VOLUME I

THE MODERN SHOTGUN

A COMPREHENSIVE WORK IN THREE VOLUMES
ON SPORTING GUNS AND AMMUNITION

MAJOR SIR GERALD BURRARD, Bt.
D.S.O., R.F.A. (retired)

THE MODERN SHOTGUN

VOLUME I.

THE GUN

by

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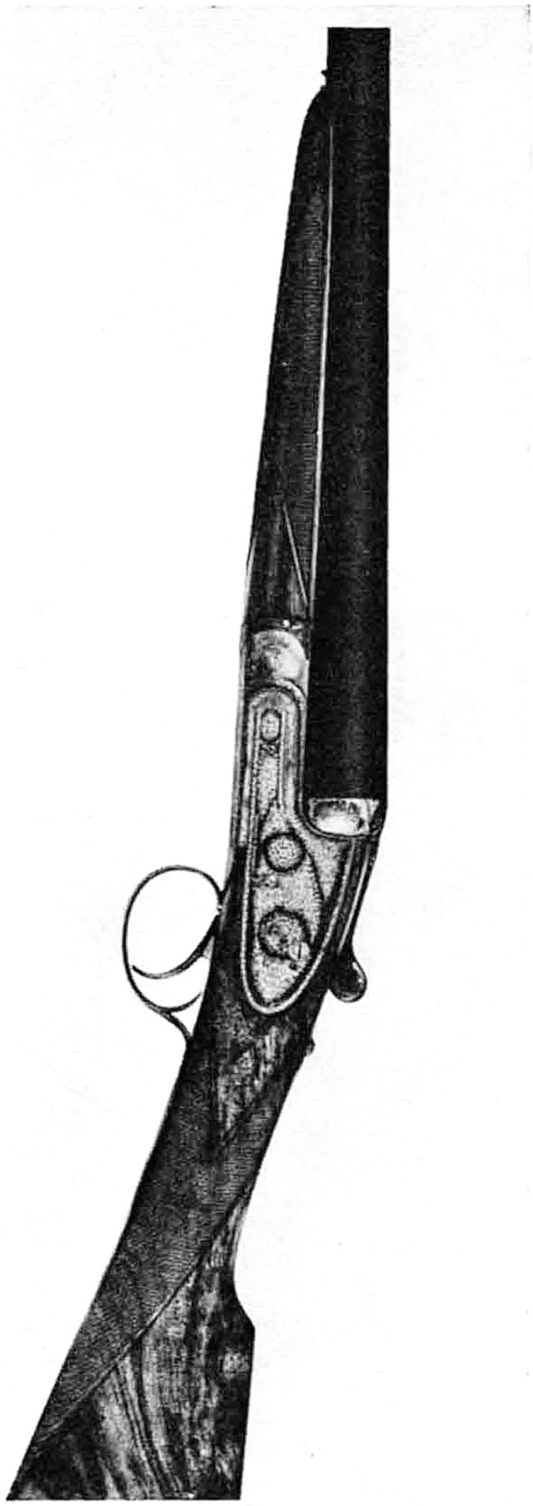


A best-grade, double-barrelled, single trigger, hammerless ejector 12-bore Game Gun

WORKS CONSULTED

The Modern Sportsman's Gun and Rifle (Vol. I), by J. H. Walsh (1882).

The Gun and its Development (Ninth Edition), by W. W. Greener (1910).

The American Shotgun, by Charles Askins (1921).

PREFACE TO SECOND EDITION

IN the thirteen years which have elapsed since the completion of the First Edition of this Volume there has been no outstanding change or development in the general principles of construction, design and manufacture of British Shotguns. The only possible exception is a tendency to make guns more easy to open without undue effort. Consequently in this new Edition I have confined myself chiefly to making a number of alterations and amplifications in the text, but have also included a detailed description of one new " Self Opening " action. At the same time I felt that another Single Trigger Mechanism deserved mention and so have added an attempt to explain its working principles.

The alterations and amplifications to which I have referred are due wholly to the very many letters of helpful and kindly criticism which I have received from readers in many countries and all continents. I have already thanked each writer personally, but would now do so again for the encouraging interest which they have shown.

But above all I have to thank my many friends in the British Gun Trade for the generous help which they have ever given me and the equally generous welcome which they extended to the First Edition.

I can but hope that this Second Edition will be received with the same kindly sympathy.

GERALD BURRARD.

WILLOW LODGE,
HUNGERFORD,
BERKS,
October 1943.

INTRODUCTION

ALTHOUGH books on sport in general, and on shooting in particular, are appearing at the present time in such profusion, it is twenty years since any book has been published which deals comprehensively with sporting guns and ammunition. Yet I feel sure that this subject interests a very large number of shooters; and this confidence is borne out by the fact that the great majority of books on shooting contain a chapter or so on guns and cartridges. Such chapters, however, must necessarily be somewhat brief; and the fact remains that the ninth, and last, edition of the late Mr. W. W. Greener's *The Gun and its Development*, which was published in 1910, is the most recent book of reference. Apart from this work, the late Dr. J. H. Walsh's *The Modern Sportsman's Gun and Rifle* (Vol. I), which was published in 1882, is the only other book which covers the ground which many shooting men would wish to tread: and much new territory has been opened up since 1882. The chapters on guns and ammunition in the Badminton Library are excellent; but here, again, the information is over half a century old.

So it would seem that there is room for a book devoted to the subject of sporting guns and ammunition, and *The Modern Shotgun* is an attempt to fill this blank.

The whole history of the growth and development of the gun has been dealt with so ably and thoroughly by the late Mr. Greener as to make any further account superfluous. I have, accordingly, confined myself entirely to a consideration of the gun itself and its ammunition.

From the very first there seemed to be three natural divisions into which the whole subject fell—the Gun; the Cartridge; the Gun and the Cartridge. A description of the gun itself must obviously come first, and yet there are certain details in the gun which cannot be either understood or appreciated until one has considered the problems arising from the actual firing of the cartridge. And these, again, entail a study of the various components of the cartridge. So it seemed that the actual effects resulting from the firing of the cartridge in the gun could not be dealt with until both the gun and cartridge had first of all been considered separately.

But as I worked it soon became evident that any attempt at a comprehensive survey of the subject on the lines I had mapped out would result in a book so large as to be unwieldy. It was, therefore, decided to publish the three parts separately, each in one volume.

In this first volume I have confined myself entirely to a brief account of the procedure of building a shotgun, with more detailed descriptions of the types of mechanisms, or actions, which are in general use. And since the merits and advantages of these different actions may become of interest to sportsmen, I have tried to survey them in a manner which, to the best of my belief, has not been set out before. If this study of a subject which has attracted me since boyhood should prove helpful or interesting to the shooting public in general, and possibly even to gunmakers, I shall feel amply rewarded.

I could never have completed this volume without the cordial help of the gun trade in general, and it gives me the most real pleasure to make this sincere acknowledgment. I would particularly like to thank all those gunmakers who so kindly lent me actions to strip and study at my leisure—namely, Messrs. Boss, Dickson, Holland, Lancaster, Lang, Westley Richards, and Woodward. From all these firms, as well as from Messrs. Beesley, Greener, Martin, Powell and Purdey, I have received the most ungrudging and generous help.

My friends, Lieutenant-Colonel Philip Neame, V.C., D.S.O., R.E., and Mr. F. W. Jones, O.B.E., have read and re-read the whole of the manuscript. To both I am indebted for much invaluable and helpful criticism.

The description of the Holland Self-Opening mechanism is practically the same as my report on this invention which appeared in the *Field*; and the section

on Barrel " Flip " in Chapter IX was originally published in *Game and Gun*. I would like to take this opportunity of thanking the proprietors of both these papers for their permission to re-publish what had already appeared in their pages.

I cannot close my acknowledgments of help without a special word of thanks to Mr. H. R. Marchant, of the firm of Messrs. Monger and Marchant, who was personally responsible for taking all the photographs used for illustrating this volume. I have never seen better photographs of guns or mechanism, and their success is entirely due to the great interest which Mr. Marchant took in the work.

Finally, I would explain that no one is more aware of the shortcomings of this book than myself. In a work of this nature mistakes are all too easy to make, and I will always be grateful for help. I can only add that it is with full realisation of its weaknesses that I offer this volume to the public.

G. BURRARD.

WILLOW LODGE,
HUNGERFORD,
BERKS,
October 1930.

CONTENTS

B

LIST OF ILLUSTRATIONS

PLATES

LINE DRAWINGS

THE MODERN SHOTGUN

CHAPTER I

THE BARRELS

EVERY part of a gun has its own particular rôle to play during use, and all are essential; but the part played by the barrels is really the most important, for on them depend the shooting capabilities of a gun. Further, the first step in the construction of a gun is the manufacture of the barrels; and when these have been made and put together the gunmaker has to think of fixing them to the action. So from the point of view both of importance and manufacture the barrels come first: let us, then, consider them first.

Before, however, we can go into any questions of material, manufacture and quality, it is essential that the definitions of the different parts of the barrels should be known and understood. I will, accordingly, give them now.

BORE. That part of the inside of the barrel which is sealed completely by the shot charge and wads as they travel along the barrel on discharge. In a rifle the bore is the part which contains the grooves, or rifling; but in a shotgun the bore is smooth and is parallel for the greater part of its length beginning from the breech end.

The size, or gauge, of a gun depends on the diameter of the bore, but this is not measured in decimals of an inch as is done in the case of rifles, but is denoted by the number of spherical balls of pure lead, each exactly fitting the bore, which go to the pound.

This method of denoting the size of the bore is a legacy from the early days of artillery. Formerly cannon always fired spherical shot, and the size of the cannon was described by the weight of this spherical shot, *e.g.* 3-pounders, 10-pounders, etc. This custom still survives in the case of a few modern cannon—60-pounder, 25-pounder, are examples, although in these cases the numbers denote the weights of shell and not spherical shot—but in the majority of big guns the size is given by the calibre, or diameter of the bore, in inches.

In the early days of "hand guns" the bores of muskets were classified similarly to those of cannon, that is, by the weight of their projectiles, which were all spherical. And it is easy to understand that since "one-sixteenth of a pounder" would have been an inconvenient and clumsy way of describing a weapon which fired a leaden ball of such a size that sixteen went to the pound, the term "Number 16" was an obvious and simple alternative. And so it came about that all smooth-bore weapons which were used in the hands were classified as Numbers 4, 8, 10, 12, 16, etc., according as the lead balls which they fired weighed 4, 8, 10, 12 or 16 to the pound. From this nomenclature the change to 4-bore, 8-bore, 10-bore, 12-bore, 16-bore, etc., is easy to understand; and since shotguns remained smooth bores after weapons used for ball had all become rifles, the method of denoting their size was never altered, and has now become firmly and universally established.

The exact diameters of the different sizes of bores are given in the Appendix.

In the cases of gauges smaller than 32 the size of the bore is denoted by its diameter in decimals of an inch; *e.g.*, ·410 and ·360. But these are the only exceptions to the usual system of measurement.

Chamber. That part of the inside of the barrel which receives the cartridge. Since shotgun cartridges are almost invariably made of paper of an appreciable thickness the diameter of the chamber must be larger than that of the bore, otherwise the wads would not seal up the bore on discharge.

Chamber Cone. That part of the inside of the barrel which connects the front end of the chamber to the rear end of the bore. Since the diameter of the chamber is greater than that of the bore, there must be a tapered part of the inside of the barrel which connects chamber and bore.

No one can have failed to have noticed, when looking through the barrels of a gun from the breech end, a dark ring at the end of each chamber which gives exactly the appearance of a definite ridge or step, and doubtess many have felt for this ridge with a pencil or some similar instrument and have been surprised not to find any indication in the way of a sudden stop. In reality there is no ridge and the dark ring is merely the shadow thrown by the chamber cone which cannot receive any direct light when the barrel is examined from the breech end.

LUMPS. The " lumps " or " irons " are the two large projections which protrude from underneath the breech end of a pair of barrels and are utilised for holding the barrels to the action, or stock portion, of the gun. They are frequently differentiated by the obvious terms, " forward lump " and " rear lump." (See Plate II.)

GRIPS OR BITES. These are the slots cut in the lumps into which the bolts of the action slide and hold the barrels in place. (See Plate II.)

HOOK OF LUMP. That part of the forward lump which is hooked on to the action when the gun is put together. (See Plate II.)

FLATS. The flat portions of the barrels on each side of the lumps which fit against corresponding flat parts on the action. (See Plate II.)

TOP EXTENSION. A projection from the breech end of the barrels which is usually situated just below the top edge of the barrels and which acts as an additional connection between the barrels and the action. (See Plate II.)

There are numerous varieties of top extension, while in many guns it is omitted altogether. The advantages and disadvantages of top extensions will be considered in a later chapter.

EXTRACTOR. A movable part of the breech end of a barrel which slides backwards when the gun is opened and withdraws the fired cartridge-case from the chamber.

In ejector guns, which automatically throw out the fired case when they are opened, there is a separate extractor for each barrel. (See Plate II.) An ejector gun can be told from a non-ejector at a glance by noting whether the extractor is in one piece or two.

EXTRACTOR STOP PIN. A screw which is invariably inserted through the forward lump and which holds the extractors in position. The head of this screw is flush with, or slightly sunk below, the lower surface of the lump. If this screw is removed the extractors can be slipped out for cleaning. (See Plate II.)

N.B.—In gunmakers' phraseology a " pin " invariably means a screw.

LOOP. The " loop " or " bolt loop " is a projection from between the underside of the two barrels a few inches from the breech end on to which the fore-end fastens. (See Plate II.)

TOP RIB. A strip of steel which lies between the two barrels on the upper side and extends from end to end. (The extreme rear end of the top rib can be seen in Plate II.)

BOTTOM RIB. A similar strip which lies on the underneath side of the barrels. (See Plate II.)

MATERIALS FOR BARRELS

We now come to the question of the material used for barrels. At the present time almost all barrels, even in the case of the cheapest grades of guns, are made of steel. Nevertheless sixty, or even fifty, years ago the majority were made of damascus, and since the use of this last-named material was retained in the lower-priced guns long after steel had come into more general use, damascus barrels cannot be dismissed without a brief description.

Damascus, or " twist," barrels can always be recognised immediately by their decided speckled and frequently beautiful pattern, while steel barrels are uniform in colour and shade throughout.

All barrels are tubes which have been specially bored, polished and put together so as to give certain definite results when a cartridge is fired in them, and the first step in barrel construction is the making of the tube.

Damascus tubes were made by taking long strips of steel and iron and twisting and welding them together. The resulting twist was flattened out into a ribbon formation and then coiled round in a long and close spiral. The edges of the spiral were then welded together, when a tube was the result. Sometimes the "ribbons" were composed of three spiral twists and sometimes of four. The object of the twisting of the original strips was to eliminate flaws.

Naturally damascus tubes varied in quality, this depending on the type of metals used in the first instance, the regularity with which the strips were twisted and welded into ribbons, and the care with which the ribbons were wound and welded into tubes.

For many years the best damascus tubes were made in Belgium, but by degrees the British makers learnt the art and turned out just as good tubes as the Belgians, although they could never compete with the latter in the prices of their cheapest tubes.

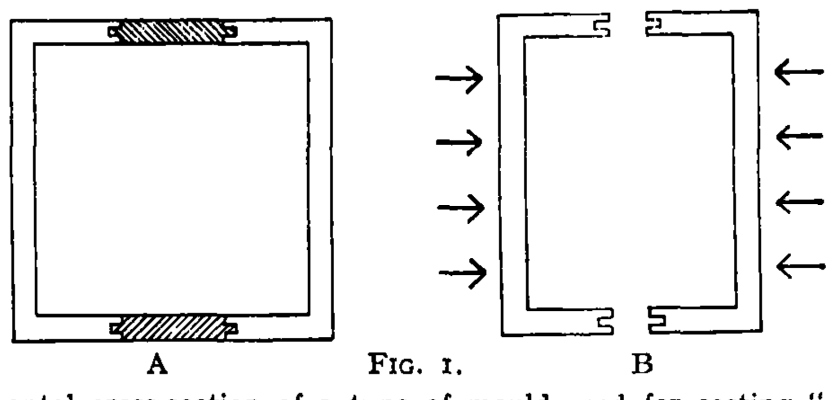
"Laminated steel" barrels were really a form of English damascus barrels for all practical purposes.

Good damascus barrels were strong and elastic but, contrary to a common belief amongst sportsmen, flaws were very frequent. These flaws, or "greys," were caused by grit or coal dust getting mixed up with the metal during the welding of the twist barrels and were a constant source of annoyance to gunmakers, even if they were no worse. Consequently it was not surprising that steel replaced damascus as a material for barrel tubes as soon as steel workers had advanced sufficiently in knowledge to evolve a process by which tubes could be made entirely from steel without the presence of those flaws which at first seemed to be unavoidable. Probably the earliest really first-class steel tubes to be made were those drawn from steel known as Sir Joseph Whitworth's "fluid compressed steel," and these soon proved to be both stronger and more elastic than the best quality damascus. This meant that gun barrels could be made several ounces lighter and yet equally as strong, so it is not surprising that steel tubes soon supplanted damascus for high-grade guns. The price of these tubes, however, was considerably higher than the older type, and so they were only used on the more expensive guns. But as time went on the quality of steel became vastly improved all round, until now even the very cheapest guns are made with steel barrels and damascus barrels are obsolete. Whitworth tubes are still amongst the best that can be obtained, although there are now first-class tubes made by other firms which are just as good and which are preferred by some gunmakers, notably Vickers " A " steel tubes.

It should be noticed that hitherto the barrels have been constantly termed " tubes." This is because the manufacture of the tubes is a special business and is not undertaken by the gunmaker in the ordinary course of events, although there are one or two firms with very large factories and facilities for making their own tubes. But all the ordinary gunmakers, including almost all the London firms, purchase their tubes ready-made and " rough bored." That is, the tubes have been bored out roughly to the required size, although naturally a very considerable margin is left for the making of the barrel.

"FLUID COMPRESSED STEEL"

Since, however, a brief description of the principles adopted in the manufacture of tubes, as well as that of



A FIG. 1. B

Horizontal cross-section of a type of mould used for casting " fluid-compressed steel."

In Fig. 1A the removable slides are still in position, and in Fig. 1B these slides have been taken out and the pressure is applied as indicated.

"fluid compressed steel," may be of interest, I will describe the process in general terms.

The steel used in gun barrels is an iron-carbon alloy which may contain special ingredients such as manganese, nickel, or chromium. The fluid steel is poured into a mould, and the resulting casting is known as an "ingot." In the case of "fluid compressed steel" the mould is of a special pattern of which a section is given in Fig 1A. The mould is about one foot square, and in two opposite sides there are removable slides which are shown shaded in the diagram. The depth of the mould is about 4 feet.

The fluid steel is poured into the mould while the removable slides are still in position and cooling is allowed to set in. The outsides of the casting cool first, and after a period of from 20 minutes to half an hour, according to the size of the casting, the outer parts will have set into a semi-solid state while the inside is still fluid. The two slides are then removed and intense hydraulic pressure is applied on the two remaining opposite sides as indicated by the arrows in Fig. 1B. The result of this pressure is that the two sides of the mould on which the pressure is applied are moved closer together, as owing to the removal of the two slides the only resistance is that offered by the semi-molten steel.

When steel solidifies in its mould it contracts, and since the outside of the ingot solidifies first, there is not sufficient metal in the mould to fill it up completely, with the result that a hollow is formed in the middle. This hollow is known as a "pipe" and is shaped like a carrot, while it may extend some distance down into the ingot as well as being of an irregular formation.

A pipe is a very objectionable formation, because unless the whole of that part of the ingot which contains the pipe is cut off, the forgings made from the ingot would contain air pockets.

Further, the impurities, or "slag," in a casting rise to the surface during the process of solidification; and when a pipe is formed the impurities collect on its surface, and so extend some way down into the casting and may remain in the forgings made from the ingot.

The method which I have described overcomes this type of defect in casting which is inseparable from a pipe when one exists, as while the steel is solidifying in the mould the liquid portions are made to flow up the centre of the casting and fill to overflowing what would have been a pipe. The impurities are squeezed out at the ends of the mould, and these ends are finally cut off and thrown away.

There are several methods of compressing the cooling ingot, and the Whitworth method is to apply a plunger at the top of the mould. And in the Harmet process the mould is tapered, the sectional area increasing from top to bottom. During cooling the ingot is forced upwards, thus reducing capacity and causing the steel which is still fluid to fill the "pipe." But the principle in all the methods is similar, namely, one of application of pressure on the ingot during the process of solidification.

When the casting of the big ingot is completed it is cut, forged and rolled into cylindrical "billets," each roughly 18 inches in length and 4 inches in diameter. These billets are then rolled and drawn out into solid circular bars nearly 3 feet in length and rather less than 1½ inches in diameter (in the case of a 12-bore). In this stage of the manufacture these bars are known as "blank." The blank is then drilled and bored out from end to end, the outside is given a slight taper and the rear end shaped, which converts it into a "tube." In this stage it is acquired by the gunmaker.

PRELIMINARY WORK

The first important work which the gunmaker has to undertake on a pair of tubes is to straighten them, as they may not always be received from the makers dead straight. This is done by a barrel setter who holds the tube slanting upwards towards the light and adjusts the angle until a shadow falls on the inside of the tube making a line of darkness against the light of the rest of the inside of the tube which runs from end to end. By foreshortening this line any irregularity or bend can be detected instantly and these are corrected by a few taps of a hammer. The setter revolves the tube in his hand until the shadow has been made to fall on every part, correcting whenever necessary, and continuing the process until the shadow can be placed anywhere and remain in a straight line, when the tube will itself be straight.

It should be noted, however, that perfectly straight tubes can very easily be bent by faulty coupling when they are joined together to make a pair of barrels. As will be seen shortly, the tubes are almost invariably joined by brazing, and the slightest movement of one of the tubes during this process means that one barrel will be " out." In order to get it true again it is bent up or down, as the case may be. So it will be realised that a bent barrel does not necessarily mean that the tube had not been straightened in the first place. At the same time it must be admitted that the risk of not getting perfectly straight barrels in a cheap gun is accentuated by the fact that the tubes used in them are often made by drawing them as tubes, and not by boring out of a solid blank, as the former process obviously means a saving of steel. Drawn tubes, however, are never so likely to be as straight as those which are bored from the solid, and at the present time all the best grades of tubes are bored out from blanks.

After the tubes have been straightened they are rough bored and sent to one of the Proof Houses for Provisional Proof, particulars of which will be given in Volume III.

METHODS OF JOINING TUBES

The next process is to join the tubes together and make them into a pair of barrels, and with this process is combined that of fixing on the lumps, which at this early stage are in one piece. The method employed for fixing together the barrels and the lumps depends on the type of tubes which are used. Now, in the brief account of the manufacture of the tube it was stated that the rear end was shaped. The nature of the shape given is of extreme importance. Ordinary tubes are shaped as in Fig. 2, but the very best-quality tubes are shaped as in Fig. 3, and are called " chopper lump " tubes because of the similarity of their appearance to that of a chopper and because the " head " of the " chopper " will eventually form the lumps of the barrels.

Whichever type of tube is used, the breech ends are filed flat and square, and dovetailed out when necessary for the attachment of the lump. The tubes and lump are then brazed together in one of the methods given in Figs. 4, 5, 6 and 7. These diagrams explain themselves, but it should be noted that if the method shown in Fig. 4

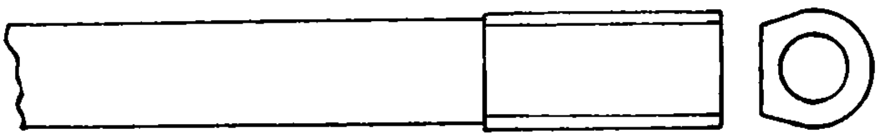


FIG. 2.

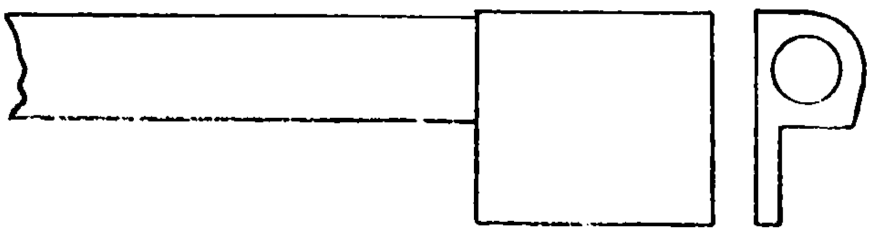
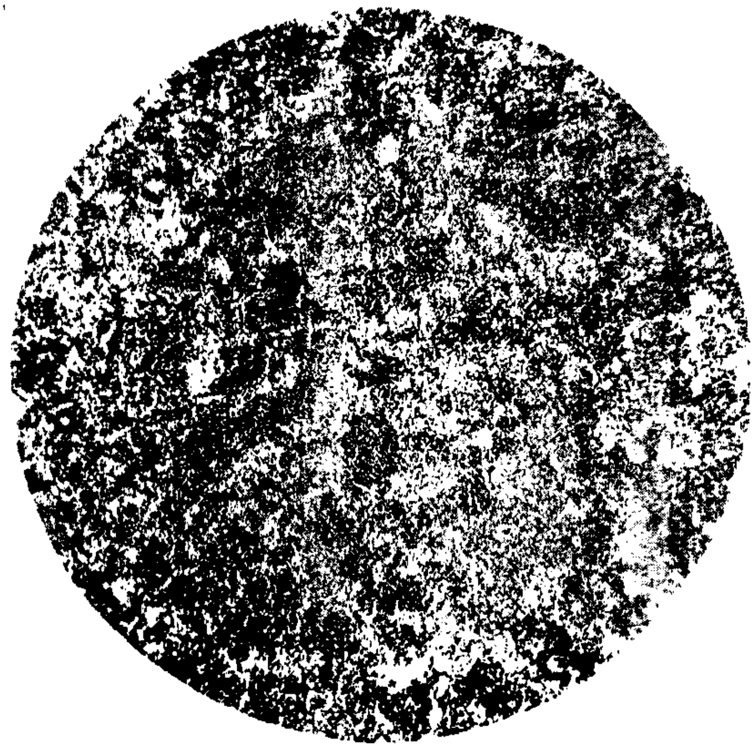


FIG. 3.

Side and end-on views of the breech ends of ordinary (Fig. 2) and " chopper lump " (Fig. 3) tubes for gun barrels.

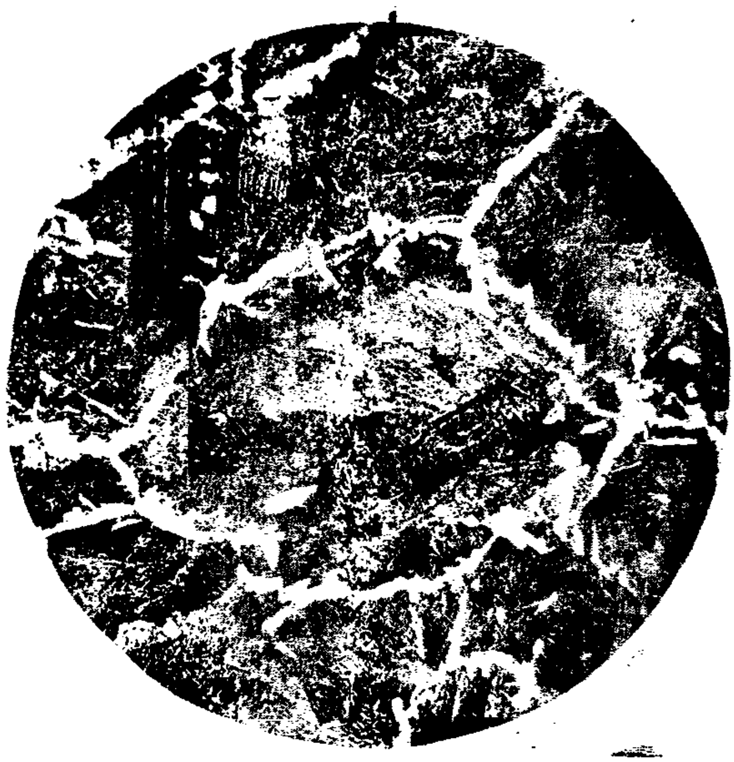
is adopted, care should be taken not to cut away too much of the wall of the barrels at A, A : also that there should be well-defined dovetails at B, B so as to avoid the whole of the strain imposed by holding down the barrels being thrown on the brazing. This method is probably the one which is most generally used.

In the method shown in Fig. 5 the brazing takes the whole of the strain on the lumps, but the brazed surface is much larger than in the case of the previous method, and so this system can be regarded as safe. It is, however, clumsy as it increases the depth of the barrels at the breech. To get over this tendency to clumsiness the



(A) A PHOTO-MICROGRAPH OF A BIT OF STEEL TAKEN FROM NEAR THE BREECH END OF A BARREL OF A BEST-GRADE GUN

The heat treatment to which the barrels were subjected during the process of brazing was carried out perfectly and the fine grain structure of the steel has been maintained



(B) A PHOTO-MICROGRAPH OF A BIT OF STEEL TAKEN FROM NEAR THE BREECH END OF A BARREL OF A CHEAP GUN

The heat treatment necessary for the brazing operation was carried out badly and the fine grain structure of the steel was completely destroyed, leaving the steel in its softest and most dangerous coarse-grained condition

walls of the barrels are sometimes reduced in thickness at A, A. This is an altogether dangerous practice if carried to excess. The object of this method is to render possible the use of round tubes, which are cheaper than shaped tubes.

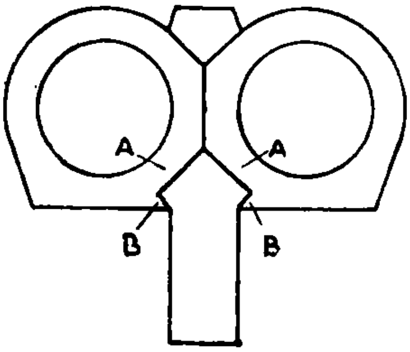


Fig. 4.

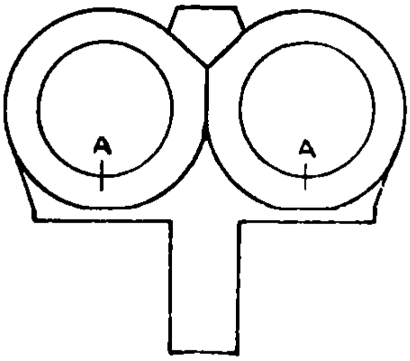


Fig. 5.

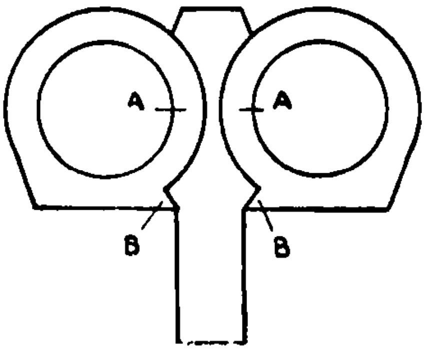


Fig. 6.

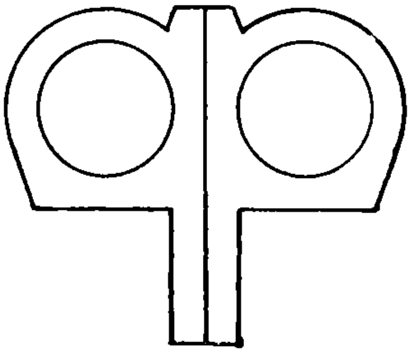


Fig. 7.

Four different methods of brazing together the breech ends, lumps and top-extensions.

Fig. 6 gives the " through lump " method which is stronger than either of the two previous ones. It is, however, more costly because it requires more fitting ; and it is inclined to be slightly clumsy as it adds to the width of the barrels. To get over this point the walls of the barrels are frequently reduced slightly in thickness at A, A ; but this work should not on any account be carried out to excess or the barrels may become seriously weakened at the very part where strength is most important. The dovetails at B, B should also be well defined.

By far the best method of all is achieved by the use of chopper lumps and is shown in Fig. 7. From the very earliest days of breech-loaders it was recognised that if the lumps could be made in one integral part with the barrels they would be stronger and safer than when attached by any other method. There were, however, serious difficulties in the way, for the lumps must be made of much harder steel than could formerly be obtained for barrels; but as boring tools, workmanship and knowledge improved, it was found possible to forge the lump in one piece with the tube, even when using sufficiently hard steel for the former. Chopper-lump tubes are the result, and their advantages are obvious. The best chopper-lump tubes, however, cost sixteen times as much as the cheapest grades of ordinary steel tubes, and so it is not difficult to understand why their use is restricted to high-grade guns. At the same time the advantages of chopper lumps are so great that I do not think it unfair to state that no gun made to-day can be regarded as a really "best" grade weapon unless chopper lumped.

It is quite easy to ascertain which method has been used for joining the barrels and the lumps. All that one need do is to remove the extractors and wipe the ends of the barrels clean, when the joining lines of the brazing can be clearly seen.

If a top extension is to be added, it is brazed on at the same time as the barrels and lumps are joined, but here again the chopper-lumped tubes have the advantage, because in their case the top extension is in one piece with the barrels, just as the lumps are.

I will now touch briefly on the question of brazing as it is a very important one which can have a great influence on the quality, and even the safety, of the gun.

In these days of home-made wireless sets I suppose "every schoolboy" really does understand soldering. Brazing can be described as a form of "soldering" in which different substances are used both for the "solder" and the "flux." Ordinary solder consists of a mixture of lead and tin. In brazing the corresponding substance is "spelter," a mixture of copper and zinc, which is a kind of brass. And instead of some flux such as resin, or the well-known "fluxite," the flux in brazing is borax.

Another difference between soldering and brazing is the temperature necessary for the operation, for in brazing the temperature required to make the spelter run must be very much higher than that used in soldering.

And it is this matter of temperature which constitutes the danger in brazing.

As has already been mentioned, gun-barrel steel is an iron-carbon alloy, which in its proper and strongest form is composed of small steel structures interlocked together in close formation. If, however, the steel is heated beyond a certain point and the temperature maintained at this level, the fine grain structure of the steel is changed to one in which the grains become very large, of different sizes, and with spaces in between them. The irregular coarse-grain structure thus formed results in the steel becoming soft like iron and losing its tensile strength.

Plate IIIA is a photo-micrograph of a bit of steel taken from the breech end of a barrel of a best-grade gun by one of the best makers in the country. The fine-grain structure is clearly visible, and the steel is in as perfect a condition as is possible, showing that the heat treatment necessary for the process of brazing was carried out to perfection. This illustration is an excellent example of what good gun-barrel steel should look like under the microscope.

Plate IIIB is a photo-micrograph of a bit of steel taken from an exactly similar place near the breech end of a barrel of a low-grade cheap gun. Here the structure is coarse, uneven and loose, and the steel is in as bad and as dangerous a state as it could be. In fact, the barrel of such a gun could not be regarded as safe.

This condition of the steel was brought about entirely by incorrect heat treatment during brazing, and Plate IVA shows a photo-micrograph of a bit of steel cut from the same barrel but near the muzzle, where the steel was not affected by the heat of brazing. The structure of the steel is similar to that shown in Plate IIIA.

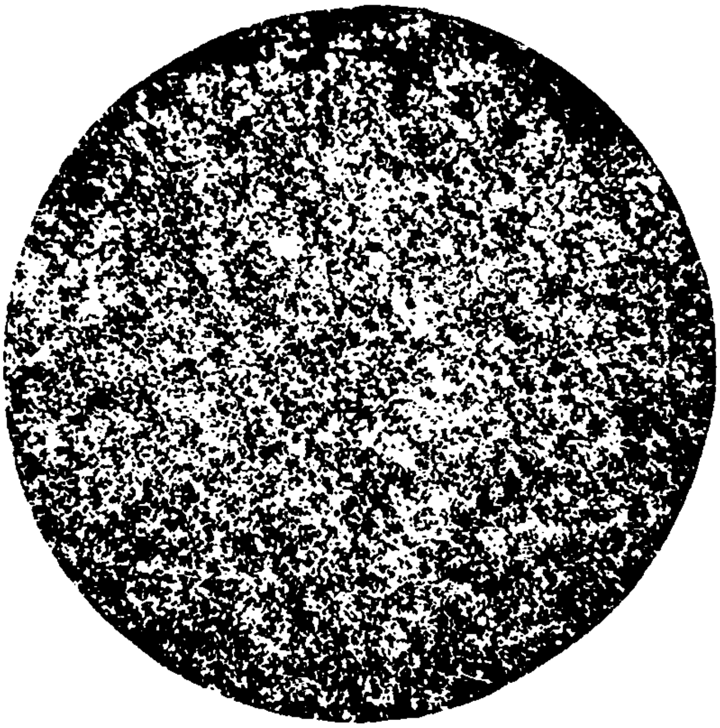
Plate IVB is another photo-micrograph of a bit of steel from the same barrel as provided the samples shown in Plates IIIB and IVA, but from a point about 8 inches from the breech. The heat had not affected the steel quite to the same extent as it had at the breech, and the steel is in an intermediate state between the structures at the muzzle and the breech.

It must not be imagined that I am going so far as to suggest that the results shown in Plates IIIB and IVB are *typical* of what one must expect from cheap guns. I do, however, maintain that they are possible. After all, by far the biggest part of the cost of the manufacture of any gun is that of the labour, and in the case of cheap guns less time can be afforded for the completion of any single process, while the workmen will not be so highly paid, and therefore not so skilful, as those employed on best guns.

There is a fifth method of joining the barrels and lumps together, which is shown in Fig. 8. Chopper lumps are essential for this system in which the two tubes are dovetailed together, any sliding in the dovetails being prevented by a couple of horizontal pins through the lumps. This method is employed by the Birmingham Small Arms Company in the manufacture of their famous cheap proprietary gun, and at first sight it would seem ideal. There are, however, some objections.

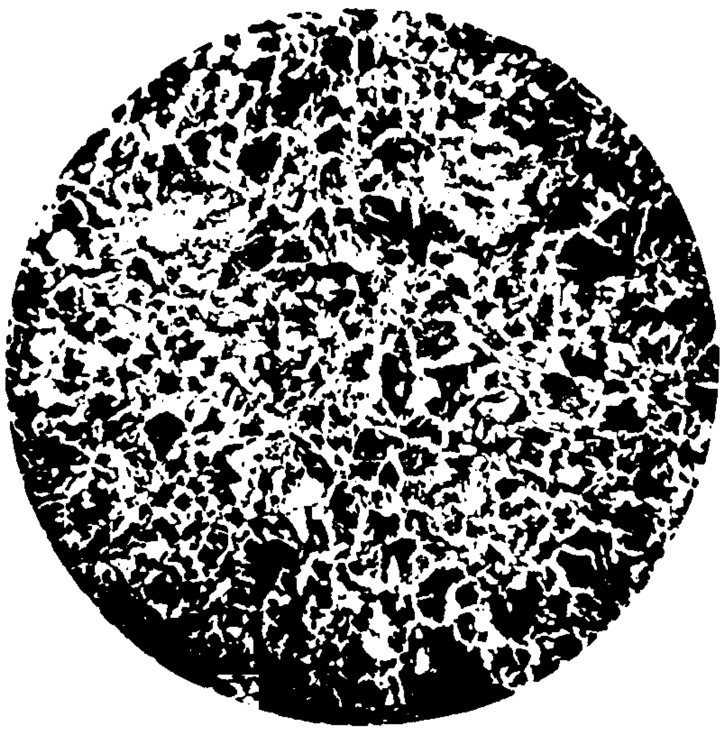
In the first place, the cost of cutting out the dovetails to an accurate fit by hand would be altogether excessive. Where mass production is carried out, special machinery can be installed for doing this work, but it would not pay the ordinary gunmaker to set up such costly machines, as he would not turn out enough guns to get back sufficient return on the capital spent on the machine, and he would be working all the time at a dead loss. So, from the point of view of economic manufacture, this method is only suitable for a factory where guns are manufactured in great numbers.

But there is another and quite different disadvantage. This is that the thickness of metal necessary for an efficient dovetail results in the inside walls of the barrels being very thick, which means wide barrels and a clumsy



(A) A PHOTO-MICROGRAPH OF A BIT OF STEEL FROM THE SAME BARREL AS THAT MENTIONED IN PLATE III (B), BUT TAKEN FROM NEAR THE MUZZLE END

This part of the barrel was not affected by the brazing operation and the fine grain structure of the steel is unimpaired. The whole barrel should be of the same texture as that shown in this photograph



(B) A PHOTO-MICROGRAPH OF A BIT OF STEEL TAKEN FROM A POINT ABOUT 10 INCHES FROM THE BREECH END OF THE SAME BARREL AS THAT MENTIONED IN PLATES III (B) AND IV (A)

Here the steel was only partially affected by the incorrect heat treatment and the structure is in an intermediate stage between those shown in Plates III (B) and IV (A)

gun, just as the " through lump " method in Fig. 6 tends to a clumsy gun. Moreover, in the case of the dovetailed lump it is not possible to reduce the thickness of the barrel walls to any appreciable extent, and guns built on this principle cannot be anything but rather wide in the

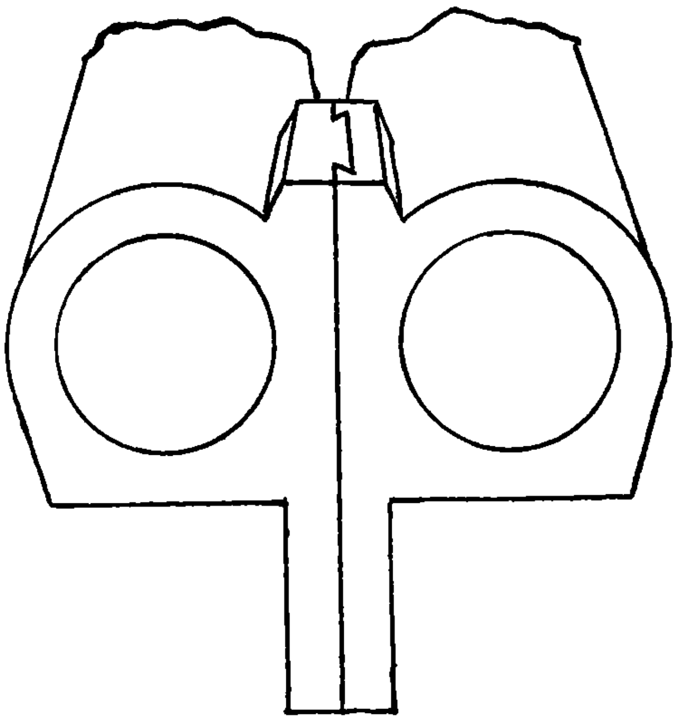


FIG. 8.—A method of joining a pair of chopper lump tubes together by which brazing is eliminated, the two tubes being dovetailed together.

breech. Further, this width is accentuated in the case of bores smaller than 12-bore, as the thickness of the dovetail must be retained, and the proportion to the diameter of the chambers becomes larger. So it will be realised that for really best-grade guns the brazed chopper lumps are supreme, with the through lump a poor second.

There is another point about the joining together of the tubes into a pair of barrels of which few sportsmen are aware and which is of considerable interest. This is that the barrels must be so set that the axes of the bores are not parallel but slightly converging, being closer together at the muzzle than at the breech. The reason for this is that the two barrels must shoot so as to hit the same spot (approximately) at 40 yards or the shooter would notice a difference between the two barrels when firing at game. If the barrels were set with their axes parallel there would be a considerable difference between their shooting.

The explanation is as follows:

When the right barrel is fired the recoil tends to throw the muzzle out to the right since the axis of the barrel is situated to the right of the centre of gravity of the gun. In the same way, a shot from the left barrel tends to throw the muzzle of this barrel out to the left. The result in the case of parallel barrels would be that the right barrel shot some distance to the right of a mark 40 yards away, while the left barrel shot a similar distance to the left of the same mark. This effect is eliminated by setting the barrels with their axes slightly converging. Consequently it is useless for a sportsman to try to check the alignment of his barrels by removing them from the stock, fixing them so that one barrel points directly at some distant mark, and then check the alignment of the other barrel to see whether this is also pointing at the same mark. I have known this done and the owner of the gun complain that his barrels were not correctly set. The truth is that if both barrels had been pointing directly at the same distant mark they would then have been incorrectly set. Accordingly the reason for the cross-set of the barrels should be realised.

At the present stage in the building the barrels are joined together only by the brazing at the breech ends for about 2½ inches of their length. This brazing is the main join, but there are also supports, or pieces of "packing" which are placed at intervals along the barrels. This packing helps to keep the axes of the barrels in the same relative position and acts as something extra in the way of support as well as in holding the two barrels together. It should, however, be realised that the barrels are really held by the brazing at the breech, and if this were to go, the packing would be of no use in itself. The packing is really responsible for the barrels remaining set in their proper position, which is a very important function, although it also helps in the general strengthening of the barrels.

It is in this stage, also, that the bolt loop should be attached. In high-grade guns the bolt loop reaches right up between the barrels after the fashion of the " through lump " shown in Fig. 6, and Fig. 9 gives an end view of the bolt loop as it should be when in position. In cheap guns the bolt loop is often merely soldered on to the bottom of the barrels and no part of it reaches up above their centres. A very efficient support to the barrels is thus lost, while there is always a risk that the barrels might get so heated in some very hot corner that the solder was slightly softened. If this were to occur, the

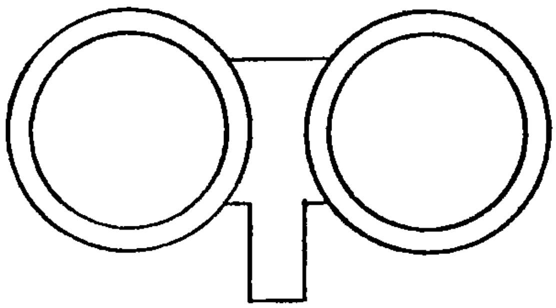


FIG. 9.

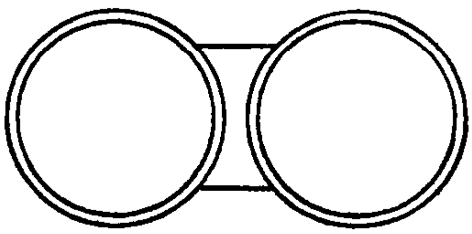


FIG. 10.

Diagrams showing how the bolt loop (Fig. 9) and a packing (Fig: 10) should be fitted to the barrels.

constant strain on the bolt loop (caused by its holding the fore-end in position while the gun was being repeatedly opened and closed) might easily loosen it from its seating.

It is, however, only fair to say that cheap guns are not likely to be used in such conditions.

On account of the risk of the solder softening, the bolt loop is brazed on to the barrels in some makes of the very best guns, and when this is done there can be no fear of the bolt loop ever working loose, while the strength of the gun is certainly enhanced.

It is in little points like this that the difference between best guns and lower-priced weapons is so marked, although there is no outward indication of the superior work. And since soldering is a considerably cheaper process than brazing, the cost of building is high in the case of a best weapon. The fixing of the loop is admittedly a minor operation and the cost will in any case be comparatively slight : but when it is remembered that there are similar differences in almost every step of the making of a gun the respective costs of production will be appreciated.

The packing used in shotgun barrels consists of a few (usually four) shaped pieces of steel which fit between the barrels. They are each similar in section to that part of the bolt loop which reaches up through the barrels, and Fig. 10 shows the proper design for a good packing. One of these packings is placed at the muzzle and the other three at intervals between the muzzle and the bolt loop. They are held in position by soldering.

In some cheap guns, especially those of Continental manufacture, the packings are not shaped in any way and are retained in position only by solder. If the solder works loose the packings will probably shift their position, when the relation between the axes of the two barrels will be changed completely, as will also be the shooting of the gun. It should, accordingly, be realised that packing plays a very important rôle in the shooting of the gun and that no gun which is not packed in the method described can be relied upon for hard use.

After the packings are fixed, the top and bottom ribs are soldered on and the barrels are ready for actioning. It may not, however, be out of place to offer a word of warning in connection with the soldering.

If any hole in the junctions between rib and barrel is left, moisture can percolate in and rust set up. Moreover, rusting, or corrosion, in such circumstances is impossible to detect without stripping the ribs off. So it is obviously essential that the work of soldering should be well done. But that is not all, for the flux may tend to help corrosion in the steel of the barrels if any particle of moisture is left under the rib during the soldering. Some kinds of flux are much more helpful to corrosive action than others. Such are any which contain zinc chloride (a very common flux for ordinary use which is the basis of more than one proprietary soldering flux) or anything in the nature of an acid. Resin is absolutely safe in this respect, and is consequently the best flux to use for gun barrels.

After the barrels have been put together they are fine bored; the chambers are made; the choke developed; and then the whole of the insides is polished. The final regulating of the choke is carried out after actual tests of shooting, the number and nature of the tests depending on the quality of, and price paid for, the gun. The whole question of choke and the boring of the forward part of the barrels, on which the shooting largely depends, is being dealt with in Volume III.

The dimensions for the rear portion of the actual bore are laid down by the law and explained in the Rules of Proof, and this question will also be considered in the chapter on the proving of guns. There are, however, no legal dimensions for the chambers and chamber cones in the various sizes of guns. In order to avoid confusion, the Gunmakers' Association has drawn up certain dimensions for the chambers and these are universally accepted in Great Britain. These dimensions are all *minimum* dimensions, that is, they give the smallest permissible size for any particular chamber. In actual practice all gunmakers make their chambers slightly larger than this accepted minimum so as to facilitate loading. If the chambers of a gun are too tight, the slightest trace of dirt, or a somewhat swollen cartridge-case, is enough to make loading and unloading decidedly difficult, which is fatal to quickness.

The cartridge manufacturers also work to these minimum chamber dimensions and have established *maximum* sizes for all the parts of the cartridge-case which are slightly less than the corresponding chamber measurements. But this difference between the maximum size of the cartridge and the minimum size of the chamber is not sufficient to allow for the practical requirements of the shooting field, and so the chambers are always bored larger than the established minimum size.

Some gunmakers bore their chambers wider than others, but an average of two-thousandths of an inch, or two " points," of looseness is fairly generally employed. That is, the diameter of any part of the finished chamber is two-thousandths of an inch greater than the generally accepted minimum. The length is usually five " points " greater than the minimum.

There are no recognised dimensions for the lengths of the chamber cones, and different gunmakers prefer different lengths; but the majority of British gunmakers make cones of from $\frac{3}{8}$ to 1 inch in length. Some attach great importance to the length of cone, but the very fact that good results can be obtained from barrels possessing cones of considerable difference in length would seem to indicate that the importance is more imaginary than real, although doubtless the two dimensions given form the limits for the attainment of the best results.

Various Continental makers, more especially the Belgians, make their cones much longer and fully up to 2 inches in length. The reason is that they often chamber their guns for $2\frac{3}{4}$-inch cases instead of the ordinary $2\frac{1}{2}$-inch case, and by using these long cones they believe that they obtain better shooting with both lengths of cartridge than they would were they to specialise on one length of cartridge as do the British firms.

This may be correct, but there is no doubt that the British gunmakers are able to obtain far better and more regular patterns by concentrating on one length of cartridge. In this country the standard $2\frac{1}{2}$-inch 12-bore cartridge is almost universally used, and it is far better to make guns to give the best possible results with this cartridge, even if they are unable to take the longer case, than to make guns which are really a compromise and which do not give the best possible results with either length of cartridge.

CHAPTER II

ACTIONS

IN the previous chapter we left the pair of barrels joined up together, so it is now time to consider how they are connected to the stock in order to make a complete gun. This connection is effected by means of the "Action," which is a steel housing which contains the mechanism for the attachment of the barrels and the firing of the cartridges and which is fastened in a more or less permanent manner to the wooden stock by screws. In other words, the action comprises the most essential parts of that mechanism necessary for the efficient working of the gun.

This steel housing is called the ACTION BODY.

The other principal parts of the action are shown in Plate V and may be described as follows:

The BAR of the action is that part which projects horizontally when the gun is held with the barrels horizontal.

The FLATS of the action comprise the flat upper surface of the bar and come into contact with the flats of the barrels when the gun is put together.

The FACE of the action, or ACTION FACE, is the smooth vertical portion which rises at right angles to the flats. This is also sometimes called the STANDING BREECH.

The STRAP is an extension of the action along the stock and is used for connecting the action body to the stock.

The LEVER is the arm which brings into operation the mechanism for opening and closing the gun. This lever is usually situated on the top of the action as in Plate VA, in which case it is called a TOP LEVER. It can, however, be placed at one side of the action, or under the trigger-guard, when it is known as a SIDE or BOTTOM LEVER.

The Cross Pin or Action Pin is the large screw through the front end of the bar on to which the barrels are hooked when the gun is put together.

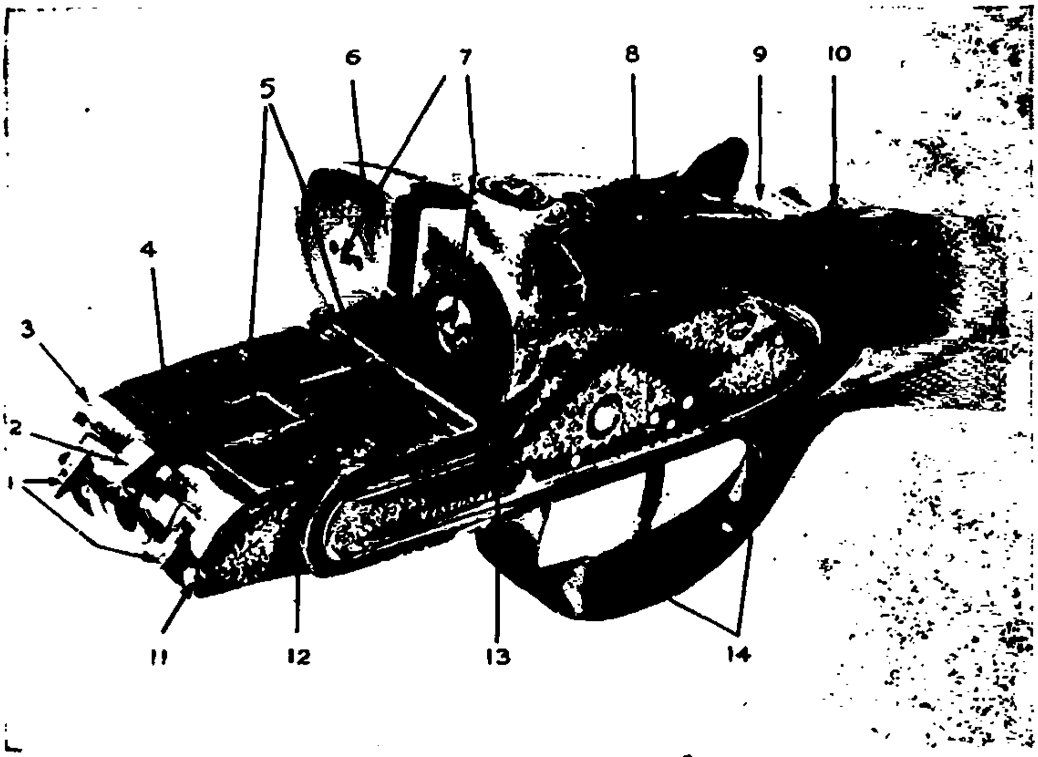
In the majority of cheaper guns a cross pin is not used, the joint being cut out of the solid action. A cross pin, however, is an advantage, as it enables a gunsmith to tighten the gun up should the fit between the barrels and action become slack in course of time, or owing to some excessive pressure. In old and worn guns it is not infrequently possible to see daylight between the breech end of the barrels and the face of the action when the gun is held against the light. A gun in this state is stated to be " off the face," and the barrels can be put back on the face if there is a separate cross pin. This pin is removed and the barrels forced with their breech end against the action face, and the hole for the cross pin is reground and slightly enlarged. A new cross pin is then inserted which will hold the barrels against the breech face as before.

This operation cannot be performed when there is a solid joint.

The top illustration on Plate V shows a medium-priced gun in which there is no cross pin, the joint being cut out of the solid. The lower illustration shows action body of a best-grade gun which has a separate cross pin. In the photograph the cross pin is seen just behind the action body.

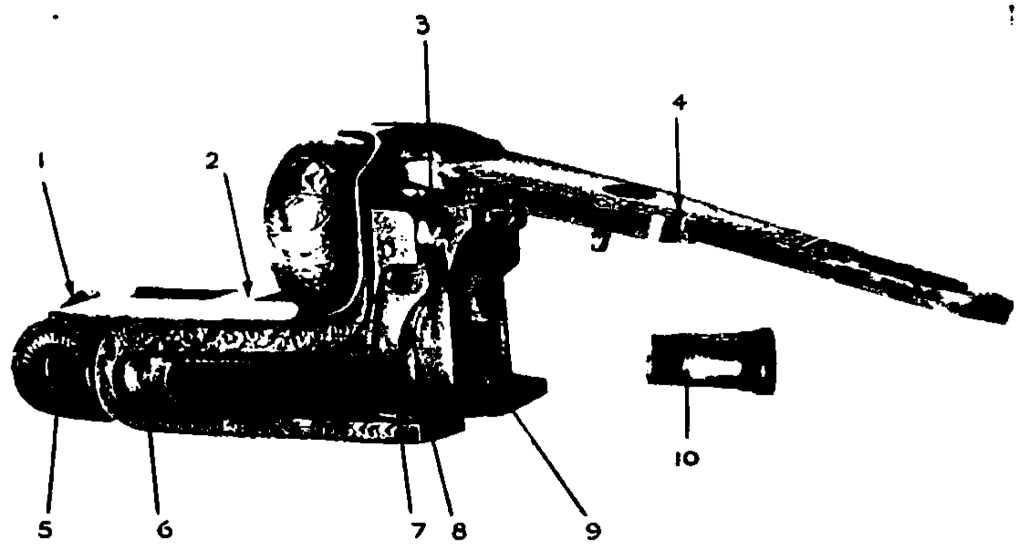
The Frontispiece shows a gun with a separate cross pin.

It should be noted that the head of the cross pin frequently seen in best-grade guns is a dummy, which is held in position by a small keep screw inserted through the top of the bar. It is not possible to have a solid screw from outside edge to outside edge because of the two slots in the bars in which the cocking levers work. So the actual cross pin occupies only the central part of the bar, and the hole through which it is inserted is filled by a dummy head, or cover, and a similar cover is fitted in the other end of the hole on the opposite side of the bar.



(A) AN ACTION OF A GUN WITH THE NAMES OF THE DIFFERENT PARTS MARKED

1, Cocking Levers; 2, Extractor Toe or Cam; 3, Solid Cross Joint; 4. Flat; 5, Action Bolts; 6, Action Face or Standing Breech; 7, Strikers; 8, Lever; 9, Strap; 10, Safety Slide; 11, Knuckle; 12, Bar; 13, Side Plate; 14, Triggers



(B) A FINISHED ACTION BODY WITH THE CROSS PIN REMOVED AND SHOWN SEPARATELY

1, Extractor Toe or Cam; 2, Flat; 3, Striker; 4, Strap; 5, Hole for Cross Pin; 6, Hole for Cocking Pin; 7, Recess for Main Spring; 8, Slot for Cocking Lever; 9, Slot for Action Bolt; 10, Cross Pin (removed)

It should also be noted that in some very cheap Continental guns a dummy screw head is engraved on one side, or even on both sides, of the front end of the bar, which is presumably intended to convey the impression of a separate cross pin. In these guns the dummy screw head really is a dummy, and the knuckle is solid.

The KNUCKLE of the action is the rounded end of the bar on to which the fore-end fits.

The other parts will be named as they come up for consideration.

THE ACTION BODY

In making an action, the first thing that a gun-maker must do is to obtain an action body. This is a lump of steel which is usually stamped out from a solid bar. The metal used is, or should be, a carbon steel which may contain a small percentage of nickel. Its most important characteristic should be toughness combined with elasticity rather than extreme hardness. The importance of this will be realised later.

Fig. 11 shows a solid action body in its rough state, the bar, face and strap being obvious.

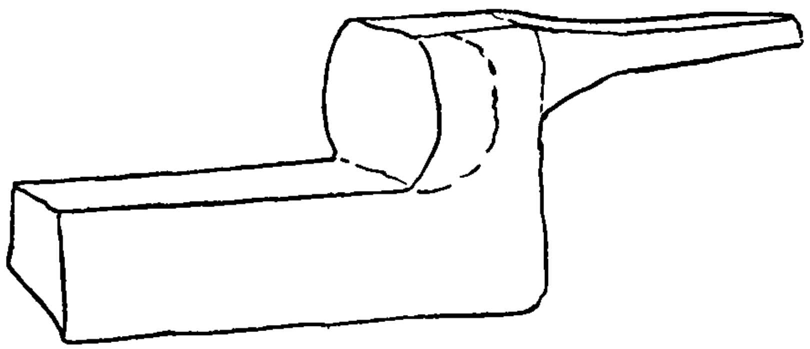


FIG. 11.—An action body in the rough state.

A very great deal of work is necessary for the cutting out from this solid body all those spaces necessary to accommodate the bolting and firing mechanisms, and the process of "actioning"—that is the fitting of the barrels to the action and the insertion of these mechanisms—is the most costly part of the whole of the manufacture of a gun. If the work is skimped in any way the gun may be not only unreliable, but unsafe, for reasons which will be explained in this chapter.

It is quite unnecessary to describe the actual work of cutting out the action body from the rough, but I cannot place too much emphasis on the extreme importance of this work.

Let us now proceed to consider the problem of fastening the barrels to the action.

A perfect method of attachment is one which fulfills all of the following points:

(1) Ease and simplicity of manipulation.

(2) Strength.

(3) Compactness.

(4) Lightness.

(5) Neatness and freedom from projections which would interfere with loading.

During the evolution of the modern breech-loader all sorts of different methods were tried for the fulfilment of these five points, and the light of practice and experience proved that the system of hooking the barrels on to the action was by far and away the best. The result is that this system has survived in all countries where sporting guns are manufactured, and so it will make an excellent starting-point from which to work up to the complete attachment.

Fig. 12 is a diagram showing how a pair of barrels is hooked on to the front end of the bar of the action by

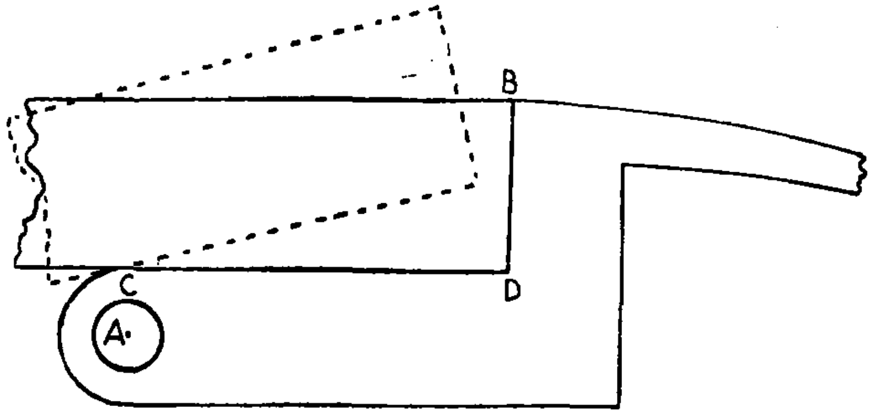


Fig. 12.—Diagram to illustrate the principles of the attachment of the barrels to the action.

the hinge pin. A is the hinge pin on to which the forward lump hooks at C. The barrels are then free to revolve round A until they assume the closed position BD.

The problem to be solved is the best method of holding the barrels to the action body so as to prevent them revolving about A.

It is clear that the greatest leverage is obtained by effecting a second junction at B, since B is the point on the barrels which is farthest away from A.

But the only method of achieving this is to have a large and strong extension at the breech end of the barrels at B which fits into a slot in the action and is then kept in position by some bolting device. If this extension is large and the bolting device strong, the attachment is complete and nothing further is necessary. This type of action is used in America and there can be no two opinions as to its strength. But it does not fulfil our other requirements, for it is heavy, clumsy, and interferes seriously with quick loading; while it also adds to the size of the action behind the face and thus results in a longer and more cumbersome gun.

In view of the fact that the bar is an essential feature of the action as it is required to carry the hinge pin, and since this bar *must* have a certain depth, it is clear that if it is possible to bolt the barrels down to the bar along the line CD, a union will be made without in any way adding to the size of the action, and thus the action would be much neater and more compact, as well as being light.

Here, again, all sorts of experimental systems were tried, and finally one stood out far in advance of all others. This was devised by the late Mr. James Purdey in 1867, and since the expiration of his patent it has become practically universal in this country with certain modifications and improvements on the original design. But all such changes are matters of detail and the principle remains the same as that of nearly seventy years ago.

THE PURDEY DOUBLE BOLT

Two lumps are cut out from the one solid lump fixed to the barrels as described in the previous chapter. The forward lump hooks on to the action at the hinge pin as in other types of connection; but slots, or "bites," are cut out of the rear edges of both lumps. The lumps fit into separate recesses in the action, and when the gun is in the closed position a bolt slides forward from the rear and enters the two bites on the lumps.

This bolt is wider than the lumps as it slides in horizontal grooves in the bar of the action and so holds the lumps down firmly to the bar. Fig. 13 is a section through

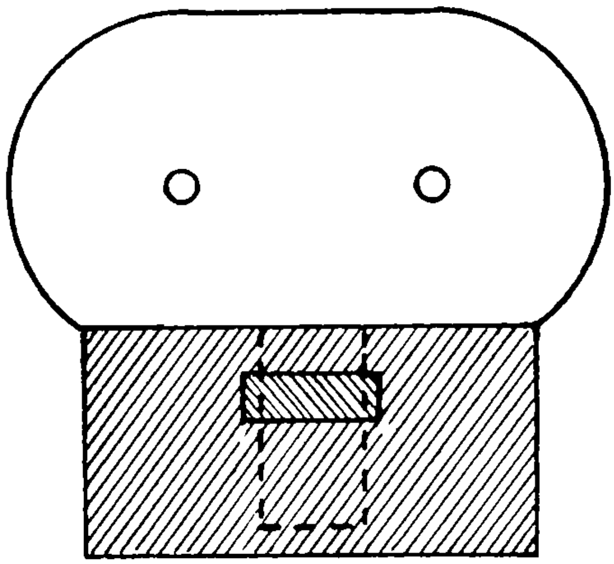


FIG. 13.—Section through the bar of an action showing how the bolt holds the lumps.

the bar of the action, showing how the bolt holds the lumps.

The bolt is cut out about the middle in order to allow the rear lump to drop through it into position when the bolt is drawn back in the grooves.

The drawing back of the bolt is effected by means of an elliptical slot in its rear end. A cam, or arm, attached to an upright pillar, or spindle, describes part of a circle when this pillar is revolved by the action lever. This cam works in the elliptical slot in the bolt, and so draws the bolt back and pushes it forward when the lever is moved.

Fig. 14 is a full-sized drawing of an action bolt. A, A are the two bearing edges which fit into the bites on the lumps. B is the rectangular slot through which the rear lump passes when the bolt is drawn back; and C is the elliptical slot in which the cam of the lever revolves.

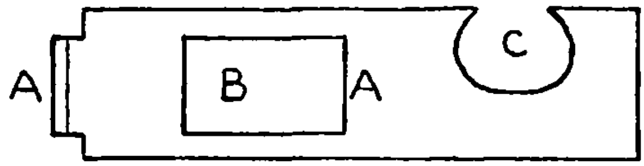


FIG. 14.—An action bolt (full size).
A, A, bearing edges. B, slot to receive the rear lump. C, elliptical slot to receive the cam operated by the action lever.

Fig. 15 is a sectional diagram (not to scale) which shows the working principles of this Purdey double bolt, and which really explains itself. When the lever (A) is pushed over, the cam (B) is revolved and draws back the bolt (C) until the two bearing parts (shaded in the diagram) are clear of the bites in the lumps, when the gun

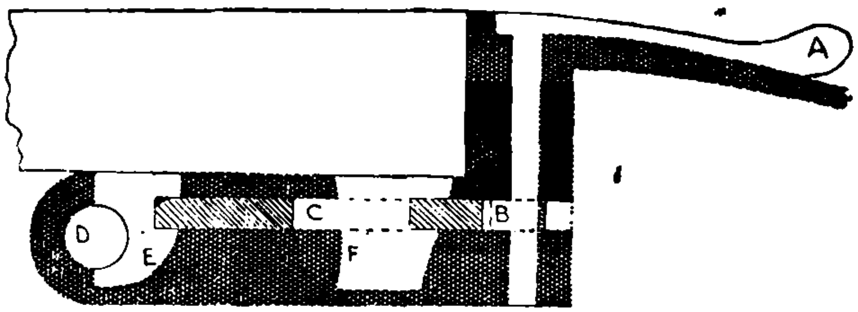


FIG. 15.—Sectional diagram showing the working principles of the Purdey double bolt.

can be opened by revolving the barrels about the hinge pin (D).

Since the bolt (C) must be placed in the middle of the action, it will be clear that the centre about which the cam (B) revolves must be to one side of the middle line of the action body. This is achieved by placing the spindle, which carries the cam and which is revolved by the lever (A), on a slant. The centre of this spindle is situated in a vertical plane *across* the action, and is therefore shown upright in the diagram, but the lower end of the spindle is to one side of the middle of the action, the top end being in the middle.

The lever is placed at right angles to the spindle, and so does not work in a horizontal plane when the gun is held level, but moves slightly upwards as it is pushed outwards.

Incidentally this upward movement is an advantage in case any grit gets jammed between the lever and the strap. If the lever moved in a horizontal plane the obstruction would be jammed during movement and might interfere with the operation of the lever; but as things are, the gap between the lever and strap is increased as the lever is moved, and pressure on any little obstruction is relieved.

It will be seen that the top edge of the forward bearing edge of the bolt is very slightly bevelled, and it will be noticed that the forward lump is also bevelled in a very pronounced manner at E. The result of this is that when the gun is closed this bevelled part (E) of the forward lump pushes the whole bolt back until the gun is completely closed and the bites of the lumps are exactly opposite the grooves in which the bolt slides. When this happens, the bolt slips forward of its own accord as the lever (A) is actuated by a spring (not shown in the diagram) which keeps it in the closed position unless pressed over.

This automatic closing, or snapping to, of the bolt is known as a "Snap Action" and is an enormous convenience in rapid loading.

When the gun is in the fully open position the bolt is partially held back by the lumps, while this pressure has the additional effect of locking the bolts to a slight extent, and thus helping to hold the gun in the open position while loading is completed. But on any pressure being brought to bear on the barrels in the way of closing the gun, the bevel (E) comes into operation.

It is hardly necessary to add that the fit of the bolt in the bites, as also that of its sliding in the grooves, must be perfect or else the connection will not be firm.

The front edge of the rear lump (F) should be cut on an arc of a circle which has for its centre the centre of the hinge pin (D). This ensures the best possible lock of the lump in the action, as naturally the action must also be cut out on the same circle.

The shape of the rear edge of the rear lump is not so important, provided it fits exactly against the action, and some gunmakers cut this edge on an arc of a circle centred about the hinge pin, while others cut it straight as shown in the diagram.

In fitting the barrels to the action the first thing done is to cut out the hook of the forward lump and the lumps are then cut separately and fitted by degrees into the proper action for that particular pair of barrels.

TOP EXTENSIONS

There is no doubt that the Purdey double bolt makes an ideal connection between the barrels and bar of the action. It is strong, simple, easy to operate, and requires no additional space. But is it sufficient? Before this

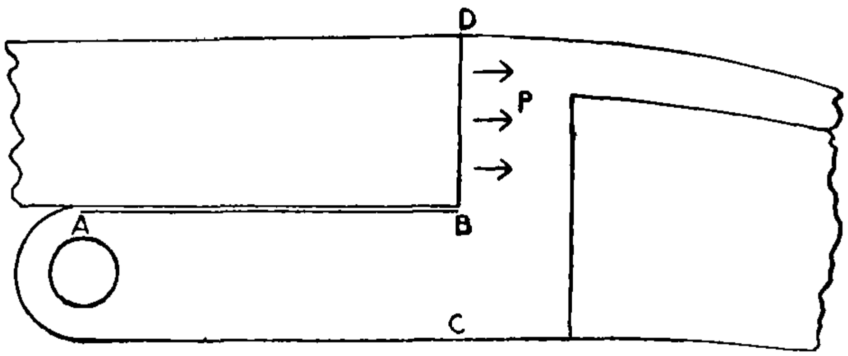


FIG. 16.—Diagram to illustrate the effect of a firm union between the barrel and the bar of an action.

question can be answered we must see what stress, if any, still remains to be met.

This can best be done with the help of the diagram given in Fig. 16. The barrels are assumed to be held solidly to the bar of the action along the double line AB. When the gun is fired, pressure (P) is directed against the face of the action as shown by the arrows. Since there is no union between the barrels and the action face, there must clearly be a tendency towards separation along the line DB.

The late Dr. Walsh described in *The Modern Sports-*

man's Gun and Rifle (Vol. I, pp. 150 and 151) how he fixed an attachment to an ordinary game gun by which a strip of silver paper was held across the top of the breech at D. Any separation of the barrels from the face of the action stretched the silver paper and broke it. He found that with a double bolt alone the silver paper was broken every time on the gun being fired, but that when the barrels were held to the breech at D by the addition of an efficient top connection the silver paper was not broken.

This certainly proved conclusively that there is an actual, as well as a theoretical, tendency for the barrels to separate slightly from the action at D, and that the Purdey double bolt alone did not eliminate this tendency.

After all, this is not surprising, as all the double bolt can possibly do is to clamp the barrels firmly down to the bar of the action. If the bar remains absolutely rigid there can be no separation of the barrels from the breech face. But practice has proved that the bar does not remain quite rigid, but bends slightly downwards owing to the thrust of the pressure against the face of the action.

In commenting on this, Dr. Walsh wrote:

> "Now we know by experience that a piece of iron may be bent backwards and forwards several times without breaking, but on continuing this bending for a considerable number of times a breakage shows itself by degrees. It follows, therefore, that a gun may be used for a time having this weak point in its action without accident, and yet may give way at last, though the charge has not been increased."

This is absolutely true, but when considering Dr. Walsh's conclusions it is only fair to remember that he wrote in 1882 when barrels were still made of "twist" because steel was so unreliable. Since then steel has improved enormously in quality and elasticity, and there can be no comparison between the steel used in a modern action with that which was used fifty years ago. Incidentally this tendency of the bar of the action to bend downwards explains the necessity for using an elastic steel in gun actions.

But the fact remains that there is this tendency to bending on the part of the bar, with the result that the bar and breech face really act as a bent lever. The line of weakness is through the action at BC, which is the section of the bar where it is held, the load being applied along AB.

There are three methods of increasing the strength of this bent lever and so eliminating the risk of breakage due to repeated bending of the bar of the action.

(1) Elimination of a sharp angle at the junction of the bar and face of the action.

(2) Addition of a top extension grip to the barrels.

(3) Improvement of the sectional structure of the action through the junction of the bar and face.

The first of these methods is now universal and in all guns the junction between the bar and face of the action follows a distinct curve which is really an arc of a circle of small radius. In some cheap guns the angle is made too pronounced, as the cost of cutting a small circular arc is higher than that of cutting a plain right angle. The difference in cost is slight, but the makers of very cheap guns have to look to every penny in order to keep the price down below that of foreign competitors, and the manufacturers of some Continental guns are bad offenders in the matter of sharp angles to their actions.

After Dr. Walsh's demonstration of the opening of the breech when the barrels were held by the double bolt alone, top extensions were widely adopted and have been retained by some makers in all their guns up to the present time.

The simplest of all top extensions is that known as the doll's head, which is merely a circular swelling at the end of the extension which fits into a corresponding recess in the top of the action. The doll's head was one of the earliest patterns of top extension, being evolved by Messrs. Westley Richards. It is made in numerous variations, but Fig. 17 shows a typical form of a simple doll's head.

In spite of its age and simplicity, it is one of the most efficient of all top extensions, although it does not appear to be very popular in its simple form, being generally reinforced by the addition of some sort of bolt. The only reason that I can see for its apparent unpopularity is that the principles of its action are not understood, either by sportsmen or numbers of gunmakers.

Since there is no bolt to hold it down and the gun is consequently opened without any sort of resistance once the action lever is pressed over and the lumps unlocked, there is a not altogether unnatural belief that the Doll's Head can serve no purpose. This is quite incorrect, and

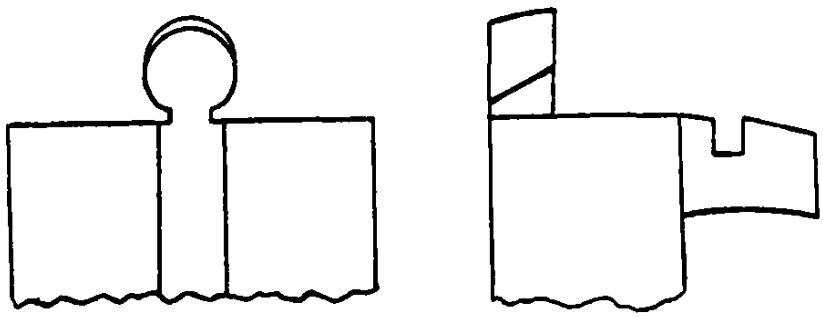


Fig. 17.—Top and side view of a doll's head top extension.

the real efficiency of the doll's head can be seen from the diagram given in Fig. 18.

When the gun is opened for loading the barrels revolve about the centre of the hinge pin, A, the doll's head moves along the dotted lines, *a*, *a*. But when the barrels are bolted down to the bar, the centre of movement on the discharge of the gun is in the bottom edge of the bent lever, B, and the tendency of the doll's head is to travel along the dotted lines *b*, *b*. This it cannot do owing to the increased diameter of the head which fits in a correspondingly shaped recess in the action, and so a perfect union between barrels and action is provided.

In spite of the efficiency of the plain doll's head it is comparatively seldom that one sees one at the present time which is not "reinforced" by the addition of some bolt. Even Messrs. Westley Richards use a bolt which enters into a small horizontal bite in the rear edge of the head, and a very common combination is that shown in Plate II, in which the doll's head is used in conjunction with a plain horizontal extension which fits into a slot in the face of the action, a bolt moving forward above this extension.

All these additions are unnecessary, and in low-priced guns they are often merely "eye wash," for reasons which will be explained shortly.

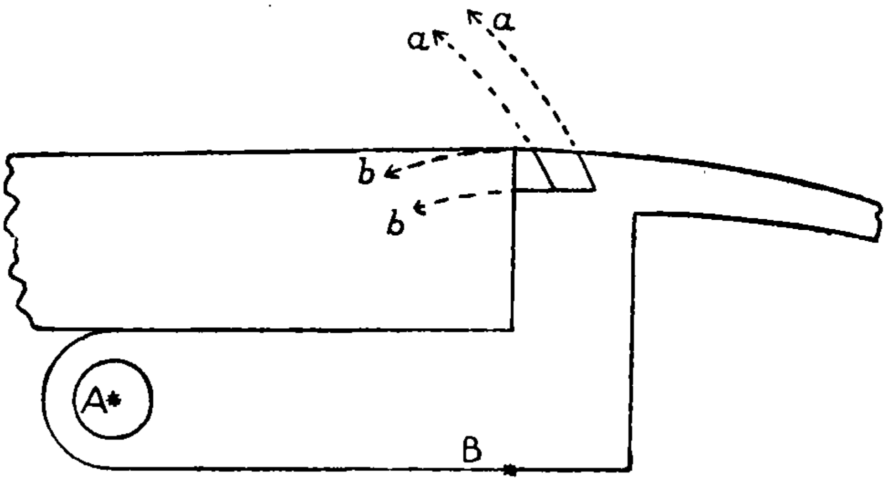


FIG. 18.—The principles of the doll's head.

Probably the commonest extension of all is the cross-bolt which was originally introduced by Messrs. Greener and is still one of the principal features of their well-known guns.

This form of extension is shown in Fig. 19. The extension is of even thickness throughout its length and is held in position in its recess in the action by a circular bolt which moves across the action and through a corresponding hole in the extension. This circular action bolt locks into a hole in the action on both sides of the extension, thus holding the barrels against a strain in any direction which can possibly be applied. Theoretically the cross-bolt is just as efficient, although not more so, than the doll's head; and when it is properly made and fitted this theory is borne out in practice.

Unhappily in many cheap guns the bolt is fitted in such a way as to be of little practical use. The fit of a cross-bolt, or indeed any type of bolt, can be tested easily in the following manner:

Smoke the whole of the top extension above the flame of a wax taper or any lamp which gives a smoky flame.

Then wipe all the deposit of smoke off the outside of the extension, leaving only the inside of the circular hole in the extension covered with smoke. Now put the gun together and close it. On opening it again, examine the circular hole in the extension.

If the cross-bolt fits properly the smoke will have been rubbed away, but if the smoke is left intact there is clear proof that the bolt is not biting in the extension.

I have amused myself by testing a number of cross-bolts in this manner, and it is extraordinary how com-

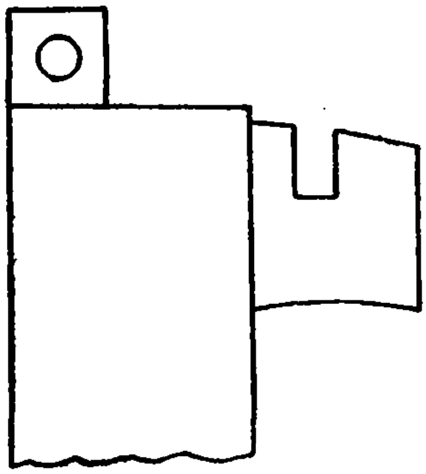


FIG. 19.—Side view of a cross-bolt top extension.

paratively rare it is to find one in which there is a proper fit between the bolt and the extension, especially in cheap guns. It is, however, pleasing to record that I have never yet tested a cross-bolt made by Messrs. Greener which did not fit.

In case it may be thought that I am criticising the *design* of this top extension, I will take the liberty of quoting the following passage from the *Gun and its Development*, by the late Mr. W. W. Greener, who was most emphatic in his condemnation of the careless manner in which cross-bolts are frequently fitted.

In commenting on guns made " both in Birmingham and on the Continent by manufacturers who cater for the wholesale market," Mr. Greener continued :

" Unfortunately, many of these guns are far from fulfilling requirements, as the cross-bolt demands accurate workmanship and very careful fitting if it is to bear its proper share of the work in holding the action and barrels together. . . . Instead of a round cross-bolt a square bolt is used by some makers, but the form has no advantage, and its use is detrimental, as the extension of the top rib is weakened more by a square hole than by a round one of the same area. Breech actions in which the extensions have been too light for the work required of them have shown weakness first between the hole and the junction of the extension with the breech ends of the barrels, but the tendency to break there is lessened by having the hole round. With a sharp angle, as needed for a square bolt, the extension needs to be much thicker and broader to give equal strength, and this makes the action clumsy, as it also widens the slot-way which the cross-bolt has to bridge ; the bolt, too, must be made larger to give equal strength, since the bearings supporting it are farther asunder. Added to these disadvantages is the extra trouble of fitting a square bolt accurately." (*Vide The Gun and its Development*, 9th Edition, pp. 156, 157.)

Mr. Greener's advocacy of the circular bolt as opposed to a square one is, of course, absolutely correct.

It may be argued that even when the cross-bolt does not make a tight bearing with the top extension it will in any case prevent any material opening of the breech on firing.

This is certainly true up to a point, but there are two facts which must be remembered :

First, that the object of the top extension was to prevent any bending of the bar of the action. An ill-fitting cross-bolt will probably be found on a cheap gun with a weak bar and action. If any bending begins, no matter how slight, it is possible for a fracture to occur in course of time if the metal in the bar is of inferior quality and too thin in section. In fact, the cross-bolt will in all probability be found not to be doing its duty in the very type of action which needs its help the most.

The second point is that if any movement is allowed to begin, what is called " dynamic action " sets in. This merely means that the cross-bolt receives a definite blow as the result of the movement of the barrels and the bar. Everyone knows that a blow delivered by a moving body is more intense than a similar pressure applied without movement. For instance, if you want to burst open a locked door you can apply more force by taking a run at it than you can merely by shoving. When you take a run you apply " dynamic action " and when you merely shove you exert " static pressure."

When the cross-bolt fits tightly it only has to withstand static pressure : but when it does not fit it has to withstand dynamic action. The constant repetition of this dynamic action tends to make the bolt become looser and looser until it can finally be in such a state that it will have little effect towards the prevention of the bending of the bar of the action.

The third general type of top extension is a plain horizontal extension which fits into a slot in the action face and is then held down by a bolt which slides forwards above the extension.

This type obviously cannot be fitted at the very top of the barrels or there would be no room for the holding-down bolt, and it is frequently fitted about halfway between the top and bottom of the barrels. In this position it is popular with some of the makers of best-grade guns who want to make use of an additional grip in some special gun designed for heavy charges, as it can be made to protrude through slots in the extractors, and so it is partially hidden by the extractors. On this account it is sometimes termed a " concealed " extension, and it certainly has the advantage over extensions of the doll's head and cross-bolt type that it does not interfere in any way with the work of loading.

At first sight it may seem a mistake not to have the extension as near the top of the barrels as possible in order to obtain leverage, but in reality a slight lowering of the position of the extension may become an advantage.

Fig. 20 shows diagrammatically two plain extensions of this horizontal type A and B, which are situated at different heights on the barrels.

The centre of movement which the top extension has to combat is at C, and the dotted lines P_1, P_2, P_3 show the direction of motion of the different parts of the extension, A, when the bar of the action bends about C.

Similarly the dotted lines T_1, T_2 show the same direction of motion in the case of the extension, B.

Now, the lower the extension is, the shorter is the radius of motion, as the extension will be nearer the centre of movement, C. And the shorter the radius of motion, the more curved will be the arc of movement. The result is that there is a bigger space between the highest point of the arc T_1 and the extension B than there is between the arc P_1 and the extension A.

Consequently, if the bolt does not fit close above the extension, there is a better chance of some sort of resistance to the bar bending in the case of an extension which

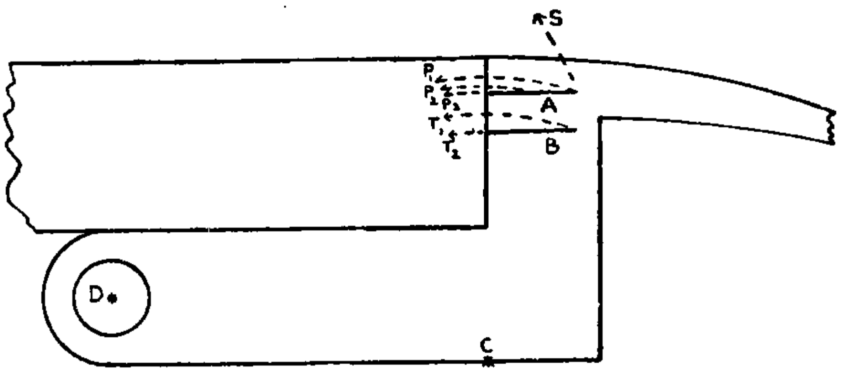


FIG. 20.—The principles of a plain top extension held down by a horizontal bolt.

is fitted half-way down the barrels than in that of one which is near the top.

Similarly, the shorter the extension the less the distance between its upper surface and the arc of movement, as may be seen by looking at the dotted line P_2.

This again means that with a short extension there is less latitude for an ill-fitting bolt. In fact, it might possibly happen that a short extension fitted high up could revolve about the point C without touching the bolt at all if it happened to be a very badly fitting one! Such a combination is admittedly unlikely, but the fact that it is a possibility proves that too much reliance should never be placed on this type of top extension.

The man who buys the gun and the salesman who sells it probably both think that the bolt has to prevent a tendency of the gun to open when centred about D, in which case the extreme end of the bolt would follow the dotted line S. But this idea is quite incorrect, as has already been shown.

Since there is a tendency for almost any form of top extension other than those situated just above, or within, the extractors to interfere with the ease of loading which is so essential in quick shooting, some gunmakers have adopted a sloping extension. In this form the upper surface slopes downwards to the rear. It is usually fitted below the top of the barrels so as to interfere as little as possible with loading, and it works in a slot in the action face, being held in position by a bolt which slides forward and bears on the upper, and sloping, surface of the extension. There is no doubt that this form of extension leaves more room for loading, but since the only justification for its presence is a prevention of the bending of the bar of the action, let us see how it fulfills this purpose.

Fig. 21 gives a diagrammatical view of one of these sloping top extensions, AB being the extension.

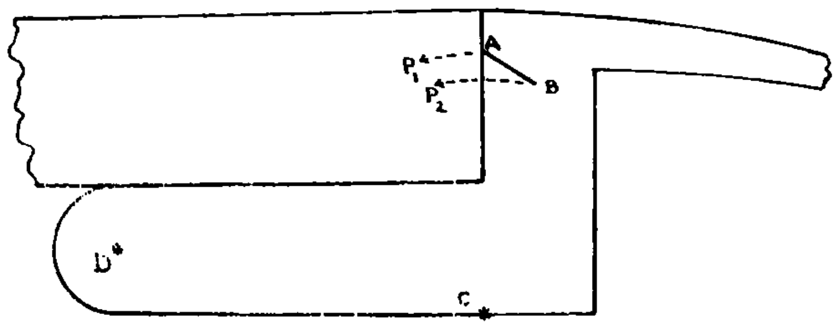


FIG. 21.—Diagram to show the futility of a sloping top extension.

Now the centre of movement which this extension has to resist is situated, as has already been explained, at C. Consequently the two ends of the extension, A and B, will have a tendency to move along the arcs of circles centred at C, as shown by the dotted lines P_1 and P_2.

It is perfectly obvious that no pressure applied on the upper surface AB can possibly resist any movement in this direction, and so it will be seen that any form of extension in which the upper bearing surface slopes downwards to the rear is *utterly useless*.

The only possible purpose which can be served by an extension of this type is to give an altogether false sense of security to the owner of the gun who may be impressed by the quite irrelevant fact that such a system of bolting does prevent any tendency of the barrels to open about the hinge pin, D.

The same applies to any extension which is fitted with a bite into which a bolt slides forwards where the lower surface of the bite slopes downwards to the rear. Such bites are sometimes cut, but they can be of no service whatever.

In any case, as I have already explained, any form of extension which is gripped by a bolt should be regarded critically on account of the difficulty of obtaining a tight bearing with this extension bolt as well as with the double bolt in the bar of the action. The more bolts there are, the more difficult it is to make them all fit exactly.

This will readily be understood by anyone who has ever tried to make a four-legged table, stool or chair stand absolutely level on the ground. When there are only three legs there is no difficulty at all, as the feet of all three cannot help but reach the ground. But directly a fourth leg is added there comes the difficulty of cutting it to the exact length. If a shade too long, it raises one of the other legs off the ground ; and if a shade too short it fails to reach the ground. In either case the stool will rock to and fro.

But if a fifth leg is added the difficulty becomes greater, because there are more legs to throw out of bearing ; and the greater the number of legs the greater the difficulty of fitting them.

It is on this account that collapsible stands for supporting cameras, surveying instruments such as plane tables and theodolites, artillery directors and range finders, are always made as tripods—that is, with three legs. Were there four legs it would be impossible to obtain stability when the ground was not dead level, no matter how accurately the legs had been made to length. So we see that complete stability depends on (1) accuracy of all leg lengths, and (2) surface of the ground.

The same holds good in the case of fitting bolts in a gun action. The two bearing surfaces of the double bolt are comparatively easy to fit as they are both moving in the same slot, which is cut in one operation. But directly an additional bolt is brought in at the top of the action face the difficulty of getting a *tight fit on all three bolts* is increased out of all seeming proportion. In fact, the cost of the work necessary to ensure such a fit is sufficient to prevent its attainment in the case of very cheap guns except by a happy accident. I have already pointed this out when dealing with cross-bolts, but would like to pay tribute again to the beautiful work which Messrs. Greener invariably display in the fitting of their bolts, work which stands out almost unique in this particular respect in guns which are sold at the price of Messrs. Greener's cheapest grade of weapon.

Sometimes one hears of guns which are sold at a very low price being fitted with " quadruple " grips, or even more. The difficulty of establishing a tight bearing when four, or more, bolts are used is so great as to ensure that it is not done at the price at which these guns are sold.

I have been into this question of top extensions at considerable length because they are as often as not a snare and a delusion. In certain types of actions a top extension is advisable, as will be explained later, and when this is the case the best extension is either a plain doll's head or else a *well-fitting* cross-bolt.

In high-grade guns where an extra grip is thought advisable the " concealed " plain extension is excellent, for in guns on the building of which the best workmanship is expended the bolt can be relied upon to fit. An excellent example of an unobtrusive top extension, or " treble " grip, is shown on Plate XIIB.

Having dealt with the importance of rounding the angle between the bar and action face, and also with top extensions, there remains only the third method for preventing the downward bending of the bar of the action which causes a separation of the barrels from the action face. It will be remembered that this method was a strengthening of the actual bar itself.

As has already been explained, an action bar is really a bent lever, and so it is a sound principle to follow as far as is practically possible the sections used for girders in engineering.

But before we can begin to consider this problem we must know what the body of the action has to contain, as it is useless to design a strong section for the bar of an action if we leave no room for the mechanism necessary for the working of the gun!

We have already seen that the bar has a horizontal slot cut out of it along its length to accommodate the bolt which grips the lumps of the barrels. In addition to this bolt there are the locks which have to be fitted in somewhere. So it will be as well if we leave the action body for the present and turn our attention to the locks. When we have seen what these comprise and how they operate we will know better how to shape the body of the action to receive them.

CHAPTER III

THE LOCKS

THE Lock of a gun is that mechanism which causes a blow to be struck on the percussion cap of the cartridge, and thus fires the gun. As sporting guns are invariably double-barrelled there must be two such sets of mechanism, one for each barrel. Hammerless guns are now so universal that I will not at first consider any form of lock having external hammers. Of course all locks have hammers, but in hammerless actions these are enclosed inside the action and so are not ordinarily visible.

The locks of hammerless guns as made to-day are of two general, and quite distinct, types: those which are fitted into the body of the action; and those which are fixed behind the action body and let into the side of the gun. The former type are called Box Locks, or Body Locks, and the latter Side Locks.

THE ANSON AND DEELEY LOCK

Box locks are now almost universally made to one design, such variations as do exist being minor details rather than general principles. This general design has changed little since its introduction in 1875, when it was patented by Messrs. Anson and Deeley, who were two workmen employed by Messrs. Westley Richards. It was the first efficient hammerless action, and it could receive no greater praise than the fact that it is still the commonest action in general use.

A separate slot is cut into the body of the action for each lock, these being inserted from the back and below. Fig. 22 gives diagrams of the principal working parts of an Anson and Deeley lock in its three different positions. In each diagram A is the hammer, or Tumbler as it is invariably termed. It will be noted that the striker, or firing pin (the peg which actually strikes the cap), is an integral part of the tumbler, although it is fitted separately in some designs of box locks. The tumbler is pivoted about an axle, B, which is a plain peg

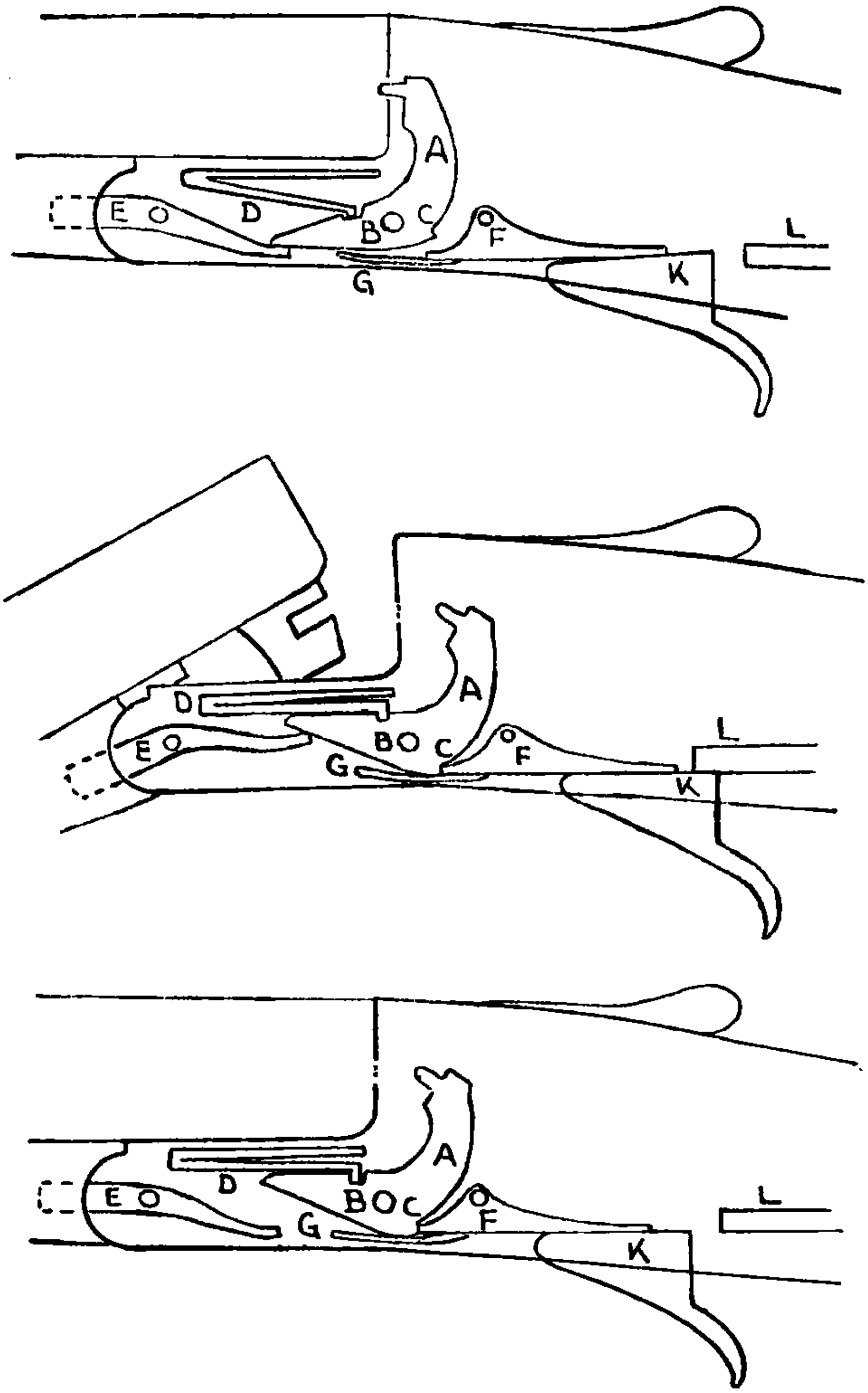


FIG. 22.—Diagrams showing the principal working parts of the Anson and Deeley action.

Top.—Gun closed and fired. The trigger B is still pressed.
Centre.—Gun opened.
Bottom.—Gun closed and ready for firing.
References.—A, Tumbler or Hammer; B, Tumbler Peg; C, Bent; D, Mainspring; E, Cocking Lever or " Dog "; F, Sear; G, Sear Spring; K, Trigger; L, Safety Stop.

inserted right through the action from side to side and which forms an axle for both tumblers. The tumbler, A, revolves about this peg, B.

In the lower edge of the tumbler there is a notch, C, which is called the Bent.

D is the mainspring, one end of which fits into a small notch on the upper edge of the tumbler, as shown in the diagrams. In the upper diagram the mainspring is relaxed, and the tumbler is held with the striker just protruding through a hole in the face of the action. This is the " fired " position of both tumbler and mainspring.

E is the cocking lever, or cocking " dog." It is pivoted about a peg which goes right through the bar of the action and carries the other cocking lever as well. The end of the cocking lever further from the tumbler protrudes through the knuckle of the action into a slot in the fore-end.

The firing levers, which are always called " Sears," are also both pivoted about one peg which traverses the lower rear end of the action body from side to side. In the diagrams the sear of the lock shown is marked F. Its forward end is held upwards by a flat sear spring, G, which is attached to the body of the action.

The trigger, K, is hinged at its front end by a peg (not shown in the diagrams) which also carries the other trigger (also not shown in the diagrams). This peg is not driven through the action body, as it occupies a position behind the rear end of the body, but through a projection sticking up from a flat strip of metal which is let into the wood of the stock and corresponds to the strap of the action on top. It differs, however, from the strap in that it is not an integral part of the action body.

The upper part of the trigger, known as the trigger blade, is in contact with the rear portion of the sear.

Let us now assume that the gun has just been fired when the various parts which have been described will all be occupying the positions shown in the top diagram.

As the gun is opened the fore-end rotates round the knuckle of the action and depresses the front end of the cocking lever, E. This raises the rear end of this lever, which lifts up the front part of the tumbler, thus revolving the tumbler about its axle until at length the bent, C, comes opposite the end of the sear, F. When this happens the end of the sear is immediately lifted up by the pressure of the sear spring, G, until it engages in the bent, and so prevents the tumbler from falling back into its original position when the pressure exerted by the cocking lever is removed.

The act of the tumbler revolving compresses the mainspring, D.

At the same time the rear end of the sear, F (which is depressed when the front end is lifted by the sear spring), presses down the trigger.

The pressing over of the action lever, besides withdrawing the bolts which hold down the barrels, also actuates the safety arrangement. This mechanism has not been shown in the diagrams for the sake of simplification. The principle of most safety devices is the same, namely, to move a stop into position immediately above the blade of the trigger. This stop is marked L in the diagrams, and in the centre diagram it is seen in its forward position above the trigger blade, thus preventing the blade from being raised, and so locking the trigger. This one stop locks both triggers. The fact that it is brought into position by the movement of the action lever, and thus locks the triggers automatically when the gun is opened, has resulted in it being called an "Automatic Safety." Not all safety devices are automatic, in some there being no connection with the action lever. In these the principle of locking the triggers is identical to that described, the only difference being the necessity of having to pull the safety slide back by hand when it is desired to put the gun "at safe."

It should be noted that the only action of this "Safety" is to *bolt the triggers*. It is entirely independent of the tumblers or sears, and it is possible for the sear to be jarred out of the bent while the trigger is still locked by the safety bolt. I mention this because I have met shooters who believed that the movement of the safety slide on a gun uncocked the tumblers.

Let us now turn to the bottom diagram in Fig. 22, which shows the positions of the various parts of the lock after the gun has been closed again. The lifting of the barrels has resulted in the front end of the cocking lever being raised by the fore-end as it revolved round the knuckle ; but in all other respects the tumbler, mainspring and sear retain the positions they occupied when the gun was opened, because the fact that the sear is caught in the bent prevents the tumbler from being revolved by the pressure of the mainspring.

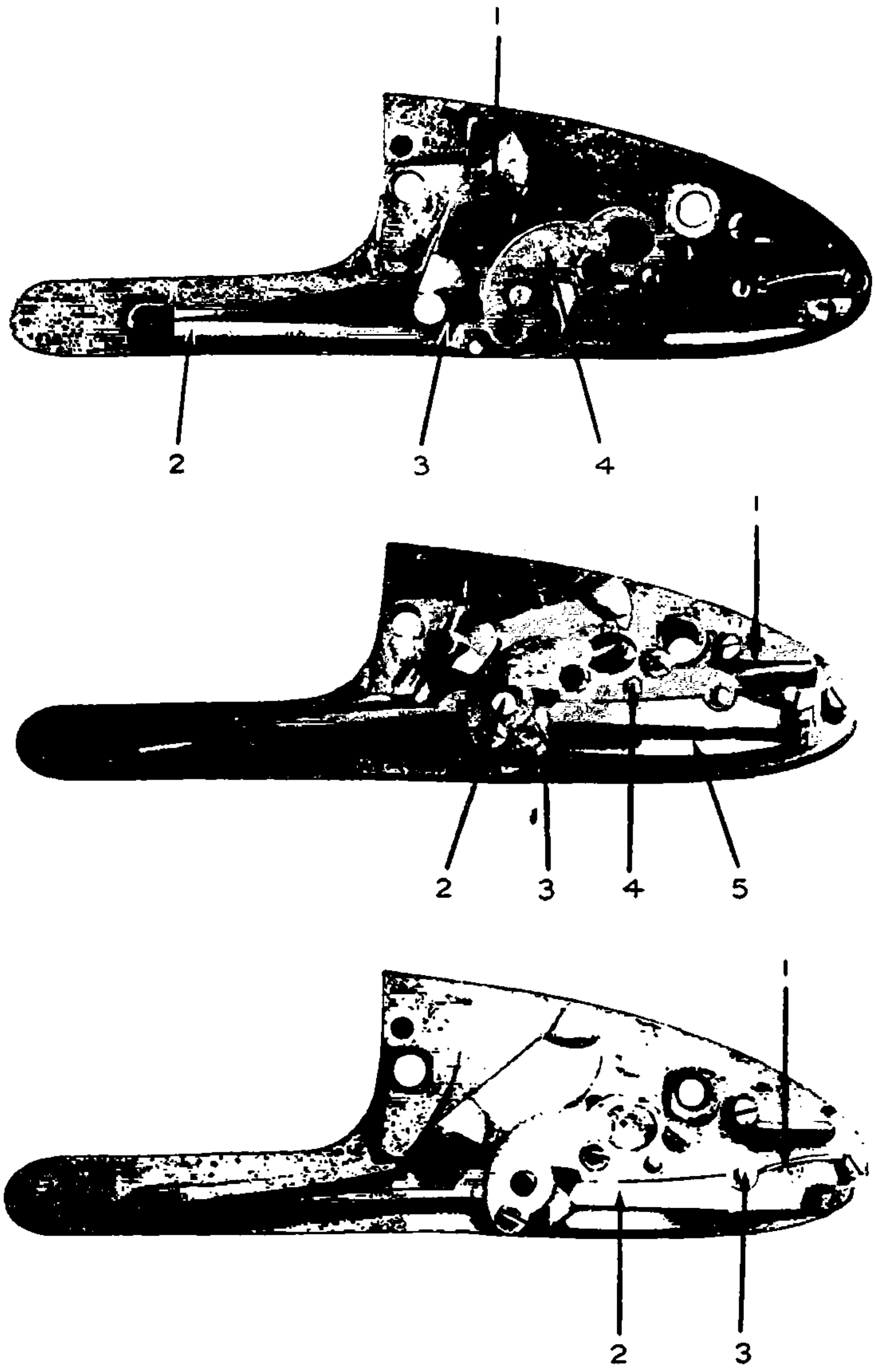
In this bottom diagram the safety stop, L, has been moved out of position by means of the slide on the strap of the action, and the gun is ready for firing.

On the trigger being pressed, the rear end of the sear is raised, which depresses the front end until it is clear of the bent, when the pent-up force of the compressed mainspring is free to act and revolves the tumbler with great speed until it again occupies the position shown in the top diagram, and so strikes the cap of the cartridge and fires the gun.

An important point to note is that the locks are cocked by the opening of the gun.

It would be hard to imagine anything much simpler than this action, and it is not surprising that it has retained its place for over half a century.

There is, however, one serious disadvantage in the design of this type of lock, namely, the position of the peg which forms the axle for the tumblers. As has been seen, this peg is driven right through the body of the action from side to side, fitting in holes drilled in the body. Now the design of the lock is such that this tumbler peg *must* be placed almost directly underneath the angle of the action, which means that a hole must be bored right through the action in just that very line which we have seen is the line of greatest weakness.



A Bar Action Side Lock

Top. Position of parts immediately after firing: 1, Tumbler; 2, Main Spring; 3, Swivel; 4, Bridle

Centre. The lock at full cock: 1, Sear Spring; 2, Tumbler Axle; 3, Sear Nose in Bent; 4, Sear Peg; 5, Sear

Bottom. The sear has been jarred out of the bent and the tumbler has begun to fall but has been stopped by the intercepting safety: 1, Intercepting Safety Spring; 2, Intercepting Safety; 3, Intercepting Safety Peg

Reduced to [illegible] size

The fact that the action is pierced by a hole in this line can only entail still further weakening of the action body. There is no getting away from this, and unfortunately it is impossible to move the position of the tumbler peg to any appreciable extent. If it is moved either forward or back there is not proper scope for the necessary rotation of the tumbler, and the same applies if it is lowered. The most that it is possible to do is to move it very slightly back so that the centre of the hole does not lie exactly on the line of greatest weakness; and there are few Anson and Deeley actions, if indeed any, in which this line of weakness does not pass through, or touch the hole, since it cannot be bored too small or the tumbler peg would lack sufficient strength.

I will return to this point a little later on, but will add now that there are two further, although comparatively minor, weak spots in the design of this type of lock which will also be considered shortly. These are the union between mainspring and tumbler, and the position of the peg on which the sear revolves.

The locks are covered in by a plate which is screwed on to the bottom of the action and called the Bottom Plate.

BAR ACTION SIDE LOCKS

Side locks are, as has already been stated, those locks which are let in on each side of the gun and behind the body of the action. In some side locks a part of the mechanism extends to the front and is let into the side of the bar of the action, while in others the whole of the lock is situated behind the action body. The former type are called Bar Action Side Locks, and the latter Back Action Side Locks.

Plate VI shows three different positions of the parts of a Bar Action Side Lock, and in each position the names of the different parts, or limbs, are labelled.

All side locks are operated by means of a cocking lever which works in a longitudinal slot in the bar of the action and is similar to the cocking lever of a box lock. Since the cocking levers in side locks are situated in the bar of the action, they make a separate unit in the mechanism and do not form an integral part of the lock itself. For this reason they are not shown in the photographs.

The essential of any lock is a tumbler, or hammer, which must revolve on an axle. And this axle must have bearings, or supports, on each side of the tumbler. In the case of a side lock there is no part of the action body available for these bearings, and so they must be provided by other means. The bearings for the axles of the tumbler and sear are situated in two steel plates which are held together by screws. These plates are parallel and the tumbler and other parts are placed between them. The outer plate is much the larger, as it has to cover in the whole of the space cut out of the side of the gun for the reception of the lock. This outer plate is called the Side Plate.

The inner, and smaller, plate is called the Bridle.

Both the Side Plate and Bridle are clearly shown in the photographs, and it will be seen that they are held together by three screws.

The tumbler and axle are forged in one piece, the axle bearing in holes in the side plate and bridle. The end of the axle which bears in the side plate is, in the case of almost all best guns and some others, marked with an "Indicator." Sometimes this indicator takes the form of a small engraved arrow, and sometimes a line of gold or platinum is inlaid along a diameter of the end of the axle. The purpose of this indicator is to enable one to tell at a glance whether a lock is cocked or not. When the lock is in the "fired" position the indicator is parallel to the length of the gun; but when the tumbler is cocked the indicator makes an angle with the length of the gun.

At the bottom front end of the tumbler is another round knob which makes the bearing for the cocking lever.

The mainspring is compressed between the tumbler and a projection on the side plate, which also acts as a stop and prevents the tumbler from revolving too far on firing.

The front end of the mainspring is fitted with a peg which fits into a hole in the side plate. This fixes the point of the mainspring and prevents it from moving when the spring is compressed and relaxed. In a box lock the point of the mainspring is not fixed, and does change its position when the gun is fired. This difference is worth noting, because the movement of the point of the mainspring in the case of a box lock is utilised in one type of ejector mechanism. But this will be dealt with fully in the chapter on ejectors.

The most important difference, however, between the fitting of the mainspring in box and side locks is the bearing between the spring arm and the tumbler. In the box lock, it will be remembered, the end of the spring fitted into a notch in the tumbler. But in a side lock the spring arm bears on the end of a swivel which in its turn is connected to the tumbler. This connection is by means of a pin about which the swivel is free to revolve, and so it will be seen that the actual point of bearing of the mainspring *changes its position in relation to the rest of the tumbler as the tumbler revolves.* This relative change in position of the mainspring bearing can be seen easily in the photographs on Plate VI. In the two lower photographs the bearing is much more in a direct line with the tumbler axle and bearing for the cocking lever than is the case in the top photograph. At first sight this change of relative positions may seem a matter of minor detail; but in actual fact it is one of great importance and adds considerably to the efficiency of the lock.

When a compressed spring is relieved, it exerts considerable force as it relaxes; but this force is not constant, being greatest when the spring is most compressed, and least when the spring is least compressed. The result is that in a box lock the force with which the tumbler falls diminishes as it rotates, being weakest at the completion of the fall, just when the greatest possible force is required for the striking of the cap.

The insertion of a swivel between the tumbler and the end of the mainspring avoids this diminishing of force on the relaxing of the spring, and either maintains a constant force throughout the fall of the tumbler, or actually increases this force towards the end of the stroke.

This action of the swivel can best be explained with the help of Fig. 23.

The tumbler axle is A, and B_1 C_1 represent the

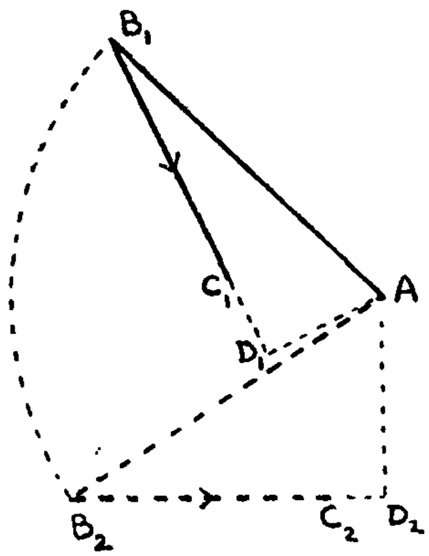


Fig. 23.—Diagrammatical explanation of the method by which the insertion of a swivel between the mainspring and tumbler increases the force of the fall of the tumbler.

A is the tumbler axle; B_1C_1 the position occupied by the swivel when the tumbler is at full cock; and B_2C_2 that of the swivel after the tumbler has fallen. AD_1 and AD_2 are the perpendicular distances between the tumbler axis and the swivel.

position of the swivel when the tumbler is at full cock. The swivel is hinged to the tumbler at B_1 and the main-spring is fixed to the other end, C_1. On firing the tumbler rotates about A, and finally the swivel occupies the position B_2C_2.

Now since the swivel is free to revolve round the pin by which it is attached to the tumbler, it will be clear that the force exerted by the spring on the tumbler can act *only* in the direction of the swivel. This means that in the full-cock position the spring is exerting a pull on the tumbler which acts along the line B_1C_1, and in the fired position this pull is acting along the line B_2C_2.

The further away the line of pull is from the tumbler axle, the greater will be the leverage it can exert towards revolving the tumbler. The amount of leverage is, therefore, the perpendicular distance between the tumbler axle and the line of the swivel.

In the full-cock position this leverage is represented by the line AD_1, and in the fired position by the line AD_2. AD_2 is greater than AD_1, and so the leverage possessed by the spring is greater in the fired position, that is, at the end of the fall of the tumbler, than in the full-cock position. It will, therefore, be realised that when the pull of the spring is weakest it has the biggest leverage for turning the tumbler, and this compensates for the loss in power of the spring.

It is, in fact, quite possible so to design a lock that the total turning force increases as the tumbler falls, even though the pull of the spring gets weaker. It is entirely a question of the length of the swivel and the position of its point of attachment to the tumbler. Where there is no swivel the turning force decreases as the tumbler falls and the blow is not so strong as that resulting from a spring of the same strength which is linked to the tumbler by a swivel.

As has already been explained there is no such union between the mainspring and the tumbler in a box lock. However, there is some provision for reducing the weakening of the blow as the tumbler approaches the end of its travel. This is effected by the forward movement of the mainspring which has already been pointed out. The pressure exerted by the lower arm of the mainspring on the tumbler must act in a vertical line through its point of contact with the notch in the tumbler—I am assuming that the gun is horizontal. Consequently the rotational leverage is the length of the perpendicular from the centre of the tumbler axle to this vertical line. A glance at Fig. 22 will show that this leverage must clearly be greater in the fired position than in the full cock. This is due to the forward movement of the mainspring during the fall of the tumbler. So the leverage of rotation does increase while the mainspring is relaxed and thus the weakening of the rotational force exerted is compensated by the greater leverage which it is given. But this increase in leverage is not so great as that given by a well designed swivel although it is certainly better than none.

The general action of the lock is similar to that of the box lock. The top photograph, as has already been stated, shows the lock in the " fired " position. On the gun being opened, the fore-end revolves round the knuckle of the action and depresses the front end of the cocking lever in exactly the same manner as in the case of the box lock. The other end of the cocking lever is raised, and takes with it the knob on the tumbler with which it is in contact, thus revolving the tumbler about its axle until the bent comes into a position opposite the tumbler sear, which slips into it and keeps the lock at full cock, as shown in the centre photograph.

The only difference in the working of the sear between the side lock and the box lock is that in the side lock the sear spring is placed *behind* the peg on which the sear revolves and forces the rear end of the sear down, thus lifting the front end. In a box lock, it will be remembered, the sear spring was placed *in front* of the sear peg and underneath the sear, lifting the front end of the sear into the bent. In both locks the front end of the sear is lifted into the bent by the action of a spring, and the position of the spring is immaterial.

In a side lock, however, the rear end of the sear is bent at right angles so as to form an arm which protrudes towards the centre of the gun. The sole purpose of this is to obtain a bearing between the trigger blade and the sear, which would not be possible in the case of a lock in which the sear is situated so much to one side unless it was fitted with an arm which reached over the trigger blade.

In the top and bottom photographs only the end of this right-angled arm can be seen, but in the centre photograph the angle is plainly visible.

The trigger works in exactly the same way as in a box lock, the blade lifting the end of the sear, and so releasing the other end of the sear from the bent, when the tumbler falls under the influence of the mainspring.

The automatic trigger safety bolt also works in an identical manner.

Side locks, however, have an additional safety device which is known as an " Intercepting Safety."

In the description of the box lock it was explained that the trigger safety merely bolted the trigger blades and so prevented them from being raised; but that it did nothing towards rendering a gun safe in the event of the sear being jarred out of its position in the bent.

The intercepting safety was specially designed to meet such an eventuality.

In the photographs on Plate VI it will be seen that the sear seems to be in two parts, and the reason for this has probably not been clear. The smaller sear in front is really a part of the intercepting safety device.

An examination of the lower and backmost portion of the tumbler will reveal a projection which protrudes from the tumbler to the level of the bridle. This is the Intercepting Safety Stop, and its back edge is really nothing more than a very deep bent.

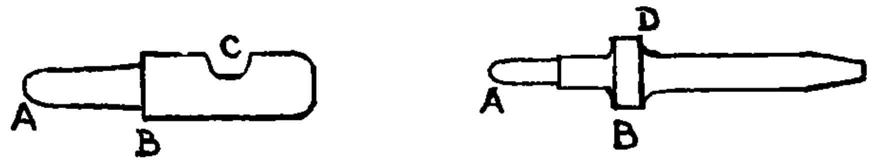
When the lock is at the full-cock position, as in the centre photograph, there is a distinct space between the rear edge of the intercepting safety stop and the front edge of the intercepting safety sear. On the trigger being pressed, the trigger blade lifts simultaneously the arms of both the tumbler sear and the intercepting safety sear, and the tumbler is then free to rotate.

But if the trigger is not pressed and yet the tumbler sear is jarred out of the bent, the tumbler cannot rotate far before the intercepting safety stop comes into contact with the front end of the intercepting safety sear, and the lock parts are then in the position shown in the bottom photograph on Plate VI, as the intercepting safety sear is acted on by a spring in the same way as the tumbler sear.

When the tumbler is stopped by the action of this intercepting safety it cannot be moved except by the cocking lever, and the gun must be opened and the tumbler re-cocked, when it can be fired as usual directly the trigger safety is released by means of the safety slide on the strap of the action.

It will thus be seen that the possibility of an accidental discharge due to the sear being jarred out of its position in the bent is provided for in a side lock.

There is another difference in the design of all side locks when compared to box locks, and that is the striker. In the box lock the striker is an integral part of the tumbler, but this is not possible in a side lock owing to



A B

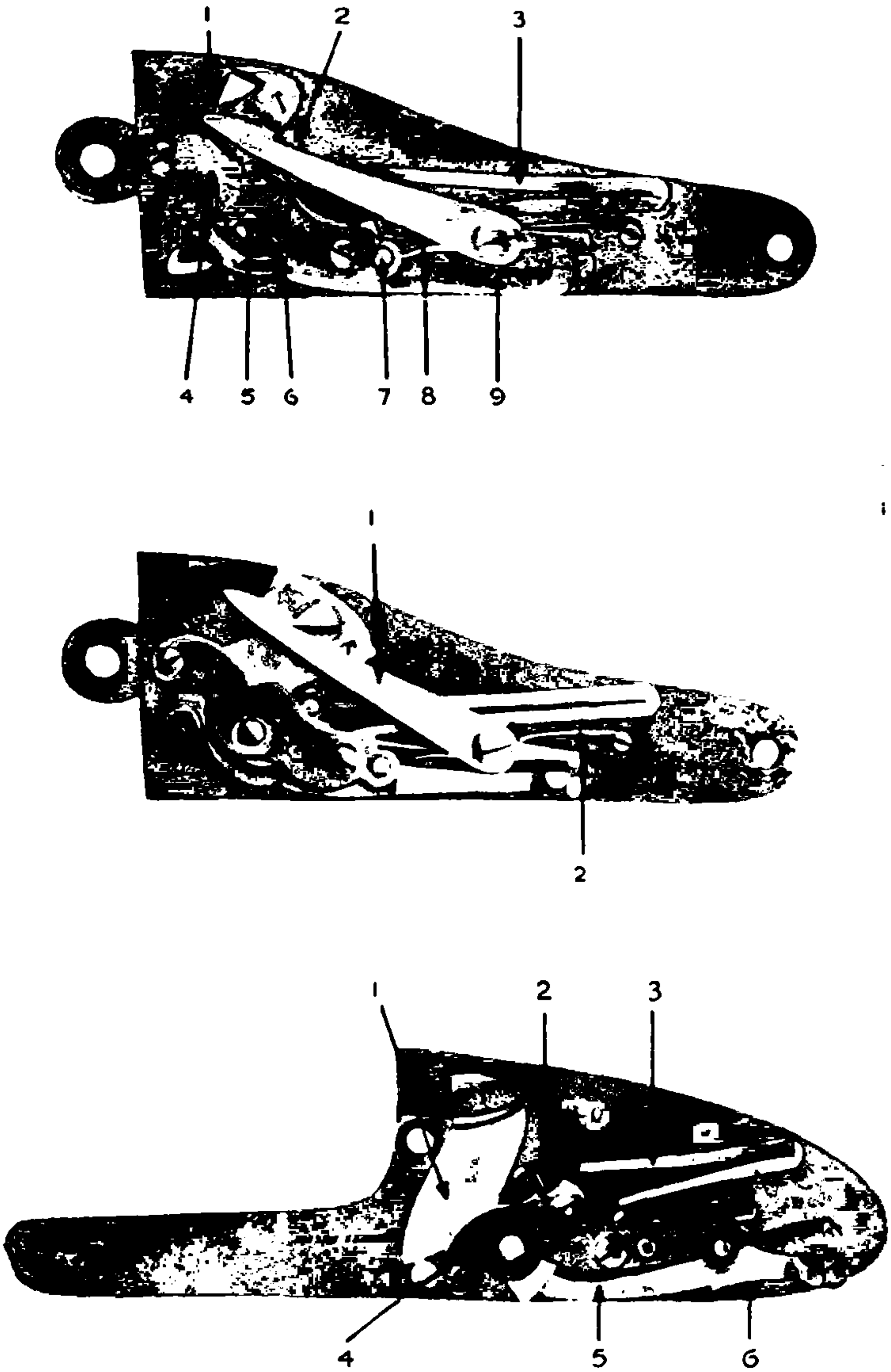
FIG. 24.—Two patterns of Strikers, or Plungers, used in side locks (actual size).

the manner in which the lock is let into its position in the gun. Consequently the striker must be a separate limb.

Fig. 24 shows two patterns of strikers, or " plungers " as they are sometimes called, belonging to side locks. In each type the point, A, protrudes through a hole in the action face and strikes the cap. The tumbler hits the other end and drives it forward. It is prevented from going too far by the shoulder, B. When the pressure of the tumbler is removed on the lock being re-cocked, the striker is pushed back by the cap as the gun is opened.

In the type shown in Fig. 24A the striker is inserted from the rear, and to prevent its moving too far back there is a small stop screw, or " pin," which is inserted through a corner of the action body and projects into the slot, C. (See bottom illustration, Plate V.)

The pattern shown in Fig. 24B is inserted from the front, that is, through the action face, which has a com-



Two types of Back Action Side Locks

Top. The positions of the parts immediately after firing: 1, Tumbler; 2, Swivel; 3, Main Spring; 4, Bridle; 5, Tumbler Axle; 6, Sear Nose; 7, Sear Peg; 8, Sear Spring; 9, Sear
Centre. The same lock with the intercepting safety stop in action: 1, Intercepting Safety; 2, Intercepting Safety Spring
Bottom. Another lock in the "fired" position. In this type the side plate is of the same shape as that of a bar action lock: 1, Tumbler; 2, Swivel; 3, Main Spring; 4, Bridle; 5, Intercepting Safety; 6, Sear

Reduced to [illegible] size

paratively large hole bored out of it to receive the striker. This hole is fitted with a screw plug, or "bush," in the centre of which there is a smaller hole through which the point of the striker protrudes. (See top illustration, Plate V.) The backward movement of the striker is limited by the shoulder, D.

This method of fitting the striker has the advantage of permitting the bush to be renewed should it become pitted by the action of any escaping powder gases, or through other causes. Such pitting is all too common and it is an unsightly disfigurement to a good gun.

In some designs of gun there is a small coiled spring which is fitted round the thin front part of the striker, and which butts against the shoulder, B, thus forcing the striker back when the tumbler is cocked. Theoretically this is a better plan, but experience has proved that the backward pressure of the fired cap when the gun is opened is sufficient.

The lock is fixed to the gun by two screws, or "pins," which are inserted through the two holes seen in the side plate. The front pin screws into the rear end of the action body, and the back pin reaches right through the gun and screws into the corresponding hole in the side plate on the other side.

BACK ACTION SIDE LOCKS

In Back Action Side Locks the whole of the mechanism of the lock proper is situated behind the body of the action, the only part of the lock situated in the bar being the cocking lever. This is operated in the same general way as in the box lock or bar action side lock.

The two upper photographs on Plate VII show two positions of the parts of a back action side lock. The principle of holding the parts between a side plate and bridle is the same as in the bar lock, the difference being the position of the mainspring which is situated behind the tumbler. It is connected to the tumbler by a swivel as in a bar lock, and so the maximum efficiency of tumbler blow is obtained.

The general principle of operation is exactly the same as in a bar lock, but in this particular type of back action lock the intercepting safety device is of a different design, although the principle remains unaltered. The centre photograph shows the tumbler caught by the intercepting safety after the tumbler sear has been jarred out of the bent.

The lock is held to the gun by two screws as is the bar lock.

The bottom photograph on Plate VII shows another type of back action lock which approximates in general lines more to the bar lock. The mainspring, however, is behind the tumbler, which is the distinctive feature of back action locks, but the intercepting safety device is exactly the same as that used in the bar lock. The side plate in this case is shaped like that of a bar lock, being provided with a dummy arm which extends forward in a groove cut out of the bar of the action.

The object of this design of side plate is to provide a lock which gives the pleasing appearance of the bar lock without one of its disadvantages, namely, too much cutting away from, and consequent weakening of, the bar, in order to receive the mainspring of the bar lock.

CHAPTER IV

THE LOCKS (*continued*)

IN the last chapter I did my best to describe the three different types of locks in general use. So, before we go any further, it may be as well to consider their respective merits. In order to do this we must take in turn the following points:

(1) STRENGTH. That is the degree in which each type leads to strength or weakness in the body of the action.

(2) EASE IN COCKING. A very important point, as a lock which is difficult to cock means a gun which is stiff to open—a serious disadvantage when shooting fast.

(3) EFFICIENCY. That is the efficiency of the lock in actually firing the cartridge, and so reducing the tendency to miss-fires.

(4) "QUICKNESS." By this is meant the length of time which elapses between the trigger being pressed and the gun being fired.

(5) SAFETY.

(6) DELICACY OF TRIGGER PULL. A smooth, crisp pull is a great advantage in shooting, while anything in the nature of a drag in the pull is fatal to good work.

Having considered the merits of each type of lock in regard to these six points, we will be able to form some conclusion as to which is the best.

STRENGTH

In the last chapter I pointed out that the bar of an action was really a bent lever and that its plane of greatest weakness was the vertical section through the bar at the angle of the action. I also drew attention to the extreme importance of making this section as strong as possible. We were not able, however, to consider how this section could be strengthened until we knew the nature and extent of the mechanism which it had to contain. We have now seen the three different types of locks commonly used, and so we are in a better position to study what effect they have, if any, on the strength of the bar, and therefore on that of the gun.

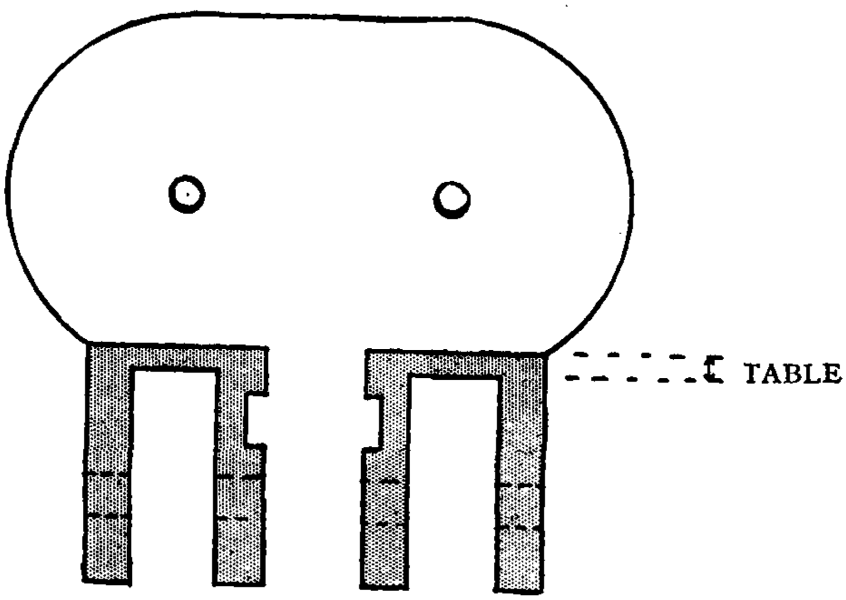


FIG. 25.—Section to scale through the angle of the action of a box lock gun weighing 6 lb. 8 oz.

The best way of doing this is to take actual examples, and so in Figs. 25, 26 and 27 I have drawn to scale actual sections across the bars of three different types of actions all of which belonged to guns of the same weight, namely 6 lb. 8 oz., and with the same length of barrels. In this way it is possible to obtain an absolutely fair idea of the strength of the different types.

All three sections have been taken vertically through the bars immediately in front of the action faces.

Fig. 25 shows the bar of a box lock (Anson and Deeley) gun. I purposely went out of my way to select a well-designed and strong gun, and the section shown is taken from a standard Webley Proprietary gun, which is wider in the bar, and so stronger, than many similar guns on the market. Width across the bar means that the pressure is extended over a larger area and is consequently less intense at any particular spot.

The big central slot with a groove on each side is the slot which receives the rear lump of the barrels, the bolt working in the grooves as explained in Fig. 13.

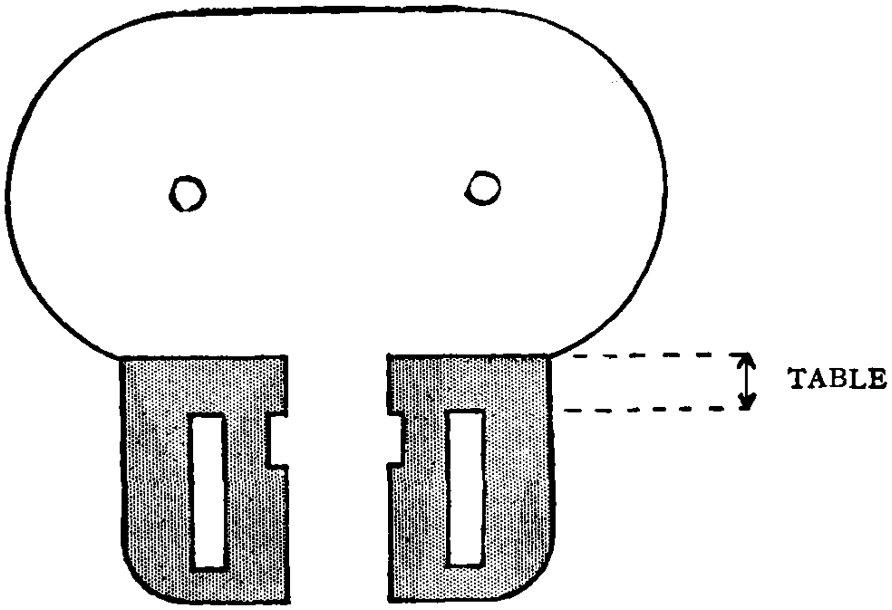


FIG. 26.—Section to scale through the angle of the action of a back action side lock gun weighing 6 lb. 8 oz.

The two slots on either side, which are cut from the bottom, take the locks.

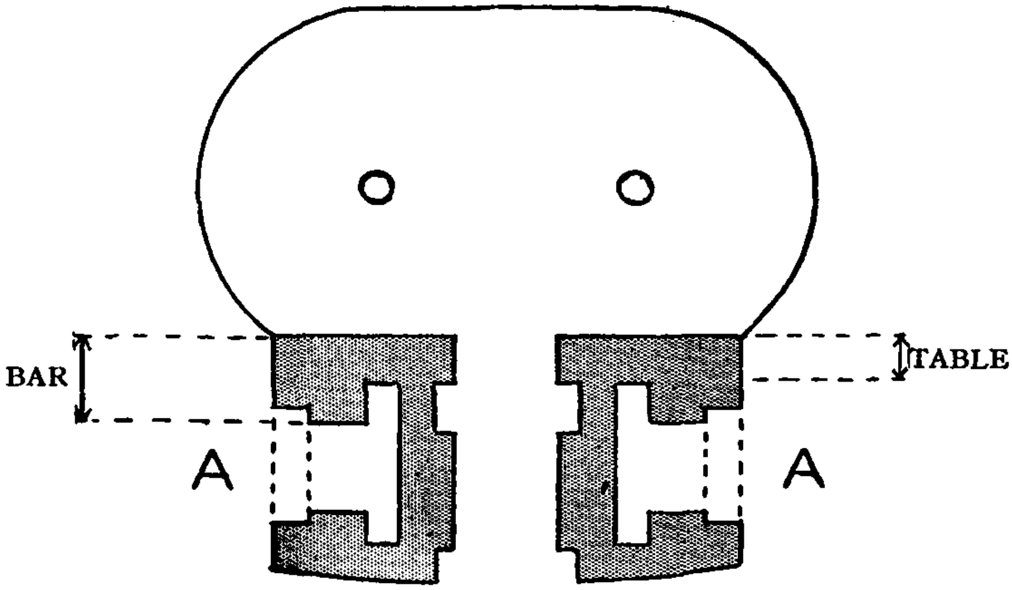


FIG. 27.—Section to scale through the angle of the action of a bar action side lock gun weighing 6 lb. 8 oz.

It is impossible to study this section without being struck by the thin " table " left above the locks. And yet the " table " in this case is stouter than those which are often left in light box lock guns, where strength is sacrificed for lightness.

Similarly, the outer walls of the action shown in Fig. 25 are thicker than those often seen in light Anson and Deeley guns.

The hole through the action to take the tumbler axle, or " Peg," has been shown dotted, and it will be seen that this hole comes in a most unfortunate place, being situated almost exactly in what may be termed the line of "greatest weakness" of the bar. Nevertheless this hole is not necessarily such a source of weakness as many suppose. This is because it is situated very near the "neutral axis" of the bar.

When the bar bends, the steel particles of its composition in the top part are pulled apart; or in other words, they are placed in a state of tension. Similarly, the particles in the bottom part of the bar are pushed together, or placed in a state of compression. These states of tension and compression are obviously greatest in the top and bottom edges, becoming less as the distance from these edges is increased, until, in the middle of the bar, the state of tension changes to one of compression, and *vice versa*. In this part of the bar the steel particles are not submitted to any stress whatever, and the line along which the state of compression changes to one of tension is called the "neutral axis."

The existence of a neutral axis in any girder is recognised in all engineering, and all girders can consequently be lightened to a great extent by being made thinner along the line of the neutral axis without in any way reducing their strength.

The exact position of the neutral axis depends on the method of application of the load on the girder as well as on the shape of the girder. But in the case of the bar of a gun action the neutral axis can be assumed, without material error, to be situated along the middle line.

Consequently it would be quite possible for very small holes to be drilled through the bar of an action along this middle line without affecting its strength, and the existence of the hole for the tumbler peg in a box lock gun is not such a source of weakness as might at first sight appear. In fact, if the tumbler peg were like Euclid's point, and " without parts or magnitude," it would cause no reduction in strength. The fact that the tumbler peg must of necessity be fairly stout means that the hole for its reception must extend considerably beyond the neutral axis into those parts of the bar in which states of tension and compression are in existence. So the effect is that this hole for the tumbler peg *does* weaken the bar, although not as much as many believe.

In actual practice it is probably better to drill the hole just below the middle line of the bar where the steel is in a state of compression, and if the hole could be sited behind the vertical line through the angle of the action it would be better still.

When a short steel girder is used as a cantilever and a gradually increasing load is placed on the extended part, the cantilever will first begin to bend and finally, if loaded beyond the elastic limit of the steel, it will stretch and crack at the top, that is in the part which is under tension. In other words fracture tends to occur first in the tension area which suggests that if any metal must be removed from the girder it is better to take it from the compression area.

The analogy of a cantilever is not exact as the problem of a shotgun action is complicated by the combined effects of both tension and bending, while some of the parts of the action are subjected to sheer strain. Further there is the constant repetition of whatever strains or stresses there may be, and it is the impact due to repeated stresses which will cause any steel unit to give way ultimately if the reserve of strength is insufficient, and especially if the metal is of poor quality and the fit of the different parts is faulty.

If, therefore, the hole for the tumbler peg is bored " low and behind " it is doubtful whether the strength of the bar is reduced to any material extent. Nevertheless it will be quite obvious that a design in which there is no hole at all must result in a stronger action.

Fig. 26 is a similar section through the bar of a gun fitted with back action side locks, and the increased strength is obvious. There is an identical slot in the centre for the lump and action bolt, but the only other slots are the narrow ones cut out from the front to receive the cocking levers.

The "table" of the action, which is the part submitted to a tensile strain on firing, is much deeper; and the walls are half as thick again as those of the box lock gun, while they are not weakened by any hole. They are, in fact, strengthened by being connected at the bottom to the central walls.

A corresponding section through the bar of a bar action side lock is given in Fig. 27.

It will be seen at once that the sides of the bar have been cut away from the outside edges to the slots for the cocking levers so as to make room for the front portions of the locks, namely, the mainsprings and side plates. (See Plate VI.) This makes the action weaker than that of the back action lock, but the "table," where the state of tension exists, is thicker than that of a box lock gun, although not quite so thick as in the back action gun.

The girder section, however, is excellent, as the two sides correspond in section to that of one-half of an **H** girder, which is one of the strongest girder sections known in engineering. Also there is no weakening of the section by any hole as in the box lock.

The action is reinforced to a certain extent by the bars of the side plate which fit into the positions marked by the dotted lines A, A. These side plates, however, are not an integral part of the section, and so the additional strength which they provide is not so great as might at first sight appear, for steel, when in a state of tension, is not strengthened very much by support from the frictional contact of additional material. But the bars of the side plates do help to "stiffen" the action to a certain extent, although this extent is not as great as is frequently imagined.

Having considered these three different types of action, there can be no doubt that the back action side lock makes the strongest gun, while the box lock is the weakest.

At the same time it is only right to point out that the bar of a box lock gun is invariably shorter than the bar of a side lock for reasons which I will give later. Theoretically this should make no difference *because as long as the pressure on the breech face is acting exactly parallel to the bar there cannot be any component part of that pressure acting downwards on the bar*, and so the length of the bar does not affect the strength of the action in any way.

In actual practice, however, this condition can never exist because the breech face should be cut at an angle slightly less than a right angle so as to increase the strength of the bent lever. There will consequently be a component of the backward pressure which acts downwards on the bar, which must then act as a lever. This component part of the total pressure can never be anything but very small, and so the leverage effect of the bar is not as great as might be imagined. But it exists, and once the bar begins to bend it is increased.

It is, therefore, true that the reduced length of the box lock bar results in it being somewhat stiffer, *section for section*, than that of a side lock.

But this comparatively slight increase in stiffness does not compensate for the altogether inferior sectional design, and I do not think any unbiased person could deny that the back action side lock is the strongest action, with the bar action side lock next, and the box lock a poor third.

It is consequently perfectly safe to rely on the strength of the action in either type of side lock and to omit the fitting of any sort of top extension in a gun intended for ordinary use. Not only does the absence of a top extension greatly facilitate loading, but it also adds appreciably to the general appearance and neatness of the gun.

In the case of a box lock gun, even an exceptionally well-designed one such as is shown in Fig. 25, I am not at all sure that a top extension can be omitted with safety. It can be argued, and rightly, that I have pointed out that many of the top extensions in common use are mere "eyewash" and take no part in the strengthening of the gun, and so that guns do actually stand up to the strain of firing without a top extension.

It is certainly true that many top extensions are useless, but it is also true that box lock guns by no means infrequently crack across the bar through the angle of the action. I am perfectly aware that many gunmakers who make these light, cheap box lock guns, as well as the salesmen who sell them, will deny the probability, and even the possibility of such a thing ever happening; and they will declare that they have never seen such a cracked action in their lives. I can only say that they have been singularly fortunate. Some years ago there seemed to be something almost in the nature of an epidemic of actions cracking across the angle, and no less than five guns, all by the same maker, were sent up to the *Field* within a few months.

And since then manymore such cases have been brought to my notice. Yet it must not be supposed from this that such accidents are common. They are not. When one remembers the enormous number of guns in use, they can only be regarded as being rare. But that they are unknown I deny absolutely. It is because such accidents *do* occur at times that I am inclined to regard an efficient top extension as being advisable, and it is interesting to note that both Messrs. Westley Richards and Messrs. Greener, the two firms which have always specialised in box lock guns, both use top extensions; Messrs. Westley Richards employing a modified doll's head, and Messrs. Greener their cross-bolt.

It may be urged that even a light box lock gun is quite strong enough for normal pressures, and that when they do happen to crack it is only because of an exceptionally high-pressured cartridge.

This has not been my experience, such as it is; and in no case of a cracked box lock action that I have seen was there ever any indication of an excessive pressure. If the action is too weak in section, and more especially if the metal is not of best quality, it is likely to give way in course of time simply through the constant repetition of the bending movement which was explained in Chapter II.

The B.S.A., in their cheap Anson and Deeley Proprietary gun, have abandoned the top extension. These guns are certainly strong: but they are up to full weight, and I am sure that the metal used in the action bodies is of better quality than that in many cheap guns one sees, especially those of Continental manufacture.

As long as the width of the action is maintained, and the gun is not made too light, a top extension may be superfluous. But at the present time the general tendency is to reduce the weight of guns, and it is in these *light* box lock guns—that is, less than 6 lb. 7 oz.—that I regard an efficient top extension as advisable.

And it is in this reduction of weight that a side lock gives such an advantage, for it is possible to cut away considerably from the metal of the action, even of a bar lock gun, without affecting its strength to any material extent. This can be seen in Fig. 28, which is the section through the bar of a light 12-bore bar lock gun. It will be noticed, when comparing this section with the one in Fig. 27, that the depth of both the " table " and the bar has been maintained; as has also the semi-**H** girder section; the weight being reduced by a slight narrowing of the action and cutting away from the bottom.

I seem to have wandered away from locks back to top extensions. But it is impossible to keep the two separate when discussing the relative strengths of the actions fitted with the different types of lock. And after all, the addition of a top extension is an important factor both in appearance and ease of loading; so since the necessity, or lack of necessity, for such an addition

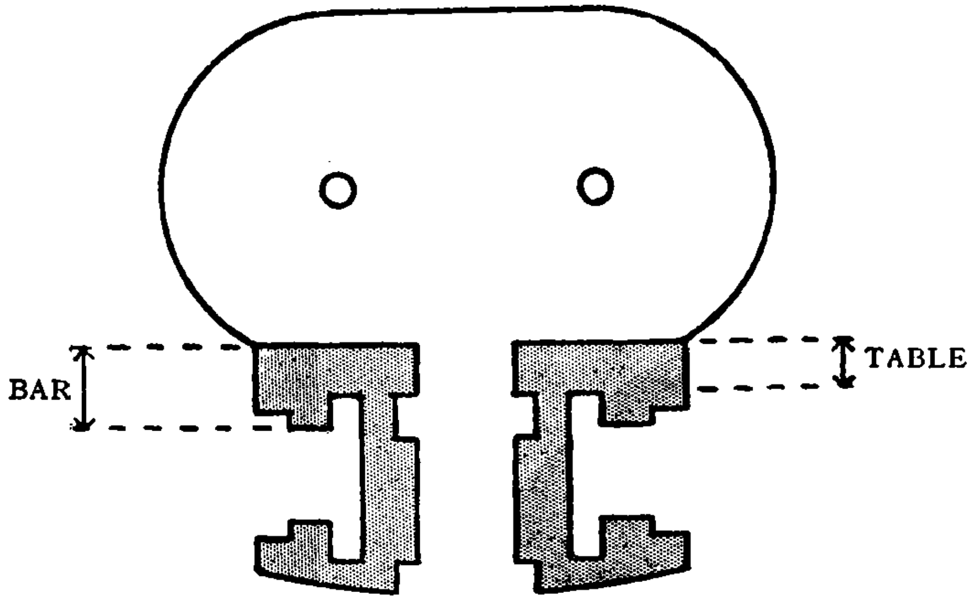


FIG. 28.—Section to scale through the angle of the action of a bar action side lock gun weighing 6 lb. 4 oz.

This diagram shows how the weight of the action of a side lock gun can be reduced without any material reduction in strength. The thicknesses of the table and the bars are the same as in the action shown in Fig. 27.

is dependent largely on the type of lock used, one cannot ignore the question of top extensions when considering the merits of the different locks.

EASE IN COCKING

All three types of locks which have been described are cocked on the same principle, namely, by means of a cocking lever which is operated by the fall of the barrels when the gun is opened. The front end of this lever fits into a slot in the fore-end, and is actually moved by the fore-end. But it is the fall of the barrels, which carry the fore-end with them, that provides the force necessary for operating the cocking lever.

The limits of movement for this lever are fixed partly by the space available in the bar of the action, but chiefly by the angle through which the fore-end can be turned. So it is the limitation of movement at the knuckle which really governs the design of the cocking lever.

Fig. 29A shows the cocking lever in a box lock action. AB represents the lever in the "fired" position, and A_1 B_1 when it is in the "full-cock" position, the lever turning about the pin, C, which is the fulcrum.

In this diagram C has been placed half-way between A and B. The result is that the movement of A when being depressed to A_1 is exactly the same as that of B when raised to B_1. Unfortunately this gives A more movement than can be permitted by the slot cut in the knuckle, so the extent of the movement must be curtailed.

This can be done in two ways:

The first is by changing the position of C to a point

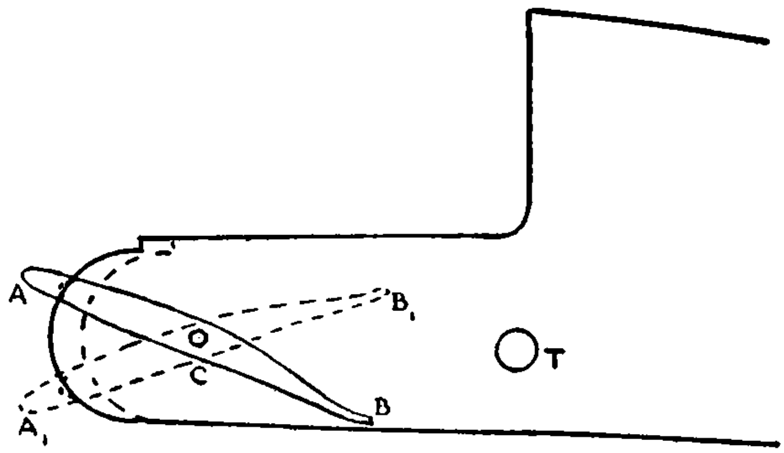


FIG. 29A.

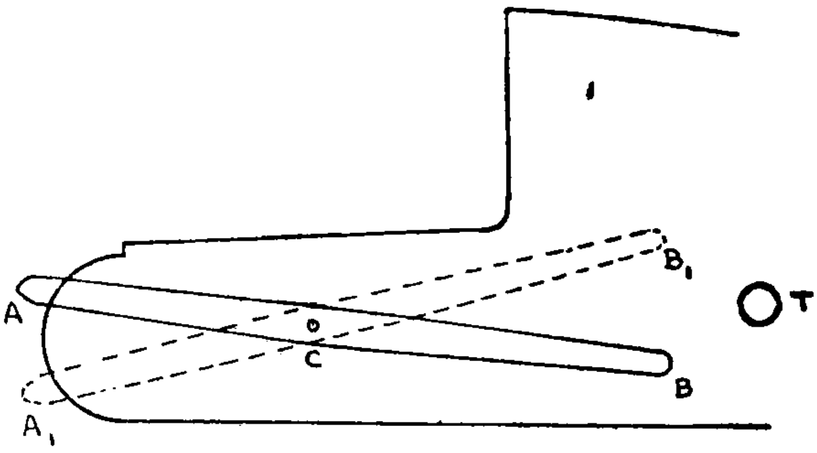


FIG. 29B.

The difference in leverage obtainable for cocking between a box lock (Fig. 29A) and a side lock (Fig. 29B).

nearer to A. But if this were done, the result would also be an increase in the movement of B, for which there is no room in the bar of the action.

The other method of curtailing the movement of A is to keep C in the same position, so that the movement of B is not affected, but to shorten the length C A, and cut the lever down in length. When this is done, the *angle* through which the lever moves is the same as before, but the distance traversed by A is less and fits in with the movement allowed at the knuckle.

When the front part of the lever is shortened, the bar of the action is shortened at the same time, as shown by the dotted lines in Fig. 29A. This reduction in length of the bar has the double advantage of reducing the weight of the action body and slightly strengthening the bar by making it a shorter lever.

Let us now turn to Fig. 29B, which shows the cocking lever in a side lock. The first point to notice is the much greater length of the lever. This is necessary because side locks are all situated *behind* the body of the action instead of *in* it as is a box lock. So a longer lever is required to reach the tumbler.

In the diagram AB shows the lever in the "fired" position as before, and A_1 B_1 when the tumbler is lifted to full cock. Owing to its length, sufficient movement can be obtained for both ends of the lever by turning it through a smaller angle than was necessary in the box lock. The positions of B and B_1 are determined by the position of the tumbler, and these positions fix the position of C within comparatively narrow limits.

In order to obtain as great a mechanical advantage as possible, CA is kept long. This can be done better than in the case of a box lock owing to the smaller angle through which the lever turns. And since C is fixed, the only way of lengthening CA is by placing the knuckle farther from C, or in other words, by having a longer bar to the action.

In both locks the mechanical advantage obtainable with the cocking lever depends on the ratio of CA to CB, and in both types this ratio would be about the same.

But leverage in cocking is also obtained by the distance between the point of bearing of the rear end of the cocking lever on the tumbler (B in the diagrams) and the tumbler axle (T). The greater this distance, TB, the better the mechanical advantage.

In this respect the box lock is certainly superior, as the tumbler can be fitted with a longer arm for purposes of cocking than is possible in a side lock.

In actual practice, however, this superior mechanical advantage in cocking possessed by the box lock is usually sacrificed by a further shortening of the front end of the lever, CA, so as to bring about a bigger reduction in the length of the bar, which, as has been seen, increases strength slightly and decreases weight.

And the position of the pin, or fulcrum, C, is almost always in the centre of the circle from which the arcs are struck which form the solid joint of the hinge of the action and the knuckle. Thus the whole movement about the knuckle on the opening or closing of the gun is concentric, which simplifies the work of fitting and cutting out the fore-end.

So the net result probably is that there is very little, if anything, to choose between the mechanical efficiency in cocking possessed by box and side lock guns. The former design gives the advantage, but this superiority is utilised towards increasing the strength of the action and decreasing the weight of the gun.

Even so, guns vary in the matter of ease of cocking, as there is considerable scope for the selection of the most suitable position for the pin, C. The most important point is that the gun should open wide. Not only does this simplify loading, but it also means that the barrels have dropped through a bigger angle; and the greater the angle through which they are dropped, the more is the effort of cocking distributed throughout the movement; and this means that the effort is less intense at any moment, which results in greater ease in cocking.

It is probable that this problem of distributing the effort of cocking most suitably has been one of the most difficult which the designers of actions have had to solve. Various different principles have been adopted, such as cocking the locks with the lift of the barrels, that is, by the closing of the gun instead of by the opening; and Messrs. Stephen Grant used to make an action in which one lock was cocked when the gun was opened and the other when it was closed.

But the general use of ejectors, which are invariably " set " by the lift of the barrels on closing the gun, has resulted in guns being almost universally built so as to cock the locks when the barrels are dropped in opening. And if we assume that the pin on which the cocking lever turns is placed in the most suitable position, either in the longer bar of the side lock or the shorter bar of the box lock, the actual ease of cocking in either case will depend more on the strength of the mainspring which has to be compressed than on the type of lock.

It is probably true that the cartridge manufacturer has done as much, if not more, towards the ease of cocking of guns as the gunmaker. For the more sensitive and efficient a cap is, the less violent need be the blow necessary to explode it. And as caps have improved, so have the mainsprings of guns become weaker. And, of course, a weaker mainspring is less difficult to compress and so results in the gun being easier to cock.

Should anyone doubt this statement, let him test the cocking of a double hammerless big-game rifle against that of a shotgun. In a rifle intended for use against dangerous game the mainsprings are made much stronger than in a gun so as to reduce the risk of missfires to an absolute minimum, and also because rifle caps are thicker than those used in shotguns and so require a stronger blow to indent them. The effect of these stronger mainsprings is very noticeable in opening such weapons and shows that the mainspring is a bigger factor in the smooth and easy working of a gun than is generally realised.

EFFICIENCY

The efficiency of a lock depends on the force with which the striker hits the cap. This force, in its turn, depends on the weight of the tumbler and its velocity at the moment of impact. In all locks the weight of the tumbler is so similar that the only point we need consider is its velocity at the end of its fall.

This velocity depends on (1) the distance through which it travels; and (2) the force which causes it to rotate.

In Fig. 30, T is the tumbler axle and A the head of the tumbler at full cock. On firing, the tumbler rotates and assumes the position TA_1. The distance through which the head travels is the arc AA_1, and the length of this arc is governed by the angle ATA_1, and the length TA.

In all side locks the angle ATA_1 is about the same, but it is generally slightly less in box locks.

Similarly, the length TA is so nearly the same in all locks as to make no practical difference.

Consequently the distance through which the head of the tumbler travels is, for all practical purposes, the same in all side locks, but rather less in box locks, and so there is a certain theoretical advantage in favour of the side lock.

The force which causes the tumbler to rotate is

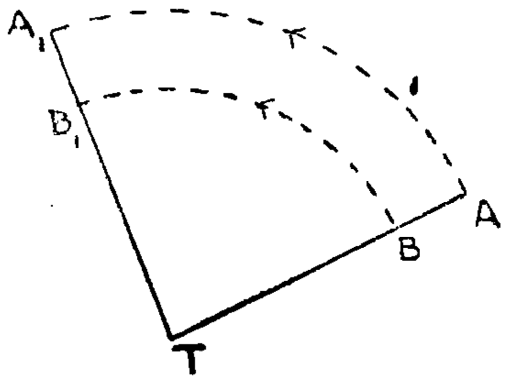


FIG. 30.—Diagram to illustrate the efficiency and speed of a lock.

derived from the spring, and we have already seen how a spring tends to diminish in strength as it is relieved. But it will be remembered that the introduction of a swivel between the tumbler and the spring overcame this reduction in force. Consequently there can be no doubt that side locks which are fitted with these swivels must be more efficient than box locks which are not. But it is only fair to remember that this loss of strength of the relaxed spring is partially overcome at least in box locks by the forward movement of the mainspring.

In the case of side locks, however, the striker is a separate unit, and consequently a certain amount of force is lost in overcoming the inertia of this stationary striker, and in some guns the striker spring as well, and driving it forward on to the cap.

So in this respect the box lock has the advantage over the side lock. But this advantage is usually nullified by the fact that box locks are fitted with weaker mainsprings. It will be remembered that in the description of the lock it was pointed out that the mainspring in a box lock is not fixed at the point, but that it moves its position during compression. This change of position sets up a certain amount of friction which tends to increase the difficulty of cocking, and consequently the mainsprings are made weaker so as to ease the effort of cocking by the opening of the gun and so avoid the necessity of utilising the natural superiority in mechanical advantage of the cocking system by increasing the length of the bar and so reducing its cross-sectional strength.

Further, the inertia of the striker is small and the striker spring is weak ; so, for practical purposes, I think that this point can be balanced against the smaller distance through which the box lock tumbler travels, and the result declared " all square."

The really important point as regards efficiency is the swivel connection between mainspring and tumbler, and this must result in the side lock being superior even when the mainsprings are of the same strength and the forward movement of the box lock mainspring is taken into consideration.

QUICKNESS

Some makers declare that their locks are " quicker " than others, meaning that a shorter time elapses between the pressing of the trigger and the striking of the cap. It may, accordingly, be of interest to see what can affect this speed of tumbler fall, for it is the time taken by the tumbler to rotate that prevents instantaneous discharge on pressing the trigger.

The problem is really similar to that discussed under the previous heading of Efficiency, for the time of fall depends solely on (1) the angle through which the tumbler rotates; and (2) the speed with which it rotates.

Contrary to a popular belief, the length of the tumbler has nothing to do with "quickness," a long tumbler falling in exactly the same time as a short one, provided the angle through which it falls is the same.

This can be seen from Fig. 30. T is the tumbler pin as before, and A the end of a long tumbler, and B the end of a short one, both at full cock. On firing, these two ends assume the positions A_1 and B_1. It will be clear that although A has covered a bigger distance, it has arrived at the end of its journey at exactly the same moment as B.

Since it has been pointed out that the angle of fall is less in the case of box locks, it would appear that such are "quicker" than side locks. The difference, however, is too small to have any practical effect, and if it exists it is cancelled by the extra efficiency of the action of the mainspring in a side lock due to the insertion of the swivel as opposed to relying solely on the movement of the mainspring. For the speed of rotation, which is the second of the two factors governing the time of fall, depends entirely on the strength and efficiency of the mainspring.

Accordingly for all practical purposes it can be assumed that the quickness of box and side locks is the same, the time of fall of the hammer being about 0·002 of a second.

Incidentally it may be of interest to mention, even though the statement has nothing to do with the subject under consideration, that all actions in which the striker is actuated by a rotating tumbler are much quicker than those in which it is pushed forward by means of a coiled spring, as in bolt actions used in rifles.

So it will be realised that the locks used in shotguns are the quickest in action of any method of firing a gun or rifle.

SAFETY

At first sight the superiority of the side lock in the matter of safety seems to be overwhelming on account of the intercepting safety which is fitted both to bar and back action locks, but which is omitted in the box lock. This superiority, however, is not so great as might be expected, and for two reasons.

The first is that experience has shown that although an intercepting safety is theoretically an absolute protection against a gun being " jarred off," in actual practice it frequently happens that any shock which is enough to jar the tumbler sear out of the bent is also enough to jar the intercepting safety sear sufficiently out of place to permit the tumbler to rotate without the intercepting safety stop being caught. Consequently the intercepting safety device cannot by any means be regarded as the absolute safeguard which it may seem to be.

The second reason is that the tumbler sear in a box lock is less sensitive to the effects of jar than that of a side lock.

The late Mr. W. W. Greener in his *The Gun and its Development* explained this by the greater width of tumbler which is usually found in a box lock. This greater width means a broader bent and sear, and consequently greater bearing surface.

It is with great diffidence that I find myself in disagreement with such a noted authority and practical gunsmith, but I am inclined to doubt whether this explanation is correct.

The tumblers of box locks are made as thin as possible so as to occupy a minimum amount of space in the body of the action in order not to weaken the action more than necessary. There is really little to choose between the thickness of many box and side lock tumblers, those in Messrs. Westley Richards' excellent box locks, for example, being certainly no thicker than the majority of side lock tumblers, if indeed they are as thick. And yet these Westley Richards locks are no more liable to jar off than other types of box locks.

I believe that the real explanation is to be found in the difference in leverage in the sears used in box and side locks.

If the illustrations of a box lock in Fig. 22 and those of the different side locks in Plates VI and VII are examined, it will be seen that the peg about which the sear revolves is placed far more centrally in the sear in all the side locks than in the box lock, where it is placed much closer to the tumbler end of the sear than to the trigger end. The effect of this must be that the box lock sear provides the trigger with an altogether better leverage than is obtained in the side lock.

It is consequently possible so to shape the bent of a box lock that a considerably greater *direct* pull is necessary to release the sear than could be applied in a side lock without making the *trigger* pull far too heavy. Owing to the superior mechanical advantage given to the trigger by the sear of a box lock, it is possible for the same pressure on the trigger as on that of a side lock to result in double the force being applied at the bent of the box lock as in the side lock. For example, a trigger pull of 4 lb. will give about 4 lb. of pressure at the bent of a side lock, while it would give about 8 lb. of pressure at the bent of a box lock. So it will be seen that the sear of a box lock can be set deeper in the bent than can be done in a side lock for the same weight of trigger pull.

I believe that this is the real reason why box locks can be made less liable to jarring off than side locks, although it is possible that sometimes a stronger sear spring, which is possible in a box lock owing to the greater trigger leverage, is an extra help.

It should be noted that I am assuming that both types of locks have been properly designed, for the relative positions of the sear peg, tumbler axle, and the bent can have a tremendous influence on the stability of the sear in the bent, and an ill-designed lock of any type is a source of real danger. But I will try to deal with the effect of the position of the sear peg when considering the question of trigger pull.

On the whole, however, I think it must be admitted that the presence of an intercepting safety does increase the safety of any action, and that no lock which has not one of these devices fitted should be regarded as quite as safe as one in which it is present. For this reason side locks must be classed as being safer than box locks as both are usually made. It is, however, perfectly possible to fit an intercepting safety to a box lock similar in general principle to that shown in the upper of the two locks in Plate VII. When this is done, both types of lock are equally safe. But, as I have pointed out, this intercepting safety is almost universally omitted from box locks, and so I think that first place should be given to side locks when the question of safety alone is being considered.

DELICACY OF TRIGGER PULL

The delicacy, "sweetness," or "crispness," of the trigger pull is one most important, if not the most important, of all the factors which tend to good shooting. The trigger pull depends a great deal on the shape of the bent in the tumbler and the nose of the sear, and "regulating" a trigger pull is the work of filing the bent and sear nose into the best possible shapes for the particular lock in question. Such work needs an extraordinary light and skilful touch, but no matter how skilful the workman, he will never be able to get as good a pull on some locks as on others. This is because the design of the lock is really the governing factor in trigger pulls, and not the regulating, although it is frequently stated that the regulating is the only thing that matters.

Trigger pulls are usually described as being "light" or "heavy" according to the amount of pressure required to release the sear from the bent; and it is commonly believed that a light pull is an advantage. For this reason it would seem that the superior leverage possessed by the box lock which has just been explained must give the advantage in the matter of trigger pull to this type of action. Owing to the leverage it would seem that the most delicate adjustments could be possible, as the variation produced by a slight shaping of the bent will only be reproduced in part in the resulting change in trigger pull.

As a matter of fact, this increased leverage is a disadvantage to a trigger pull because it results in the movement of the sear nose in the bent being *magnified* at the rear end of the sear. Consequently the trigger has to make a bigger movement for a corresponding movement of the sear nose than is the case in a side lock where the sear is much shorter. The bigger the movement necessary for the trigger to cause the release of the tumbler, the more likely is the trigger pull to become a " drag " rather than a crisp, short pull ; and a dragging pull is most objectionable.

The truth is, however, that delicacy of trigger pull—and incidentally the stability of the sear in the bent—is not influenced nearly so much by any mechanical advantage conferred by the sear as by the relative positions of the tumbler axle, the bent and the sear peg when the tumbler is in the full-cock position.

For the line joining the sear peg to the bent should be at right angles to the line joining the bent to the tumbler axle when the tumbler is at full cock.

When this condition prevails, the pressure exerted by the mainspring on the actual nose of the sear, which is imparted by the bent, will act at right angles to the direction of the movement of the sear nose as it is released from its position in the bent. Consequently the frictional resistance on the sear nose will be least when the angle formed by the tumbler axle, bent and sear peg is a right angle.

The bent cannot be placed vertically beneath the tumbler axle or there would be no room in the lock for the sear and trigger blade ; so the bent is always placed behind a vertical line through the tumbler axle.

This means that if the line joining the sear peg to the bent is to be perpendicular to that joining the bent to the axle, that the sear peg must be situated *above* the bent.

This is the first important principle in lock design which should be realised.

The second is connected with the distance of the sear peg from the bent.

When the rear end of the sear is lifted by the trigger blade the sear revolves round the sear peg, and the nose of the sear describes an arc of a circle. *It is the curvature of this arc and the line of its direction in relation to the bent and tumbler axle that are the real controlling factors towards the possibility, or impossibility, of providing a perfect trigger pull.*

The *direction* of the arc of movement is governed by the position of the sear peg in relation to the bent and tumbler axle, the principle which has already been considered.

The *curvature* of the arc depends on the distance of the sear peg from the bent.

The nearer this peg is to the bent, the more pronounced is the curvature of the arc described by the sear nose when it moves in the bent. The distance of travel is certainly small, but it is enough to mar the sweetness of a pull if the radius of movement is too short. And so it will be realised that it is a mistake to place the sear peg too close to the tumbler.

This is the second essential principle of lock design.

It is here that the box lock is at a disadvantage. The sear peg in the case of a box lock is driven through the back part of the action body, and even when it is placed as near the edge of the body as possible it is still too close to the tumbler from the point of view of obtaining a perfect trigger pull.

The increased leverage possessed by a box lock sear is thus thrust upon it by the enforced proximity of the sear peg to the tumbler, which means a short length of sear in front of the peg, or fulcrum.

If we look at the side locks, on the other hand, shown in Plates VI and VII we see how much farther away the sear peg has been moved from the tumbler. This has been done on purpose by the designer in order to obtain as flat an arc as possible for the travel of the sear nose.

And in the case of the bar action side lock it will be seen in the middle photograph on Plate VI that the angle formed by the tumbler axle, bent and sear peg is an exact right angle—the ideal placing of these three points. For when the angle is greater than a right angle, the sear nose has to push the bottom of the tumbler forward before it can be moved free of the bent ; and this means an uncomfortable trigger pull as the mainspring has to be compressed during the first part of the movement.

In the back action side locks the designer has not had the same room at his disposal for the placing of the sear peg owing to the mainspring occupying so much space behind the tumbler, and so the angle made by the tumbler axle, bent and sear peg is somewhat greater than a right angle.

In the box lock matters are still worse, as it is impossible to site the sear peg to the greatest advantage without coming out of the action body. So the peg is driven as close to the rear edge as possible in order to obtain a maximum radius for the sear nose ; but it cannot be so sited as to make a right angle with the bent and tumbler axle. And so, in order to obtain stability of the sear in the bent, the bent is considerably undercut so as to provide a firm grip on the sear nose. This shape of the bent would mean a very heavy pull were it not for the superior mechanical advantage of the box lock sear. Thus safety from jarring off is obtained, but extreme delicacy of pull is lost.

For unless the sear peg is centred to the greatest possible advantage, not only is a perfect trigger pull more difficult, if not impossible, to obtain, but there is also greater risk of the sear being jarred out of the bent by a sudden blow unless the bent is heavily undercut.

It is by no means rare for a gun to develop the fault of giving double discharges, that is of the left barrel being jarred off by the discharge of the right when the right trigger only has been pressed. If a gun shows a tendency to this fault it may mean that either the sear nose or the bent has become worn owing to one being harder than the other. Such wear is far more likely to occur in a lock in which the angle formed by the tumbler axle, bent, and sear peg is greater than a right angle than in a lock which is properly designed, as the frictional resistance to the movement of the sear nose out of the bent is greater. In a lock of this sort the fault is really congenital owing to its design, although it can be corrected by re-shaping the bent or the sear nose. But frequently the only permanent remedy which is possible is to fit a new tumbler or sear, or even both, or else to have a heavier trigger pull. A properly designed lock will seldom develop such a fault, especially if the sear nose and bent are of identical degrees of hardness.

From this it will be realised that a well designed bar action side lock is superior to either of the other types from the point of view of delicacy and crispness of trigger pull, and that the back action side lock comes next, although there is not much to choose in this respect between well-designed box locks and back action side locks.

COMPARISON OF THE DIFFERENT LOCKS

We are now in a position to form a fair comparison of the three different types of locks which have been described and which are in general use.

In two out of the six points which combine to make a perfect lock—namely, Ease in Cocking and Quickness—all three types of locks have been seen to be equally efficient. In two more—Efficiency and Safety—the two types of side lock are slightly superior to the box lock, although when the latter are fitted with intercepting safeties they equal the side locks in this last respect.

But in the matter of strength the box lock is undoubtedly inferior to the side locks, while the back action side lock is the strongest of all.

It is sometimes claimed that the box lock tends to a stronger stock as less wood has to be cut away from the head of the stock which is not, therefore, weakened to the same extent as it is in a side lock gun. Actually there can be no doubt whatever that the weakest part of the stock is the " small " or " hand," just in front of the comb. This is common to all guns and the strength of a stock, like that of everything else, is the strength of its weakest part. But if a careful comparison is made it will be found that really there is not nearly so much difference in the amount of wood which has to be cut away to accommodate the two different types of actions, box locks and side locks, while the Breech Pin (the main screw or " pin " holding the stock and action together) is usually sited somewhat more advantageously in a side lock. So I think that so far as the strength of the stock is concerned there is nothing to choose between the different types of actions.

And in the last, but important, question of trigger pull the bar action side lock proved better than either of the others, although it is true that this superiority is a point of extreme nicety.

It must, therefore, be admitted that the bar action side lock is the best of all three, since it is as good, or better, than the other two types in five out of the six points, while in regard to strength it permits the use of an action which is quite sufficiently strong for normal use without the addition of any top extension, which can be both unsightly to the eye and a hindrance in quick loading.

Added to these advantages there is the further one of beauty ; and personally I do not think this is unimportant. The lines of no box action lock can compare with those of a really well-designed bar action side lock, and the nearest approach is the back action side lock with a plate shaped in imitation of a bar action. The more usual type of back action lock is not pleasing to the eye, and I myself would always choose a good-quality box lock in preference to one of these guns unless I wanted a weapon in which great strength was the first consideration.

And finally it must be remembered that a side lock is not quite so weatherproof as a box lock, as it is easier for moisture to work in round the edges of the side plates, especially in a new gun, than past the bottom plate of a box lock. But with ordinary care, such as rubbing the action all over at intervals with vaseline which will work in and seal whatever joints there may be, the risk of damage from this cause is not very great: certainly not nearly so great as some gunmakers who specialise in box lock guns are at times wont to declare. For, on a rainy day, the wet gets into the locks and action most readily through the slots in the knuckle which take the cocking levers, and through the slots in the bar which receive the lumps. These slots are common to all ordinary actions, both side lock and box lock, and the best precaution is to keep the front ends of the cocking levers and the action bolt well greased.

In this comparison I have made no reference to price because I have only been considering which was the best. There are many who cannot afford best-grade bar action side locks, but that is no argument against this type of gun.

It should be noted that sometimes box action guns are made with dummy side plates to imitate the outward appearance of a side lock, and I have known sportsmen who possessed such weapons and actually believed that they were the owners of bar locks. I do not suppose that any salesman would definitely sell a customer such a gun as a side lock, as to do so would be a deliberate swindle. But comparatively few shooting men would think of querying the type of action, and in such cases the salesman sometimes holds his peace.

These dummies may be detected by the fact that usually there are no pins showing in the plates, such as must show in true side locks, while the bar of the action is typically short and the triggers are much farther forward. The triggers of side locks must be placed farther back on account of the locks being farther back in the gun.

REBOUND LOCKS

It will have been noticed that in all three types of lock which have been described the tumblers remain in the " fired " position until the gun is re-cocked, with the result that the strikers remain pressed forward on the cap. In some types of lock the tumbler automatically moves back again through a small distance after it has delivered its blow, and the striker is withdrawn at the same time into the position which it occupied before being struck by the tumbler. Such locks are called Rebound Locks.

The primary object of a rebound lock is to ease the effort required for opening the gun. In rifles, for instance, which fire very heavy charges the pressure generated in the cartridge-case drives the cap right on to the striker, and if ordinary side locks were used the striker would not slip back under the pressure of the cap when the pressure of the tumbler was removed on the rifle being opened. Consequently it might happen that the strikers would stick in the caps and the gun would be difficult to open.

The rebound lock overcomes this difficulty.

Its action is similar in every way to that of an ordinary side lock, but the upper arm of the mainspring is made longer than usual, and the front part of the tumbler is given a special shape. On firing, the tumbler rotates, and *just* before it has driven the striker quite home, the shaped part in front hits the elongated upper arm of the mainspring. The impetus of the tumbler carries it on and it completes its fall, slightly compressing the upper arm of the mainspring as it does so. But immediately the blow is spent this upper arm of the mainspring reasserts itself and revolves the tumbler back a little, so as to lift its head off the striker.

The strikers of rebound locks are fitted inside small coiled springs as mentioned on page 77, and so they are drawn back again directly the pressure of the tumbler is relaxed.

In hammer guns rebound locks were almost essential, as otherwise the hammers must be lifted a little by hand so as to relieve the strikers before the gun can be opened. It should, however, be remembered that the strikers in all hammer guns point *downward*, and consequently hit the cap at an angle. So when the gun is opened the cap cannot push the striker back as easily as it can in a hammerless side lock, and so start it on its backward movement, but instead it encounters extra resistance owing to the angle at which the striker is placed.

In hammerless guns, however, there is no such necessity for withdrawing the striker, and if a striker does stick, it is almost invariably due to the point being badly shaped. But in rifles, where the pressures are much higher, rebound locks should certainly be fitted.

This type of lock has the disadvantage that the rebound action must tend to ease the force of the tumbler blow just at the critical moment, and on this account a stronger mainspring must be employed in order to obtain the same efficiency. This means a slight increase in effort required for opening and cocking the gun. For this reason rebound locks are not often fitted to ordinary guns.

In the case of box locks the striker is an integral part of the tumbler and so gets automatically withdrawn by the opening, and cocking, of the gun. So the question of a rebound action does not arise.

HAMMER GUNS

Hammer guns, that is, guns in which the hammers are situated on the outside of the action, are seldom made now except in the very cheapest grades of guns, and these are usually of Continental manufacture. However, good-quality hammer guns can frequently be picked up second-hand at a very low price, while it must always be remembered that two of the best game shots of the past forty years have invariably preferred hammer guns to hammerless. I refer to His late Majesty King George V and the late Marquis of Ripon, better known, perhaps, as Lord de Grey.

So hammer guns deserve mention.

The locks of all hammer guns are side locks, and their general design is identical with the hammerless side locks which have been described. The parts are all situated between an outer lock plate and an inner bridle, and the principles of mainspring, swivel, tumbler and sear are exactly the same as in side locks. The only big differences are the shape of the tumbler and the absence of the cocking lever.

The tumbler has no " head " on the inner side of the lock plate, but an enlarged head is fitted to the axle outside the plate, and it is this head which makes the visible hammer. The lock is cocked by pulling the head back by hand until the sear engages in the bent.

Intercepting safeties are omitted because it is always obvious when hammer guns are at full cock, and consequently sportsmen are assumed to be more careful. Besides, this invention was not adopted until the advent of the hammerless action. There is, however, no reason why hammer guns could not be fitted with intercepting safeties.

Hammer guns which have been made since 1875, or about that date, are all fitted with rebound locks, which greatly facilitates loading, as has been explained. Prior to this date the locks were not usually rebounding, and in these early guns it was necessary to lift the hammers so as to relieve the pressure on the strikers before the gun could be opened. The tumblers of these locks had an additional bent cut in the bottom edges which was much deeper than the normal firing bent. The sear caught in this bent as the tumbler was rotated when the hammer was raised, and further rotation brought the sear into bearing with the firing bent. If the sear was left in the first, or " half cock " bent, the trigger could not be pulled because the bent was of such a shape and depth that the only means of releasing the sear was by further rotation of the tumbler.

The purpose of this "half-cock" position was to provide for a position into which the hammer could be drawn when it was desired to open the gun after firing. If the hammer had to be placed at full cock while the gun was reloaded, there was the risk of an accidental discharge through the sear being jarred out of the firing bent. The half-cock position thus provided a very efficient safety device, although it was unavoidably slow in operation.

On the introduction of rebound locks the half-cock action was dropped.

It has been stated that all hammer locks are side locks. Like hammerless side locks they comprise two types, bar action and back action. The principles of the two types are identical with those of the corresponding types of hammerless side locks which have been described.

Owing to the absence of a cocking lever the bar of the action need not be cut out to receive this limb, and consequently the sectional strength of the bar of a hammer gun is superior to the corresponding type of hammerless action, and a back action hammer gun has the strongest bar of any type of gun in existence.

THE QUALITY OF LOCKS

In the locks, almost more than in any other part of the gun, the question of quality and workmanship is of an importance which cannot be over-estimated. The steel from which the various limbs are made should be harder than that used in the barrels or action body and is usually a carbon steel hardened with nickel or chromium.

The workmanship and design should be of the highest order, as badly finished and designed locks can be a constant source of annoyance in the matter of trigger pulls.

I have pointed out the superiority of bar action side locks over the other types. It should, however, be remembered that I was only taking into consideration locks of best material and workmanship. A side lock is an altogether more complicated piece of mechanism than a box lock, and for this reason they do not lend themselves to second-class work. It should be remembered that one of the chief advantages of the side lock was the absence of the necessity for a top extension, which tends to make the work of loading more difficult. Consequently if a top extension is added to an ordinary side lock gun one of the advantages of this type of action is nullified. In special guns which are designed to fire abnormally heavy charges a top extension may be advisable. I am, however, now dealing with ordinary game guns intended for use in Great Britain with normal cartridges. So if a gunmaker thinks the addition of a top extension necessary for a side lock gun, it really amounts to an admission that such a gun is not a really high-grade weapon. And in this case I think the money would be better laid out in the purchase of a good box lock gun.

The bar action side lock is on the highest pinnacle of gun design, but the work cannot be skimped or the superiority is rendered abortive. If value for money is a matter of more importance than the last word in nicety and refinement, I fancy that a better bargain can be obtained by the purchase of a box lock, while cheap side locks are guns to be avoided.

CHAPTER V

EJECTORS

IN the previous chapters I have done my best to describe how the barrels are put together and held to the action; and the types of mechanisms in general use which fire the cartridge. The next thing to consider is how to get rid of the empty cartridge-case after it has been fired.

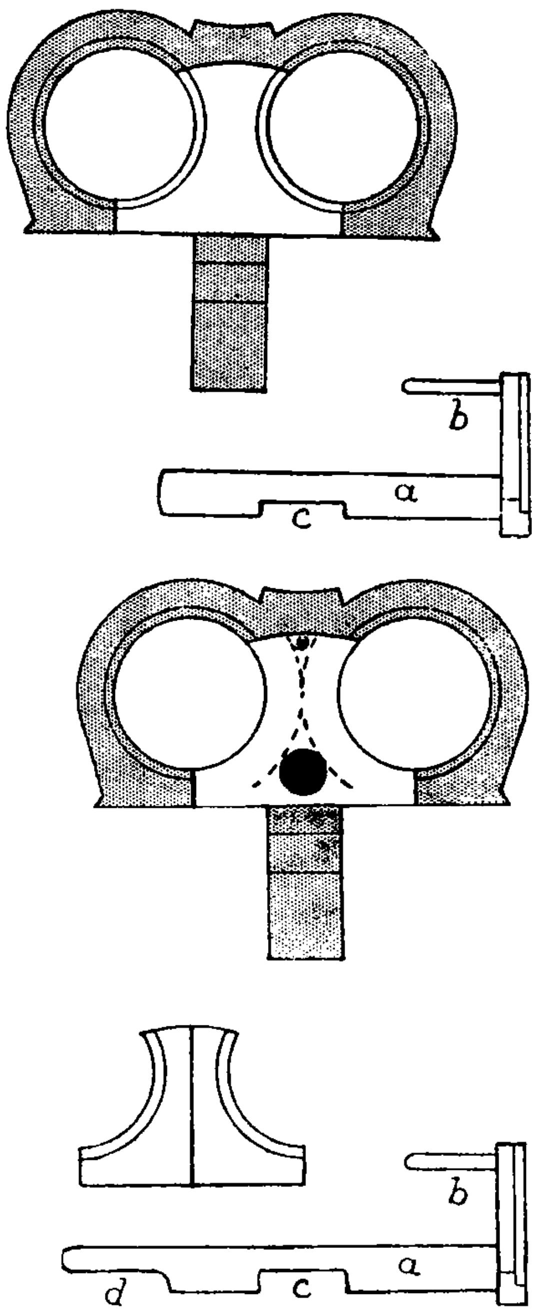
This is done by means of an Extractor, which is an invention almost as old as the breech-loader and older than the central-fire cartridge, being designed in 1852 by Mr. Charles Lancaster, the founder of the firm which still bears his name although incorporated with Messrs. Grant and Lang.

The working principle of the extractor is very simple.

The extreme rear ends of the brass heads of all cartridge-cases are fitted with a rim which is a small portion of slightly greater diameter than the rest of the case. This rim fits into a corresponding recess which runs round the circumference of the breech end of the chamber. A portion of the breech end of the barrel is so made that it moves to the rear when the gun is opened, and withdraws the fired case, since the rim of the case fits in the recess in this movable part of the barrel which is known as the extractor. In ordinary double-barrelled guns the extractor for both barrels is made in one piece, as can be seen in Fig. 31A.

In this diagram the solid part of the breech end of the barrels is shaded, while the movable extractor is left plain.

Figs. 31B and C show how the extractor is fitted and operated. In Fig. 31C the extractor has been removed from the barrels, and two holes, which are coloured black, can be seen in the breech end. These two holes receive the two "legs" of the extractor, a side view of which is shown in Fig. 31B. In this drawing the principal, or "long leg," is marked *a* and the secondary, or "short leg," is marked *b*. Two legs are necessary or



A

B

C

D and E

FIG. 31.—Extractors in non-ejector and ejector guns.

A. The breech end of a pair of barrels of a non-ejector gun. The extractor is left plain, and the rest of the barrels B shaded.
B. A side elevation of the extractor in Fig. A. The long leg is marked *a*; the short leg, *b*; and *c* is the slot which receives the stop pin.
C. The breech end of the pair of barrels shown in Fig. A, with the extractor removed. The holes for the long and short legs are marked in black. They should be bored between the walls of the barrels (shown in dotted lines).
D. End view of the extractors of an ejector gun. They are similär to the extractor shown in Fig. A, but are cut into two exactly similar parts by a vertical and longitudinal section, as shown.
E. A side elevation of the extractor shown on the left in Fig. D.

the extractor would tend to rotate on withdrawal, since the long leg is round. A square leg would mean a square hole which would weaken the breech end of the barrels more than a circular hole of the same area, a point which was explained in the description of the Cross-Bolt top extension on page 51. So the addition of a short leg is necessary merely to prevent this rotation.

The front end of the long leg butts against the " Extractor Toe " or " Extractor Cam," which is a projection on the knuckle of the action. (See Plate V.) When the barrels revolve round the knuckle on the gun being opened, the extractor cam remains stationary since it is a part of the action, and consequently the extractor is pushed out and up to the rear.

Considerable leverage is derived from the weight of the barrels which thus help the extraction of a tightly fitting fired case.

The extractor is prevented from coming right out by means of a screw which is inserted through the forward lump and fits into a slot, *c* in Fig. 31B, in the long leg. This screw is called the " Stop Pin " and can be seen in Plate II.

The chief points to which attention must be paid in the fitting of the extractor are the position of the holes for the legs. These should not be made bigger than is necessary for the strength of the extractor and should be drilled *absolutely straight and centrally* into the breech end of the barrels. Further, they should be so situated as not to encroach upon the thickness of the walls of the barrels.

Fig. 31C shows how the two holes should be placed. The internal circumferences of the walls of the barrels are shown in dotted lines, and it will be seen that the areas of the holes do not extend between these dotted lines and the insides of the chambers. There is usually plenty of room for the hole for the long leg, but not so much for that of the short leg, in spite of its smaller size, owing to the fact that the extractor does not reach far above the centre of the barrels. On this account extractors should be made on the big side so as to extend to a point where there is sufficient divergence between the walls of the barrels to provide space for the reception of this hole for the short leg.

Incidentally, a big extractor has the advantage of obtaining a better grip on the rim of the cartridge-case, which can be a help if the case is inclined to jam or stick. When the edge of the extractor which fits under the rim is too small, there is a tendency for a tight-fitting case to ride over the extractor and remain stuck in the chamber with the head underneath the extractor. This is a great nuisance when out shooting, but if such a thing should occur, really the quickest method of dealing with the trouble is to take the barrels off the gun, remove the stop pin, and take out the extractor, when a better grip can be obtained on the head of the cartridge. This may seem a somewhat unnecessarily lengthy operation, but it will probably save time in the end.

In the early days of breech-loaders bursts were not infrequently caused by one barrel wall being weakened by the hole for the short leg not being drilled centrally, and this was a comparatively fruitful source of accidents in converted muzzle-loaders.

In order to overcome this difficulty, the late Mr. W. W. Greener devised the plan of utilising the top extension as a guide for the upper part of the extractor, and this method is now universal when top extensions are fitted. (See Plate II.)

If, however, the extractor is made sufficiently large (an advantage in its efficiency, as has been seen) there is no real difficulty in drilling the hole for the short leg.

In some cheap guns the walls of the barrels are frequently thinned too much on the inside during the joining together of the tubes, and it is in such cases that there is not much margin of safety. But in these weapons a top extension is usually fitted, which may be quite useless as a top extension but which makes an excellent extractor guide!

In best-grade chopper-lump barrels I should say that the margin of safety in the walls is so ample that a slight encroachment on their thickness could be made without any risk. Nevertheless, the *principle* of such an encroachment is wrong, and should, therefore, be avoided; especially as it is quite unnecessary.

We now come to Ejectors.

In guns fitted with extractors such as have been described, all that the extractor does is to withdraw the fired case from the chamber on the gun being opened. The shooter then has to remove the empty case by hand. But in guns fitted with ejectors this last work is done automatically, the empty case being flung out when the gun is opened. This end is achieved by a mechanism which is not unlike a miniature lock and is situated in the fore-end. At the critical moment the tumbler of this lock strikes the front end of the long leg of the extractor and flicks it backward, the result being that the fired case is flung out for a distance of several feet.

The first point to realise is that the extractor in a non-ejector gun is made in one piece so that the cartridges are withdrawn from both barrels simultaneously. Since, however, an ejector should only fling out the fired case, the extractor in an ejector gun must be made in two pieces, one for each barrel. This is done by cutting the ordinary extractor into two by a longitudinal divide which can be seen in Fig. 31D and Plate II.

In actual fact each extractor is made separate, and the two parts are ground down to fit together into one whole, as it would be impossible to make any cut sufficiently fine for the purpose of separating the two parts out of one. The effect, however, is as described.

Another minor difference is in the stoutness, length and shape of the long legs. These are stouter in ejector guns, as each leg is only half the size of a single solid leg, and they are longer, as they must extend beyond the extractor cam so as to reach the ejector tumblers in the fore-end. A side view of an extractor of an ejector gun is seen in Fig. 31E. In this diagram *a* and *b* are the long and short legs as before, as is also the slot, *c*, for the stop pin. The front end, however, is lengthened and slotted again at *d*. The extractor cam works in this slot and actuates both extractors, as already described. The ejector tumbler hits the extreme front end of the long leg which extends above and beyond the extractor cam.

At first sight the retention of the extractor cam may seem unnecessary in view of the fact that the extractors are driven back by the ejecting mechanism.

The extractor cam, however, serves two essential purposes.

(1) It operates both extractors simultaneously and quite independently of the ejecting mechanism, *which only comes into play when a particular barrel is fired.* If there were no extractor cam the cartridges would remain flush with the breech ends of the barrels when the gun was opened without being fired, and unloading would be most difficult.

(2) It causes what is known as "Primary Extraction."

When a cartridge is fired it expands and fits the chamber tightly and is frequently difficult to move without the application of some force. But once this force has been exerted and the movement has begun, the subsequent extraction is easy. It is the *initial* movement which is the difficulty.

The causing of this initial movement is called Primary Extraction, and the work is performed by the extractor cam, as no ejecting mechanism would be sufficiently powerful to move a tightly expanded case from the chamber, although once primary extraction has been achieved the work of subsequent ejection is easy.

Incidentally, should the ejector mechanism fail to work, the extractor cam operates the withdrawal of the extractors as in a non-ejector gun and the fired cases can be taken out by hand. This may be useful on occasions, but such occasions should be so rare in a well-made gun that I do not think that it should be regarded as a *normal* function of the extractor cam, as are the withdrawal of an unfired cartridge and primary extraction. It is, however, certainly essential to have a reserve method of extraction should the normal ejection fail.

The next thing to consider is the actual ejecting mechanism.

It has already been stated that this consists of a miniature lock placed in the fore-end, the tumbler of which falls and hits the front end of the long leg of the extractor and so flicks it backward. Since only the fired case is ejected there must obviously be two such locks, one for each barrel. There have been a great many designs for ejecting mechanisms during the past fifty years, but a process of what may almost be termed " natural selection " has resulted in two patterns becoming so universally adopted that they can be regarded as standard. As is only to be expected, different gunmakers make variations of these patterns, but such differences as do exist are mostly in the matter of detail, the general principles being almost universal.

These two standard types of ejectors are the Deeley and the Southgate. The former is the older, and so it is more fitting to take it first.

THE DEELEY EJECTOR

This ejector was first patented in 1886 and was invented by one of the collaborators in the designing of the Anson and Deeley lock, from whom it derives its name.

The essential parts of the mechanism are shown in Fig. 32, the actual ejector limbs being shaded.

A is the ejector tumbler which rotates about a peg, B, under force applied by a spring, C, which is attached to the tumbler as shown by a swivel, the other arm being bedded in the fore-end. This tumbler, A, is provided with a bent, D, into which fits a specially shaped sear, E, which rotates about a peg, F. The other end of this sear protrudes from that part of the fore-end which fits on the knuckle of the action, as shown at G.

The "trigger" which "fires" this lock is situated in the bar of the action, and in Anson and Deeley actions forms an integral part of the mainspring. In the description of the Anson and Deeley lock it was stated on page 65 that the point of the mainspring was not fixed as in a side lock, but changed its position on compression and release. The fact that this point occupies different positions in the bar when the gun is at "full cock"

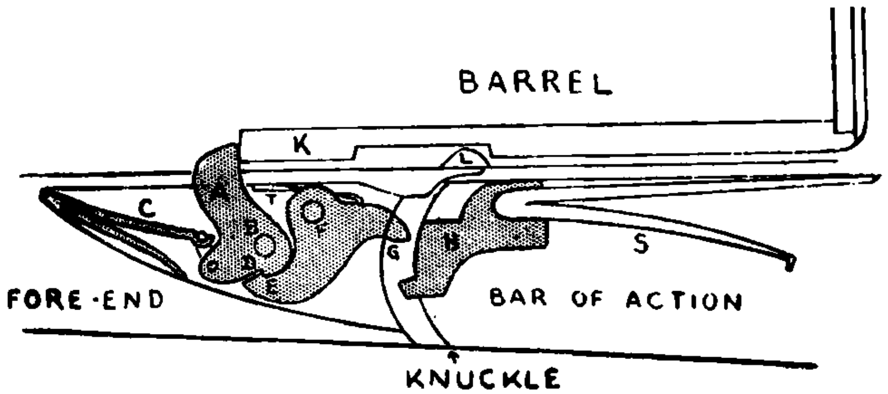


FIG. 32.—The working parts of the Deeley Ejector. The extra links necessary for the ejector mechanism are shaded.

A is the ejector tumbler which revolves about an axis, B, under the power of the spring, C. D is the bent in the tumbler into which the sear, E, is lifted on rotation about the pin, F, by the pressure of the spring, T. H is the "tripper" attached to the mainspring of the lock, S, which protrudes out of the knuckle and engages with the corresponding projection, G, on the sear, E. K is the extractor rod and L the extractor cam.

and "fired" is utilised for bringing the ejecting mechanism into operation. An additional limb, H, is attached permanently and solidly to the point of the mainspring, S. In the diagram this limb, which really constitutes the "trigger" for the release of the ejector sear, is shown in the "fired" position when its extreme front end just protrudes beyond the knuckle. When the gun is cocked the front end of the mainspring, S, changes its position as mentioned, and the tip of the limb, H, is withdrawn inside the knuckle.

The action of this ejector is as follows:

On the gun being closed the extractor is forced into its position in the breech end of the barrels by the face of the action, and the front end of the long leg, K, pushes the ejector tumbler, A, round, compressing the spring, C, until the bent, D, comes opposite the sear nose, E. When this happens the sear is rotated by the small sear spring, T, and the sear nose, E, catches in the bent, D, and retains the tumbler, A, at full cock.

On the gun being fired in the point of the mainspring, S, changes its position in the bar of the action and the end of the limb, H, is moved so that it protrudes beyond the front edge of the knuckle.

When the gun is opened the extractor cam, L, pushes the extractor forward and so unseats the fired case and withdraws it from the chamber; and as the opening movement is continued the front end of the limb, H, lifts the rear end of the sear, G, with the result that the sear nose, E, is eased out of the bent, D. When this occurs the ejector tumbler, A, rotates under the power of the spring, C, and hits the front end of the extractor rod, K, thus giving the whole extractor a sudden and smart backward impulse which throws the fired case out of the gun.

On the gun being closed, the cycle of operations begins again as before.

This ejector, as will be gathered from the fact that the changing position of the mainspring is utilised for operating the ejector sear, was designed for use in conjunction with the Anson and Deeley lock. It can, however, be fitted to a side lock gun, but in this case the "trigger" is operated in a different manner. This "trigger" is situated in the bar of the action as before, but is pivoted to positions with its point inside and outside the edge of the knuckle by means of the cocking lever. In all other respects the principle of working is identical with that which has just been described.

THE SOUTHGATE EJECTOR

The other type of ejector in general use is that known as the Southgate. Many gunmakers claim to have patterns of ejectors of their own design and usually refer to them as their "special two piece" ejector, but almost all such ejectors without exception are modifications of the Southgate. As a matter of fact, it would really be more correct to call this type of ejector the "Holland," as in its present form it is more like the original Holland patent taken out in 1893 shortly before the Southgate patent was taken out in the same year. The real credit for the invention, however, should be given to the late Mr. F. Beesley, who was one of the most fertile inventors the gun trade has known, as it was Beesley who sold his idea to Messrs. Holland and Holland. But for some reason or other the name Southgate has always been applied to this type of ejector, so it is better to follow the general custom.

The principle on which the Southgate ejector works is quite different from that of the Deeley, which is really a miniature lock in every sense, while the Southgate works on what is known as the "over-centre" principle. It may, therefore, be as well to describe this principle before giving details of the actual ejector mechanism.

The over-centre principle will best be understood with the help of the diagram in Fig. 33 which is an

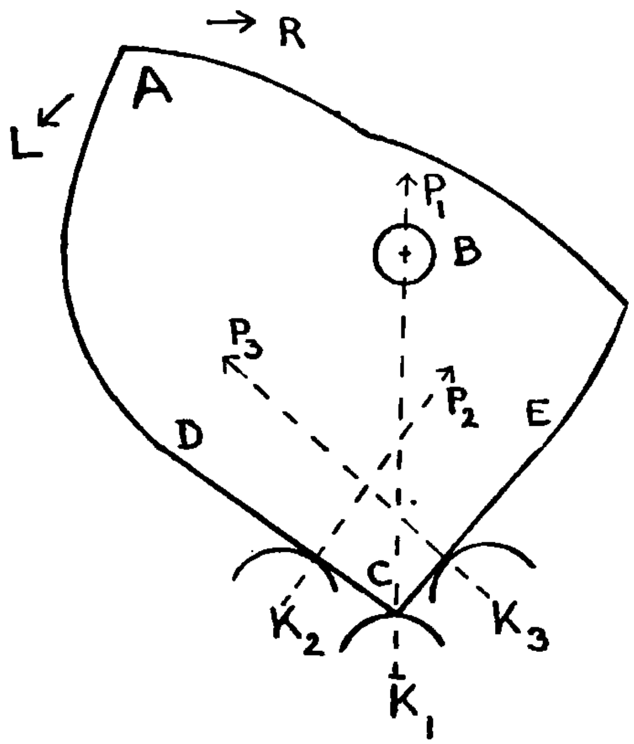


FIG. 33.—Diagram to illustrate the "over-centre" principle as applied to an ejector tumbler.

enlarged view of an ejector tumbler which rotates about an axle, or peg, B. The bottom edge of the tumbler is shaped in a pronounced angle at C, while the surfaces CD and CE on either side of this edge are flat.

Now if pressure is applied on a flat surface by pressing a round-headed knob on that surface, the only direction in which the pressure can act is in the direction of the line which joins the centre of the round knob to the point where the circumference of the knob touches the surface.

In the case of an ejector tumbler, upward pressure is applied from below by means of an arm of a **V**-spring, the end of the arm which touches the tumbler being rounded.

When this knob is in the position K_1 the pressure on the tumbler will be in the direction of the line joining the centre of the knob to the point of contact with the tumbler, namely, C. In this particular position this line, when continued, passes through the centre of the axle, and the direction of the pressure is shown by the dotted line P_1.

It will be quite clear that since the direction of this pressure passes through the centre of the axle, there will be no tendency for the tumbler to rotate. That is, when the knob is in the position K_1 there is no turning force on the tumbler.

When, however, the knob is moved to the position K_2 the direction of pressure (which is still in the line joining the centre of the knob to its point of contact with the edge of the tumbler) is given by the dotted line P_2, and there will now be a turning force on the tumbler which will tend to revolve the top, A, to the left as shown by the arrow, L.

Similarly, when the knob is moved into the position K_3, the pressure will act as shown by the dotted line P_3, and the turning force will rotate the tumbler about its axle so that the top, A, revolves to the right as shown by the arrow, R.

Now in actual practice it is not possible to move the knob which applies the pressure since it is the end of an arm of a fixed spring. But a similar effect can be produced if the tumbler is forced round through a small angle until the position of the knob is changed from one side of the angular edge, C, to the other.

Let us assume that the tumbler is held in such a position that the knob is at K_2 and pressing on the surface CD in the direction P_2 so that the top of the tumbler, A, tends to rotate in the direction, L.

If the tumbler is now forced round slowly in the opposite direction the knob will gradually assume the position K_1, when the pressure is neutral as far as any turning effect on the tumbler is concerned. But if the tumbler is forced round a little further the knob will come into the position K_3 and the spring pressure will then revolve the tumbler so that the top, A, moves in the direction, R.

So it will be seen that when the knob was in the initial position at K_2 and the tumbler was forced round, the spring was *opposing* this forcible rotation. But directly the point C was passed, the spring changed its direction of action and *helped* the forcible rotation.

The passage of the point C is known as moving "over centre" because at this point the centre of rotation is in an exact line with the direction of the pressure exerted by the spring.

The important point to realise is that as soon as the over-centre position is passed, the turning power of the spring acts in the opposite direction to that in which it acted immediately before the over-centre position was reached.

Probably the commonest adaptation of the over-centre principle is in an ordinary pocket knife where the same spring first of all holds the blade shut and then in the open position, the force necessary to move the base of the blade past the over-centre position being applied by the thumb-nail.

Once the principle is grasped, the working of the Southgate ejector will be readily understood.

Figs. 34A and B show the essential parts of one of these ejectors, and for the sake of simplicity all other parts of the gun and mechanism have been omitted.

In both diagrams *a* is the ejector tumbler which revolves about the peg, *b*, and *c* is the " over-centre " edge. The frame which holds the peg, *b*, is the metal part of the fore-end and it also holds the spring, *s*. The circular part of the frame at the right of each diagram is the part of the fore-end which fits on to the knuckle of the action.

In Fig. 34A the ejector tumbler is " set " at " full

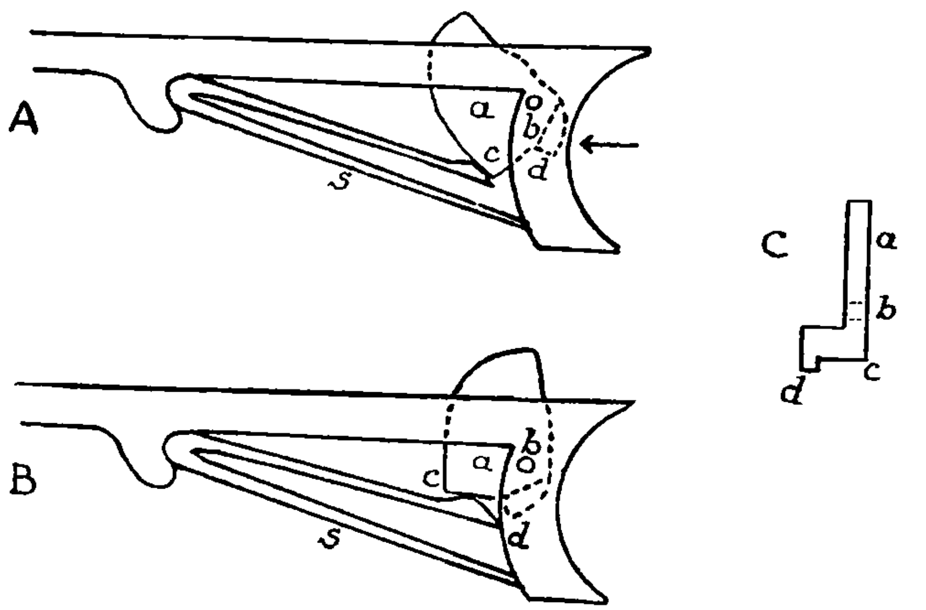


FIG. 34.—The mechanism of the Southgate ejector.

A, The tumbler cocked. B, The tumbler in the " down " position. C, End view of the tumbler. In each diagram *a* is the tumbler which rotates about a peg, *b*. The spring is *s*, which acts on either side of the " over centre " edge, *c*; and *d* is the projection which engages with the corresponding projection on the cocking lever.

cock," that is, it is so placed that the spring tends to turn the top of the tumbler to the left. It is prevented from turning farther over by the framework in which the whole mechanism is held, for the tumbler moves in a slot in this frame. So it will be seen that in this position the tumbler is held firmly by the spring.

A special limb projects from the knuckle of the action and engages with the tumbler at *d*, *but only when the gun has been fired*. So long as the gun has not been fired this limb is tucked out of the way.

On the gun being opened after firing, this limb presses against the lower part of the tumbler (as shown by the arrow in Fig. 34A) and forces this part of the tumbler down, and as the gun is opened still farther the tumbler is slowly rotated until the over-centre position is reached and passed. Immediately this happens the tumbler is flicked round by the spring into the " fired " position shown in Fig. 34B. As it turns it hits the rear end of the long leg of the extractor and shoots it backward exactly as the Deeley tumbler does, and so ejects the fired case.

It will be noticed that the gun has to be opened some way before the over-centre position is reached, and during this part of the opening primary extraction is carried out by the extractor cam, as has already been described in the account of the Deeley ejector.

On the gun being closed the extractor is forced home as in the Deeley ejector and the long leg pushes the ejector tumbler back until the over-centre position is passed, when the spring holds it " cocked " as before firing.

The variations in design of this type of ejector are almost all connected with the shape of the limb in the bar of the action which engages with the point, *d*, on the ejector tumbler. In the original Southgate design this limb was operated by the cocking lever, but in the Beesley design (Holland's patent) this extra limb was done away with entirely, the front end of the cocking lever being fitted with a projection which did its work and only came into play when the cocking lever was in the " fired " position. This reduced the number of limbs in the mechanism, and thus tended to simplification. On the patent expiring, the system was adopted by almost all makers who fitted the Southgate ejector, and its adoption gave rise to the name, " two piece " ejector. There are minor variations in the actual shape of the engaging parts of the cocking lever and ejector tumbler, but the principle is the same in all.

Since the long leg of the extractor is placed almost centrally in the gun and the cocking lever distinctly to one side, the part *d* on the tumbler which engages with the cocking lever is placed at the end of a short arm, as shown in Fig. 34C, which gives an end-on view of an ejector tumbler.

COMPARISON OF THE DEELEY AND SOUTHGATE EJECTORS

From the point of view of efficiency, which is after all the most important, there is really little to choose between these two types of ejector which have been described. The Southgate is certainly more commonly fitted, but this may be on account of the greater simplicity of its design; for it is undoubtedly superior to the Deeley in this respect.

The Southgate is also probably more easy to "regulate" or "time."

It sometimes happens that the ejector tumbler, or "kicker," falls too soon and strikes the end of the extractor leg before primary extraction has been achieved. When this occurs, the blow is wasted and the cartridge is not ejected.

Similarly, the tumbler may fall too late, which again means failure to eject. The ejector mechanism must be so timed that the tumbler falls just before the gun is fully open and after primary extraction is quite complete.

In the case of the Southgate the "timing" is regulated by the position of the over-centre edge (*c* in Figs. 33 and 34) in relation to that of the tumbler peg, and a touch with a file on one side or the other will quicken or delay the over-centre action.

In the Deeley ejector the "timing" is done by altering the shape of the sear nose and tumbler bent. This is a similar operation to regulating the trigger pull in a lock, and is certainly more tricky than that of easing the position of the over-centre edge. Further, there is perhaps more risk of the "pull" of the sear nose in the tumbler bent changing than that of the over-centre position.

So, on the whole, I think that the first place may perhaps be given to the Southgate system: but there is very little in it.

In both types of ejector the two tumblers are placed side by side in the central line of the fore-end, and both rotate on the same axle, or peg.

They can be recognised at a glance, for in the Southgate the tops of the two tumblers, or "kickers," are close up to the rear end of the fore-end, and the tumbler peg can be seen near the top edge of the fore-end and in the corner of the metal frame.

In the Deeley ejector the tumblers are well back from the rear end of the fore-end and no axle, or peg, is visible.

Finally, it is most important to notice that in both these types of ejector the springs are compressed by the lift of the barrels, that is, by the closing of the gun. It will thus be realised that the work of cocking the locks and ejectors is evenly distributed; the locks being cocked by the opening of the gun and the ejectors by the closing.

THE BAKER EJECTOR

There is one other pattern of ejector which is still sometimes favoured by a few gunmakers, and so deserves attention. This is the Baker Ejector.

Fig. 35 gives a sectional view of a fore-end in which a Baker ejector has been fitted. The mechanism comprises a specially shaped box, A, A, which is pivoted in the upper edge of the fore-end at B. This box contains a plunger, or slide, D, which compresses a coiled spring against the front end of the box, as seen in the diagram, a rod, which is part of the slide, running up the middle of the spring and acting as a guide.

The upper part of this slide protrudes from the box through a slit in the top, and projects above the fore-end. The rear end of this upper portion of the slide is fitted with a small notch, or sear, which catches in a correspondingly shaped edge in the frame of the fore-end at E.

There is a projection, C, on the lower edge of the box which lies in a slot in the rear portion of the fore-end which butts against the knuckle of the action.

On the gun being fired a rod, F, is forced out from the knuckle of the action into the position seen in the diagram ; and when the gun is opened this rod engages with the projection, C, and lifts the whole box, A, which pivots about the peg, B, until the sear at E is free of the bent. The coiled spring then extends as there is nothing to hold it in compression any longer, and the slide, D, is suddenly pushed against the front end of the extractor leg, thus producing ejection of the fired case.

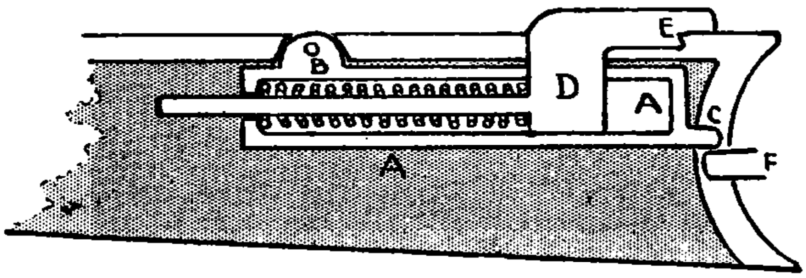


FIG. 35.—The Baker ejector.

Primary extraction is caused by an extractor cam as usual.

When the gun is closed the extractor leg pushes forward the slide, D, and thus compresses the coiled spring until the bent, E, reaches a position ahead of the edge which holds it, when it slips into place, as the rod, F, is withdrawn into the knuckle of the action when the gun is cocked, and so there is nothing to prevent the box, A, from pivoting down, which it does under the pressure of the extractor leg, as the part of the slide which is in contact with the leg is slightly bevelled.

The rod, F, is usually attached to the tumbler of the lock and is driven forward when the tumbler falls, and withdrawn as the tumbler is cocked. This is a convenient system for those actions in which an ordinary cocking lever is not employed (some of which will be described in Chapter VII), and consequently the Baker ejector is one which is useful for converting non-ejector guns to ejectors, as all that need be added to the lock is a plain rod, and there is no necessity for any specially shaped end to a cocking lever. However, there is a disadvantage in using the fall of the tumbler to force forward the ejector rod, namely, that efficiency of the lock is lost to a certain extent, as a part of the energy of the tumbler is used up on the ejector rod instead of all being concentrated on the firing of the cap. The result is that miss-fires are a contingency unless the mainspring is well up to full strength.

CHAPTER VI

FORE-ENDS, STOCKS AND FINISHING

HAVING dealt with the barrels, action, locks and ejectors, there remain one or two other details before we come to the question of the woodwork, that is the fore-end and stock, and the general finishing of the gun, in which engraving should be included.

Among the details which deserve attention are the final furnishings of the action, and of these the Trigger Plate can be taken first.

This is really a steel bar which carries the triggers and which projects from the bottom of the rear end of the action in exactly the same way as the Strap does from the top (see Plate V). The difference between the Trigger Plate and the Strap lies in the attachment to the body of the action. The strap, as has already been seen, is forged or stamped out as an integral part of the body. The trigger plate, however, is separate and is screwed firmly to the bottom of the action body. It is further held by a strong screw, or "pin," which is known as the Breech Pin and is inserted through the top of the strap down into the trigger plate. This pin is almost invariably placed between the safety slide and the spindle of the action lever, and its head can be seen in the strap when the lever is pushed over.

Apart from providing a framework for the triggers which are both hinged on a peg which is driven through a projection on the trigger plate, called the Trigger Box, this plate strengthens the stock considerably in the weakest place, and so serves a double purpose.

The next thing to consider is the safety mechanism which is operated by the safety slide.

This, as has already been explained in the description of the locks, merely bolts the triggers and prevents them from being moved in any way. The number of designs for this bolting mechanism are legion, but they are almost all based on one principle, which is shown in Fig. 36.

A bent lever, A, is pivoted about a peg, B, which is fixed in a bearing which projects up from the trigger plate. The top end of the lever, A, is inserted through a slot in the strap and attached to the actual safety

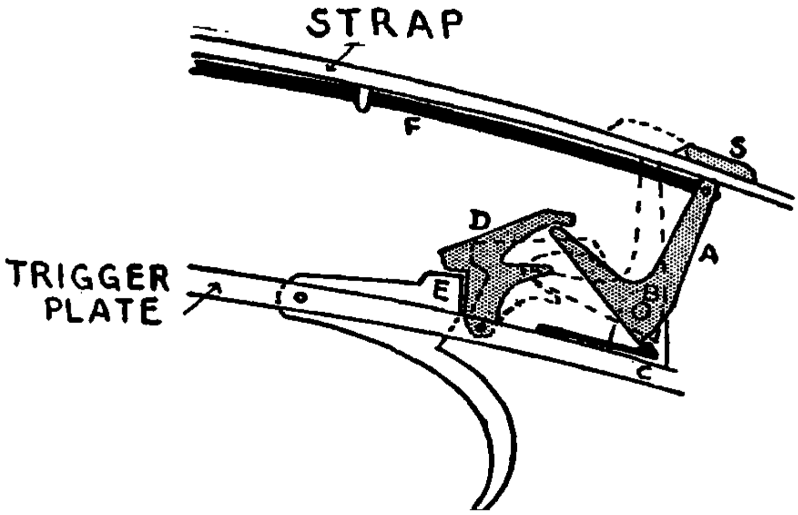


FIG. 36.—Diagram showing the principle of the working of an ordinary safety.

S is the safety slide on the top of the strap. A is a bent lever pivoted at B and operated by the slide, S. C is a spring stud which keeps the lever in position. D is the actual safety stop which bolts the trigger blade, E. F is the rod which connects the bent lever, A, to the action lever.

slide. This slot in the strap is shown in the lower photograph on Plate V.

The other arm of this bent lever, A, operates the actual safety bolt, D, which is hinged in the trigger plate. In the diagram the bent lever, safety slide and safety bolt are all shaded and are shown in the "Safe" position, in which the safety bolt is in position immediately above the trigger blade, E, and so prevents it from being lifted up by pressure on the trigger.

When the safety slide is pushed forward, the other end of the bent lever is dipped and this end rotates the safety stop, D, and so moves it out of position over the trigger blade. The positions of the various parts are now shown in dotted lines.

The bent lever is held in the "Safe" and "Fire" positions by means of a spring stud, C, and the top end of the lever is connected by a rod, F, to the action lever. When the action lever is pushed over to open the gun, a cam on the upper end of its spindle forces the rod, F, to the rear and so automatically puts the safety mechanism to " Safe."

There now only remains the Trigger Guard and we will have finished with the metal and can pass on to the wood.

The trigger guard is a curved bit of steel which is attached to the trigger plate and serves to protect the

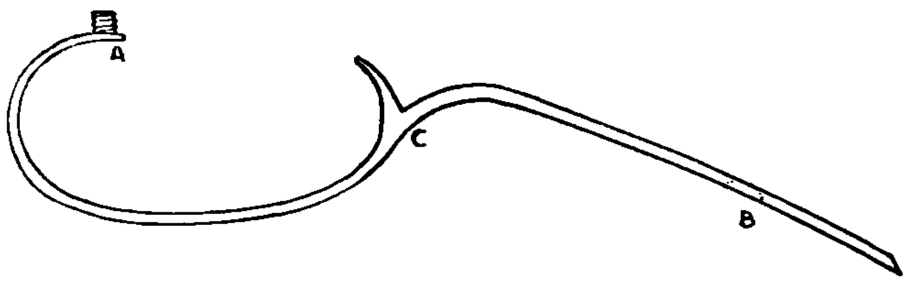


FIG. 37.—A typical trigger guard.
The front end is furnished with a screw, A, which screws into the trigger plate. The rear end is kept in position by a screw which is inserted through the hole at B.

triggers from catching in projections, or receiving blows, and so helps to prevent accidental discharge of the gun.

The side view of a typical trigger guard is shown in Fig. 37. The screw at A is an integral part of the guard and screws into a hole in the trigger plate in front of the triggers, the trigger guard being turned round and round as the screw is inserted and screwed home. When this screw is tight the trigger guard should be in the correct position over the triggers.

It is finally set by another screw which is inserted through a hole, B, through the trigger plate and into the stock ; and sometimes there are two such screws.

The most important point in the design of a trigger guard is the slope at C. If this is too perpendicular to the grip the guard will almost certainly bruise the primary phalange of the middle finger on the gun recoiling. Few things can be more painful, and although there are both remedial and preventive measures, a badly shaped trigger guard is the most common cause. One good remedy is to unscrew the screw at B and slip an ordinary rubber umbrella ring over the end of the guard until it reaches the point C: the screw B can then be re-inserted. This rubber ring makes an effective cushion and is an almost certain cure. But it is better to have a properly shaped trigger guard in the first instance.

One little refinement which is sometimes seen on best guns, and which was first introduced by Messrs. Boss, is a thickening and rounding of the outer edge of the guard. I have used one of these guards for the past five years and it is certainly a distinct minor improvement in comfort, as a sharp edge against the trigger finger while holding the gun ready, but before actually putting the finger to the trigger, is avoided.

FORE-ENDS

The purpose of the Fore-end was originally to seal the attachment of the barrels to the action. This end is achieved by the rear end of the fore-end being cut on an arc of a circle which is of the same radius as the knuckle. The fore-end butts against the knuckle and so maintains the bearing of the barrels, through the hook, on the cross pin. The result is that it is quite impossible to lift the barrels off the cross pin as long as the fore-end is in position, although its presence does not interfere in any way with the barrels being revolved round the cross pin, as is done when the gun is opened or closed.

But in order to effect this hold, the fore-end must be fixed so firmly to the barrels that it is for all practical purposes a part of them for the time being.

This attachment is effected by means of the Loop, the fitting of which was described in Chapter I, and in view of the important part the fore-end plays in the stability of the gun the value of a properly fitted loop will be realised.

There are various methods of bolting the fore-end to the loop, and one of the earliest was by means of a flat bolt which was pushed by hand through the fore-end at right angles to its length, and which passed through the loop, thus bolting the fore-end firmly in position. This bolt was withdrawn by hand: theoretically with the thumb-nail, but more frequently with the blade of a knife, screw-driver, or other similar implement.

In modern fore-ends the bolt is actuated by a spring and works in line with the barrels, and not across them. The end of the bolt is bevelled as is the loop, and consequently a comparatively slight pressure pushes the bolt back. It is forced home into position by the spring directly the fore-end is bedded, and a perfect union is achieved.

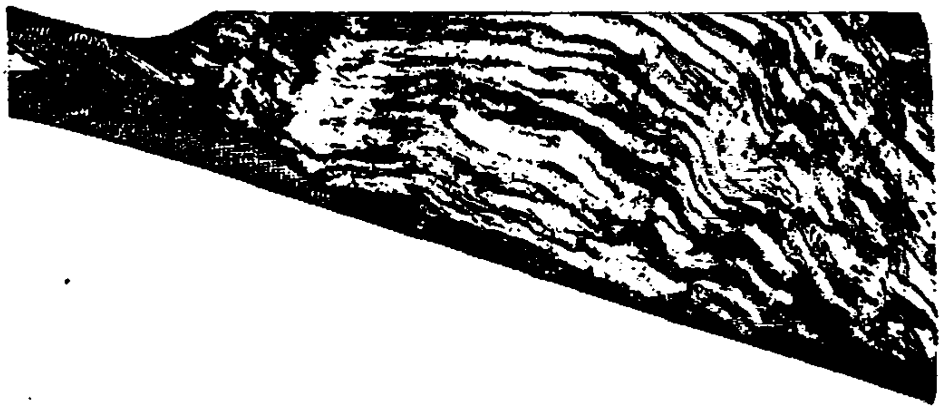
To take the fore-end off, this bolt is unseated by an easy pressure of a finger on a fitting outside the fore-end, when the attachment can be lifted off.

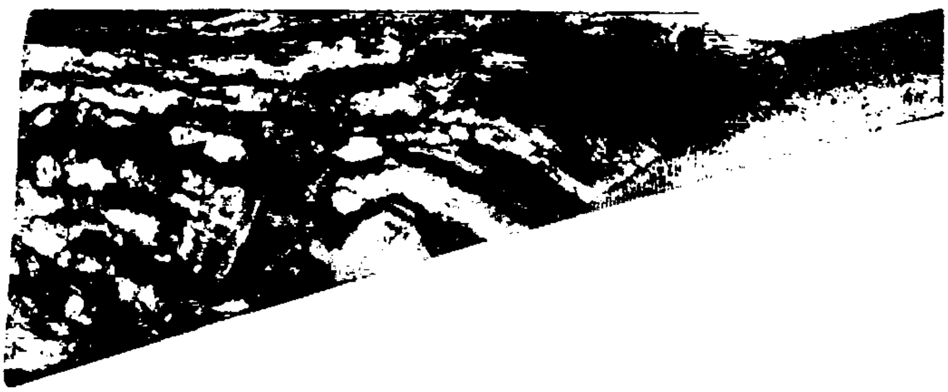
This pattern of fore-end is known as a "Snap" fore-end, as it snaps on into position, and there are two types in common use, the Anson and the Deeley. In the Anson the bolt extends just beyond the tip of the fore-end in the form of a small stud, and in the Deeley a metal loop is placed just below the tip which is lifted with a finger. This lifting of the loop withdraws the bolt. Both these types are excellent, but the Anson is perhaps the neater in appearance and slightly easier to manipulate. One is shown in Plate VIII.

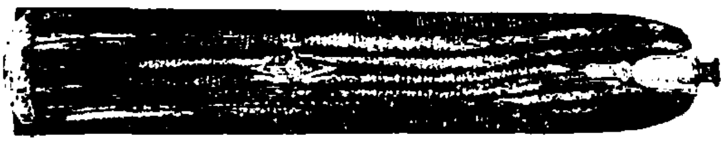
Apart from the fact that the fore-end makes an ideal grip for the forward hand when using the gun, its other chief use is to act as a receptacle for the ejector mechanism, as was explained in the last chapter.

WOOD FOR FORE-ENDS AND STOCKS

The wood used in fore-ends and stocks must be tough, hard and not liable to split. These are practical essentials. But I cannot help feeling that the æsthetic quality of beauty should take a high place as well,







Top. An exceptionally well-figured walnut stock which has been lengthened by the addition of a wonderfully matched piece of walnut. In the actual gun the join is not nearly so noticeable as in the photograph

Centre. A beautifully figured walnut stock

Bottom. The fore-end of the same gun of which the stock is shown in the middle photograph. The beautiful figuring of the stock is continued in the wood of the fore-end in a most unusual manner. This fore-end is fitted with an "Anson" snap fastening

provided it can be obtained without any sacrifice of utility and durability. Happily, we have in walnut an ideal wood which is not only tough, hard and not given to splitting, but is also frequently figured in a beautiful manner which is a joy to the eye.

Walnut, however, varies tremendously in quality, the best wood coming from the South of France and the adjoining part of Italy. Gunmakers buy their stocks roughly cut in blocks, and best-quality stocks cost on an average from £40 to £50 in the rough state, although much higher prices are asked, and given, for exceptionally well-figured stocks, especially when two such stocks are matched as a pair, and I have heard of as much as £100 being paid by a gunmaker for a particularly well-matched pair of figured stocks in the rough state. But a beautiful figure should always be subordinated to a straight grain, especially in the "hand," or "small" of the stock which forms the grip for the trigger hand.

In a best-grade gun the stock and fore-end are cut out to fit so closely to the metal that perfect seasoning of the wood is essential. If the wood is not seasoned, not only is it more difficult to cut out cleanly, but there is also the risk of subsequent swelling or warping which would be fatal in the case of any gun in which the fit between wood and metal is so close. In cheap guns the fit is much looser so as to allow for swelling, as well as to lower the cost of fitting. But a tight fit is a most useful adjunct to the general stability of the gun, and in high-grade weapons the stock and fore-end are shaped and recessed to fit the various parts of the framework and action in a way which would do credit to the most skilful cabinet-maker.

If the locks are taken off a best-grade side lock gun this fitting of the wood can be seen, and I fancy that such an inspection will surprise a good many owners of guns, as almost every screw head has its proper recess in the wood.

In order to ensure the wood being properly seasoned before use, gunmakers keep their rough stocks stored in a dry room and weigh each stock separately every six months or so, not using any stock which continues to lose weight. On an average few stocks can be used much before two years after purchase, and some take considerably longer to dry, even though they are sold as thoroughly seasoned.

Apart from the fact that these periodic weighings mean labour, and therefore cost money, it should not be forgotten that the gunmaker has the capital value of the stock put away and earning no interest during the whole time the stock is seasoning. This may not seem much in the case of a single stock, but when there are a large number in storage the total works up into quite an appreciable sum of money lying idle.

There is also always the risk of an apparently perfectly sound and straight-grained stock splitting in the shaping, and this represents a dead loss.

I have emphasised this point of view because one so often hears shooting men speak of the "exorbitant" cost of a best gun, whereas the truth is that the price of a cheap gun is frequently far more "exorbitant" when the profit is considered on a percentage basis.

And this periodical weighing further enables the gunmaker to grade his stocks according to their weight, for by no means all stocks of the same size and bulk are of the same weight.

This variation in weight is due to the different density of the wood obtained from different trees. It is common knowledge that trees of the same variety will grow at different paces even when planted comparatively close together, the variation in growth being due to some accident in the soil. Trees which grow quickly provide wood which is less dense than that yielded by trees which grow slowly, and for this reason the wood of the oak is much heavier than that of the willow. The differences in density of wood from the same variety of tree is never so great as the extreme example which I have just quoted: but it exists more frequently than is generally realised, as anyone who has tried to grow "cricket-bat" willows will know. Those willows which grow very quickly provide light wood and are much more valuable than the trees which have developed more slowly, even though planted quite close.

The gunmaker grades his rough stocks according to their density and reserves the lightest for specially light guns. Since the stocks of all good guns are hollowed out in order to make the gun balance and handle well, the question of the density of the wood used may seem rather in the nature of hair-splitting. But it is not so in reality, for in very light guns the gunmaker has to think of every half-ounce in order to combine the maximum possible strength with the reduced weight.

I am, of course, now only referring to high-grade guns. The maker of cheap guns could not possibly afford to pay attention to such refinements, while the stocks of some of the very cheap Continental guns probably cost the same number of shillings as a maker of best guns would pay pounds for one of his stocks.

I think it possible that some plastic may replace wood as a material for both stocks and fore-ends in many guns in the not very remote future.

When the stock has been shaped and fitted to the action, it is actually attached to the action by screws through the strap and trigger plate. It should, however, be remembered that the shaping of the stock includes fitting it to the individual customer's measurements, and it is in this work again that there can be no comparison between high-grade and cheap weapons.

The "fit" of a stock comprises its "Length," "Bend," and "Cast Off."

The Length is obtained by three different measurements, namely, from the centre of the front trigger to the heel of the butt, to the centre of the butt, and to the toe of the butt.

The Bend is given by the perpendicular distances between the comb and heel of the butt to the continuation of the line of the top rib.

The measurements for both Length and Bend are shown in Fig. 38.

The "Cast Off" is given by the perpendicular distances from the comb and heel of the butt to a vertical plane through the top rib of the gun when the gun is held horizontally.

In the case of a man who shoots from his left shoulder the gun is given "Cast On," the stock being bent to the opposite side of the vertical plane through the ribs.

Cast Off always means that the central plane of the stock is situated wholly to the *right* of this vertical plane when the gun is held in the normal position, and Cast

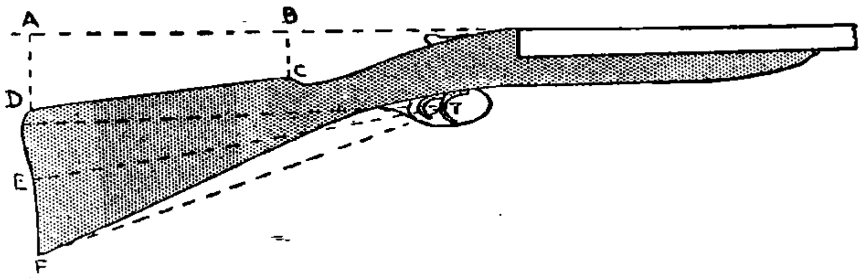


FIG. 38.—How "Bend" and "Length" in a gun stock are measured.

AB is the continuation of the straight line of the top of the barrels. C is the "Comb," D the "Heel," F the "Toe," and E the centre of the butt. T is the middle of the front trigger. "Bend" is given by the two measurements, BC and AD. "Length" is given by the three measurements, TD, TE, TF.

On that the stock lies wholly to the *left* of this vertical plane. The man who shoots from his right shoulder requires Cast Off, and the one who shoots from his left shoulder needs Cast On.

Cast Off or On, Bend and Length are naturally all dependent on the physical peculiarities of the shooter and can only be obtained by an experienced gun-fitter, just as a well-made coat or pair of breeches must be the work of a good tailor, or cutter.

I will deal with this question of the fit of a gun at greater length in Volume III, and have only touched on it here in order to emphasise the work necessary for the shaping of the stock of a good gun.

The fore-end is shaped and fitted as accurately as the stock, although there is naturally far less work entailed in the operation.

The initial work on the gun is now completed and there remains only the finishing, but before this is done the gun is sent again to one of the Proof Houses to undergo the final, or Definitive, proof.

In this stage both the wood and the steel are in their light, natural colour, and the gun is termed as being "in the white."

On its return from proof, and while still "in the white" the shooting of both barrels is regulated by numbers of actual tests on a pattern plate. I propose to deal with the regulating and boring of the barrels in the section on Patterns and so will say no more now, except that the work frequently takes a considerable amount of time and occasions the expenditure of a considerable number of cartridges.

The next step consists of the hollowing out of the stock in order to obtain the correct balance and handling of the gun. This may be done before the regulating of the shooting, but both processes are carried out while the gun is still "in the white."

BALANCE

Balance is one of the most important and desirable points in any gun, but the term is not altogether a happy one, although it is hard to find a better. One often hears it stated that a gun should balance at a certain point, usually one a little way in front of the trigger guard. This statement is correct as far as it goes, but it does not go nearly far enough. For example, it would be quite easy to make a solid stick, weighted at intervals with lead, which weighed exactly the same as a gun and which balanced about a point which was at identically the same distances from the ends. Yet such a stick might seem to be far heavier when handled as a gun, while it might also seem lighter. This apparent difference in weight has nothing whatever to do with the point of balance, which would be the same in either case, but is dependent entirely on the *distribution* of the weight.

Let us take as an example an ordinary ash stick 4 feet long which weighs 1 lb. And then let us make the weight up to $6\frac{1}{2}$ lb. by adding two lead weights, each of which turns the scale at $2\frac{3}{4}$ lb., but let us make the addition in two different ways.

First of all, let us place them together at a point just over 19 inches from one end of the stick, as shown in the diagram in Fig. 39A. If the stick is of even

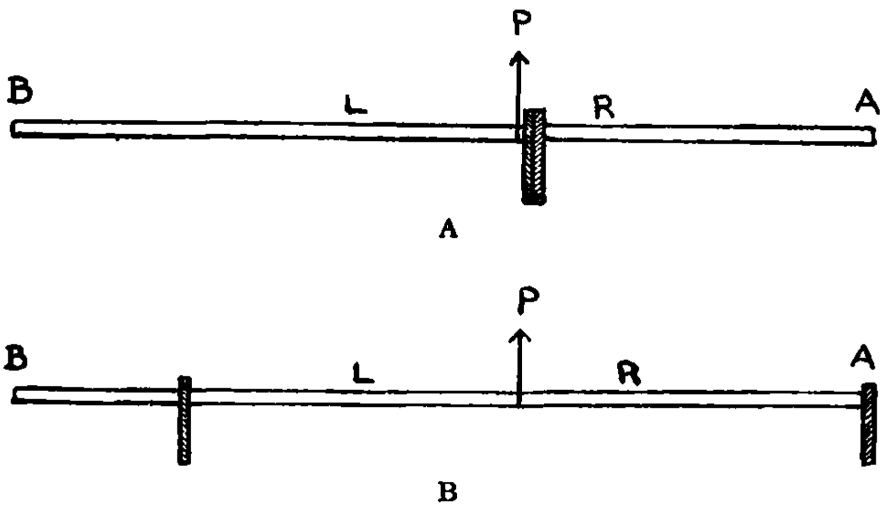


Fig. 39.—Diagram to illustrate the effect of the concentration of weight on the balance of a gun.

thickness it will be found that it will now balance about a point, P, just 20 inches from the end, A; and if it is now held like a gun at R and L, A being the butt, it will be easily swung round, or pointed in any direction.

Now let us move the weights so that one is placed at the extreme end, A, and the other $9\frac{1}{2}$ inches from the other end, B, as shown in Fig. 39B. It will be found that the stick will still balance at exactly the same point, P, as in the first arrangement of the weights, but if it is held as a gun at R and L the feeling will be very different. Not only will it appear heavy to swing round, but it will also be almost impossible to point it quickly owing to the apparent change in weight.

And yet in each case the total weight of the stick is the same, as is also the position of the point about which it balances.

Anyone can try a simple experiment on these lines for himself which will prove that weight and point of balance are not the only factors which tend to ease of handling, or " balance " in a gun.

The explanation of the difference in handling of the stick for the two positions of the weights lies in the distribution of the total weight. In the first case almost the whole of the weight of the stick and lead was concentrated between the hands, and consequently it was easy to overcome the natural inertia of the stick and lead. It must be remembered that the stick weighs 1 lb. and that this weight is evenly distributed along its length. So those parts of the stick, RA and LB in the diagrams, which lie between the points of grip and the ends, weigh something; and this is why it would be incorrect to state that *all* the weight was concentrated between the hands.

In the second case, almost the whole of the weight of stick and lead was outside the hands, and consequently it was much more difficult to overcome the inertia of stick and lead.

I have no intention of entering into the mathematical problems arising from the question of inertia, as I think that they would be out of place in this book; but if any reader is sufficiently interested in the subject he can easily find further information in one of the recognised text-books of dynamics of rotation.

So it will be realised that true " balance " in a gun, which makes a gun feel light in the hand and easy to handle or swing quickly in any direction, is dependent on the concentration of the major portion of the weight between the hands, rather than the position of the point about which the gun balances.

If it were possible to concentrate all the weight of the gun between the hands, its inertia would be most easily overcome, but the gun could be moved round *too* easily and that degree of stability which is essential in shooting would be lost. For the inertia of the forward part of the barrels helps one to steady the gun; but the exact proportion of this inertia to that of the whole gun must largely be dependent on the individual. Some men like more steadying influence in front of their hands than others, and this is why some shooters find it difficult to shoot with very short-barrelled guns, while others find them a help. If some inches are removed from the muzzle end of a pair of barrels the inertia of the amount which is removed is lost. This loss helps some and hinders others: there can be no definite ruling for all.

But the greater proportion of the weight of a gun should in all cases be concentrated well between the hands.

In rifles which are required for target shooting the weight should be distributed from end to end so as to make the rifle "balance" badly, when it will be more difficult to overcome its inertia and swing it round; or, to look at the problem from another view-point, it will be more easy to hold the rifle still, which is the end desired.

It has been suggested that the different parts of a gun, that is, the barrels, fore-end and stock, should all be built to certain specified weights and to balance about certain specified points. If this were done, all guns could be made to "balance" equally well almost by rule of thumb. Such a practice would certainly improve the "balance" of many cheap guns, but it could not be applied to guns specially built to suit individual shooters. For not only do men vary in their ideas of the best "balance," but both barrels and stocks are made of different lengths.

There can be no doubt, however, that the principle is sound, and it is certainly adopted by the builders of "best" guns, although they may not actually weigh and test the points of balance of the different parts of a gun. But they all keep the weights of their barrels well back and those of their stocks well forward.

STOCKS

The concentration of the weight of the barrels in the breech end depends on their taper, but the concentration of the weight of the stock forward is achieved by hollowing out the butt end. This is done by boring a hole down into the end of the butt and cutting out what wood must be removed. The big hole formed in the butt is sealed by fitting another piece of wood to match into it, and when the butt is roughened it is not easy to see where this bit of wood has been inserted without fairly careful scrutiny.

Butts are frequently fitted with heel-plates, which are usually made of vulcanite or horn, and sometimes of steel. I can see no object in having the butt of a gun shod with steel unless the gun is to be used as a walking-stick. It is true that this is sometimes done, but the practice is not to be recommended. It is also true that one sometimes has to place the butt on the ground, but gentle placing is a very different thing to severe usage, and should not damage any gun. For this reason I would never have a heel-plate on a gun of my own, as I think that the addition of such a plate spoils the look of a nice stock. But this is, after all, a matter of opinion.

If the gun is to be taken abroad where it may get rather rough usage it is a sound precaution to have tips of steel put on the heel and toe, such steel tips not looking nearly so ugly as a complete plate.

It frequently happens that a second-hand gun is bought in which the stock has to be lengthened. This is usually done by fitting on an extra piece of wood, but such additions are seldom sufficiently well matched as not to be too visible, and so somewhat unsightly.

An example of what can be done in the way of matching wood is shown in the top photograph of Plate VIII. This is the neatest extension of a stock which I have ever seen and the matching of the grain and figure of the wood is wonderful, while the actual join is considerably less noticeable on the gun than in the photograph.

Such matching of the wood is, however, altogether exceptional and an alternative method for lengthening a stock is to have a rubber recoil pad attached. This does not look like a subsequent extension, as guns are not infrequently fitted with rubber recoil pads when new.

A recoil pad can be a great boon to those who are at all sensitive to recoil or to almost anyone who uses a gun in a hot climate where one frequently has to shoot in nothing but a thin shirt. There are, however, two objections to rubber recoil pads. First, that they add weght at the extreme end of the gun and so tend to increase the inertia of the stock ; and second, that they sometimes prevent quick mounting of the gun to the shoulder by sticking to the coat.

However, I do not think that either of these objections are very serious. The butt should be tight on the shoulder when the gun is swung, and so the inertia of the recoil pad is only noticeable while the gun is being mounted to the shoulder, and is not nearly so serious from the point of view of spoiling the balance of a gun as would be the addition of the same weight at the muzzle. And the second point can be overcome by rounding the pad so that it slips easily into place on the shoulder. I had a rubber recoil pad on a gun which I used regularly for ten years and I never once knew it stick when bringing up the gun.

In the whole process of fitting the stock to the action the most important step is the boring of the hole through the head of the stock to receive the Breech Pin. Not only must this hole be of exactly the right size to take this screw with a tight fit, but it must also be bored at *exactly* the right angle. If this is not done the head of the stock will not bear against the action body correctly when the breech pin is screwed home tight, and to remedy this lack of fit the hole for the breech pin must be enlarged. The stock will then probably work loose from the action in course of time if the gun is submitted to ordinary hard or rough usage. So important is the absolutely accurate boring of the hole for the breech pin that a first-class stocker would sooner discard a stock rather than fit one in which this hole had not been bored quite true. It is in details such as this, which are all unseen and unsuspected, that a best-grade gun is so superior to a cheap one. And it is obvious that such details must add to the reliability of the gun, just as it is equally plain that the maker of a cheap gun cannot possibly afford to be so particular.

The only further addition to the stock consists in the oval on the lower edge for the owner's initials or crest. In best guns this is usually gold and it undoubtedly makes a very pleasing finish. Sometimes the initials in gold are let into the wood. This also looks very well, but I think I prefer them engraved on the oval myself. This, however, is a trifling matter; but initials or some distinguishing mark are almost essential.

The final work on the stock is the chequering of the "hand," or grip, so as to provide a rough surface for the trigger hand and thus prevent slipping. This part of the stock should not be round in cross-section as it usually is in cheap guns, but should be slightly diamond shaped, the corners, of course, being rounded. A "diamond grip" gives a better and more pleasant hold, and the wood should be slightly cut away so as to allow the trigger finger to slip forward, almost being guided on its way, to the trigger. It is little niceties such as this, which are probably not realised by the majority of shooters, which indicate the amount of care and thought bestowed upon the building of a good gun and make such a gun more pleasant to use and handle. Their absence makes no difference to the *shooting* qualities of the gun, but they would be missed by anyone who had only used good guns even though he was unaware of their existence.

The fore-end is chequered in the same way, and for the same reason, as the stock; all the wood is then oiled and the metal work all " blued " in some blueing solution. Blueing, or blacking, is not an easy process and should not be undertaken by amateurs. There are various different methods, one of which is as follows: The metal to be blued is first polished absolutely clean and then the solution is painted on and the barrels put in a cupboard for some time, with the result that rust is formed. The surface is then cleaned with a wire brush. This procedure has to be repeated several times to get a good colour. The blueing solution used generally contains small percentages of ordinary commercial nitric acid, but there are numerous different prescriptions and the method of use varies in each case.

The gun is now ready for use, although it is not finished, and in this stage it is termed to be " in the black."

Guns in the black are frequently sent out to their purchasers to use for a time, even for a season, in order to let them have a thorough trial before final finishing.

ENGRAVING AND FINISHING

The next step is the engraving on the action and side-plates. How often one hears men say that the only difference between a cheap gun and an expensive one is the engraving, or that they do not want to pay for mere engraving and that a cheap gun is the same thing. No belief could be more erroneous. A best gun is something in the nature of a real work of art in which the maker very rightly does, and the owner certainly should, take great pride. In course of time, when the colour of the final case-hardened parts wears off, which colour cannot be replaced as can blueing, the side-plates and action would become bright and polished surfaces which would flicker in the sun almost like a heliograph. The barrels are sometimes bad enough in this respect, but they can be re-blued. The engraving breaks up this surface and, further, has the effect of hiding the screw heads, lines of junction of trigger or side plates and action body, or even any scratches which come through use, and thus adds enormously to the appearance of the gun when its original colouring has worn off. A new gun may look very pleasing to the eye with the tones of blues and browns resulting from the case-hardening of the action ; and in this state engraving may seem superfluous. But a gun after three or four years is a very different matter, and it is from then onwards that engraving makes such an enormous difference in the gun's appearance.

The cost of engraving is comparatively slight. It is true that there is usually more engraving on a first-grade gun than on a second-grade one. But every penny has to be cut down in the case of the second-grade gun in order to build it to the price, and it is no exaggeration to state that the percentage cost of the engraving is no higher, if even as high, in the case of the best gun as in the cheaper.

Engraving can vary greatly in quality, and the rough, uneven work which is sometimes seen on comparatively low-priced guns is really better omitted. But good engraving is a joy.

There are two general types of engraving, heavy and fine. Any maker will use either according to the customer's wish, but the fine type of scroll work, frequently known as " Purdey Engraving," is more usually seen ; Messrs. Holland and Holland being almost alone in their preference for the heavy type, although they will naturally finish their guns with the fine type if so desired. Personally I like the fine engraving, but this is solely a question of individual preference.

The last process of all in the finishing of the gun is the case-hardening of the action body and side-plates.

To do this the gun is completely stripped and the parts to be case-hardened are placed in bone ash and heated in a furnace to a dull red heat, when the surface layer of the steel absorbs carbon. This treatment results in the steel being coated with a layer of intense hardness, while the strength of the inside is unaffected.

The colour of case-hardened steel is different, comprising the most beautiful shades of browns and blues. But unfortunately this colour is not permanent and gradually fades in use. It is not difficult to get a good colour; nor is it particularly difficult to obtain the correct degree of hardness; but it is a matter of considerable difficulty to get a combination of beautiful colour and proper hardness.

After the case-hardening the gun is reassembled and can be considered as finished. The side plates and action are sometimes given a coat of thin varnish to protect them and so preserve the colour. But this varnish soon wears off, seldom lasting more than a season. For this reason I have made it a practice with one gun of mine which has an exceptionally beautiful colouring to have the side plates revarnished at the end of each season. The result has certainly been gratifying as the colour is still as good as ever, although other guns made at the same time have lost theirs.

The gun is now finished, but before I close this chapter I will take the opportunity of emphasising again the great difference in actual quality between really best grade and cheap guns. I know that I have constantly referred to this difference, but even so I regard it as something so vital that it is impossible to over-estimate its importance.

In a best gun, that is a real best gun, no detail is too small for the closest attention throughout the whole process of manufacture. The fit of the bolts, and yet the smoothness of working, are perfect: and the bearing surfaces between bolts and grips carefully made of equal hardness. This is a most important detail, as were one surface harder than the other the softer would soon be worn away and looseness would be established.

The difference in the cost of the raw materials in a best gun and of those of the cheapest may not seem to be very great, except in the case of the barrels and stocks, and, after all, there is not much else left! But the real difference in the cost is in the labour expended.

Over sixty per cent. of the actual selling price of a best gun represents the cost of labour. And when one remembers the costs of raw material, and overhead charges such as the upkeep of machinery, heating, lighting, etc., as well as the expense of shooting and regulating, it may possibly be realised that gunmakers are not the profiteers which they are often declared to be. Then there are such items as rents and rates on establishments, and the truth is that in the end the actual percentage profit on a best gun is appreciably smaller than on the cheapest sold. I am quite sure that it is impossible to get better value for money in any other commodity than is given in a best gun, and for this reason a best gun is the cheapest article which can be bought for the price demanded.

CHAPTER VII

SPECIAL ACTIONS

WE have now completed a description of what can be regarded as the standard types of game guns. As has been pointed out, there are many minor differences which are adopted by various gunmakers: but the general principles of the actions and mechanisms which have been described are common to almost all. There are, however, a few actions which differ so materially from the normal, either in the whole design or else in some important part, that they deserve special attention. Such actions are the specialities of the following gunmakers, whom I have purposely placed in alphabetical order so as to avoid any seeming suggestion of superiority: Boss; Dickson; Greener; Holland and Holland; Lancaster; Purdey; Rosson; and Westley Richards.

I will take these special actions in turn, and it will be interesting to note how many of these specialities have been designed with a view to increasing the ease of opening the gun after firing.

THE BOSS ACTION

The individuality of this action is the ejector, the other parts being similar to what has been described, bar action side locks always being used which are fitted with intercepting safeties of the type shown in the upper photographs of Plate VII.

The ejector, however, is quite distinct and the principle of its design is shown in Fig. 40A.

A slide, S, is operated by a coiled spring, the other end of which butts against a stop which is an integral part of the frame of the fore-end. The front end of this slide is a long rod which is situated in the middle of the coiled spring and which runs in a hole in the stop, as shown in the diagram. The top of the slide protrudes above the upper face of the fore-end and drives the extractor leg backward in ejection.

When the fore-end is removed from the gun the slide, S, is held in its forward position, the coiled spring being compressed, by the tipper, or sear, T. This tipper

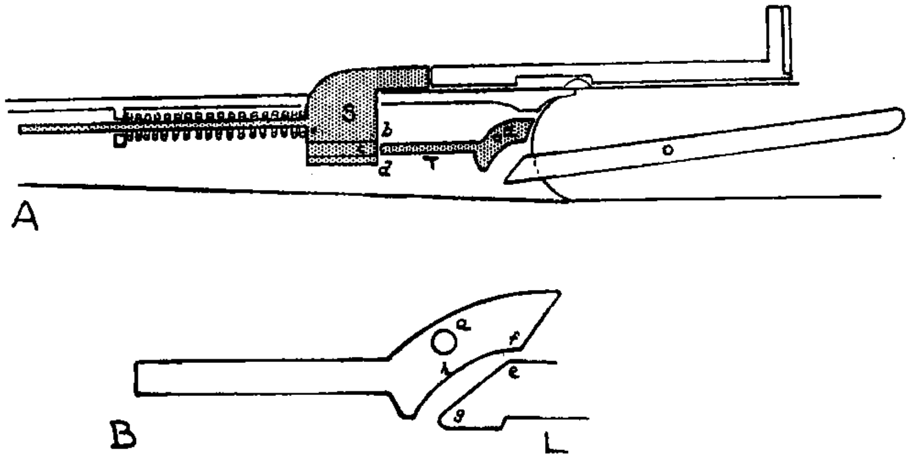


FIG. 40.—The Boss ejector.

is pivoted at *a* and its front end is raised by a spring (not shown in the diagram) so that it butts against the rear end of the slide at *b*, thus holding the slide forward. But directly the fore-end is fitted to the gun, the knuckle of the action presses up the rear end of the tipper and rotates it slightly about its pivot so that the front end comes opposite a slot, or gutter, in the slide, which is marked *c* in the diagram. When the tipper is in this position the slide can move forward under the pressure of the spring, the point of the tipper merely lying in the gutter, *c*, in the slide.

The slide, however, is held back when the gun is closed by the extractor leg which butts against it, keeping the spring in compression.

On the gun being opened in the normal manner without having been fired, the coiled spring forces the slide against the front end of the extractor leg which in turn forces the extractor against the face of the action, and thus helps the opening of the gun. But as the motion is gradual and not a sudden blow, the extractor is not *flicked* backwards so as to produce ejection.

When the gun is fully open the coiled spring is extended and has forced the extractor right back to the limit of its movement. The extractor head is thus pushed farther out from its place in the breech end of the barrel than is done by an ordinary extractor cam, and the cartridges in the gun are withdrawn considerably farther than in other guns.

In an ordinary ejector gun when one barrel is fired and the gun is opened it will be seen that the extractor which has been operated by the ejecting mechanism is protruding appreciably farther than the one which has been only operated by the extractor cam. The extractors in ejector guns always move farther out than those in non-ejector guns because the extra range of movement is necessary for the production of perfect ejection. And in ordinary ejector guns the extractors are not withdrawn to their full limit except on ejection. In the Boss action, however, the extractors are *always* withdrawn to their full distance whenever the gun is opened, and whether it has been fired or not, because the ejector springs are always free to act when the fore-end is in position on the gun. This results in the cartridges being withdrawn a greater distance when the gun is opened for unloading for any reason, and this certainly makes the operation of unloading easier in cold weather as a larger portion of the cartridge is available on which to get a hold with the fingers.

On the gun being fired the cocking lever, L, is lifted in the knuckle when its action on the ejecting mechanism can best be followed by the help of the diagram in Fig. 34B, which gives an enlarged view of the front end of the cocking lever and the tipper, or sear, in the fore-end.

As the front end of the cocking lever, L, is lifted on the gun being fired, the corner, *e*, hits the point *f* on the tipper, T, and rotates it about its axis, *a*, until its point comes opposite the point *d* on the slide (Fig. 34A), which is below the gutter, *c*, and thus holds the slide forward and keeps the spring in compression.

As the gun is opened, primary extraction is achieved by a cocking cam as usual, and the point *g* of the cocking lever (Fig. 34B) is brought into contact with the curved edge, *h*, on the tipper. This curve is eccentric to the movement round the knuckle, and when the gun is nearly fully open the point, *g*, pushes the tipper so that it rotates slightly about its axis until its front point comes opposite the gutter in the slide of the ejector.

Directly this happens there is nothing more to hold the coiled spring in compression, and it is immediately released, when it flicks the slide backward with considerable force against the end of the extractor leg, thus producing ejection.

On the gun being closed after loading, the slide is forced back by the extractor leg into its original position, but the slide is not *held* back by the tipper until the cocking lever, L, lifts the front end of the tipper and so brings its point against the bottom of the slide at *d*; and this only occurs on the gun being fired.

This is undoubtedly an extremely simple and efficient ejector which helps the work of opening the gun for unloading. In fact, if one wants to unload, it is only necessary to press over the action lever, when the gun opens by itself an account of the pressure of the extractors against the face of the action. This effect, however, is only produced when the gun has not been fired, and therefore when the work of opening is not so difficult owing to there being no necessity for compressing the mainsprings since the locks are already cocked. When the gun has been fired the ejector spring is held in compression until the movement of opening is almost complete, and consequently they cannot take any part in helping this movement.

The real advantage in this ejector lies in the fact that the cartridges are always withdrawn to the full extent whether the gun has been fired or not.

It is only fair to state, however, that if one turns a gun over, both cartridges will drop into the hand considerably quicker than they can ever be withdrawn singly; and so it is doubtful whether this advantage is very material.

There is also the point that even if a coiled spring breaks it is still effective, whereas when a V-spring breaks it is useless. But V-springs are now so well made that they are wonderfully reliable.

The chief point about the Boss ejector is that it is easy to regulate and is free from any disadvantages, while it does possess the advantages which have been given.

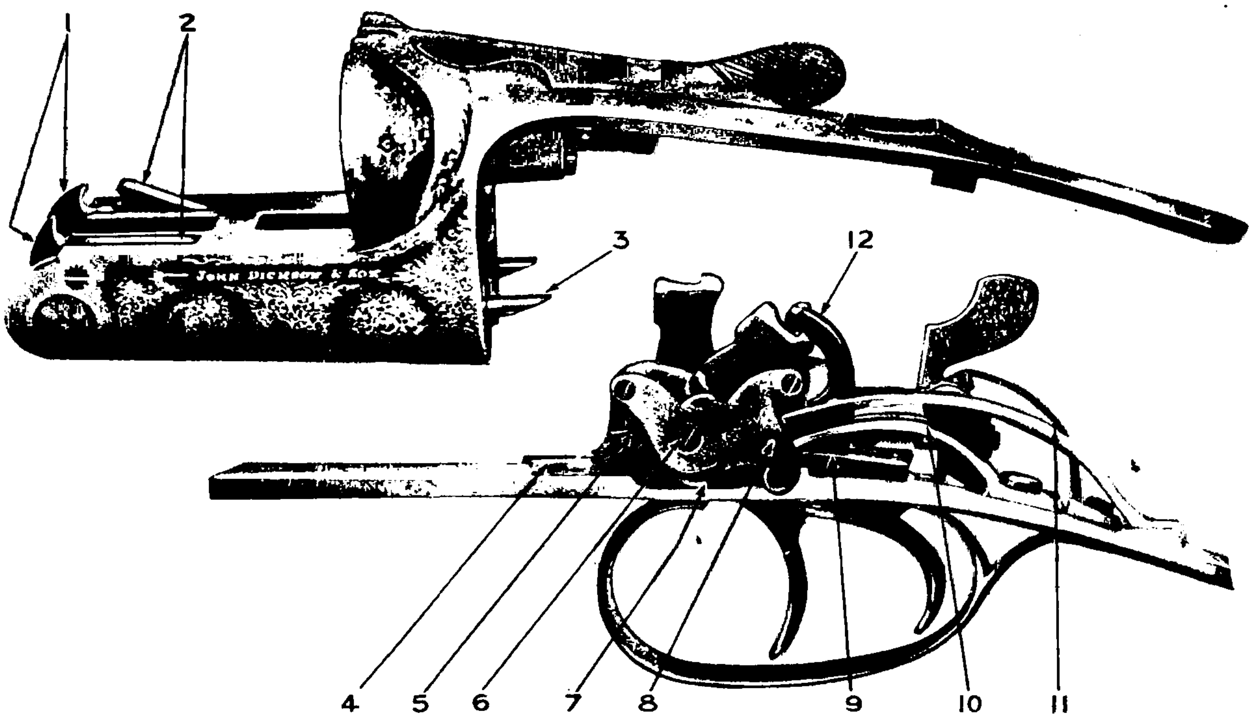
THE DICKSON "ROUND" ACTION

The Dickson Patent "Round" Action, which is the descendant of the old Macnaughten Trigger Plate Action, is something as distinct as it is unique in design, being the connecting link between box and side locks.

The name is derived from the rounded shape of the body as well as from the absence of square or sharp edges. The original Patent was obtained in 1880, and the locks are carried entirely on the trigger plate and are inserted from underneath; but they occupy a space *behind* the body of the action, as do side locks. The two photographs on Plates IX and X show how the locks fit in behind the action body. In Plate IX the locks are seen detached from the body of the action, being carried by the trigger plate; but in Plate X the trigger plate with the locks has been placed in position.

The foundation for each lock is formed by a plate which is an integral part of the trigger plate and which stands up in the middle of the action, and between the locks. This vertical plate carries one lock on either side, and really corresponds to a side-plate in a side lock, except that in the Dixon action the plate supports both locks instead of one.

A bridle is screwed to each side of this central plate, and the tumblers and sears are situated between the central plate and these bridles, each bridle being secured by three pins, as can be seen in Plates IX and X. In Plate IX the left lock is cocked and the right is in the



THE DICKSON "ROUND ACTION"

1, Extractor Kickers; 2, Ejector Compressors (right, unset; left, set); 3, Ejector Rod (cocked); 4, Cocking Lever; 5, Ejector Lug; 6, Tumbler Axle; 7, Sear Nose (in bent); 8, Sear Peg; 9, Sear; 10, Sear Spring; 11, Main Spring; 12, Intercepting Safety

PLATE IX

fired position, so both tumblers are visible; but in Plate X both locks are cocked.

The mainsprings are quite different to those of any other locks, being strong flat springs which are held at the rear ends in beddings in the trigger plate.

The connection between the front ends of the mainsprings and the tumblers is effected by means of small rollers, and Fig. 41 shows how this connection is made. The roller fixed to the front end of the mainspring, S, is clearly shown. This roller fits in a curved recess in the tumbler, T, only part of which is shown. The pressure exerted on the tumbler by the spring must act along a line joining the centre of the roller and its actual

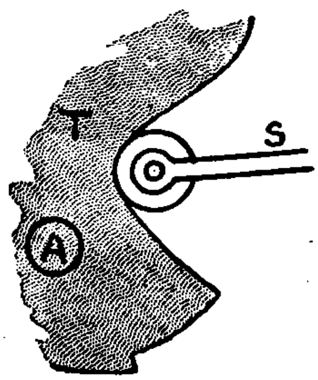


FIG. 41.—The connection between the mainspring and tumbler in the Dickson "Round" action.

point of contact with the tumbler. When the tumbler rotates the position of the roller with respect to the tumbler axle, A, is changed, and the line of direction of the pressure applied to the tumbler is also changed. The part of the tumbler on which the roller bears is so shaped that this line of application of pressure is further from the tumbler axle in the "fired" position than it is in the cocked position; and consequently the leverage for revolving the tumbler is greater in the former case than in the latter. The result is that the efficiency of the spring is maintained throughout the fall of the tumbler just as it is when a swivel connection is used.

The sear spring is of the same type, but is in the shape of a two-pronged fork screwed to the lock plate, one prong working on each sear.

It will be seen that since the mainsprings are placed behind the tumblers these locks are really back action locks, but since each spring has but a single arm, and not two like a **V**-spring, they do not occupy so much space and there is, therefore, ample room for siting the sear peg to the greatest advantage. This has been done, and both Plates IX and X show that the angle formed by the tumbler axle, bent, and sear peg is a right angle. Further, the sears themselves are short, and so no exaggerated movement of the trigger is necessary to release the sear nose from the bent. The result is that these locks provide the same ideal facilities for the regulation of the trigger pulls as is found in bar action side locks, but in no others.

SYSTEM OF COCKING. The tumblers are cocked, and the mainsprings compressed, by the fall of the barrels on the gun being opened, but here again the principle of the action is different from that of any other.

In order to understand it the section through the bar of the action shown in Fig. 42 should be studied.

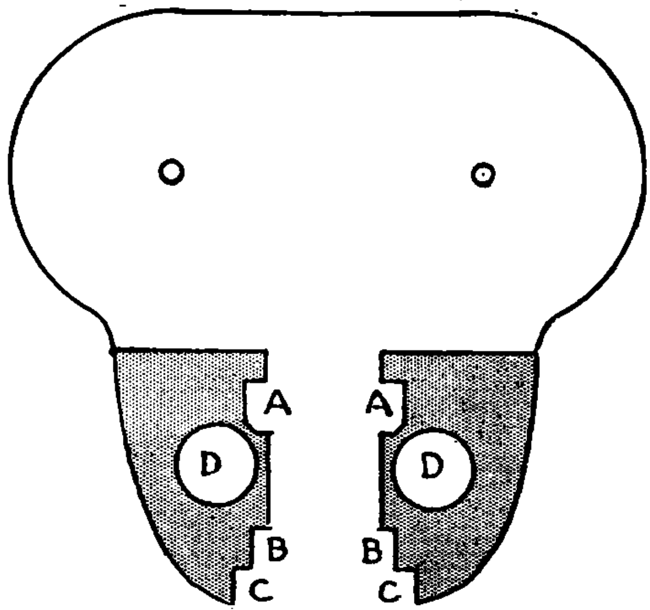


FIG. 42.—The Dickson " Round " action gun. A cross section through the bar of the action immediately in front of the action face.

A,A—the slot for the action bolt. B,B—the slot for the bar which operates the cocking levers. C,C—the slot into which the trigger plate fits. D,D—the holes for the ejector rods and spiral springs.

In this section the vertical space in the middle is for the lump, as in all other actions, and AA is the slot for the action bolt, and CC that for the trigger plate; also as in other actions.

Immediately above the trigger plate, however, there is another slot, BB, in which a flat bolt is free to move longitudinally. The front end of this bolt butts against a specially shaped lug on the fore-end, and when the gun is opened and the fore-end revolves round the knuckle, this lug pushes the bolt to the rear in the slot BB.

The rear end of this bolt is fitted with a short arm on each side, and these two arms press against the front ends of the cocking levers and push them back as the bolt moves back. The cocking levers are pivoted to the tumblers, and so the backward movement of the special cocking bolt is translated into a turning movement on the tumblers, which are rotated into the full-cock position when the sears engage in the bents.

On the gun being closed a special projection on the bottom of the forward lump engages in a slot in the front end of the cocking bolt and draws it forward out of the way of the cocking levers which move forward as the tumblers fall.

It will be seen that the force of cocking is applied as a direct thrust by means of the cocking bolt, the power which generates this thrust being derived from the lower part of the fore-end as it rotates round the knuckle. Thus the weight of the barrels as they fall is utilised to help drive back the cocking bolt, and the mechanical advantage is very good, while the effort is distributed evenly throughout the opening of the gun.

I do not think that this system results in any noticeably increased ease in cocking, but it is certainly as good as any other, and far better than some cheap box locks in which the friction set up by the moving mainspring is considerable.

Safety Devices. There is an ordinary top safety slide which bolts the rear ends of the trigger blades, as in all guns, but the automatic action is somewhat different, as the action bolt is used for pushing the safety stop into position on the gun being opened. The rear end of the action bolt butts against the front end of a curved rod and pushes it back as the bolt is withdrawn by the cam on the spindle of the action lever. The other end of this curved rod is attached to the safety lever and so the safety stop is forced into position over the trigger blades. In Plate IX this safety stop is in the "Safe" position over the trigger blades; and in the lower photograph it is in the "Fire" position.

In addition to this standard arrangement there is a special device for the purpose of preventing a double discharge, that is, one barrel being jarred off by the other.

This consists of a small pendulum (see Plate X) which reaches down from an overhanging part of the safety lever and is held in position centrally between the two trigger blades by a spring. The outside edges of this pendulum are bevelled, and when the right trigger blade is raised the pendulum is forced over the left blade and thus locks it in position for as long as the pressure is retained on the right trigger. When this pressure is released the pendulum assumes its central position once more and the left trigger can then be pulled.

On the left trigger being pressed the opposite action takes place and the right trigger is locked.

There is no intercepting safety, and I think this must be regarded as a weak spot in the design of the locks. I am well aware, and have already pointed out, that these intercepting safeties are by no means the absolute safeguard in practice which they are in theory. But I do believe that their presence provides an additional element of safety, and for this reason I think that they should not be omitted; and this belief is apparently shared by all makers of high-grade side lock guns, for all such guns are fitted with intercepting safeties.

This omission of an intercepting safety seems all the more extraordinary in view of the fact that there appears to be ample room for its accommodation. Were one fitted, this lock would be in all respects the equal of the very best design of bar action side lock, as its efficiency is ensured by the roller connection between tumbler and mainspring, while the sear pegs are centred to the best possible advantage for obtaining perfect trigger pulls.

EJECTOR MECHANISM. The design of the ejectors is as unique as that of any other part of the action. The long legs of the extractors are not semicircular in section, both fitting into the same hole in the barrels, but are entirely separate. Each leg is circular in section and fits into holes drilled into the barrels, as shown in Fig. 43.

It can be stated at once that such a placing of the holes requires the greatest care if the walls of the barrels

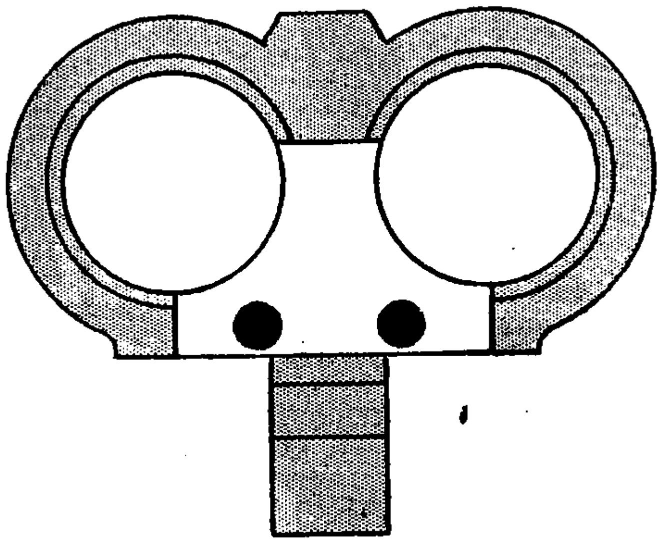


FIG. 43.—The Dickson "Round" action gun. The breech end of the barrels with the extractors removed, showing the separate holes for each extractor leg.

are not to be weakened. In order to make room for the holes there must be slightly greater thickness below the bottoms of the chambers than is usually necessary. The drawing in Fig. 43 has been made carefully to size and scale, and shows the holes for the extractor legs. The barrels are chopper lumped, as would be expected in a best-grade gun, and I am quite certain that there is an ample margin of safety and strength.

The extractor legs being situated on either side of the centre means that they cannot be actuated by an ordinary extractor cam, and so this somewhat unsightly projection is left out. This in itself is a practical advantage because an extractor cam is always liable to get broken, apart from increasing the difficulty of putting a gun together.

Instead of a single cam each extractor leg is actuated by a separate "kicker." These can be plainly seen in Plates IX and X. Fig. 44 gives a longitudinal section of the bar of the action showing the ejector mechanism, all of which is situated in the body of the action, none being in the fore-end as in other types of ejectors.

In Fig. 44, *a* is the kicker, which pivots about a pin screwed into the bar. The top end of this kicker fits

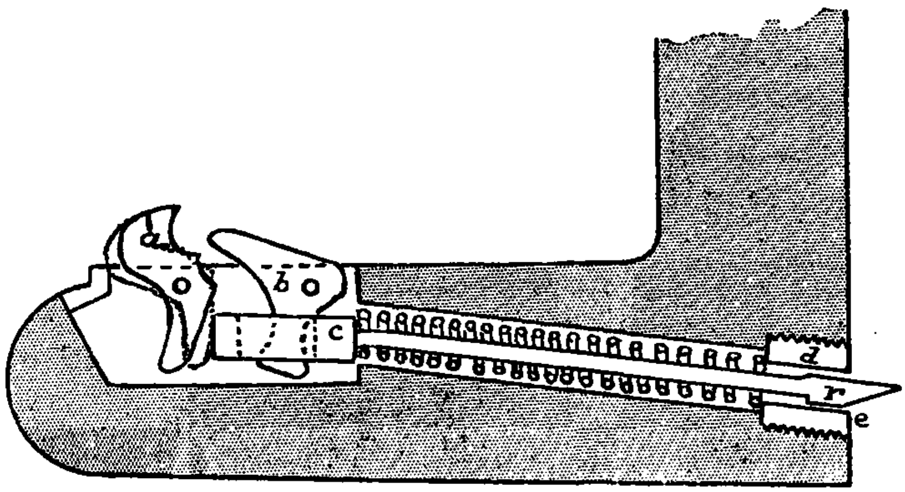


FIG. 44.—The Dickson "Round" action. The ejector mechanism. *a*, the kicker for the long leg of the extractor. *b*, the compressor which works in a slot in the plunger, *c*. This plunger is attached to a rod, *r*, which protrudes from the rear of the action body, and which lies in the middle of a spiral spring which is held between the plunger and a screw bush, *d*.

just in front of the forward end of the extractor leg. When the gun is opened the kicker butts against a stop in the bar which prevents it from turning any farther, as shown by the dotted position in the diagram, and it then acts exactly like an ordinary extractor cam, forcing the leg of the extractor back as the barrels are turned round the knuckle.

Pivoted about another pin, and in the same slot as the kicker, there is a "compressor," *b*. The lower end of this compressor works in a slot in a cylindrical plunger, *c*. The rear end of this plunger is attached to a rod which lies in a circular hole in the bar of the action (Fig. 42, D, D) and ends in a specially shaped head, *r* in Fig. 44, which just protrudes out of the back of the action body.

Round this rod there is a coiled spring, one end of which butts against the plunger, *c*, and the other end against a screw bush which is let into the back of the action body and is marked *d* in Fig. 44.

On the barrels being closed the flats press down the compressors, of which, for obvious reasons, only one is shown in Fig. 44. As the compressor, *b*, is pressed down it turns about its pin and its lower end forces the plunger, *c*, to the rear, thus compressing the coiled spring. When the compressor is almost flush with the flat of the bar the head of the rod, *r*, is protruding farther from the back of the action and a notch in this head catches on the corner, *e*, thus holding the rod and plunger back and keeping the spring compressed.

The ejector is now set.

In Plate X the left ejector is set, and the right is not. The left ejector rod is seen to be protruding farther from the action body, while the compressor is flush with the flat of the bar. In the right ejector the rod does not protrude so far and the compressor is raised up above the level of the flat of the bar.

On the gun being fired the tumbler of the lock falls.

As the gun is opened after firing, the kicker (Fig. 44, *a*) forces the long leg of the extractor back, thus causing primary extraction. At the same time the cocking lever gradually forces the tumbler of the lock round towards the full-cock position. But just before it reaches this position a lug on the bottom front corner of the tumbler engages with the head of the ejector rod, and lifts it out of "catch." The spring is thus released, when it flicks the plunger (Fig. 44, *c*) forward against the bottom end of the kicker, which imparts this sudden blow to the end of the extractor leg and thus throws the extractor backward, so causing ejection of the fired case.

In Plate X the head of the ejector rod is seen almost touching the lug on the bottom front corner of the tumbler. This photograph was specially taken without the trigger plate being placed quite tight home so as to avoid touching the head of the ejector rod with the tumbler, and it shows how the lug on the tumbler lifts the head of the ejector rod out of "catch."

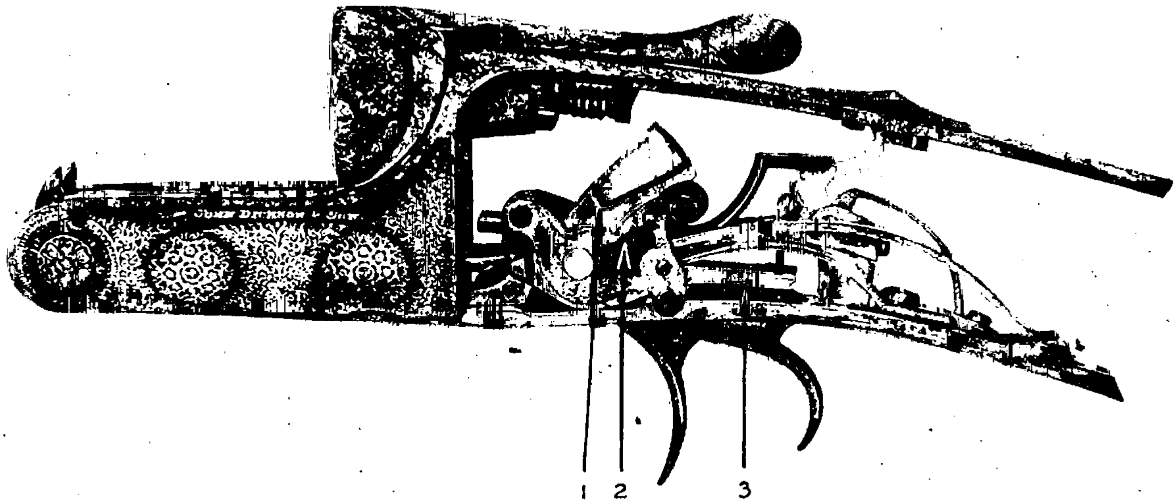
This ejector is simple and efficient; while being in the body of the action it results in a lighter fore-end, and so greater concentration of the total weight in the middle of the gun. But in this respect it must be admitted that the weight of the ejector mechanism is very small, and I doubt whether the change of position from the normal makes any noticeable difference in the handling of the gun.

As in the Boss ejector the springs are spiral; and so, if one should break, it will still be effective. Here again, however, I think the advantage is more theoretical than actual.

It will have been noticed that the locks are cocked on the gun being opened, and the ejectors set on the gun being closed. Equalisation of effort is thus obtained.

STRENGTH. But the outstanding merit of this action is its strength. An inspection of the section through the bar of the action which is given to exact scale in Fig. 42 will convince anyone of the great strength of this type of bar as compared with any other type, even of a back action side lock action. The only weakening of the bar is the hole for the ejector rod and spring; and this is a circular hole which weakens the bar less than a rectangular hole of the same area, as was explained on page 56 when discussing cross-bolt top extensions. Owing to the special design of the cocking system, there are no cocking levers extending through the bar requiring deep slots to allow for their movement.

There is the additional fact that the absence of long cocking levers obviate the necessity for a long bar to the action, and consequently the bar of this "Round" action is as short as that of a box lock, thereby possibly making the bar slightly stiffer and stronger, section for section, than any ordinary side lock bar. The section given in Fig. 42 is that of a gun weighing but 5 lb. 14¼ oz., with 28-inch barrels. This fact will demonstrate the great possibilities of strength in this action.



THE DICKSON "ROUND ACTION"
1, Tumbler; 2, Bridle; 3, Trigger Blade
This illustration does not show the Intercepting Safety

On account of this special strength and rigidity a top extension is quite unnecessary.

I have dealt with this Dickson action at considerable length because it is so unique and has such undoubted merits that I think it deserves description in detail. The workmanship is faultless, and the design of the lock such that it is as good and efficient as a bar action side lock. I do not see that it is any *better* than a bar action side lock, but it is certainly as good, although I think the addition of an intercepting safety should be made. Its great merit, however, lies in the strength of the bar; and on this account it is peculiarly well adapted for the building of very light guns.

THE GREENER "FACILE PRINCEPS" ACTION

Messrs. Greener have always specialised in box lock actions and have evolved two actions which differ materially from the ordinary Anson and Deeley. The first of these is known as the "Facile Princeps" action, a diagram of which is given in Fig. 45.

The chief feature of this action is the system of cocking, the usual cocking levers being omitted, and the actual raising of the tumblers being carried out by the forward lump.

The lower front parts of both tumblers consist of long arms which reach forward into the bar of the action as far as the rear face of the slot which receives the forward lump. The front ends of these tumbler arms are curved inwards until they almost meet in the middle line of the bar.

In Fig. 45A the side view of the left tumbler is shown, *a* being the cocking arm.

In Fig. 45B both tumblers are seen from below, *a* being the arm of the left tumbler as before.

In the bottom of the forward lump, *b* (Fig. 45A), there is a plunger, *c*. When the barrels are separate from the stock this plunger can be pushed right home into its circular recess in the lump. But when the fore-end is fitted on, a projection in the lower edge of the fore-end, *d*, fits into a corresponding slot in the front edge of the forward lump and holds the plunger, *c*, so that it protrudes to the rear.

On the gun being opened this plunger, or cocking piece, which is situated just under the junction of the two curved cocking arms of the tumblers, lifts these arms

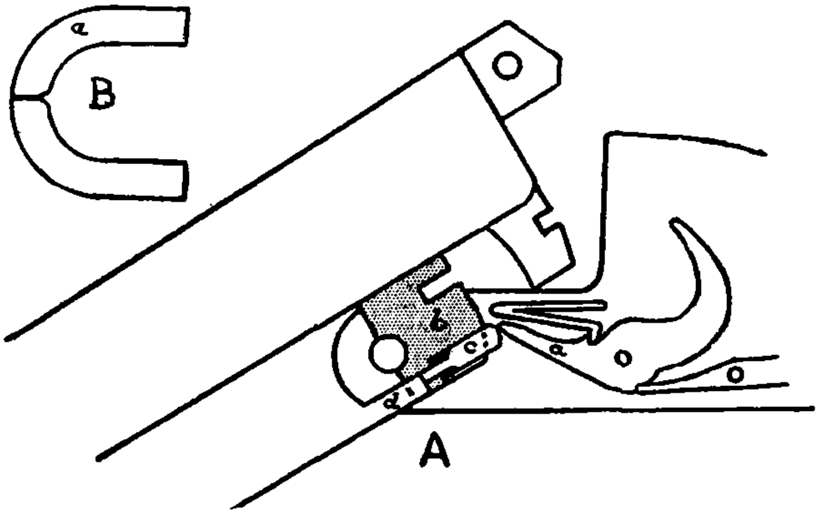


FIG. 45.—The Greener "Facile Princeps" action.

and so rotates the tumblers until the sear noses slip into the bents and hold the tumblers at full cock.

If only one lock has been fired there is naturally only one tumbler to lift, but the action is just the same.

There is no extractor cam on the knuckle of the action, but one is fixed to the rear end of the fore-end instead.

The cross-bolt top extension is always fitted.

The action as described is a non-ejector, but an ejector can, and frequently is, added; the Baker ejector almost always being used. This has already been described, so a further description is superfluous.

THE GREENER "UNIQUE" ACTION

This action differs from the previous one in that it is always an ejector action, the ejecting mechanism being certainly quite unique, as there is no separate ejector spring, the mainspring of the lock being used to operate the ejector as well as the tumbler.

The principle of cocking is, in the main, similar to that employed in the " Facile Princeps " type of action, the power being applied by the bottom of the forward lump which is fitted with a sliding " tripper," which is held protruding backward by a projection on the bottom of the fore-end. But instead of there being a single " tripper " or plunger, a separate one is fitted on each side of the lump, and consequently the curved cocking arms of the tumblers do not reach quite so far inward towards the middle of the action.

On each of these special cocking " trippers "—Messrs. Greener call them " swivels," but this name seems to be likely to confuse and so I have termed them " trippers " —is pivoted an ejector lever, the upper end of which reaches into a slot in the extractor leg.

Fig. 46 is a diagram of this action, and in this drawing

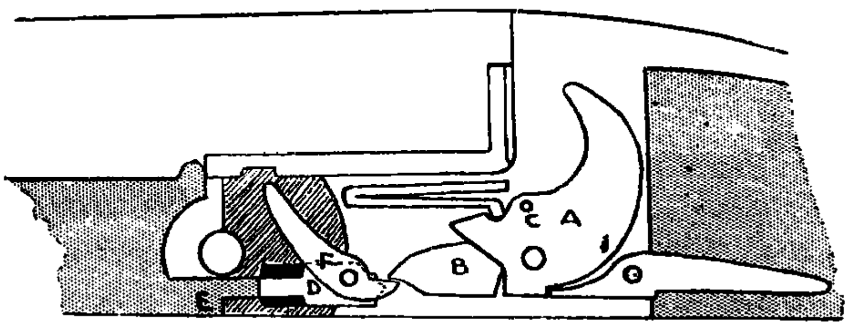


FIG. 46.—The Greener " Unique " action.

D is the cocking " tripper," which is kept protruding backward from the lump by the projection on the fore-end, E. The ejector lever is marked F.

We now come to the other difference between this action and the " Facile Princeps," namely, the cocking arms of the tumblers. These are not solid with the tumbler, but are separate parts. In Fig. 46, A is the tumbler, and B the cocking arm which is pivoted to the tumbler at C.

The effect of this arrangement is that when the tumbler is rotated round its axle to the full-cock position, the arm B is drawn to the rear and so shortened.

We now come to the working principle of the action which is as follows:

On the gun being opened after firing, the cocking arm of the tumbler, B, is right forward and is engaged by the cocking "tripper," D, as the barrels are turned about the knuckle. This movement cocks the lock, both parts of the tumbler moving together until the tumbler has been rotated about its axle to such an extent *that the bent has moved some little way past the sear nose.* This, of course, puts extra compression on the mainspring.

The gun is at this moment open to its full extent, and primary extraction has been achieved by a cam on the fore-end as in the "Facile Princeps" action.

When this position is reached the front end of the cocking arm, B, slips past the point of the "tripper," D, *and by the power of the mainspring, which is in a state of maximum compression,* is flicked down on to the lower end of the ejector lever, F. This blow on the lower end of the lever, F, turns it about its axis and the top end hits the extractor leg, thus causing ejection.

As the gun is closed the main part of the tumbler, A, is forced round by the mainspring until the bent comes up against the sear nose, which prevents any further turning of the tumbler, and the lock is held at full cock.

On the gun being fired the cycle of operations is repeated.

Owing to the space necessary for the free movement of the ejector lever, there is no bite in the forward lump. At first sight this may seem a source of weakness, but I do not think it is in view of the fact that there is a good bite in the rear lump and a stout cross-bolt top extension is always fitted.

This action is certainly extremely ingenious, the utilisation of the mainspring for the work of ejecting as well as that of firing being particularly clever. There is the advantage of having all the weight concentrated in the actual body of the action, which has already been explained in the description of the Dickson "Round" Action; but in other respects there do not seem to be any points of sufficiently striking superiority to warrant the suggestion that this is a better type of action than those normally employed.

It should be noted, however, that both these Greener actions are distinctly superior to the great majority of Anson and Deeley actions in the matter of the correct centring of the tumbler sears, and in most Greener locks the angle formed by the tumbler axle, the bent and the sear peg is very nearly, if not quite, a right angle. This placing of the limbs is possible on account of the somewhat exceptional thickness of the upright part of the action, or standing breech, which gives more latitude for the placing of the sear peg. The result is that Greener locks must be superior in the matter of trigger pull to ordinary Anson and Deeley locks, although the long sear arms which are inseparable from any box lock must prevent them from being quite on the same level as a well-designed bar action side lock.

The extra thickness through the standing breech, which is typical of most Greener actions, must also add to the strength of the action: but it adds to the weight as well. Greener guns, however, are invariably up to full weight, as this firm have very rightly always attached great importance to *width* of action, so as to maintain strength.

Both the "Facile Princeps" and "Unique" actions possess the simplicity of the Anson and Deeley in conjunction with improved trigger pull. And when the solid strength of these somewhat heavy guns is remembered, it is not surprising that Greener weapons are extremely popular in the Dominions, Colonies, or unpopulated parts of the world where strength and reliability are of primary importance.

In almost all Greener guns the usual pattern of safety bolt is replaced by a simpler device which is operated by a bolt on the side of the stock just in rear of the action body. This safety device locks the trigger blades, but is non-automatic; that is, it is not operated by the action lever on the opening of the gun. Consequently a gun must always be set definitely at "safe," as it will not be so set automatically when re-loading. Many shooting men consider this non-automatic safety as a source of danger; but the Greener device tends to a somewhat stronger stock as it occupies less space than the ordinary mechanism, which means that less wood need be cut away to receive it. Further, in Greener actions the main pin holding the stock and action together is situated at the back end of the trigger plate and action strap, thus ensuring great strength and holding power.

THE HOLLAND SELF-OPENING GUN

The special feature of the Holland Self-opening gun lies in the addition of a mechanical device which makes the effort of opening the gun, whether it has been fired or not, so easy that all that is necessary to do is to push over the action lever, when the gun opens by itself, ejecting the fired cases when it has been fired, or merely dropping the barrels when it has not.

Before considering this device it should be remembered that the opening of the gun cocks the locks and compresses the mainsprings, so the effort entailed in this operation is entirely saved.

The device is only fitted to best-grade guns which are of the ordinary bar action side lock type with the "Holland," or "Southgate," ejector.

The mechanism comprises only three parts, namely,

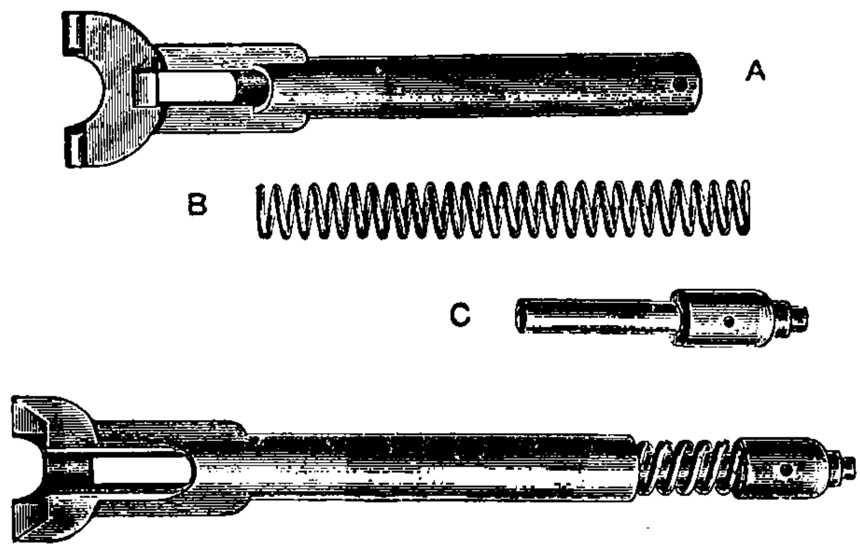


Fig. 47.—The component parts of the Holland Self-opening mechanism.

a slide (A in Fig. 47A) which is operated by a coiled spring, B, and a plunger, C.

Fig. 47B shows these three parts assembled, the underneath side of the slide being shown, while in Fig. 47A the upper side of the slide is seen.

The plunger is anchored to the loop for the fore-end, and this is brazed to the barrels as described in Chapter I. The two ends of the slide fit on either side of the forward lump, the whole attachment being contained in the natural recess formed between the barrels, as shown in the top photograph of Plate XI.

In order to understand the mechanism, let us put the gun together in the ordinary way.

When the barrels are hooked on as usual, it will be found that the two ends of the slide which lie on either side of the forward lump butt against corresponding projections on the knuckle of the action. As the barrels are lifted the slide is pushed forward by these projections until the rearmost ends of the slide are clear of the front edge of the forward lump, when the gun is finally closed.

During the forward movement of the slide the coiled spring has been compressed between it and the plunger, which is anchored in the loop, as already mentioned.

Fig. 48 shows in diagrammatic form how this compression is brought about.

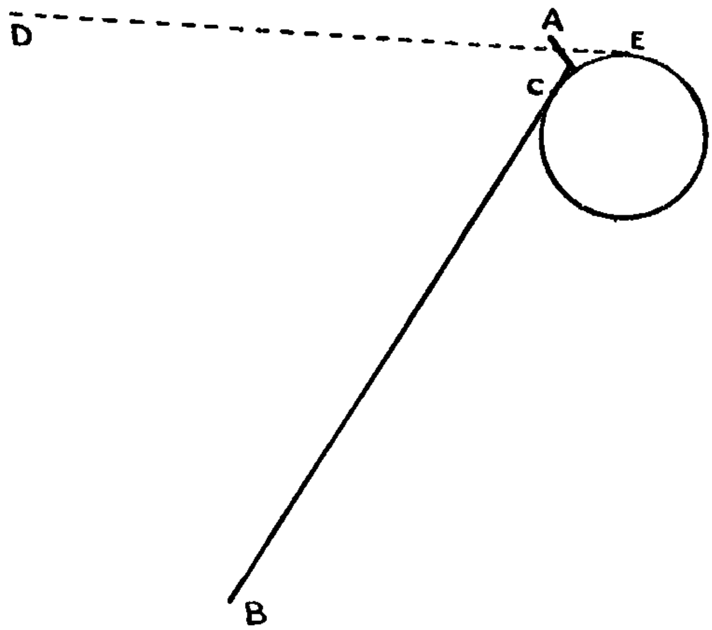


FIG. 48.—Diagram to show the principle of the Holland Self-opening mechanism.

Here A is the projection on the knuckle of the action, and B the loop which is brazed to the barrels. C is the position of the forward edge of the forward lump when the barrels are first hooked on to the action. As the barrels are raised the front edge of the forward lump moves along the arc of a circle upward and rearward, passing the point A, until it reaches its final position, E. In this final position the loop occupies the position, D.

Now the distance between the front edge of the forward lump and the loop is obviously fixed, since both ends are fixtures on the barrel.

The distance between the projection on the knuckle of the action and the loop is not thus fixed. In the first instance this latter distance is AB, which is greater than the fixed measurement BC; and in the final position this distance has been reduced to AD, which is less than DE, a measurement which is the same as BC.

It will thus be seen that the fixed point A is gradually approached and finally passed by the front edge of the forward lump as the latter changes position from C to E.

But we have already seen that the rear end of the slide butts against this fixed projection, A; which means that the slide is pushed forward through a distance AE, thus compressing the coiled spring by this amount.

The fore-end is snapped on in the usual manner, the tops of the ejector tumblers fitting in the slot cut through the slide for this purpose.

So long as the gun is closed the coiled spring is under compression, but directly the bolt is withdrawn from the bites in the lump when the top lever is pushed over, this spring asserts itself and pushes the slide rearward against the projection of the knuckle of the action. Since the bolt is no longer holding the barrels down, this rearward pressure of the slide forces the barrels over, thus opening the gun. At the same time this opening of the weapon compresses the mainsprings and operates the ejection of the fired cases.

The method of operating the ejector tumblers for the purpose of primary extraction when the gun has been fired, or normal extraction of the unfired cases when the gun is merely opened for unloading, is different from that employed in ordinary guns.

The tumblers are each made in two pieces which interlock, one of these pieces being the tumbler proper, and the other a " driving member " which carries the over-centre edge. They are so fitted that the tumbler can move independently of the " driving member," but directly the latter is operated it engages with the tumbler and carries it with it.

The effect of this arrangement is such that a portion of the knuckle of the action bears on the lower ends of both tumblers and forces them round when the gun is opened, thus causing primary extraction, when the gun has been fired, or complete extraction when it has not. When the gun has been fired the cocking levers operate the " driving members " of the tumblers and force them over-centre as in an ordinary Southgate ejector, with the result that they flick the tumblers round after the movement necessary for primary extraction has been carried sufficiently far.

This is a distinct improvement as it does away with the necessity for an extractor cam on the knuckle, and thus adds to the neat appearance of the gun as well as removes a projection which is liable to become damaged, and which tends to make the act of hooking the barrels on to the action when putting the gun together slightly more difficult, as the extractor cam must always be fitted into its proper place in front of the extractor legs.

As the barrels are lifted once more after reloading the slide is pushed forward again and carries with it the top parts of the ejector tumblers. These tumblers can only move *backward* independently of the " driving members," and so when they are pushed *forward* by the slide they carry the " driving members " with them, and thus cock the ejectors.

Fig. 49A shows the slide in its rearmost position with the ejector tumblers uncocked, and Fig. 49B shows the final position occupied by the slide when the gun is closed with the ejector tumblers fully cocked.

There are three possible objections to this device;

First, there is the complication to the working parts of a gun by the addition of an extraneous attachment.

It is true that simplification in design and elimination of unwanted limbs have been the main object of gunmakers for very many years; but at the same time this new mechanism is so simple that the working parts of the gun cannot be regarded as being in any way complicated by its addition. It is entirely hidden from view,

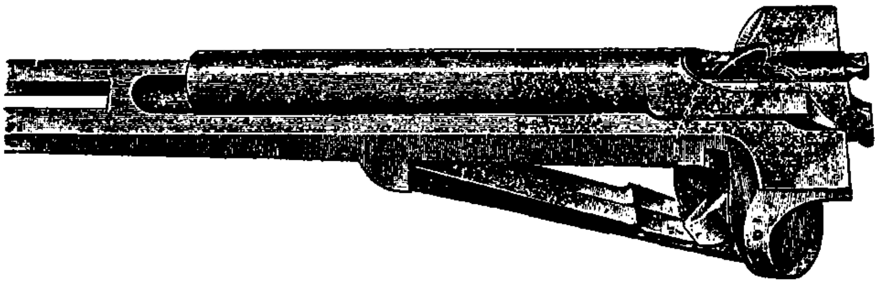


Fig. 49A.—The Holland Self-opening mechanism before the ejectors are cocked.

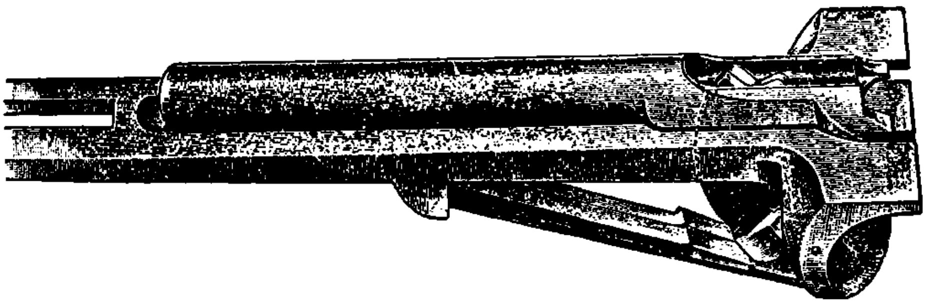


Fig. 49B.—The Holland Self-opening mechanism after the ejectors are cocked.

and being enclosed, the spring is protected from rust or dirt clogging its movement.

Should an inspection ever be necessary, the spring can be stripped in a moment by the insertion, when the barrels are closed, of a stout pin in the hole provided for the purpose in the tube of the slide. This hole can be seen in Fig. 47A and in the top photograph of Plate XI. But there is really nothing to get out of order and nothing which is in the least likely to go wrong.

The next objection is that of the addition of extra weight.

In reply to this it is only necessary to say that the extra attachment weighs but $1\frac{1}{4}$ oz., while the fore-end is lightened by $\frac{3}{4}$ oz. through the making of the recess necessary to receive the slide. The total additional weight is, therefore, but $\frac{1}{2}$ oz., while this attachment is fitted to 12-bores weighing but 6 lb. 4 oz.

The third objection is that the act of compressing the coiled spring must need extra effort in closing the gun, and so what is gained in opening is lost in closing.

In theory additional effort must be employed, but in actual practice it is not noticeable, partly because the leverage exerted against the end of the slide is very great, and partly because the whole of the force exerted by this leverage is applied *directly* on to the end of the slide.

The total effect certainly is that this mechanism gives the easiest closing for a self-opening ejector that I have ever known, while the opening of the gun is so easy that all one need do is to push over the lever, when the gun opens of its own accord, ejecting the fired cases, and compressing the mainsprings. And this in spite of the fact that the mainsprings are of full strength.

There are also two improvements in the design of the lock which deserve mention. The first of these is the employment of a slight rebound action which leaves the strikers free from pressure and so allows them to be pushed back by the caps, when the gun is opened more easily than in a gun in which the pressure is not relieved until the tumbler has been lifted off the rear end of the hammer by the cocking action. This rebound action is too slight to weaken the efficiency of the lock to any material extent, and so abnormally strong mainsprings are not necessary.

This slight rebound action also has the effect of relieving the pressure on the cocking levers, and so frees the fore-end from contact with the front ends of these levers. The result is that the fore-end can be removed or replaced quite easily with the locks fired off. In some guns the fore-end can only be removed when the locks have been fired by using a lever to prise it off.

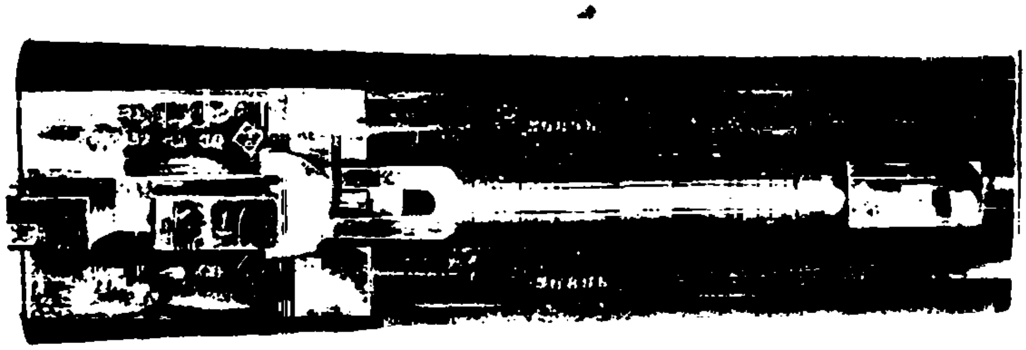
The second improvement is in the fitting of the springs which actuate the cocking levers. These are reversed, with the result that the locks can be taken off and replaced equally easily whether they are cocked or uncocked.

THE LANCASTER "TWELVE-TWENTY" ACTION

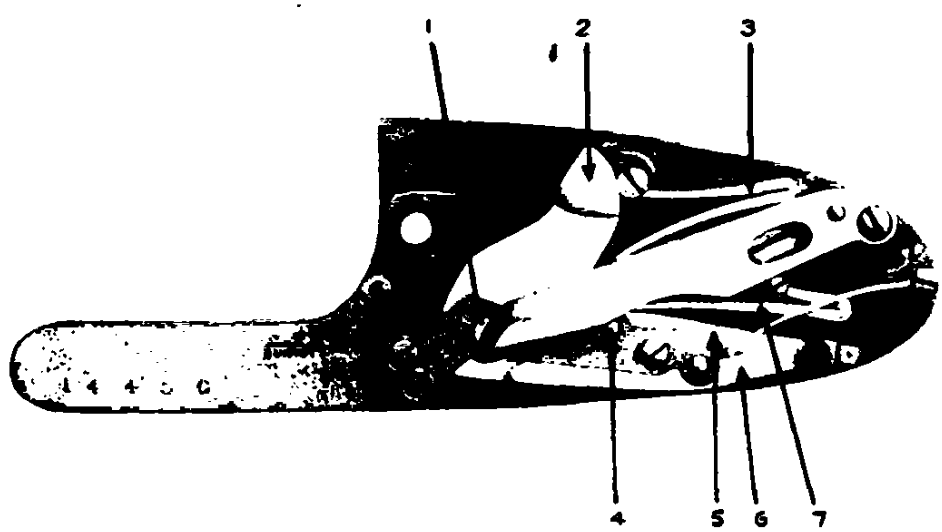
The purpose of this action is, as its name suggests, to enable the maker to build a 12-bore as light as a 20-bore; or, in other words, to bring about the possibility of great reduction in weight without a proportional reduction in strength. And there is no doubt that this end is achieved successfully, while there are three incidental advantages which in themselves are by no means unimportant, namely: the opening of the gun is exceptionally easy; the extractor cam on the knuckle of the action is done away with; and the design of the action is such that when the gun is taken apart, whether the locks are fired or not, both the mainsprings and ejector springs are relieved and not in a state of compression.

In view of the fact that maximum strength is the primary object, so as to render possible the reduction in weight, it is not surprising that the action is a back action side lock. The lock, however, is of a special design, and the usual cocking levers for each lock are replaced by one single lever which lies along the middle of the action in the slot which already always exists for the reception of the lumps and action bolt. So it will be realised that as far as the lock alone is concerned, the bars of the action can be solid, thus affording the maximum strength possible. But if ejectors are to be added, as they invariably are, space for some sort of connection between the lock and the ejector must be found; and so, in actual practice, the bars are not solid. Nevertheless, the design results in the possibilities of altogether exceptional strength, as will be seen later. It is first necessary, however, to see how the mechanism works.

A photograph of one of the locks is given in the bottom half of Plate XI, from which it will be seen



(A) UNDERNEATH VIEW OF THE BARRELS OF A HOLLAND & HOLLAND SELF-OPENER GUN SHOWING THE SELF-OPENING MECHANISM IN POSITION



(B) THE LOCK OF A LANCASTER "TWELVE-TWENTY" GUN

Reduced to ¾ size

1, Tumbler Axle; 2, Tumbler; 3, Cocking Spring; 4, Sear Peg; 5, Sear; 6, Intercepting Safety; 7, Sear Spring

that the lock is, as has been stated, a back action side lock with an intercepting safety device, the side plate being fitted with a dummy bar for the sake of appearance.

Cocking System. Since the mainspring is almost entirely concealed in the photograph by its special case, the system of cocking will probably be understood best with the help of the diagram in Fig. 50, which should be studied in conjunction with the photograph on Plate XIb.

The first point to realise is that the mainspring is encased in a special case, or housing (B in Fig. 50), which is pivoted at its upper end by a pin (C in Fig. 50). In Fig. 50 this housing has been drawn as if it were transparent, and the mainspring can be seen in position inside. It will be noticed that the upper arm of the mainspring is roughly twice as long as the lower; that the point of the spring is pivoted to the housing by a peg, E; and that the lower end of the upper arm is shaped in a knob, D, which fits into a corresponding recess in the tumbler, T.

The lower end of the housing, B, extends downwards over the tumbler and reaches to the rear end of the cocking lever, A.

Immediately above the housing, B, is another **V**-spring, S, the upper arm of which is fixed to the side-plate by a pin, while the lower arm presses downwards on the housing of the mainspring.

The next thing to consider is the cocking lever, A. This lies in the central slot of the bar of the action and is pivoted in the action body, as shown in Fig. 50. The front end of the lever reaches into the slot for the forward lump, and when the gun is put together and closed the bottom of the forward lump depresses the front end of the cocking lever and thus raises the rear end, which protrudes from the back of the action body. This rear end of the lever is fitted with two arms which extend horizontally outwards and so connect the lever with the locks. The outer ends of each of these arms fit just under the points of the mainspring housings, as shown in Fig. 50; so when the gun is closed the forward end of the mainspring housing is raised, the whole housing pivoting about its upper end at C, and compressing the cocking spring, S.

Let us now assume that the gun has just been fired. On being opened the forward lump is raised from off the front end of the cocking lever, A, which is no longer held down. The cocking spring, S, consequently asserts itself and presses down the mainspring housing, B, which depresses the rear end of the cocking lever and thus raises the front end ready for meeting the forward lump

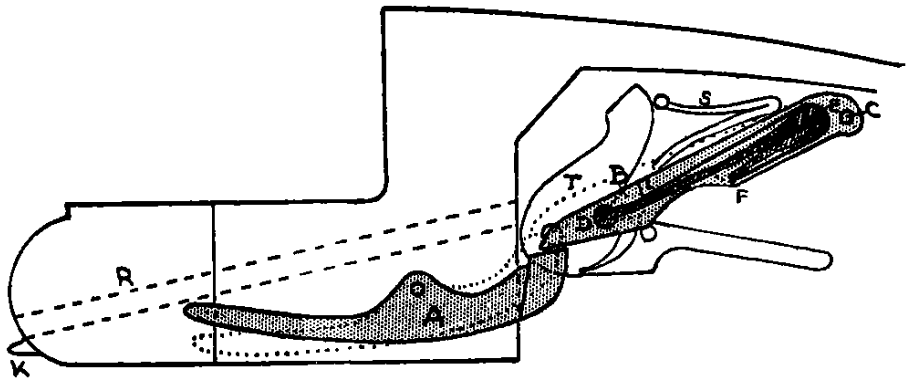


FIG. 50.—Diagram of the cocking device in the Lancaster action.

when the gun is closed again. This movement also helps considerably in the opening of the gun.

Now, inside the mainspring housing there is a corner, L, which presses on the upper arm of the spring near the end which fits into the recess in the tumbler. Since the point of the mainspring is fixed to the housing at E, the effect is that as the housing rotates under the influence of the cocking spring, S, it carries the whole mainspring with it. This results in the upper arm of the mainspring becoming a lever for rotating the tumbler back about its axle. This it does by the pressure on the tumbler of the knob, D, and the tumbler is rotated until the sear nose catches in the bent, when the tumbler is in the fully cocked position.

It will thus be seen that the cocking spring, S, automatically turns the tumbler back into the full-cock position as the gun is opened, but that the mainspring is not compressed by this movement.

Fig. 50 shows the positions of the limbs at this moment, that is, when the gun is in the open position.

On the gun being closed again the forward lump depresses the front end of the cocking lever, which movement raises the rear end. This lifts the front end of the mainspring housing and compresses the cocking spring, S, *and at the same time compresses the mainspring.*

This last act is achieved as follows:

The point of the mainspring is held by the peg, E, and the other end of the upper arm, D, is held in the tumbler recess. Since the sear is in the bent the tumbler cannot rotate, and so it will be seen that the upper, and longer, arm of the mainspring is held fixed at both ends. As the housing turns upwards about the pin, C, it leaves the upper arm of the mainspring stationary and the corner on the inside of the housing at, F, lifts the end of the lower arm of the mainspring upwards and thus compresses the whole spring by forcing the lower arm to approach the upper, final compression being obtained when the gun is fully closed and the rear end of the cocking lever in its highest position, as shown by the dotted lines in Fig. 50.

So it will be realised that in this action the tumbler is actually cocked as the gun is opened, but that the mainspring is not compressed until the gun is closed.

On the trigger being pressed the sear nose is released from the bent, and the tumbler is left free to revolve under the pressure of the compressed mainspring. The upper arm of the mainspring rotates the tumbler until it hits the striker and so fires the cap. As the tumbler rotates and the compressing force in the mainspring is relieved, the upper arm, which bears on the corner of the housing, L, carries the housing with it, and the whole housing turns about the pin, C. As this happens the cocking spring, S, is compressed. But when the tumbler blow is spent, the cocking spring begins to reassert itself and presses the housing down again slightly. It is not strong enough to compress the mainspring in any way, but it has just sufficient strength to depress the housing a little after the mainspring has become fully expanded. This slight downward movement of the housing carries the upper arm of the mainspring with it and so brings about a *rebound* action with the tumbler.

The mechanical advantage obtained when closing the gun and compressing the mainspring is excellent, as the front arm of the cocking lever is longer than the rear arm, while considerable leverage is obtained by pressing up the bottom end of the mainspring housing, since the point, F, which is the point of application of pressure, is less than half-way along the housing.

The general effect of this cocking system is that the gun opens very easily, although not so easily as a real self-opening gun, but decidedly more easily than an ordinary action; and at the same time the closing is no stiffer than that of a normal gun, partly because of the excellent mechanical advantage for the compression of the mainspring, and partly because there are no ejector springs to compress, as will be seen when we come to the ejector mechanism.

EJECTOR MECHANISM. This is also of a special design since there is no ordinary cocking lever for actuating the ejector, and the mechanism is shown in Fig. 51. It con-

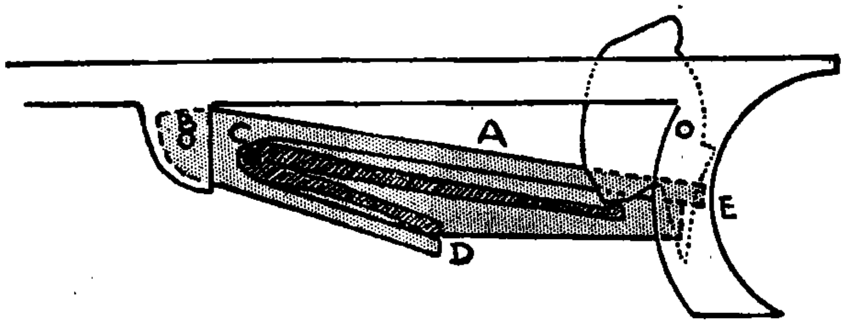


FIG. 51.—The Lancaster ejector.

sists, as will be seen, of a typical tumbler with an over-centre edge which is operated on by a V-spring. The peculiarity of the mechanism, however, consists in the manner in which this spring is held, for it is encased in a housing not unlike that used for the mainspring of the lock. In the diagram A is the housing which is pivoted in the frame of the fore-end at B. The spring is fixed in the housing by a peg, C, and the upper, and longer, arm reaches just under the over-centre edge of the tumbler. The end of the lower arm of the spring butts on the housing at D.

Normally the ejector spring is never compressed, and extraction is effected by means of two little lugs (K in Fig. 50) situated near the bottom edge of the knuckle of the action which press against downward extensions of the ejector tumblers and force the tumblers round as the gun is opened, thus causing the extractors to be pushed out. On the gun being closed the extractors are pushed home and the legs turn the ejector tumblers back into their original position.

Connection between the locks and the ejectors is established by two ejector rods, one for each lock. These rods are circular in section and fit in the bar of the action, as indicated by the dotted lines, R, in Fig. 50.

When the tumbler of the lock falls and fires the gun, just before it has travelled its full distance it hits the rear end of the ejector rod and pushes this forward. The front end of this rod then emerges from the knuckle and engages underneath the projection (E in Fig. 51) on the rear end of the housing of the ejector spring. This projection holds the rod out by means of the special shape of its end, as the rod would otherwise be withdrawn by its spring when the pressure of the lock tumbler was removed by the rebound action of the lock.

When the gun is opened primary extraction is effected by the lug (K in Fig. 50), as already explained. But since the ejector rod is held under the extension on the housing of the ejector spring, the rear end of this housing is lifted as the gun is opened, the whole housing pivoting about the peg B in Fig. 51. The upper, and longer, arm of the ejector spring is held under the ejector tumbler, and so the ejector spring is compressed by the upward rotation of the housing, pressure being applied a the end of the lower arm (D in Fig. 51).

While this pressure is being brought about the tumbler is gradually being forced towards the over-centre position, and this position is reached just after the spring is fully compressed. The ejector then acts like an ordinary Southgate.

Directly ejection has occurred the pressure of the housing of the ejector spring on the front end of the ejector rod is lightened as the spring is no longer compressed, and the ejector rod is withdrawn home into the knuckle by its own coiled spring. So when the gun is closed the ejector spring remains free and is not compressed.

STRENGTH. As has been seen, the only limb for which accommodation has to be found in the bar is the ejector rod. And this is a circular rod but $\frac{1}{8}$ inch in diameter, so the hole necessary for its reception weakens the bar only to a small degree. If the bar were left solid, apart from this hole, this action would be even stronger than the Dickson "Round" Action. In actual practice, however, it is cut away to a certain extent in order to reduce the weight, but this recessing is almost wholly in front of the line of greatest weakness, and so the resulting section across the bar is really very similar to that of a back action side lock. But when comparing sections one should also compare weights, and a Lancaster action with a section as is commonly used results in a 12-bore gun weighing as little as $5\frac{3}{4}$ lb. with 28-inch short barrels. So it will be appreciated that lightness is gained without any real sacrifice in strength, which means that the action is one of exceptional potential strength in cases where extreme lightness is not regarded as essential.

It may seem a pity that it is necessary to drive a hole right through the body of the action in order to receive the peg which forms the axis of the cocking lever. This hole, however, is sited in the best possible position. In the first place it is situated behind the line of greatest weakness across the bar; and further, it lies entirely below the neutral axis of the bar, so it cannot affect the strength of that part of the metal which is under tension, while that part under compression has sufficient reserve strength to render the drilling of a hole of this size permissible. This hole is also placed close to the neutral axis where the strain on the metal is least, and consequently I think that it is but fair to state that this hole cannot weaken the action to any appreciable extent.

Apart from its strength, which incidentally renders a top extension quite unnecessary, the other advantages of the action are that it results in a very easy opening of the gun without any corresponding difficulty in closing, while the " drop " of the barrels, or the distance which they open, is noticeably greater than usual. This is an important point as it greatly helps the work of loading, especially in cold weather.

Other advantages are that when the gun is taken to pieces and put away in its case not one single spring is in a state of full compression; and the by no means unimportant one that the lock is the easiest I know to take to pieces, as there are no springs to compress when assembling the limbs.

It seemed to be a pity that a certain amount of efficiency should be lost owing to there being no swivel connection between tumbler and mainspring. But on my pointing out this detail to Messrs. Lancaster I was interested to learn that the welcome addition of a swivel was being made in the later models.

Another possible cause of reduction in efficiency is the fact that the tumbler has to drive forward the ejector rod just before it hits the striker. This point, however, has been realised in the design, and owing to the angle of the ejector rod in the body, the shape of that part of the tumbler which hits the rod, and the end of the rod itself, this rod has a straight push through, while friction is reduced as much as possible by the fact that the actual bearings are situated only at the top and bottom ends of the rod. Consequently that loss of energy in the tumbler, which is almost inevitable with this general type of ejector, has been reduced to the absolute minimum possible.

And when considering the design of the lock it should be noted that the sear peg has been very well centred, the angle formed by the tumbler axle, bent and sear peg an almost exact right angle when the tumbler is at full cock. This has been possible on account of the special shape of the mainspring which has left more room in the lock than is to be found with the usual type of back action side lock, and the result must be that the trigger pull of this lock is of the same high order as that of a bar action side lock.

The famous old firm of Lancaster has lately been incorporated with that of Messrs. Grant and Lang. But as this action was first brought out by Lancaster I feel that it should still be honoured by that well-known name, even though it has been adopted in recent years by the equally famous firm of Messrs. Powell of Birmingham.

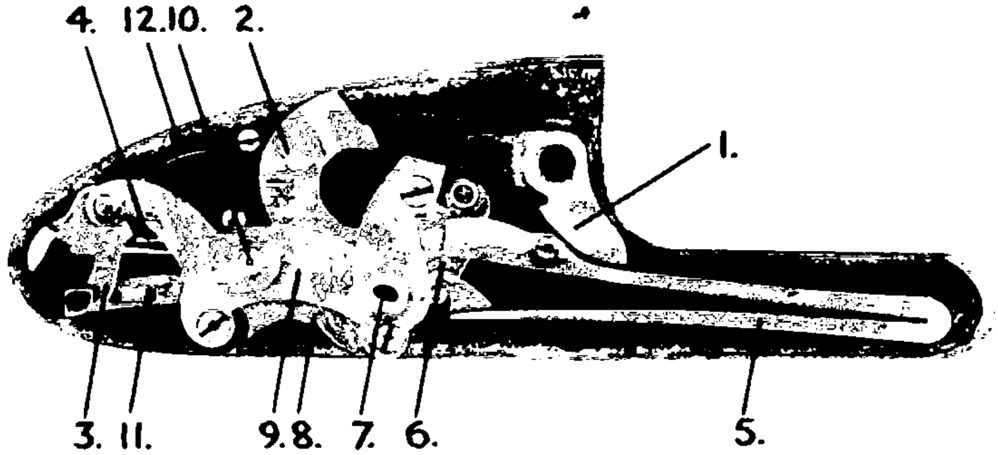
THE PURDEY ACTION

Of all the special actions the Purdey is unquestionably the most famous. This is not merely because of the reputation of the name—for reputation alone would never maintain anything at the top of the tree for five years, let alone for sixty—but because of the undoubted merits of the design and the quality of the workmanship.

It is really a remarkable achievement for an action which was patented in 1880 to be still among the very best today, and this fact is a wonderful testimonial to the genius of the inventor, the late Mr. F. Beesley, who was one of Messrs. Purdey's workmen before he set up business on his own account, and who sold the invention to Messrs. Purdey.

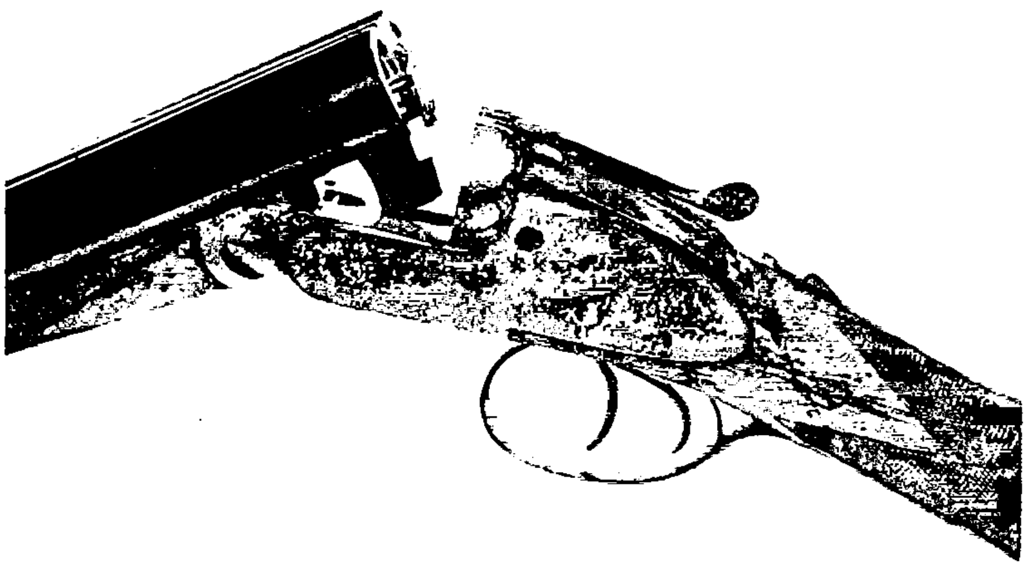
The action is a bar action side lock and possesses the merits of this type of action, but it differs from the ordinary bar lock in many important points, which will be understood if the description of the action is followed.

The upper photograph in Plate XII shows one of the locks with the various parts named, and Fig. 52A is a diagram of the same lock added for purposes of reference. In this diagram A is the tumbler; B the bridle; C the mainspring; D the swivel connecting the mainspring to the tumbler; E the tumbler sear; F the



(A) Components of Purdey Lock

1, Compressor; 2, Tumbler; 3, Intercepting Safety; 4, Sear Spring; 5, Main Spring; 6, Swivel; 7, Tumbler Axle; 8, Sear Nose in Bent; 9, Bridle; 10, Sear Peg; 11, Sear; 12, Intercepting Safety Spring



(B) A Purdey Gun showing the wide "drop" of the barrels when the gun is open

intercepting safety (coloured black); G a stud on the tumbler; and H the main compressor.

When the lock is in position on the gun this main compressor comes into position over the top end of the mainspring, as shown in Fig. 52A.

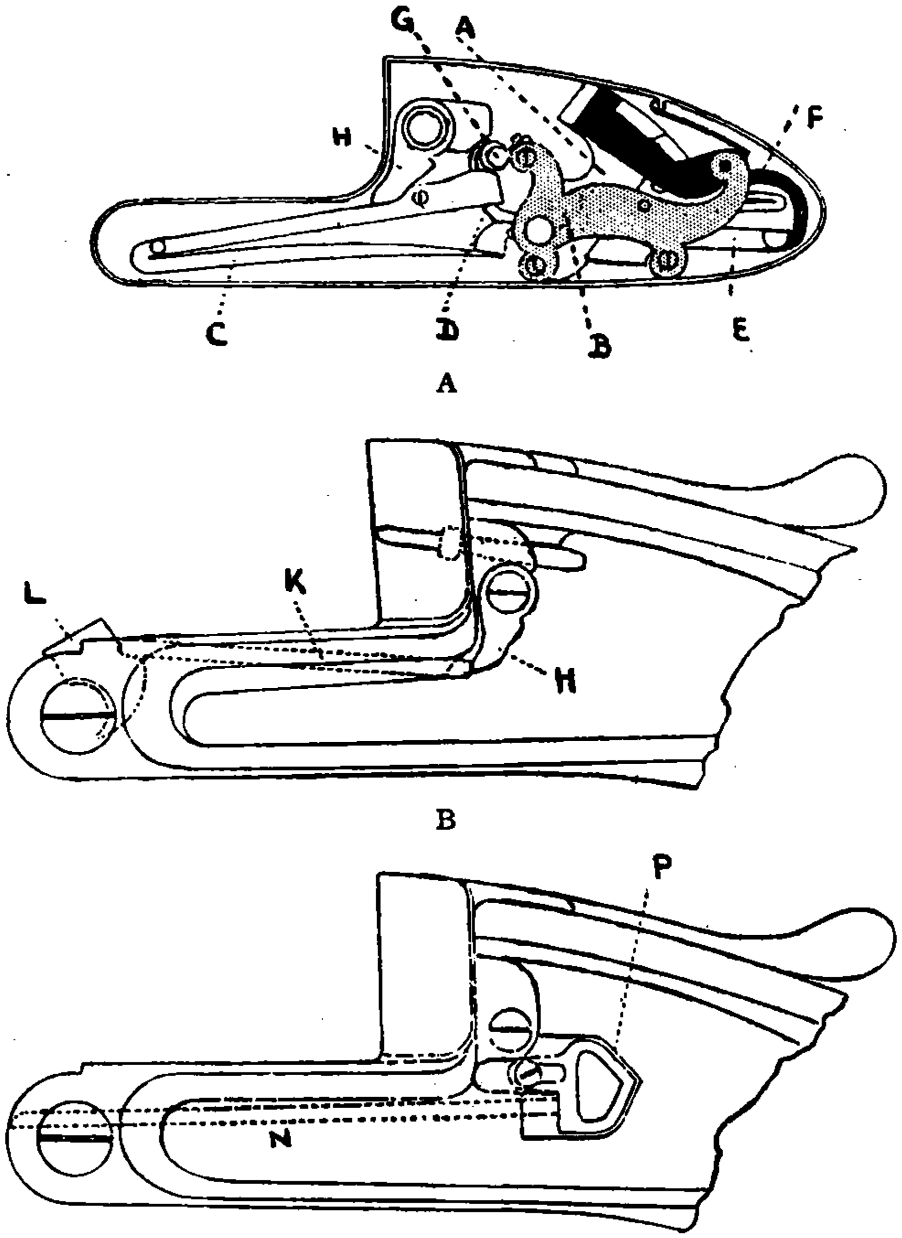


FIG. 52.—The Purdey action.

COCKING SYSTEM. The principle of the cocking system lies in the fact that the two arms of the mainspring are of appreciably different strengths. The upper arm is the more powerful and is used to produce the rebound action of the tumbler on firing, and also to cock the tumbler when the gun is opened. The lower, and less powerful, arm is used for rotating the tumbler in the firing of the gun.

The principle of working will perhaps best be understood by following the movements resulting from putting the gun together and then firing it.

As the barrels are hooked on and lifted in closing, the flats butt against the two specially shaped front compressors (one for each lock), one of which is shown in Fig. 52B and marked L. This front compressor is forced round by the flat of the barrel and pushes backwards in its movement the cocking rod, K. The rear end of this cocking rod butts against the main compressor, H, and rotates it about its axis.

The bottom point of this compressor rides on the top of the mainspring, as can be seen in Fig. 52A, and this part of the upper surface of the top arm of the mainspring is cut on a curve, so that as the point of the main compressor is pushed backward by the cocking rod, the upper arm of the mainspring is depressed, thus putting the whole spring in a state of compression.

The maximum compression is attained when the cocking rod is in its extreme backward position, the upper surface of the front compressor, L, being flush with the flat of the bar of the action and held down in that position by the flat of the barrel.

On the sear being released from bent by the pressure on the trigger, the upper arm of the mainspring is held down firmly by the main compressor, which is held in its turn by the cocking rod, front compressor and barrel. So the *lower* arm of the mainspring flicks downwards on relief and rotates the tumbler, thus firing the gun.

The stud, G, on the tumbler hits the rear end of the upper arm of the mainspring just before the tumbler hits the striker and further compresses the upper arm a trifle with the impetus of the tumbler blow. But directly this blow is expended the upper arm of the mainspring reasserts itself and springs back against the main compressor, flicking the tumbler back a short distance and so causing the rebound action of the tumbler.

On the gun being opened the pressure on the upper arm of the mainspring is released, and it immediately asserts itself in two distinct ways.

First of all the curved upper surface rotates the main compressor, H, about its axis and so pushes its point forward. This carries forward the cocking rod, which in its turn revolves the front compressor. The upper surface of this front compressor butts against the flat of the barrel and causes the gun to open.

The second action of the upper arm of the mainspring is to raise the stud, G, on the front of the tumbler, which it carries with it as it expands. This results in the tumbler being rotated backward about its axle until the sear catches in the bent.

It should specially be noted that this revolving of the tumbler is not a sudden flick which might result in the bent overshooting the sear nose, but is a comparatively steady and perfectly uniform movement.

On the gun being closed after reloading, the flat of the barrel butts against the front compressor and compresses the mainspring, as already described.

There are three main points to notice in this action :

(1) The tumblers are revolved into the full-cock position by the upper arms of the mainsprings as the gun is opened.

(2) The mainsprings are not compressed until the closing of the gun.

(3) The upper arms of the mainsprings push the barrels open when the action bolt is withdrawn from the bites in the lumps, and so the gun is a self-opener. This self-opening movement is so efficient that if the lever is pushed over, the gun will open at once of its own accord without any further pressure being needed on the barrels, and the fired cases will be ejected.

EJECTOR MECHANISM. The ejector is of the Southgate type, with two modifications. The first of these is the addition of two studs which operate *inward* and at right angles to the length of the gun under the influence of two springs. One of these studs is on each side of the ejector mechanism and they are situated immediately above the upper arms of the ejector springs when these springs are compressed.

Their effect is to keep the springs in a state of compression and so prevent the upper arms flicking the ejector tumblers round when the over-centre position is passed on their being turned about their axes.

The other modification consists of the special shape of the lower front edges of the ejector tumblers, as these tumblers are utilised for operating the extractors when the gun has not been fired, and for causing primary extraction when it has been fired.

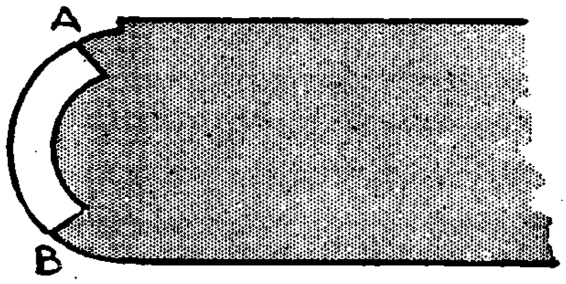


FIG. 53.—Diagram of the knuckle of the Purdey action.

Fig. 53 is a sectional diagram of the middle of the knuckle of the action. It will be seen that the centre part is cut away and that two projections are left, A and B. The upper projection is formed by a short bar which is screwed down to the knuckle and is known as the "Cross Bar." The lower projection is an integral part of the action and is called the "Tit-Bit."

On the gun being opened the tit-bit butts against the lower parts of the ejector tumblers and causes them to turn about their axes. This results in the extractors being forced backward, which results in extraction when the gun has not been fired, or primary extraction when it has.

On the gun being closed the cross bar butts against the upper parts of the ejector tumblers and turns them in the opposite direction.

Actual ejection is brought about by means of an ejector rod which is shown in Fig. 52C and marked N.

The rear end of this rod is shaped in a loop, P, which fits over the stud, G, on the tumbler.

On the gun being fired and the tumbler falling, the ejector rod is carried forward until the front end protrudes from the knuckle of the action. This front end is bevelled and slips just inside of the stud, which keeps the ejector spring in a state of compression, thus forcing the stud outward and so permitting the ejector spring freedom of action.

The ejector now works exactly like an ordinary Southgate, primary extraction and re-cocking of the ejector tumblers being carried out by means of the tit-bit and cross bar as described.

On the tumbler being revolved back into the full-cock position it withdraws the ejector rod with it and so leaves the stud in the ejector mechanism free to be pushed inward by its spring directly the ejector spring is compressed. When this occurs the ejector spring is held as before.

General Remarks. Theoretically, a certain amount of efficiency of the lock is lost by the combination of the rebound action and the fact that the tumbler has to carry the ejector rod forward with it. In practice, however, this loss is overcome by the use of a somewhat extra powerful mainspring.

The only criticism which can seriously be advanced is that the balance of work in compressing the main and ejector springs is not well proportioned, all four springs having to be compressed when the gun is closed after both barrels have been fired. The result is that closing is noticeably stiffer than with guns in which only one set of springs has to be compressed by this action.

The effort of closing, however, is modified to a certain extent by the altogether exceptional distance through which the gun opens. This means that a bigger movement is made round the knuckle and so the work of closing is distributed considerably more than would be the case if the gun only opened through a normal angle.

The advantages of this action are the self-opening effect resulting from the upper arms of the mainsprings, which is a great help in actual shooting; the exceptional distance which the gun opens, which facilitates loading, particularly on a cold day; and the fact that the barrels are held open by the upper arms of the mainsprings until the closing movement is begun.

The lower photograph on Plate XII shows a Purdey gun in the open position, and the altogether exceptional gape can be seen.

Minor advantages are the omission of the extractor cam, which adds to the neat appearance of the action; and the fact that the mainsprings are always relieved when the gun is taken to pieces and put away in its case.

But the best proof of the undoubted merit of this action is the fact that Purdey guns still fetch the highest prices in the second-hand market after sixty years of trial in the hard school of practice.

THE ROSSON SELF-OPENING ACTION

This action was introduced in 1933 by Messrs. Rosson of Norwich. And since it is the self-opening principle which is new and distinctive I will confine my description of the action to this particular part of the mechanism.

Fig. 54 shows three different positions of the essential limbs; and with a view to avoiding any possibility of confusion, all parts which are not directly connected with the self-opening action have been omitted in the drawings, which are longitudinal sections of the action body showing the Cocking Lever, L, and the Tumbler, T. A rectangular slot is cut in each side of the bar of the action to accommodate the cocking levers and ejector rods of the right and left locks, and in the diagrams one of these slots is shown with a cocking lever in position.

This cocking lever is the most distinctive component of each lock and is of a special shape as may be seen. It pivots about a pin, P, and is recessed to take two **V**-springs. The larger of these springs, M, is the mainspring of the lock, while the smaller, C, is best described as the Cocking Spring.

Fig. 54A shows the lock in the fired position when the gun is closed, that is the lock immediately after firing.

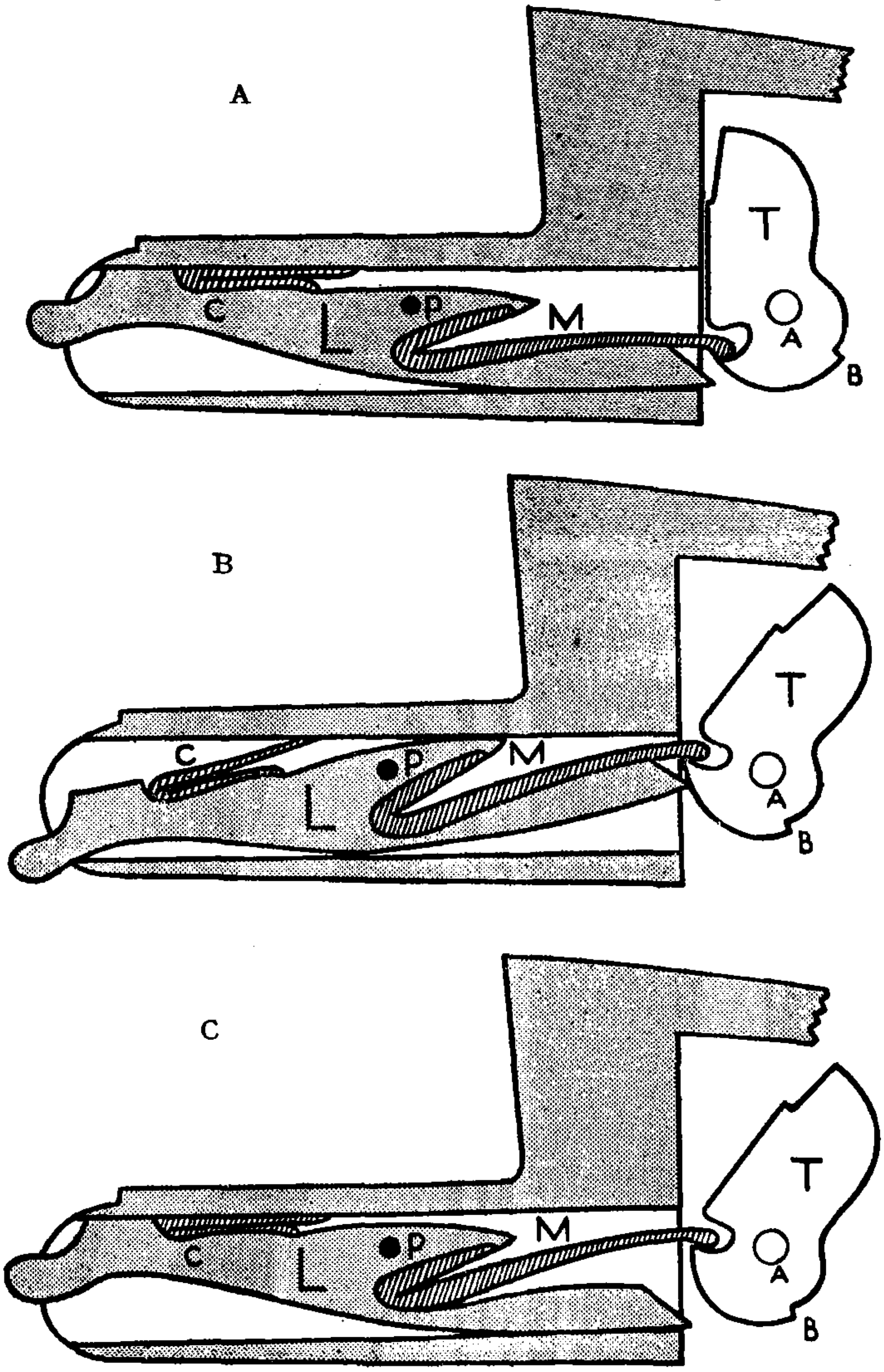


FIG. 54.—The Rosson action.

On the action bolts being withdrawn from the grips in the lumps by the movement of the action lever the barrels are no longer held down to the bar, and the cocking spring, C, is able to assert itself. This it does, and in relaxing it forces down the forward part of the cocking lever, which pivots about P. The forward end of the cocking lever, which protrudes from the knuckle of the action, is in contact with the rear part of the fore-end; and so when this front end of the cocking lever is forced downward by the cocking spring it carries the fore-end with it. And since the fore-end is fixed to the barrels, these are also carried down. In other words, the gun opens and the component parts assume the positions shown in Fig. 54B.

Let us now consider what is happening at the other end of the cocking lever.

As the front end is depressed the rear end is raised, and carries with it the mainspring, M. The lower and longer arm of the mainspring fits in a recess in the tumbler, T, as can be seen in the diagrams. This end of the lower arm of the mainspring carries the tumbler with it, rotating it about its axle, A, until it reaches the full-cock position shown in Fig. 54B, in which it is held by the sear (not shown) which slips into the bent, B. The rear end of the cocking lever also butts against the tumbler and thus helps the mainspring to rotate it.

On the gun being closed the rear part of the fore-end carries up the front end of the cocking lever, compressing the cocking spring, C, until the lever again occupies the position in which it originally started and which was shown in Fig. 54A, and which can now be seen in Fig. 54C. But although the cocking lever has returned to its former position the mainspring, M, has been compressed because the end of the lower arm is prevented from moving down with the cocking lever by the tumbler. The difference in the condition of the mainspring can be seen by comparing Figs. 54A and C.

The gun is now ready to fire, and on the trigger being pressed the tumbler is rotated under the influence of the mainspring, and these two limbs immediately take up the positions shown in Fig. 54A.

When the action lever is pressed the gun opens of its own accord, ejecting the fired case, or cases, and the sequence of events which has just been described is repeated.

EJECTOR MECHANISM. The ejector is the usual Southgate and so needs no special mention beyond the fact that the ejector locks are actuated by separate ejector rods, as the cocking levers are not utilised for operating the ejectors. These rods are flat, being thin but deep, and fit in the same slots as the cocking levers. They pivot on separate pegs and the rear end of each rod fits into the same recess in the corresponding tumbler which receives the arm of the mainspring. Thus when the tumbler falls the rear end of the ejector rod is depressed and the front end raised into a position in which it can actuate the ejector lock in the fore-end in the manner usual with Southgate ejectors.

GENERAL COMMENTS. It will be seen that in one respect the principle employed is similar to that used by Messrs. Purdey in their famous action: the locks are cocked by the opening of the gun, but the mainsprings are not compressed until the gun is closed. And since the ejector springs are also compressed by the closing of the gun as well as the cocking springs, which are a special feature of this action, it will be realised that after firing both barrels no less than three pairs of springs have to be compressed by the closing of the gun. The effect is that the gun is certainly somewhat stiff to close, although by no means unduly so, and this tendency to stiffness in closing is the price paid for the delightful manner in whch it opens.

The necessity for a separate ejector rod may be considered by some to be a disadvantage, but I do not regard it as being at all serious, even if it exists. There is no real complication in having the ejector rod as a separate component; nor must it be forgotten that simplification can sometimes be carried to excess by utilising a single limb to fulfil several functions, when the niceties of fitting can become so minute that the single limb is more difficult to adjust than two components. And since the cocking lever clearly does not lend itself to combining a dual purpose in this action as it does in a more standard form of side-lock I think that Messrs. Rosson were well advised not to try to be too clever.

There are really only two serious drawbacks to a separate ejector rod: risk of breakage; and loss of efficiency in the blow of the tumbler.

In this Rosson action the ejector rods are particularly strong, as they have great depth in comparison to their width, and are quite unlike the thin and delicate ejector rods which were at one time common. So I do not think that there is anything to fear on this score.

Nor is there that same inevitable loss of efficiency due to the tumbler having to *push the ejector rod forward* as it falls. In such actions the inertia of the ejector rod must be overcome, and the work thus entailed does incur a reduction in strength of the tumbler blow. But in this Rosson action the ejector rods pivot on pegs, and the work necessary to rotate one of these rods about its pivot is appreciably less than that required to move a whole rod bodily forward.

A more serious argument which could be advanced against the efficiency of this lock would be that based on the absence of any swivel connection between tumbler and mainspring. Theoretically a swivel could be inserted; but in practice a swivel would add so greatly to the complication, especially when it came to removing a lock, that I think Messrs. Rosson were wise to rely on the strength of their mainsprings.

Since the mainsprings are actually housed in the bar of the action this lock must be regarded as a bar action lock. At any rate it has the advantage of the ordinary bar action side lock in that there is ample space on the side plate to permit the limbs of the lock being sited to the greatest advantage; and the angle between the tumbler axle, bent and sear peg is a right angle when the lock is cocked, thus giving full scope for a perfect trigger pull.

The cross-section of the bar in prolongation with the action face is superior from the point of view of strength and rigidity to that of the usual bar action side lock, and this increase in potential strength permits the building of a light gun without any necessity for a top extension.

Finally a not wholly negligible advantage of the action is the fact that when the gun is taken to bits and put away in its case the mainsprings *must* be relaxed. In putting the gun together again a certain amount of hand pressure is required to slip the fore-end on. But when doing this the main and cocking springs are compressed, leaving the gun ready to load.

THE WESTLEY RICHARDS HAND-DETACHABLE LOCKS

The firm of Westley Richards, like that of Greener, has always specialised in the development of the box lock and is undoubtedly the leading exponent of the Anson and Deeley Action. Although the *principle* of this action is exactly that of a typical Anson and Deeley, there is one great change in design which is really revolutionary.

This is the Hand-detachable Lock.

Instead of the limbs of the lock being pivoted on pegs driven right through the body of the action, each lock is carried on a separate plate, something after the manner of a side lock. These plates are slipped into the recesses in the action body from underneath, when they occupy the normal positions taken up by Anson and Deeley locks and operate in the usual way.

But the system of carrying the locks on separate plates enables them to be slipped in or out of the action by hand. The bottom plate is hinged just in front of the trigger-guard and is held by a spring fastening, at the knuckle. All that is necessary to do when removing the locks is to press this spring fastening, when the bottom plate opens like the lid of a metal match-box. The locks can then simply be lifted out and put in again at will.

There is no possibility of them being put back in an incorrect position because they will only fit in one way.

Nothing could be simpler; while the very simplicity is a sure token of the efficiency of the invention.

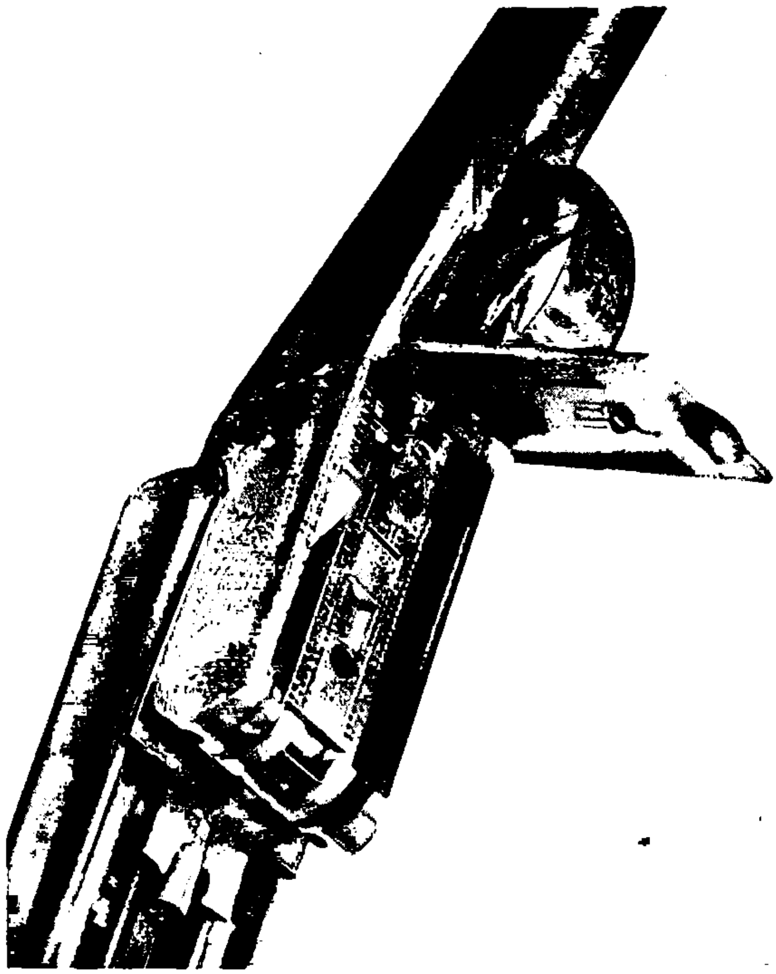
The upper photograph on Plate XIII shows a gun with the hinged bottom plate open and with the right lock removed, while the lower photograph shows the right lock.

The workmanship of these locks is really beautiful, and this action cannot help but appeal to those who like to be able to inspect and clean their locks regularly; while the system also admits of having duplicate locks, a decidedly useful safeguard in out-of-the-way countries.

Another advantage of these locks, and a very big one, is the fact that there is no necessity for any hole being bored right through the body of the action to receive the tumbler peg. I have pointed out that this hole is a potent factor in weakening the bar of a box lock action, and its omission adds greatly to the strength of the action. The result is that Westley Richards guns are undoubtedly the strongest, weight for weight, of all guns fitted with Anson and Deeley actions, and probably of all box lock actions. In fact, the strength of the bar would seem sufficient to render a top extension unnecessary in a gun of full weight, but a doll's-head extension with a Westley Richards bolt is always fitted whether the gun is light or heavy.

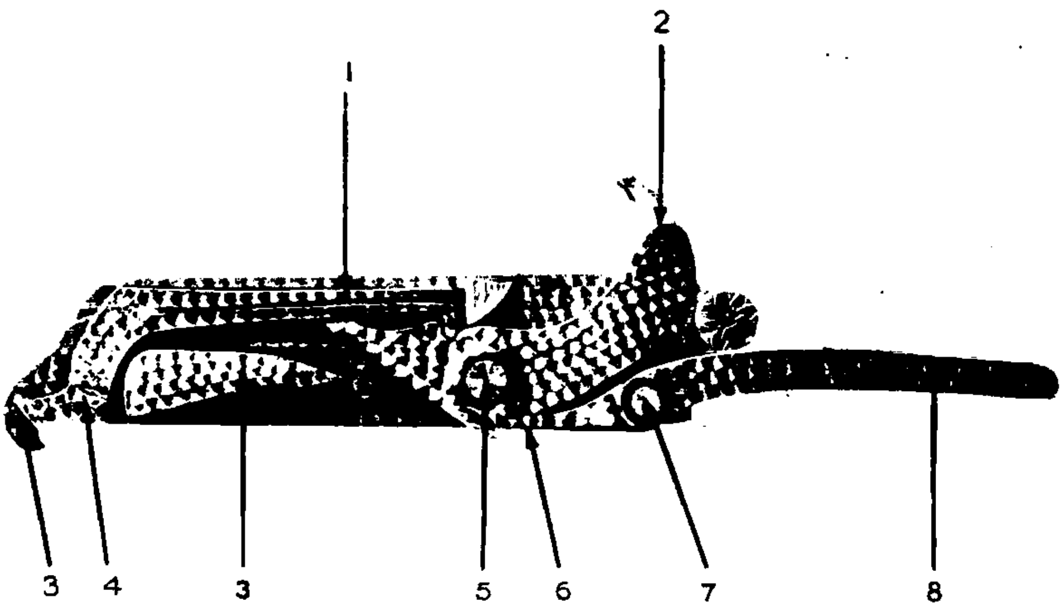
The ejector is invariably the Deeley.

The only criticisms which can possibly be directed against this action are those which must always be inseparable from the Anson and Deeley design, and which have been dealt with fully in Chapter IV. It should be noted, however, that the Westley Richards locks are far better designed than those in many cheap box lock guns; yet even so an examination of the lock in Plate XIIIB will show that the angle formed by the tumbler axle, bent and sear peg is appreciably bigger than a right angle; and the sear arm is on the long side.



(A) THE ACTION OF A WESTLEY RICHARDS GUN FITTED WITH HAND-DETACHABLE LOCKS

The hinged bottom plate is open and the right lock has been removed



(B) A WESTLEY RICHARDS HAND-DETACHABLE LOCK

Reduced to ⅞ size

1 Main Spring; 2, Tumbler; 3, Cocking Lever; 4, Ejector Tripper; 5, Tumbler Axle; 6, Sear Nose in Bent; 7 Sear Peg; 8, Sear

HAND-DETACHABLE SIDE LOCKS

Owing to the success of the Westley Richards invention of hand-detachable locks, various devices have been brought out to facilitate the taking off of ordinary side locks. I am bound to confess, however, that I think all such devices a mistake. Side locks are quite easily removed by taking out the two screws, or " pins," which hold the side plates to the action body and each other. These pins can be removed with a turn-screw that fits, and I have always held the view that if any owner of a gun is unable to use a turn-screw sufficiently well to remove these pins without burring the slots in the heads, he had better leave his locks alone.

It may here be noted that all screws which are duplicated in both locks of a gun can be distinguished by the presence of a cut across the points of those which belong to the *left* lock. The screws which belong to the right lock have no such mark.

Side locks are composed of a greater number of limbs than box locks; and so they are more complicated and more delicate. Accordingly I am sure that it is a mistake for anyone to play about with them unless competent to do so; and I regard the ability to use a turn-screw as the test for such competence. It is admittedly not a very severe test, but if it can be passed, the locks should suffer no harm. If the owner of a gun is unable to use a turn-screw he had certainly better not examine his side locks!

Incidentally it may be mentioned that when a side lock is taken off it should always be removed and put back at full cock, otherwise considerable difficulty will be experienced in getting the lock into position.

After the two side pins have been taken out, the side of the bar of the action just in front of the side-plate should be given a sharp tap with the handle of the turn-screw, when the side-plate will be lifted up sufficiently to permit its removal by hand.

At one time several different firms catered for the demand for hand-detachable side locks, but now, to the best of my belief, only two firms still do so, namely Holland and Lang.

In both these patterns of locks the front pin is omitted, the side-plate being held in front by a dove-tail. In the Holland lock one long pin passes right through the action from side to side, being inserted through the left plate and screwing into the right plate. The head of this pin is shaped as a lever, which can be turned by hand. I have always regarded this lever as unsightly, and it spoils, to my mind, the lines of these beautiful guns. I cannot help thinking that it is better replaced by an ordinary headed screw, or " pin," which is just as easily removed by the competent as the lever-headed screw.

The Lang system is different and is certainly neater in appearance. In this both locks are entirely independent of each other, and either can be removed by lifting up a small circular flap in the rear part of the side-plate which forms a handle to a short screw with an interrupted thread. Half a turn of this screw will release the lock. When the flap is folded down it fits flush with the side-plate and locks the screw in position, while it is almost invisible, being hidden by the engraving. I have sometimes wondered, however, whether these short screws with interrupted threads can be relied upon always to keep in place. They cannot possibly turn unless the flap is lifted, it is true : but if the hinge of a flap were to work loose, and the flap were to be raised accidentally, there would seem to be a risk of the lock dropping off.

But really side locks can be taken off so easily by those who are competent to examine them that I am inclined to regard these detachable devices as unnecessary.

CHAPTER VIII

SINGLE TRIGGERS

THERE are two more departures from the normal in gun design which cannot be regarded as specialities of any particular firm since it is open to any firm to adopt them. These are Single Trigger Guns and Over and Under Guns.

In the first type, instead of having a separate trigger for each lock, one trigger only is fitted, and one barrel can be fired after the other by consecutive pulls of the trigger.

In the second departure from the normal the barrels of the gun are placed one over the other instead of alongside each other, and hence the name " Over and Under."

As almost every maker will fit a single trigger if desired, and as it is possible for any maker to build a gun with the barrels placed vertically instead of horizontally, I have classed these two types of gun together and propose to consider them in this and the following chapter.

SINGLE-TRIGGER GUNS

We will take the Single Trigger first.

The advantages usually claimed for this system are:

(1) The second barrel can be fired more rapidly after the first owing to there being no necessity to shift the finger from the forward to the rear trigger.

(2) The length of the stock of the gun is exactly the same for both barrels, and so a better fit is obtained.

I must confess, however, that I regard both these advantages as theoretical rather than actual. I believe quickness to be far more a matter of individual temperament than anything to do with having two triggers to the gun or one, and I am quite sure that a naturally quick man will always be able to get off both his barrels sooner than a naturally slow one, irrespective of the number of triggers that either uses. For this reason it is doubtful whether a naturally slow man can be turned into a quick one by the change from two triggers to one.

Further, I know of more than one very fine and quick shot who declares that he can get off his second barrel more rapidly with an ordinary double trigger than a single.

But, on the whole, it is probably true that the majority of men will be able to fire their second barrel slightly more quickly with a single trigger than with double. Here again, however, I doubt whether this slight increase in quickness confers any real advantage.

And the advantages of the second point claimed would seem in practice to be equally problematical. Is the fit of the gun really altered to any appreciable extent by the change to the rear trigger? I doubt it. If it were, men would invariably shoot better with their right barrel than their left; and I am quite sure that they do not.

But there are other advantages of the single trigger which are certainly real, although they may not be very pronounced.

First of these is the prevention of the bruising of the front of the trigger finger by the front trigger when the left barrel is fired. Comparatively few men suffer from this, as it is due to some personal peculiarity of loose holding, provided the gun fits properly. But if anyone is so troubled a single trigger is a cure.

The second minor advantage is the ability conferred of wearing gloves. Gloves are a curse with two triggers, but with one they become no hindrance. Probably the majority of shooters may never want to shoot in gloves; but there are some who may, and such will find single-trigger guns a boon.

Personally I am one of those who likes to use gloves in cold weather because I happen to suffer from particularly bad circulation in my right fingers owing to a damaged hand, and in cold weather my fingers get numbed and lose their sense of touch. For this reason I took to a single trigger five seasons ago, and it has been a perfect joy to me ever since.

So I think it is fair to state that single triggers can, in certain cases, be a real help; and that as such they add to the efficiency of the gun.

The majority of shooters get into the single-trigger movement very quickly. I can truthfully say that I never experienced the slightest difficulty or inconvenience in the change and got into my single trigger after less than twenty shots. But some men find it more difficult, while a few can never become accustomed to one trigger.

I think it is far more difficult to go back to two triggers after having grown used to one, than to change to one from two: and for this reason I would never advise anyone to have a single-trigger gun if he had other guns, or double rifles, which he used at times and which were fitted with double triggers.

Since the position of the trigger finger need not be moved between the firing of the two barrels, it will be obvious that this change of position of the means of transmitting the power of the finger from one lock to the other must be achieved by some mechanical device. And this means an addition, and therefore a complication, to the mechanism in the action.

In some types of single-trigger mechanism a "Selective" device is added. This enables the shooter to fire his barrels either in the order of right, left, or else in that of left, right. Such a device must clearly add still further to the complication of the mechanism, and the more complicated any machine is, the greater is the risk of some part coming out of adjustment, when the working of the whole will be stopped. For this reason the majority of gunmakers do not recommend a selective single trigger, but rather one in which the right barrel is always fired first or *vice versa*. This is not nearly such a disadvantage as some shooters may imagine, and personally I would always prefer to have both my barrels bored the same, when it is immaterial which is fired first. I will, however, deal with this aspect of the case more fully when I come to the question of Patterns.

It would be almost impossible in a single book, as well as of more than doubtful interest, to attempt to describe even a fair proportion of the different single-trigger mechanisms.

Considerably over a hundred different single-trigger patents have been taken out; the great majority of these patents seem to be in use; and no two seem to be alike! Consequently a detailed description of them all is out of the question.

I propose, therefore, to take four non-selective mechanisms of known and proved reliability, and one selective mechanism, and consider them in detail. It cannot be said that these are typical mechanisms, as all are so different: but they can be regarded as indicating the general principles on which single-trigger mechanisms work.

The non-selective mechanisms which I have chosen are the Boss, Holland, Lang and Woodward, simply because either personal friends of mine or I myself have used these actions regularly and so I am in a position to form a fairly good opinion of their reliability. I have chosen the Westley Richards selective action because it is almost the only single trigger in which the standard mechanism is selective, and this device is not a mere addition.

But before we come to study any of these mechanisms it may be as well to consider the difficulties against which the designer of a single trigger has to contend.

Apart from the intricacies of the mechanical side of the problem, there is the human element of the shooter. When a man presses a trigger and fires a gun the whole gun recoils and moves backward. This backward movement draws the trigger away from his finger, and he instinctively renews his grip by further pressure. *The effect is that he actually takes two pulls at the trigger to fire one shot; the first pull firing the gun, and the second pull being instinctive and involuntary.*

Consequently, were a single-trigger mechanism so arranged that an immediate second pull fired the left barrel, the left barrel would always be fired involuntarily whenever the right was fired, and there would be a double discharge. This is clearly something to be avoided at all costs, and the chief difficulty in all single-trigger mechanisms is to make allowance for the second involuntary and intermediate pull and so avoid a double discharge.

In some types of mechanism three distinct pulls on the trigger are allowed for in working, and when the gun is snapped off empty one is conscious of three distinct pulls. The first of these fires the right barrel; the second is the intermediate pull; and the third fires the left barrel. The involuntary pull which comes after the discharge of the second barrel is ignored, as it can have no effect since the gun would then be empty. Yet when one of these same guns is loaded and fired, one is only conscious of two pulls: one for the right barrel, and the second for the left. This fact alone is ample proof of the existence of the intermediate involuntary pull, and anyone can try this simple experiment for himself.

Mechanisms which allow for this intermediate pull are known as being devised on the "Three Pull System," a system which has been adopted by Boss and Woodward.

In other mechanisms a delay is caused between the discharge of the first barrel and the second lock becoming ready for firing; and this delay allowed the shooter to make his intermediate pull before the second barrel can be fired.

Of the five mechanisms which I am taking, the Boss and Woodward are on the Three Pull System and the others are on the "Delayed Action" system.

THE BOSS SINGLE TRIGGER

The firm of Boss have certainly done more for the establishment and perfection of the modern single trigger than any other, and so it is only fitting that alphabetical order places them first.

The entire mechanism is carried on the trigger plate and can be seen in the various phases of action in the diagrams in Fig. 55.

The mechanism consists of a drum, or turret, T, which revolves round a vertical spindle, S, being forced to turn round this spindle by an internal spring which is not shown in the diagrams.

The top of this spindle, S, is fitted with a lug, as can be seen in the diagrams, and this lug prevents the turret moving vertically up on the spindle *except when it is in one particular position in which the lug on the spindle slips into a groove in the turret.*

The turret has two horizontal grooves in its circumference, and on both edges of the lower groove there are specially shaped cogs, *a*, *b*, *c* and *d*, not one of which is exactly in the same vertical plane through the axis of the spindle. The cogs *a* and *c* are on the upper edge of the groove and *b* and *d* in the lower edge.

The trigger blade, K, is specially shaped and is shown shaded in Fig. 55A. In Fig. B, C and D only the rear part is shown for the sake of simplicity.

This trigger blade is hinged at Q in a vertical pillar which is an integral part of the trigger plate and is called the " trigger box," and there is a small peg driven through the lower corner of the blade at P which prevents the trigger from being pressed too far and so raising the top of the trigger blade unduly.

Let us assume that the gun is ready to fire.

In this phase the two arms of the tumbler and intercepting safety sears occupy the position R in Fig. 55A immediately above the rear part of the trigger blade and pressing against the outer edge of the cog, *a*, and thus holding the turret in the position shown in the diagram and so preventing it from turning about the spindle, S.

On the trigger being pressed, it and the trigger blade occupy the position shown by the dotted lines in Fig. 55A. This lifting of the trigger blade raises the sear arms which fires the right barrel. The sear arms are immediately flicked up out of the way and do not enter into the picture again.

At the same time the specially shaped rear end of the trigger blade presses against the bottom of cog *a* and so still keeps the turret from revolving.

This marks the end of the first pull.

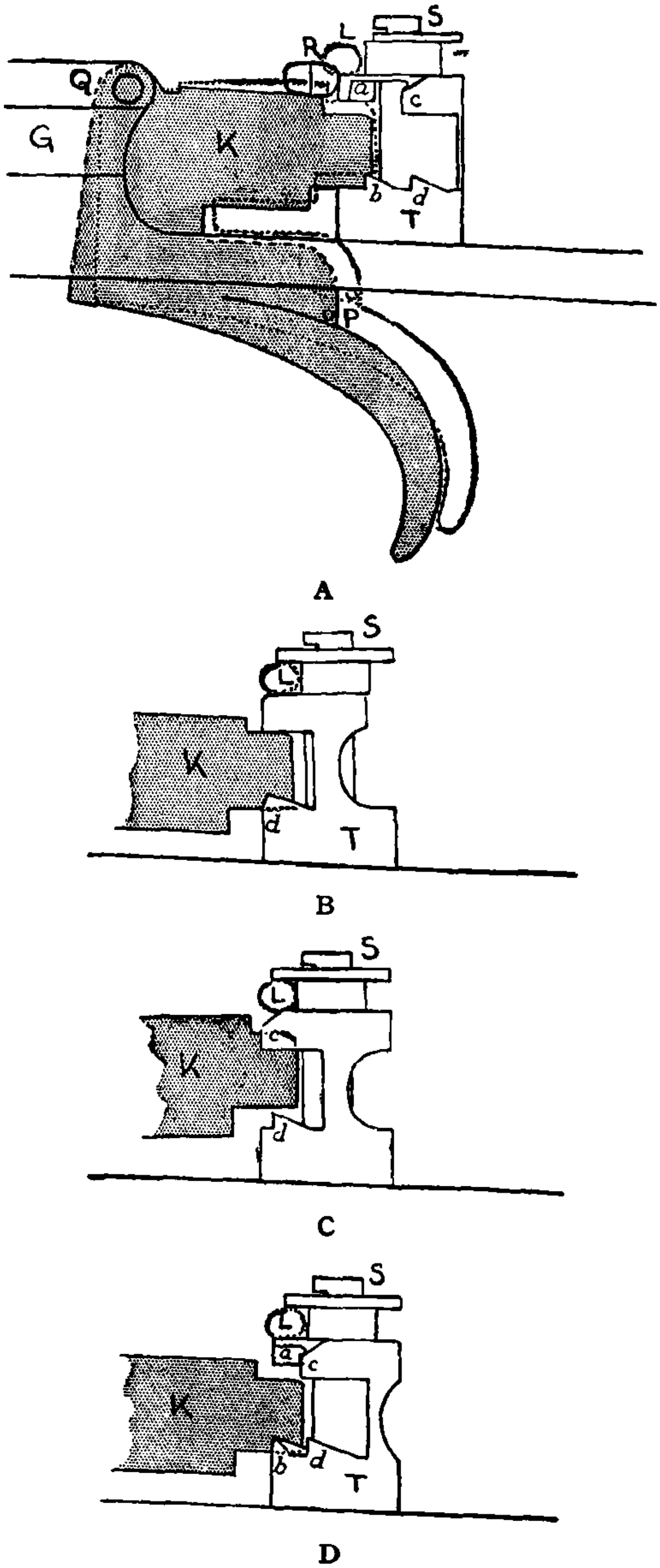


FIG. 55.—The Boss Single Trigger Mechanism.

The gun now recoils and the trigger slips away from the finger with the result that it is pressed back again into its normal position by the trigger spring (not shown in the diagrams). Immediately this happens the pressure of the trigger blade on cog *a* is relaxed and the turret at once revolves until it is stopped by the cog *b* hitting the lower part of the trigger blade, as shown in Fig. 55B.

The finger now contracts and takes the second and involuntary pull and the trigger blade is again raised.

The rear part of the blade is now raised above the cog *b* and so the turret revolves still farther. But it cannot turn far because the upper part of the trigger blade catches cog *c* and the turret is held in the position shown in Fig. 55C.

The second and involuntary pull has now been taken.

The next phase is that the trigger is voluntarily relaxed by the shooter in order to take what he believes to be his second pull, but what is really his third.

When the trigger is relaxed, the top edge of the blade drops clear of cog *c* and the turret immediately revolves still farther until cog *d* hits against the lower edge of the trigger blade, when the position is that shown in Fig. 55D.

The mechanism is now ready for the left barrel to be fired.

This is achieved by the sear arms of the left lock (shown in dotted lines) fitting in the upper groove in the turret, L. Until this position of the turret is reached the lug on the head of the spindle, S, prevents the turret from being moved up on the spindle, and so the turret is held down. This means that the sear arms of the left lock have also been held down throughout the cycle of operations described, and so have been kept in the " safe " position.

But directly the turret has turned to the position shown in Fig. 55D, the slot in the middle comes opposite the lug on the spindle, and so the turret is now free to be lifted vertically up on the spindle.

When the trigger is pressed again, the rear part of the trigger blade, which is now engaging in the lower groove in the turret, is raised *and carries with it the whole turret* which is lifted up on the spindle. This upward movement of the turret raises the sear arms of the left lock, which are in the groove, L, and the left barrel is fired.

When the trigger is released after firing, the turret drops back again into the position shown in Fig. 55D.

On the gun being opened a lever is pushed horizontally backward in the groove, (G), shown in Fig. 55A, by a cam on the spindle of the action lever. This lever engages with the outer edge of the turret and revolves it back about its spindle, until it re-assumes the position shown in Fig. 55A, and it is held in this position so long as the action lever is over and the gun open.

Directly the locks are cocked the sear arms of the right lock are brought down again into the position, R, in Fig. 55A, and those of the left lock are ready to engage in the upper groove in the turret when the turret revolves into the position shown in Fig. 55D.

The cycle of operations which has just been described can then be repeated.

A selective device can be fitted to this mechanism which consists of a horizontal **V**-shaped arm pivoted by its point to the upper edge of the trigger blade. This arm is actuated by a stud situated on the right side plate. The two ends of the arm can be brought under the right or left sear arms according to the position of the stud, and so either lock can be fired first at will, as when the trigger blade is raised it carries the **V**-shaped arm with it, and so lifts the sears.

THE HOLLAND SINGLE TRIGGER

This mechanism is of an altogether different type and works on a totally different principle, as the involuntary pull is allowed for by what may almost be termed a " delay action " in the mechanism which prevents the mechanism for firing the second barrel becoming effective until sufficient time has elapsed for the involuntary pull to be completed.

The mechanism is shown in the diagrams in Fig. 56 and can in general terms be described as a slide which moves backward and forward on the trigger blade. This slide is fitted with two arms which stick out on either side, the right arm being situated some distance in front of the left.

When the gun is cocked the right arm is under the sear of the right lock, and on the trigger being pressed the whole of the trigger blade and slide is raised and the right lock is thus fired. Directly this happens the slide moves forward and during this forward movement the involuntary pull is made. At the completion of the forward movement the left arm of the slide comes into position under the sears of the left lock, and when the trigger is pressed again this lock is fired.

The whole success of the mechanism depends on the correct timing of the forward movement of the slide, and this is governed by (1) the distance apart of the two arms of the slide; and (2) the speed of the forward movement.

The distance apart of the two arms is a fixed quantity, once it has been ascertained by experience, while the speed of the forward movement is controlled by a coiled spring, and so it is of paramount importance that this spring should always remain as nearly as possible at the same strength.

But these facts will perhaps be appreciated better if we follow the details of the mechanism with the diagrams.

Fig. 56A shows the specially shaped trigger blade, which is hinged by a pin at A in a pillar standing up from the trigger plate. The slot B is to permit movement when the trigger is pressed, as a special screw is fitted into the pillar at this point for guiding the slide, and if there were no slot in the trigger blade the trigger would be immovable.

The slide rests on the flat surface, C, and D is merely the projection over which the ordinary trigger bolting safety slips and so locks the trigger in position.

Fig. 56B shows the slide when viewed from above.

R and L are the two arms which fire the right and left locks respectively, and E is a groove in which a lever works which moves the slide backward and forward.

The whole mechanism is seen assembled in Fig. 56C, and in this position the right lock is ready for firing.

The slide, S, is shown resting on the trigger blade

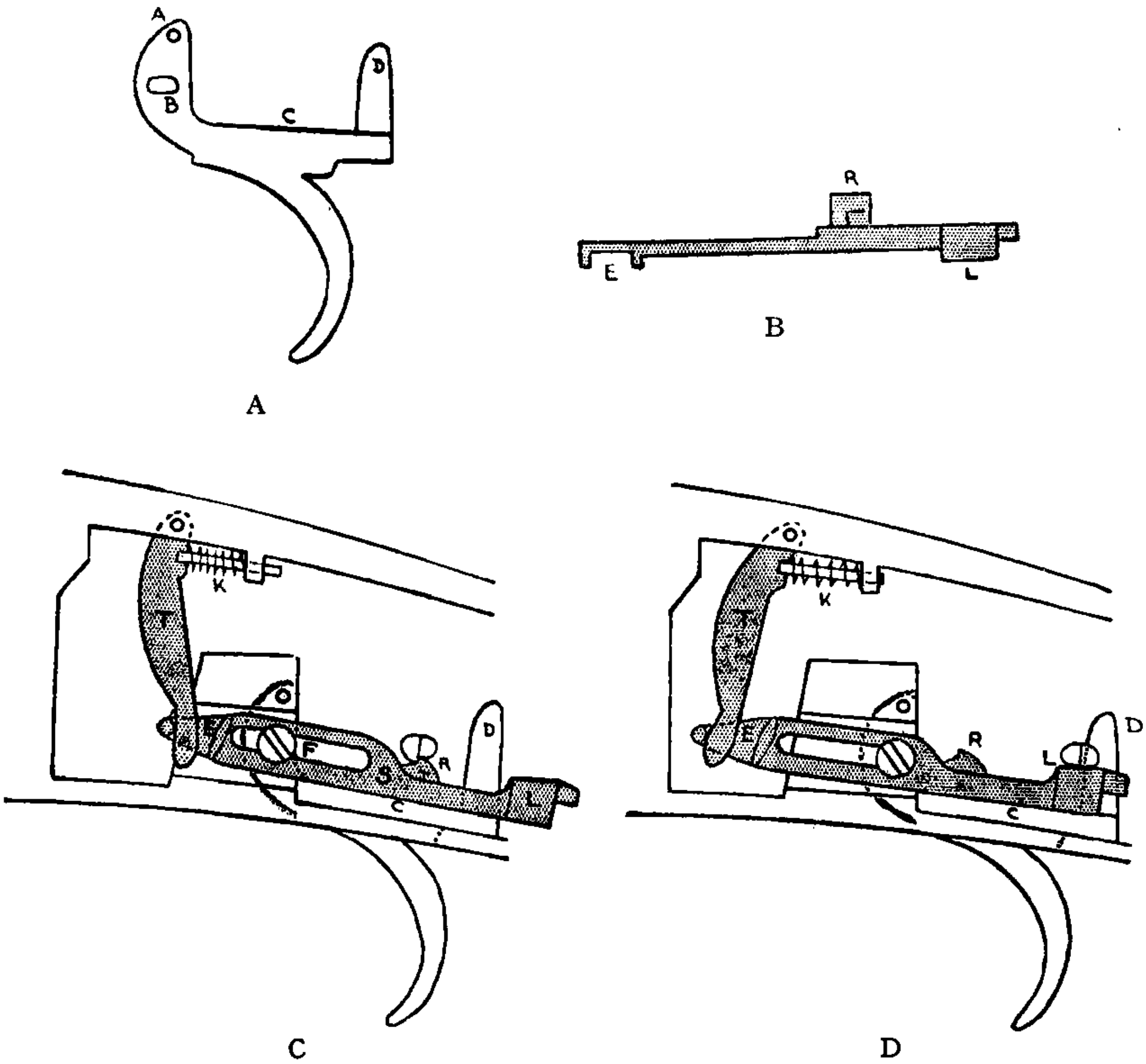


Fig. 56.—The Holland Single Trigger Mechanism.

in its extreme backward position. A screw, F, fits in a slot in the slide and is screwed into the pillar to which the trigger blade is hinged. This is the screw for the reception of which the slot B in the trigger blade (Fig. 56A) is cut.

An arm, T, is hinged in the strap of the action, as shown, with its lower end fitting in the slot, E, in the front part of the slide. This arm is actuated by a coiled spring, K, which tends to push it forward unless held back in some way.

The arm is actually held back by the slide which in its turn is held back by the sear arms of the right lock which engage with a little notch on the top of the arm, R, as shown in the diagram.

On the trigger being pressed the whole trigger blade is raised. This carries with it the slide, S, and consequently the arm, R, lifts the right sear arms, thus releasing the tumbler, when the gun is fired. The sear arms are then lifted up out of the way by the sear springs, and there is nothing to hold the slide back.

The result is that the coiled spring, K, asserts itself and pushes the arm, T, forward. The lower end of this arm pulls the front end of the slide, and so the whole slide moves forward on the trigger blade, the screw, F, acting as a guide and stop, until its extreme forward limit of movement is reached, when the different parts of the mechanism occupy the positions shown in Fig. 56D.

During the time occupied by this forward movement of the slide the involuntary pull is made and completed.

When the slide is in the position shown in Fig. 56D, the arm, L, comes immediately under the sear arms of the left lock, which are shown in section in the diagram. Consequently on the trigger being pressed again these sear arms are raised and the left barrel is fired.

From the point of view of construction this mechanism seems very simple, but the parts must all be fitted with extraordinary accuracy, and the strength of the coiled spring must be gauged with extreme nicety. For, as has been explained, the interval necessary for the taking of the involuntary pull is allowed for by the time occupied by the slide moving from back to front; and this depends on the distance apart of the two arms, R and L, and the strength of the coiled spring, K. If this spring were too strong the slide would move forward too quickly, and a double discharge might be the result.

This mechanism is not really adaptable for a selective device. It is true that Messrs. Holland do, when specially required, so fit the trigger that it can be pushed forward and downward at will. If this is done when the mechanism is in position to fire the right barrel, the catch on the arm, R, is lowered below the sear arms of the right lock which no longer hold the slide back. Consequently it moves forward and brings the arm, L, under the sear arms of the left lock, thus permitting the left lock to be fired first.

The right lock, however, cannot then be fired unless the mechanism is reset by pushing over the action lever as in opening the gun. For the arm, T, is actuated by an arm on the action lever (not shown in the diagrams) which pushes the arm and slide back when the gun is opened; and on the locks being cocked the sear arms of the right lock engage in the notch on the arm, R, and hold the slide back in the ready position.

A device such as this, however, can hardly be called a selective mechanism as it only allows the left barrel to be fired, and not left, right, without further movement of the action lever.

[NOTE.—In the most recent models the arm, T, has been placed in rear of the pillar, or trigger box, so as to permit the whole of the head of the stock being solid. This is an improvement as the gun is rendered stronger. Another change is in the housing of the coiled spring, K, which is no longer exposed on the action strap, but is carried in the arm, T, in a small hole which takes the spring and a plunger. The principle underlying the working of the mechanism, however, remains unchanged.]

THE LANG SINGLE TRIGGER

This mechanism works on the same general principle as the Holland, in that time is allowed for the taking of the involuntary pull before the firing of the left lock is possible. But the method of allowing for this time is quite different.

The trigger blade holds a horizontal peg which is free to rotate in its bearing and which is placed at right angles to the line of the gun. Each end of this peg is fitted with an arm placed at right angles to the peg, and also approximately at right angles one with the other.

When the gun is cocked the right arm of the peg comes under the sears of the right lock. On firing, the peg revolves in its bearing in the trigger blade until the left arm comes underneath the sears of the left lock, which can then be fired at will.

The involuntary pull is taken during the time occupied by the revolution of the peg in its bearing in the trigger blade, and consequently depends on (1) the angle through which the peg has to revolve in order to bring the left arm into position; and (2) the speed of revolution which is controlled by a spring.

The mechanism is shown in different positions, and from both right and left sides, in the diagrams in Fig. 57.

Fig. 57A is a view from the left when the mechanism is set for the right barrel to be fired. The trigger blade is left plain and marked T. It is hinged at A in a pillar, or "trigger box," which is an integral part of the trigger plate. The two arms of the ends of the revolving peg are marked R and L; R being the arm for the right lock, and L that for the left. The circular peg to which they are attached is shown dotted in the lower part of the arm, L, in diagrams 57A and D.

The two arms are of different shapes, the top of the right arm being fitted with a notch into which the sear arms of the right lock drop when the lock is cocked, as shown in Fig. 57A and B. These sear arms hold the right arm back and prevent the peg from being rotated by the spring shown in Fig. 57B.

This spring, S, is a flat spring, the rear end of which is screwed to the trigger plate, as shown. The front, and free, end fits into a circular slot, C, in the bottom of the right arm.

Directly the trigger is pressed, the blade T is raised, which caries with it both arms R and L. The left arm being out of position has no effect, but the right arm, R, lifts the sears of the right lock and so fires the right barrel. On this happening the sear arms are lifted up out of the way by the sear springs and there is nothing to prevent the spring, S, from rotating the arms. This it does, and the arms are turned into the positions shown in Fig. 57C and D; further turning being prevented by the point of the arm R butting against the trigger blade.

The top of the left arm, L, now comes into position immediately under the sears of the left lock, and when the trigger is pulled again the left barrel is fired.

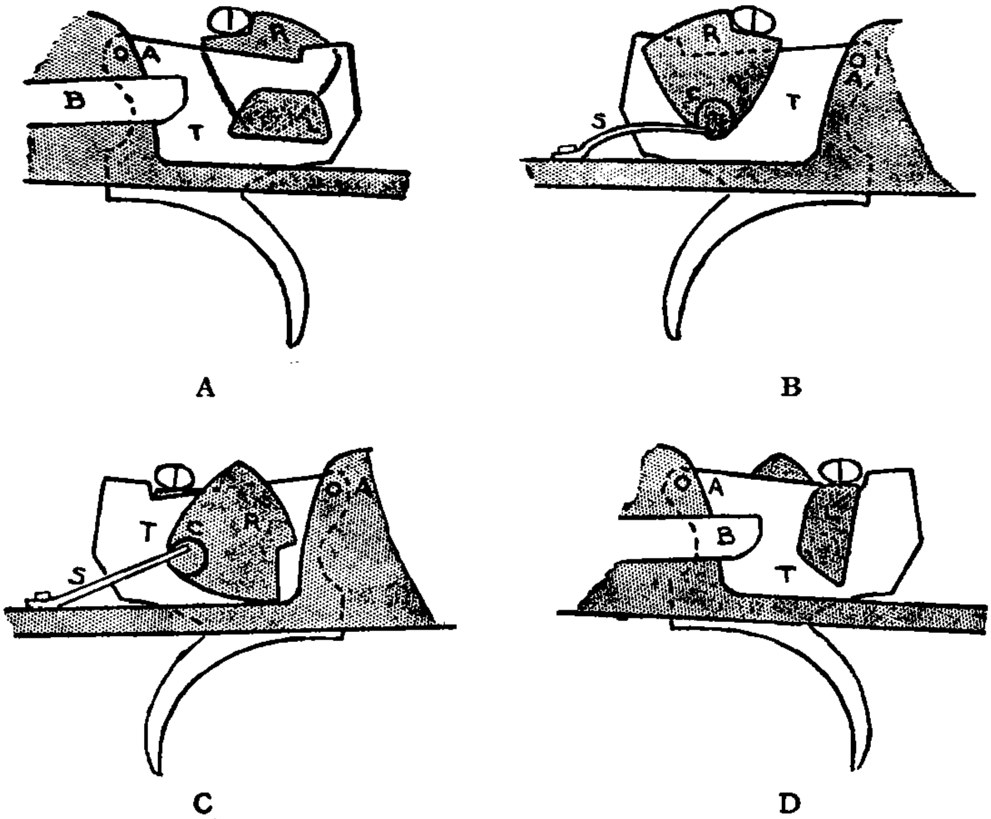


FIG. 57.—The Lang Single Trigger Mechanism.

The period occupied by the second, or involuntary pull, is allowed for by the time necessary for the revolution of the two arms from the position shown in Fig. 57A and B and those shown in Fig. 57C and D. This time is dependent on the angle between the two arms and the speed of revolution which is governed by the strength of the spring, S.

The sear arms of the left lock can be seen in section sitting on top of the arm, L. On the left barrel being fired these sear arms are lifted up out of the way by their springs.

On the gun being opened a rod, B, in Fig. 57A and D, is pushed backward by a cam on the spindle of the action lever. The rear end of this rod is bevelled and pushes against the specially shaped front surface of the arm, L, and revolves this arm backward. This turns the peg on which the arm is fitted, and with it brings the right arm back into the position shown in Fig. 57A and B. Directly the right lock is cocked the sear arms catch in the notch in the top of the arm, R, and the mechanism is held in position ready for the right barrel to be fired once more.

This mechanism cannot be fitted with a selective mechanism.

THE WESTLEY RICHARDS SELECTIVE SINGLE TRIGGER

Both the principle and design of this mechanism are entirely different from those of the three which have been described. The various diagrams in Fig. 58 show the mechanism in different phases of operation and from both the right and left.

In order to simplify the task of description Fig. 58A and B do not show all the limbs. In Fig. 58A, T is the specially shaped trigger blade which is pivoted to a pillar (technically known as the "trigger box", or "breech pin block") on the trigger plate at A. Pivoted to the rear portion of the trigger blade is a special "Lifter," L. This lifter is pivoted at K, which is at its extreme lower end, and the top part is so shaped that the centre of gravity lies *behind* the pivot, K. Accordingly when the trigger blade, T, is raised on the trigger being pressed, the lifter, L, has a natural tendency to fall backward about the pivot, K, as shown in Fig. 58B.

After falling a short distance the top end of the lifter comes up against a specially shaped post, P, and is prevented by this post from further movement. This "post" is called the "Cut-off."

This post is pivoted into the trigger plate, as shown in Fig. 58A, but the bottom is so shaped that there is little freedom of movement. Movement is further restrained by a spring, which is not shown in the diagrams, and the effect is that this post has a little "give" in it instead of being absolutely rigid.

In order to prevent the lifter, L, from toppling over on to the cut-off, P, whenever the trigger is pressed, the top of the lifter is connected to the top of the trigger blade by a small coiled spring which is of sufficient strength to hold the lifter up so that it moves up into the position shown by the dotted lines in Fig. 58B when the trigger is pressed.

When, however, any pressure is applied on the lifter sufficient to neutralise this power of the coiled spring, the lifter falls against the cut-off on the trigger being pressed.

So it will be seen that there are two possible positions for the lifter to move into when the trigger is pressed; one backward against the cut-off, and one straight up; also that these positions will be assumed by the lifter according as pressure to neutralise the power of the spring is applied or not.

It is essential that this action of the lifter, which is dependent on the application of pressure, should be understood; as on it depends the working of the mechanism.

The lifter is fitted with two pegs, B and C, in the positions shown in the diagrams, and these pegs protrude slightly on both sides of the lifter, forming studs.

The other essential parts of the mechanism consist of a slide, S, which can be moved backward and forward by a small stud on the underneath side of the trigger plate, which is shown shaded in Fig. 58A, B, C and E, as it is placed on the right-hand side of the trigger and is so only visible when the action is seen from the right.

Pivoted to this slide, and one on each side, are two specially shaped leaves. The right leaf is marked M in Fig. 58C and E; and the left leaf is marked N in

Fig. 58D and F, each leaf only being visible from its own side of the action.

Although these leaves are pivoted about the same pin in the slide, S, they are of different shapes. Each,

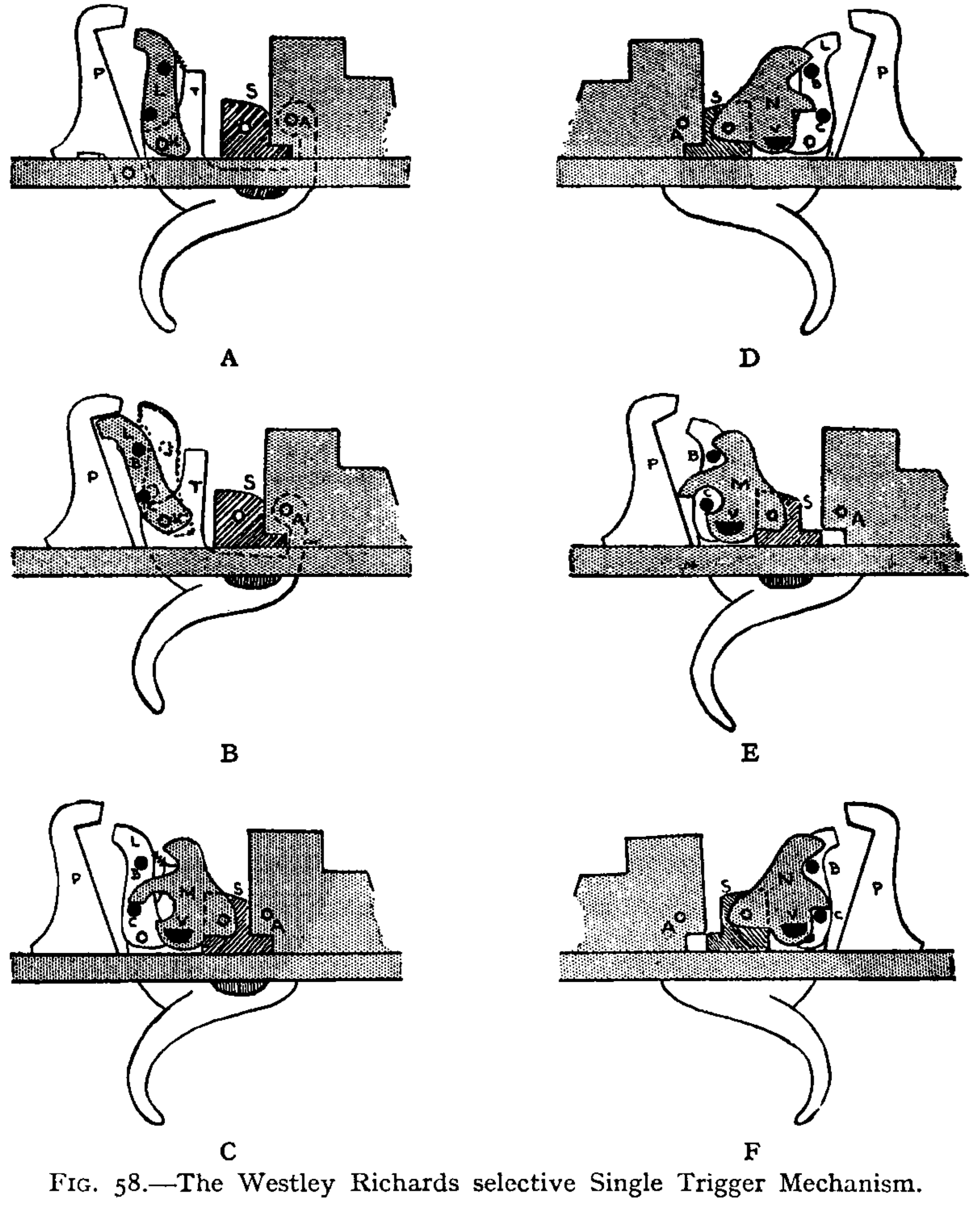


FIG. 58.—The Westley Richards selective Single Trigger Mechanism.

however, carries a semicircular stud, V, which projects outwards. The sear arms of the locks rest on these two studs, the right sear resting on the stud of the leaf M, and the left sear on that of the leaf N.

When the slide, S, is in its forward position the leaves M and N occupy the positions shown in Fig.

58C and D; and in this position of the slide and leaves the right barrel is fired first and the left barrel second.

The action of firing is as follows:

An arm of the right-hand leaf, M, rests on the stud, C, on the lifter; and since the sear arm is pressing on the stud, V, *downward pressure is brought to bear on the lifter which neutralises the small coiled spring before mentioned.*

This situation can be seen in Fig. 58C.

Fig 58D shows the other side of the action at the same time. Here, it will be noticed, there is no direct contact between the leaf, N, and the lifter. The stud, C, is well clear to the rear of the leaf, and the upper stud, B, is *just not touched by the upper part of the leaf.* Accordingly the pressure of the left sear arm cannot be transmitted to the lifter by the leaf, N, but only by the leaf, M.

On the trigger being pressed the lifter is swung back under the head of the post into the position shown in continuous lines in Fig. 58B, owing to the pressure on the stud, C, neutralising the coiled spring. Simultaneously with this movement the stud, C, which is raised with the lifter, rotates the leaf, M, about its pivot. This raises the stud, V, which raises the sear arm of the right lock, and so fires the right barrel.

The top of the lifter falls against the cut-off, P, and is caught under the specially shaped head Owing to the give in the cut-off already mentioned, the lifter is not immediately released, and *during this delay in the release of the lifter the involuntary pull is taken.*

It should be noted that when the lifter moves upward and backward, as it does when the first pull is taken, the stud, B, moves *away* from the leaf, N, owing to the special shape of the upper part of this leaf. (See Fig. 58D.)

On the lifter being released it falls back into the position occupied in Fig. 58C and D.

The sear arm of the right barrel is lifted up by its spring when the lock is fired *and so the pressure on the* *lifter is removed.* The result is that when the trigger is pressed once more the lifter is raised straight up into the position shown by the dotted lines in Fig. 58B. As this occurs the stud, B, engages with the top part of the leaf, N, and rotates it about its pivot. This raises the stud, V, which lifts the left sear arm, and so the left barrel is fired.

When, however, the slide, S, is pushed into its backward position the source of application of pressure on the lifter is changed. Before it was derived from the right sear arm: it is now derived from the left.

This will be seen in Fig. 58E and F.

Fig. 58E shows the right leaf, M, in its position when the slide, S, is pushed back. It will now be seen that the special shape of the leaf so arranges matters that there is a big gap between the stud, C, on which it pressed formerly, and the edge of the leaf; further, that the upper stud, B, does not quite touch the top part of the leaf. Accordingly the leaf, M, can no longer transmit any pressure on to the lifter.

The corresponding position of the leaf, N, is given in Fig. 58F. Here the stud, C, is right under a part of the leaf, whereas previously it was well to the rear. The leaf is pressed down by the sear arm which presses on the stud, V, and so this pressure is transmitted by the left leaf, N, to the stud, C, and so to the lifter.

When the trigger is now pressed the lifter again rises into the position shown in Fig. 58B, under the head of the cut-off, on account of the pressure of the left leaf, N. And in so doing it rotates the leaf, N, about its pivot, with the result that the stud, V, is lifted, thus raising the sear and firing the left barrel.

The lifter is caught by the head of the cut-off as before and held for a fraction of a second while the involuntary pull is made, and on the trigger being released again it drops back into its normal position.

But now the left sear arm will have been moved out of the way, and consequently the source of pressure on the lifter has been removed. Accordingly, when the trigger is pressed again, the lifter moves straight up and the stud, B, engages with the upper part of the right leaf, M, rotating it about its pivot and thus firing the right barrel.

When the lifter moved up and backward, as it did on the first pressure of the trigger, this stud, B, was not brought into contact with the right leaf, M, and so the right barrel was not fired, just in exactly the same way as the left barrel was not fired on the first pull of the trigger when the slide, S, was in its forward position.

It will accordingly be seen that pressure on the lifter can only be brought to bear on one side at a time. When the slide is forward the pressure comes on the right; when the slide is back the pressure comes on the left. And on whichever side the pressure comes that barrel is fired first, the other barrel being fired by the upward movement of the lifter which occurs when there is no pressure on it.

This mechanism is certainly most ingenious, and the fact that it is selective really adds nothing in the way of complication. It will be obvious, however, that every part must fit with absolute accuracy, and the strength of the coiled spring is a matter of considerable nicety. If this spring were the least bit too strong, or if the leaves were not of the exact shape, or the studs in the lifter were not perfectly sited, both leaves would be rotated by the lifter on the first pull of the trigger, which would mean a double discharge.

THE WOODWARD SINGLE TRIGGER

Like that of the Boss the Woodward single trigger works on the three-pull system but here all similarity ends, for the Woodward mechanism is based on what may be termed the " swinging blade " principle since there are three separate blades operated as the occasion demands by the one trigger but all of which are swung, or hinged, on the same pin in the trigger box.

Fig. 59 shows these three blades separately, that operating the right lock being on the right and that operating the left lock on the left. The actual trigger with its blade is in the centre. All three blades are viewed from the right.

It should be realised at the very outset of any study of this mechanism that the central blade, which is an integral part of the trigger, never comes into direct contact with either of the sears. Its real function is to enable the finger to bring first the right blade into action with the first pull of the trigger, then to create the necessary delay which is absorbed by the second and involuntary pull, and finally to bring the left blade into effective action with the third pull.

The right and left sear tails fit against the hollows in

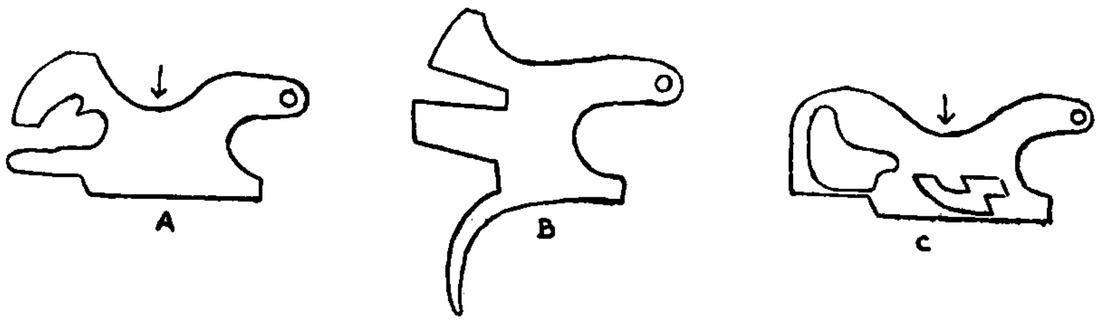


FIG. 59.—The Woodward Single Trigger Mechanism.

the top edges of the right and left blades which are obvious in Fig. 59C and 59A respectively, but which, for the sake of extra clarity are indicated by arrows. To avoid complications in these and the subsequent diagrams the sear tails have been omitted since the positions which they occupy are really obvious.

The other essential component is a specially slotted slide and Fig. 60 shows this slide in its housing on the trigger plate together with the trigger and its central blade in position. It will be seen that the front end of this slide moves in a hole through the trigger box, while the rear end through a hole in a stop fixed to the trigger plate. This rear end of the slide is surrounded by a spiral spring which is compressed when the slide is pushed forward between the enlarged head of the extreme end of the slide from behind and the fixed stop in front. Thus if there is no force pushing or pulling the slide forward this spiral spring asserts itself and forces the slide in its extreme rearward position.

The central part of the slide carries a hinged unit (A in Fig. 6o) which is free to swing about the hinge-pin, B, and drops into a recess cut out of the main slide as can be seen in the diagram. This hinged unit, like the slide, is slotted in the middle so as to allow the central trigger blade to swing upwards and downwards in the middle of both the slide and whole mechanism. The rear end of this hinged unit rides on the top edge of the lower arm of the central blade and can thus be moved up or down in unison with the movement of the trigger.

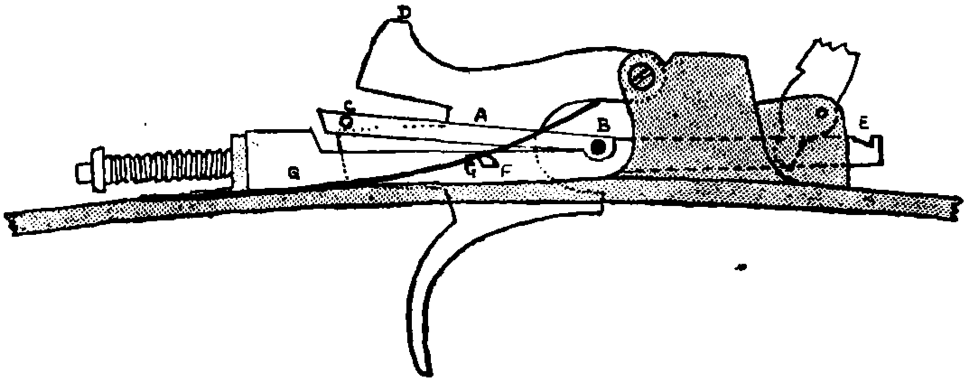


Fig. 6o.—The Woodward Single Trigger Mechanism.

And here it can be explained that the sole purpose of fitting an upper arm to the rear end of the central blade is to provide a butt against which the safety device can operate and lock the trigger. The seat for the safety device is marked D in Fig. 6o.

A round peg is driven through the rear end of the hinged unit of the main slide with its two ends protruding for some little way on either side. This peg (C in Fig. 6o) operates the right and left blades in their proper turn and provides the essential connection between the trigger and the two blades which control the right and left locks respectively.

Fig. 6o shows the slide in its most rearward position, that is the position it occupies after both locks have been fired. When the gun is opened the slide is pulled to its extreme forward position by a lever operated by the action lever of the gun, and when the slide reaches this extreme forward position a short arm carried by the right sear which protrudes inwards and at right angles to the sear drops into a slot, or bent, in the top and very front of the slide (E in Fig. 60). The slide is now in its most forward, or cocked, position and ready to exercise its control directly the trigger is pressed.

This control is effected by means of the specially shaped stud (F in Fig. 60) which sticks out from about the middle of the right hand side of the slide. It will be seen that this stud moves in a specially shaped slot in the right blade.

The only other component which deserves mention is the trigger spring (G in Fig. 60), which is a long and narrow stirrup spring, fixed by a screw to the trigger plate at its rear end and with its base underneath the arms of all three blades just behind their hinge with the trigger box.

Let us now consider what happens to the right blade when both barrels are fired in succession.

Fig. 61 shows the essential parts of the mechanism viewed from the right. The visible parts of the trigger and central blade have been stippled and those of the left blade shaded. The right blade has purposely been left plain.

Fig. 61A shows the mechanism when both locks are cocked and ready to fire. The slide is in its extreme forward position with its specially shaped stud, F, in the front part of the forward recess in the right blade; and with the peg, C, resting against the upper edge of the rear recess in the right blade.

Fig. 61B shows the trigger pulled back in the first pull. The central blade is naturally raised and has carried with it the rear end of the hinged unit of the slide. The peg, C, in this unit has in its turn lifted the rear end of the right blade, thus firing the right lock.

But the raising of the sear tail not only frees the right tumbler but also frees the protruding arm of the sear from engaging in the bent in the extreme front of the slide. Consequently the coiled spring which controls the slide immediately comes into action and draws the slide back a little way. The lower edge of the forward slot in the right blade then cuts against the stud, F, and momentarily holds the slide still.

These positions assumed by the various limbs are all shown in Fig. 61B.

Directly pressure on the trigger is relaxed the sear brings both the right and central blades back into their

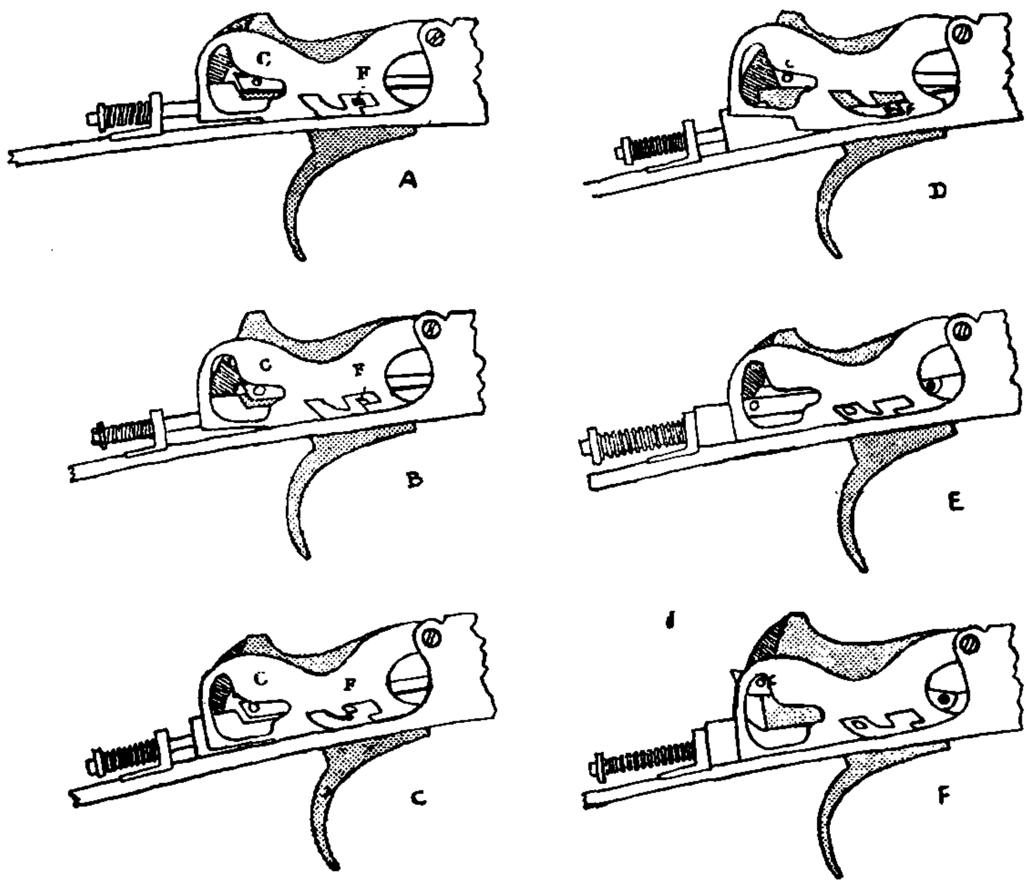


FIG. 61.—The Woodward Single Trigger Mechanism.

original position while the coiled spring pulls the slide back until further movement is checked by the stud, F, engaging with the "cog" protruding downwards from the top edge of the forward slot in the right blade.

This is clearly seen in Fig. 61C which also shows how the peg, C, is still in contact with the upper edge of the rear slot in the right blade although the rearward movement of the slide has carried this peg slightly further along this upper edge of the slot.

Next comes the second, or involuntary, pull.

The central blade is naturally raised and carries with it the hinged unit of the slide so the peg, C, again raises the right blade. Since the right lock has been fired this second movement of the right blade cannot effect the lock mechanism. It does, however, lift the "cog" protruding from the top edge of the forward slot in the blade free of the special stud, F, on the slide.

This position of the essential limbs at the moment of the second, or involuntary, pull is shown in Fig. 61D.

The pressure of the lower edge of the forward slot in the right blade against the stud, F, momentarily holds the slide. But directly this pressure is relaxed the coiled spring can again assert itself and pull the slide right back to its extreme rearward position.

Fig. 61E shows the positions of the limbs when the trigger is released after the second, or involuntary, pull.

Now comes the final pull which fires the left lock.

The central blade and hinged unit are lifted together as before but the peg. C, merely moves freely up in the rear slot in the right blade so that the right blade never moves at all. For its movement is no longer needed as it was. During, the first pull the right blade not only fires the right lock but also frees the slide and begins to control the backward movement of the slide. During the second pull the sole function of the right blade is to continue to control the movement of the slide, this control being completed when the trigger is relaxed for the second time, after which the right blade serves no further purpose and is so left stationary. This can be seen in Fig. 61F which also shows the left blade now lifted for the first time.

But the fortunes of the left blade and left lock are shown in Fig. 62.

We must now start again with the gun cocked and the slide in its extreme forward position. Once again the central blade and trigger are stippled in the diagrams while this time the visible portions of the right blade are shaded and the left blade is plain.

Fig. 62A shows the left blade and other components when the gun is cocked and ready to fire. It will be noticed that the peg, C, in the special hinged unit of the slide is not pressing against any part of the left blade but is situated in the middle of what may be termed the forward upper " bay " of the slot in the end of the blade. There is, however, a special flat stud, K, on the end of the slide which fits against the lower edge of the extreme end of the slot in the blade, and which thus

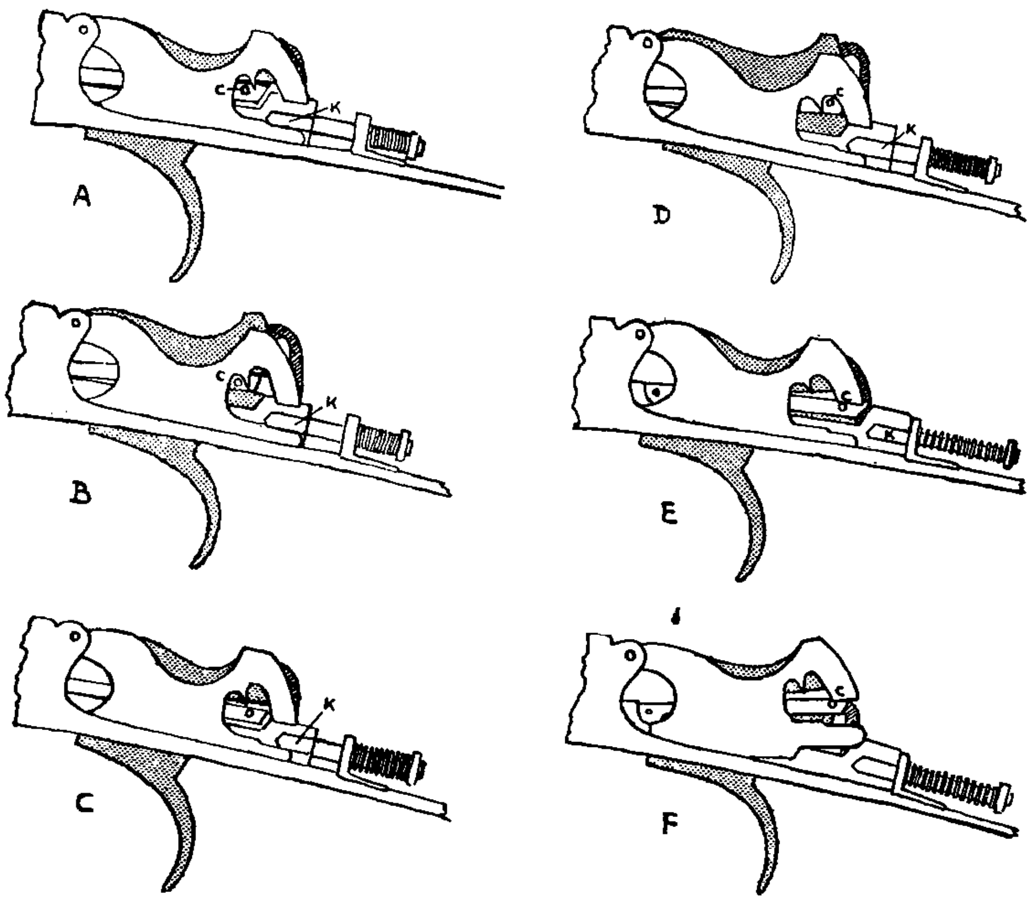


FIG. 62.—The Woodward Single Trigger Mechanism.

holds the left blade in position and prevents it from moving, so providing an admirable prevention against any risk of discharge while the right barrel is fired.

When the first pull is taken and the right barrel fired the central blade and the peg, C, are lifted as has already been described but this time the peg, C, merely moves up in the forward upper " bay " in the slot in the left blade which is held down, as has been explained by the stud, K.

On the trigger being released the slide moves backward for a part of the way, as has been explained, but the stud, K, is still engaged with the lower edge of the slot in the left blade. Fig. 62C shows the component parts in position when the trigger is relaxed after the first pull.

Fig. 62D shows the trigger pressed during the second, or involuntary pull. The central blade is lifted but the peg, C, has merely moved up in the rear upper " bay " in the slot in the left blade and so has made no contact with this blade which still remains held in its original position by the stud, K.

The trigger is once more relaxed when the slide moves back to its extreme rear position carrying the stud, K, clear of the lower edge of the slot in the left blade but bringing the peg, C, into contact with the upper edge of this same slot as can be seen in Fig. 62E.

Now comes the third and final trigger pull. The central blade and peg, C, are lifted as on previous occasions but now the peg, C, lifts with it the left blade as is shown in Fig. 62F, thus firing the left lock.

Although a detailed description of this mechanism is necessarily somewhat lengthy the mechanism itself is really very simple for a single trigger mechanism. Its successful working is controlled by the coiled spring at the end of the slide which is not only strong and reliable but would continue to function even if it did break as is the manner of coiled springs since the two broken portions butt against each other and act almost like two separate springs.

Consequently I feel that this Woodward three-pull " swinging blade " mechanism is an exceptionally strong and reliable single trigger, especially as the limbs themselves are all remarkably robust.

CHAPTER IX

OVER AND UNDER GUNS

OVER and Under guns, as was explained at the beginning of the last chapter, are guns in which the two barrels are fitted in a vertical plane, one above the other; and not in a horizontal plane, or side by side, as is ordinarily done. This system of superimposing the barrels is not new: it is, in fact, as old as double-barrelled weapons, for such were originally made with one barrel above the other; and it was not until a later period in the history of fire-arm development that the "side by side" method of joining the barrels became almost universal. Breech-loaders, however, present a very different problem in manufacture to muzzle-loaders; and over and under guns are far more difficult to adapt to a breech-loading system than guns of the ordinary type. For this reason over and under guns fell into abeyance for the best part of a century, and it was not until modern experience had rendered the ordinary breech-loader almost as perfect as possible that this same experience was applied to building guns on the over and under principle.

Before we enter into any details of design it will be as well first to consider the reasons which led to this departure from the normal.

The primary object was the search for something new. A degree of finality having apparently been reached in ordinary hammerless ejectors, the makers of best guns very naturally wished to bring in some improvement as otherwise their businesses would suffer owing to the extraordinary longevity of the weapons they built. For the best gun has an almost indefinite life and can be passed on from father to son; and is a very different proposition from a motor-car which shows signs of wear after a comparatively very short time. During the process of evolution of the breech-loader, when one type of action superseded another, and when ejectors were brought in and improved, guns became out of date after a few years, and their owners replaced them in order to obtain the most modern weapons and not because they were worn out. But once a sort of finality was reached, guns remained in use year after year, while replacements were no longer necessary.

There can be no doubt that it was this fact which was one of the chief contributory causes to the introduction of reliable single-trigger mechanisms, and it is equally true that this invention has amply justified its existence.

And, finally, the search for something new in gun design led to the re-introduction of over and under guns.

But no new invention can possibly last unless it results in some real and definite improvement. A new design of any manufactured article may have a brief life owing to the ever-present desire of a percentage of potential purchasers to possess something new and different. But, to last, the invention must not merely entail difference from existing design: it must entail some tangible improvement.

Modern over and under guns have now been established for over twenty years, and so it is obvious that they must possess some advantages which are not possessed by ordinary guns, else they would certainly not have survived the period of the War.

The advantages which are usually claimed for them are:

(1) Greater ease and quickness in taking aim, or "getting on one's bird."

(2) Better balance.

Both of these, especially the first, are very important points, so it may be as well to consider the merits of the claims.

A single barrel presents a narrow line to the eye when aim is taken, and consequently a more accurate aim should result than when the wide line of the double barrel is seen. The over and under gun combines the advantage in the matter of aiming of the single barrel and the quick second shot of the double.

I think that this may be absolutely true, certainly in theory, and up to a point in practice. But I must confess that I doubt whether the benefit conferred by the narrow line of aim is so generally great as some enthusiastic admirers of the over and under gun would have us believe. The truth probably is that individuals vary very considerably in the degree of help which they receive unconsciously from the line of the barrels. Some men may derive no advantage at all from a narrow line, while others may find their shooting improved to an astonishing extent; and the great majority will probably find that they come in varying degrees between these two extremes.

In America, where single-barrelled weapons have always been popular and where rifle-shooting with single-barrelled arms has always been almost universal, over and under guns are extremely popular. But in Great Britain we have been for some generations accustomed to guns with horizontally placed barrels, and we have become so accustomed to them that the majority of us probably find that the advantages conferred by over and under guns are not sufficiently great as to warrant the cost of a change.

The best, in fact the only, method of determining this question is to try one of these guns for oneself at some shooting school. If the benefit conferred is marked, the question of advantage is settled: but if it is not marked there is no reason to condemn the type of gun, because, as I have stated, this is really a matter of individuality and few shooters will be affected quite alike.

I have used the word "aim" with diffidence, because in reality one should not "aim" with a gun in the sense that one does with a rifle. Nevertheless, there can be no doubt that even the quickest shots are helped —unconsciously perhaps—by the line of the barrels;

and it is the instinctive utilisation of this help that constitutes " aiming " with a shotgun.

The question of balance is really one of our old friend, Inertia, which was dealt with in Chapter VI.

The action bodies of over and under guns are usually heavier than those of ordinary guns because metal has to be extended over a larger area. In order to keep the total weight of the gun down it is lightened at the ends in every possible way, and consequently there is usually a slightly greater concentration of weight in the middle part of the gun. The effect of this concentration is that there is less inertia in the ends and so the gun is easier to turn about its middle. But, as I pointed out in Chapter VI, this is not necessarily an advantage to all shooters, as there are some who are unquestionably helped by a little more inertia forward in the barrels. And so we see that the advantage of balance is really like the matter of aiming, and one which everyone must settle for himself.

There are two other minor advantages which should not be overlooked.

The first of these is that the narrow grip on the fore-end may be a help to those who find it difficult to hold an ordinary gun on account of some physical disability; and I know of at least one man who is unable to hold an ordinary gun but who can shoot with an over and under almost as well as ever.

The other point is that the increased depth of the barrels prevents one from tilting the plane of the barrels when taking aim. This is one of the commonest causes of bad aiming, but it is also one which over and under guns help to correct in some individuals. But here again, this is an individual advantage rather than general.

The disadvantages of this type of gun are really their appearance and their cost.

Beauty and symmetry of design count for a very great deal in a best gun, and over and under guns seem to have a " heavy " look and lack the thoroughbred appearance of ordinary guns. It is quite possible that this is largely a matter of habit, and that anything new looks abnormal. But I do not think it is entirely so, and I have never yet seen an over and under gun which possessed quite the beautiful lines of an ordinary best weapon. If these guns were to come into more general use we might grow more accustomed to the strangeness of their appearance, and their lines might gradually become less pronounced with increased experience in design. But as things are at present I cannot help thinking that their appearance is a handicap to their adoption in many cases.

Then their cost must necessarily be high, for an enormous amount of extra work is entailed in their manufacture.

I think, therefore, that it is probably correct to take the view that in the case of the majority of shooters the advantages conferred by over and under guns are not really sufficiently marked to justify the departure from the normal in appearance or the extra price necessary for the purchase.

But when anyone finds that the advantages derived are real, he should certainly ignore appearances and pay the additional cost.

BARREL "FLIP"

Over and under guns, however, call for the consideration of an altogether different problem connected with all fire-arms, whether cannon, rifles or shotguns. The very existence of this problem is realised by few sportsmen, and by no means all gunmakers: nevertheless, it plays a most important part in the building of all guns, especially those in which the barrels differ from the normal, either in their position relative to one another, or in their length.

This problem is that of "Jump" or "Flip."

In order to simplify a consideration of the question of Flip I will first of all borrow three elementary definitions from Artillery work.

Angle of Elevation. The angle which the axis of the bore makes with the horizontal when the gun is set ready to fire.

LINE OF DEPARTURE. The actual line of direction taken by the projectile when it leaves the muzzle of the gun.

ANGLE OF DEPARTURE. The angle which the Line of Departure makes with the horizontal.

The layman will very naturally think that the projectile will begin its journey in exactly the same direction as the gun was pointed immediately before firing; in other words, that the Line of Departure is merely a continuation of the Axis of the Bore when the gun is set ready to fire, and that the Angle of Departure is the same as the Angle of Elevation, and further that it is silly waste of time to have two definitions for what is obviously the same angle!

Now this is a very natural point of view. But it is also not unnatural to assume that no body of men will go out of their way to complicate life by making up two entirely different definitions for the same thing.

As a matter of fact, the Line of Departure is *not* a prolongation of the Axis of the Bore when the gun is set ready to fire; and the Angle of Departure is therefore, *not* the same as the Angle of Elevation

The difference between the Angle of Departure and the Angle of Elevation is known in Artillery parlance as "Jump." In other words, "Jump" is the vertical angle which the axis of the piece describes under the shock of firing during the interval between the ignition of the powder charge and the exit of the projectile from the muzzle. When the muzzle of the piece moves upwards the jump is said to be positive; and when the muzzle moves downward the jump is negative.

We can now leave cannon and pass to small arms.

In both rifles and shotguns there are really two elements of jump which must be distinguished. These are:

(1) The weapon moves as a whole about the point of the stock where the recoil is taken and gives a *positive*

jump because the centre of the barrel is invariably *above* the centre of gravity of the weapon. In fact, the effect of recoil is to throw the muzzle up.

(2) The barrel bends, or flips, during the same interval of time in which the first-mentioned movement of positive jump is taking place.

The second of these two elements of movement is much the more important, as it exercises the controlling factor in the total movement of the weapon during the shock of firing, and consequently in sporting and military small-arm gunnery the term " Flip " is invariably used instead of " Jump," and is regarded as including both elements.

The flip of a barrel consists partly of a bending, just as a fishing-rod bends when an angler strikes, and partly of a vibration set up in the barrel, partly by the movement of the cartridge-case and breech fittings under the sudden application of the powder pressure, and partly by the actual movement of the projectile along the bore.

The *bending* of the barrel during recoil is always negative, because the barrel becomes the arc of a circle and the axis near the muzzle has a direction downward in comparison to its original position, just as the point of a fishing-rod assumes a more downward direction when the angler strikes.

But the effect of barrel vibration may be either positive or negative according to the time the projectile takes to travel up the bore, and whether the projectile leaves the muzzle at the top or bottom of a vibration.

Actually the resultant flip is the sum of these two effects and it also includes the jump, as has been explained.

Now flip varies with every barrel and action, and even with the same barrel and action when they are bedded differently to the stock. It is dependent on the length and thickness of the barrel; the method of support which the barrel receives; the rigidity of the attachment of the barrel to the action, as well as the action itself; and the tightness of the bearing between the action and the stock.

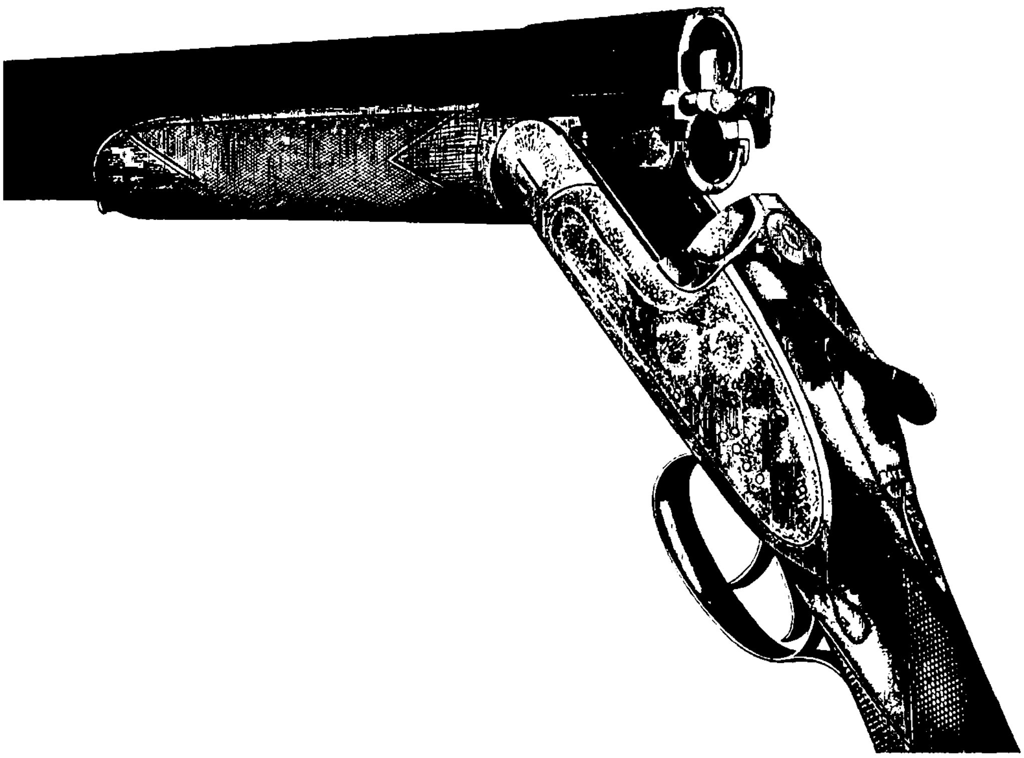
In the case of rifles flip is counteracted by the sighting of the weapons, and it is because of flip that the sights cannot be set so that the line of sight is exactly parallel to the axis of the bore. If there were no such thing as flip and the sights were set parallel to the bore, the bullet would strike a distance below the point of aim equal to the distance of the axis of the bore below the line of sight, that is, about 1½ inches, provided the range was sufficiently close to permit the drop of the bullet under the influence of gravity to be negligible.

In rifles flip is actually measured by arranging the sights so that the line of sight is exactly parallel to the axis of the bore. The rifle is then shot at 25 yards, when, if there were no flip, the bullets would strike the target the same distance below the point of aim as the axis of the bore is below the line of sight. The difference between this theoretical point of impact on the target and the actual point of impact gives the flip.

If, for example, the axis of the bore is 1½ inches below the line of sight the bullets would strike 1½ inches below the point of aim if there were no flip. It is found, however, that they strike 5½ inches below the point of aim; and so the effect of the flip is to throw the bullets 4 inches low at 25 yards. Since 1 inch at this range subtends an angle of ¼ minute, the total flip is 16 minutes of angle; and as the effect is to throw the bullets downward the flip is negative.

We can now return to shotguns pure and simple. I have explained that flip is dependent on the length and thickness of the barrel, the action, etc. Now in all ordinary guns of the same length of barrel the thickness of the barrel is very much the same, while the actions are also of the same general type. The result is that although individual guns and barrels undoubtedly do differ, the general nature of their flip is similar, while the amount usually lies within certain comparatively narrow limits.

PLATE XIV



Messrs. Woodward's Under and Over Gun

The bifurcated lumps, half of each lump being situated on either side of the lower barrel, can be plainly seen

Flip cannot be measured with such absolute nicety in shotguns as in rifles, partly because they are not fitted with sights and partly because the spread of the shot charge prevents the marking of some definite point of impact from which to take measurements.

If, however, some comparatively small mark such as a 2- or 3-inch bull is put on a pattern plate at 40 yards and aim is very carefully taken along the rib of the gun a fairly good idea of the flip will be obtained by measuring the vertical distance between the centre of the pattern and the point of aim.

This measurement in itself will not give the flip because an allowance must be made for the fact that the rib of a shotgun is never parallel to the plane of the axes of the barrels. In an ordinary 12-bore the breech end of the rib is about $\frac{1}{8}$ inch higher above the centres of the barrels than the muzzle end. The effect of this is to give all guns a slight angle of elevation when aim is taken along the rib. At 40 yards this angle subtends roughly 10 inches with barrels of from 30 to 28 inches in length; about 11 inches with 27- to 26-inch barrels; and 12 inches with 25-inch barrels.

If the centre of the pattern is placed *below* the point of aim, these values must be *added* to the distance below in order to obtain the flip.

And if the pattern is centred *above* the point of aim, the *difference* between this distance above and the figures just given must be taken as the actual effect of flip.

A series of shots should be made and a mean of the results taken, when it will be found that the majority of ordinary guns fitted with 30-inch barrels have a negative flip of round about 20 minutes of angle; or in other words, that they throw the centres of their patterns roughly 9 to 12 inches low at 40 yards.

There is nothing extraordinary about this, and nothing disadvantageous, as this tendency to throw the charge slightly low is counteracted in shotguns by the amount of bend given to the stock which really corresponds to sighting in a rifle.

Many gunmakers have learned by long experience the amount of bend which is usually required by a man of a certain height when he is being fitted with an ordinary gun with 30-inch barrels that they are probably quite unaware of the fact that they are compensating for the effect of flip when giving a certain degree of bend.

Over and under guns, however, present a different problem. The fact that the barrels are placed one above the other imparts great vertical rigidity, and with these guns there is no flip due to the bending downward of the barrels, or due to the vibration. In fact, the flip consists entirely of the positive, or upward, jump and the result is that such guns *have a tendency to throw their charges slightly high, rather than low as do ordinary guns.* Consequently the allowance made for flip by the amount of bend must be altogether different in over and under guns to that given in ordinary weapons.

In view of the fact that flip varies, as has been explained, with individual barrels and weapons, it would be impossible and useless to lay down any hard and fast rule. But, generally speaking, it is safe to state that over and under guns require more bend in the stocks than ordinary guns. This is not a defect, as I have seen stated. In fact, it can sometimes be an advantage.

There are some sportsmen who find that a very straight stock bruises their faces, but who cannot shoot with more bend. Such should try an over and under gun, and they may find their troubles are removed.

Guns with barrels appreciably shorter than 30 inches present a very similar problem, as the short barrels are stiffer and less liable to bend than the longer ones. There is no hard and fast rule, as individual weapons must always vary in their behaviour, but no appreciable departure from an original barrel length should be made without trying the new gun at a Shooting School in order to ascertain what alteration in bend of stock should be made to counteract the difference in flip of the two guns.

This, however, has nothing to do with over and under guns. In fact the whole question of barrel flip may seem more suited to a chapter devoted more to the subject of internal ballistics than to a particular type of action. But it would be impossible to consider over and under guns adequately without emphasising the importance of having them specially fitted for the bend of the stock, and an explanation seemed the necessary accompaniment to such a warning.

But there is another effect of jump which must be considered before we can leave the subject finally. Since the top barrel is higher than the bottom barrel the actual jump caused by the discharge of the upper barrel is greater than that caused by firing the lower. This would mean that were the axes of both barrels mathematically parallel the upper barrel would tend to shoot higher at any given mark than the lower. To overcome this tendency to "shoot apart" the axes of the barrels are set slightly converging. This convergence of the barrels has already been pointed out in Chapter I when we were considering the construction of a pair of ordinary horizontally placed barrels. In ordinary guns this tendency of the barrels to "shoot apart" is more pronounced than in over and under guns, because in the case of the former the lateral jump causes the right barrel to shoot to the right and the left to the left, that is in opposite directions. But in over and under guns the jump acts in the same direction for both barrels and the difference is merely one of degree. Consequently the amount of convergence necessary to make the two barrels "shoot together" will be greater in the case of guns with the barrels fixed side by side than in that of over and under guns.

Personally I think it a mistake to attach much importance to this difference, and I cannot agree that it constitutes any definite advantage to the over and under gun. It is certainly a fact that in many cheap guns with horizontally placed barrels, and less frequently in some guns of better quality, the barrels do not "shoot together." But that is a fault in manufacture, and if over and under guns were as common as the ordinary type, and could be made as cheaply, I have little doubt that individual guns would occur in which the barrels did not "shoot together" also.

This "shooting together" of the barrels is naturally of far greater importance in the case of rifles than in shotguns when the projectile consists of a single bullet, usually less than half an inch in diameter, as opposed to a shot charge with an effective spread of about 30 inches at 30 yards and 40 inches at 40.

In the case of rifles variations in bullet weight and velocity can easily cause a well regulated pair of barrels to shoot apart up to 8 inches, or sometimes even more, at 100 yards, and such a divergence would be disastrous to accuracy when shooting with a single bullet. But in the case of a shotgun changes in velocity or weights of the shot charge have no such serious effects. In the first place these changes are seldom so great as they can be in rifles, and in the second the ranges are much shorter while the spread of the shot helps to hide any increase in divergence of anything up to a maximum of about 6 inches at 40 yards. While the belief occasionally encountered that the weight of the shooter can have any material effect on the shooting together of the barrels of a shotgun has not been born out by a fairly considerable experience of testing double rifles at a target. And rifles are far more sensitive to changed conditions than shotguns.

Nor do I find it easy to believe that with shotguns this tendency of the barrels to shoot apart is immaterial at 30 yards but fatal at 40, where the spread of the charge is proportionally greater, as is sometimes declared.

I feel that a more likely explanation for the failure of some men to bring off long shots, or close, or even sitting shots at small targets, lies with them rather than their guns, and some such undoubtedly do find the single barrel of an over and under gun a definite help to accuracy as has already been explained.

We can now return to the guns themselves.

Owing to the height of the superimposed barrels the body of the action is of a different shape to that of an ordinary gun, the bar being **U**-shaped in section, and the lower barrel dropping completely into the hollow formed by this " **U** " instead of on to a flat bar.

But both for the sake of appearance and convenience in handling it is desirable that the depth of the gun should be reduced as much as possible. For this reason several makers have discarded the ordinary type of lumps which projected downward from the lower surfaces of the barrels and have split the lumps into two vertical halves, so to speak, fixing one set of halves on each side of the lower barrel. The action bolt is bifurcated, one arm fitting along each side of the lower barrel and working in the bites in the lumps.

This modification of the ordinary bottom grip results in the saving of a considerable amount of space, and guns built on this principle are not so deep as those in which the more usual form of bottom lump is retained.

A gun opened, showing the bifurcated lumps, can be seen in Plate XIV.

The bifurcated lump has the further advantage that it raises the level of the plane in which the holding down of the barrels is effected. This is an important point in guns in which the extra height of the superimposed barrels must result in an increased leverage in the production of the bending effect across the angle of the action. The nearer the bifurcated lumps are placed to the central plane of the two barrels the less pronounced is the bending leverage, and therefore the less the strain placed on the action.

But it is obvious that the **U**-shaped design for the bar of an over and under gun must result in great sectional strength through the bar of the action, as the two vertical sides of the " **U** " are girders of considerable depth. It will be realised, therefore, that this type of gun possesses exceptional natural strength, provided it is properly designed. But at the same time the **U**-shaped bar takes up a lot of metal, and so the action bodies are on the heavy side. In fact, the chief difficulty in building an over and under gun is to keep down the weight.

The bending effect across the angle of the bar is clearly greater on the discharge of the top barrel than of the bottom, and consequently it is a good plan to arrange the locks so that the bottom barrel is fired by the front trigger, and the upper by the rear trigger. Most shooters use their first barrels more than their second, and so there must be a slight reduction in the total strain on the action if the lower barrel is normally fired first.

The fore-end is also **U**-shaped in section and is an expensive item to fit properly. The ejectors are invariably placed in the fore-end, one ejector lock being situated on either side.

I will now give brief descriptions of the actions designed by five firms who have all made a special study of this type of gun. I do not mean to suggest that no other firms have successfully built over and under guns, as they have. But I am taking the actions of five firms who can truthfully be described as having specialised in these guns as being typical examples of these actions at their best.

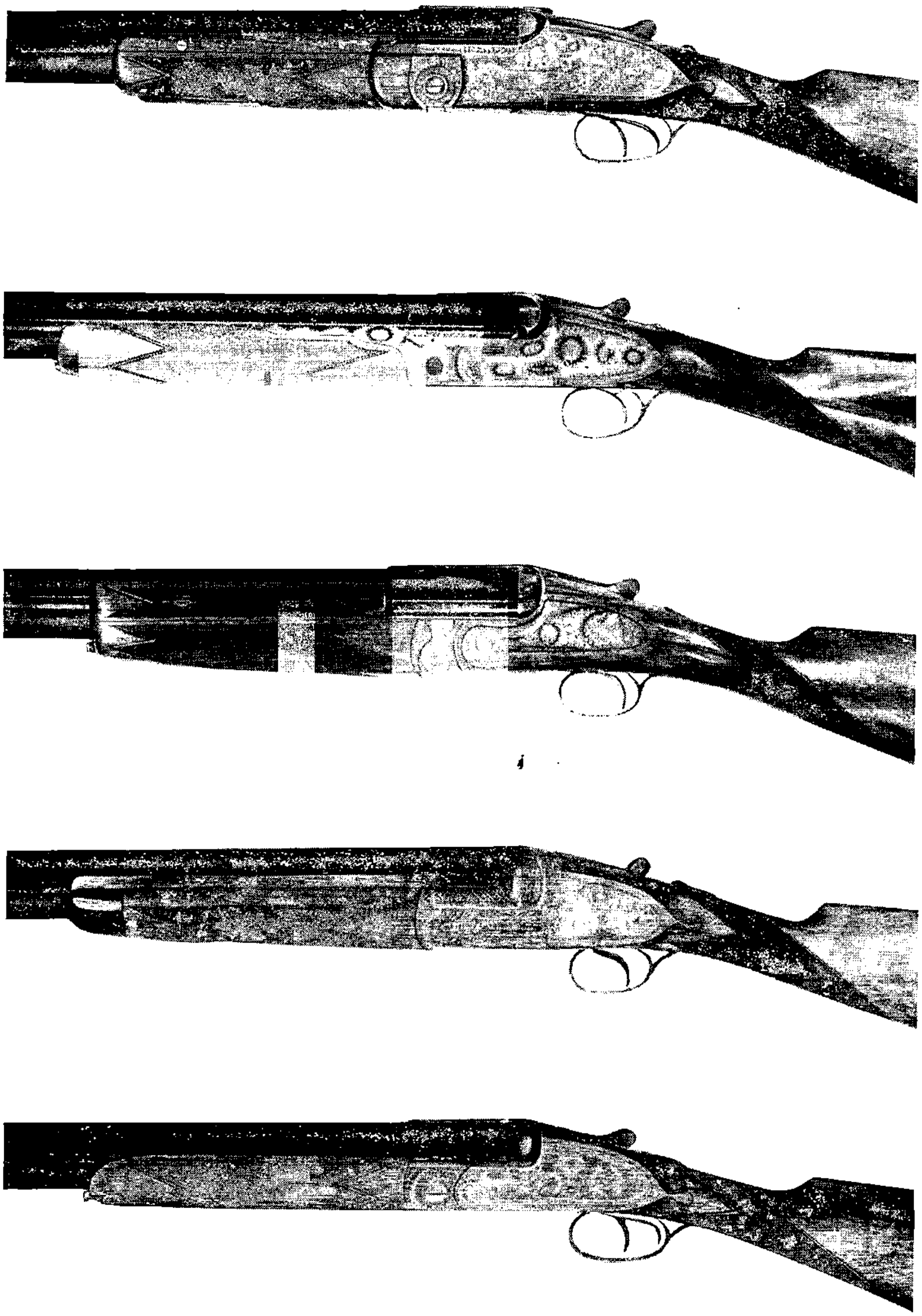
Plate XV shows the lines of these five makes of over and under guns, and it will be noticed that there is by no means that unanimity in design which is to be found in the case of ordinary guns, a fact which tends to show that finality may not have been attained.

The actions to be described are those by Beesley, Boss, Lang, Westley Richards, and Woodward.

THE BEESLEY "SHOTOVER" GUN

In this gun the forward lump has been greatly modified. The fore-end is held to the stock, or housing, by the joint pin and is not detachable unless this screw is removed; at the same time it is free to revolve about this screw, thus allowing for the movement necessary

PLATE XV



THE FIVE DIFFERENT OVER AND UNDER ACTIONS DESCRIBED IN THE TEXT

Reading from top to bottom, the guns are by Beesley, Boss, Lang, Westley Richards, and Woodward. The lines of the guns are well shown in this photograph

in the ordinary opening and closing of the gun. The barrels are held in this cradle-like fore-end by a shallow hook and oscillate with the fore-end in the ordinary manipulation of the weapon. The effect is to obtain a strong interlocking action, while the barrels can be removed with ease.

The ordinary rear lump is bifurcated, as has been described, and the actual bites are situated one on each side of the bottom edge of the lower barrel. There is, however, an additional forward extension of this bifurcated bolt which locks into recesses cut on each side of the rear end of the hinged fore-end. The fore-end is thus held by two grips, and the barrels are also held by two grips.

With a view to combating the increased leverage for the bending of the bar of the action a top extension has been fitted above the centre of the top barrel. This top extension is longer and wider than those fitted in ordinary guns and is pierced by a *vertical* hole into which a stout circular bolt shoots *upwards* when the gun is closed, thus forming a really efficient hold against any bending tendency of the bar. This bolt is, in fact, a vertical cross-bolt.

In order to overcome the difficulty of obtaining a direct blow on each striker the locks are so arranged that the upper barrel is fired by an ordinary type of lock, and the lower barrel by an "underhung" lock, that is, a lock in which the tumbler is upside down. The result is that horizontal strikers are used and a direct blow is obtained on each.

The locks are back action side locks, and the ejector of the ordinary Southgate type.

This is a very strong action, but a very costly one to build, while it is rather on the heavy side.

THE BOSS "O.U." GUN

In this gun the bifurcated lumps are placed on each side of the lower barrel, the bites being level with the centre of the bore. The effect is that the lower barrel itself is really the lump. The fore-end is detachable, lifting off the front of the knuckle. The locks are bar action side locks, and the strikers are sloping, the blow on the cap being delivered by the special shape of the end of each striker. The Boss special ejector is used.

This is a light gun for an over and under, only weighing $6\frac{1}{2}$ lb., while the depth of action is but little greater than that of an ordinary gun. The whole action has been exceptionally well thought out and the workmanship is beyond praise.

THE LANG "OVER AND UNDER" GUN

The Lang action retains the usual type of underneath lump instead of adopting a bifurcated lump. The result is that the body of the action is rather deeper than the Boss, yet the weight is kept down to $6\frac{1}{2}$ lb.

The locks are bar action side locks and the ejector the Southgate.

THE WESTLEY RICHARDS "OVUNDO" GUN

The lump is bifurcated, the two bites being placed almost on a level with the central plane of the two barrels. The locks are the Westley Richards special hand-detachable locks of the Anson and Deeley pattern, and the ejector the Deeley.

The action is fitted with dummy side-plates for the sake of appearance.

THE WOODWARD "UNDER AND OVER" GUN

In the Woodward gun the lumps are bifurcated and placed on each side of the lower barrel, the bites being only just below the central plane of the two barrels.

The forward lumps are also bifurcated and *interlock* in dovetails on the insides of the two walls of the bar, thus holding the two walls together and preventing them from splaying outwards. This interlocking action is a patent and is undoubtedly a great and marked improvement in the design of over and under guns.

The barrels hook on to the housing exactly like those of an ordinary gun, and the fore-end clips on as usual. The locks are bar action side locks and the ejector the Southgate.

This is a beautiful action; light and of scarcely greater depth than that of an ordinary gun.

As I have stated, over and under guns are made by other firms; and I have seen excellent guns of this type by Green of Cheltenham, Holland and Lancaster. But of all the actions which I have seen, I must confess that the Woodward seems to combine best the maximum of strength, neatness and ease of manipulation with light weight and faultless workmanship.

Incidentally, this opinion would seem to be shared by some other gunmakers who have paid Messrs. Woodward the compliment of imitating their gun and action as far as the law permits. In fact, I know of one case where the interlocking patent was actually infringed. This form of flattery may possibly be embarrassing, but is certainly an indication of the opinion of this action formed by different gunsmiths.

The would-be purchaser of an over and under gun will be well advised to visit all the firms who specialise in these weapons and satisfy himself which action suits his own requirements best. But, other things being equal, the points to look for are: light weight, small depth in the action body, ease of taking the gun to pieces and putting it together—a most important point, and ease in loading.

APPENDIX

DIAMETERS OF THE DIFFERENT SIZES OF BORES

THE size of the bore of a shotgun, as has been explained in Chapter I, is determined by the number of spherical balls of pure lead, each exactly fitting the bore, which go to the pound.

In Proof Acts and Rules the diameters of all bores have been calculated on the basis of a specific gravity of lead of 11·352.

So if *N* is the number of the "bore," or "gauge," and *d* the diameter of the bore in inches, we get:

$$d^3 = \frac{4{\cdot}6578}{N}.$$

The following table gives the diameters in inches of all bores from Gauges 4 to 32.

Number of Gauge.	Diameter of Bore.	Number of Gauge.	Diameter of Bore.
4	1·052	19	·626
5	·976	20	·615
6	·919	21	·605
7	·873	22	·596
8	·835	23	·587
9	·803	24	·579
10	·775	25	·571
11	·751	26	·563
12	·729	27	·556
13	·710	28	·550
14	·693	29	·543
15	·677	30	·537
16	·662	31	·531
17	·649	32	·526
18	·637	—	—

MINIMUM STANDARD DIMENSIONS FOR SHOTGUN CHAMBERS ESTABLISHED BY THE GUNMAKERS' ASSOCIATION

Designation.		Chamber.			Recess for Rim.		
Gauge.	Nominal Length. Inches.	Length. Inches.	Diameter at Forward End. Inches.	Diameter at Rear End. Inches.	Diameter. Inehes.	Depth. Inches.	Radius of Arc. Inches.
4	4	4·000	1·035	1·090	1·200	0·130	0·030
8	3¼	3·250	0·914	0·930	1·035	0·115	0·020
10	3¼	3·250	0·845	0·861	0·933	0·074	0·020
10	2⅞	2·875	0·845	0·859	0·933	0·074	0·020
12	3	3·000	0·800	0·815	0·886	0·074	0·020
12	2¾	2·750	0·800	0·813	0·886	0·074	0·020
12	2½	2·560	0·800	0·812	0·886	0·074	0·020
14	2½	2·560	0·763	0·775	0·847	0·068	0·020
16	2¾	2·750	0·732	0·745	0·815	0·062	0·020
16	2½	2·560	0·732	0·744	0·815	0·062	0·020
20	2¾	2·750	0·685	0·698	0·766	0·060	0·020
20	2½	2·560	0·685	0·698	0·766	0·060	0·020
24	2½	2·500	0·649	0·661	0·728	0·060	0·020
28	2½	2·500	0·614	0·626	0·688	0·060	0·020
32	2½	2·500	0·562	0·574	0·636	0·060	0·019
0·410	2	2·000	0·465	0·475	0·537	0·060	0·015
0·360	1¾	1·750	0·415	0·424	0·479	0·050	0·015

INDEX