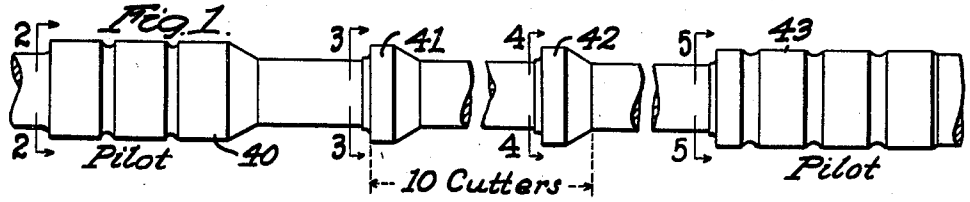
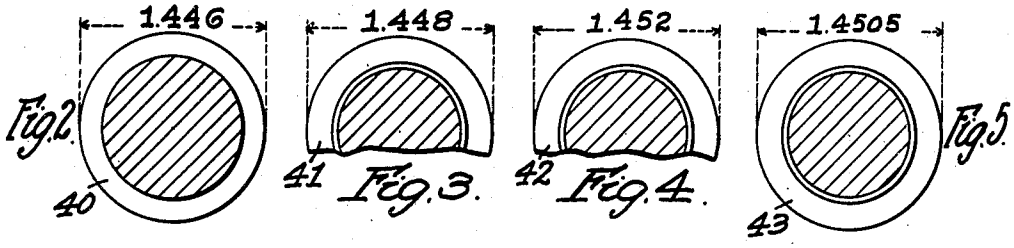
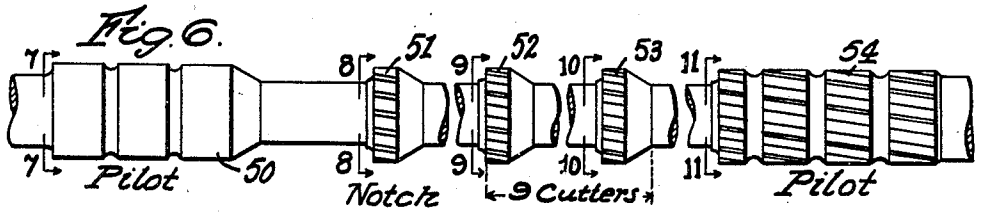
Oct. 5, 1943. O. W. BONNAFE 2,330,863

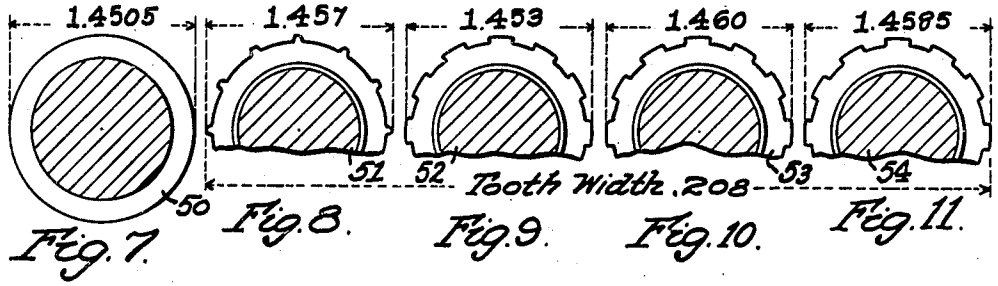
METHOD OF RIFLING GUN BARRELS

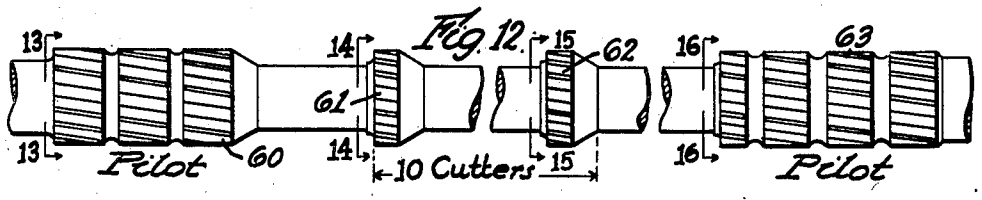
Filed July 21, 1941 2 Sheets-Sheet 1

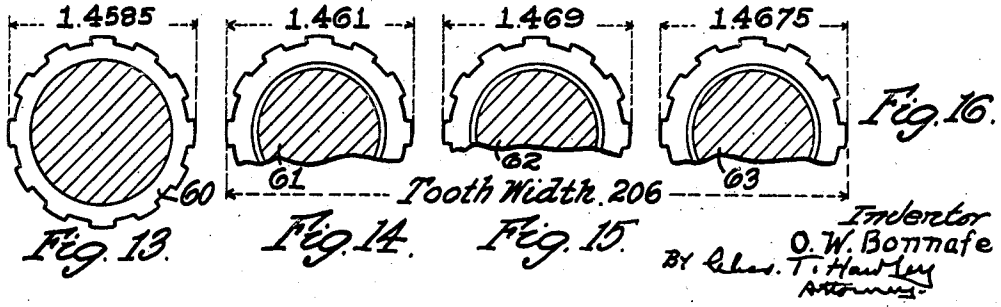












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METHOD OF RIFLING GUN BARRELS

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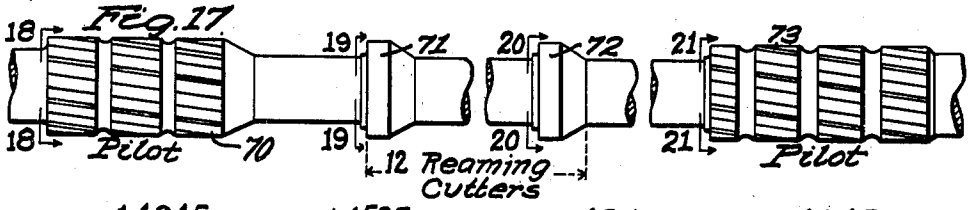
Fig. 17



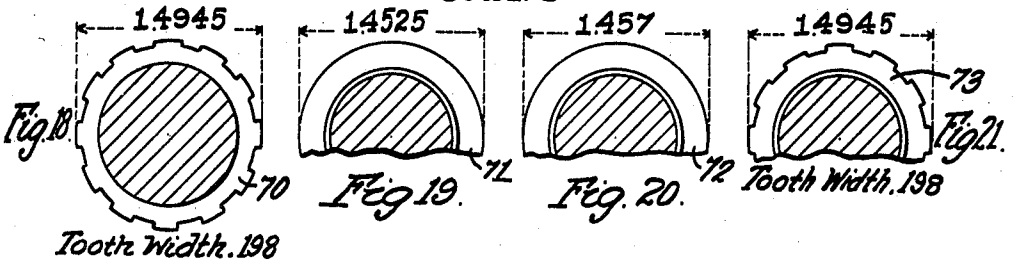
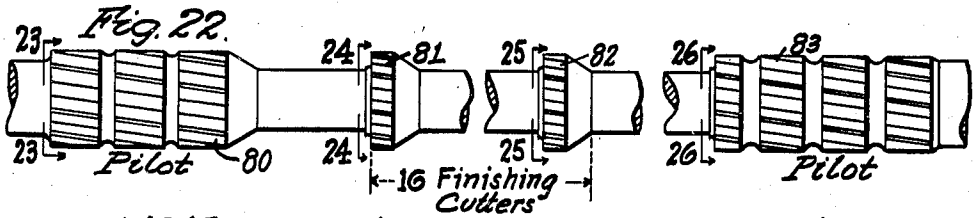


Fig. 22.



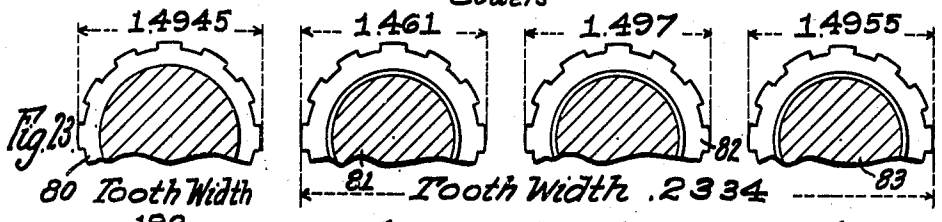
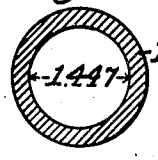


Fig. 24. Fig. 25. Fig. 26.

Fig. 27.



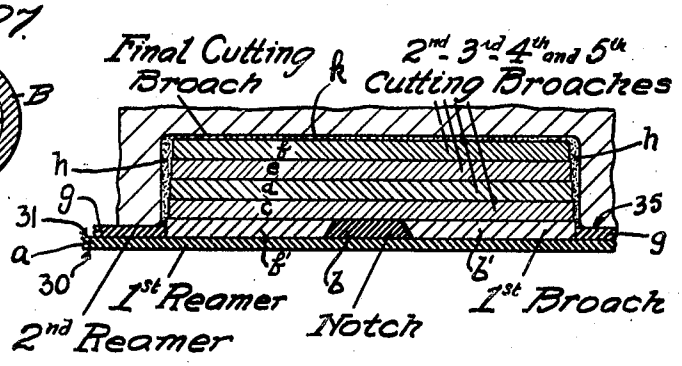


Fig. 28

Fig. 29.

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METHOD OF RIFLING GUN BARRELS

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Application July 21, 1941, Serial No. 403,414

3 Claims. (Cl. 90—28.1)

This invention relates to the rifling of gun barrels to provide a twist or spin for the projectile. For this purpose, a plurality of shallow helical groves are formed in the bore of the gun.

It is the general object of my invention to provide a more rapid and more economical method of producing such helical grooves. More specifically, I provide a method of rifling gun barrels by a series of reaming and broaching operations, which operations develop all of the helical grooves simultaneously, rather than singly as heretofore practiced.

My invention further relates to certain ordered procedure which will be hereinafter described and more particularly pointed out in the appended claims.

Reamers and broaches adapted for use in the practice of my improved method are shown in the drawings, in which

Fig. 1 is a partial side elevation of a broaching reamer adapted to perform the first reaming operation in my improved method;

Figs. 2, 3, 4 and 5 are sectional end elevations, taken along the lines 2—2, 3—3, 4—4 and 5—5 respectively in Fig. 1;

Fig. 6 is a partial side elevation of the first grooving broach, adapted for performing the initial notching and first grooving operations;

Figs. 7, 8, 9, 10 and 11 are sectional end elevations, taken along the lines 7—7, 8—8, 9—9, 10—10 and 11—11 in Fig. 6 respectively;

Fig. 12 is a partial side elevation of the second grooving broach, adapted for performing the second grooving operation;

Figs. 13, 14, 15 and 16 are sectional end elevations, taken along the lines 13—13, 14—14, 15—15 and 16—16 in Fig. 12 respectively;

Fig. 17 is a partial side elevation of a broaching reamer, adapted for performing the second reaming operation;

Figs. 18, 19, 20 and 21 are sectional end elevations, taken along the lines 18—18, 19—19, 20—20, and 21—21 in Fig. 17 respectively;

Fig. 22 is a partial side elevation of the sixth grooving broach, adapted for performing the final sizing and finishing operation on the helical grooves produced by the preceding operations;

Figs. 23, 24, 25 and 26 are sectional end elevations, taken along the lines 23—23, 24—24, 25—25 and 26—26 in Fig. 22 respectively;

Fig. 27 is a transverse sectional view of a gun barrel to be grooved or rifled;

Fig. 28 is a transverse sectional view of the same barrel after it has been rifled by my improved method; and

Fig. 29 is a conventionalized transverse sectional view on an enlarged scale, showing the portions of stock removed successively by the tools shown in Figs. 1 to 26 inclusive.

By my improved method, I produce a completely rifled and reamed gun barrel by passing a number of broaches once only through the barrel to be rifled. Each of these broaches operates simultaneously on all of the grooves to be formed in the barrel. The rifling operation is thus performed much more expeditiously than by the usual procedure of forming each rifle groove separately and by repeatedly passing a single-tooth cutter through each groove.

In Fig. 27 I have shown a transverse section of the gun barrel B which is to be grooved or rifled, and for purposes of illustration have indicated that the barrel has an initial internal diameter of 1.447".

In Fig. 28 I have shown a transverse section of the same barrel B, after the barrel has been reamed and rifled by my improved method. The reamed internal diameter is now 1.457" and the barrel has been provided with twelve grooves G which are equally spaced and which have an outside diameter of 1.497" at the bottoms of opposite grooves.

I will first describe my general method of operation, and I will then describe the different broaches and their component parts in more detail.

The general method of operation will be readily understood by reference to Fig. 29, which is an enlarged cross section of a segmental portion of a gun barrel, with a groove formed therein by my improved method. Fig. 29 has been conventionalized by showing the cutting sections as linear instead of curved, as the curvature would be very slight when the groove is enlarged to the scale shown.

The line 30 in Fig. 29 represents the initial internal diameter of the gun barrel B to be broached. The section *a* represents the portion of stock removed by the operation of the first broaching reamer (Fig. 1) and the line 31 represents the reamed surface.

The stock removed by the first grooving broach (Fig. 6) is indicated at *b* and *b'*. The portion *b*, which is relatively narrow, is removed to full depth by a single notching cutter and the spaced portions *b'* are removed by a plurality of successively-operating broaching cutters, all as shown in Fig. 6. The line 32 indicates the depth of the first grooving cut.

The letters *c*, *d*, *e* and *f* (Fig. 29) indicate the

portions of stock removed by the second, third, fourth and fifth broaching cutters respectively, each of these broaches being like the broach shown in Fig. 12, except for gradual increase in diameter.

It will be understood that the stock in each of these portions *a* to *f* is removed in a series of thin layers by successive cutters increasing progressively in diameter. It will also be noted that each portion *c*, *d*, *e* and *f* is of slightly less circumferential length than the preceding portion. In actual practice, this difference in length commonly does not exceed .002" but is sufficient to provide effective clearance for the cutting ribs of the grooving broaches.

After the fifth cutting broach has removed the stock portion *f*, the portions of stock *g* between adjacent grooves in the gun barrel are reamed to finish size by the second broaching reamer shown in Fig. 17. The finished diameter of the bore is indicated by the line **35**.

I then finish the rifle grooves by use of the sixth grooving broach, which removes the small clearance portions *h* left at the ends of the different broached portions *c* to *f*. This broach also very slightly increases the circumferential width of the grooves and takes a very slight finish cut in the bottom of each groove, as indicated at *k* in Fig. 29. This last broach also rounds off the inner and outer corners of the grooves to provide fillets, as indicated at **37** and **38** in Fig. 29.

This completes the rifling operation, which has been entirely performed by passing two broaching reamers and six grooving broaches once only through the gun barrel. These eight machine operations take the place of the very large number of separate passes of a single-tooth cutter previously customary.

I will now describe the specific construction of each of the two reamers and six broaches shown in detail in Figs. 1 to 26 inclusive.

In Figs. 1 to 5 I have shown the construction of the first broaching reamer, which is provided with a leading pilot **40**, a first reaming cutter **41**, a plurality of intermediate reaming cutters (not shown), a last reaming cutter **42**, and a rear pilot **43**, all pilots and cutters being of circular cross section.

If it is assumed for purposes of illustration that the initial bore of the gun barrel is 1.447" (as shown in Fig. 27), the leading pilot may have an outside diameter of 1.446", so that it will slide with slight clearance in the bore of the gun barrel B. The first reaming cutter **41** is shown as having an outside diameter of 1.448". The succeeding intermediate cutters are increased gradually in diameter by .001" or less per cutter, the final cutter **42** having a diameter of 1.452". The rear pilot **43** is slightly reduced for clearance to 1.4505". One or more of the cutters immediately preceding the last cutter **42** may be of the same diameter as said last cutter.

In Figs. 6 to 11 I have shown the construction of the first notching and grooving broach, which is provided with a circular leading pilot **50**, a notching cutter **51**, a first grooving cutter **52**, intermediate grooving cutters (not shown), a last grooving cutter **53**, and a ribbed rear pilot **54**. The leading pilot **50** has the same diameter as the rear pilot of the first reamer, namely, 1.4505". The notching cutter **51** has narrow V-shaped teeth, with an over-all diameter of 1.457". The first grooving cutter has wider teeth and an over-all diameter of 1.453" between the tops of the grooving ribs. The intermediate cutters increase gradually in diameter and the last one or more cutters **53** has an outside diameter of 1.460", while the ribbed rear pilot **54** has an outside diameter of 1.4585".

During the operation of this broach, it is necessary that either the tool or the work be positively rotated to provide the correct initial twist or pitch for the rifle grooves. Each cutter is shown as having twelve cutting ribs, which will produce twelve parallel helical grooves in the gun barrel B, as shown in final form in Fig. 28.

In Figs. 12 to 16, I have shown the construction of the second grooving broach, which is provided with a ribbed leading pilot **60**, a first grooving cutter **61**, intermediate grooving cutters (not shown), last grooving cutter **62** and rear pilot **63**. The broach shown in Fig. 12 is similar to the broach shown in Fig. 6, except that both pilots are ribbed and that a grooving cutter takes the place of the notching cutter **51**. The dimensions of the different parts of the second grooving broach are as shown in Figs. 13 to 16 respectively.

During the operation of this and succeeding broaches, it is not necessary to positively rotate either the tool or the work, as the ribbed pilots will cause the cutters to follow the twist or pitch already established.

The third, fourth and fifth grooving broaches are identical in construction with the second grooving broach as shown in Figs. 12 to 16, except for progressive differences in diameters, which may preferably be as shown in the table hereinafter set forth.

It should also be noted that the circumferential width of each cutting tooth of the first grooving broach is shown as .208" (Figs. 8 to 11), which dimension is reduced to .206" in the second broach shown in Figs. 12 to 16, and this dimension is progressively reduced .002" for each of the succeeding grooving broaches. By thus slightly narrowing the successive cutting teeth, a slight clearance is provided at the edges of each preceding cut, so that the broaches will cut more freely in the very tough metal used for gun barrels.

Following the operation of the fifth grooving broach, the second reaming operation is performed by the second broaching reamer, which is shown in Figs. 17 to 21 and comprises a ribbed leading pilot **70**, a first circular reaming cutter **71**, a plurality of intermediate reaming cutters (not shown), a last reaming cutter **72**, and a ribbed rear pilot **73**, these parts having the dimensions shown in Figs. 18 to 21 and the pilots having a rib width of .198", being slightly reduced for clearance.

It should be noted that the ribbed pilots of the second reamer (Fig. 17), cause the reaming cutters to have the same helical movement as the preceding grooving cutters. Any tool marks left in the work by the reaming cutters will thus be parallel to the rifle grooves, rather than to the axis of the gun barrel, which is obviously a substantial advantage.

After the second reamer has taken the final cut in the bore of the gun barrel, the sixth or finish grooving broach shown in Figs. 22 to 26 completes the rifling operation. This sixth grooving broach comprises a ribbed leading pilot **80**, a first grooving cutter **81**, a plurality of intermediate grooving cutters (not shown), one or more final grooving cutters **82**, and a ribbed rear pilot **83**. Reference to Figs. 23 to 26 and comparison with the dimensions in the table follow-

ing in the specification will show that the first pilot in the sixth grooving broach has the same outside diameter as the rear pilot of the fifth grooving broach, also that the tooth width has been substantially increased from .200" to .2334" but that the over-all diameter of the first cutter has been reduced to 1.461", as compared with a diameter of 1.496" for the last cutter which previously operated.

The sixth grooving broach thus cuts first at the edges of the grooves only, but increases in depth of cut more rapidly than with the preceding broaches, the increase in diameter being preferably around .003" per cutter.

The final grooving cutter (or cutters) **82** has an outside diameter of 1.497", as compared with 1.496" for the last grooving cutter of the fifth broach, showing that the final cutter not only reams the sides of each groove to full width but also takes a final thin finish cut over the bottoms of the grooves.

The tooth section in the final cutters of the sixth grooving broach is also slightly modified to leave rounded fillets at the inner and outer corners of the grooves, as shown at **37** and **38** in Fig. 29.

The function and operation of the different broaches will be readily apparent from the foregoing description, taken with the diagram in Fig. 29 which clearly indicates the portions of stock removed by each reamer or broach in the successive steps of my improved rifling method.

The following table shows the comparative dimensions of the two reamers and six broaches used in the method of rifling gun barrels above described.

Table

	Leading pilot	Notch	1st cutter	Last cutter	Rear pilot	Width of cut	Stock removed
1st ream	1.446	-------	1.448	1.452	1.4505	-------	*a*
1st broach	1.4505	1.457	1.453	1.460	1.4585	.208	*b-b'*
2nd broach	1.4585	-------	1.461	1.469	1.4675	.206	*c*
3rd broach	1.4675	-------	1.470	1.478	1.4765	.204	*d*
4th broach	1.4765	-------	1.479	1.487	1.4855	.202	*e*
5th broach	1.4855	-------	1.488	1.496	1.4945	.200	*f*
2nd ream	1.4945	-------	1.4525	1.457	1.4945	.198	*g*
6th broach	1.4945	-------	1.461	1.497	1.4955	.2334	*h-k*

It will be understood that the dimensions given in this table (and also as shown in the drawings) are illustrative only, and that these dimensions, as well as the number of broaches and the number of cutters per broach, may all be varied to suit operating conditions. The number of rifle grooves in the gun barrel may also be increased or decreased.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:

1. The method of rifling gun barrels which comprises initially reaming the bore of said barrel, broaching a plurality of initial helical grooves in said barrel, increasing the depth and slightly decreasing the width of said grooves by successive helical broaching operations, each performed on all of said grooves simultaneously, reaming and thereby finishing the bore of said barrel, and thereafter increasing the width and progressively increasing the depth of said grooves to finish width and depth by a final helical broaching operation.

2. The method of rifling gun barrels which comprises broaching a plurality of initial helical grooves in said barrel, increasing the depth and slightly decreasing the width of said grooves by successive helical broaching operations, each performed on all of said grooves simultaneously and each removing approximately equal increments of material from said grooves, reaming and thereby finishing the bore of said barrel, and finishing the rifle grooves by passing an additional finish broach therethrough in a helical path which additional broach progressively increases said grooves to full width and depth.

3. The method of rifling gun barrels which comprises initially reaming the bore of said barrel, broaching a plurality of initial helical grooves in said barrel, increasing the depth and slightly decreasing the width of said grooves by successive helical broaching operations, each performed on all of said grooves simultaneously, reaming and thereby finishing the bore of said barrel by a further helical broaching operation, and finishing the rifle grooves by passing an additional finish broach therethrough in a helical path which additional broach progressively increases said grooves to full width and depth.

OLIVER W. BONNAFE.