked with his foot. From this ran a flexible or jointed shaft to the drill head with which he did the dirty work. The modern dental engine



THE DENTAL ENGINE

consists of a small and compact motor all nickled and shiny, and with about six feet of rubber covered flexible shaft; the business end of the shaft is attached to a nickeled tool about ten inches long which serves as a handle. In the end of this is a small chuck in which Doc holds his burrs, drills, carborundum wheels, and other implements of torture designed for proselyting Christian Scientists from the true faith. The chuck is arranged so that the burrs and wheels may be mounted at right angles to the handle if desired. Now this chuck is removable, and in its place may be inserted another chuck with a head which converts the rotary motion to a hammer motion—in other words, converts the gadget into a miniature riveting machine. After this brief explanation, consider the following suggestion: Next time you call on your dentist, control your feelings and temper if you can; but if he tortures you beyond human endurance, then slay him with the jaw-bone of an ass or whatever is handy—and don't leave the place empty handed. Steal his dental engine and as many of his tools as you can stuff in your pockets. Also loot the body of any spare change you may find.

(Rather than bothering about a dentist's drill, go to any hobby shop, a well-stocked hardware store, Sears etc. and buy a Dremel Moto-tool or its equivalent. All or most of the burrs, wheels, etc., are stocked).

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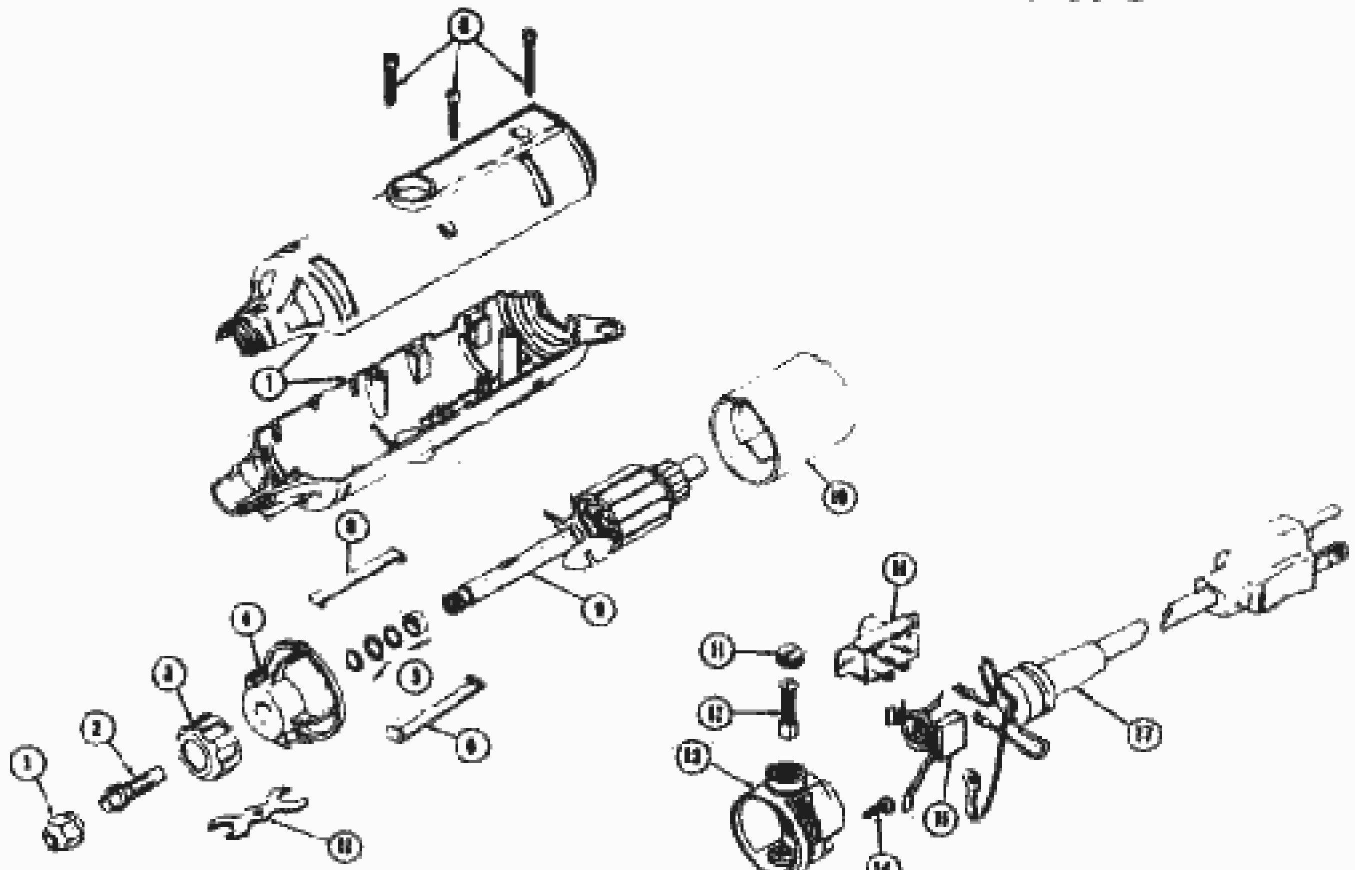

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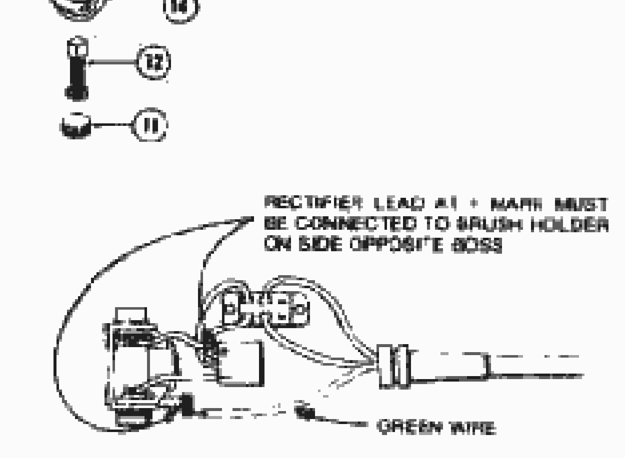
	1	660113	Chuck Cap
	2	.480	1/8 Collet
		481	3/32 Collet
		482	1/16 Collet
		483	1/32 Collet
	3	660217	Housing Cap Screw
	4	660136	Front Brg. Bracket (Comp.)
	5	990516	Thrust Washer Assortment
	6	990606	Bearing Bracket Clips (Pr.)
	7	990132	Housing Comp.
	8	990515	Housing Sc. 1 long 2 short



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If you hesitate to pursue such a course, then your best bet is to make your peace with your local tooth puller and tell him your troubles. If he happens to be a gun-crank,—and a lot of them are, for some reason—he'll understand at once. If he hasn't an old obsolete engine that you can talk him out of for a song, he will be glad to help you select the type you need, and will probably order it for you from his supply house. And his experience with the various tools and attachments will enable him to offer many helpful suggestions—moreover, he will likely make you a present of a double handful of old burrs, too worn for use on teeth, but fine for metal. And you

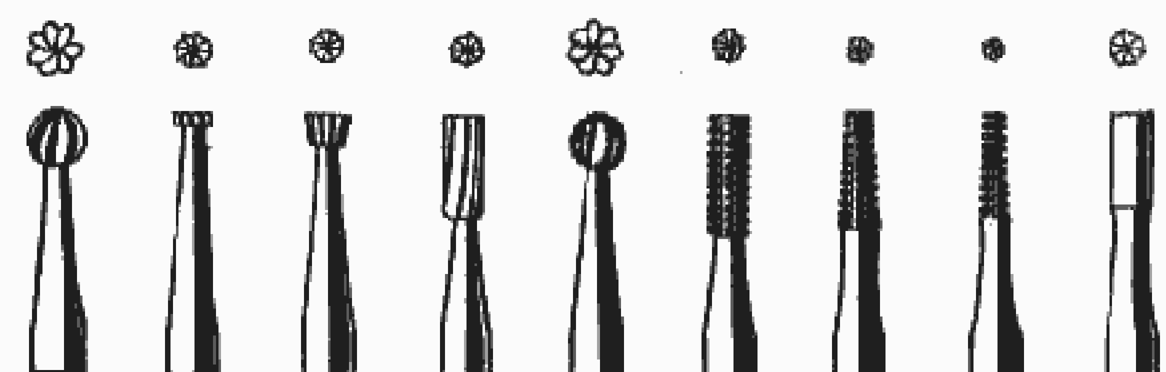

Fig. 4

A B C D E F G H I

can buy others as you need them, for the cost, barring the cost of a new dental engine, is surprisingly low. As this is written I am advised that the S. S. White Dental Mfg. Co. are putting on the market an engine to sell at $25.00—lacking the motor. The shaft is made to attach to any small motor, with suitable connections.

Figure 4 shows a number of dental burrs (they are always called "burrs" and not "drills") useful to the gunsmith. These come in sizes from No. 1/2 to No. 11, ranging from about .023 inch diameter. The No. 6 measures .067. This is a handy size for countersinking rear sight apertures, or for straight drilling where a very small hole is wanted—the pin hole in a front sight blade, for example. A number 3 or 4 round burr makes a splendid center punch. Figure 5.

It will not slip and slide off the mark even on hard surfaces. The hole may be started with a small burr, and enlarged to exactly fit the drill to be used later. Spot annealing is unnecessary, for these burrs are made to cut the hardest material.

Another advantage of using burrs is that they will cut on the side as readily as the point, hence need not be held perpendicularly. Hold them at an angle as you hold a pen in writing— the tool never hides the work and you always see what you are doing.

The Wheel burr, Figure 6, is really a small milling cutter—excellent for getting into difficult corners and uneven spots. Uses numbers 11 1/2 to 22.

The Inverted Cone, Figure 7, is used as a straight drill for small holes—cuts very fast in all sizes. Use numbers 33 1/2 to 44—they

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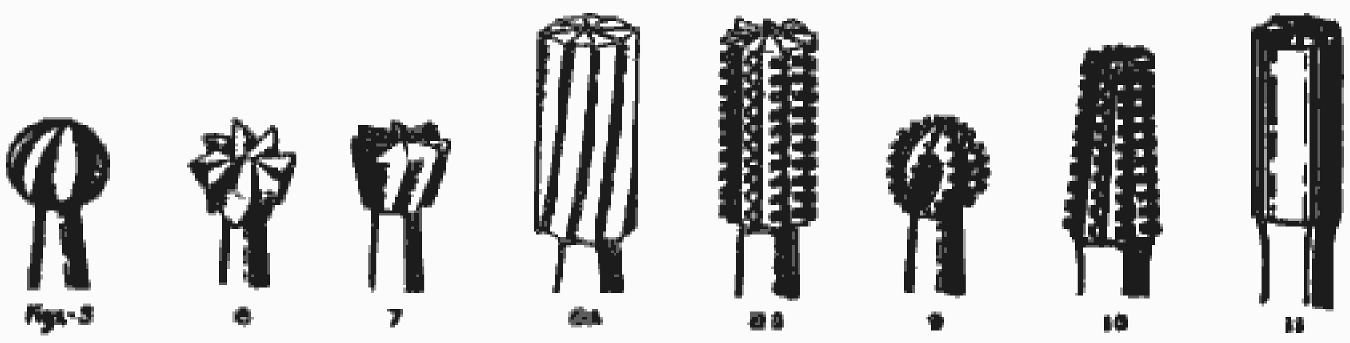
make excellent milling cutters in all sizes, even an old discarded one cutting through case hardening easily.

The Fissure burr, Figure 8, is one of the handiest of the lot. "A" is a plain burr, while "B" is a cross-cut Fissure. The sizes most commonly needed will be Nos. 557 to 562. Use it, for example, instead of a "mouse-tail" file for cutting the half round groove in a Springfield barrel through which the fixed stud pin is inserted. Cutting



on the end as well as on the side, this type of burr is especially valuable in small "tight" jobs.

Figure 9, shows a cross-cut Cherry. This is similar to the round burr in Figure 4, but cuts faster.

Figure 10, shows a tapered fissure burr known as an "inlay fissure"—not particularly useful to the gunsmith, but might be used occasionally.

Figure 11, is an end cutting fissure, used for bottoming out a hole or slot without cutting the sides. Better than an end mill or any other machine tool for cutting square bottom holes in barrels for scope block screws.

Twist drills, reamers and extra large diamond point drills may be had for the handpiece of the dental engine, from dental supply houses: but the discarded drills of the dental practitioner's office will keep the amateur or professional gunsmith supplied for years and save him many hours of time.

Vulcanite burrs (similar to those already described, but made for drilling and cutting vulcanite) are very handy for use on wood; also large size surgical burrs. What a convenience for some small, nearly inaccessible cut when inletting a stock, or fitting a small inlay!

Besides the burrs, there are the mandrels and mounted carborundum stones and wheels—all extremely useful. The various carborundum mounted points and wheels are shown in Figure 12. No need to mention their uses in gunsmithing—you've wished for just such a thing many and many a time! Knock off the case-hardening where you wish to drill a hole—level off projecting ends of screws in a receiver after fitting a Noske scope mount or a Lyman 48 sight, trim and smooth out angles and corners in parts that have been welded—there's no end to what you can do with these points and wheels; new uses will be found on every job.

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The Maxfield Mandrel, Figure 13, is a quick acting holder for paper discs of assorted thickness and sizes which are covered on one side of the stiff paper with sandpaper, garnet, carborundum and cuttlefish in all different size grits. These can be used for polishing out corners, small screw heads, sights and other small parts before bluing; also for removing rust and pits and uneven places, doing a wonderfully quick and thorough job. By cutting the paper disc as shown at "b," Figure 13, it can be forced into a hole for rounding and polishing the edges. The natural spring of the paper and the centrifugal force keeps the paper in tight contact with walls and edges, and rust, pits or dirt is removed in an instant, or a mirror like surface can be put on with fine carborundum or cuttlefish discs.

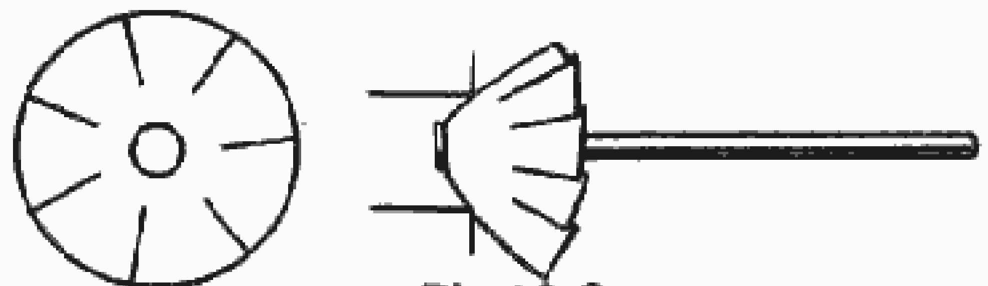

Fig. 13 B

Fig. 13

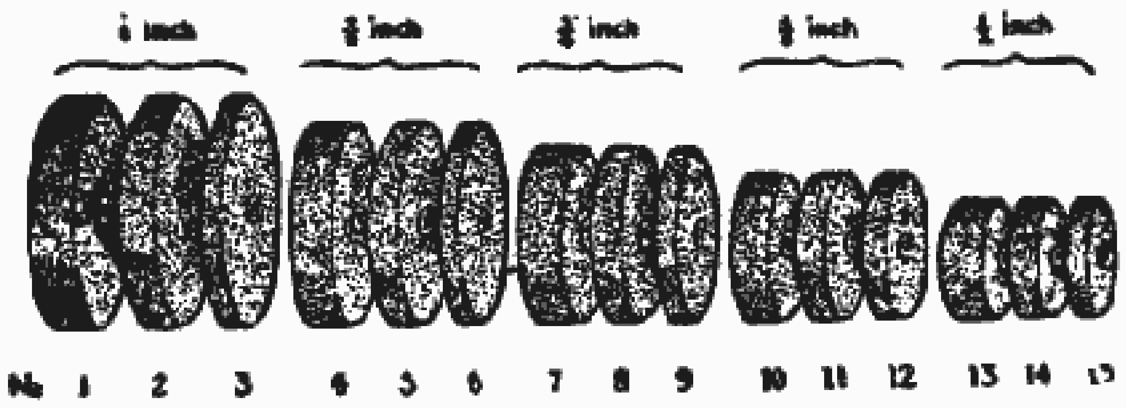

Fig. 14 B

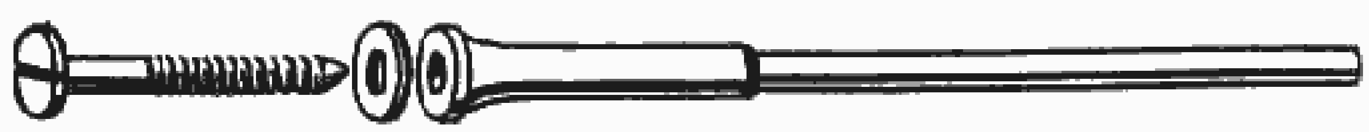

Fig. 14

Figure 14 is a mandrel for circular stones and hard rubber discs. There are solid carborundum and hard Arkansas stones of all sizes, thicknesses and grits. These small wheels are fine for sharpening cutting and boring tools of all kinds, doing more accurate work than can be done by any other means. Sharpening hand reamers, for example is a job only for the expert grinder with a lot of special

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equipment; but the amateur gunsmith can use these wheels to sharpen his reamers several times before a trip to the grinding shop is necessary. Being under full hand control at all times they can be used right up to the cutting edge.

This mandrel also holds both circular and cup shaped stiff brushes which used with a little pumice or other fine abrasive will quickly polish any odd shaped piece, getting into corners and grooves not reached otherwise.

These are but a few of the many uses to which the gunsmith can

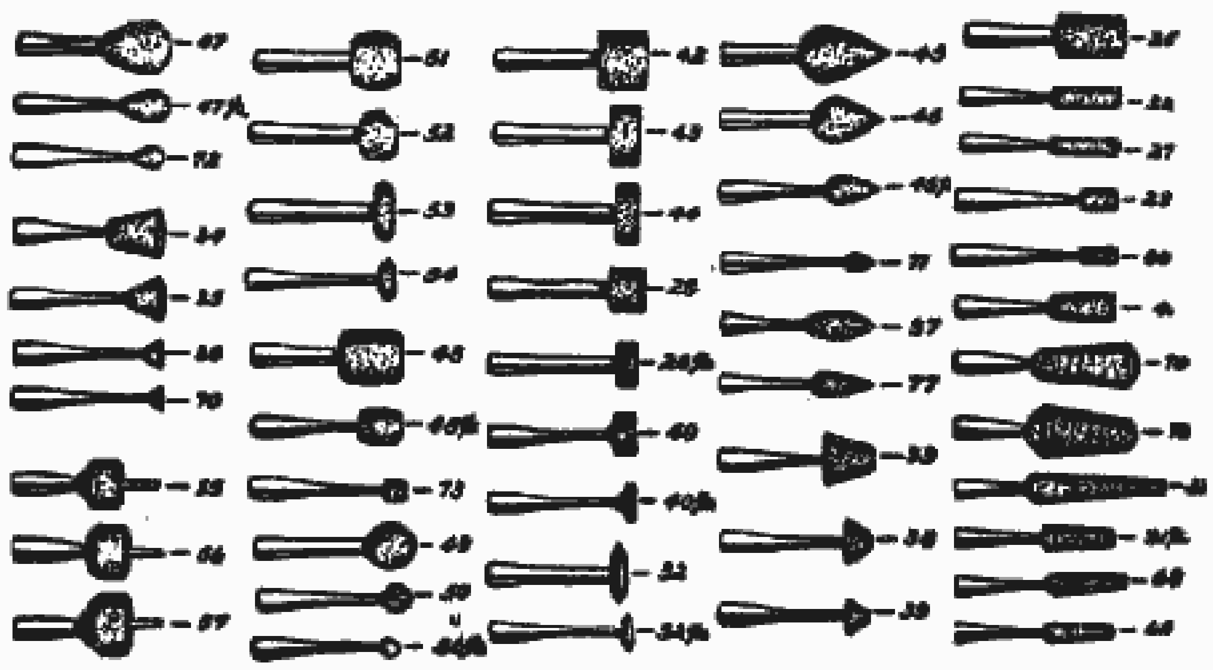

Fig. 12

put dental instruments. How often have you wondered about the shape and finish of the locking lug shoulders in a rifle receiver?—a magnifying mouth mirror costing about a dollar would have showed it to you instantly, as well as many other undercuts and "out of sight" places! A pair of cotton pliers (what the proletariat call "tweezers") is invaluable for picking up small screws, pins, and springs. A head mirror with a hole in the center will enable you to look into portions of a gun's internal economy you never expected to see—you can look down the barrel from the muzzle with the breech closed if you wish. Get the light in front of you, reflecting it down the barrel with the mirror as you peek through the hole. Drill a hole in any small mirror and try this.

A small carborundum stone or a cherry burr will forever eliminate spot annealing—you're ready for the drill in about thirty seconds. Figure 15 illustrates cutting a screwdriver slot in a broken off screw—takes only a minute to do and the screw is then turned out "easy as pie." Figure 16 shows a .22 calibre barrel being crowned with bud-shaped carborundum and Arkansas mounted points.

The hammer motion of the special head before mentioned is useful in a variety of ways—for light riveting of pins, peening screws used

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to fill up holes in barrels, etc., and a thousand and one others. One of its most important uses is that of producing a beautifully matted surface on sight ramp, top of barrel, or even on receiver. This is described in a later chapter.

It would be possible to go on almost indefinitely naming the uses of dental instruments in gunsmithing—but one must stop sometime. For a good while I used the dental engine principally for matting,

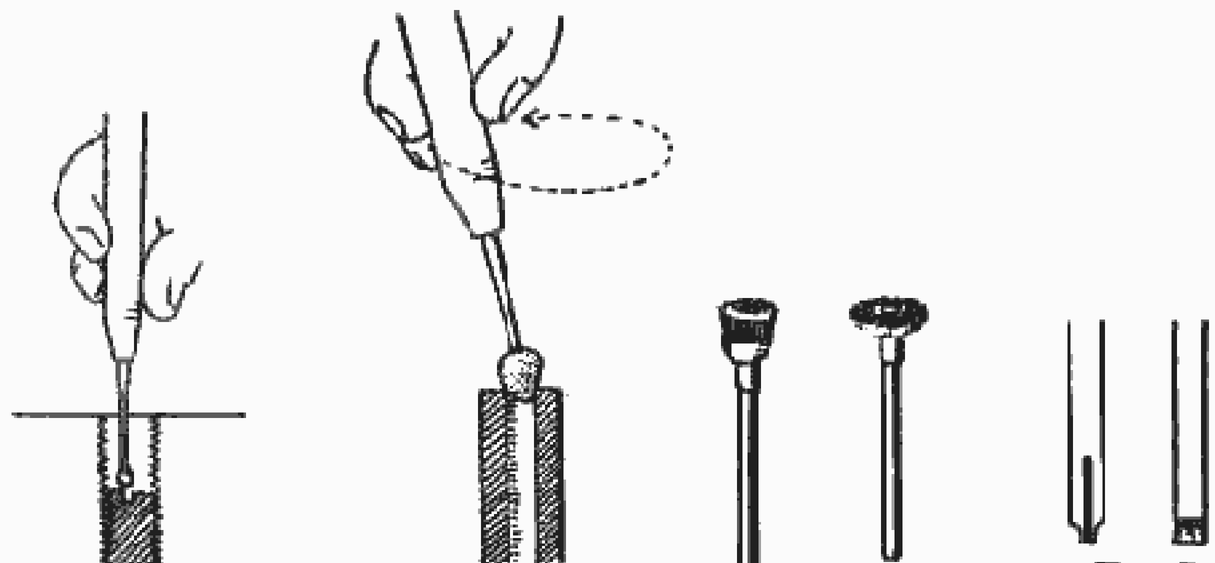

Fig 15 Fig. 16 Fig. 17

and for drilling small holes, and I am indebted to Dr. E. W. Harper, of Watertown, S. D., for introducing me to its greater possibilities. Dentistry is one of the highest branches of scientific mechanics, and the man at the bench may, by using his head, learn much from the man in the laboratory.

SPECIAL HOME MADE TOOLS: The gunsmith, requiring a tool not regularly made and sold, usually makes what he needs for the job at hand. There are, moreover, numerous tools used almost constantly that he will have to make or do without. Among these may be mentioned split screwdrivers. Make these as shown in Figure 17. Eight inches is a convenient length, and handles are not necessary, neither need they be hardened and tempered, as they are used only for holding the screw while starting it into a hole that cannot be reached by the fingers. Make them up in several sizes to fit most screws used in guns, selecting drill rod of the nearest size for each one. Make the split about 1 1/4 inches long with a hacksaw blade having the "set" ground off the sides of teeth. Shape point as shown with the rattail file. Half a dozen split screwdrivers in a box that is easily accessible are a real convenience.

CHECKING TOOLS: The amateur gunsmith will require at least two tools, while the professional will want half a dozen or more in various sizes and cuts. So many different patterns have been described in outdoor magazines in recent years that one is puzzled as to which type to select and learn to use. For be it known that none of them will do even passing good work for the rank, raw be-

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ginner. Checking is an art, just like sculpture, or rolling Bull Durham, or running over pedestrians. It has to be learned. Given the finest checking tools ever made the amateur will find them as awkward as his first pair of skates, and will swear to high heaven the tools are worthless.

And right here I want to digress for a moment. This thing of blaming one's lack of skill on the tools is why a lot of folks never learn to shoot. There never was a gun turned out by any reliable factory that wouldn't hit somewhere in the neighborhood of where it was held. There is a type of individual who is of a nervous temperament, and who cannot be suited. I have a friend who is a pistol and revolver fan. Neither Colt nor Smith & Wesson ever made a gun that was exactly right, for him. One time the gun will be shooting low; another time high; again ignition is poor. Always there is a perfect alibi in the gun, to account for the poor shooting. Another may take the same gun and make good scores with it—makes no difference—the damn gun is no good.

Trapshooters are also prone to blame it on the gun. Either the stock is too straight or too crooked, or it has too much pitch or not enough. They wear out their guns with continual alterations—"raising the pattern" and similar superstitions; they bankrupt themselves buying new guns, and immediately selling them at a heavy loss; yet they never learn to shoot. The man who is so constituted that he will break right down and admit that maybe the man who built the gun knew just a little something about gunmaking, is very likely to take most any gun out and bust his share of bluerocks, or bag his share of furred or feathered game. Practice is essential to good shooting. The man who practices constantly with a poor gun, or an ill-fitting gun will be a far better shot than the one who tries out and discards a dozen or so a year, though the latter may burn more powder. The fact is a man has to handle and shoot a gun a good while before he can really say whether it fits or not—and about ninety-nine per cent. of the birds who bellyache about their guns don't use them long enough to get acquainted with their good or bad points.

So it is with checking tools, or any other tools requiring reasonable skill to use. The amount of time you spend learning to use them makes a lot more difference than the type of tools you have. Chapter 12 of this book is intended as a complete course in the essentials of checking; and if you will follow the instructions given therein you may later design any kind of tool you please, and you'll be able to use it. What you know about checking is what counts most.

The tools I shall describe were introduced to my attention by John Dubeil who used to make stocks in the Hoffman plant—and a better stockmaker, or a more painstaking workman than John, I never expect to find. These tools have given the best results of any in my hands. Maybe they won't in yours. But as I have tried about every kind I have ever heard of, my best advice is that you make up this

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type of tool and LEARN TO USE IT—then, if you find better tools, there's nothing on earth to stop you from changing. Your skill won't leave you on that account.

Figure 18, shows three tools and a bent escapement file. "A" is the line spacer; "B" is the V-tool or deepening tool with which the diamonds are pointed up; "C" is a border cutter—seldom necessary but sometimes used; and "D" is the file for finishing up the diamonds.

All these tools but the file may be made of 5/32 inch drill rod. The V-tool may be made of 3/16 inch rod if preferred.

Cut a piece of rod about 8 inches long, heat the end cherry red and forge it flat, then bend to the angle shown. Shape it up carefully

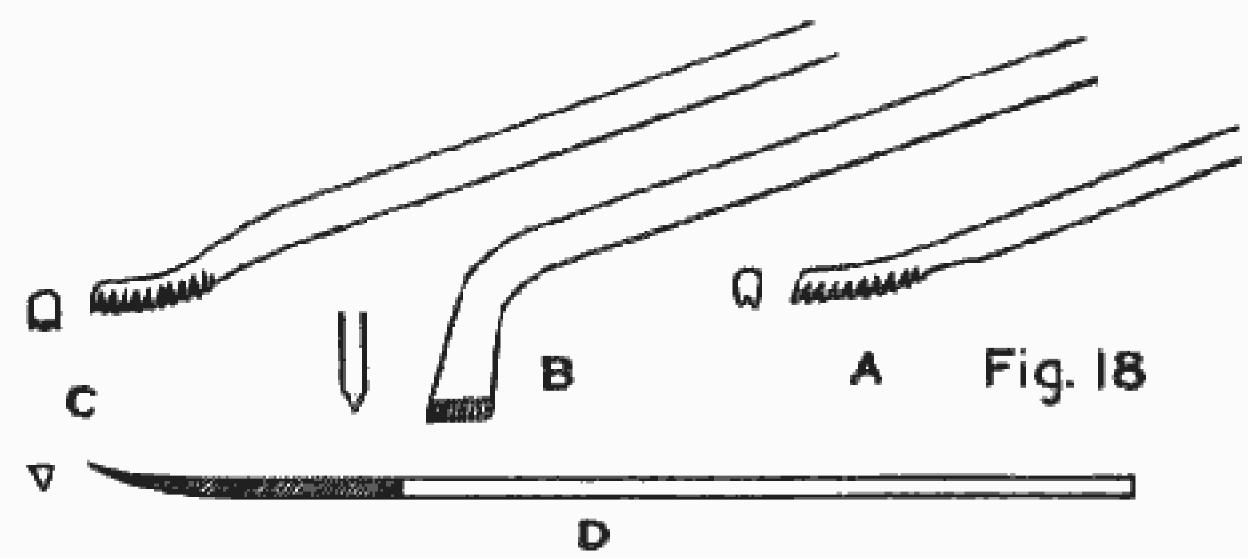

Fig. 18

with a file; cut the groove in underside very deep, using a die-sinker's knife edge needle file. Use a 3-square escapement file to cut the teeth, and note that these are cut on the sides of the tool, and not across the bottom. Each of the two edges of the line spacer is sharp, so that the file, being turned in slightly during the cutting, the teeth take form both on sides and bottom edge. The teeth may be almost vertical, or they may lean forward or back slightly. I have all three kinds, as some work better on some woods and some on others. Generally I find that the tooth which slopes back toward lower edge follows a line easier, and cuts with less tendency to catch and jump. After cutting the teeth on both sides, heat the cutter end bright cherry red and dip it in water; then dip in linseed oil and flash off the oil once to draw the temper. This leaves it plenty hard for good work, yet soft enough so that the teeth may be touched up a bit with a file when dull.

Before cutting the teeth rub the two edges of cutter on a block of wood and measure the distance between lines carefully with sharp dividers. Then after the teeth are filed, cut a few lines and see how many they run to the inch. If the cutter is too wide, dress off both sides slightly until the cut is narrowed sufficiently and re-sharpen the teeth before tempering. The size cuts best adapted for various grades of wood is discussed in Chapter 12.

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The size of the teeth of a cutter may vary from 16 to 24 per inch. Hard wood without large open pores is easier to check, and a 20 or 22 point cutting edge is very satisfactory. 16 to 18 points seems to work best on more open grain wood. There is no convenient way to accurately space the teeth—file a few on scrap stock for practice and measure them, then space them by eye, preferably under a jeweler's magnifying glass.

I've heard a lot about three and four row spacers, and while the idea sounds splendid, I have yet to see any such that would work, for me. Of course in such a spacer the teeth must be cut crossways, while the side teeth can be cut only on the two row tool. And the side teeth are the ones I will continue to use until someone shows me the error of my ways.

The V-tool is forged out to the shape shown, and filed to about 1/8 inch thick or less, then the edge beveled back about 1/4 inch, forming a sharp V. This edge should have an angle of about 26 degrees, or a trifle less than the angles on a 3 square file. Cut the teeth on the sides just as you did on the liner, but make them very fine—as fine as you can cut—and space them if possible so they will be even on both sides; otherwise the edge may be ragged. After this tool is hardened and tempered, the teeth should be touched up lightly on the sides with an Arkansas slip stone, to even them. This tool seems to work better and be more easily controlled after it is broken in and dulled a trifle.

The border cutter cuts a sort of reverse bead—a thin V line, a wider U line, and another thin V line. Personally I do not admire these borders on checking and seldom use this tool.

The border tool must be toothed across the bottom, since there is no other way of forming teeth on the middle section; but these teeth should run diagonally, rather than straight across, at about the angle of the teeth on a mill file—and their shape should follow the teeth of a cross-cut saw, rather than those of a ripsaw. Teeth should also be cut on the sides, similar to the line spacer, these teeth corresponding to those cut across the bottom.

Any of the three tools above described may be made in any size desired. Square up the end of shank by filing or grinding to a point and drive on a common file handle of a size that fits your hand well. The length of tool, from ferrule to point, should be from five to six inches.

The bent file is made from an escapement file, or a 6-inch die-sinker's 3-square needle file. The escapement file is best. To bend the file without blunting the teeth you will need a small quantity of the file-hardening compound described in Chapter 21. Coat the points of the files with this mixture and let it dry slowly for a day. Then heat the point dull cherry red and quickly press it against a piece of brass. It cools very quickly and two heats will probably be needed. Let cool, and again coat with the hardening compound

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and let it dry. Then harden by heating the point bright red and dipping into cold water. The compound may then be brushed out with a file card. This leaves the file very hard and brittle, so use it carefully to prevent breaking. The compound is used merely to prevent the heat from forming "scale" on the edges of the teeth.

Figure 18-E shows an ingenious checking tool designed and made by Mr. John Crowe of St. Joseph, Missouri, while Figure 18-F shows a modification of the same tool which I made after seeing Mr. Crowe's. This tool, by reason of the single edge cutter may be shaped up very accurately. The guide is pivoted at the rear. with a small coil spring which forces the edge of guide below cutting edge normally, but permits the cutter to be pressed down onto the wood against the tension of the spring. The guide thus rides in the last cut, keeping the cutter in line and parallel with it. This one tool is used both for the preliminary spacing and for the finishing of the diamonds, and does a good job. I found Mr. Crowe's device a little awkward at first, as I am accustomed to using longer tools. This of course is only a matter of habit, and what we are used to. The longer cutter with narrower blade gave me better results; and while only time and use can show the possibilities of a checking tool, I would not be surprised if this should make a convert of me in the course of time.

SPECIAL KNIVES, SCRAPERS, ETC. Make these as needed from hacksaw blades, harden and temper in oil. Knives having

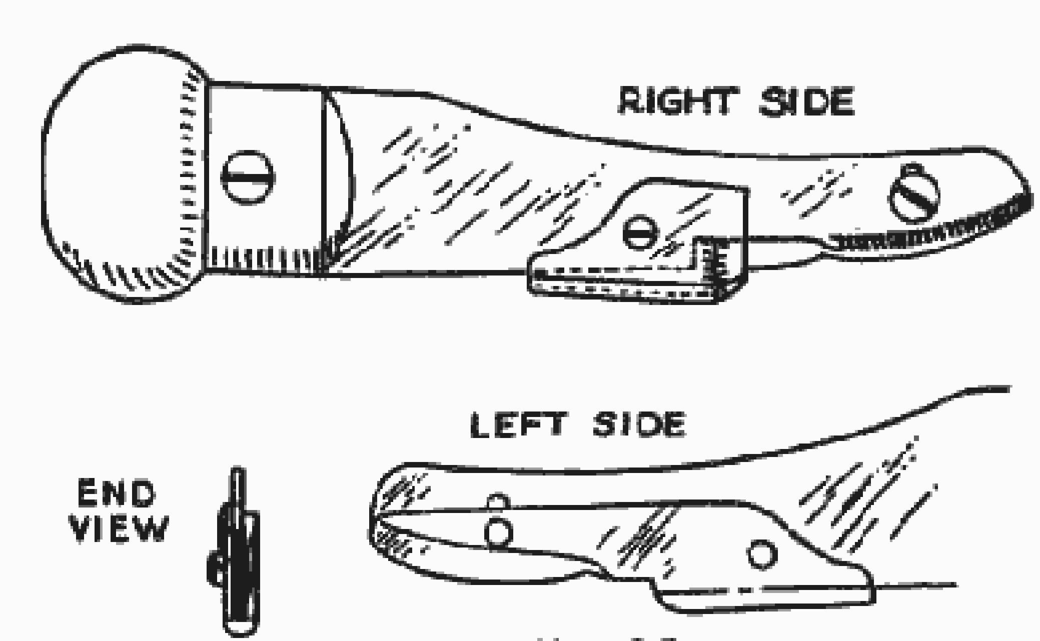

Fig. 18 E

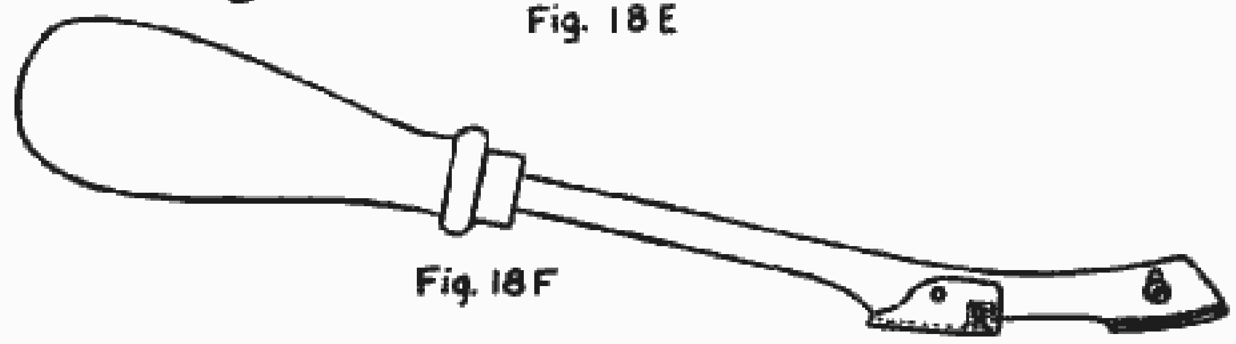

Fig. 18 F

bent blades of various sizes and shapes are very handy in trimming up difficult places in stock mortices.

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BOTTOMING TOOLS. Ordinary chisels and carving chisels often will not reach into a deep cut to clean out the bottom surface smooth and even. A bottoming tool should be made from drill rod, forged and filed to shape to meet the requirements of the job. Typical bottoming tools are shown in Figure 19. They may be any shape indicated by the cutting you want to do, and may be made of drill rod.

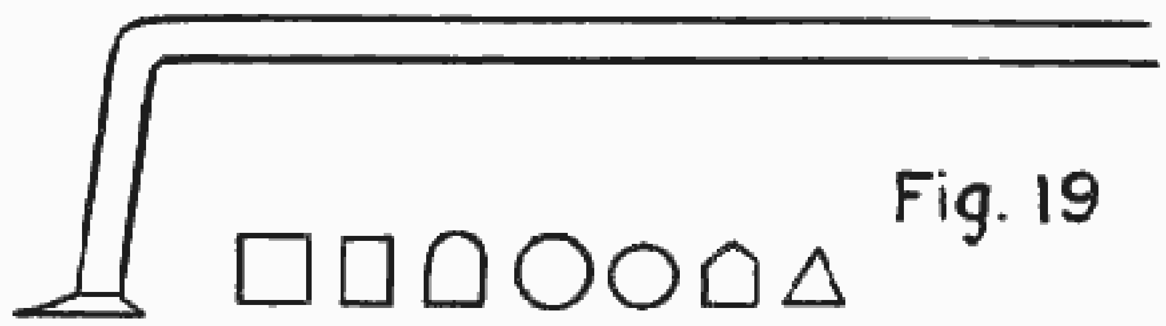

Fig. 19

Heat the end cherry red and quickly clamp it in the vise, then upset the end to desired size by hammering. Two heats may be necessary. Then heat and shape the shank as desired, file to shape, harden, and temper at light straw. The edges should then be sharpened on an oilstone. Square the shanks and fit file handles. Make up a bottoming tool whenever you feel ambitious—there's no such thing as having too many of them.

Special shaped chisels are sometimes made by filing a piece of drill rod to the desired contour. Very good small gouges are made in

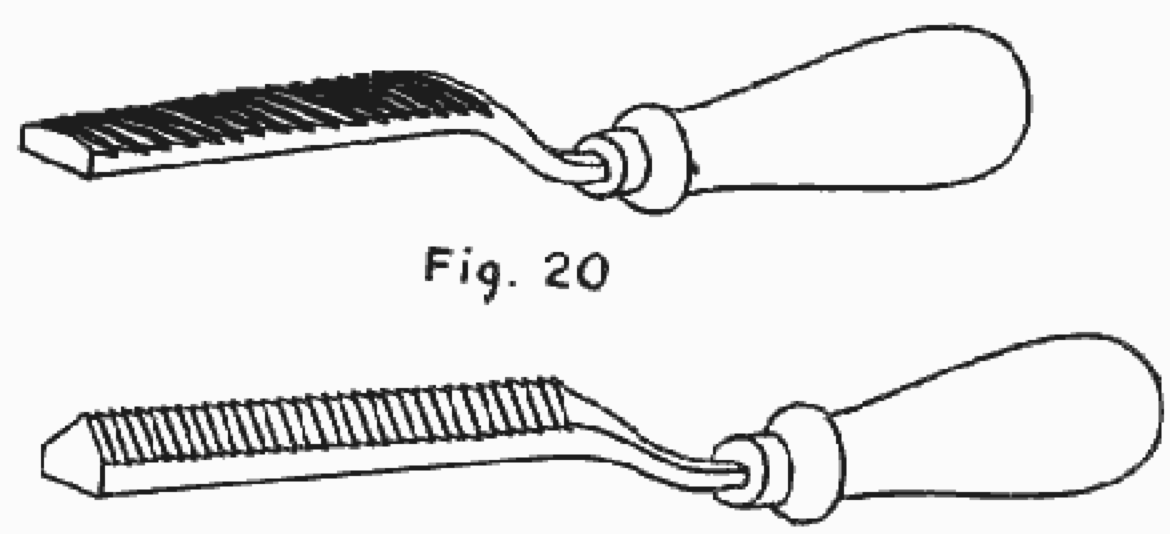

Fig. 20

this manner. Their quality is improved if forged a little before shaping up. Temper in oil at light straw, and hone edges carefully.

SPECIAL RASPS AND RIFFLERS, for wood and metal often save time and labor. These should be made from high grade tool steel, the teeth carefully filed in after a little forging to make the grain more compact, and then hardened in oil at bright red heat. Draw the temper in a clear gas flame, but draw it just as little as possible—just enough to take the stress out of the metal and avoid breaking the teeth off. Chill in water the instant a *very pale* straw color appears. Figure 20 shows a couple of quickly made rifflers

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that are very handy for roughing off metal, and others may be made any shape to suit the job. Ten or twelve teeth per inch will be about right.

Before trying to hold a barrel or a finished stock in the vise, make a pair of VISE-BLOCKS like Figure 21. Saw these from hardwood about 7/8 inch thick, and glue heavy felt (1/2 inch thick) to their faces. The notch rides over the sliding bar of the moveable jaw, and the felt absolutely protects the finish of parts and prevents it being marred, yet the vise can be set up very tight if necessary.

Also make FALSE VISE-JAWS for holding small metal parts without marring, by bending pieces of heavy sheet brass or copper to hang on the vise-jaws. False jaws of lead or babbit are also very useful at times. These are easily made as follows: Unscrew the

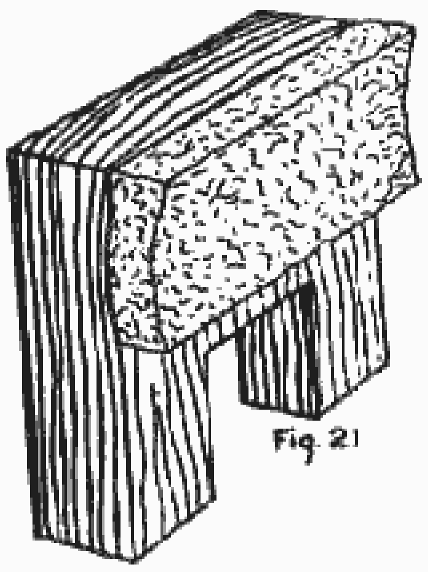


Fig. 21

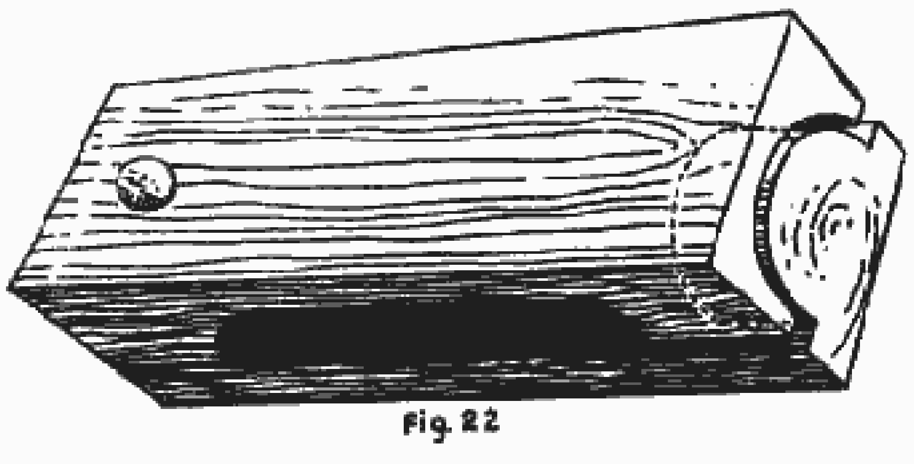


Fig. 22

vise so the jaws are about 3/8 inch apart. Get a lump of stiff clay and pack it against the opening at each end, letting it extend like a box about 1/4 inch above one jaw, and across the jaw about an inch from the edge. Also pack clay under the opening between the jaws. This forms a mould into which the lead is poured. When cool, loosen the vise slightly and lift it out; cast another one in the same way, and you have one for each vise-jaw. With these lead jaws heavy pressure may be applied to hold parts without damaging them; moreover, parts that are so shaped that the regular vise-jaws will not grip them, are easily held rigid in these lead jaws.

The average man would be stumped at the problem of holding a shotgun trigger guard, for example, without bending it in the vise. The gunsmith shapes up two pieces of wood to fit the shape of guard, and fastens the ends together, making the false vise shown in Figure 22. The guard is placed between the wood jaws which are then clamped in the vise, and the guard held firmly for filing. The same idea may be adapted to any thin parts, and is particularly useful for filing flat springs which might be damaged if straightened out in the vise.

SCREW VISES: Cutting down a small screw to very short

length is a hard job. It cannot be held in the vise, nor in the fingers. Take a piece of brass 1/2 x 2 inches, and about 1/16 inch thick. Drill and tap a hole near one end for the screw. Turn in the screw the required distance and grind off the projecting end. The thread will be clear to the extreme point when it is turned out. For screws 1/8 inch or larger which must be filed, run a narrow saw cut from the end of the brass into the hole. Turn the screw in the required distance and clamp the brass strip into the vise edgeways, the sawcut giving a tight grip to keep the screw from turning. This kind of a "screw vise" is also handy for rounding off the end of a headless screw, for use in unused sight screw holes in barrel, tang, etc.

PITCH GAUGE: Buy a common steel square and rivet, weld or braze a four-foot strip of steel in line with the edge of long blade. By holding the short blade against buttplate of rifle, with the blade touching aperture sight at a point in line with center of aperture, the distance from blade to front sight at point on blade immediately above front sight, gives the pitch of the butt.

FLAT DRILLS for bottoming, counterboring, etc. Figure 23 shows various types of flat drills easily made for special jobs. In certain alterations in which original parts are bent or welded, the screw holes are sometimes squeezed or filed. Standard drills and countersinks probably will not serve to open up or countersink a new hole, as the screws are likely to be bastard size both in shank and head. A flat countersink or counterbore may be made from

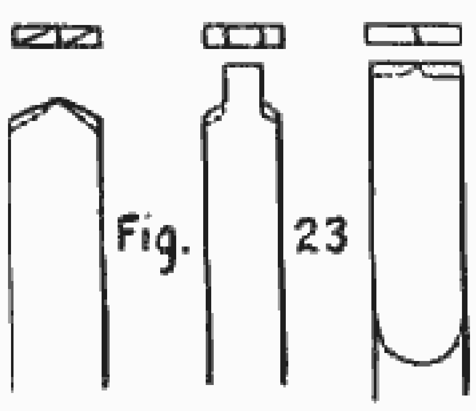


Fig. 23

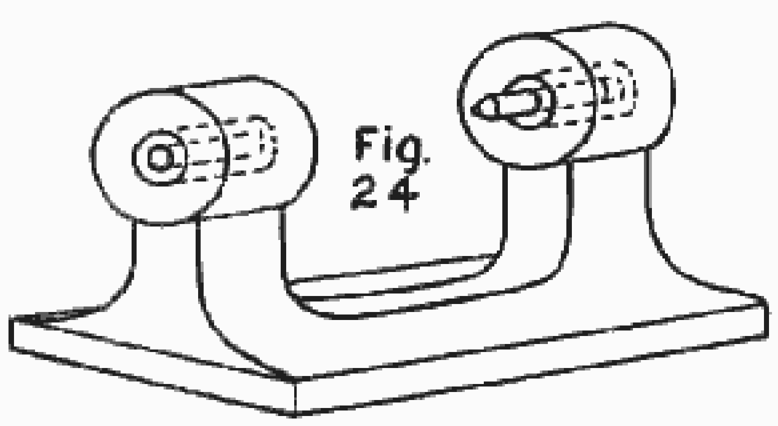


Fig. 24

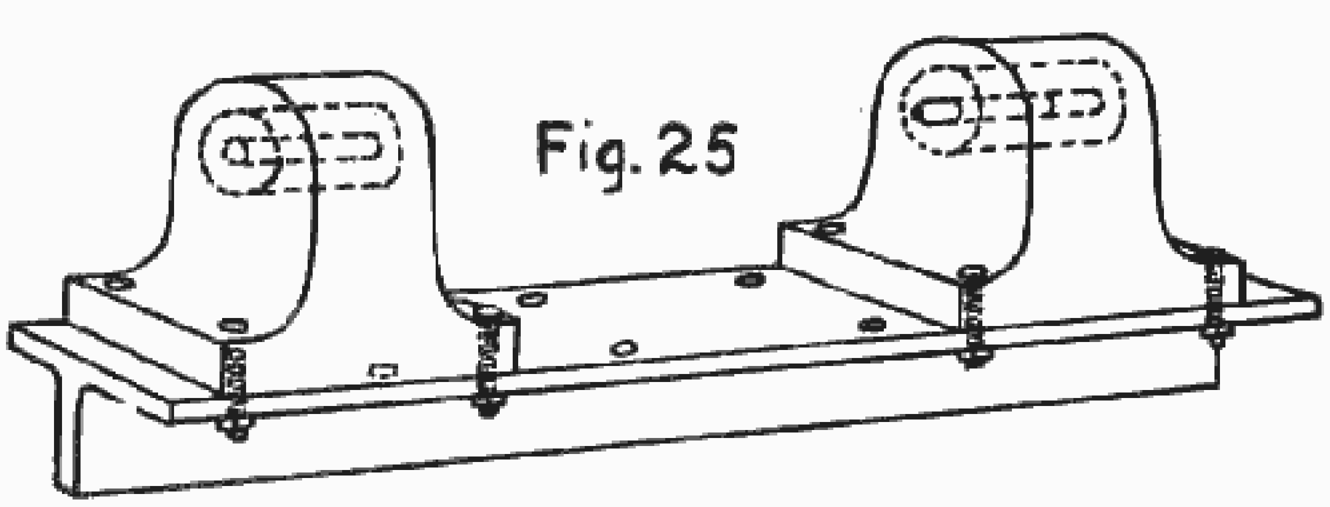


Fig. 25

drill rod. Cut a piece two or three inches long, just a trifle larger than the hole is to be. File or turn the pilot to required size, and file cutting edges on sides or end as required. Harden, draw at dark straw color, and use in the breast or hand drill. For bottoming a small hole in barrel, use stock the same size as the drill. Drill hole a short distance with twist drill, then use a flat drill cutting only on the end to scrape out the bottom. Flat drills may be made in any size for drilling holes in wood. Taper them sharply toward the shank, and shape the point into a wide V, beveling the edges from opposite sides.

The DRILL JIG shown in Figure 24 is worth its weight in gold. The best way is to make a pattern, or have one made in a pattern shop, then have the frame cast at a foundry. Bushings removable from the headstock are made to fit the different size drills you will ordinarily want to use. The hole in head and tail stock should be accurately machined, and the hole in tail stock fitted with a bushing to take a regular tapered lathe center, with cup point. The use of this jig for drilling Springfield guard screw holes and similar work is mentioned later on, and explained fully.

An adjustable drilling jig may be made at small cost as shown in Figure 25. This is a piece of 2 x 3 inch T-bar, with the top planed true and level. Holes are drilled at 2 inch intervals so that the tail stock may be set at any desired distance from the drill.

The CHECKING CRADLE, for holding stocks while being checked, is described and illustrated in Chapter 12.

TEMPLETS and their uses will be mentioned in Chapter 10, and elsewhere. It is advisable to have templets of butt shapes, also for magazine mortices, and similar uses that will be encountered more or less frequently. A number of different templates and their

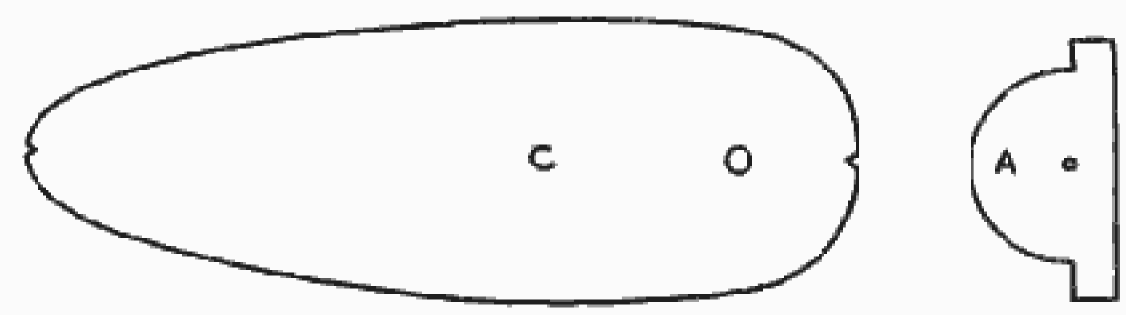
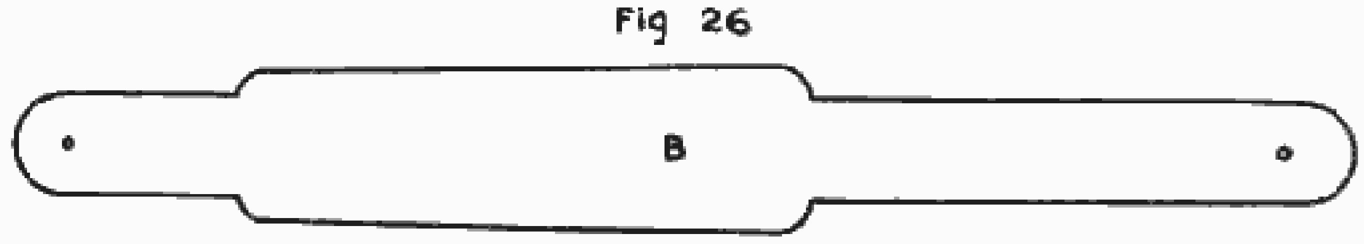
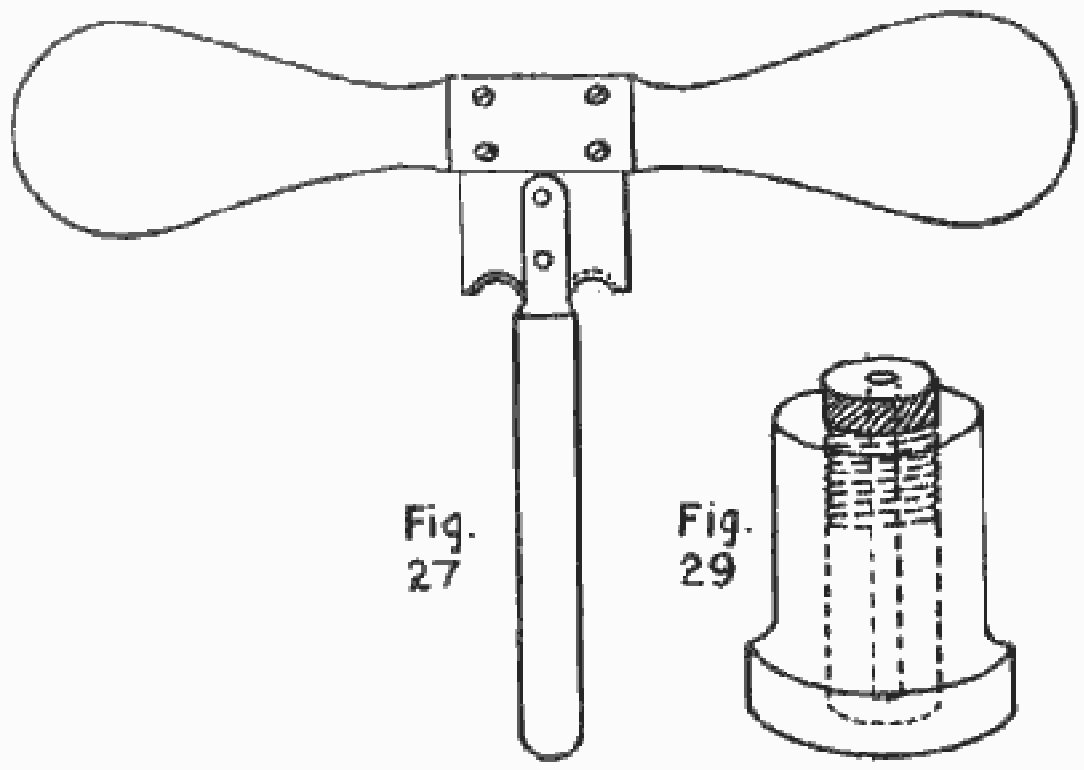


Fig 26



uses are shown in Figure 26. To make an accurate templet for a magazine cut, for example, take the old stock and coat the wood around the mortice with lampblack and oil. Press down on this a piece of clean stiff white paper. Remove the paper carefully and cut out on the outline left by the black. Paste this to a piece of

spring brass about 1/32 inch thick, and file the brass carefully to shape. Try it often in the mortice in old stock, until it just fits snugly. Now file it about 1/32 inch smaller all round—this to give you a margin of safety and to allow for thickness of pencil point or scriber when marking around it. Do not make the screw holes full size, but locate their exact centers on the templet and drill them 1/16 inch. Lay the templet on the stock so the center line shows through these holes, and drive a brad into each hole to keep the templet in place while marking. The brad hole then gives you the center for the guard screw holes.



Small templets to serve also as depth gauges may be made to fit the receiver mortice at various points, saving you a lot of time by enabling you to cut down to the depth indicated by templet without frequently trying the action. Such a templet or gauge is shown in Figure 26 "a." This one gives the depth and shape of extreme forward end of receiver mortice. The round side is struck on a 5/8 inch radius. By means of this, one can go right ahead and cut away wood at this point until the side wings of templet rest on top of the stock blank.

MUZZLING CUTTERS: The crowning of a barrel muzzle is often puzzling to the amateur who has sawed off a barrel and doesn't know how to get the muzzle trued up square, with edge nearly rounded. In Chapter 24 I have described a simple method of lapping it true by means of graduated sizes of brass balls. The gunsmith who has frequent calls to cut off and crown Krag barrels, for example, will find the simple cutter shown in Figure 27 a convenience, for speeding up the job and reducing cost. The blade is made of tool steel 1/16 inch thick, with cutting edges beveled on opposite sides. The edge should be shaped and beveled, and the

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pin holes drilled after which the blade is hardened and drawn at dark straw color, then the sides ground flat and true by rubbing on an oil stone, and the cutting edges whetted. The pilot is also of tool steel, turned to shape and the end slotted on milling machine; then it is hardened, ground and polished to exactly .300 inch. It is attached to the cutting blade by two small screws as shown in cut. The handle is then made from machine steel, slotted and attached to the blade. To use place the barrel in vise with muzzle slightly lowered, so that no chips may work in against the pilot, and turn by hand. Finish by lapping inner edge of cut true with a 5/8" brass ball, as described in Chapter 24.

Brass balls, for lapping and trueing barrel muzzles, should be obtained in the following sizes:—3/8, 1/2, 5/8 and 3/4 inch diameter. Get at least two of each size in case you spoil or lose one. Drill a little more than half way through each ball with a No. 29 twist drill, and tap the hole 8 x 32; turn in a screw 1 inch long, cut off the head, and use the screw as a shank for holding.

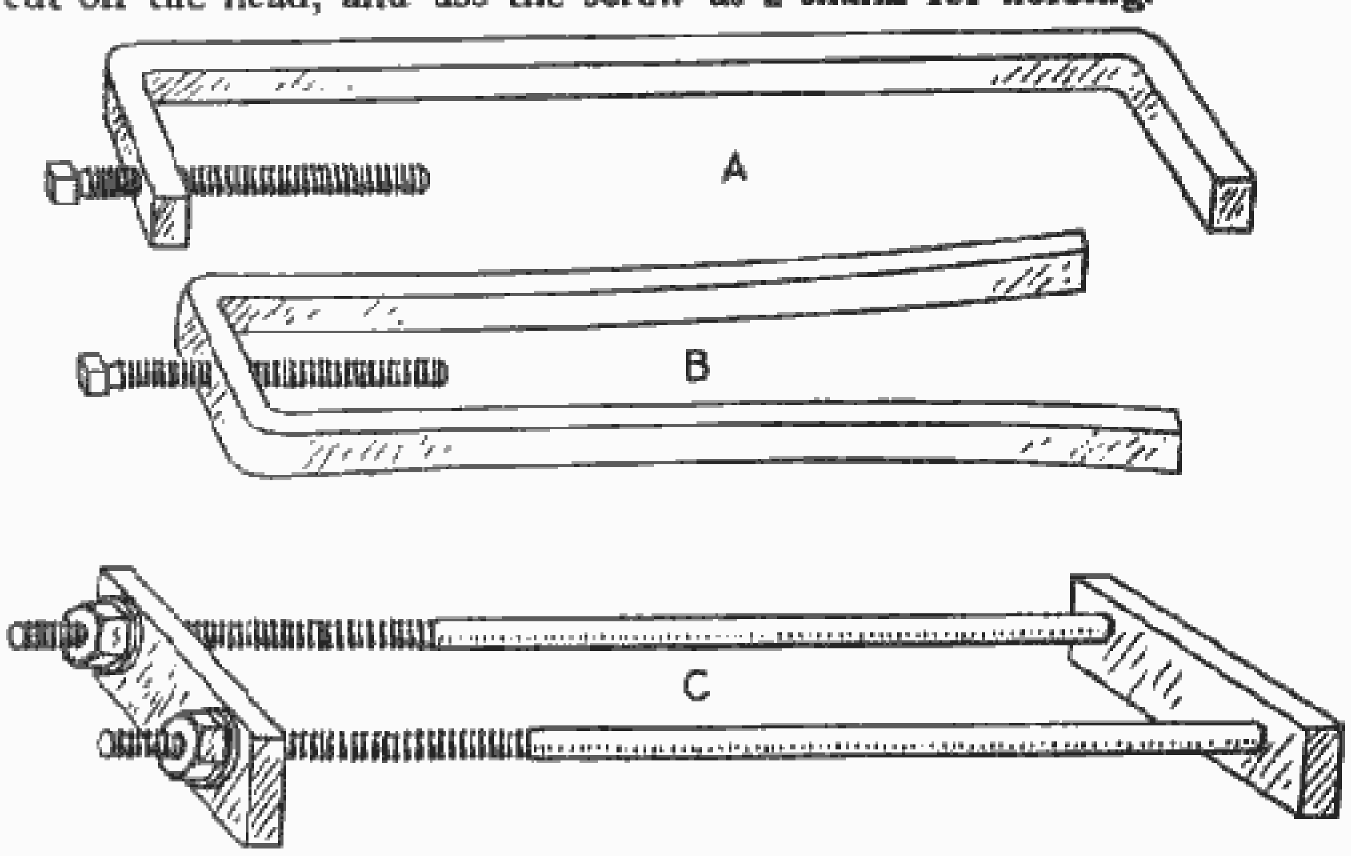

Fig. 28

CLAMPS: For attaching horn, ebony, ivory or other forend tips, there are two special types of clamp, known as the long C-clamp, and the Y-clamp or fork clamp. Figure 28 A shows the long C-clamp, which is made of a piece of 3/4x5/8 inch cold rolled steel heated and bent as shown, and one end drilled and tapped to receive a standard 3/8 inch cup-point set screw 3 inches long. These clamps may be made any length required, so that one end is in-

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serted in the magazine mortice of a Springfield, Mauser or similar stock, while the set-screw is tightened up against the block of horn or whatever is used for a forend tip. This clamp may also be used on the Krag by hooking the end into the magazine mortice on one side. A piece of heavy leather should be used under end of clamp to prevent damaging the wood.

The Y or fork clamp is also made from 3/4 x 5/8 inch cold rolled steel, bent to the shape shown, the distance between center of prongs being about 2 1/2 inches. This clamp is used for setting forend tips on stocks having no magazine mortice, such as the Model '73 Springfield. A strong vise is required for using this clamp, the clamp being slipped over the forend with one leg on either side; it is then placed in the vise, the jaws of which press the legs tightly against the sides of forend, after which the set-screw is tightened.

Sketch C, Figure 28, shows the butt clamp with which every gunsmith is familiar. This is used largely in stocking shotguns and single shot rifles. The end pieces are 1/2 x 1 1/4 inch cold rolled steel, with 7/16 holes drilled in ends. Into these place two long 3/8 inch bolts, and long enough to reach from the front of action to the butt of stockblank. The distance between the rods should be 4 inches. If long bolts cannot be secured use iron rods and thread both ends for nuts. When placing clamp on the work, tighten up the nuts on opposite sides a little at a time, to equalize the pressure.

Sometimes when using a hand drill it is difficult to judge when the drill is starting at a right angle to the surface of the work—drilling the screw hole in end of pistol grip, for example. This can be overcome by first drilling a hole the required size in a block of hardwood about 1 inch thick; have someone hold this tightly against the stock with the drill through hole in block, which will guide the drill straight into the work. If unable to drill the block straight, make up a number of small blocks, and take the drills likely to be used most to some shop having a drill press, and have the holes drilled. Three or four holes of different sizes may be drilled in each block.

A still more accurate method is to make a pattern and have it cast in iron like Figure 29. The bottom of this casting is then surfaced in the lathe, and a 5/8 inch hole drilled clear through and reamed to size. The upper end of hole is threaded for 1/2 inch. Now make several steel bushings to fit smoothly into the hole in casting, and leave the upper end of bushings large enough to thread into the threaded portion of hole. The bushings are then drilled in the lathe, with various sized drills. Each bushing should be stamped with the size of its hole. A jig of this sort will speed up small drilling jobs and avoid drilling holes at an angle. It must be held with the base tight against the work, and the drills used should be long enough to reach through the hole the required distance.

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Chapter 5

MATERIALS AND METALS NECESSARY

MODERN gunsmithing has taught the desirability of numerous small parts not formerly used on factory made arms. Many of these will be described in detail in later chapters. Since they are largely made of special material a brief discussion of some of the raw stock which the amateur or professional may require from time to time seems to be in order.

The common or garden variety of corner hardware store has little to offer in this line; the place to buy materials is from firms specializing in machine shop supplies, of which several are listed in the Appendix. It is well to understand exactly what you require before placing an order—because hardware men are not mind readers, and as a rule they know little enough about firearms. So make your instructions definite, and avoid disappointment and delays.

While I am not in the business of handling material for the trade, I receive many requests from amateur gunsmiths to supply them with things they cannot buy locally, and although this necessitates a trip to a supply house I have always endeavored to serve these chaps to the best of my ability,—but it takes mighty close guessing sometimes to decide what they want, or whether they know themselves. Here is a typical request received a few days since: *"Please send me a piece of steel tubing 1/4 inch thick and large enough for a Krag barrel band."*

Now how could I possibly know what to send this man? He may have wanted to make a swivel band to be located at the same point where the military swivel band was originally placed; and for that matter, the rifle and carbine have their lower bands differently located. Or, he may have wanted to make a band to provide a rear sight base over one of the two screw holes in top of barrel. Again he may have had in mind a collar to ease off the abrupt jump-

off from receiver shoulder to barrel. What he should have said was "—a band for the Krag barrel to be fitted so many inches from receiver"—then I would have had something to go on. On the other hand, had he been ordering from the supply dealer himself, this plan would have been a poor one, since the dealer probably wouldn't have a Krag barrel to measure, wouldn't have known anybody who had one, wouldn't know a Krag barrel from a vinegar barrel if he met 'em both in church, and wouldn't give a cuss whether he filled this fifteen cent order or not. It isn't hard to set the calipers on a barrel and measure its exact diameter where a band is to be fitted—then the man who fills the order knows what is wanted, or somewhere near it. I mention this merely as an illustration of the importance of being explicit when ordering stock.

Having mentioned BARREL BANDS, we may as well start this discussion with an outline of the materials from which they are made.

That mentioned most often in gunsmithing articles in magazines seems to be old hacksaw blades. Use blades if you want to—they make mighty poor bands, and the steel does not take a good blue to match the barrels. A yard strip of 1/16 x 5/32 inch cold rolled steel will keep you in band material for quite a spell and won't cost over a quarter. Moreover, it will blue to match the barrel. Heavy black sheet iron is about as good if you have some scraps of it, for a band should be dressed to about 1/32 inch thick when finished anyhow, and need be no wider than 1/2 to 9/16 inch.

Cold rolled steel bar stock 1/4 x 3/8 inch square is good for the little block under the barrel to which the ends of band are fastened, and into which the swivel screw is threaded. A foot or so of stock this size may come handy for lots of small gadgets.

The best bands are made in one piece, and the best material for this type is the round seamless cold drawn steel tubing known commercially as Shelby Tubing. This material is also useful for a variety of other items, being perhaps the most generally useful of all material to the gunsmith. Shelby Tubing differs from pipe in that the latter is made from flat stock bent around mandrels and the edges brazed or welded; tubing, on the other hand, is drawn through dies and is without weld or seam, and of very smooth even grain and texture. It cuts nicely, takes a good polish, blues easily by almost any method, and may be bought in a wide range of sizes, both diameter and wall thickness. In the supply catalog before me there are four solid pages of Shelby tubing sizes, of which only a few need be considered here. It might pay the reader to secure a supply catalog listing this material, for future reference. Unfortunately it is listed by outside diameter and wall thickness, and since we are mainly concerned with the inside diameter, it becomes a case of "figger, Nigger, figger." In some sizes the wall thickness is quoted in British Wire Gauge measure; in others, in fractions of

an inch. Here are some uses to which the various sizes may be put.

3/4" OD (outside diameter), 14 ga. WT (wall thickness)	Welded to blade as described later makes very good front sight ramp for Springfield. Other sizes could be selected for barrels of various sizes.
1 1/8" OD, 7/32" WT 1 1/8" OD, 3/16" WT 1 1/4" OD, 7/32" WT 1 3/8" OD, 1/4" WT	Will make swivel band for almost any sporting barrel where attached by screw through forend.
1 1/2" OD, 5/16" WT 1 1/2" OD, 3/8" WT 1 1/2" OD, 7/16" WT	For bands with swivel stud to be soldered on barrel ahead of forend, for most sporting size barrels.
1 1/4" OD, 1/16" WT	Makes plain band for breech of Springfield barrel to cover notch after removing original sight base.
1 7/8" OD, 3/8" WT	Makes band with base for No. 6 Lyman folding leaf sight to fit Springfield barrel at breech, covering notch in barrel.

—and so on. Whatever your fancy in inventive genius may conceive, you'll probably find some use for Shelby tubing, and you'll just as surely find the tubing available in a size suited to your purpose. Sight covers, and hoods, muzzle protectors or tompions, wells under grip cap for spare front sight—and numerous others.

Detailed instructions for making such parts will be found in Chapter 24. It must be remembered, however, that since most barrels are tapered the band must have a similar taper when finished. Tubing will stand a good deal of stretching, or it may be reamed to size and taper; so it is advisable to order it a trifle smaller inside than the finished band is to be. For barrel bands select tubing to fit the barrel two or three inches ahead of the location of band, unless the taper is very sudden.

The best material for swivels, connecting links for slings, and the like is BESSEMER STEEL RODS. These come in four foot lengths and cost little. The rods are lightly coppered to prevent rust, and this must be scoured off with emery cloth before using. Bessemer rods are stiff and strong, but designed for cold bending. They come in sizes from 1/16 to 11/64 inch by 64ths; and from 3/16 to 3/8 inch by 32nds.

1/8 to 9/64th inch is the size for swivels and strap links. The 9/64 size is an easy fit in a No. 25 twist drill hole, which hole also fits the pivot bar of the detachable swivel, thus we may standardize on this size for all sling fittings.

In the smaller sizes Bessemer rod also makes good pins for sights, etc., although drill rod is stronger, and available in a wide range of sizes.

The smaller sizes of DRILL ROD are useful in many ways. By keeping it on hand in a dozen or more sizes one is equipped to make any pins needed on short notice. The old damaged or broken pin may be measured by trying it in the Starrett drill gauge mentioned in Chapter 3; when you know the size, it is easy to try your

stock of drill rod in the gauge until you find a piece the same size, cut off the length needed for the pin, round up the ends, and there you are. In a pinch I have cut off the end of a twist drill for a pin, trying different drills until the exact size was found. It beats a nail or piece of wire all holler!

Cold rolled STEEL IN FLAT BARS is used for the forms for bending swivels and links, and a few pieces six or eight inches long should be kept on hand for this purpose. Use stock 5/16 x 1 1/4 inches as a form for swivels to take the government sling; grind or file the edges round and smooth. A piece 5/16 x 7/8 inch wide is the right size for links to be used in straps fitting the detachable swivels. The making of these links and swivels is fully covered in Chapter 24.

SWIVEL SCREWS: The best swivel screw is of course made up on the lathe with the kind of head required. It is well, however, to have on hand a few 5/16 inch hexagon head cap screws, S. A. E. standard, for the rush job. Grinding the head round and drilling it from side to side for the swivel makes a fairly good job.

MACHINE SCREWS: Only experience will show what you are likely to require in the way of small screws, but the following sizes I have frequently found useful, and would suggest keeping a dozen or so of each size on hand, both filister head and flat head in all sizes.

10 x 32 8 x 32 6 x 32 6 x 40 5 x 40 4 x 36 3 x 48 2 x 56	These should all be iron screws: you will seldom or never have use for brass machine screws in gun work. Round heads should never be used—either a fillister head in counterbored hole, or a countersunk flat head should be used.

You will need a few flat head wood screws from time to time in sizes from No. 5 to No. 8, and in lengths from 3/4 to 1 1/4 inch. A few flat head brass screws may be kept for emergency repairs on stocks. Sizes and lengths should be assorted. Always use iron woodscrews in tangs and other parts of the gun where steel is joined to wood. A No. 9 oval-head iron wood screw makes a first class butt plate screw.

A few brads, nails, etc., always come in good and should be found about every shop.

ADHESIVES: For cementing horn to wood there is nothing equal to the old fashioned white flake glue sold in paint stores and occasionally in drug stores. Being made from hoofs and horns, it is perfect for this work. Brown or amber flake or stick glue has not proven satisfactory. Prepared liquid glue is all right for cementing sandpaper to wood wheels, and such jobs, but don't use it where strength and endurance are required.

Du Pont Household Cement is a pyroxilin compound, and the

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best cold adhesive I have ever seen. It comes in 25 cent tubes, and after drying is both waterproof and oil proof. Many glues will deteriorate and allow the joint to break open after prolonged contact with oil or grease. Du Pont Cement and some of its uses will be mentioned frequently in subsequent chapters. It is sold by many hardware and paint stores, and by the larger mail order houses.

Plastic Wood is a paste made of finely divided wood, with a binder added until it is the consistency of putty. It is used in a variety of ways, such as filling small holes, knots, etc., in repairing stocks. It will be mentioned later. It is sold in large and small cans at hardware, paint, and some drug stores. Buy the small can, as it may dry out if long unused after being opened.

PAINTS AND OILS: Shellac, orange or white. Useful for cementing sandpaper to wood wheels, and in various stock finishing mixtures.

Linseed Oil, Raw: For finishing stocks. Used alone, or with other ingredients. Specify Archer-Daniels-Midland Company's linseed oil.

Boiled Oil: There is no kettle boiled linseed oil on the market today. The compound boiled oil of the above company is perfectly satisfactory.

Varnish: Valspar, or Du Pont's Spar varnish, for oiling compounds. Sherwin-Williams hard rubbing varnish for full varnish finishes.

Lacquer: Du Pont's clear Duco lacquer for finishing stocks. Must be used in an air brush.

Alcanet root, for darkening oil mixtures. Gives a deep slightly purplish brown. Obtainable at drug and paint stores.

Oil Soluble Red: A dark red powder, useful for imparting a reddish cast to linseed oil. Obtainable at wholesale drug and chemical houses.

New Method Gun Bluer: Made and sold for bluing guns, and so used by those who don't know any better. Really useful for touching up the shiny end of a pin, point of a screw, etc., without removing part from gun. Also useful for painting the edge of a leaf sight which was filed down while on barrel.

Stain: Sometimes a stock will be very light in color, or have light streaks which look better darkened. Use Johnson's Wood Dye, or Ad-El-Ite Stains in Walnut or Mahogany to get the desired tint.

Turpentine: Occasionally needed in stock finishing compounds. Get genuine spirits turpentine, not turpentine substitutes sold by some paint stores. Hercules Steam Distilled is about the best.

Cup grease, No. 3—any standard make: Used in polishing stocks, also for greasing guns for shipment or storage. Melt it and throw in a handful of iron filings, keeping it melted for two or

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three hours, to free it of any acid. Then strain through cloth until clean, and let harden.

ABRASIVES: Sandpaper or Glasspaper, Nos. 1, 1/2, 0, and 00 will be needed in stock making and finishing. Garnet paper is better than sandpaper for use on wood wheels. Carborundum or Aloxite cloth in rolls 2 inches wide is far better than emery cloth for polishing barrels and actions. Use Nos. 1/2, 0, and 00. Emery cloth is better for final polishing as it breaks down more quickly. For an extremely bright finish, follow with Crocus cloth—this is made in but one grade, very fine.

Valve grinding compound, oil or water mix: If oil mix is used, the Carborundum compound is best. Use it for lapping barrels.

Emery, No. 120, for lapping barrels.

Pumice stone and rotten stone—powdered: Used for polishing stocks. Keep it in large sifter top cans for convenience.

HEAVY FELT, 1/2 inch thick: Used for padding vise jaws, and for rubbing stocks. Obtainable at harness shops and large paint stores.

WOOD FOR STOCKS: Should be purchased in ready cut blanks, or else in planks from 2 to 3 inches thick. See list of dealers in Appendix. After cutting out blanks, save your scrap for repairs and patches, pistol stocks, forends, etc.

TOOL STEEL, SPRING STEEL, etc.: The sizes and grades likely to be needed are discussed at length in Chapter 21.

Brass: A few heavy pieces of brass and copper are useful as soft bench blocks, for riveting, driving off military sights, etc. Pieces 1 inch thick sawed from 2 to 3 inch brass bars are very handy. They may be purchased cut as desired from machinery supply houses. Sheet brass and copper 1/16 inch thick should be kept for protecting vise jaws. Get soft brass if possible, as the hard sheets sometimes break when bent. Use 1/32 inch sheet brass for templets.

Solder in various grades may be had at hardware, machinery, and wholesale jewelry supply houses. Tin, lead, bismuth, etc., as well as spelter and silver solder may be bought from the same sources.

Lead: Keep a few pounds of scrap lead—old pipe, etc.—for making very soft bench blocks and vise jaws, also for making barrel laps.

Horn, for forend tips, also ivory, must be purchased from one or two firms who import it in small quantities. Carabao or Asiatic buffalo horn is best. See the Appendix for firms handling this material.

Dowel rods in 3/8 and 1/2 and 5/8 inch sizes are convenient for making plugs for barrels, dowels for forend tips, stock patches, etc., and a few should be kept on hand at all times. Carried in stock by machinery supply dealers and some retail hardware stores.

Oil, for sharpening stones, as well as lubricating actions. Marble's

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Nitro Solvent oil is the best light oil I know of for general use. Economical in quart cans at $1.50. Also used in oil bluing, as described in Chapter 20, and for "lamping" bright spots on barrels.

Chemicals for bluing processes, case-hardening, tempering and coloring metals. Many of these are not found in the corner drug store. See Appendix for list of dealers.

Bakelite and hard rubber in sheets 1/4 inch thick makes a good inlay material. Obtainable wherever radio supplies are sold. Hard rubber rod 1/4 inch in diameter is used for chasing rifle bolts.

Hard fibre, both red and black, in sheets of varying thickness, also tubes and rods is sold by machinery supply houses and electrical houses. Used in building up butts, and sometimes for making butt plates and grip caps. Hard fibre rod is better than brass or copper for driving out barrel sights, unless very tight. Will not mar the bluing.

Buying materials is like buying tools—no use getting anything you do not need. It doesn't take long to get a good many dollars invested in a lot of stuff you may not use for a year, if ever. A knowledge of the right tool or the right material for the job will prove helpful to you in avoiding mistakes when the time comes to buy.

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CHAPTER 6

FIRST STEPS FOR BEGINNERS

THE man who has never attempted even a simple repair on a gun and who is notoriously inadept with tools can scarcely expect to start in and turn out the class of workmanship found in the best shops. Gunsmithing, while a trade in itself, is really made up of the rudiments of other woodworking and metal working trades, with a number of specialized branches and operations of its own. For this reason the rank, raw beginner is often less handicapped than the man who is expert in one of the branches of mechanics applying to gunsmithing but who knows nothing of the others.

The beginner has nothing to unlearn; he does not, for example, expect to cut an action mortice in a stock with the same degree of fit that a carpenter would make in morticing in a door lock. He is not likely to make the mistake of the machinist who, understanding lathe work, blunders ahead and turns down a barrel without thinking of the "kinks" it is likely to acquire as stresses are released. The beginner meets all problems with a wide open mind, and accepts the instructions of men who are familiar with gun work; and therein lies his adaptability. In the course of time he will turn out very creditable work, often far better work than the cabinet maker or the machinist, albeit he could not make a living in either trade.

If a man is entirely unskilled in the use of tools, so that he is forced to call in a carpenter to hang a screen door, or to drive into a garage to have the carburetor on his car adjusted, it behooves him to first of all familiarize himself with the mechanical trades into which he will delve to a greater or less degree, acquiring some knowledge of their terminology, and some acquaintance with the uses of various tools.

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As a first step in the right direction he should occasionally buy a copy of Popular Mechanics, Science and Invention, and similar magazines. In their pages will be found many helpful suggestions for amateur mechanics, from which he will in time absorb a certain amount of "atmosphere" and general understanding. If there is a first class hardware store in his town, he should cultivate the acquaintance of some salesman who knows tools, and will aid him in proper selection of things needed, and explain their uses in detail.

One of the very first things the beginner should do is to write to leading tool makers and secure their catalogs, and study them carefully.

These are more than catalogs—they are valuable textbooks. Besides the information they give, they are indispensable when it is necessary to order some special tool from a small dealer who never heard of it, and who may try to tell you that "there ain't no sich animule." Again, while the rather extensive list of tools named in Chapters 3 and 4 may seem like they should cover every possible requirement, there may be some job the amateur gunsmith wants to do that is not covered herein. Familiarity with the catalogs will enable him to select other tools for special jobs with certainty.

It is a good idea also to secure the complete catalogs of Sears-Roebuck and Montgomery Ward. These mail order houses handle many high grade standard tools, and can often ship them much quicker than the local small dealer can obtain them through jobber or manufacturer—and sometimes they sell them at slightly reduced prices. In using mail order catalogs, however, it pays to avoid the cheap "private brand" articles of unknown origin.

Dealers' catalogs should also be secured and studied carefully. In addition to the many standard tools listed, they also list much raw material, iron, steel, brass, screws, etc. that will sooner or later be needed. Studying the catalogs not only familiarizes one with the supply of such materials, but enables him to order intelligently when the time comes.

But the most important thing of all to the beginner in the field of amateur gunsmithing is a thorough knowledge of guns and loads—not only his own guns and his own loads, but of all makes and models

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of guns, and all the cartridges he may want to use some day. To this end he should study carefully every catalog he can get his hands on, both American and foreign. Study the details of various actions; learn how they function; decide which are their good points, and their weak ones. Examine all the guns you can get hold of, and learn exactly how they work, and handle. Get all the cartridge catalogs you can and study them carefully—they are real textbooks, full of valuable information.

The chap who starts in to repair his first gun with only a hazy idea of what the various parts are for, and how the action functions will find himself as bad off as the boy who took his French harp apart to see what made the music—and likely he'll have enough parts left over to make another gun when he reassembles it. But, having acquired a good understanding of principles, and learned how much similarity there really is in guns of different makes and models, you will soon develop an intuitive understanding of mechanisms, so that you need not hesitate to dismantle any action for the first time. You can drop the parts loosely together in a box, and it won't be like working a Sam Lloyd puzzle to put them together again.

Before attempting the more difficult jobs such as complete remodeling of a military rifle, adjusting the trigger of a fine target arm, etc., it is well to get one's hand in with a number of easy jobs and practice work where there will be no great loss if you spoil some material or parts. The practice you will get in making up checking tools, simple chisels, screwdrivers, etc., will stand you in good stead later. Learn trigger pull adjustment first on a cheap single shot rifle; let your first bluing job be an old pot-iron that is ready for the scrap heap anyhow—and if it turns out well, you're that much ahead.

An old wreck of a single barrel shotgun is a mighty good one to start your training on—and most single barrel shotguns are old wrecks. Don't be afraid of damaging it, because that's usually impossible. Fix up the trigger pull, replace damaged screws or pins, make a new spring or two where needed, perhaps a new firing pin; repair the broken stock (they're always broken somewhere), try your hand at checking it; put on a front sight, polish out the barrel (it'll need it) or try your luck at cutting off a few inches of the muzzle and re-choking by the overboring process described in Chapter 31. If the barrel is in very bad shape, cut it off ten or twelve inches, cut off the stock back of pistol grip, and make an "auto and burglar gun" of it. One of those "high power long range Texas Ranger guns" from Roars and Sawbuck will give the student-gunsmith more fun, as well as more real constructive experience, than a brand new stiff would give a medical student! And it will probably have more different things the matter with it, too.

This book is not intended as a mere compilation of shop kinks and detailed descriptions of specific jobs; rather, it is prepared

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with a view to its use as a text book, to be studied thoroughly. By familiarizing himself with the entire book before going to work, the reader should have a clearer understanding of the reason behind various instructions; knowing that he will be able to develop initiative to the point of devising ways and means of doing things which are not specifically described.

Woodworking tools, while not difficult to master, call for reasonable skill. The aspiring gunsmith should study the methods of expert woodworkers—not merely carpenters, but cabinet makers, musical instrument makers and repairmen, turners, and pattern makers. Of the trades named, perhaps the last more nearly approximates the skill required of the stocker than any of the others. The gunsmith can learn something from nearly all of the mechanical trades, but in "nosing about" for information, he should avoid those shops where "rough and ready" methods are the rule rather than the exception. Don't expect to see close machine work being done in the garage—the motor mechanic would be helpless on the simplest sort of gun work. Study the work of experts, and learn from them.

Finally be sure that your knowledge of firearms is practical and not theoretical. Be sure you know *what* you want to do, and *why*, before you worry about the *how* of the matter. Study the works of Whelen, of Crossman, Askins, Hatcher, Fitzgerald and other authorities who know whereof they speak. Before making up your mind to risk long hours of time and hard-earned dollars' worth of materials to prove your theories—check up on their practicability through the knowledge of others, whose experience has covered a wider field than your own.

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Chapter 7

GENERAL SHOP PRACTICE AND USE OF TOOLS

MUCH of this chapter will be of no interest to those already having a knowledge of common tools and their uses; it is written largely for the benefit of the beginner, who has spent his life working with head rather than hands; and who finds himself awkward in the use of even the simplest tools, and whose knowledge of their uses and possibilities is limited.

Woodworking tools will receive first consideration. Having "tooled up" his shop, the amateur is likely to believe he is ready to go to work. But not just yet. Edge tools of all kinds usually come from the factory ground, but not honed or whetted to a fine working edge. It is necessary to understand, first, how to properly condition new edge tools for use; and second, how to keep them in tiptop shape for finest work.

The bit of cutting blade of your jack plane will do as a first illustration. Remove it by unlocking the cam clamp of the iron holder on the outside. Remove this holder, and you will find the bit can be lifted out, attached by a large set-screw to its guard. Loosen this screw, using the edge of the bit holder as a screw driver. Note that the sharp edge of the guard was set within about 1/16 inch of the edge of the bit.

Now study the bevel ground on the bit. Note that it is about 1/4 inch wide, and slightly hollow ground. Being made primarily for carpenter work on soft wood, the bevel of the edge is usually somewhat shorter than is needed for best results in hardwood. However, if you have no grindstone, leave the bevel alone for the present. Later, if you have access to a good sand grindstone—not an emery wheel—you can grind the bevel back about 1/32 inch, but not more than that.

You will note that little if any WHETTING has been done

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on the edge. Take your combination coarse-and-fine carborundum stone, and set it on the bench with the smooth face up. Apply a few drops of oil to center of stone. Hold the plane bit in both hands as in Figure 30, with the heel of bevel resting on the stone, as in "A," Figure 31. Now slowly lift the upper end of bit, tilting it forward until you feel the edge touch the stone, and the oil squeezes out in front of this edge. Figure 31-B. The heel of bevel is thus very slightly lifted from the stone, so that only the edge will be sharpened. Maintaining a firm but not too heavy pressure,

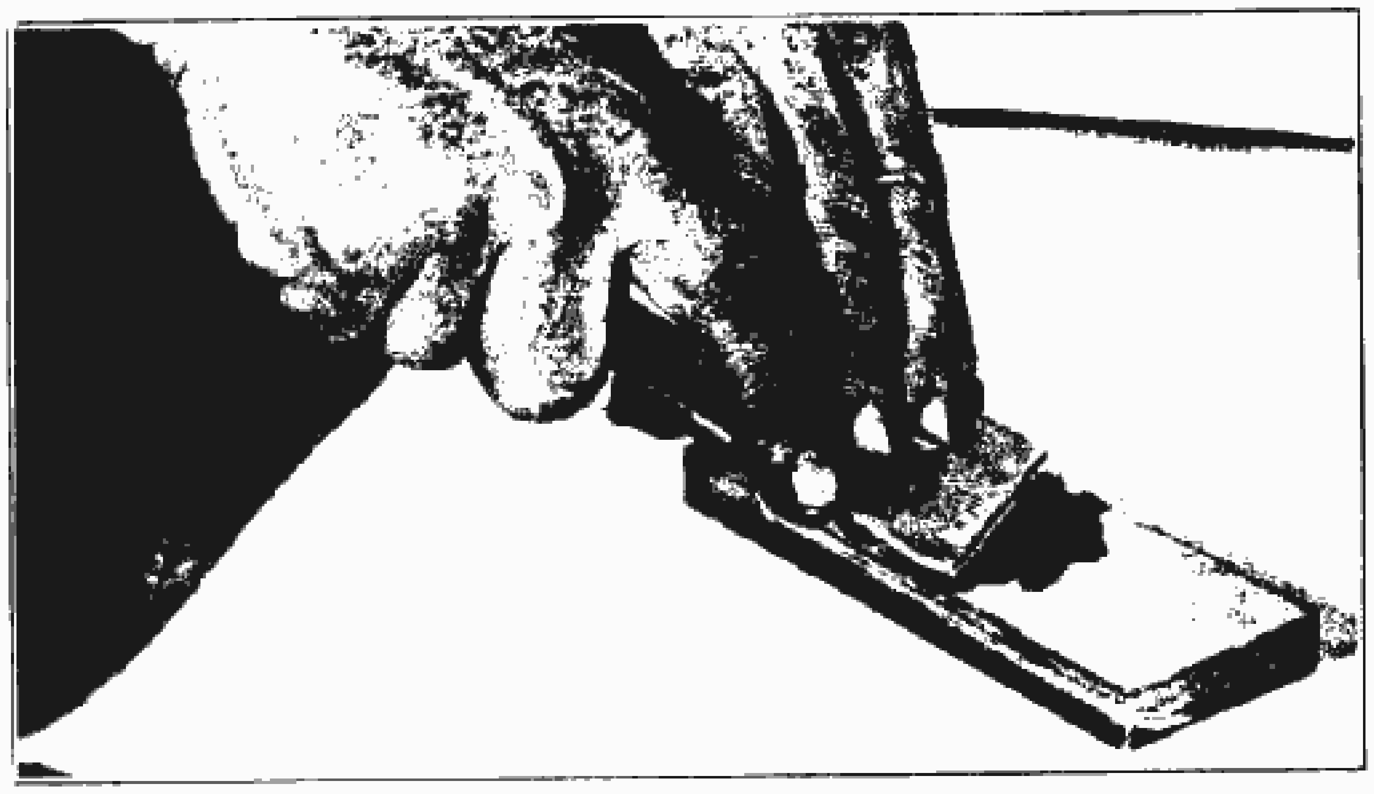

Fig. 30

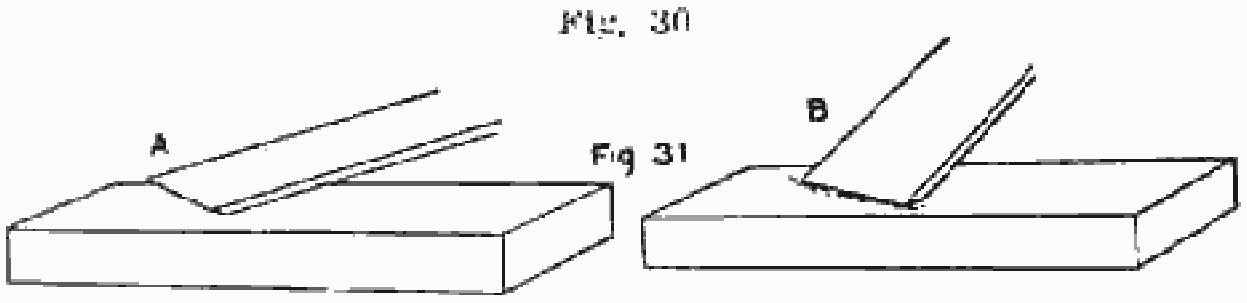

Fig 31

and holding the wrist joints stiff, so as not to change the angle of the bit with the stone, move the bit in a long oval stroke, with greatest pressure as you go *against* the cutting edge. After a few strokes lift, wipe off the oil, and examine the bright whetted edge. This short bevel should be about 1/32 to 3/64 inch wide, and should be even clear across the width of the bit. If it tapers off toward one corner, it shows the pressure is too great on the opposite corner. Try again, until you have a smooth, even narrow bevel clear across the edge, with a fine "wire" edge turned on the flat (unbeveled) side of bit. Lay this side *perfectly flat* on the stone, and rub back and forth until this wire is whetted off. It will not all be removed but will be partly turned over on the bevel. Reverse and whet the beveled side as before, removing more of the wire and turning the rest on the flat side. Continue whetting

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the two sides alternately until all the wire is removed and the edge feels sharp to the fingers. Remember, the flat side of the bit must not be beveled the least bit.

Now replace the carborundum stone with the Lily White Washita oilstone, and whet the bit on both sides in the same manner. Be sure to keep the same bevel on edge each time you whet it, and always bring the heel of bevel against the stone first, then tilt it until the heel is barely lifted from the stone, and oil is squeezed out in front of the edge. This stone will produce a finer wire edge, which is carefully whetted off, first one side then the other.

Test the edge by wetting the thumbnail and drawing the bit across it. No danger—it won't cut through the nail at all. If very sharp and smooth, as it should be, you feel it "take hold," and any roughness or dull spots will be noted instantly. Continue whetting on the Washita until the edge is perfectly smooth, sharp and true. At this stage it should shave hair from your arm almost as smoothly as a razor. Now strop the edge on the flesh side of a piece of heavy leather, nailed to a piece of wood, or one end of the bench, or other suitable place. Be careful not to rock the blade in STROPPING, thus rounding the edge. Note that in whetting, most of the cutting is done *against* the edge, while all stropping is done away from the edge.

A splendid tool strop is made by bolting together a number of narrow strips of heavy leather, such as saddle skirting, with slender stove bolts. Sandpaper both sides smooth and even. In whetting tools, the oil and grit from the stone works up into a greasy paste. Always clean this from the stone immediately, and spread it on one side of the strop or leather block. Use this side for the first stropping, and finish on the clean side. When properly sharpened the plane bit or any other wood working tool should cut a hair cleanly as any razor. You can't begin to appreciate the value of this kind of an edge until you have used it and then try to use the kind of edge usually found on tools! It's the same difference as driving a flivver with three cylinders missing and the gas tank empty and two flat tires, when you've been driving a new Cadillac.

The foregoing will apply to all plane bits, though the angle of the bevel differs somewhat for different type planes. For example, a block plane bit lies down much flatter than that of a jack plane, and the bevel of the edge is wider accordingly.

When assembling the plane, reverse operations used in removing the bit, and note carefully how much of the edge of bit projects through the slot. There is a long lever under the bit by which the blade can be shifted from side to side, to even up the projecting edge. The bit moves in the opposite direction to the lever in some planes and in the same direction on others. Shift it until it is perfectly even, and draw it back with the adjusting screw until it *barely* projects below the surface. Some mechanics adjust plane

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bits entirely by feel; a better way for most people is to hold the plane bottom up in a good light, and sight along the surface. Any variation in depth of bit at either side will be instantly noted.

In USING THE JACK PLANE most beginners (and also many mechanics who should know better) will turn it at an angle on the work, instead of pushing it in a straight line. The reason for the long body of the plane is to carry the cut in a straight line, to true up and straighten an unequal edge. Turning the tool sideways permits it to follow the curves and hollows, thus failing in its purpose. Holding it straight on the work is particularly important in straightening up the top line of a stock, which is one of its principle uses in gun work.

Start in with the lightest possible cut—the bit scarcely scraping the wood. After two or three strokes, if it does not take hold better, set the bit very slightly deeper. Thin, almost transparent shavings give you better control of the work, and produce a better job.

If you find you are cutting against the grain, reverse and work from the other end. When the grain runs "every which way" as it often does in stock blanks, just do the best you can.

When using the smooth plane to merely clean up the side of a rough piece, it is often permissible to turn the plane at various angles to get at the hollow places. Sometimes, in very curly wood, the smooth plane will cut better *across* the grain than it will from either end.

In starting a stock job, one flat side—usually the right side, should be planed perfectly flat and true as a working surface from which

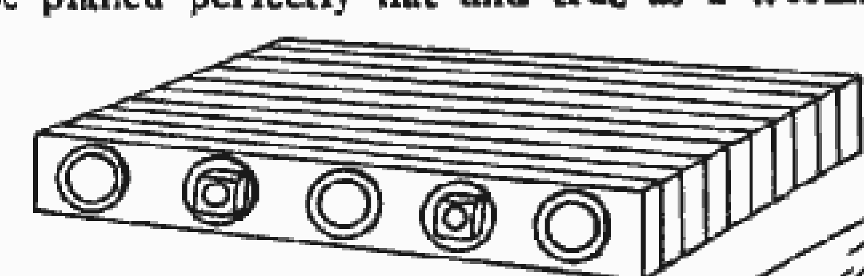

Fig. 32 A

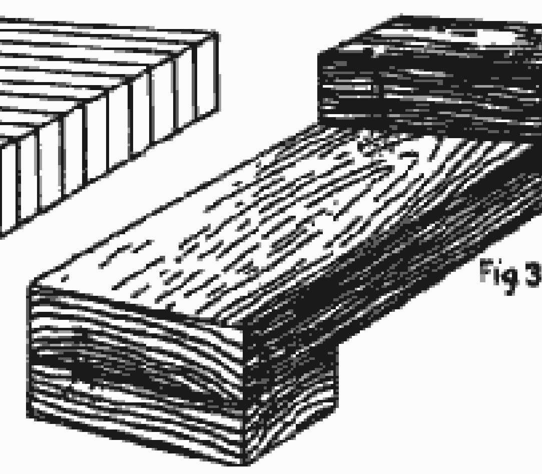

Fig 32 B

the center line is run with the marking gauge; and on this job use the jack plane, and sight along the surface to be sure it is kept in a straight line.

The block plane was made for cutting across end grain; yet it cannot well be used for such jobs as truing up the butt of a stock,

because it invariably chips the edges at end of cut. It is a handy little tool however for many small jobs, such as shaping up patches, squaring up ends, etc. Make a bench-hook of hardwood as shown in Figure 32B, and use the plane on its side for small work, which is held in the hook. This device is also called a "shoot board."

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Never stand a plane upright on the bench when through using it. It should always be laid on the side to prevent the edge becoming damaged. Wherever you keep your planes when not in use, either lay them on their sides, or else have them blocked up with thin strips of wood.

Never drag the plane back on the edge of bit during the return stroke. Either lift it completely off the work, or at least lift the rear end, letting the frame ride on its point. Nothing ruins the cutting edge so quickly as dragging it back on the work after the cutting stroke.

CHISELING: Next in importance to the gunsmith come the chisels used in stock inletting. I have mentioned the J. B. Addis

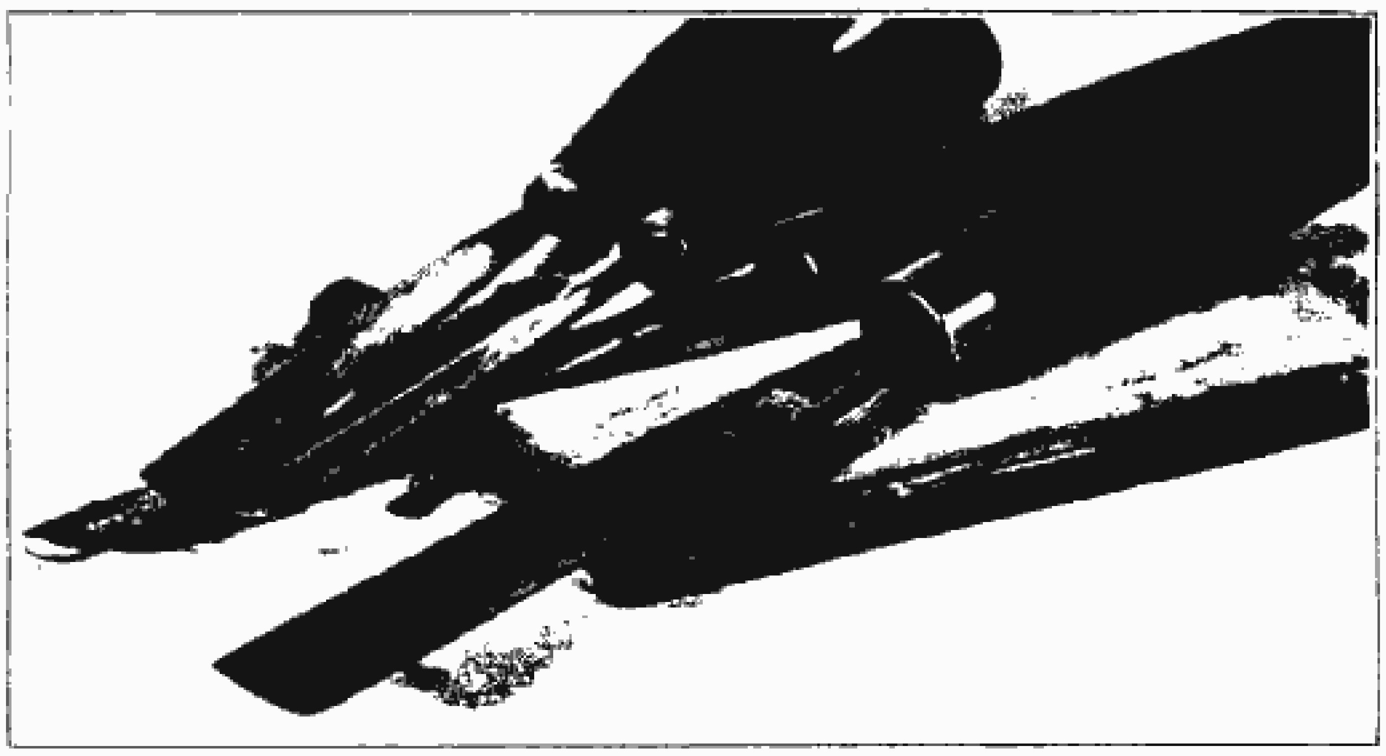

Fig. 33

wood carving chisels as being best for this work. If you do not have these, then your carpenters' chisels and gouges must be ground with a much longer bevel than the carpenter or cabinet maker uses—grind the bevel from half again to twice as long. Also, it should be a rounding bevel instead of straight.

Carving chisels, or any others used for stock making, should have a double bevel. The most pronounced bevel is of course on the bottom or outside; but the top or inside of blade should also be slightly beveled, contrary to the custom of other woodworkers, who bevel chisels on one side only, like plane bits. And both bevels must be very long, gradual, and slightly rounding—the bevel running off into the line of the blade without any definite stopping point. Figure 33 shows a number of carving chisels properly sharpened.

Your chisels will come to you only rough ground, probably with a thick unfinished edge. Use the coarse side of the combination

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carborundum stone first, and carry the bevel well back. Do not have any short bevel at the extreme edge as you did on the plane bit. Sharpening the outside or bottom causes a wire edge on the inside. This is worked off with the round edges of the carborundum slip hone first, then with the Washita and finer slips, the inside being gradually beveled, but not nearly so much as the outside. Finish both sides on the Washita stones, then strop both inside and outside on leather. For the hollow chisels or gouges, bend or fold a piece of leather to fit into the curve, and rub the leather away from the edge, not against it.

Carving chisels must be as sharp as human effort can make them. They must be so sharp that they will make a smooth, polished cut *against* the grain if necessary. The wood carver's test for sharpness is to try the chisel or gouge *across* the grain of a piece of very soft, spongy pine or "deal." It is not sharp enough for this purpose until it will make a smooth cut in this manner without the least suggestion of tearing.

The slip stones should be kept handy, also the strop, and edges of chisels touched up frequently. Much time is saved, and split or rough cuts are entirely avoided.

Fig. 34

Figure 34 shows the best method of manipulating the carving chisels. The hold will vary slightly with the nature of the work,

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but both hands should be used whenever possible, to give best control. Figure 81 shows an easy way to cut out a deep channel, such as the guard channel in a rifle stock, when impossible to get in line with the cut. A hollow chisel is used across the grain, which prevents tearing or splitting; the humps are worked out in the same manner as the rough cutting is done, and the bottoming tool is used to level up the bottom of channel. Wood carvers' rasps, or "rifflers" are also handy for this work.

THE DRAW-KNIFE is an accepted tool of the carpenter, but should be used advisedly by the gunsmith. In Chapter 11 I have not mentioned the draw-knife in connection with stockmaking, for the reason that I very seldom use it, nor do I consider it necessary. The only time it can earn its keep is when used for roughing off the corners of a very straight grained blank, on which there is no chance of running in too deeply. The draw-knife is a perverse instrument, following the grain of the wood with the tenacity of an old millionaire after a chorus girl. Before you realize it, there's a bit peeled out, just a sixteenth of an inch perhaps, deeper than you wanted it.

There are stockmakers, however, who use the draw-knife with consummate skill, doing nearly all of the shaping with it. I can see no reason for this, as a good cabinet rasp will do the job just as rapidly, and with absolutely no danger of going too far.

The American workman holds the draw-knife straight across the work, and pulls it toward him by main strength and awkwardness, ripping and tearing off the kindling at a great rate. His draw-knife has a short bevel, and is seldom sharper than the law allows. The Englishman, on the other hand, considers it as a cutting tool; he grinds a long bevel back on the blade, and even bevels the bottom side slightly also. He then stones the edge until it is razor sharp, and in using it, holds it at a decided angle on the work. The left handle is further from his body than the right, and instead of giving it a straight pull, he uses a curving stroke, bringing the right hand in closer to the work at the end of the stroke. Thus instead of ripping and splitting the wood, he pares it cleanly, even cutting across and sometimes against the grain without splitting. He didn't learn this technique in a day or a week, however; such workmen are usually apprenticed to their trade very young, and their skill comes with their years of experience. At that, a man with a good rasp will shape up his stock just as quickly as the English workman will with his draw-knife.

The SPOKE-SHAVE is a cross breed between the draw-knife and the plane. The bit should be sharpened like a plane bit, and set in the same manner. Set it for a very shallow cut. It is useful for trimming down the work after the draw-knife, and is used in the same manner,—providing you like the tool. I can do three jobs with a cabinet file while I'm doing one with the spoke-shave, and do them better.

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SAWS: The average man uses a saw very clumsily—and this is nearly always partly due to the fact that he has a very poor tool to work with. The Atkins or Disston saws mentioned in Chapter 3 will do good work from the start, and are easy to keep in shape. Saws for hardwood should have rather finer teeth than those for pine. Keep them well sharpened, and with medium set.

A saw vise costs only about 75 cents, and is essential for sharpening saws. Clamp the saw about 3/8 inch from the edge. Run a flat mill file lengthwise over the teeth one or two strokes, to equalize their length. Then take a slim taper saw file, set it in

most of them to run wobbly. Sometimes this wobble is caused by the bit not being straight, and all bits that are sprung should be promptly discarded. The solid center bits are stronger and generally better than the flat twist in this respect. Keep returning your brace to the dealer for exchange until you get one that is reasonably well aligned. One mistake the beginner makes is to buy the largest sweep he can find—which means a brace that is rather springy, when it should be stiff. Select a heavy brace, with a large, strong chuck, and a sweep of not more than ten or twelve inches—ten is plenty.

There is no reason, traditional or otherwise, for a black or very dark stock. A rich deep brown, with perhaps a slight reddish cast, with the dark and light portions showing in pleasing contrast is, to my mind, the most beautiful stock of all. If you want it black, you can paint it.

VARNISHING STOCKS. Some people think that the only way to finish a stock in a hurry is to varnish it. Personally, I see no

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excuse for a varnish finish in any case, since I can, by one or other of the methods above described, turn out an oil job about as quickly as a good varnish job, if speed is needed.

Nevertheless, varnish is the thing on some woods other than walnut, and since it is occasionally preferred for walnut by some, a few remarks on varnishing are in order.

After the stock has been sanded and "whiskered," as for oiling, mix up some natural (uncolored) wood filler with spirits turpentine until the consistency of thin cream. Apply with a stiff paint brush and let dry for an hour. Then take a piece of coarse cloth such as burlap, and rub off across the grain.

An easy way to hold a stock while working on it is to have a tapered stick eight or ten inches long which will rest easily in the barrel channel. Turn the stock sideways and clamp the forend in vise, using a vise block or felt or leather pad to protect the bottom surface. Now you can use your rag across the grain like shining a shoe. Another good way is to hold the stock in the checking cradle, as described and illustrated in the chapter on Checking.

After rubbing off the filler, let stand till next day, then go over lightly with very fine sandpaper. Wipe off carefully with a clean rag, and be sure there are no particles of grit or dust on the surface. Get 1/4 pint of hard rubbing varnish and 1/4 pint of good spar varnish (Valspar is good; also du Pont's spar varnish), mix the two and pour out about a fourth of the mixture, to which add an ounce of turpentine. Apply this to the stock quickly with light, long strokes, using brush fairly full but not dripping, and "flowing" the varnish with a minimum of brushing. An excess of varnish will run, causing thick places in the finish—this must be avoided. Let dry until absolutely hard. Test by pressing hard with the thumb—if it shows a "thumb print" that won't rub off, it isn't hard enough.

When well hardened, take a thick piece of felt (obtainable at paint stores), dip it into water, sprinkle with powdered pumice, and scour the varnish down to a smooth even surface. Be careful not to grind clear through, but grind off all the "pimples," of which there will be plenty, unless you have a dustproof room in which to do your varnishing. When surface is smooth as possible, sponge off with clean water, wipe dry, and let stand for an hour or so. Then take the remainder of the varnish to which no turpentine was added. Mix in just a few drops of Venice turpentine, and apply a smooth even coat. This should dry for two or three days at least, after which it should be ground as before with pumice stone and water; let stand a day, polish with rotten stone and light oil on felt. Subsequent coats may be added if desired, but will only thicken the varnish, making it more liable to crack.

Some painters prefer to use shellac instead of filler, but it tends to make a more brittle outer coat, and moreover, requires more varnish for a smooth finish than when regular filler is used.

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If commercial filler is not available a good one can be made as follows:

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Powdered pumice or quartz .................1 part
Fine wheat flour ..........................1 part
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Mix to a stiff paste with boiled linseed oil, color with alcanet root, raw umber, or any pigments available to make it dark; thin for use with turpentine as needed. Common putty can also be reduced with turpentine and used for filler in a pinch, but it will be improved by the addition of a small amount of boiled oil and Le Page's glue.

Always use a dark colored filler on a stock that is to be varnished, and a white filler when stock is to be oiled. The oiling will darken the filler, but the varnish will not.

Cherry, Maple, Apple, and other dense woods, or woods that have been stained should receive one or more coats of varnish without any filler. The varnish should all be ground off the surface, leaving it only in the pores. Then a third coat may be applied and ground down very thin, after which such woods will take a nice finish with boiled or raw oil.

Mahogany and similar open grained woods soak up so much oil that it is almost impossible to complete the job. The better plan is to use filler and varnish, applying several coats and grinding each coat down thin; after which apply Formula No. 1, using it like furniture polish. Mahogany and oak are about the two meanest woods to check that I know of.

Once in a while one can get hold of a piece of African Rosewood, and it makes one of the most beautiful stocks imaginable, although too showy for some people. This wood is naturally very oily, and its first treatment should be pure turpentine, which is allowed to dry 12 hours. Then use only boiled oil, and use it sparingly. Rub it in by hand, and grind it off with pumice if it commences to coat the surface. You will secure a beautiful finish very quickly. Rosewood is a little brash for stocks, and would scarcely be selected for guns with heavy recoil, but it takes the checking better than any wood I know of.

LACQUER. Here is the quickest finish of all, and would undoubtedly be more popular if it were better known. In addition to du Pont's clear brushing lacquer there are several other brands almost equally good. No filler and no preparation of the wood are needed, except sanding and whiskering. Support the stock by the ends so that you can work all around it (set it up in the checking cradle if you have one); thin the lacquer 20 to 30 per cent. with the thinner recommended by the maker, and spray it on with a painter's air-brush or with one of the commercial hand sprayers sold for two to three dollars. There's a knack about using one of these sprayers that must be acquired by practice, but once you get it you'll never want to

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use a brush again. A lacquer stock will be dried hard and ready to use in 30 minutes to an hour and the finish will be water proof and nearly all other kinds of proof. It will look for all the world like varnish, but lacks all the disadvantages of varnish. A second application may be used, but is seldom necessary. If you object to the shine, the finish may be dulled by rubbing down with pumice stone and water, using plenty of both.

Lacquer may be used over a stained stock, but not one that has oil in it. It works best on clean, dry bare wood. It is a thoroughly practical finish, but will not bring out the beauty of the grain as an oil finish does. Nothing will.

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CHAPTER 14

REPAIRING AND REMODELING STOCKS

PERHAPS the gunowner may hesitate at re-stocking his gun until experience with tools has given him a measure of confidence. Remodeling an old military stock, or a factory stock, to give a better fit and to conform more nearly to our present ideas of stock design will not only provide excellent practice with tools but will often result in a mighty practical, good looking stock. The job of course calls for far less work than the making of a new stock, and the tedious, particular job of inletting barrel and action is entirely avoided.

The stocks on most military rifles are extra thick and heavy in all their dimensions with the exception of length, and these may often be considerably improved by merely working them down to more comfortable and pleasing size. Sometimes one can take advantage of this extra thickness of wood to do a little re-shaping to improve the handling of stock. An example of this is the Krag stock, which has very little comb. Yet the grip just ahead of the comb is very thick, and will stand some reducing. By cutting down the grip just forward of comb,—in other words, deepening the "hand hole"—the comb is made to appear higher. Thus we take advantage of the grip's thickness by doing all our reducing on the top and sides, and none on the bottom.

Since we have mentioned the Krag, we will take this as an example of what may be done in complete stock remodeling. The Krag stock is longer than the Springfield—in fact, it is a fairly good fit for most shooters "as issued." The comb is too low, and sets too far back; the trip is too thick; it lacks a pistol grip; the butt can stand considerable thinning, also re-shaping, and the fitting of a better butt plate, or a rubber recoil pad.

INLAYING COMBS AND GRIPS. Figure 99 shows what

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may be done in the way of re-shaping the Krag butt stock to give any desired shape and dimensions. The dotted lines show the original shape of stock, while the heavy lines show its final shape after remodeling. The thin solid lines indicate saw-cuts made in the original stock, to which larger pieces of walnut are fitted. The first cut is made in upper side of grip about 1/2 inch ahead of where you want the point of comb to be located. This cut is from 1/4 to 3/8 inch deep, and slopes forward slightly toward the bottom. With the rip saw a cut is made starting at a point on the butt from 1 to 1 1/8 inch below heel; the cut goes forward to meet the first cut. It is advisable to make the saw cut 1/16 inch outside the line, and work carefully down to the line with a cabinet file. Then with file and scraper, work this edge into a perfectly straight line, and scrape out the center of the flat surface to a *very slight* hollow from side to side of stock. Now cut a piece of walnut to fit, leaving it considerably higher than you want the stock. Fit this very carefully with file and scraper, spotting the two surfaces together with blue chalk. Rub the chalk thickly on one surface, then place the other piece against it, and rub back and forward slightly. Then scrape off the spots left by the chalk until the two surfaces are in perfect contact at all points. Be sure to get a good fit at the forward point. Now slightly hollow the surface of the piece being fitted—just a light scrape or two is sufficient. Bore two 3/8 inch holes in stock at the positions shown, for dowel pins. Coat the wood around the holes with dry lampblack. Press the piece into place, so as to get an exact imprint of the holes. Find and mark the centers of these imprints, then bore the holes *about 1/64 inch off center, toward the butt, in this piece.* This causes the dowels to "draw" the piece forward to a very tight fit at the point. Now cut the dowels from a regular hardwood dowel rod, and fit them into the stock, using hot white flake glue. Cut them off so that they project from 3/8 to 1/2 inch, and bevel the ends slightly. *Now work fast*—coat edge of stock and edge of new piece with the hot glue, set the piece in place, force it down on the dowels, and clamp tightly at a point about two inches from each end. Use cabinet-makers' "C" clamps, or if you have a very wide vise, the clamps need not be used. The main thing is to get plenty of pressure, so as to squeeze the glue out of the edge, leaving wood touching wood, with no line of glue between. Let dry for 48 hours.

For a pistol grip, saw the stock at right angles to grip, at a point about 3/8 inch back of end of guard. This cut should be from 1/4 to 1/2 inch deep, depending on the fullness of original grip. The cut must be carried far enough up the curved side so as to provide the full thickness desired in new grip. The common mistake is to make this cut too shallow, making it necessary to flatten the grip like a board when shaping it up. These old stocks are usually of strong, straight grained walnut, with an ample margin

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of strength; and they are not materially weakened by inlaying pieces in this manner, especially if the pieces fit tightly at both ends, thus taking up the back thrust of recoil.

The rear cut should be made exactly where the rear end of pistol grip is to come, and should extend from 1/2 to 11/16 inch into the stock. To locate the position of this cut, lay out an outline of the old stock on paper, then mark out on it the curve and shape of the desired grip, giving the bottom of grip a length equal to the long dimension of the grip cap you purpose using. From 1 3/4 to 1 7/8 inch is about right.

Saw out a block of good sound walnut so that the grain, when shaped into a grip will run well in line with the grain in the stock. By careful selection it is often possible to match the grain. Trim out the wood between saw cuts in stock with a flat chisel, cutting and scraping the bottom of cut to a good straight line—cut a piece of hack saw blade the right length and use it for a straightedge. Scrape the center of this surface to a very slight hollow. Now lay the stock over the block you have prepared, and carefully mark the shape of this dovetail on block with the point of a knife. Do not cut the block quite to the line at first, but fit it carefully and slowly into stock. Chalk the surface of dovetail and start the block in as far as it will go, then work off the chalk smudges as required. It should be a light driving fit, and should always be pushed in and withdrawn from the same side. As you approach the final fit, file the saw cuts at end of dovetail in stock to a *very slight taper,* so that the further in the block is pushed, the tighter it will fit. Now coat both surfaces with hot glue, drive in the block—being careful not to drive hard enough to split the stock. Just a good snug fit is what you want. Then clamp stock in vise for 48 hours, setting up the vise until the glue squeezes out of the edges.

In using hot glue, it is important to get the work clamped within a few seconds from the time glue is applied. It starts to cool and set very quickly, and the difference between a perfect joint and a shoddy one that will sooner or later break depends on getting the two parts together and under pressure without loss of an instant. The right kind of a glued joint is invariably stronger than the solid wood around it—the wood usually breaking under strain before the joint will let go.

If desired a dowel can be put in through center of pistol grip, but it is not really necessary. The best plan is to use a grip-cap screw long enough to reach 1/2 inch past the joint. The hole for this screw should be larger than the threads before the joint is reached, so that only the threads that are in the stock itself do the holding. Thus the strain constantly draws the two pieces together.

RESHAPING BUTT. Next comes the shaping up of the butt, which shape of course will be governed by the shape of your butt plate. If you have a good shotgun type butt plate it will be nearly

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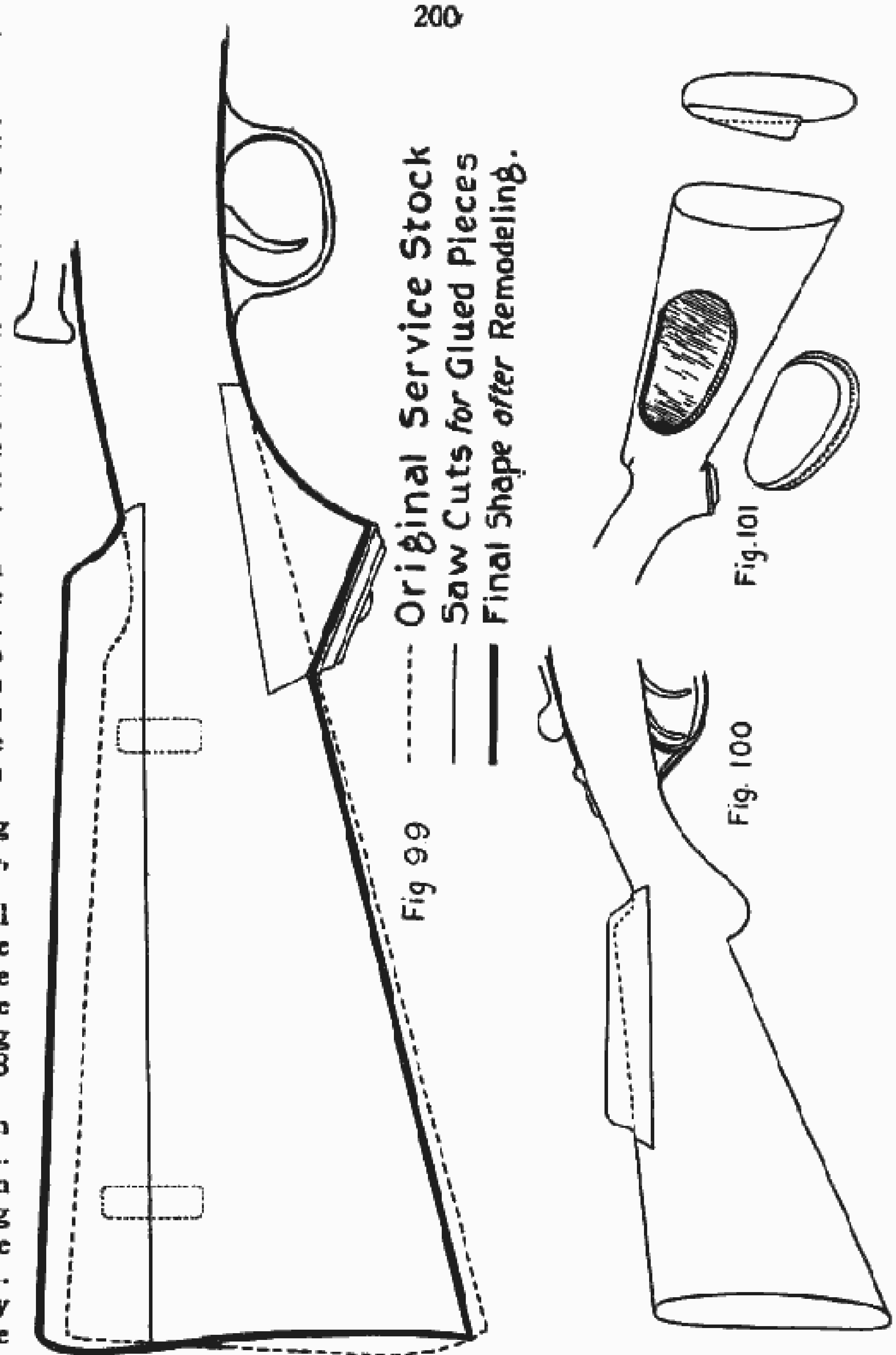

Fig 99

Fig. 100

Fig. 101

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as wide, perhaps, as the service plate. However, the butt will very likely have enough thickness to spare to enable you to give the stock a little castoff if desired. (See Chapter 9.)

First rasp off the end of piece glued on top of stock, and work down the butt from heel to toe to approximately the pitch desired—remembering that most buttplates are thicker, or have a slight hump at heel, which increases the pitch. Then find exact center of stock and mark a line from heel to toe. Now if you want castoff, mark the castoff center as described in Chapter 9, and run a line from this point to center of upper and lower edges of grip, just back of tang on top, and just back of guard on bottom. If no castoff is wanted, merely run the lines in exact center of stock.

The fitting of the buttplate or rubber recoil pad, and the shaping up of stock, are done in the same manner as for a new stock—the difference being that in this case there is less work. All of the remaining surface of the old stock should be filed off a trifle, as the wood is likely to be well soaked with oil and grease, and a fresh clean surface is desirable for the new finish. Moreover, oiled wood does not sandpaper very smoothly, but remains "fuzzy" regardless of the time spent on it.

If a grip cap is used, fit it as soon as the grip is roughed nearly to size, then work to the edges to get the final shape.

There have been some fearful and wonderful suggestions for stock remodeling contained in various magazine articles, from time to time. One man, I recall, said he fitted a small wedge-shaped piece of walnut to the toe of the Krag stock, where it is rounded off. It may be that he was able to do a good job and make the stock look like something, but personally I don't care for such tricks. If the grain of such a piece runs with the grain of the stock, it is almost sure to split sooner or later— and probably sooner. Moreover it will look just like what it is—a patch. And finally there isn't one man in a thousand who could fit such a piece without having the paper-thin edge chip or break, leaving a small gap under the buttplate. The thing to do if you want to get rid of this rounded toe—which incidently is not a bad thing, as it prevents the toe of stock cracking off when struck on the ground, is to shape the butt as shown in Figure 99, which gives four or five inches pitch, and is mighty comfortable either offhand or prone. If this makes the stock too short, a recoil pad can be used to lengthen it up to 7/8 inch, or one of various other methods may be used.

LENGTHENING STOCKS. One way to lengthen a stock is to cut a walnut block, with the grain running in the direction of the stock, fit and glue it to the butt, which has first been sawed off square and the surface accurately finished. I am unable to consider this at all good practice. First, it looks like a patch, which it is. The grain cannot be well matched, nor can a good joint be made. Due to the grain running the short way of the block it is difficult to get a per-

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fect glueing surface, and when sufficient pressure is applied for a glued joint, the block will likely crack. Nevertheless, this practice is often followed, so let your conscience be your guide. Use the "C" clamp or the fork clamp illustrated in Chapter 4 for clamping the block in position, and have a hardwood block under the setscrew.

Sometimes layers of heavy leather are used to lengthen the stock. This makes a fairly good looking job, and also makes it easy to fit the butt plate, because there is a certain amount of "give" in the leather. The pieces should be cut a little larger than the butt; coat both sides of all but the outside piece with du Pont Cement, and clamp in position as already described. Let dry 48 hours or longer. Then fit butt plate, using file and sandpaper to shape the leather butt, attach plate, set the screws up tight, then buff off leather on sandpaper wheel, as described in Chapter 11 for fitting rubber recoil pad.

Another material that may be used in the same manner is fibre. Strips of red and black fibre cemented alternately give a good appearance and look less like a patch than leather. Moreover, they take a better finish. The linseed oil used for finishing the stock does not do so well on leather, so that it is necessary to do a lot of extra rubbing with shoemaker's "heel ball," beeswax, etc., to complete the finish on the leather—then it will be rough most of the time. No special treatment is needed for finishing the fibre—just sand and oil it when finishing the stock.

A butt extension block may also be made by glueing up thin layers of various colored woods—maple, cherry and ebony, for instance, and this may be fitted and glued to the butt, giving a very good appearance.

When fitting the piece to upper edge of stock from which the comb is shaped up, be careful about holes in the butt. In some rifles these will be so close to upper edge that you will saw into them when making the cut for this piece. In that case it is advisable to measure the holes and turn up walnut plugs to a tight push-fit and long enough to fill holes completely. Don't get them too tight. Coat them with hot glue, apply glue in the holes, and drive in the plugs. Afterward the stock may be recessed as desired for a trap butt plate.

PATCHING. I have often seen instructions for building on pistol grips which recommended hollowing out a block of walnut to fit the round side of the original grip. I don't like this for two reasons. First, because the correct fitting of the round surfaces runs into more time than anyone is willing to pay for; and moreover, due to the oil in the wood, the glue joint is going to have mighty little strength, requiring a long screw or a dowel to make it secure, and even then it will probably come loose in time. Finally, the feathered edges of the false grip where they join sides of stock, are bound to show, even if the grip is checked. It's just contrary to the laws of woodworking to get a good joint in this manner. If

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one feels that the dovetail method is likely to weaken the stock, he may use the other way if desired; but I never knew a stock to break because of a dovetail grip.

When shaping up a stock on which a false comb has been glued, it may prove necessary to undercut the comb slightly (See Chaper 9), as the original stock is not very thick at that point, and the piece may have a square edge showing after shaping to required thickness. Undercutting here brings the surface smooth and also helps the appearance of stock.

The foregoing will apply to a number of stocks having straight grips, when it is desired to have a pistol grip. Some rifles have a long tang extending back of trigger guard, and on such the practicability of fitting a pistol grip depends on the type of action. If the tang is merely to strengthen the trip it may be bent to the desired curve, then the grip dovetailed in, and tang inletted into it, thus adding strength. Quite often some of the action springs or other working parts are attached to this lower tang, in which event some careful study is advisable before attempting to change its shape. An example of such a job will be found in the description of the remodeled Single Shot Winchester described in Chapter 30. Chapter 24 also gives detailed instructions for bending tangs, and making necessary inside alterations.

The shotgun owner whose stock has a pistol grip back under the middle of stock where it does no good, may decide the stock would look better with a straight grip—and usually his decision is the right one. It is quite easy to make the change. Set the stock in the vise and saw off the grip, then use the cabinet file to round off edges to conform to the lines of stock. Be careful not to file further into the checking than necessary. Carefully sandpaper the bare portion, then straighten out the tang of trigger guard. Most shotgun guards are made of soft iron and may be re-shaped cold. Use a smooth faced hammer, and rest the guard on a steel, iron or brass bench block with a heavy leather on it. When the tang is the right shape, screw in the guard, then inlet the tang into the stock, as described in Chapter 10. Finally refinish the bare spot and check the grip, following the lines of the original checking as far as they go, and using a checking liner *exactly* the same width as the original diamonds. Don't try to get by with a liner that is *almost* correct,—your checking will come out all galley-wampus. If you haven't the right size liner, make another.

REFINISHING. Any stock having an oil finish may have any part worked off or reduced in size; after which the bare spot may be finished to match the balance of stock perfectly. Just follow instructions for finishing new stocks, doing most of the oiling on the bare spot, and then working on entire stock as the finish nears completion. Altering or cutting down a varnished stock necessitates, or should necessitate, complete refinishing. Some gunsmiths would rub

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over the spot with oil and shellac, or try to "splice" the varnish. To do the job right, remove all the old varnish, prepare the stock for a new finish, and oil or varnish as desired.

The trapshooter may take a notion he wants a Monte-Carlo comb on his gun. No reason why he can't have it. Cut down as shown in Figure 100, make and fit the block in same manner as the grip was fitted in Figure 99—that is, slightly wedging the dovetail. Drive in the block snugly with plenty of hot glue, let dry a couple of days, and shape up as required—then refinish stock. In this instance it will probably be impossible to carry the comb forward very much as most shotguns have upper tang extending back nearly to the comb. This job should not be attempted on any gun like the Winchester hammerless pump, or the Remington or Browning Automatic, or any gun having an attachment screw running through the grip from the butt, or any part of the "works" such as recoil springs, etc., located in the grip.

INLETTING CHEEKPIECE. Making and fitting a cheek piece to a stock originally made without one is a job no one need be afraid of. Select a piece of walnut matching the stock in grain and color. Cut it to size and shape desired, leaving a base portion about 1/8 inch thick at lower edge, and 1/4 inch thick at upper edge. This piece may be practically finished around the edges before any work is done on the stock. Lay it in position on stock and mark around it carefully with knife point. Cut out the seat in stock, removing more of the wood at the upper edge than at lower edge of recess. Fit the cheek piece into this depression with chalk, spotting both surfaces into perfect contact. Use hot glue, and leave the stock clamped for 48 hours or longer. Then round off upper edge to conform to lines of stock and shape up cheek piece on surface as desired, then refinish entire stock. Fitted in this manner there will be no visible joint except along top edge of comb, and if the wood matches and the fitting is carefully done, this will be well-nigh invisible. Figure 101 shows the method of fitting the cheek piece, also a sectional view of the stock recess. No dowels, screws, pins or nails are needed if your glue is good and the fitting properly done—there is no strain on a cheek piece.

REMODELING BUTTPLATES. The question of a suitable buttplate usually comes up when remodeling a military or factory-made stock. Military buttplates were designed—apparently—for making dents in the armory floor. However, the military plate may often be remodelled as outlined in Chapter 24, which also describes the making of special buttplates.

The Mannlicher-Schoennauer buttplate is almost ideal in shape and size, and has the very desirable long trap for cleaning materials. For strictly offhand shooting it is ideal. Many, however, find it unsuited to prone shooting, as it is more deeply hollowed than the shotgun plate, and has considerably more "hump" at the heel. This

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plate may be purchased from Von Lengerke & Detmold, of New York City. The Mauser sporting type buttplate is even better designed and better made. It is a heavy drop forging, and the trap is set in on a square milled cut around the edges of the hole, instead of being merely bevelled. It is a trifle smaller than the other, being barely 5 inches long, which will take it out of the running for those demanding the largest plate obtainable. The Mauser plate may be had from A. F. Stoeger, Inc., New York City. The Mannlicher-Schoennauer plate has deep cross corrugations, while the Mauser plate is smooth. It may be corrugated or checked, or may be given a sharp matted surface by stippling, as described in Chapter 19. This, to my mind, is the best way to roughen up a buttplate. It takes mighty little roughening to prevent a steel plate from slipping on the shoulder. Some insist on having deep coarse diamond or square checking on it, or very deep cross corrugations, in the belief that anything else will slip. I like to shoot with as few clothes on as possible—particularly as little as possible on my right arm and shoulder. And I have come in with the print of a very rough buttplate clearly stamped on the skin of my shoulder and the blood showing through—this through an O. D. Shirt and underwear. Such a rough buttplate will stay put not one bit better than one with almost a smooth surface, and is far easier on the shoulder. Fine diamond checking or cross scoring or fine stippling only are needed.

RE-SHAPING FOREND. Re-shaping a military forend into one more suitable for sporting use is generally easy because there is plenty of extra wood to work on. The different kinds and shapes of forend tips are described in Chapter 9, and one may work out almost any shape desired, so long as it is not larger than the original forend.

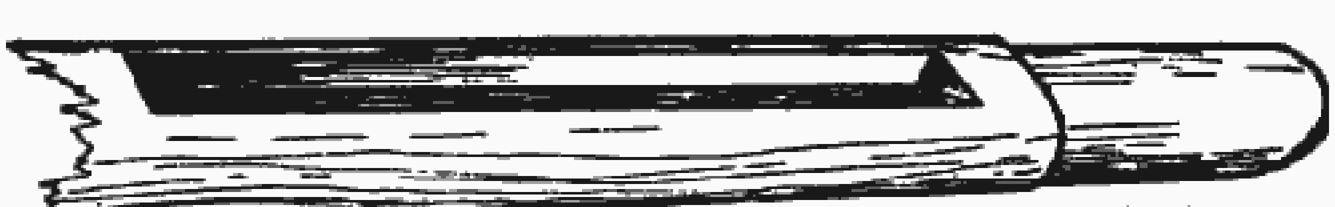

Fig.102

Even then it is entirely practicable to square up the sides, dressing off enough of the original wood to get rid of the oil, and glue on slabs which are later worked down into a beaver-tail forend.

One may object to the hand-grooves along the sides. These can be removed by cutting them out to a wide V-shape as shown in Figure 102, then planing down strips of walnut to match and glueing them into the grooves. This is much easier and makes a better joint than trying to fit pieces into the round grooves, and it also gets rid of the oil, so the glue will hold. Use hot glue, and lay a strong

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strip of wood over each of the strips, then clamp in the vise for 48 hours before shaping. The strips should be spotted in with chalk, same as other patchwork, and don't depend on the glue filling up any gaping edges, because it won't. The instant the checking tool hits it, it's out. Fit the strips tight at all points.

Most military stocks have deep channels cut in the forend under the barrel to lighten the stock. Usually cutting the forend to sporting length exposes one of these at the end. This one must be filled to make a good job. I usually use a piece of solid wood from the same stock, taken from the muzzle end where there is no channel —this gives a piece of walnut that will match. Square this piece

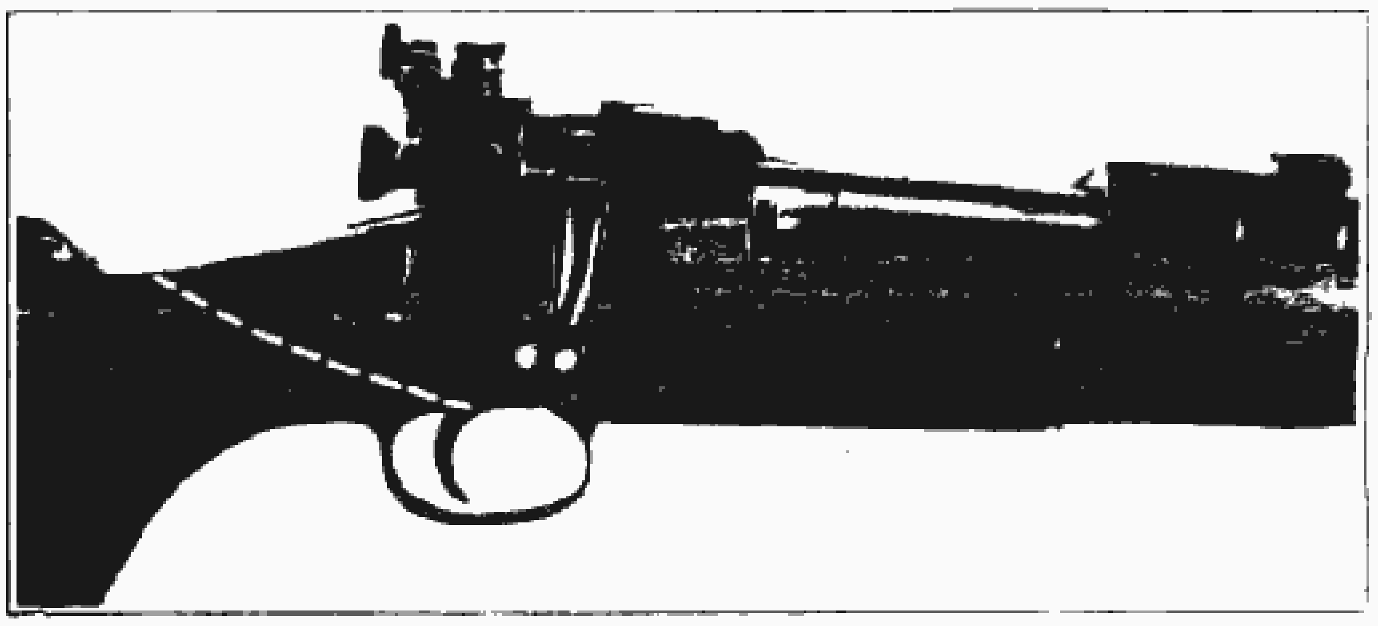

Fig. 103

up to a snug sliding fit in the hollow under barrel at muzzle. Coat it with hot glue, or du Pont cement, also coat the inside of hollow. Slip it in place, and clamp in the vise from side to side, also use a small clamp from top to bottom. Or, place a round stick on top in the barrel channel and clamp from top to bottom of forend in the vise, using a hand clamp against the sides. When dry, cut the heads off four small cigar box nails, and drive them in, two on each side, sinking them well below the surface. When the stock is sanded and oiled the holes will close up and will not be noticeable.

The barrel is held to the forend by the original outside band, or by one of the inside bands described in Chapter 24, according to the design of your forend.

REPAIRING BROKEN STOCKS. Sometimes—but not often —a broken stock can be repaired to make it as good as new, and as strong. Usually a new stock is indicated. Since no two breaks are exactly alike, the exercise of a little ingenuity is usually required to decide how to make the repair and whether or not any repair is practicable.

Stocks of bolt action rifles, if they break at all, usually break across the grip as indicated by Figure 103, or else split vertically

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back of the tang screw. The former is caused by improper selection of wood, so that the grain at grip runs downward toward the guard, or by too small a grip, or both. The split back of tang is caused by incorrect inletting of the action, leaving it too tight against the wood on sides of receiver, especially toward the rear where the tang tapers;—this, and lack of support against the shock of recoil thrust.

A grip broken like Figure 103 always calls for a new stock. It may be repaired to give service for a time, however, by coating both surfaces with hot glue or du Pont cement and clamping together under heavy pressure. Then put two brass wood-screws in each end, drilling the holes carefully to avoid further splitting. Then wind the entire grip tightly with copper wire, using about No. 24 gauge size. Fasten the wire at beginning of winding by laying the end under five or six turns. Wind on evenly and smoothly over the entire break, then fasten the end by holding tightly and running on solder for about an inch to hold it to the last winding. Cut off, leaving about an inch project, and force this under the windings. Coat the wire all over with solder, working it well in between the windings with the soldering copper, uniting the wires into a solid covering. Then dress off the surface smoothly with emery cloth. A repair of this kind will occasionally prove as strong as the stock was originally, and equal to it in all respects except appearance.

Once in a while some maker will let his enthusiasm for beautiful grain run away with him to the extent of making a stock with curly cross grain at the grip. I was recently called on to repair a broken grip like Figure 104, which shows the direction of the crack on both sides. The grain ran almost at right angles to the grip, and the break had followed the grain, extending almost to the bottom on right side, and about half way down on the left. This was a hign grade English 8-bore, and it was desired to make a permanent and invisible repair if possible.

After removing the action from the stock, the latter was held tightly in the vise, with felt covered blocks gripping the grip just back of the crack. A red fiber block was then laid in the upper tang channel, and vigorously hammered until the forward portion broke off, the crack continuing in an angle forward through bottom of lock recesses. Various trials showed that there was no way to hold the parts together with clamps, and that only the action itself would hold them. Both of the broken surfaces were then slightly coated with du Pont cement, which was allowed to dry a few minutes; they were then placed together and the action parts fitted, with a layer of blotting paper under the tangs to provide extra tension, then the screws set up as tightly as possible. The edges of tangs were lightly greased to prevent the cement sticking where it oozed out. The stock was left without touching for nearly a week, then the action

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removed and the repair tested by putting a block of fibre in upper tang channel and hammering, as when breaking off the piece. When the stock showed no signs of letting loose under some pretty vigorous blows, it was decided the job might hold. Then to further reinforce it, a round-head brass wood screw 2 3/4 inches long was turned in as shown in Figure 105. The hole for this screw was drilled starting just below the lock plate shoulder in extreme rear of lock

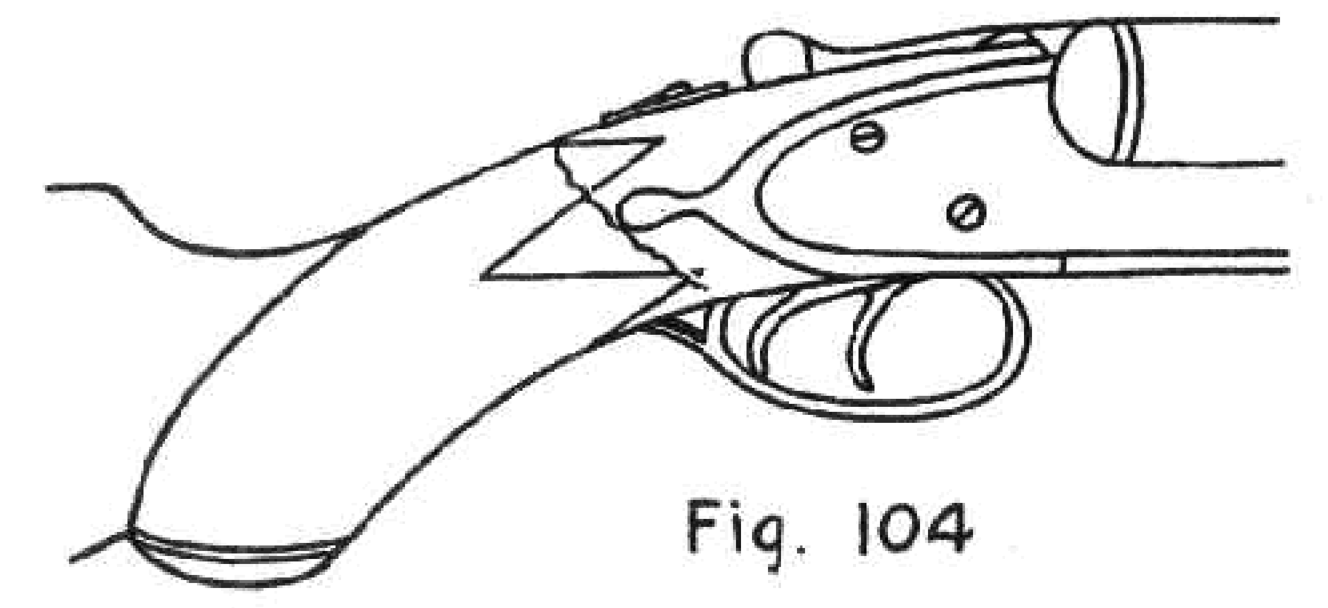

Fig. 104

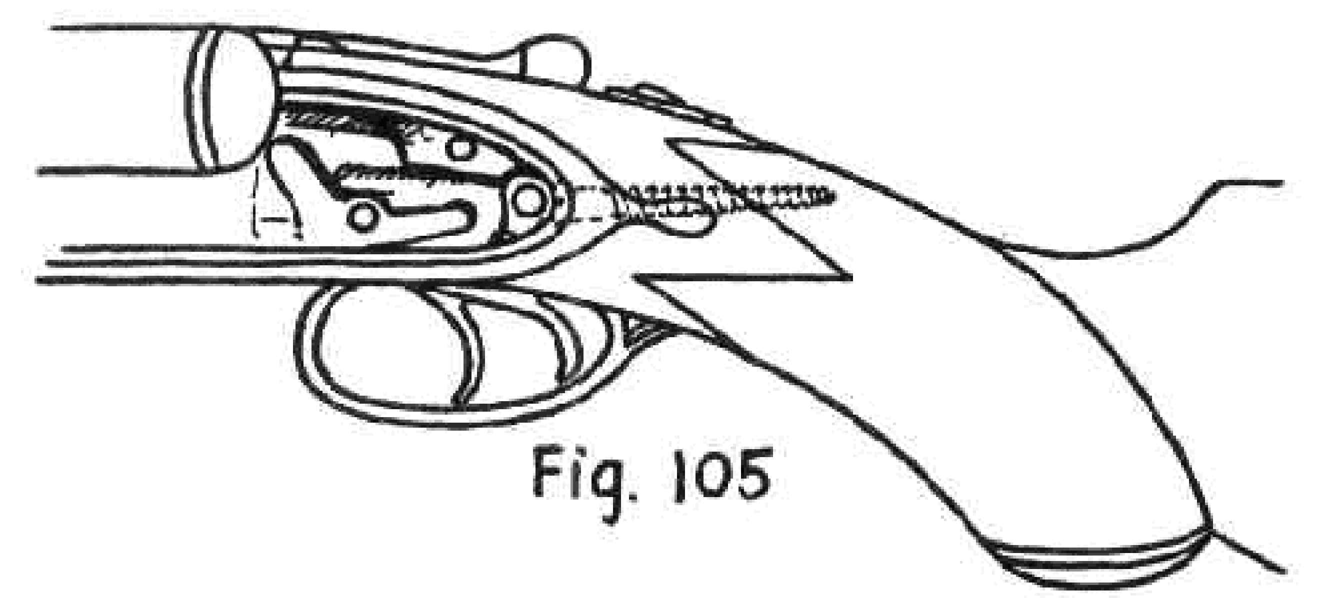

Fig. 105

recess, running back at a sharp angle almost in line with the stock and nearly at right angles to the break. Outer end of screw hole was drilled body size, the threads being allowed to take hold only in the inner end of hole, to give a good draw. This screw was then turned up very tight. Then the surplus cement was carefully scraped from the edges of the break, and the wood dressed down on edges where they showed on bottom under the action recesses by scraping and fine sandpaper. Most of this break had occurred in the checking of the grip, so all the checking was completely retraced with the V tool after the stock had been re-finished. I don't know whether this repair held, but have heard nothing to the contrary from the owner to date. I would expect it to hold indefinitely.

Because of the perverted ideas of some factories with regard to

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pitch and shape of buttplates, splitting off the toe of a stock is a common occurrence. It doesn't take much of a blow when dropping the gun on the butt to split off a piece two or three inches long. The ideas of some mechanics relative to repairing such breaks is occasionally startling. A Model '99 Savage was brought to me recently on which a broken stock toe had been repaired by drilling a hole through the butt edgewise, from heel to toe, through which a long stove bolt had been inserted. The nut had been set up tightly with a washer under it, and the end of bolt peened or riveted to keep the nut from coming off. When I called the owner's attention to the fact that the stock was loose and wobbled on the receiver, he asked me to tighten it, and was quite surprised when I told him there was no way to get a screwdriver in to the butt screw past that stove bolt! After several futile efforts to slip the screwdriver past the said bolt, he instructed me to make a more satisfactory repair, which was done by grinding off end of bolt and taking it out, gluing on the broken toe, and reaming out and plugging with walnut the holes in toe and heel, then refinishing stock.

INLAYING AND PLUGGING. Plugging holes in this manner is a job requiring some care. The holes should first be cut out true with a Forstner bit. Then turn the plug to exact size, making a snug fit but without enough pressure to cause splitting. The easiest plug to make is of course the one with end grain exposed, but it is more conspicuous on the stock. To make a plug with side grain exposed, screw a piece of pine onto the face plate of the lathe, and on this glue a 1 inch thick piece of walnut. Set the tool rest across the bed, that is parallel to the face plate's surface, and turn the plug from the end, same as when turning a disk; then cut off to the required length. Half an inch is plenty in most cases, and the grain may be lined up with the grain of stock, then, when oiled, will take the same finish and be almost unnoticeable.

Small inlays are easily made from walnut, bakelite or fiber to fill up recesses left by removing swivels and the like. To get the shape required, coat the stock around the recess with dry lampblack, press a piece of white paper over it, then trace the impression on the piece from which the inlay is to be made. Shape up the inlay carefully, with a file, trying often for fit, and tapering the edges slightly. Coat inside of stock recess with du Pont cement, also coat bottom and edges of inlay; press into place, cover with paper, and clamp in vise. when using the vise for clamping, if the jaw is not swiveled to turn at an angle, make a wedge shaped piece of wood to give the required fit to parts being clamped.

Sometimes in remodeling rifles—the Krag is an example—it will be desired to use the handguard in order to cover sight screw holes, or rough places on the barrel. Figure 106 shows a method of remodeling a handguard. The rear sight hole is cut to a dovetail, into which is fitted a thick block of walnut. Coat edges of dovetail and bottom

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of block with du Pont Cement, slide the block in tightly, and clamp in the vise with light pressure. When dry, the projecting top of block may be held in the vise while inside is dressed out with a hollow chisel to conform to the curve of barrel channel. Then, holding the block in vise so that handguard stands vertical, saw off

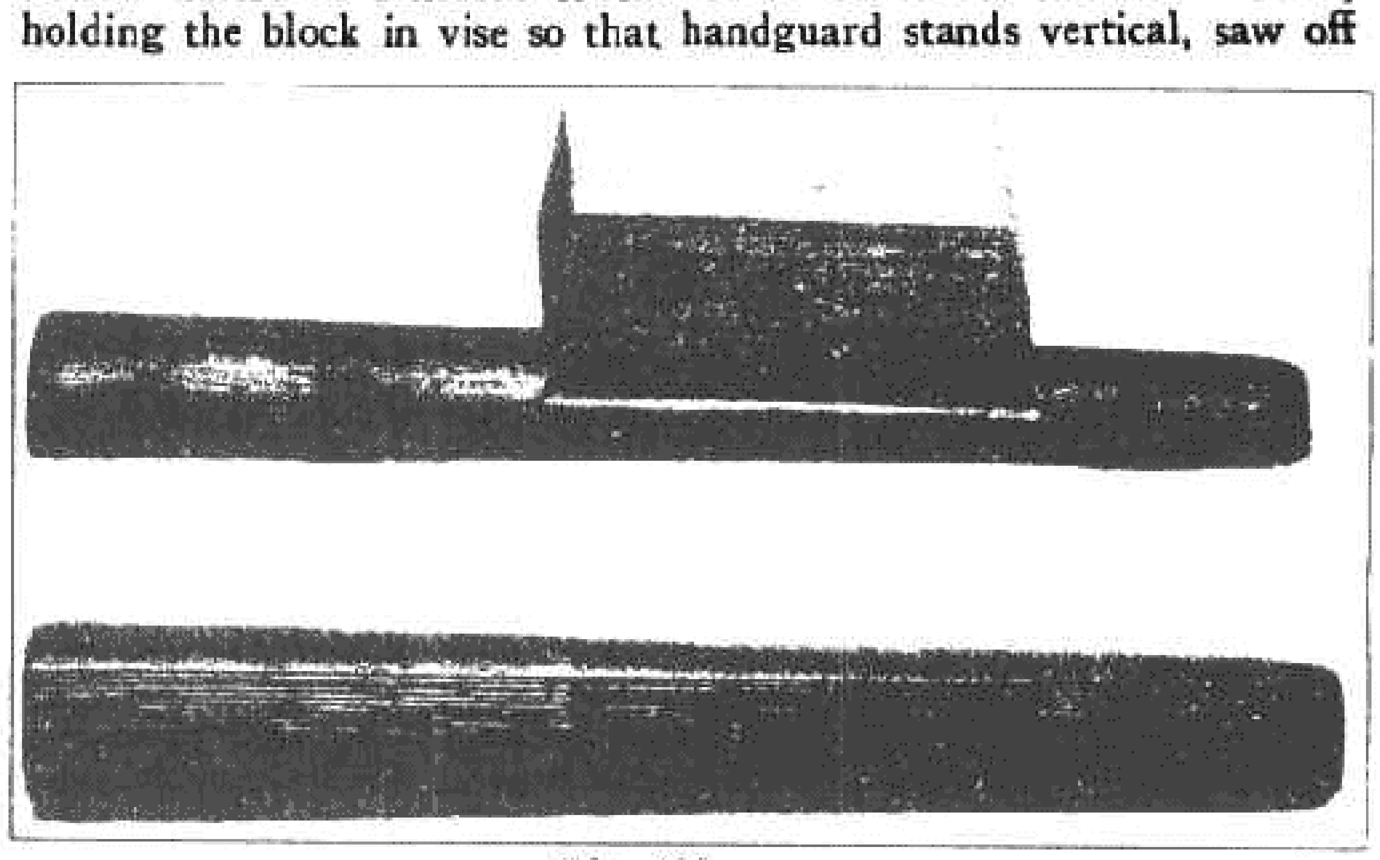

Fig. 106

excess wood, snap handguard into position on rifle, and round off top of patch with cabinet file. Smooth up with sandpaper and oil to match rest of guard. This job will be further improved by checking the upper side of guard in a strip half an inch wide, or by scoring it lengthwise with the line spacer.

SPLIT GRIP. When a rifle stock is cracked at rear of tang, the best thing to do is to get a new stock. A temporary repair may be made by forcing the crack open as far as possible with a thin bladed chisel, and squeezing in some du Pont cement. Clamp stock firmly in vise until cement dries, then drill through stock from side to side and insert a 1/8 inch brass screw. Countersink the head, and also countersink on other side and set up a small nut as tightly as possible. Cut off end of screw and rivet slightly to prevent nut turning. If a high power rifle having considerable recoil it is advisible also to wrap the grip with wire, and solder the wire, as already described, or at least to wrap it tightly with surgeon's adhesive tape. A roll of this tape an inch wide should always be carried in the field kit for temporary repairs.

After repairing the break the next thing is to remove the cause. Don't expect a stock to fit if the action is able to exert a splitting effect every time the gun is fired. First scrape the inside of all action cuts clean, then coat the action with lampblack and oil and fit into place. Relieve all pressure at sides, particularly the rear, by cutting

out wood, just as in fitting the action into a new stock. If the smudges indicate the recoil lug has not a good bearing against the shoulder in stock, insert a metal plate as described in Chapter 10. Then assemble, and set up the screws very tightly. In doing this be sure the screws are not too long so that their points bear against bottom of hole, stop them before they are exerting pressure on stock. If such is the case, grind or file off the points sufficiently to give them good tension.

Stocks having small splits lengthwise can sometimes be permanently repaired by breaking them entirely apart at the splits, and gluing, either with hot flake glue, or with du Pont cement. For small surfaces I find the latter best, while I like the glue for large joints. The pieces must be broken apart carefully, with due care not to bruise the edges; also, take care not to lose any small splinters that may develop. They should be kept in position, leaving one end of splinter attached if possible. They must be coated all over with the glue or cement, and worked carefully in their place before the parts are clamped. Perfect contact and tight clamping are the secrets of good glued joints. Merely "pressing parts firmly into place" as the directions say, or binding with twine, will not answer—get a hundred pounds or so pressure on them, and leave it a while! *The more of the glue or cement you can squeeze out of a joint, the better and stronger the joint.*

REMOVING DENTS AND NICKS. Stocks that have been badly marred by an accident can often be brought back to new condition by careful treatment. Examine the places and decide whether they are merely dents, or whether they are nicks. If no wood has been gouged out, dents can easily be raised up even with the surface. Fold several thicknesses of cotton cloth, wring it out in water and lay over the spot. Take a hot flatiron and rub it over the cloth, wetting the cloth and repeating again until the dent is raised level. This will do for shallow dents. For very deep dents, take a can holding a gallon or so and having a tight fitting lid. Punch a hole in lid and solder into it a small piece of brass tubing, over which slip a rubber tube long enough to handle conveniently. Make a nozzle from a six inch length of brass tubing fitting tightly into the rubber. Pinch the outer end together and solder, then drill a 1/16 inch hole in one side near end.

Fill can two-thirds full of clean water and set it on the fire. When it starts boiling, pinch or clamp the rubber tube until you have a pretty good head of steam. Then turn the small jet from the nozzle into center of dent. Work it round over the sunken spot, lightly tapping the wood around dent with a small, smooth hammer. It may take several cans of water to do the trick, but dents which look utterly hopeless can be raised in this manner, which is employed in furniture stores to recondition pieces damaged in shipping. The more steam pressure you have the better. A good "corn" still of heavy

copper, with a strong screw cap, would of course be better than the can I have described.

Steaming out a dent by either of these methods will not hurt an oil finish except at the place where the steaming occurs. The spot when dry should be smoothed off with very fine sandpaper, and re-oiled until it matches the rest of stock. A varnish finish will of course be ruined by the steaming, and that is a good time to decide to remove all the varnish and oil finish the stock.

Sometimes a stock will be gouged or scratched on barbed wire, sharp rocks, etc., and of course when wood has been removed, no amount of steaming will level the surface. Very slight scratches and nicks are best removed by rubbing out with fine sandpaper, then refinishing the spot. A real bad gouge must be filled up. Plastic Wood is very good for this purpose if properly handled. All varnish or oil must be scratched out from the gouged spot, exposing the bare wood. Take a small lump of plastic wood, which is soft and works like putty, and force it into the hole. Smooth off the surface, letting it extend slightly above the hole, and when dry and hard it may be dressed down even with a fine file and sandpaper.

Plastic wood after drying does not take stains readily, and as it is nearly white in color it should be stained before drying. As soon as it is worked into the hole (it begins to set on the surface very quickly) work in a little raw umber or other coloring—even a drop of common brown paint will do in a pinch. Work this well into the surface, but don't work it into the entire mass, or it may cause it to loosen. After it has dried a day or so it may be smoothed down and oiled, using plenty of alcanet or other coloring in the oil.

Instead of Plastic Wood, a mixture of powdered walnut with glue or cement may be used, and this will have a much better color. Set a block of good hard walnut end grain up in the vise and use a moderately fine bastard cut file to make the powder. Sawdust or coarse filings do not work well. Coat the inside of hole with du Pont cement, then very quickly mix some of the cement with the powdered wood to the consistency of the stiff putty, and force it into the hole. Build it up a little higher than the surrounding surface, as it shrinks in drying. Then file and sandpaper smooth, and oil. This mixture should dry two or three days before being filed off. Le Page's glue may be used instead of du Pont cement, but the latter makes the hardest and best repair. Hot glue does not work well for this purpose.

Sometimes when remodeling the service stock of a military rifle, (our own Springfield for example), the barrel channel in forend will be found much larger than the barrel, not touching it at any point. This is called a "full floating barrel." Rather than making a slipshod job by gluing strips against the sides of barrel channel, measure this channel carefully with dividers, and turn up a piece of wood in the lathe to just fill it snugly. Glue this piece into the

channel, and when dry cut off the projecting upper half with ripsaw, and plane down level with edges of stock. Then cut a new channel, same as when inletting a new stock, to fit the barrel snugly at bottom and sides. The cutting of a barrel channel is not the difficult job which many suppose, particularly when the action is already inletted.

Another way which I have never seen but have had described to me as entirely successful is to fill in the square grooves under barrel with strips of wood, then quickly pack Plastic Wood into the barrel channel and press the barrel firmly into place, letting it form its own channel, and leaving it there several days until the Plastic Wood is thoroughly dry. The barrel must be covered with a light coating of grease to prevent sticking. My suggestion would be to use Plastic Wood except at the upper edges, and use the powdered walnut and cement mixture here where the filling will show.

While the Springfield service can be remodeled by piecing out where needed, there is little reason for doing so with the D. C. M. Sporter stock available at five dollars to members of the National Rifle Association.

CHAPTER 15

RIFLE BARREL DESIGN AND FITTING

WE debated a long time as to whether we would include instructions for boring, reaming, and rifling barrels in this book, and we decided not to for several reasons. These operations are a separate art in themselves, and a very specialized art in these days. To describe them would require several hundred pages, and such description would be intelligible only to a trained machinist or toolmaker, who alone is competent to undertake such work. While it is possible for a very skilled and ingenious machinist to set up an engine lathe to bore, ream, and rifle a barrel, yet generally speaking, heavy and expensive special machine tools are necessary for this work, and these are far beyond the resources of the small professional or amateur gunsmith, necessitating a large and expensive layout which must be in addition to a general purpose machine shop, the latter being needed for related work and for tooling up for the rifling operations. Even a very modest equipment may easily run to $25,000 or higher. The various boring bits, reamers, and rifling cutters cannot be bought, but must be made, hardened, and ground by the workman himself, who must have the necessary skill. Such skill cannot be taught in any book, but requires years of training in general machine work.

There are a number of large companies as well as small firms in this country who supply professional and amateur gunsmiths with barrels bored and rifled to order to any specification at a reasonable price. It is also often entirely practical to remove barrels from certain rifles, such for example as the surplus military rifles which have been sold in large quantities and at low prices since the World War, and fit these barrels to other receivers and chamber them as desired. In addition barrels for the Springfield rifle can be bought by members of the National Rifle Association through the Director

of Civilian Marksmanship, and these barrels can be cut off at the breech, be rethreaded, fitted to other rifle actions, and rechambered, or of course they can be fitted to the Springfield breech action by anyone having the necessary headspace gages. We are therefore going to confine ourselves to giving the gunsmith that information which will enable him to draw up proper specifications for his rifle barrels, to fit them to proper breech actions, and if necessary to chamber them for the cartridge desired.

BARREL STEEL: In general the steel used in the manufacture of rifle barrels may be divided into four classes:

1. Black powder barrel steel.
2. High power carbon steel, sometimes called "Ordnance Steel."
3. Nickel steel.
4. Stainless or rust proof steel.

Under these general classes each barrel manufacturer has his own specifications as to chemical composition and physical properties under which he buys his steel from the steel mills in the form of long bars. It would do us little or no good to know all these specifications in detail, so instead we will look at the general properties of these four classes of barrel steel.

BLACK POWDER STEEL, the steel generally used before the advent of high power cartridges and jacketed bullets, is generally a rather soft, simple carbon steel. It is easily machined, and works up into a smooth, even, and uniform bore and rifling. Its limitations are that it has not the tensil strength and elasticity for cartridges giving breech pressures over about 25,000 pounds per square inch, that is for high power cartridges, and it often wears out very quickly from friction when bullets jacketed with hard metals are used. For .22 and .25 caliber rim fire rifles to be used with lead bullets exclusively it is probably as satisfactory as any of the other classes of steel, and it is believed that its use should now be restricted to these calibers of rifles.

HIGH POWER CARBON STEEL, or Ordnance steel, is the steel now being used by a majority of the manufacturers of high power rifles, including Springfield Armory, The Remington Arms Company, and the Savage Arms Corporation. It is an exceedingly satisfactory steel for all kinds of rifle barrels, being easily machined, having high tensil strength, excellent wearing qualities, and making very fine barrels. A typical composition of such steel is:

Carbon	0.45 to 0.55
Manganese	1.00 to 1.30
Phosphorus (max.)	.05
Sulphur (max.)	.05

Often it is heat treated to increase its yield point and its ultimate strength, which in Government barrels are about 75,000 and 110,000 pounds per square inch respectively.

NICKEL STEEL is used for barrels by the Winchester Repeating Arms Company, the Niedner Rifle Corporation, and several small barrel makers. It was also used at Rock Island Arsenal at the time that a portion of the Model 1903 rifles were being made there. Theoretically it is the best steel for high power rifle barrels, and it is used almost exclusively in England for this purpose. It is slightly more difficult to machine than carbon steel, sometimes requiring a slight change in tools used. It has high tensil strength, excellent wearing qualities, slightly more resistance to corrosion than the ordinary carbon steels, and makes most excellent barrels. From an entirely practical point of view it has not been demonstrated that nickel steel is markedly superior to carbon steel for rifle barrels, but most riflemen think it is. Certainly among the older and more used rifle barrels in the writer's gun-room, the nickel steel barrels seem to have worn less, and to be brighter and in better condition than carbon steel barrels of similar service. Much of the popularity of nickel steel for barrels is due to its use by the Winchester Repeating Arms Company, who for thirty-five years have been manufacturing barrels of this steel which have been superb in their workmanship, accuracy, and wearing qualities. The chemical composition of Winchester nickel steel is 3 1/2 per cent. nickel and 0.30 to 0.40 carbon, and it is made by the acid open hearth process.

As this chapter is being written STAINLESS OR RUST-PROOF STEEL, is coming more and more into use for a great many purposes. Whether it will be the barrel steel of the future or not cannot be foretold at present. Some of the earlier forms, such as Poldi "Anticoro" steel and Boehler "Antinit" steel, have been imported from Austria and Germany for some years and used in rifle barrels. The chemical composition of these two steels is not known. The American so called "Stainless" steel, as now being used to a limited extent for rifle barrels, is really not a steel at all, but a high chrome iron. A typical composition of this iron as now being used in rifle barrels is chromium 13 per cent., carbon 0.10 per cent., and copper 1.50 per cent. Certain intricate heat treatment is necessary in order to make it both machineable and rust-proof. None of these steels are absolutely rust-proof—all will rust if given enough exposure, but they are very much more resistant to rust than the other barrel steels. Poldi "Anticoro" steel for example, is so resistant that it takes five to ten times as much application of the bluing solution to blue it (which is a rusting process) as ordinary barrel steels. Stainless steel is still further resistant, cannot be successfully blued, and is generally copper plated outside and then subjected to a treatment which turns the copper black. All of these steels are very difficult to bore, ream, and rifle, requiring tools of a very special steel. This, in addition to the original cost of these steels in the bar, make barrels constructed of them much

more expensive than ordinary barrels. Owing to the difficulties connected with machining, heat treatment, bluing and fitting of these steels, it is thought that they cannot be utilized profitably in work by the average gunsmith who had better place orders for complete barrels fitted to actions and bolts, and ready chambered by the manufacturers specializing in them.

OUTSIDE DIMENSIONS AND WEIGHTS. Besides being of proper steel, a rifle barrel must have a certain minimum thickness or wall diameter in order to be safe against bulging or bursting, this thickness depending upon the cartridge to be used, that is the breech pressure. Other things being equal, the heavier the barrel the more accurate it will always be. Barrel length also must be considered, and there are many other factors which must be carefully weighed in the final determination of the diameter and length of the barrel of any rifle.

The barrels of our old lever and pump action repeating rifles were made very light in weight and small in diameter in order to reduce the weight of the complete rifle. They were also usually cut with two or three transverse dovetail slots for the attachment of sights and forearm. Such barrels performed fairly well with black powder cartridges, the breech pressures of which did not often exceed 20,000 pounds per square inch, and they will still be satisfactory for such light cartridges as the various .22 calibers in rim fire, and the .25-20 and .32-20 center fires. But such barrels are not satisfactory for modern high power cartridges giving pressures from 36,000 pounds to 50,000 pounds, not because they are not safe enough, but because they are not stiff enough. These thin, slotted barrels when fired with high power cartridges vibrate with very great amplitude and as each cartridge differs slightly from every other cartridge, one may set up a slightly different vibration from the next, and thus cause a delivery of the bullet from the muzzle at a widely varying point in the vibration. The result is mediocre accuracy.

In the design of modern barrels, in addition to safety and stiffness, we must consider the ultimate weight of the rifle and its balance. In a hunting rifle we desire as light weight as is consistent with accuracy and moderate recoil, and the balance should be only a short distance in front of the trigger so it will handle and move quickly for snap shots and shooting at running game. In a target weapon, on the other hand there should be weight to hold it steady, and this will also minimize movement from little tendencies to flinch or jerk the trigger, or small muscular tremors, which will not disturb it so much. And with the target rifle we prefer that it be a little muzzle heavy so that in the process of holding and aiming it will swing slower towards and away from the bull's-eye.

To reduce weight and give the desired balance, and at the same time minimize vibration, the modern hunting rifle barrel is made

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heavy at the breech end. This large diameter or cylindrical portion (see "A" Figure 107) is carried forward to a point corresponding to the forward shoulder of the chamber. There is then usually a short, sharp taper to a point approximately 2 inches ahead of the chamber, thus insuring heavier metal over that portion of the barrel where the chamber makes the walls thinner and where the peak of the pressure comes. From the forward end of this short taper there is usually one (occasionally two) long, straight taper to the muzzle. Figure 107 shows a hunting rifle barrel of this design intended for a high power cartridge, and the accompanying table gives the approximate dimensions at the various points for the

DIMENSIONS OF HIGH POWER RIFLE BARRELS

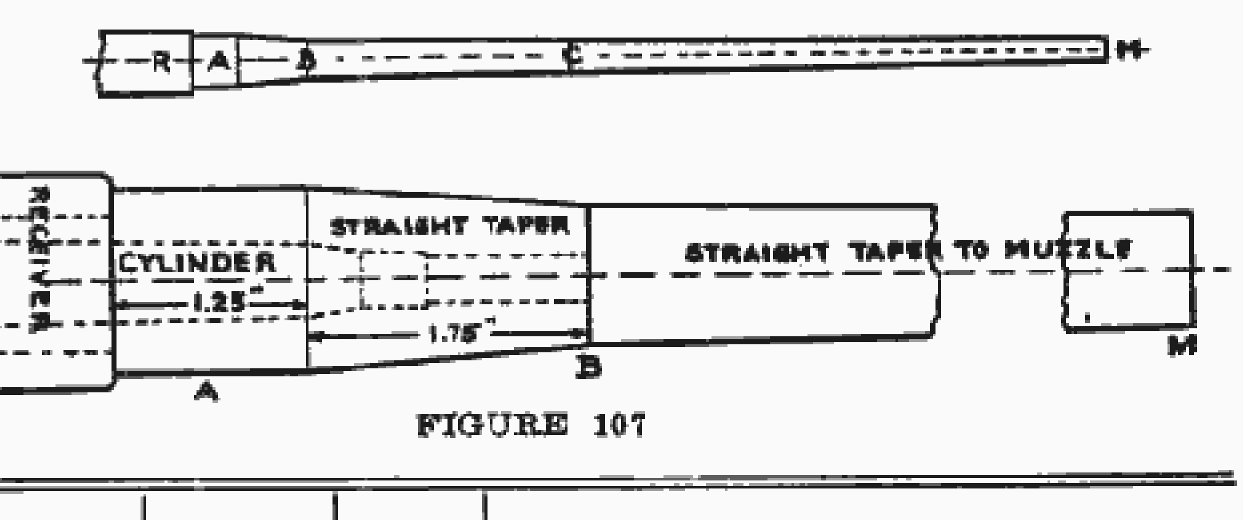

FIGURE 107

No.	Diam. at A	Diam. at B	Diam. at M	Remarks
1	1.00	.75	.50	Minimum weight .25 cal. barrel.
2	1.05	.850	.550	Minimum weight .30 cal. barrel. Accurate .25 cal. barrel.
3	1.14	.956	.647	Springfield .30 cal. service barrel. Diam. at C .77", C being 9.00" from receiver, B-C and C-M being straight tapers. Minimum .35 Magnum barrel.
4	1.14	.956	.647	Springfield .30 and .22 cal. sporting barrels.
5	1.18	1.00	.70	.35 Magnum barrel, minimum .375 and .400 Magnum barrels.
6	1.20	1.05	.75	.375 and .400 Magnum barrels.
7	1.25	.....	.875	International Springfield Free Rifle barrel. Taper breech to muzzle.
8	1.05	.....	.90	Winchester Single Shot No. 3 barrel, round, .30-40. Straight taper breech to muzzle.

most common calibers, weights, and kinds of rifles. Generally speaking a barrel of the dimensions of the service Springfield barrel (No. 3 in the table) is the lightest barrel from which really first class accuracy can be obtained with cartridges of power and caliber similar to the .30-06 U. S. Government. Fine results can be had from such cartridges as the .25-35 W.C.F., and .30-30 with slightly lighter barrels. The barrels for .35 and larger cartridges of the Magnum class should be slightly thicker than the service Springfield barrel for the best accuracy and moderate recoil. Particularly

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these hunting rifle barrels should not be suddenly reduced to small diameter an inch or less forward from the receiver. Many foreign hunting rifles have a short radius of concave form cut about a quarter or half inch forward of the receiver, reducing very quickly to a quite small diameter at this point. Such barrels do not, as a rule, give very fine accuracy, for they vibrate excessively, and the slight difference in the load causes very different sight adjustment to be required. There is no objection to making barrels slightly lighter than the above provided their owner understands that he must sacrifice somewhat in accuracy. For example, a .30-06 rifle made with a barrel like the No. 2 in the list will make a fine light rifle for deer and moose in country where these animals are scarcely ever shot at long range, but one must not expect it to perform with satisfactory regularity on mountain sheep at 300 to 400 yards.

Barrels intended for target shooting have much less pronounced tapers, and are heavier. Thus the very heavy "Free Rifle" barrel used in the International Matches (No. 7 in the list) has but one straight taper its entire length from 1.25 inch at the breech to .875 inch at the muzzle. This is about the heaviest barrel that is advisable, as if a heavier barrel be used the muscular effort to hold the rifle of such resulting weight will make for trembling. It is well to have the breech of the barrel where possible, only slightly smaller in diameter than the receiver where the latter joins the barrel, as this gives better appearance than where there is a sudden drop from a large receiver ring to a small barrel. Thus on a Krag rifle, or on the .22 caliber Model 1922 Springfield, or Winchester Model 52, a very excellent diameter for a target barrel is 1.10 inch at the breech, tapering gradually to .75 inch at the muzzle. Such single taper barrels are also better to mount target telescope sights on, where the two bases are screwed to the top of the barrel, than sudden taper barrels of the hunting type.

It will be noted that a majority of the hunting rifle barrels have a diameter of .647-inch at the muzzle. This is for convenience sake to permit of fitting the front sight stud with its encircling barrel band as made for the Springfield rifle, or the many inclined ramp front sight bases which can now be had in more or less finished condition for this size muzzle. If other diameter at muzzle is selected it will usually be necessary for the gunsmith to make by hand the front sight band and stud to fit.

Considering that a Springfield or Mauser breech action is used, and a rather light walnut stock of medium density, with barrel length of 24 inches, a No. 1—.25 caliber barrel or a No. 2—.30 caliber barrel will cause the rifle to weigh approximately 7 to 7 1/4 pounds, No. 3—.30 caliber 7 1/2 to 8 pounds. No. 4—.30 caliber 7 3/4 to 8 1/4 pounds, No. 5—.35 caliber 8 3/4 to 9 1/4 pounds, and No. 6—.375 caliber 9 to 9 1/2 pounds. Barrel No. 3 differs from barrel No. 4 in that the former has three tapers instead of

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two, and is slightly smaller than the latter at a point 9 inches forward from the breech, and hence slightly lighter. A No. 7 "Free Rifle" barrel 28 inches long, on Springfield action with rather heavy stock and heavy International butt-plate will cause the rifle to weigh from 12 1/2 to 14 pounds, depending upon stock, fittings, etc. A Winchester single shot rifle with the Winchester No. 3, 30 inch barrel (No. 8 on list) .32-40 caliber, pistol grip stock, shotgun butt, weighed about 10 pounds. In giving the weight of rifles the weight with iron sights, unloaded, and without gunsling, is usually that given unless otherwise specified.

So far we have not considered BARREL LENGTH at all. Twenty-four inches from receiver to muzzle is perhaps the best average length for high power hunting rifles, except that those of .375 caliber and over had better be regarded as standard at 26 inches. The longer the barrel the higher the muzzle velocity that a given cartridge will develop. With the Springfield cartridge 1 inch in barrel length is equivalent to approximately 25 f.s. in velocity. With the Krag using the older W.A. powder which burns more completely in short barrel length, the difference between a 30 inch barrel and one of 22 inches is only 60 f.s. in muzzle velocity. As the barrel is shortened muzzle blast, flash, and report become greater, and these become very objectional with high power rifles when the barrel is made shorter than 20 inches, which should be regarded as the minimum length for rifles of high power, particularly .30 caliber. Eighteen inches should be the minimum length for .25 caliber barrels, and 22 inches for .375 caliber barrels.

It is not true that the longer the barrel the better the accuracy. The most accurate length for .30 caliber barrels is between 24 and 28 inches, but we cannot say that a 28 inch barrel is any more accurate than one of 24 inches. In fact the longer a barrel the greater the chance that there may be a tight or loose place in the bore which may affect accuracy, and it is usually best to choose a length of barrel that the factory is accustomed to making on the theory that the workmen will do better work on something that they are thoroughly accustomed to doing day after day than on an unaccustomed special order. Of course if iron sights are used the longer sight radius of the longer barrel minimizes errors of aim. Also some men can hold and swing steadier when firing offhand with a long barrel than they can with a short one. This is why most International Match rifles are made with barrels 28 and 30 inches long. Rifle barrels are usually shortened below 24 inches to make them lighter, or handier on horseback, or because of fancied easier handling particularly in thick brush. One inch of barrel length at the muzzle of a .30 caliber Springfield barrel of service type weighs about 550 grains, or a little over an ounce. To find the weight of a round bar of steel; square the diameter in inches and decimals of

an inch, and multiply by .2225, and the result will be the weight in pounds of a section 1 inch long. To find the weight of a rifle barrel, or a section of such barrel, first find the weight of a bar of the outside diameter of the barrel, and subtract from it the weight of a bar of the diameter of the bore.

A barrel for a cartridge like the .25-20 can of course be made very much lighter than one for a high power cartridge, and still give excellent results. The barrel on the .25-20 Winchester Model 53 rifle measures .85 inch at breech and .57 inch at muzzle, and is perhaps the minimum barrel that will give fine accuracy in this caliber.

Barrels for the .22 caliber rim fire cartridges can probably be made as light as .60 inch at breech and .40 inch at muzzle if of good steel. Such a barrel 10 inches long fixed from machine rest might group as closely as an inch at 25 yards with suitable .22 Long Rifle ammunition. The .22 Long Rifle cartridge seems to give its maximum muzzle velocity in a barrel somewhere between 18 and 22 inches long. It is doubtful if any increase in accuracy (human element eliminated) results from increasing the length over 24 inches or the diameter over that given for the Springfield sporting type barrel (No. 4 on the list). Both weight and length are given to .22 caliber barrels to give proper appearance and balance to rifles, and to maintain a weight and swing that will enable the shooter to hold the rifle steady. Thus the Winchester Model 52 rifle has a quite heavy 28 inch barrel, and the expert shot finds it very convenient from the standpoint of hard and steady holding in all positions. But the same rifle could probably be fitted with a light 18 inch barrel and from a machine rest this light, short barrel might give quite as good average groups as the longer and heavier standard barrel.

TURNING DOWN BARRELS: Rifle barrels should be turned to the desired weight and shape in the process of manufacture, and not after they have been bored, reamed, and rifled. Turning a completed barrel down to reduce its diameters and thus lighten it almost invariably results in releasing strains in the steel to such an extent that the barrel bends considerably. We have seen .30 caliber heavy barrels that were turned down to lighten them bend so much that one could not see through the bore when viewing it from breech or muzzle. Military rifles are frequently remodeled into sporting weapons, and when the military rear sight fixed bases are removed from these barrels there will be a rough, ugly, uneven portion of the barrel exposed. Such a barrel may be placed in a lathe and this rough place turned smooth, and the barrel polished for bluing and no bending will result if the work is done carefully.

First you make a plug for the muzzle to hold it in the lathe. This plug is shown in Figure 108. It must be made of hardened steel and ground on centers. If made of soft steel it is liable to cause wear and to freeze in the bore. The long shank which goes into the bore must be a push fit on the top of the lands. The center hole

must be located and drilled with a small drill, and then countersunk with a 60 degree countersink as in all lathe work. Place the muzzle plug in the muzzle of barrel and fit to dead center of lathe. Put the breech end of barrel in chuck or live center, attach a lathe dog to barrel, and tighten up on face plate with dog and raw hide belt lacing. Then when you have the barrel running truly in the lathe turn a short length on the barrel to true diameter about an inch in front of the rough portion of the barrel. If possible turn only through the bluing or Parkerizing finish. Set the steady rest up here. Then using a second-cut flat file or a mill-file, smooth up the rough portion of the barrel, giving it an even taper and contour with the adjoining portions of the barrel. The file should be moved at right angles to the axis of the barrel, and with light uniform pressure. It is advantageous, although not essential, to give the file a slight rocking movement. Each successive stroke should advance a small fraction of an inch lengthwise of the work until the total length is covered. The file strokes may be slower than in vise work, but holding the file still on the lathe always causes rough and botched work. It is desirable to finish up with a very fine file. When the rough portion has thus been trued up, the entire barrel should be polished to remove the old bluing and to give a mirror-like surface prior to rebluing.

If the original barrel had a very rough Parkerized finish it may be desirable to go over the entire barrel lightly with a file to smooth up, leaving the steady rest in place. Then remove the steady rest and lightly file smooth the spot where it bore. Next take medium emery-cloth and move it back and forth by hand lengthwise of the revolving barrel until it is polished and perfectly clean all over. Then repeat with fine and extra fine emery-cloth and crocus cloth each in turn until a perfectly smooth, mirror-like surface is obtained. The barrel is now ready for final polishing as explained in Chapter 18.

It might be remarked here that in purchasing a Springfield rifle for the purpose of remodeling, it is always better to purchase one of the sporting models which has no rear sight fixed base attached, and with a barrel which is already polished and blued from receiver to muzzle, thus making it unnecessary to do all this lathe work, or even to reblue.

STRAIGHTENING BARRELS. When a shooter contemplates turning down a barrel to smaller than its original diameter he should consider carefully the facts and dangers that almost invariably attend such an operation.

In turning down the barrel originally, it was in all probability removed from the lathe and carefully straightened *after each cut*. After rifling, it was again checked for straightness, and straightened if necessary. The pressure of the lathe tool always springs the barrel slightly out of a straight line, so that straightening after each cut is

necessary to keep the outer surface concentric with the bore. The final straightening leaves the bore approximately straight (very few bores are absolutely straight) and the tension of the metal such that it stays straight under normal conditions.

Now, a cut only a few thousandths of an inch deep, taken from the outer surface of such barrel, may, and usually does release internal stresses in the metal, causing the barrel to spring back to its original crooked or curved state as it was before being straightened.

A very common mistake of the amateur is to center his barrel in the lathe, and turn it down to the size wanted, without thought of straightening. The fact is, he probably cannot tell by looking at it whether it is straight or not. He finishes the job and stocks the barrel and action, only to find that it is shooting far—very far—from its previous sight adjustment. Probably it is necessary to shift the sights well off center to bring the group into the black. And—here's the worst of it—that cussed group moves up or down, right or left, stringing its shots all over the paper, as the barrel becomes warm from firing.

How come? The barrel looks straight on the outside—and probably is. But were you to saw it in two at the right point, you would find that the wall was considerably thicker on one side than the other—the difference often being quite plain to the eye, without any measurements. What has happened is that the very first cut taken from the outside sprung the barrel slightly, or else released stresses which permitted it to spring itself. Subsequent cuts, either lighter or heavier, sprung it some more—perhaps causing a compound bend; the light finishing cuts gradually turned the outside true and comparatively straight, while the bore remained crooked. Thus there are places where the wall is thicker on one side of the bore than the other, and this brings about a complicated state of affairs.

The crooked bore causes the barrel to shoot away from its normal sight adjustment; as the barrel becomes heated from firing, the expansion of the thicker wall being greater than that of the thin side, the barrel naturally bends itself in the direction of the thin walled side; and the hotter it gets the more it bends. There is no remedy for this except straightening of the bore, and turning the barrel down smaller to make it concentric—straightening after each cut—and this is likely to reduce the size entirely too much.

The third result likely to be encountered, will be the increased "whip" of the thinner barrel, making it more susceptible to even the slightest variations of load; such a barrel is permanently erratic in its shooting, and there is nothing to be done for it. The best results that can be obtained from such a tube involve the use of only reduced loads, giving minimum vibration and whip—and the bullets should be selected by weighing and measuring, holding them within limits of 1/4 grain, and of .0005 inch diameter; and powder charges should be weighed, and held to 1/10 grain. Really the best thing

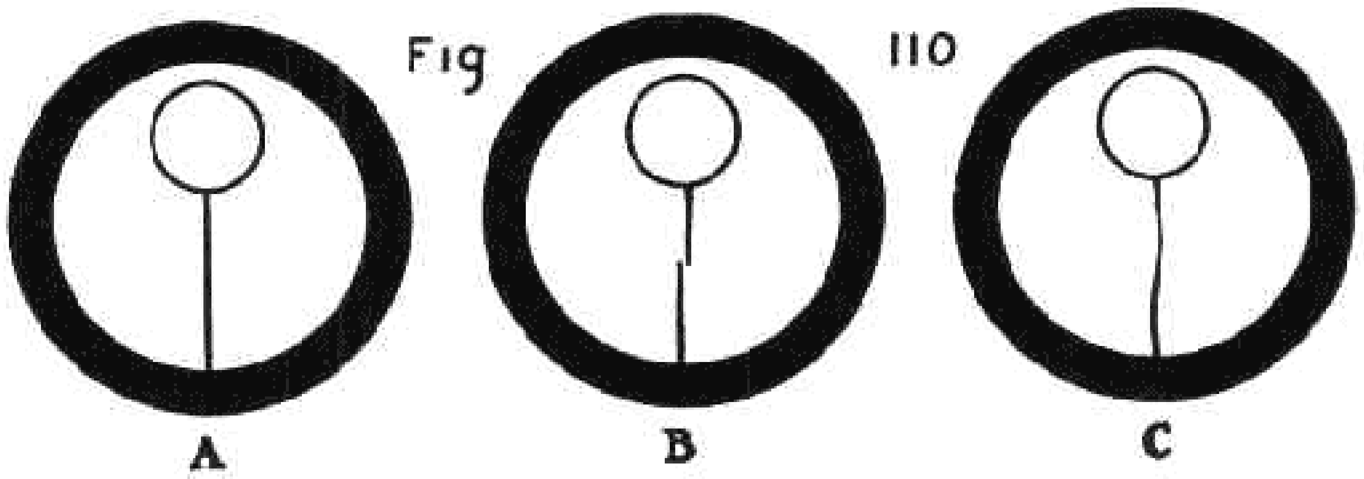
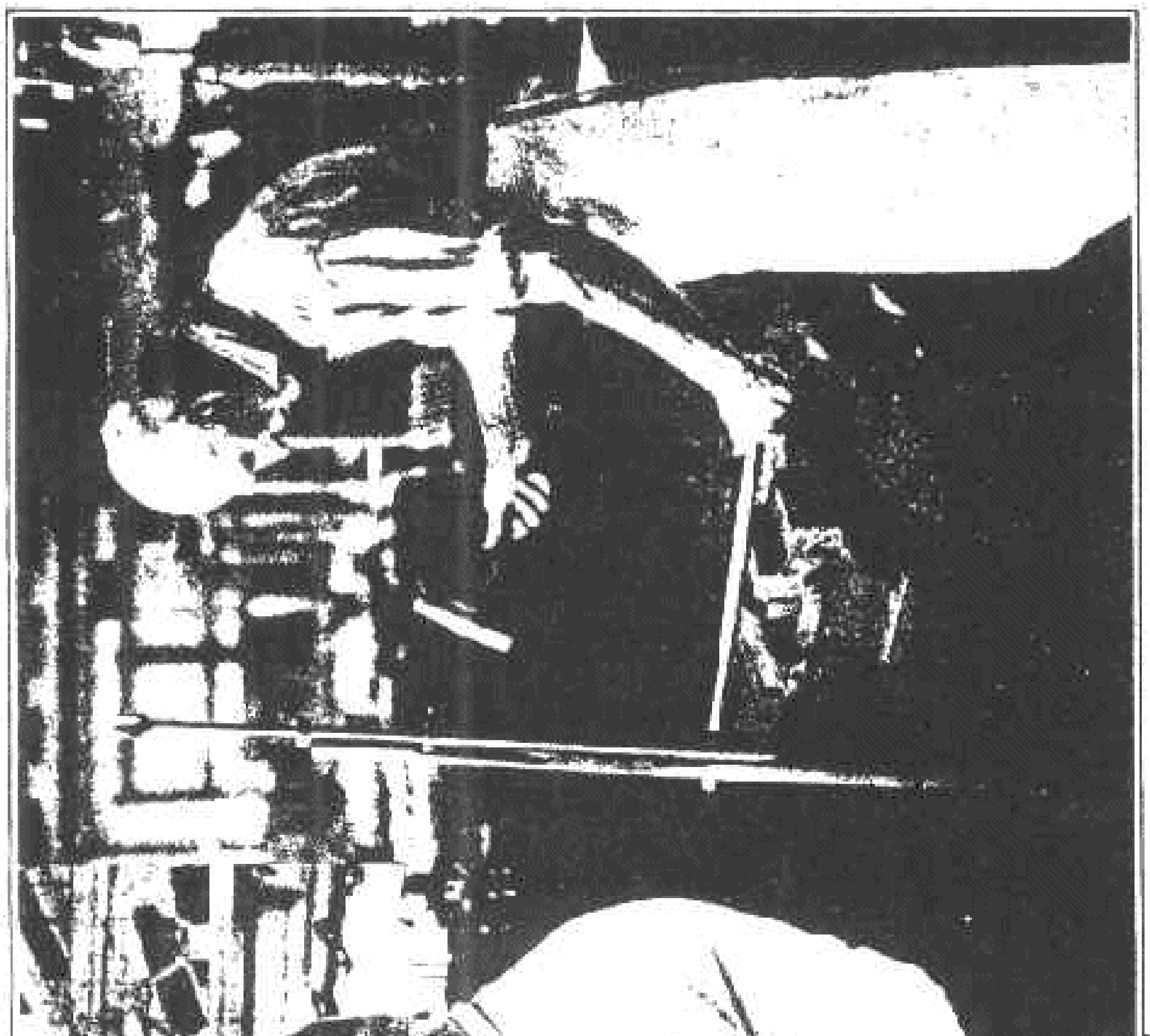


Fig 110

A B C



a barrel by either the old or the new method. At the left is party at the right is using a lead hammer and blocks in the old ioned way.

of it. This throws a distinct shadow along the bottom of the bore. If the shadow's edge appears perfectly straight, as in Figure 110-A, the barrel is straight along that surface if the shadow "breaks," as in Figure 110-B, or shows a curve or bend, as in 110-C, the operator knows there is a crook or curve in the barrel at that point.

The skill of the operator lies in his ability to judge by eye the exact location of the kink or curve, and its direction; and to slide the barrel backward or forward on the lower fingers to exactly the right point, turning the wheel exactly the right amount to exert the required pressure to straighten the bore. By watching the shadow carefully he can tell when it is straight—but here the trouble begins. He must give it enough pressure to bend the barrel slightly in the opposite direction, just sufficiently so that when it springs back, it will spring to a *straight* line. Too little pressure will not remove the bend permanently; and too much will bend a kink in it the opposite way. Taking it by and large, the barrel straightener's job isn't the easiest on earth; yet a few of them become so expert that they can straighten out a bore with great exactness in a minute or so, locating the right place to set the clamp with almost uncanny precision.

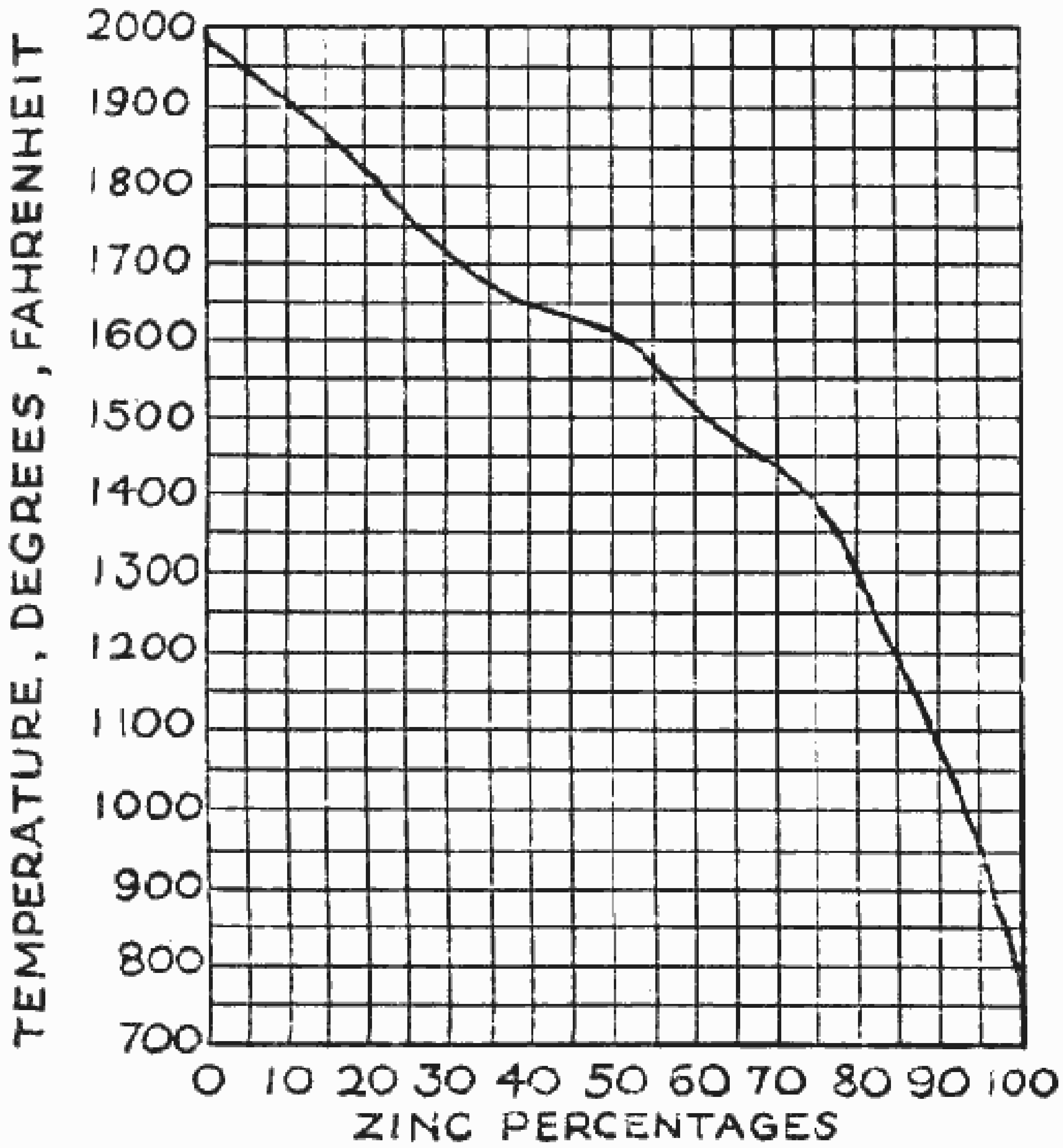
The older method of straightening barrels is to rest the barrel

on two blocks of lead placed close together, striking it with a lead hammer at the point of the bend. I have heard it argued that this method was superior to the more modern clamp, since the sharp hammer blow breaks the fibres of the metal somewhat, preventing the barrel springing back to its original crook as it heats up in firing;

ALLOYS OF COPPER AND ZINC

Percentages in the solder

Copper	100	90	80	70	60	50	40	30	20	10	0
Zinc	0	10	20	30	40	50	60	70	80	90	100
Melting Point Fahr.	1983	1904	1823	1706	1652	1616	1508	1436	1292	1076	786



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For joining German silver and steel, or for articles made of German silver, use the following:

Copper	35 parts
Zinc	55.5 parts
Nickel	9.5 parts

Other very good German silver solders are:

Copper	38 parts	or	Copper	36 parts
Zinc	50 parts		Zinc	56 parts
Nickel	12 parts		Nickel	8 parts

When mixing brazing alloys using lead and tin in composition always melt the brass and other metals with highest melting points first. When the softer metals or alloys are added, stir the mixture thoroughly, cover the surface with powdered charcoal and bring to almost a red heat.

WELDING may be defined as the joining together of two pieces of similar metal by autogenous fusing, in which the two parts are heated to the melting point and molten metal of like character run into the joint.

In the blacksmith's method of anvil welding, which may be stated as a metallurgical process, the surfaces to be joined are brought to melting heat or just short of it, and worked together by hammering.

Electric arc welding is a process by which the surfaces to be joined are heated to melting point at one spot by an electric arc formed between the surfaces and a rod of similar material held close to it. The heat from the arc fuses the end of the rod, and the metal therefrom is deposited in the joint.

Forge welding, as practiced by blacksmiths, is the oldest known form of welding—so common that instructions on the subject would seem superfluous, but for the fact that a machinist or gunsmith is not necessarily familiar with it, and a study of the fundamentals may prove of some value in the repair and manufacture of certain tools.

The success or failure of a forged weld depends on the fluxing. The film of oxide, or "scale" must be immediately washed away and forced from between the surfaces being welded. The metal must be worked only at the proper heat, which in iron and steel is indicated by their vigorous sparking as they are removed from the forge. Sometimes a number of heats is necessary to complete a large weld.

The early gunsmith made his rifle barrels by bending flat bars of iron around a mandrel and welding the edges together, and the perfection of his work is seen on the many fine specimens of flint and percussion arms now so treasured by their owners. In many of them the weld is practically invisible. He used a charcoal fire—the very best for anvil welding, and he "struck while the iron was hot."

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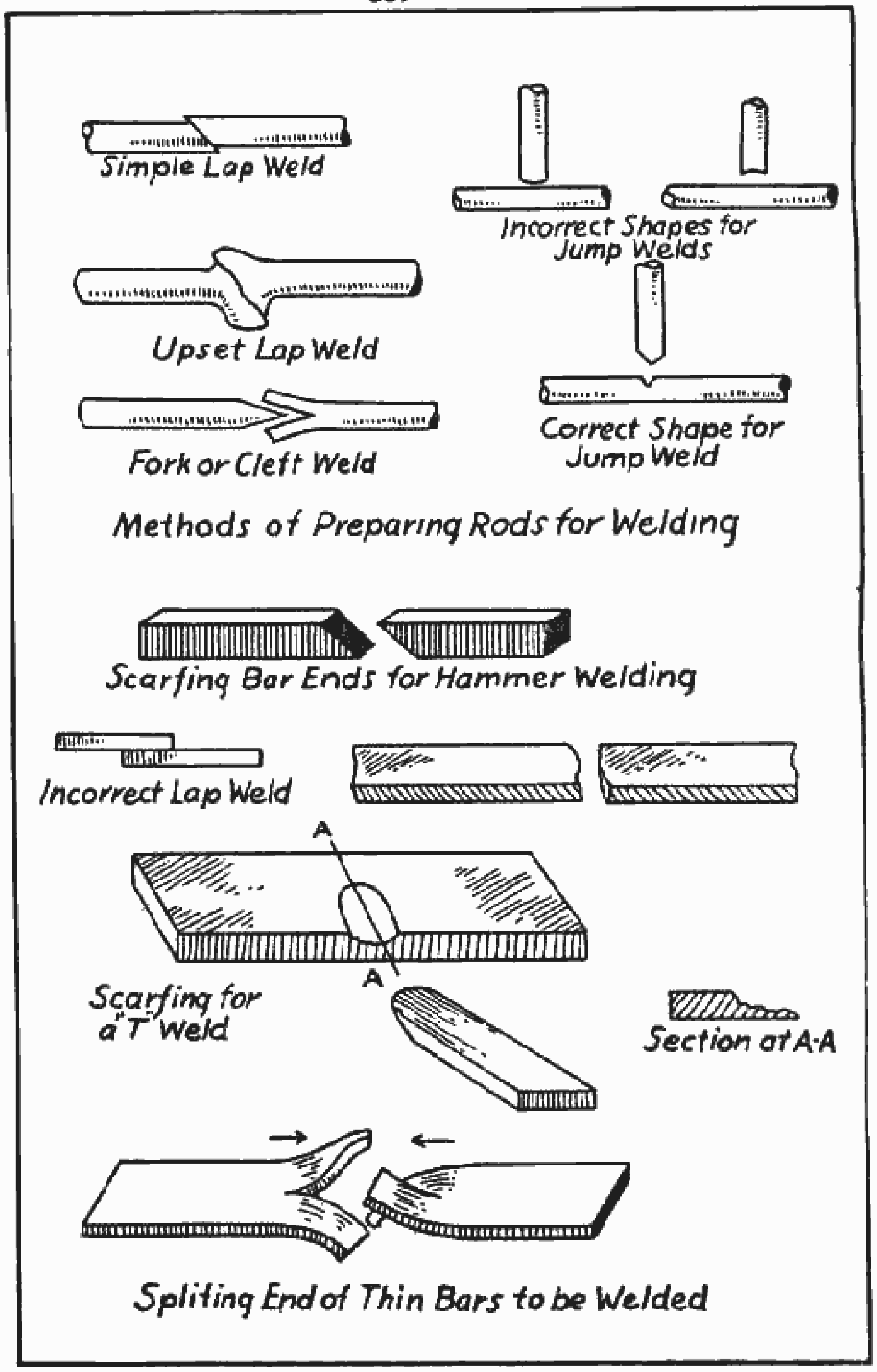

Fig. 132

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The principal disadvantage of forge welding is the large area of metal which must be heated, and the distortion or in some instances the physical changes in the metal, which results from this heating. For example, short reamers and bits used in barrel machines are not adapted to any form of welding because of the danger of burning out the carbon from the steel. For this reason the long shanks of such tools are usually brazed onto the cutters, as the red heat of brazing will not burn them.

Preparation of the work is the first consideration. Figure 132 shows various standard welds, and the method of shaping the ends of parts. For a simple lap weld the pieces are beveled and slightly rounded at the point of union. This rounding permits of the scale that is loosened by the flux being worked out by hammering. In an upset lap weld the parts are hammered out to a larger area than the original stock—this to gain strength because a forge weld has not more than three quarters the strength of the original metal. The fork or cleft weld is popular for joining two rods together. A jump weld is used for joining the end of one bar to the side of another, and the right and wrong methods of preparing the pieces for this weld are shown. Never attempt a lap weld between the ends of flat bars without scarfing them as shown.

A good forge and anvil, with two or three tongs and hammers, anvil chisel and fuller, constitute the equipment needed. Charcoal makes the best fire; next comes coke. Fine coal may be used, by wetting it down around the edge of the fire so that it forms into coke. The fire should be rather deep in the center and should be blown until all visible gases are burned out.

Place the two ends to be welded in the fire, cover with coals and blow with bellows or fan blower until the two ends are bright red, then drop on them the flux, which may be borax, sand, powdered marble or sal ammoniac—or one of the commercial welding compounds. A mixture of borax and river sand, about half and half, makes a good flux for welding. Return the parts to the fire and bring them to white heat, so that they are emitting sparks; lift them in the tongs, and strike them smartly on top of the anvil, which will knock off most of the scale. Bring the ends together as desired and hammer until nearly cool, bringing them to the shape desired.

There is a knack about forge welding that can only be learned by long experience. Some old-time blacksmiths can weld steel at very low heats—scarcely more than cherry red; while some men never learn to make a good weld. If the reader has ambitions along these lines, he can do no better than to cultivate the village smith and study his form and methods. But blacksmithing is apparently becoming a lost art—the garage now occupies the place of honor under the spreading chestnut tree.

AUTOGENOUS WELDING, usually by means of the oxy-acetylene torch, is the most useful to the gunmaking trade. Yet it

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is a highly specialized trade in itself, and most gun shops find it advantageous and economical to send their welding outside. An oxy-acetylene torch is, however, almost a necessity for many odd jobs of bending, such as bolt handles, etc., where it is desired to keep the heat localized as much as possible, and for this work an investment in a torch and outfit will probably pay dividends even if the shop does not do its own welding. The equipment needed consists of a tank of oxygen and one of acetylene, with suitable gauges for each, several feet of heavy rubber tubing, and the torch. This equipment is shown in Figure 133, and the cost complete will be around two hundred dollars.

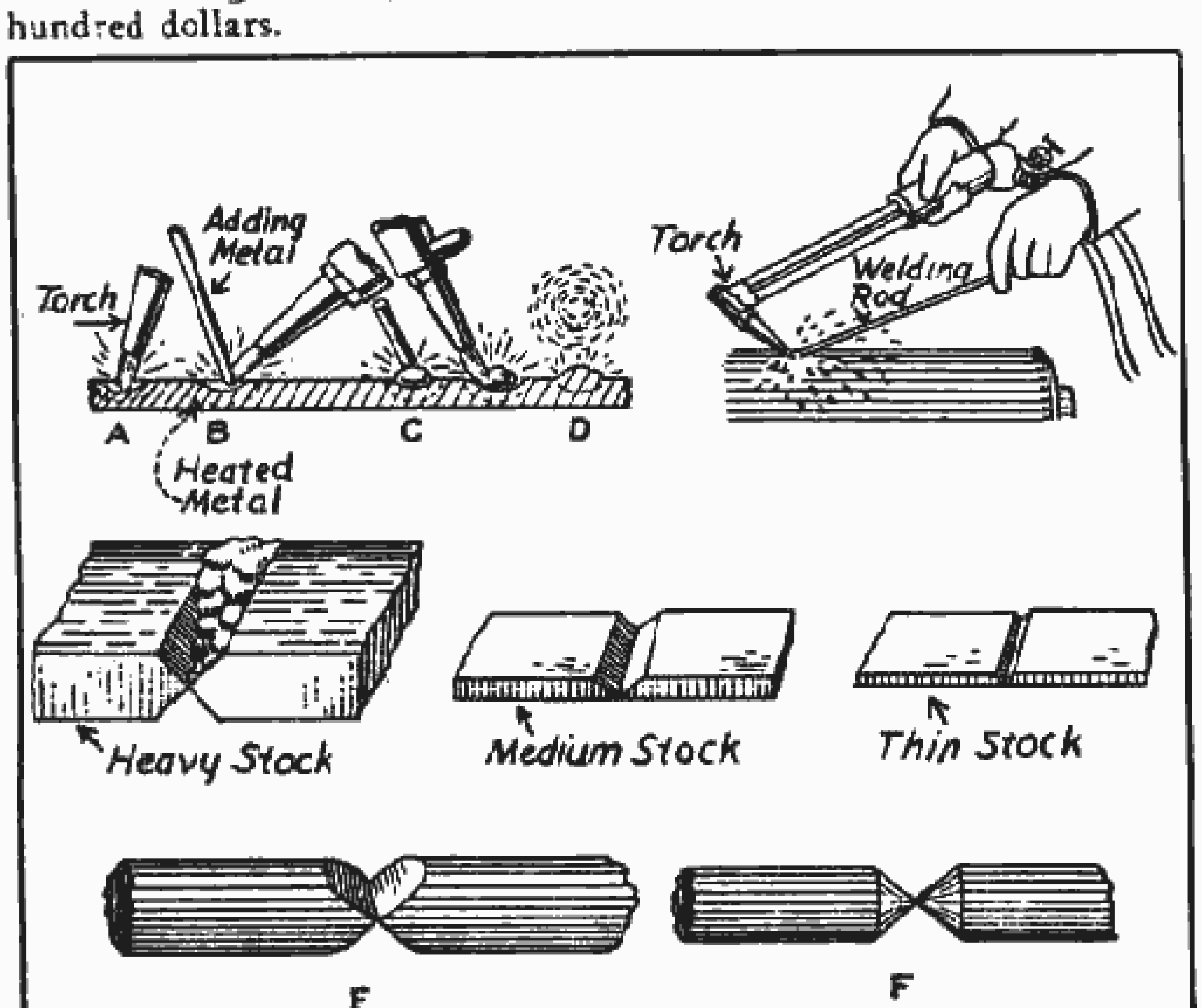

Fig. 134

Figure 134 shows the method of scarfing edges to be welded and various ways of manipulating the torch and welding rod. In every case the metal must be filed or ground well back from the edge, forming a wide notch or groove into which the metal is flowed. This method being entirely different in principle from forge welding, there can be no lapping as is practiced in the latter method. When preparing work for the welder, leave plenty of space for him to fill in new metal. This preparation of the work is important to the shop that sends its welding out. When properly prepared, and clamped or held in suitable jigs, the welder proceeds without loss of time, and cost of the work is kept down to a minimum.

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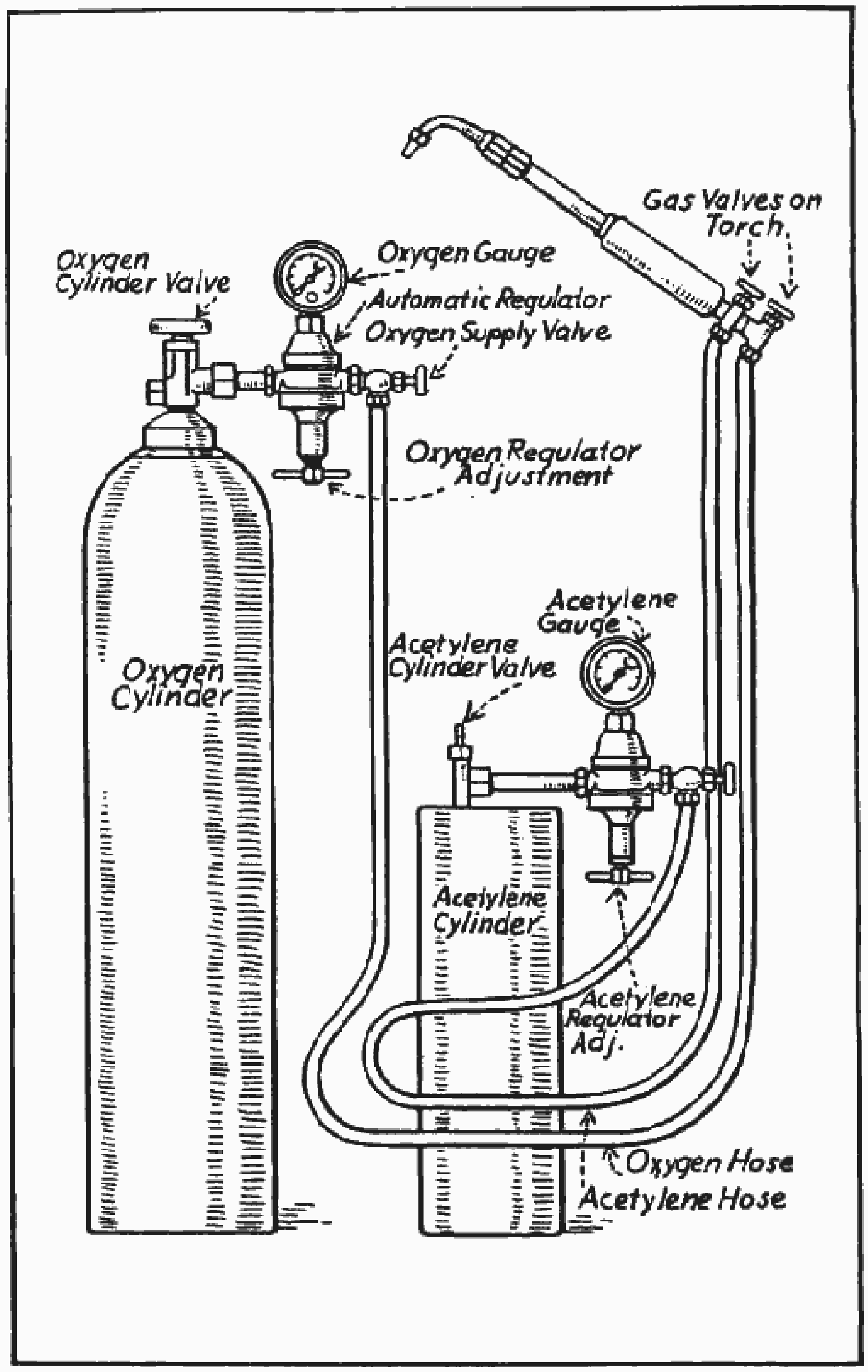

Fig. 133

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ELECTRIC ARC WELDING AND ELECTRIC WELDING differ somewhat in the technique and apparatus employed. The seams of gas tanks on automobiles are often electric welded—but not arc welded. The method employed in the Ford plant is to run the seam, after it is pressed together, through the two copper rollers which form the contacts. These bring the edges of the tank metal into contact, while welding heat is generated at the point of contact, and the two pieces are made into virtually one piece.

"Spot welding" is similar, except that the two pieces of sheet metal are held between the ends of two copper rods carrying current of the right intensity to generate welding heat at point of contact. This is a most useful process commercially, being quite rapid, and the joints permanent. An example of its use may be found in the metal stools and chairs used at soda fountains the legs being thus "tacked" or "spotted" to the metal rim of the seat.

Arc welding may best be understood from Figure 135, which

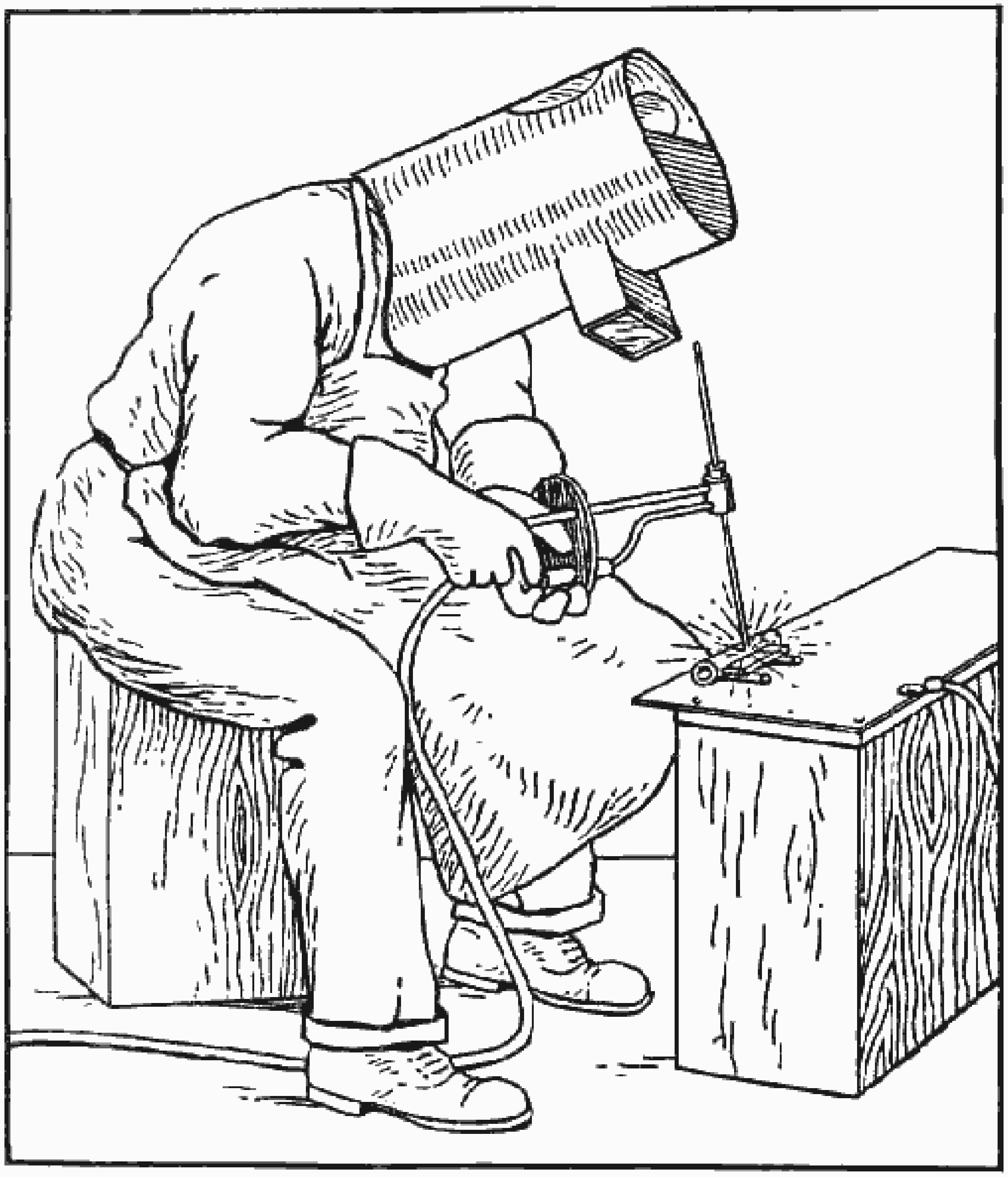

Fig. 135

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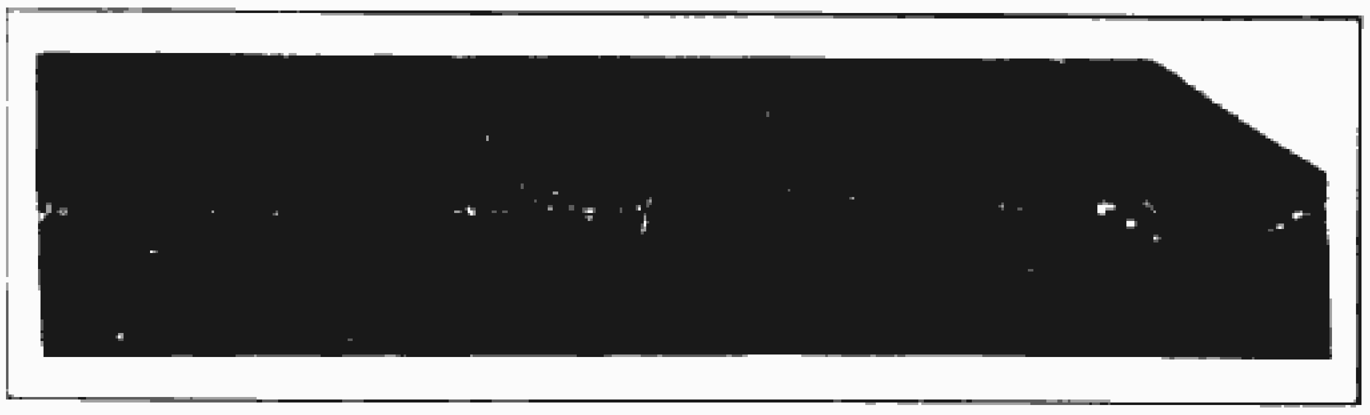
shows an arc welder at work and illustrates the operation clearly. As for acetylene welding, the edges must be widely scarfed, and the welder touches the work with the welding rod at short intervals, forming an arc which deposits the molten metal each time it is lifted. The illustration below shows a piece that has been arc welded, before the excess metal has been dressed off.



When sending work out, the welder should always be instructed to not dip the job to cool it after welding. Let it cool gradually, otherwise the joint may harden so that annealing is necessary before it can be finished. When doing any welding or bending on bolt, receiver, or other hardened or heat treated part, the portions subject to wear or pressure (locking lugs, lug recesses, cams, etc.) must be protected by wrapping with wet rags or waste.

The various specific alterations and repairs involving the use of soldering, brazing and welding are discussed in detail in the next chapter.

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Chapter 24

MANUFACTURE AND SUBSTITUTION OF SMALL PARTS

MODERN gunsmithing, particularly that branch of the work applying to custom-built arms and remodeled military rifles, as well as special target pistols and rifles, has brought into accepted use many small parts not formerly known on the standard factory products. Many of these are not necessary to the functioning of the arm, nor do they affect its shooting qualities—their principal use is that of convenience in handling, and in improving appearance. The private gunmakers are loath to part with any of these "gadgets" for the use of amateurs desirous of adding them to their own factory and military arms; besides they take the attitude—and a very sensible one it is in many instances—that the man purchasing such parts lacks both the tools and mechanical ability to fit them properly; and they do not care to see their pet "rinctums" cobbled onto guns lower in quality than their own products.

Our logical course, then, if we are determined to have our pet shootin' iron equipped with sun parlor, sunken bath tubs, disappearing beds and all the latest gadgets, is to make and fit them ourselves. And happy to relate, their making is not beyond the reach of even the amateur after he has acquired reasonable familiarity with his tools, provided he follows instructions carefully.

Much of the material needed for barrel bands, and the like will not be found in the ordinary hardware store, but must be purchased from machinery supply houses; among these may be mentioned the Cleveland Tool & Supply Company, Cleveland, Ohio; Standard Supply & Equipment Co., Philadelphia, Pa.; the Ellfeldt Hardware & Machinist's Supply Company, Kansas City, Mo.; and the M. L. Foss Machinist's Supply Company, Denver, Colo. There are doubtless a number of others able to serve equally well—I merely mention these firms as I happen to know that they carry large stocks and are thoroughly reliable.

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PLUNGERS AND THEIR USES. The simple plungers shown in Figure 136 have a variety of uses, particularly in remodeling. Their construction is quite simple, and the method of fitting also, particularly if one has a good drill press with suitable vise on the table for holding the work. One or two V-blocks with clamps are also useful.

In Figure 136, A shows a ball end plunger, which is useful for taking up the jump in a bolt handle when the gun is fired; also for forcing the bolt firmly against one side of receiver to assure alignment of a cocking piece sight, and similar uses.

The Krag rifles, for example, usually have a fault common to the Model 30 Remington, some Springfields, and many Winchester 54's and other bolt actions—that is, when the gun is fired, the bolt handle jumps up an eighth inch or so. This fault may be entirely eliminated by setting a small ball-end plunger in the edge of the right receiver wall at rear end, and drilling a small depression in the front edge of bolt handle where it touches the plunger. The spring forces the rounded end of plunger into this depression holding the handle down firmly until it is raised by the shooter. A similar plunger may be set into some bolts near the rear end to bear against the inner wall of receiver, or else into the receiver wall to bear against the side of bolt, forcing it tightly against the opposite wall, and giving assurance that the cocking piece sight will be correctly aligned each time the bolt is closed.

B, Figure 136 shows a plunger that is useful in connection with caterpillar sights when fitted into a ramp, and for other uses. A tenon is turned on upper end of plunger, the plunger setting vertically into upper edge of ramp under the forward end of the sight. When inserting the sight the plunger is forced down out of the way. A hole large enough to receive the plunger tenon is drilled in the flat tail piece at front end of sight. When sight is fully in place in its slot, the plunger snaps up, the tenon going into this hole. The end of tenon should be filed flush with upper surface of the sight tail. To remove sight, simply press in plunger with match, pin, or bullet point, while pushing sight forward out of the slot. Be careful to hold thumb over plunger as sight is removed, so that plunger and spring do not jump out of the hole. This cannot occur if a pin is used to hold the plunger, as shown at B, Figure 136, but the pin may be omitted on a sight plunger if desired.

Plungers should always be made of good steel, and should fit the hole very closely, but not too tight to slide freely. Drill rod of the right size makes good plungers with a minimum of turning or filing. The square notch is cut with a file, to accommodate a transverse pin which prevents the plunger jumping out when the pressure is removed. It is easiest to shape up the bottom end of plunger on a piece of stock several inches long; cut the notch and fit it into the hole on the spring, then mark and cut to length, afterward shap-

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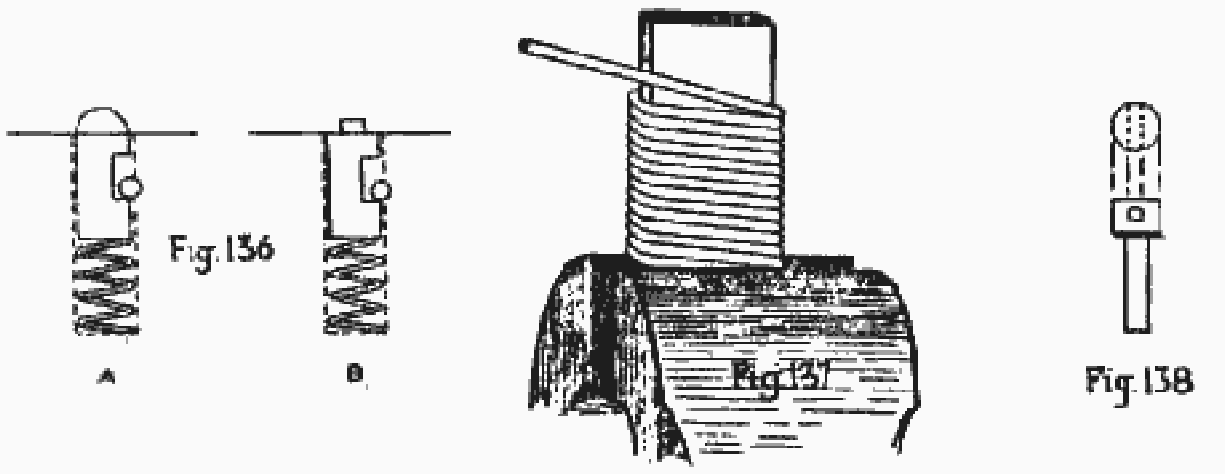
ing the upper or outer end as required. Any plunger subject to much wear must be well hardened or it will soon become useless.

Even if made of drill rod the best method is to case-harden them in cyanide, then polish the wearing end smooth with an Arkansas hone.

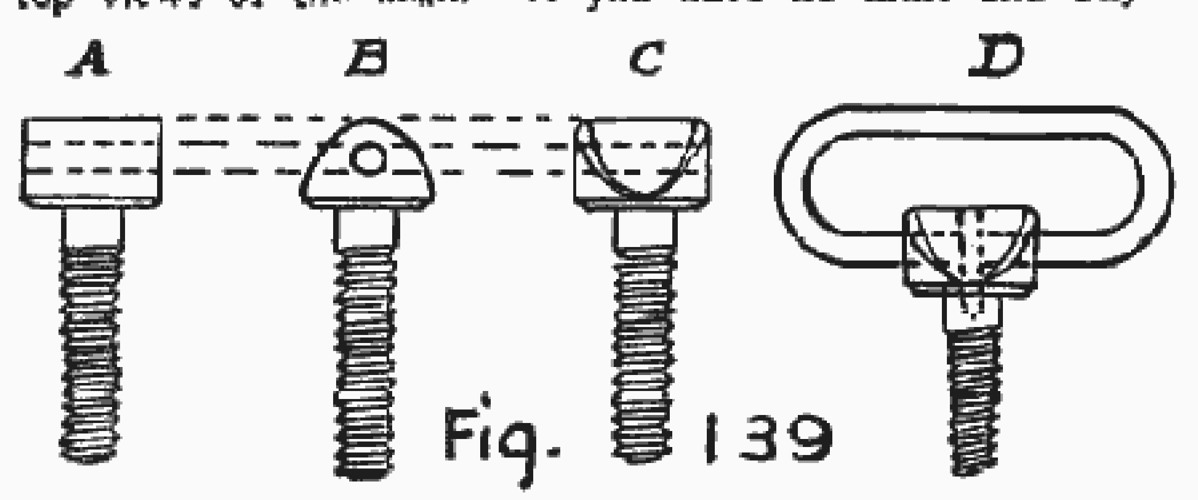


In Chapter 5 I have mentioned round Bessemer steel rods as being the best material for MAKING SWIVELS AND LINKS FOR SLING STRAPS. The size rods ordinarily selected for this use is 9/64 inch, and the method of making the swivels and links is as follows: First, rub off the copper coating by drawing the rod back and forth through emery cloth held in the fingers. Next make up the bending form by taking a piece of flat bar cold rolled steel and rounding the edges by grinding or filing. This bar need be no more than six or seven inches long; its width and thickness to be the dimensions desired for swivel or link. A swivel to take the 1 1/4 inch government sling should be 1 1/4 inch by 5/16 inch inside—so make the form from this size bar; a 7/8 inch sling calls for swivels and links bent on a 7/8 by 5/16 inch bar. Set this bar upright in a strong vise, with one end of the Bessemer rod caught by the vise; then wind the rod around the forming bar in a close spiral until all of it is wound up—see Figure 137. Strike each coil on the flat side with a hammer after bending over the rounded edge. When the entire rod is wound like a spring on the forming bar—or when you have as many coils wound as you expect to need cut the coils down the center of one flat side with a hacksaw, when they will drop off the bar. The coils will be perfectly formed links except that the ends are twisted sideways an amount equal to the diameter of the stock. They may be blued at this stage, or the entire swivel assembly may be blued together. If making links for sling, bring the ends together smoothly by holding the closed side in a vise and bending the ends toward center with straight jaw pliers. Then buff them on the wire buffing wheel, and blue by the heat and oil method described in Chapter 20.

SWIVEL SCREW. The loop or link is only half the swivel; but before going into details of a finished swivel with screw and link permanently joined, we must consider the type of screw necessary for use with detachable swivels. As these swivels (Figure 151C) are just a trifle over 1/2 inch between the side bars, we need a

screw with head 1/2 inch in diameter. Any machine shop can make this in a few minutes. The head should be about 3/8 inches in depth, and should have a No. 25 hole drilled through it from side to side. The threaded portion should be 1 inch long, and may be cut short as required after it is finished. 7/32 x 32 is the best size if the screw is to be attached to a barrel band through the forend. If a butt swivel screw is needed, use the coarsest possible thread, so that it will hold in the wood without pulling out.

Figure 138 shows the screw blank before it is threaded, and front and top views of the head. If you have no lathe and buy these



from a machine shop, have them leave the head cylindrical as A, Figure 139. Then you can file it to the shape shown in Figure 139B, or shape it up on the emery wheel. An easy way to do this is to slip a No. 25 drill through the hole in head. Hold the drill in right hand, with head of screw resting on tool rest of grinder, point of screw held in left hand. By rocking the point up and down while the head is held against the wheel by means of the drill, the grinding can be perfectly controlled, and the head almost finished on the grinder.

A cheap substitute for these lathe made screws is a 5/16 inch hexagon head cap screw (S. A. E. standard). This head is just 1/2 inch diameter between the flat sides. By grinding or filing it round, and drilling the hole through it for the swivel it does very well, although the screw portion is really a bit too large and thread too coarse for best practice. This will cause the swivel to loosen and turn sideways if the strain on the sling is in that direction, but it cannot of course make more than a quarter turn.

A screw of the type described may be fitted through a hole in the forend and into the stud on underside of barrel band. The detachable swivels may be instantly snapped on or off, and when the sling is not being used, the heads are small and inconspicuously "streamline" in appearance.

But suppose we want to use the wider strap, for which detachable swivels are not available. A fixed swivel is easily made from the same screw, as follows: Take one of the links already prepared, and spread the ends sufficiently so that one end can be pushed clear

through the hole in screw head; then bend the ends until they meet in a straight line, and slip the swivel back until the two ends are in the center of the head. Now drill a 1/16 inch hole through center of head and drive in a pin made from drill rod; this pin entering between the open ends of swivel holds it in place, and gives the swivel slight tension so that it will not work loose and rattle. The screw head around the pin should be peened lightly to keep the pin in tight, after which the head is ground to shape, filed smooth, polished and blued. The method of pinning in the swivel is clearly shown in Figure 139D.

A good substitute for the swivel screw for use with detachable swivels may be made from an old government swivel from Springfield or Krag. Cut the swivel in two and pull the pieces out of the base. There is a pin through the center of hole in base. Run a No. 25 drill through the hole to cut out this pin—and there you are. The base is just the right width for the detachable swivel, the bar of which fits through the hole nicely—and this type of swivel base is even less conspicuous on the rifle than the screw head previously described.

If a swivel base of this type is to be used for the forend swivel the barrel band should be of the type shown in Figure 147, with filister head machine screws through the holes in swivel, extending through forend and into the block to which band is attached. On a target rifle with heavy, stiff forend, it may be preferred to omit the barrel band entirely, the swivel base being merely attached with wood screws.

Here's an easy way to fit these swivel bases into the stock: hold base in position and mark around it with a sharp scriber; also scribe outlines of screw holes. Center these holes accurately, and bore in with a 1/2 inch augur bit—just enough to cut the outline to the required depth with lips of bit. Use a flat, or slightly hollow chisel to cut out the wood between bit cuts, and even up the bottom with the bottoming tool used in stock inletting. With a very little trimming up of the edges the swivel base will flush perfectly.

In remodeling a military or obsolete rifle one may desire to use the old outside barrel band because it fits the barrel perfectly, yet this band may have no swivel and no place to put one. This can easily be overcome by taking one of the swivel screws already described, and after shaping up the head, cut off the threaded shank leaving just enough to reach through the bottom of band and project slightly on the inside. Drill and tap a hole in band and turn the screw in tightly, taking care that the hole through head stands crossways when the band is on the barrel. The inside of the hole should be slightly countersunk, and the projecting end of screw peened or riveted tight. To do this, stand the screw and band on a block of lead to prevent marring, and use a drift punch to reach to the inside end. This end after being riveted, should be filed

off flush with inside of band. If the band requires bluing, it is a good idea first to heat it red hot and flow in a little brazing spelter from the inside onto the end of screw. The spelter will go into the threads making a solid brazed joint, so that the screw can never loosen.

A still better way is to take the band to a good welder, and have him melt on some mild steel to form a good sized lump on bottom of

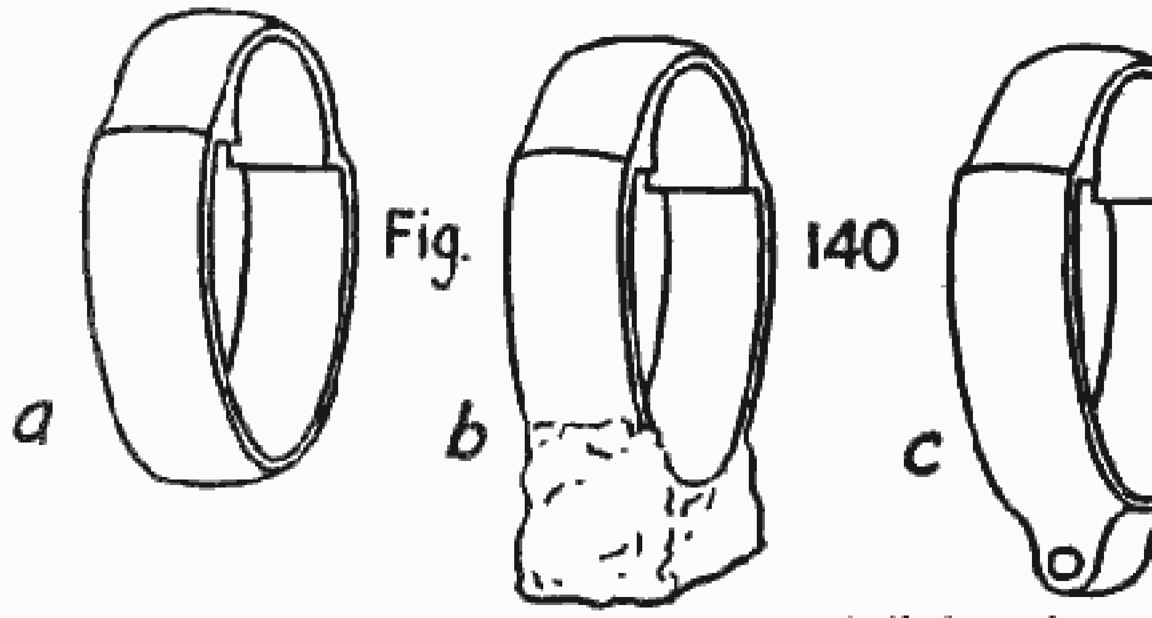


Fig. 140

band, which is afterward filed, ground and drilled to shape to form a swivel stud, as shown in Figure 140. This may be used for detachable swivels, or may be fitted with a fixed swivel, by pinning it in as described for attaching swivel to screw head.

This stunt is of value in remodeling some of the Krags which have a band with cavity for handguard, and are minus swivel. W. Stokes Kirk also sells good outside bands similar to the lower band on the '73 model Springfield, which lacks a swivel. These bands are thick enough to permit their being fitted to different barrels.

MAKING BARREL BANDS. It used to be, that whatever had to be fastened to a rifle barrel was fastened with a screw turned into the barrel, or else by a dovetail slot; and because we didn't know any better, the scheme worked like cats fightin'. But since styles must change, even in shootin' irons, we know now that such antiquated methods are so destructive to accuracy that we can't hit a flock of barns with a barrel so fastened—if we know it. So we use barrel bands instead, as a means of attaching swivel screws, and to hold barrel and forend together, and to provide bases for sights mounted on the barrel—and sometimes to cover up screw holes and other defects in the barrel itself, as well as to provide handguard fastenings.

The very best and most workmanlike bands are made from solid thick-walled Shelby tubing; the band and the stud to which the screw is attached, or which in some instances forms a sight base, being made in one solid piece. Other bands, which answer equally well, in many cases, are made from thin stock soldered, pinned, brazed, or screwed to a thicker block of steel.

Before going into details of barrel band construction, it must be

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remembered that most barrels taper, hence the inside of band must have a slight taper also. Shelby tubing and other soft steels will stand considerable stretching, therefore we select our tubing with inside diameter slightly less than the barrel diameter at the point band is to fit. If possible, select tubing with an inside diameter about the same as the barrel thickness some two or three inches ahead of the final location of band.

First we will make a simple inside band with stud for a swivel screw to go through the forearm; details of this band are shown in Figure 141. Cut a piece of tubing of the proper size about 5/8 inch long; the wall should be from 1/4 to 3/8 inch thick. Hold the piece in a large vise, and with a rather coarse cut hacksaw, lop off excess metal as shown in Figure 142. Now work off the corners on emery grinder, or with a coarse cut bastard file, until the band portion is about 1/16 inch thick. Shape up the base or stud portion so as to keep the sides parallel, and shape up fillets where the base joins the band with a small rattail file. Hold the band in vise so that the jaws press against the edges, not on the sides.

The next step is to locate the point for the screw hole in center of base, center punch it, and drill and tap the hole for the swivel

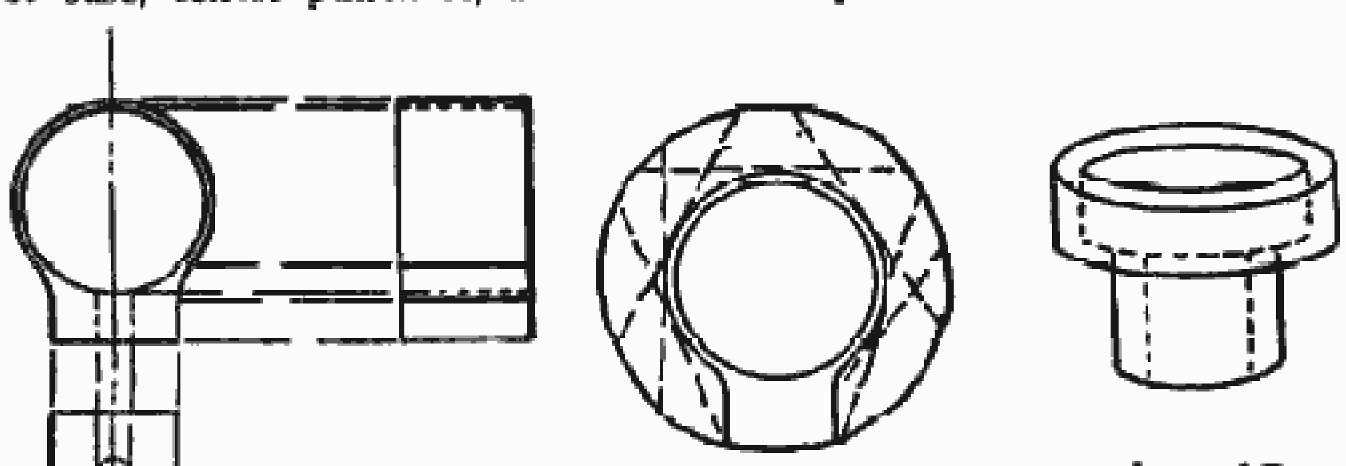
Fig. 141 Fig. 142 Fig. 143

screw. Use care to get this straight in line, otherwise the swivel will set at an awkward angle. Now we are ready to fit the band to barrel and form the taper. It may be fitted right on the barrel, or if you have an old damaged barrel of the same size and taper, use it instead. Save all old discarded barrels, as they make good forming bars for bands. Another way is to have a number of short arbors turned up with various tapers likely to be needed, and keep them for this work. This is really unnecessary, however, as the band can be fitted right on the barrel without hurting the barrel if you use reasonable care. The only damage possible is to the finish, and if a band is being fitted to a new barrel that is not to be reblued it is sometimes difficult to prevent scarring it slightly.

If the band is very rough inside—and most Shelby tubing has slight marks and ridges left by the drawing process—smooth it out

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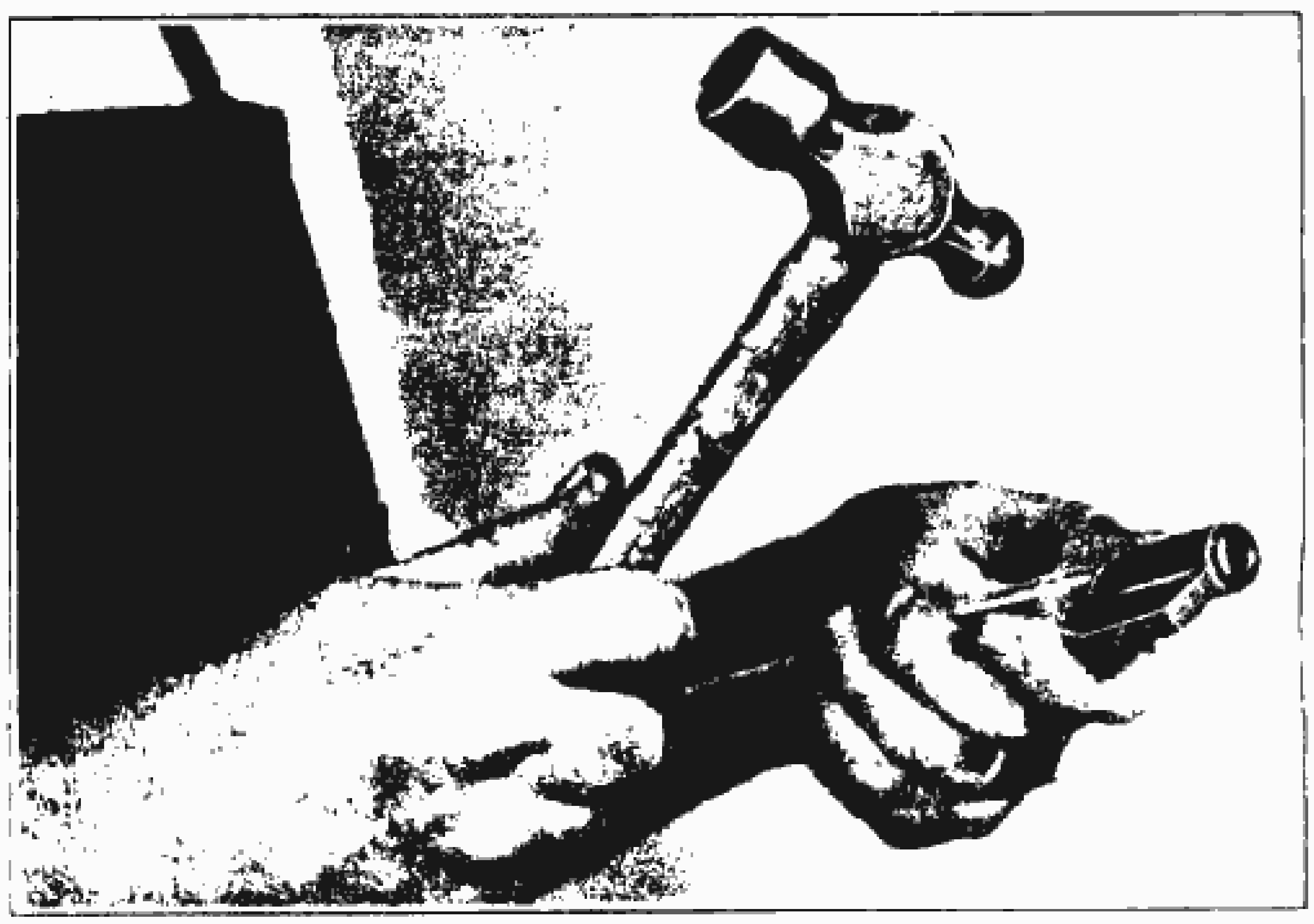
a bit with a straight reamer and polish lightly with fine emery cloth wrapped around a stick or iron rod. Wipe out all grit, and slip the band on the barrel as far as it will go. Now measure and make a light scratch mark on underside of barrel at the exact point where the center of band is to come. With a piece of brass or copper, drive the band toward this mark until it is tight on the barrel. Now hold the barrel under the left arm, with hand grasping it near the band, and with a ball peen hammer, peen the band over its entire surface, striking heavier blows along the rear edge where it fits the


Peening on a ramp front sight

barrel tightly. After a few moments of this you will note the band is loose. Drive it further on the barrel until again tight, and continue peening. Gradually the rear portion is enlarged until the band is equally tight at both front and rear edges; now continue peening with equally heavy blows over entire surface, driving the band on further as it is enlarged, until it can just be driven snugly to the mark—or rather, so that this mark on barrel is seen *through* the screw hole in band. Now peen lightly over the band again to stretch it enough to relieve the strain. You should now be able to slide it off and on by a push with the fingers, the band coming to a definite stop at exactly the right point. It may now be set in the vise and the surface of band carefully smoothed with a fine mill file, and the outer edges slightly rounded. In finishing, bring the band to about 1/32 inch thick with a fine flat Swiss file, such as a 6 inch pillar file; and use it in the direction of the barrel's length—not across the band—in the same manner as in striking barrels.

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Then polish with emery cloth in the same direction, as this makes the band appear much thinner and less conspicuous than when the polishing is done across it. No. 0 emery cloth, if used after it is well worn down, will give a sufficiently bright finish to the band. It is now ready to blue and put in place on the barrel.

A band of this type must be put on before the front sight or its base is fitted; such a band is usually used when the entire barrel has to be reblued, in which case it may be blued with the barrel. Leave it loose on the barrel, so that the bluing covers the barrel's entire surface; if the band is pushed to place before bluing, the portion of barrel under band is not blued, and if it is found necessary later to change the location of band slightly, there will be an unsightly bright ring showing on barrel at the edge of band.

If the stock is already made, the next step is to inlet the band into forend, which is easily done by pressing it down firmly to get the impression of the corners of stud. Cut out the square cavity with a chisel, then coat under side of band and stud with lamp black and oil, and spot it into place with fine chisel cuts. Very great care is necessary to avoid gaps at edge of forend where it meets the band. Also, be careful to secure absolutely equal pressure against the band on all sides. It is usually advisable to relieve the wood just enough so that it does not quite touch the band on sides, except at extreme upper edges. The cavity into which the stud rests should also be 1/16 larger all round for safety from side pressure. The bottom surface of stud should just touch the wood with the same pressure as the barrel exerts against the bottom of channel.

Coating the bottom of stud thickly with lampblack will locate the position of swivel screw hole, which is drilled from the inside; as soon as the point of drill shows on bottom of forend, finish the hole from the outside. Ream the hole larger than the screw to avoid any strains. An escutcheon or bushing set into the wood is not necessary with the swivel screws previously described, but may be used if desired. They are easily made from brass rod or thick walled tubing, turned to shape as shown in Figure 143. Shallow notches or teeth should be filed in the edge of the shoulder, to prevent it turning after it is fitted into the forend. This escutcheon should be set in flush with the surface of the wood, using a counterbore to cut the space for the shoulder, or cutting it out carefully with a half round chisel of the right size.

In my opinion it is not necessary for a band to be fitted with a noticeable gap showing between it and the barrel. A snug push fit is not going to affect the shooting of the barrel in the least, nor will it cause constriction. The thin band will expand with heat even faster than the barrel does, and bands fitted in the manner described have never given me one bit of trouble—and they surely look better than a band sticking up away from the barrel, as some fit them.

Figure 144 shows a type of special band that has proven particu-

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larly valuable to me. It is cut from tubing in the manner already described, but has a slot or keyway cut to one side of the swivel screw hole, of a size and depth to permit of its being slipped over the Springfield fixed stud. This band is most useful on the D.C.M. sporters when the owner desires the forend shaped up a little, and an inside band fitted. The band should have the keyway cut out first, then the outside roughed to shape, and peened to size over an old barrel. It is then finished and blued, the movable stud taken off the barrel, the band slipped to place, and movable stud put back. A screw for use with detachable swivels may be used in connection with this band if desired.

Figure 145 shows a band made in two pieces, the band being attached to the base block with four small screws, two in each end of

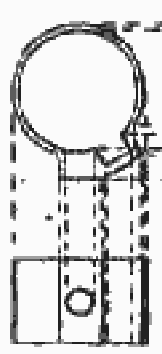
Fig 144

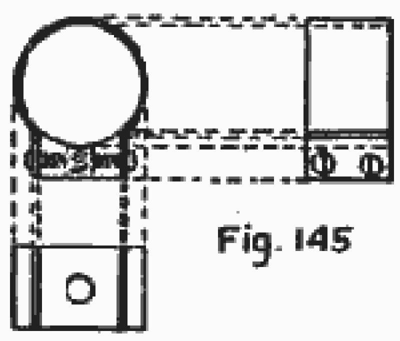
Fig. 145

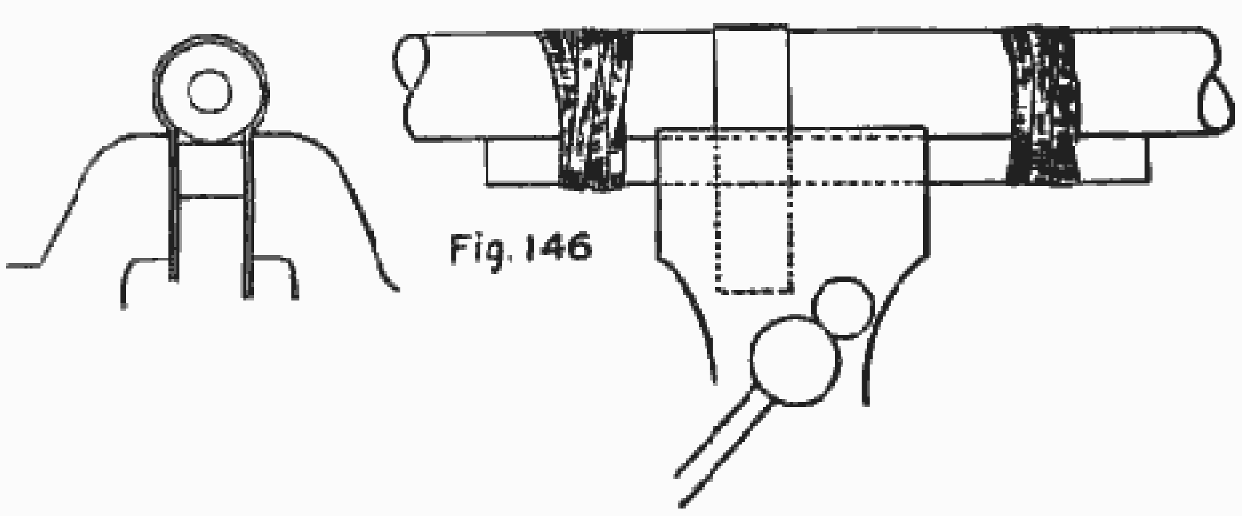
Fig. 146

the strap. The method of forming the band is clearly shown in Figure 146. A piece of square steel the same width as the base of band is to be made is taped or wired to the barrel as shown; a U bend is made in the band stock, and the piece then "straddled" over the barrel, and the vise set up tight. The base is made by milling or filing a hollow approximately the same as the curve of the barrel in a piece of cold rolled steel 1/2 x 3/8 inch. Two holes are then drilled in this and tapped for 2 x 56 machine screws, and corresponding holes of "body" size for the screws drilled in the ends of band. The screws are cut off so that they will not quite meet in the center of the block. Use filister head screws, but file the heads to about half their original thickness. Some use rivets instead—which makes things rather tough in case you want to remove the band some time.

This band is made from 1/32 by 5/8 inch cold rolled steel, and it should be fitted to barrel a couple of inches ahead of its final loca-

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tion, then peened to a perfect fit after it is assembled. It should then be filed smooth, polished and blued before putting it on to stay. This type of band looks simpler than those made in one piece—but actually there is about as much work in one as in the other, and the one piece band is much to be preferred.

A variation of this band, for use with standard swivels or swivel bases is shown in Figure 147. The base block is made longer, and is attached to the band with two screws instead of four. Holes are drilled and tapped in each end to take machine screws which hold the swivel in place. If desired the swivel loop may be removed from the base, and detachable swivels used, as already explained. This

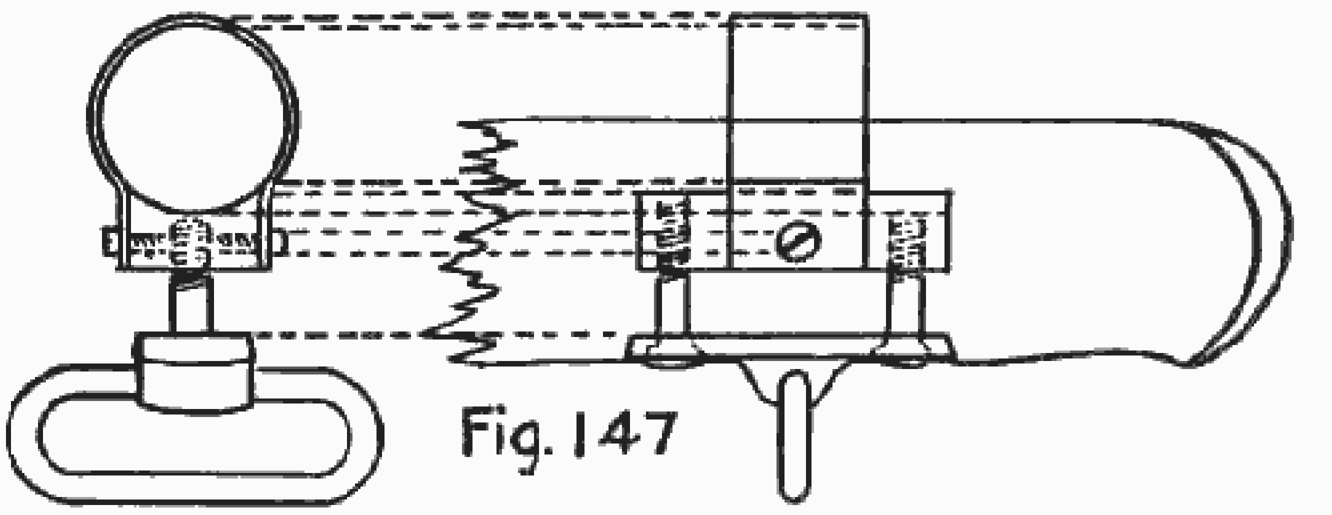
Fig. 147

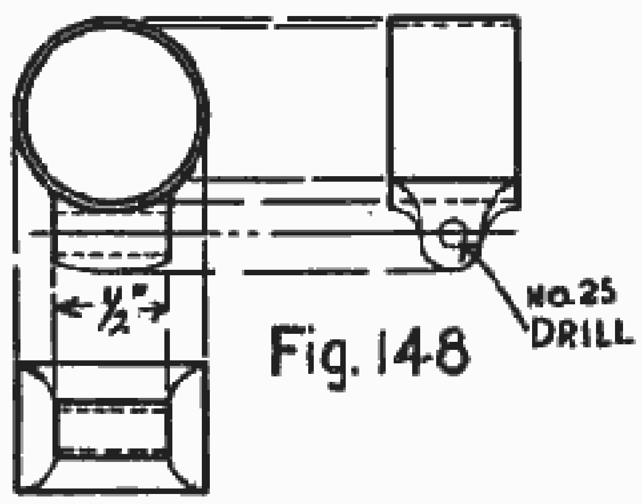

Fig. 148

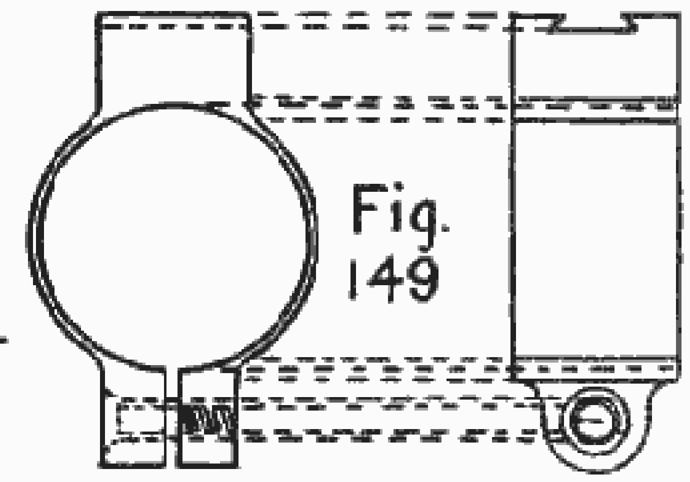
Fig. 149

is really better than the single swivel screw, as the latter may loosen and turn sideways from the pull of the sling, while a base of this kind is always in line.

Figure 148 shows an excellent swivel band for use on rifles where the forend is not fastened to the barrel. This band is stretched and peened to fit the barrel two or three inches ahead of the forend, and sweated into place as described in Chapter 23. The stud portion is made 1/2 inch wide and drilled with a No. 25 twist drill. The shaping of this stud by filing requires careful work, but the appearance warrants the effort required. Make the band of thick walled Shelby tubing, in the same manner as other solid bands are made. It may be soldered to the barrel before the final filing, the band dressed down to 1/32 inch thick or less, and barrel and band polished to-

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gether before bluing. The removal of excess solder and the polishing operations are described in Chapter 18.

The gunsmith having a number of calls for bands of any particular type will find it both convenient and economical to have tubing of the right size roughly milled to the outer shape of the bands required, and keep it on hand, sawing off a 5/8 inch length whenever a band is needed. This work can be done on a milling machine or planer to within 1/64 inch of finish measurements, and will save a tremendous amount of hand work. For bands like that shown in Figure 148, the tubing should first be turned to the contour of the swivel stud, then the excess metal milled off, leaving the row of finished studs with about 1/8 inch of space between them allowed for cutting off and finishing.

There's more than one way of killing a cat. Not long ago a man wanted this type of band mounted on a Single Shot Winchester with a No. 3 round barrel. Although he had used the rifle for years, the bluing of barrel was in perfect condition, so he demanded a band fitted without soldering and rebluing. Due to the thickness of the barrel, the caliber of which was the .25-20 S.S., this was easy. The band was made and shaped to exact size on an old barrel. A hole was drilled straight in from outside through the exact center of the swivel stud with a No. 22 drill until the drill struck the solid metal above the swivel bar hole; the hole was continued through the band with a No. 31 drill, and this inner portion tapped for one of the 1/8 x 48 screws furnished for attaching the Lyman 48 sight. The band was pushed tightly to position on the barrel and firmly seated with a couple of light taps with a piece of brass. The No. 31 drill was then inserted and the hole continued into the barrel about 5/32 inch, then tapped clear to the bottom.

The screw head was cut off and the end slotted, then the screw turned into the hole tightly, so that it projected into and blocked the swivel bar hole in the stud. A No. 25 drill inserted into this hole cut the projecting end of the screw out of the way, and the job was complete. With the swivel in place it is of course impossible for the screw ever to loosen, and the band is on to stay.

The band was of course blued before being set in place, and while the hole in outer portion of stud shows, it is not particularly objectionable.

Another way to fit such a band without refinishing the barrel is to fit the band and carefully mark its location on barrel; then carefully file off the bluing from barrel where the band covers it, keeping slightly inside the lines; tin this place with a very soft bismuth solder melting at between 200 and 300 degrees; also tin the inside of band with same solder; fit it in place and apply just enough heat to melt the solder, and quickly wipe off any that runs out from under the band—the bluing of the barrel will prevent it sticking, and this much heat will not affect the color in the least. The

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fact is, on a small caliber barrel as heavy as a Winchester No. 3, one would be perfectly safe in merely shrinking the band in place, seating it while hot with a few sharp blows with a heavy piece of brass or copper. It would surely stay put, and such a heavy barrel shooting light loads would not be constricted with the heat of firing.

SIGHT BASE BANDS. Many shooters having rifles equipped with peep sights, wish a folding leaf sight on the barrel also. It serves to check the alignment of the peep sight, and would also come into good use if the latter were broken. Figure 149 shows a sight base band to serve a two-fold purpose on a Springfield sporter, and details of its construction will suffice for all bands of the same general type and purpose. This one, fitted to the breech of barrel at the receiver, conceals the unsightly notch or groove where the wedge shaped pin fitted under the military sight base, in addition to providing a new base for the Lyman No. 6 folding leaf. It may be either milled, or sawed and filed from thick walled Shelby tubing having an inside diameter of 1 1/8 inch. (See Chapter 5). The stud forming the dovetail base for the sight should be left full height until after the band is fitted; the method of ascertaining the correct height to cut it to bring the leaf sight to proper height, is fully explained in Chapter 29. The two studs or bosses into which the set screw fits are first shaped up as one, then split by a hacksaw cut which does not go clear through the band until after the screw hole is drilled and tapped. After locating the position of this screw hole and center punching, use a No. 18 drill until the sawcut is reached; then drill on through the other half of boss with a 29 drill, and tap this hole for an 8 x 32 screw. Countersink the No. 18 hole for the screw head, which may be filed down a little to flush it. Then saw on through the band. This may be attached without removing the front sight by merely spreading it slightly with a screwdriver and fitting into place, then tightening up the setscrew. The band and lower projections must then be spotted and inletted into the stock.

The lower stud and set screw may be eliminated by making the band solid and drilling a hole for a headless screw in the sight base portion; however, if the band is loose enough to go on without scratching the barrel, the setscrew will force it slightly upward, raising the sight a trifle, and leaving a small gap between band and barrel. Another way would be to turn or ream the band to a tight fit, and shrink it on, after first bluing it. This plan is objectionable because of the necessity of first mounting the band temporarily in order to ascertain the height of sight base. Once shrunk on, its removal would be very difficult, perhaps impossible. The clamp method is undoubtedly the best of the lot.

On rifles which originally had rear sights attached to the barrel ahead of receiver by one or more screws, it is not necessary to make a split band. The set screw studs should be eliminated and the

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band made solid. Peen it to size and taper, and ascertain the height required for the sight base; cut to correct height, file in the dovetail and fit the leaf sight. Now remove the sight, and in the center of the dovetail drill straight down, a hole that is "body" size for a screw that will fit the old screw hole in barrel. It goes without saying that the sight base band was located so that its exact center came over this screw hole.

Fig. 150

Blue the band and slip it in place. Insert the screw through hole in sight base, turn it into the hole in barrel, and with a small file mark the screw level with bottom of dovetail. Remove screw, cut it to length, slot for screwdriver and turn into place. Drive in the sight, and "thar she be." It is permissible to make the base portion of band a trifle narrower than the base of the sight itself, so that the latter can be moved slightly right or left to zero it, without the difference being too prominent.

When fitting a band of this kind, the screw from the military sight may be used if desired. I prefer to save this special screw with the sight when possible, using a machine screw if it will fit the hole in barrel. It happens that the Krag and '73 Springfield military sights were attached with 8 x 32 screws, so this simplifies matters.

When remodeling the Krag, Springfield, or perhaps other military rifles, it is sometimes desirable to use a plain smooth band at the breech; for example, to cover up the notch on Springfield barrel previously mentioned; or to ease the sudden "jump-off" of the sharp shouldered Krag receiver to the barrel. Figure 150 shows three such bands. "A" merely a piece of 1 1/4 inch Shelby tubing with 1/16 inch wall (giving 1 1/8 inch or exact inside diameter), cut to 3/4 inch length and the forward edge filed as shown; "B" is a more ornamental band turned to shape; both are for the Springfield. "C" is a collar for the Krag, and is turned to shape from tubing. Any of these may be made to a rather tight fit, then blued, then heated just enough to expand them slightly and shrunk on. It is not necessary to spoil the bluing by heating the band red-hot and shrinking it on like a wagon tire. Moderate heat will expand it sufficiently, particularly if the barrel has been kept as cold as possible. In fact, even if the band is rather loose it can be shimmed up snugly with paper, and when closely inletted into the stock, it could not be moved from its position.

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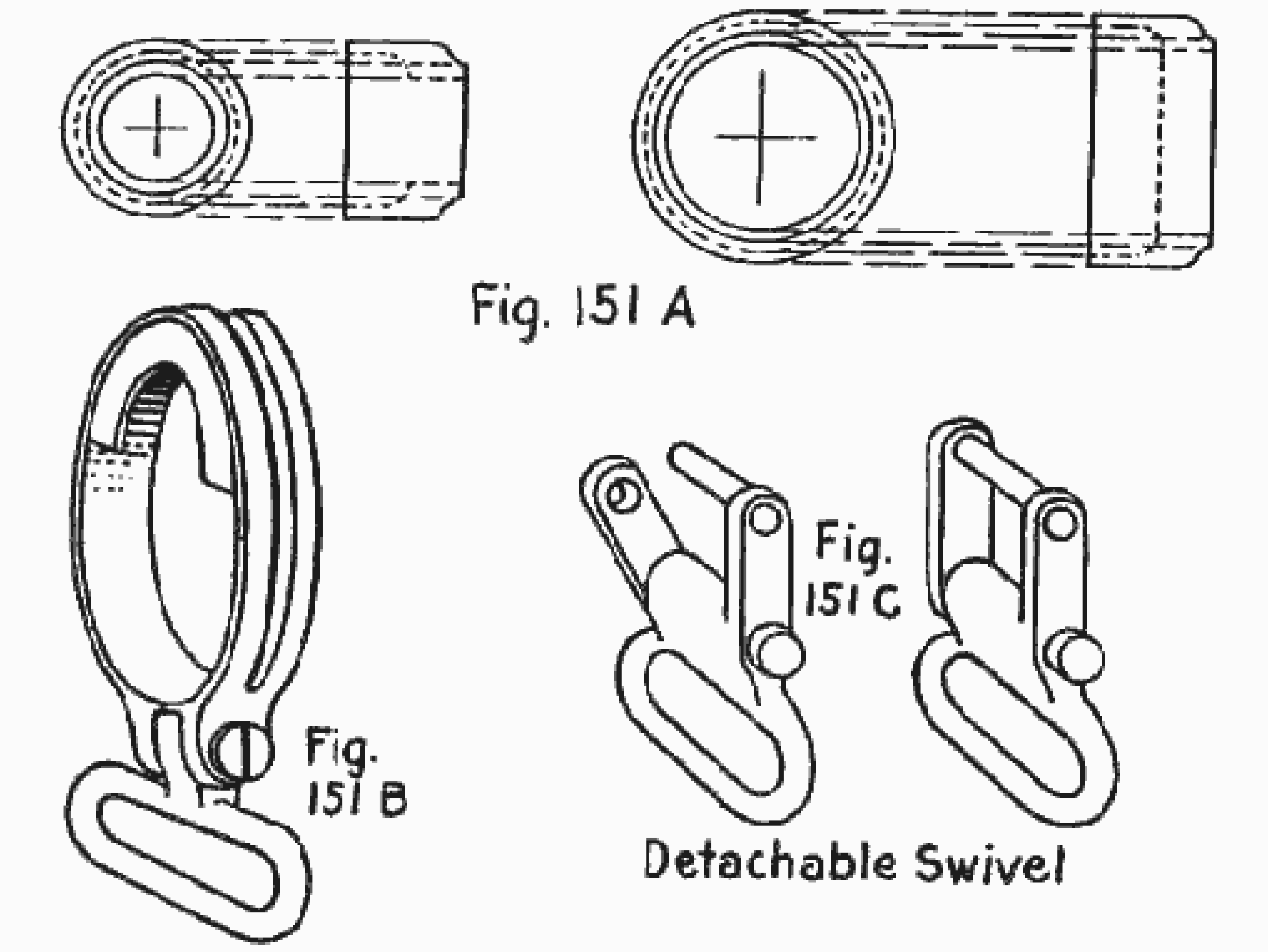
Figure 151A shows a pair of turned collars for use in keeping a handguard in place. One of the simplest ways to remodel a Springfield, if one does not care to reblue it, is to either make a new stock, or cut down and re-shape the military stock; then make a handguard to cover the rough rear portion of the barrel, and tenon the ends to fit tightly under these collars. It is not necessary that they fit the barrel tightly—in fact it is best to have them a trifle loose. The tenon of the band guard wedges under the collar, holding it firmly in place. The forward collar may be drilled and tapped on the lower side for a swivel screw, and the lower half of both collars may be dressed down until only a thin band remains—the overhanging portion being only necessary above the forend, to hold the hand guard in place.

Figure 151B shows another type of handguard band, made from a regular lower band of a Springfield service rifle. A piece of sheet steel 1/32 inch thick was fitted carefully into the upper half of band, and brazed from the inside. This piece was then filed to fit over the barrel, just clearing it without touching. This makes a much neater job than using the old band and letting the end of wood show under it.

FRONT SIGHT RAMPS. Whether or not a ramp does any real good is an open question; but in the eyes of most shooters it



adds a touch of distinction to the arm, and moreover, it helps to prevent barrel mirage from disturbing the aim, while permitting a

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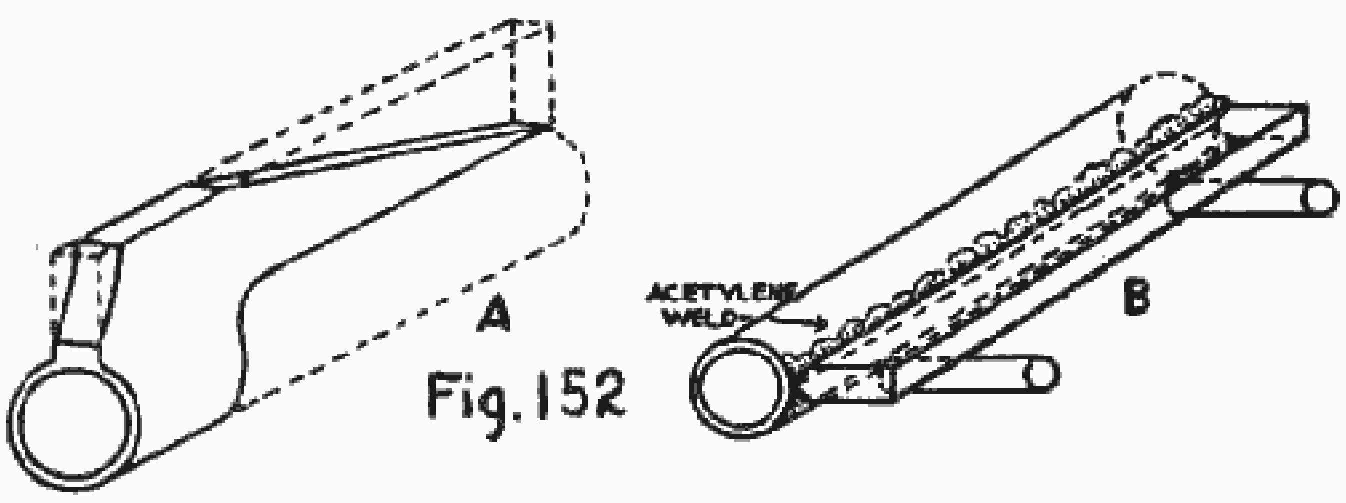
great variety of front sights to be used. With the ramp one is not limited to the use of blade sights made for military bases, but may use any of the dovetail base sights having a rather short dovetail; or he may use the caterpillar sights made by Lyman and Marble if he prefers that type. (See Chapter 29).

Figure 152A shows a type of ramp that is becoming pretty well standardized, the solid lines showing the finished shape, while the broken lines show the original blank. The blank should be made by a machinist who knows his business—it is no job for the appren-



tice—and it may be made on either the milling machine or shaper. It can be cut from thick walled tubing if the right size is available, or from solid flat stock, using cold rolled or machinery steel. The hole should be drilled and reamed to the exact size of barrel at a point 3/8 inch from muzzle, and it should be a straight hole—not tapered. The trifling taper of barrel at muzzle will assure a snug fit with good contact at rear end of ramp where it is not held by the band. The excess metal of both band and blade should be sawed and filed away, and the ramp brought roughly to shape before fitting. Then start it on the barrel, holding the blade down firmly, and peen lightly until stretched just enough to permit of its being slipped on. Chapter 23 gives detailed instructions for sweating on the ramp, and for pinning if desired. After it is mounted, solder on a temporary front sight, and sight in the arm as outlined in Chapter 29; then follow instructions for ascertaining height for dovetail; cut the dovetail and fit in the permanent sight. This may be mounted before or after bluing—it makes no difference.

A milled blank for front sight ramp will cost from three to five dollars in a machine shop. A cheaper one which is nearly as satisfactory if properly made, is illustrated in Figure 152B and described in detail under the welding instructions in Chapter 23.

The photo in Figure 153 shows a very attractive ramp made and fitted to a 39 Marlin. The original front sight was removed from the barrel slot, and filed down level with the surface of the barrel. A hole was drilled in this base, and a screw through it held the ramp, which was simply a piece of cold rolled steel 1/4 inch thick sawed and filed to shape. Between ramp and sight base a piece of ribbon

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silver solder was placed, with necessary flux, and heated redhot, then the screw was set up tightly in lieu of a clamp. The ramp was then cleaned up and polished, after its correct height had been ascertained, and the top dovetailed for the Sheard bold bead sight made for the Mannlicher-Schoennauer. The whole assembly was then blued, and the dovetail base of ramp driven into the barrel slot. This stunt is only possible on octagon barrels, as the round barrel would show gaps at edge of ramp.

On rifles requiring a very low ramp, the band may sometimes be eliminated. Many Mauser sporters imported into this country have low ramps merely soft soldered to the barrel. Personally I wouldn't carry one of them into the woods, for fear a blow would knock the ramp into the middle of next week—but the Heinies get away with

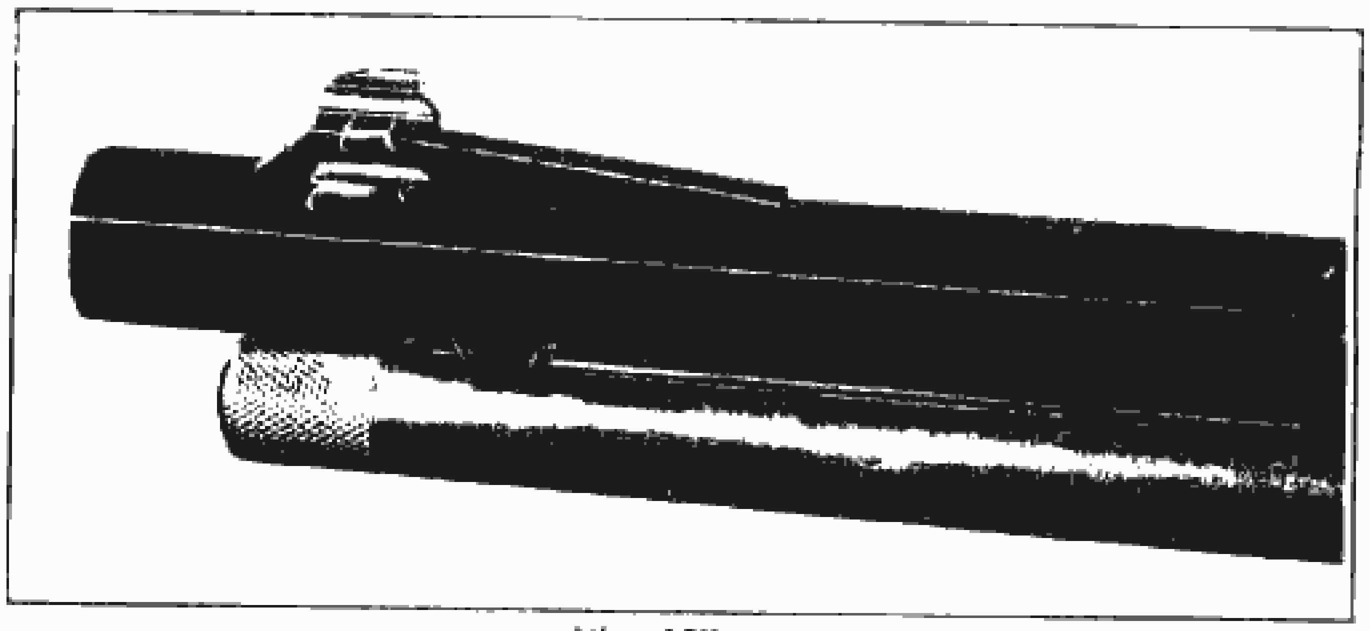

Fig. 153

it somehow. To make and fit a ramp of this kind properly, the ramp should have its lower edge milled hollow, to the exact radius of the barrel at forward end of ramp—in other words, about 3/8 inches from muzzle. A long bar of 3/4 x 5/16 cold rolled can be run under a 5/16 radius cutter on milling machine at small cost—and ramps for the Springfield or other barrel that is approximately 5/8 inch at muzzle can be sawed off as needed. Such a ramp should be silver soldered to the barrel after being clamped firmly at both ends, and unless you want to ruin the bore absolutely, coat it with the file hardening compound described in Chapter 21; this coating must dry slowly for several hours before the brazing is done. Theoretically, there is some danger of warping the muzzle slightly in the brazing process, and the real crank will choose a banded ramp attached with soft solder.

I note that at least one firm is offering a ready-made ramp at about ten dollars designed to be attached to the Springfield barrel. In justice to all concerned I would suggest that the prospective purchaser study the catalog illustration carefully before parting with his ten iron men. The ramp in question is supposed to fit perfectly

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over the spot where the original fixed stud was attached. From experience I know that this size varies quite a bit with different barrels and studs. Moreover, a ramp fitted over the lettering and ordnance insignia stamped on the barrel near the muzzle is going to look like the very devil. Before a ramp is fitted this lettering should be "struck" off and the barrel polished—and if this is done, the "store" ramp will then prove to be too large. The only way a ramp can be fitted—I mean *really fitted*, so that there is no streak of solder showing along the edges, is to make it slightly smaller than the barrel, and fit it *tightly*. Another thing—the ready made ramp is just about half as high as can be used on a Springfield; thus it requires a very high front sight which sticks way up above a ramp, making it fall far short of its purpose. One of the best things about the right kind of a ramp is that it can be made so high that you use a very low front sight, which is thus better protected, stronger, and easier to shoot accurately than a thin, flimsy affair hovering in mid air half an inch or so above the top of ramp.

The entire upper surface of the ramp should be matted, and this process is described fully in Chapter 19.

With a complete machine shop at his disposal, the gunsmith is in position to make a splendid FRONT SIGHT COVER to be attached to the ramp. Such a cover is illustrated in Figure 154, made from 5/8 inch Shelby tubing with 1/16 inch wall. To form, take a piece of 1/2 inch steel drill rod, and mill a flat 3/8 inch wide on one side. Force this into the tubing, and hammer one side of tube flat against the flat portion of rod. The flat portion is then slotted as shown, either with hacksaw and file, or by milling. The closed end may be knurled or finished smooth as preferred. One side of

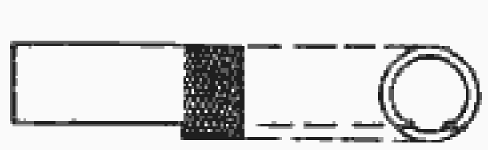

Fig. 154

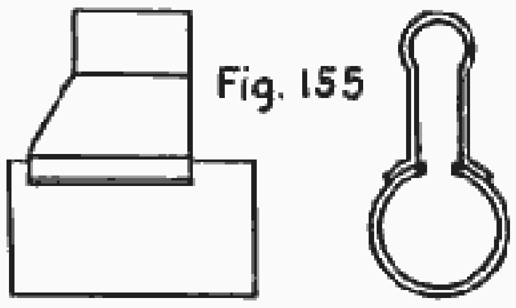

Fig. 155

this cut near the closed end should be notched as shown, and the point relieved slightly.

The barrel with ramp attached (after the rifle has been sighted in and slot cut for front sight) is now mounted on the bed of milling machine and slots 1/16 inch wide and 1/16 inch deep cut in the sides. The distance of these slots should be figured from the front sight bead, so as to about center the bead in the sight cover. A hole is now drilled in the slot on left hand side of ramp, and a round end pin of drill rod driven into it, the rounded end projecting into slot not more than 1/32 inch. When the sight cover is pushed into place, the edges slide in the grooves in ramp, while the left hand edge rides up over the projecting end of pin, which snaps into the notch in edge

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of sight cover, holding it in place by its natural tension, yet permitting easy removal when desired.

Detailed instructions for setting up and doing this job are not given, for the set-up would vary somewhat with the type of equipment available; moreover, a first class machinist will readily understand what to do from the drawings—and only a first class machinist could do the job.

Figure 155 shows a "tompion" or muzzle cover, with sight cover in combination. It may be made of thin Shelby tubing or hard brass tubing as preferred, to fit almost any rifle. The piece of tubing which slides over the muzzle is partly cut away for the sight base or ramp; and a small projection left on either side snaps over the front edge of sight base, to keep the tompion in place. The muzzle end is closed either by brazing in a round piece of sheet stock, or by threading in the end of a piece of rod equal to the inside diameter; screw this in about 3/32 inch, saw off the rod, file it flush. The sight cover portion is made of sheet brass or steel bent over a round rod in the vise just as you bent the stock for the two-piece barrel band. The lower edges are bent out for about 1/8 inch, and brazed to the tompion. The muzzle end of the tube portion of sight cover may be closed, or left open as desired. Better to leave it open. A gadget of this kind had better be made of brass, and polished—one is more likely to see it in time to avoid shooting it off if an unexpected shot presents itself. I have never shot a tompion off a rifle, and don't know whether the barrel would be damaged or not—don't think it would. But you sure would have the devil's own time trying to find that tompion!

MUZZLE PROTECTOR. Rifles that must be cleaned from the muzzle need a protector to prevent the rod wearing the edge of muzzle. This *should* be made in a lathe. Chuck a piece of steel bar at least 1/8 inch larger than the muzzle diameter, and drill a hole through it endwise barely enough to allow the cleaning rod to slide through. Now counterbore to a depth of about an inch and lap out smoothly to a sliding fit over muzzle. Then mill or saw away enough of one side to clear the front sight. Case-harden, and polish out the inside, to prevent marring barrel. No drawing is shown, as the protector would vary considerably for different rifles and sights. In this day of rustless, smokeless, dirtless and pitless ammunition and bolt action rifles, only the cranks who insist on using the old time weapons are likely to be interested in a muzzle protector. But when needed in a hurry, a good one can be made very easily if you can get hold of a piece of Shelby tubing that will just fit snugly over barrel. Cut it about an inch long, file away enough of the side to clear the front sight. Solder or braze a piece of 1/16 cold-rolled steel over the muzzle end. Center and drill this for the rod—and "thar she be!" Brass tubing is all right, but the hole will soon be enlarged, permitting it to wear the muzzle.

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PISTOL GRIP CAPS. Good ones are hard to find. The cheap hard rubber ones of factory manufacture, as seen on many shotguns are about useless, being small, flimsy and ugly. The best ones are made of cold rolled steel, but the supply is limited to the few made up by the larger custom gun makers for their own use. These plates are expensive, as they are cut out from solid stock on a profiler—which is a milling machine with a vertical cutter that can be moved in all directions. An oval shaped piece of steel is mounted on the bed of the machine as a pattern; a special formed cutter is used, having its end shaped to the edge design wanted on the finished cap, and this cutter is brought against another oval piece from which the cap is to be made. A "finger" bearing against the pattern piece guides the cutter around the stock, shaping the plate as desired. Thus it is necessary to make a special cutter, costing fifty dollars or so, for every edge design wanted, and a special hardened pattern plate for each size and shape to be manufactured. And likely as not, the grip cap of this type purchased (if one is able to purchase it at all) will not conform to the purchaser's ideas of size and shape.

A good plain grip cap may be made from a piece of bakelite or celeron radio panel 1/4 inch thick. Simply mark out the oval to size and proportions desired, cut the bakelite roughly to shape with a scroll saw or coping saw, file carefully to the outline, then drill and countersink the screw hole. In this condition mount it on the grip of the stock, and work the wood down to it, filing both grip and cap until the edges are perfectly even. Then with a medium coarse file, start in near the screw and round off the cap, thinning it toward the edges to about 3/32. Polish with fine sandpaper, then pumice, until smooth and bright.

Grip caps of horn and steel, made for Mauser sporting rifles, can be purchased from firms importing these arms, at a cost of about 50 cents each. They should never be carried in the pocket on Sunday, as their small size involves an ever-present danger of their being accidentally dropped into the collection plate instead of the customary two-bits. They are also fine for operating slot machines. But—they have possibilities. Take the horn cap, and rub the under side smooth and flat on a sheet of coarse sandpaper held on the bench; take a piece of thin horn, bakelite, or even black fibre, say 1/16 or 3/32 inch thick, and larger than the cap. Roughen its surface with sandpaper, and cement the cap to it with du Pont cement, clamping it in the vise for 48 hours. Now dress down the edges all around to the size wanted, the projecting edge of the bakelite or fibre forming an extra bead and increasing the size and shape desired. Drill the screw hole through this piece, and fit it in place.

The Mauser steel caps (which are merely thin sheet metal stampings) can be similarly remodeled, by first filing them to the form of oval desired (they usually have a very clumsy shape, being too round on the ends) and sweating or brazing them to a piece of 1/16

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inch cold rolled steel. Grind or file the edges as desired, round outer edge, scrape and polish off any solder or spelter that shows, and blue. Use the nitre or the heat and oil process if you brazed the pieces. If you soldered them, use a rusting solution, either hot or cold.

The amateur who has pretty definite ideas of his own may not be content with a remodeled grip cap; the thing for him to do it to secure a piece of soft pine, about 5/16 inch thick; cut it to the desired oval, drill a screw hole through the center, and mount in so that it can be revolved on the end of a piece of wood, which is held at any convenient angle in the vise. With file and chisel the edge is shaped up to the desired bead design, sandpapered smooth, and shellacked. Send this pattern to the nearest brass or white metals foundry, and have it cast in aluminum—the cost will not be much. This aluminum pattern can then be filed and polished very smooth and accurate in shape. Finally buff it to a bright finish. This can now be used for the cap, being finished in black as described in Chapter 20; or it can be sent to a foundry and cast in brass, bronze or copper, and given a beautiful black, blue, red, verde antique or other finish. Or it can be cast in malleable iron, carefully file finished, polished and blued. The man with some artistic ability will enjoy working up a grip cap in modeling clay or plaster, with a game head or other figure in relief, and this can then be cast in bronze, the surface engraved, and given any finish desired.

Some shooters will desire A GRIP CAP WITH A TRAP for a spare front sight. If the hole in end of grip is not so large and deep as to weaken the stock, there is no objection to this. The simplest and easiest way to make this is to first make a cap of bakelite as first described. Fit this to perfect contact and cement it with du Pont cement, using the screw to hold it until dry. Remove the screw and drill through the cap and the required distance into the grip, starting with an augur bit and finishing the bottom of hole with a Forstner bit. The size of the hole will depend on the size screw you will use to close it—somewhere around 1/2 inch. Secure a threaded bolt or large machine screw with a fairly fine thread, slightly larger than the hole. Cut off a piece of the threaded end of bolt about 5/16 to 3/8 inch long. Tap the hole in grip cap for this screw, letting the threads go into the wood of grip for only a short distance. Take the short piece of bolt, and round off the cut end slightly, polish it, and cut a screwdriver slot wide enough to take a small coin. Blue this, and the job is complete. The screw should turn into the hole tightly when its outer end is nearly flush with surface of grip cap, and the slot should be in line with center line of stock. This makes a neat job, and a thoroughly practical one, at practically no cost. A better way would be to make a special screw to close the hole, with a wide thin head having a narrow shoulder.

This same idea can be carried out with the remodeled Mauser grip

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cap already described. The cap, being of thin sheet steel, should have the space between its inner surface and the added piece filled up solid with brazing spelter. Then drill the screw hole to required size, and make and fit the screw. Since it is impractical to cement a metal cap to wood, a piece of brass tubing about an inch long and 1/2 inch inside diameter is then brazed to under side of cap; the upper end of tube is closed with a piece of brass brazed on, and in the center is drilled a hole for a short wood screw, which holds the cap in place. A well of this type can also be fitted to a solid cap of iron, steel, bronze or other metal.

Figure 156 shows clearly the method of working out the two methods just described. Very good steel grip caps with a trap door held open or closed by a jack-knife spring, similar to buttplate traps,

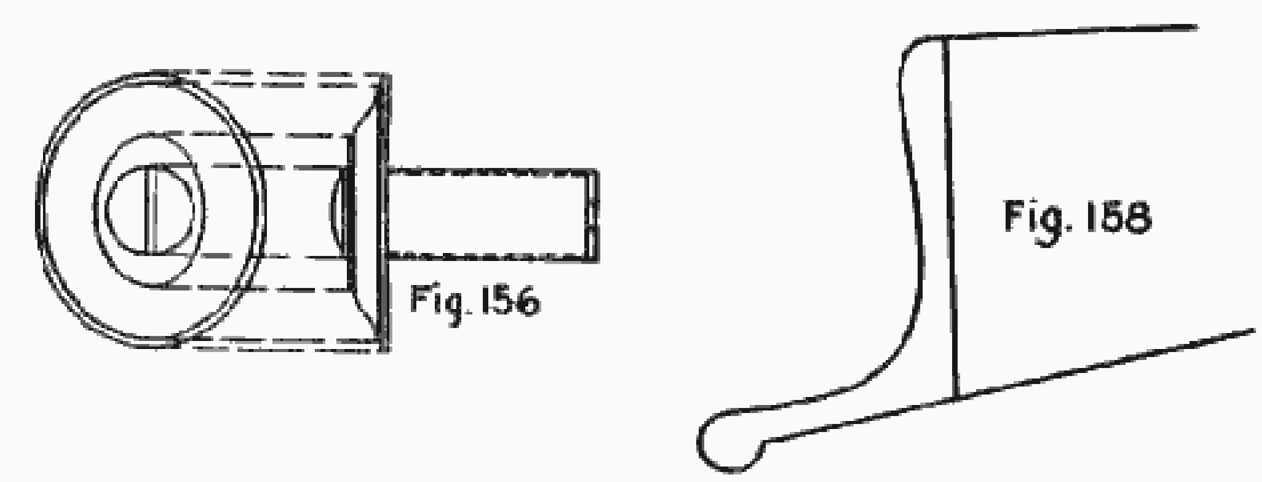

Fig. 156

Fig. 158

can be purchased from one or two English firms handling gunsmithing supplies. The screw trap as described, however, answers every purpose, is neat in appearance, and comparatively easy to make.

BUTTPLATES. About the most difficult problem the amateur designer has to face is that of securing a suitable buttplate. Formerly very little thought was given to the hinders of a gun's anatomy, almost any old piece of iron that would prevent the wood from splintering being considered satisfactory. The deeply curved crescent shaped plate was very satisfactory on the old lever actions having only moderate recoil, the shape of the plate keeping the butt to the shoulder while the lever was worked. But with the coming of bolt actions the horns of such a plate were not needed to keep the butt from slipping down, and the increased recoil of modern loads necessitated a type of plate that would distribute the blow over the largest possible area of shoulder, and with no sharp projections to stab and gouge.

The shotgun type of buttplate was found to be the best of all for use on the new day rifle. Its larger size—usually 5 inches or longer, and at least 1 5/8 inches in width, and its nearly straight shape and rounded edges made it the most comfortable as well as the most efficient. Unfortunately, these plates are usually made of the poorest kind of hard rubber, or else of horn, which is somewhat more durable, and good steel plates, which are the only kind suitable

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for the rough use that a rifle usually is given, are hard to find. Winchester makes a very good steel shotgun buttplate for about 60 cents. It is about 1/8 to 1/4 inch narrower than called for by the best rifle design, and an extra 1/4 inch in length would not hurt it any. Belding & Mull make a special buttplate which was designed for the B. & M. Model 30 Remington sporter, which more nearly approaches ideal lines. Neither of these plates has a trap for cleaning materials or what not, and recent custom has brought us to the point of demanding such a trap on the better grade rifles.

Sometimes one can remodel a military buttplate very satisfactorily. The Springfield plate is really too short; a Krag plate, which can be bought from Bannerman for a quarter, works up much better. It has a small round trap, not as desirable as the long oval traps on the expensive imported plates, but far better than none. A man should have acquired reasonable skill at forge and anvil to do a first class job of reshaping this plate. First remove the trap, trap spring and screw. Then heat the toe and straighten out the forward bend. Heat entire plate and curve it very slightly from heel to toe. Heat it again and round the plate slightly from side to side over the horn of the anvil, taking care to preserve the heel to toe curve while doing this. Next heat the trap, and bend it slightly from side to side, and refit it into its hole. This requires very careful work, and it will very likely be necessary to do some filing, due to the hole having been misshapen by the bending of the plate. Work it down carefully until the trap fits close all around the edge, and is snugly seated against the beveled edge of the hole. Now assemble the trap and plate, and file down their surfaces smoothly; round edges of plate and grind or file outer edges to exact shape desired. The long round-end lip at heel can be cut off, leaving only about 1/4 or 3/8 inch projecting, and this ground to a point. The square edge at heel should also be well rounded, and a screw hole drilled and countersunk near the heel, the original hole in lip having been removed. The plate and trap should then be polished, and the surface either file-checked or sharply stippled, as described in Chapter 19.

It's easy to say "file-checked"—doing the job is another matter. I have never found any dependable method for spacing file cuts accurately enough to call it checking; if one has plenty of time and patience, a good sharp 3 square file can be used to turn out a fine job, simply gauging the spacing of the lines by eye; but it is a slow process, and really amounts to engraving with a file. Knurling is usually out of the question without a very costly set-up of special fixtures, so the stippling method, using either a dental engine or a prick punch and hammer, offers the readiest solution.

It is possible to take the B. & M., the Winchester, or any similar steel plate and make and fit a trap in it as desired. The round trap is of course easiest to fit, and may be taken from a Krag or Spring-

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field plate. The buttplate you purpose using is carefully set up in a four jaw lathe chuck, so as to center exactly the point at the center of the hole to be cut. The hole is then turned in, and its edges beveled at an angle of about 45 degrees. The slot for the hinge of trap is filed in, and the trap heated and bent slightly to conform to the curved surface of plate. Careful filing then fits the trap into its seat smoothly. The hinge pin rests at each end in small depressions cut in the under surface of the plate on each side of the hinge slot. The easiest way to cut these depressions is with a dental engine and round burr. Lacking this, make a shallow indentation with a drill just back of the edge, and chip out the metal at edge with a small

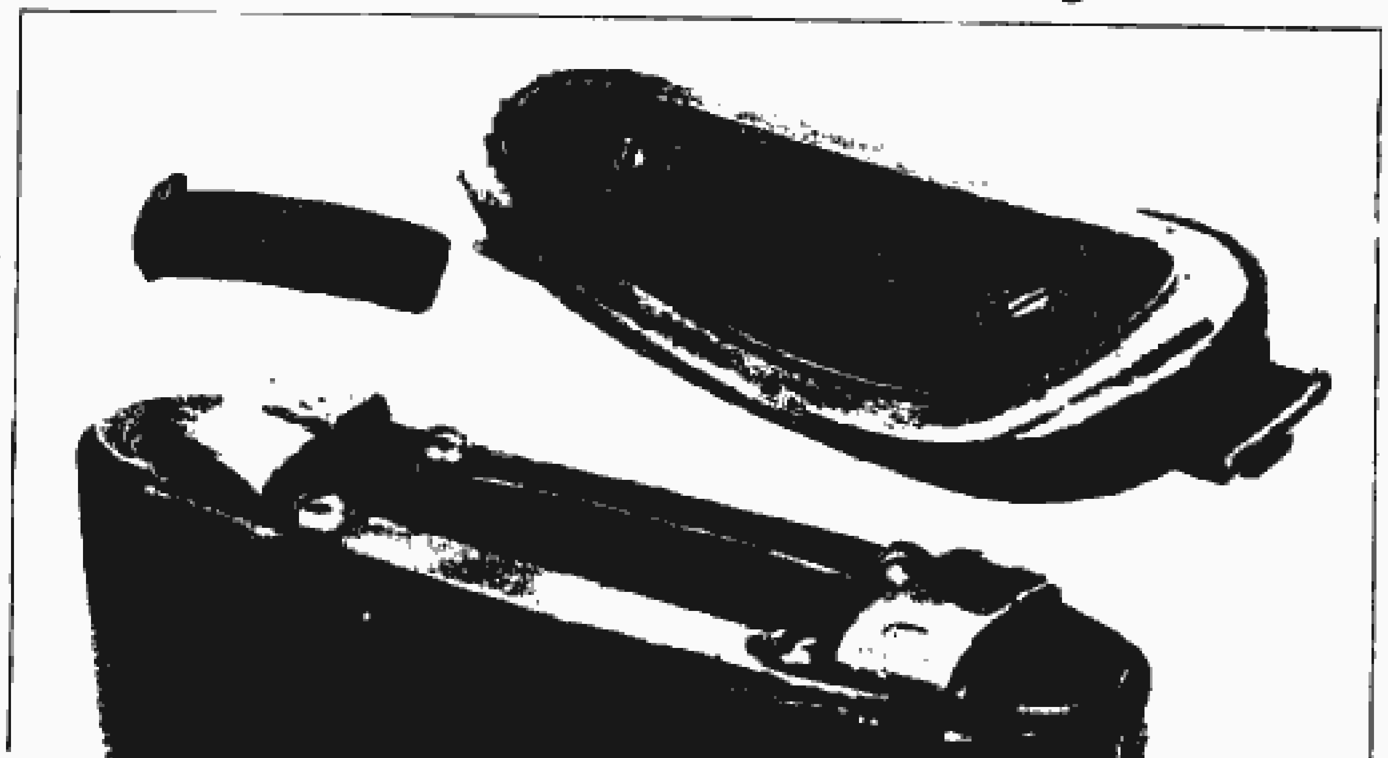

Fig. 157

sharp cold chisel. When the ends of hinge pin are correctly seated in these depressions, the trap is held in place by pressure of the spring.

Figure 157 shows a rather unique method of making the Springfield Sporter buttplate removable, giving access to a hollow in the butt. A slot was cut in each end of the plate with a hacksaw. Into this was fitted a key made of clockspring, bent over short at the outer end. This spring key fitted tightly under the lug brazed to the inner plate which was made of sheet steel 1/16 inch thick. This inner plate was smaller than the butt, permitting the buttplate to set down over it, and the plate was attached to the butt with several small wood screws. The two screw holes in buttplate were filled with the cut-off heads of the screws, riveted into the holes.

The crank with definite ideas of his own as to what a buttplate should be, will not hesitate to make it by whatever means seem best adapted to the job. One way, if he is skillful at the anvil, is to forge the plate from a bar of steel, shaping it roughly as desired, then grinding and filing to final dimensions. Another way is to

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make up a pattern in soft wood, working out the curves until they suit, and checking the surface with a rather coarse checking tool. This is then sent to a foundry and cast in aluminum. The aluminum pattern may be used, but it is best to use it only as a pattern. With a 3-square file, carefully clean up and sharpen the checking or corrugations; true up the shape, and polish all but the checked area; drill and countersink the screw holes; then send this pattern to an iron foundry for a few malleable castings—they cost little and it's just as easy to get several while you're about it. A little filing and polishing gets the plate ready to blue, and it is exactly the way you want it—not the way some manufacturer thought you should want it. The screw holes can be cast right in the plate, so that they only need to be cleaned up with a rose countersink bit.

Good malleable castings made in the finest of molding sand, are quite as good as drop forgings for articles of this kind. They come out very smooth, requiring a minimum of filing to finish; and they can be blued by heating red hot and dropping into oil, or by the nitre or hot solution processes.

The aluminum pattern is always advisable, as it can be shaped more accurately, and the checking or corrugations worked up better than in wood. Do not make the mistake of making your original wood pattern too thick—remember that iron is heavy and 1/8 inch is plenty thick for the thinnest parts, even counting the metal that will be removed in finishing. Allow only about 1/32 inch in overall dimensions for shrinkage, as this will be slight in small castings.

Remember that ordinary gray iron castings in coarse sand are utterly worthless for this class of work—send your patterns to a foundry equipped to make the best malleable castings and specializing in this work. If you know of some pattern maker, by all means consult with him while making your pattern as he will give you many valuable hints relative to the way the pattern must be removed from the mold, and in what position it will "draw" best—possibly enabling you to avoid wasting an entire job. Good buttplates can be cast in hard brass or bronze, if desired, and finished either in black or in colors.

Figure 158 shows the "free rifle" type of buttplate made of aluminum. The pattern should be made of clear white pine, in two pieces, the "horn" being a separate piece morticed and glued into the buttplate. One may follow pretty much his own fancy as to shape and design, remembering the limitations of the foundry, and the fact that the pattern must be of a shape that can be drawn from the sand. Wooden patterns must be heavily shellaced, and rubbed down with fine sandpaper and oil until very slick, to prevent the sand sticking and crumbling. Unlike cast iron, aluminum and brass castings stand considerable cold bending, so that the horn of this plate can, if necessary, be reshaped a little after finishing, in case you do not get your pattern just right. The rough casting as

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it comes to you from the foundry should be filed smooth and the shape trued up; then polish with aloxite or emery cloth from coarse to fine, then buff to a high polish on cloth buffer with Tripoli compound. The plate may be left bright or it may be blackened as described in Chapter 20.

PALM REST. A buttplate of this type naturally suggests a palm rest for the same rifle. Figure 159 gives details of one that is easy to construct and fit. The ball is a regular water polo ball of solid cork, obtainable in sporting goods stores. Order from the Director of Civilian Marksmanship an extra magazine floor plate, to which the palm rest is attached. Changing floor plates then enables one to use the rifle with or without palm rest as desired. No special instructions are needed for making this rest, as the drawing is self-explanatory. The parts may be made of cold rolled steel, brass, or aluminum.

CUTTING OFF RIFLE OR PISTOL BARRELS. Frequently, due to a damaged muzzle or in order to make an arm light or handier to use, shortening the barrel will be indicated. And there's

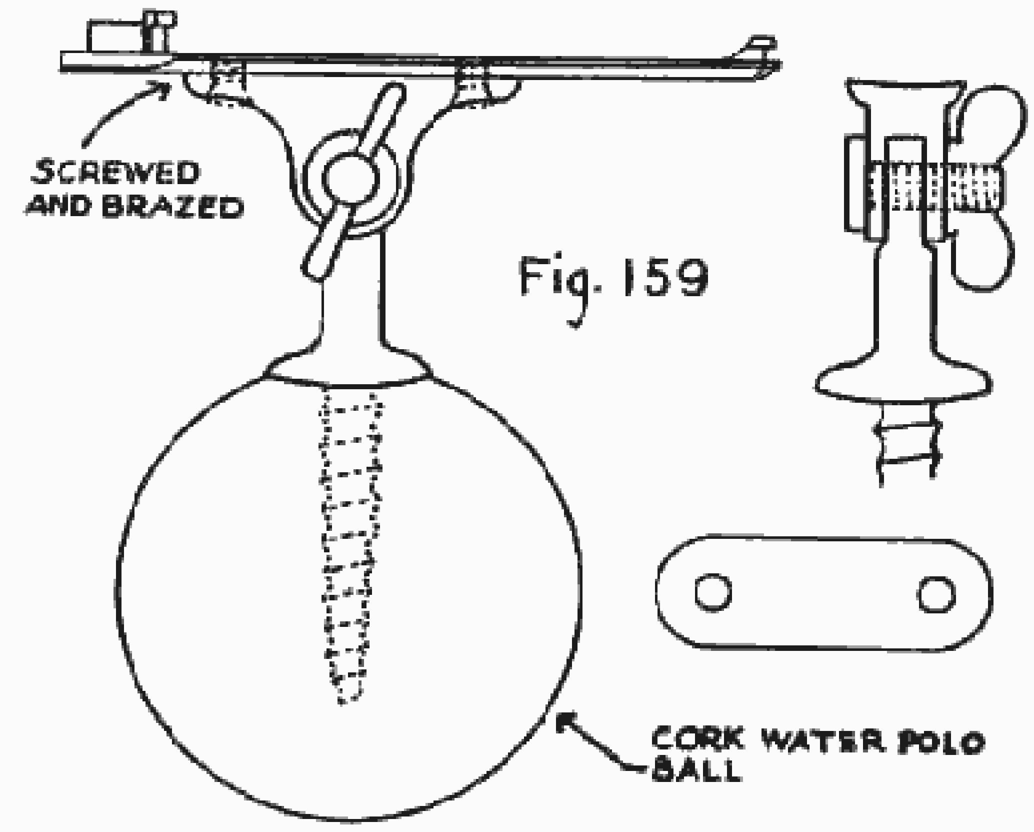

Fig. 159

just about as much bunk prevalent on this subject as you'll find in a day's journey. It isn't necessary to cut off a barrel in a lathe—in fact that is one of the poorest methods, for the parting tool usually leaves a burr on edge of bore which the crowning may not entirely remove. So it becomes necessary to file the muzzle anyhow—why bother with a lathe setup?

Mark the barrel where it is to be cut, and cut it off about 1/32 inch ahead of the mark with a hacksaw. Set barrel upright in the vise, and with a good sharp mill file, dress the muzzle flat and as nearly square as possible. Use an adjustable square if you like, or use only your eye—and don't worry about it not being perfectly

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square. The *edge of bore* will be square all right when you finish the lapping operation to be described.

But first take a countersink reamer and countersink edge of bore to a depth of about 1/32 inch—this is just to get rid of surplus metal, and hasten the lapping.

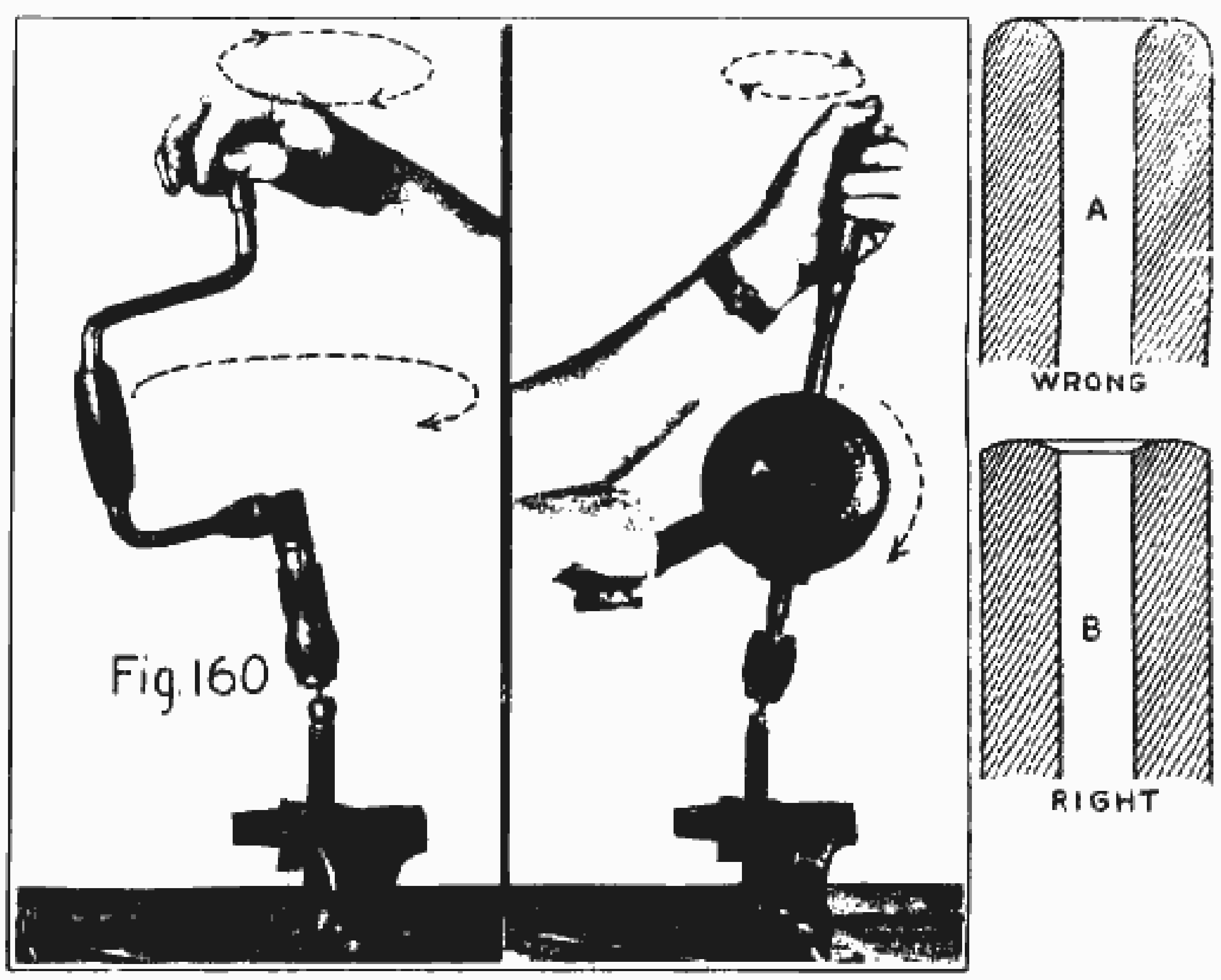

Fig. 160

Secure four brass balls measuring respectively 3/8, 1/2, 5/8 and 3/4 inch in diameter. These may be secured from Ellfeldt Hardware & Machinist's Supply Company, at Kansas City, Missouri. I find that these are not regularly stocked by many large supply dealers. Drill about half way through each ball and tap for an 8 x 32 screw, which should be turned in tightly. Cut the head off and use the screw for a shank. Start with the smallest ball. Chuck it in a breast drill or brace, and with a small quantity of valve grinding compound lap the ball into the muzzle as shown in Figure 160, the lapping occurring on the extreme inner edge of bore. Continue with the 1/2 inch ball in the same manner, then with the two larger sizes until the inner half of barrel wall is well rounded. Round off the outer edge with a file to a corresponding shape, then polish the edge, first with No. 00 emery cloth, then crocus cloth held on the ball of thumb.

A muzzle lapped in this manner cannot be otherwise than square—for the simple reason that the surface of a sphere will not touch the

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edge of a cylinder at all points until their axes absolutely coincide—in other words, until the end of cylinder is square.

When a number of barrels of the same size and caliber are to be cut off and crowned, a crowning tool may be made as described in Chapter 7. Generally speaking, however, any sort of pilot reamer is a bad thing to put into a muzzle, due to the danger of small particles of grit or cuttings sticking to the pilot and scratching the bore. If you use such a tool, be sure the bore is perfectly clean and lightly oiled, and have the pilot a snug sliding fit.

Do not crown a muzzle too deeply, rounding off the inner edge as at A, Figure 160; leave the edge sharply defined as shown at B.

REPAIRING A DAMAGED BARREL MUZZLE. When the muzzle of any barrel—either rifle, shotgun or pistol barrel—has been damaged by dropping, or otherwise, there is but one known cure—amputation of the damaged portion. Quite often only a quarter inch or so need be cut off; in other cases, two or three inches may be necessary. Sometimes a slight obstruction in the muzzle will cause a bad "ring" or swell which ruins the accuracy of the barrel; when the portion carrying the ring is cut off, the barrel shoots as well as ever. Major Robert H. Lewis was just telling me about an old '95 model Winchester which he used in Texas before entering military service. On his return to the ranch after several years, he ran across the old rifle, rusted and battered, poked away in a shed with other discarded articles. On questioning the major domo, he was informed that the gun "no good—him no hit notting now"—so he took it along and got busy with a stiff cleaning brush, bottle of Hoppe's, and a hacksaw. After cleaning the accumulated rust from the bore he tried a few shots which scattered all over a quarter section, more or less. Inspection showed the rifling all worn out of the muzzle for half an inch back. He cut an inch from the muzzle, crowned it, and proceeded to shoot a 2 inch group at 50 yards. The old gun is still in service on the Lewis ranch near San Antonio, and has many head of game to its credit since the amputation was performed.

BENDING TANGS. When remodeling a single shot or other straight grip rifle so that a full pistol grip stock may be fitted, the bending of the tang often looks like a tough job—but it isn't if you go about it right. The action should be completely stripped of all screws, pins, springs—every removable part that will come off. But before doing this make an outline drawing, full size, of the gun "as was," noting by dots and crosses the location of trigger, guard, ends of tangs, tangscrew holes, etc. Then on this same piece of paper lay out the shape you want the new stock to be, so as to show the new position of lower tang, lever, guard, and other parts. If the lower tang is removable, as is the case with the single shot Winchester, it should be removed.

The amateur usually makes his big mistake by bending both tangs.

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Usually the upper tang should be left straight as is, and only the lower one curved to form the grip. Bending down the upper tang reduces the size of the grip, and also makes the comb stick up just that much more above the handhole, when, as a matter of fact, the high comb usually wanted in the new stock is going to stick up more than will look well, without making matters worse by bending down the upper tang.

If desired the lower tang may be heated and bent by careful hammering on an anvil, but as most of them are easily bent cold, I prefer to do it that way. If hard, heat it to a dull red to anneal it; if not hard, proceed without any annealing.

Cut three pieces of round brass rod three inches long and 3/8 inch diameter, and bend one end of each at a right angle, so they will hang on the vise jaws—two on one jaw, and one on the other. Insert the tang between the three rods, so that the single rod is on the inside of the curve to be formed. Tighten the vise, making a slight bend. Loosen the vise, and move the tang or the rods to a different position as required to increase the bend, and again tighten the vise. Continue until you have exactly the curve desired. The tang will be marred very little by this method, and any slight dents may be easily filed out. Cold bending leaves the metal under stresses which must be relieved. Heat the tang to a dull red, and allow it to cool.

Be careful not to make a sharp bend at one of the screw holes—this is very easy to do. A good clean curve is what you are after. Test the shape on the layout sketch previously made until you have it just right.

When the lower tang is not removable it is not always practicable to bend it in the vise. But by setting the receiver firmly in the vise, the two notched steel bars described for bending bolt handles may be used to advantage. Set a thick piece of sheet copper in the notch to prevent marring the tang more than necessary, although a few slight dents cannot be avoided.

When a tang has been so altered it will be found in many instances that it is too long for the grip desired—in that event, simply saw off as much of the lower end as necessary, round it up, and drill a new hole for wood screw to hold the tang in place in the grip.

Very likely this bending will also damage the threaded hole into which the tang screw was originally fitted. The only workmanlike way of getting rid of this defect is to have a first class welder fill up the hole with melted steel, after which you can dress it off smooth by filing. To provide a base for the new tang screw hole, file out a small wedge shaped piece of steel, so that when fitted to position on inside of tang, its surface will be at right angles to the tang screw. Braze or hard-solder this in place, and drill the new screw hole through it. A better method, I believe, is to have the welder, when he fills up the old screw hole, also build up a good

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sized lump of metal on inside of tang in the position of the new hole. This may then be grounded and filed to shape, and the new hole drilled and tapped in it.

FIRING PINS. A common fault of the otherwise excellent low-priced single shot rifles is the frequency with which broken firing pins and faulty extractors occur. Firing pins should be made of drill rod in size equal to the largest diameter of the pin. They must be turned up true so that they will not bind or stick. If you have no lathe, file the pin carefully to shape, leaving it slightly oversize; then hold it in a chuck on the end of your grinder spindle and turn it to final dimensions with a file held against it while turning at top speed.

Flats or notches required in the side of the pin must be carefully filed in by hand, and the easiest way to hold the work is in the same chuck on the grinder spindle; lacking the grinder, check the pin in breast drill, hand drill, or even a tap wrench, which may be held in the vise. This avoids marring the pin with the vise jaws, and holds it in the most convenient position for shaping.

To harden, heat the pin to a bright cherry red and quench in oil; *and,* be sure to heat the thick end first, so that the point may not become overheated. After hardening, polish bright, then heat very carefully to an even blue color and quench in water or oil.

The importance of correct shaping and tempering of firing pins cannot be overestimated. The point must be well rounded—hemispherical—in center fire guns, and slightly rounded or flat for rim fire guns. Even a flat end firing pin must have the sharp edges "eased" off on a stone, and the end must be polished smooth. Mr. Seth Wiard of the Lyman Gunsight Corporation describes an accident which came to his notice when he was with the Remington Arms Company which may serve as a warning:

"The gun in question was of uncertain parentage, being put out under the trade name of one of the large hardware jobbers and upon one occasion, —it is not known whether or not it was the first time since repairs were made—the then owner fired it with a regular medium 12 gauge load. The firing pin drove back into the shooter's eye-ball, entirely destroying the sight of the eye, of course.

"Upon investigation I found that the firing pin was of home-made construction, evidently from some soft material such as a wire nail, and had an exceedingly sharp point. The firing pin was of the conventional type with a notch in the side of the shank so that the nose of the check screw would fit in this notch to prevent its falling out. Examination showed that the firing pin stock, being soft, and the end of the check screw being burred over due to abuse and the point being too sharp, when the gun was fired the sharp point punctured the primer and the gasses generated in the shell impinged upon the firing pin point and drove it to the rear in a manner similar to the mechanism used in the Garand semi-automatic shoulder rifle.

"Undoubtedly the firing pin acquired enough momentum through its inertia so that after its travel of the fraction of an inch necessary to bring it back against the check screw, it had enough energy to rub by the check screw and then blew back through the stock."

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The above is but one of many instances that might be related of serious accidents due to faulty firing pins. The greatest care must be exercised in the development of the firing pin profile, particularly of the point. The shank must fit the hole in frame easily, yet without excess clearance. The pin must be made of good tool steel, polished, hardened, and then the temper drawn to a point that will eliminate the possibility of breakage,—which means temper it at blue, which is the right color for all percussion tools. Blue temper in good steel means that the part will batter or dent slightly before

If you are not sure of the quality of the steel you are able to purchase, it is safest to use some old tool, such as a file, or a buggy spring, or something which you know is made of good carbon steel. If you are using new bar stock, have it considerably thicker than the finished spring is to be, as steel is often decarbonized for some little distance below the surface in the annealing or rolling operations.

Heat the bar to a medium cherry red for a distance a little greater than the total length of the spring, and forge it all over to "tighten"

The Poor Man's JAMES BOND

VOL. 4

Kurt Saxon

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