June 16, 1953 F. W. SAMPSON 2,641,822

SWAGE RIFLING METHOD

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Fig. 1.

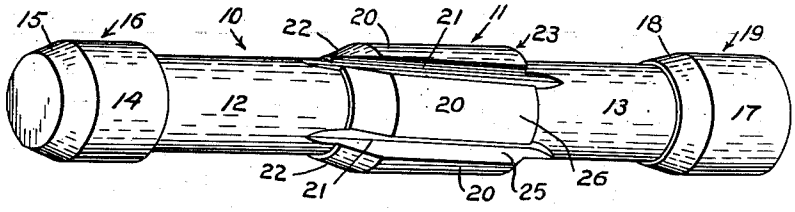


Fig. 2.

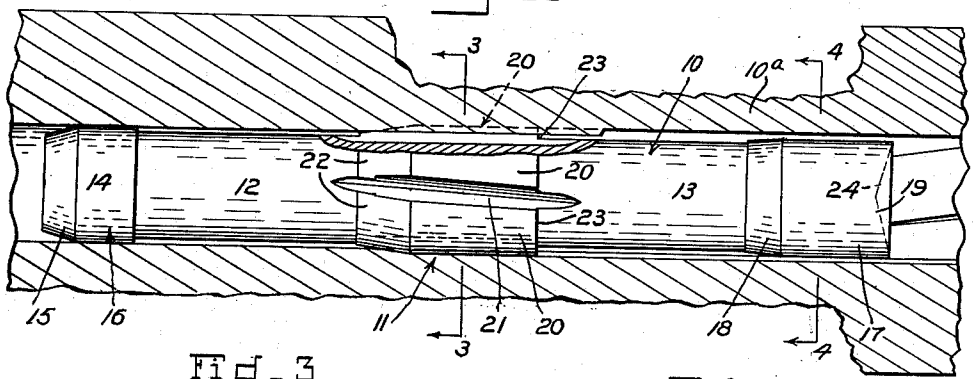


Fig. 3.

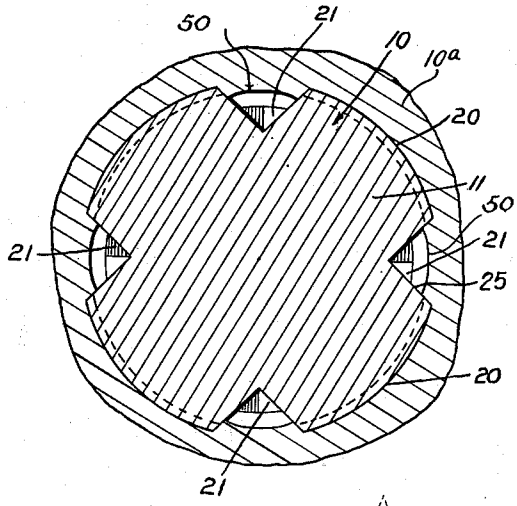


Fig. 4.

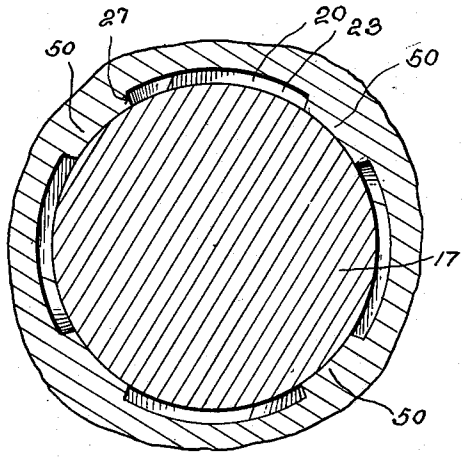
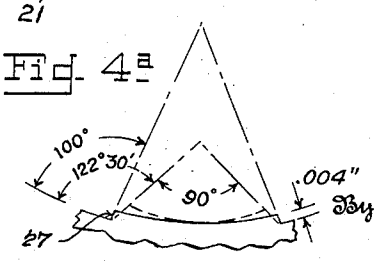


Fig. 4a.



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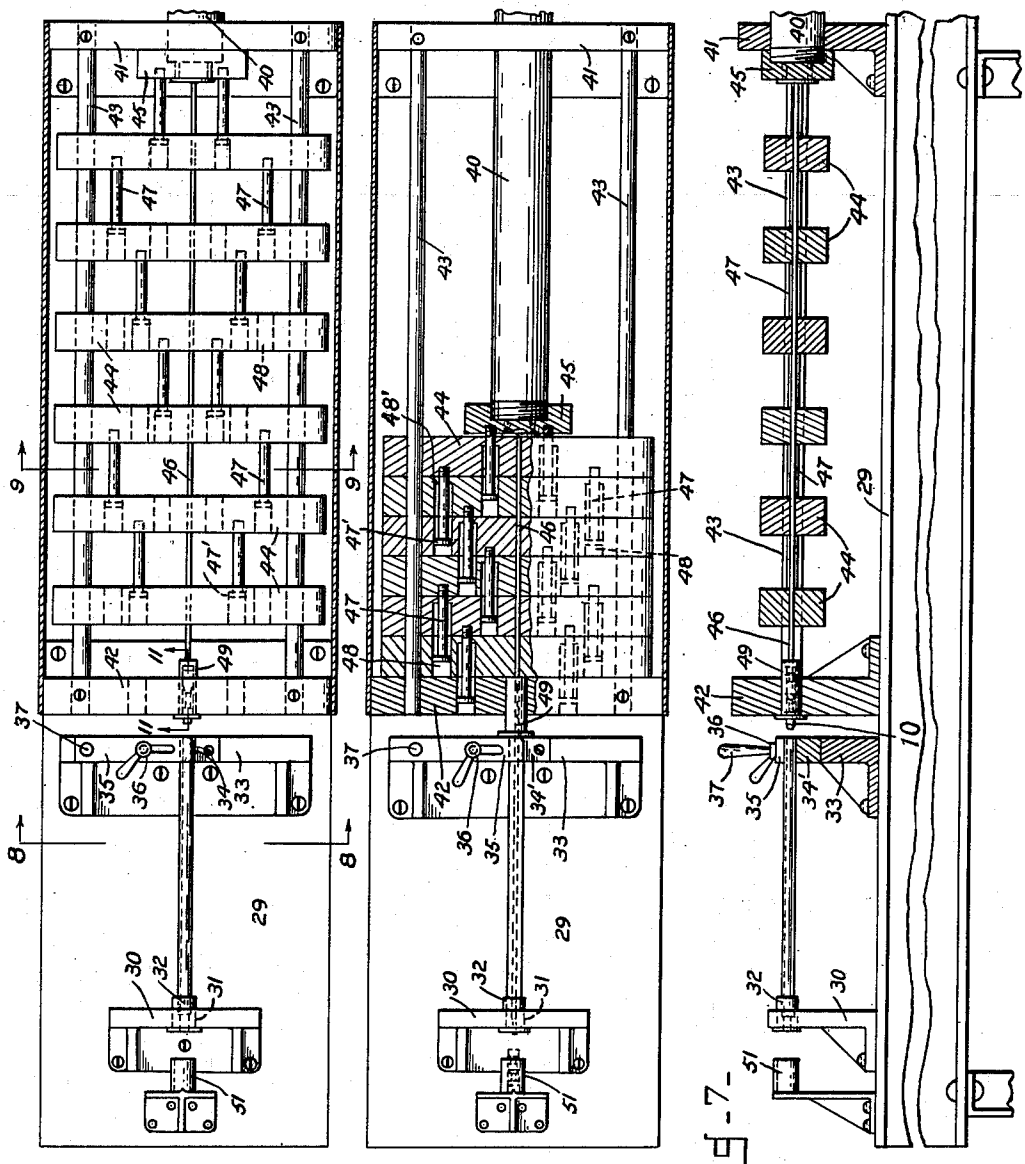


Fig-5.

Fig-6.

Fig-7.

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SWAGE RIFLING METHOD

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Fig. 8.

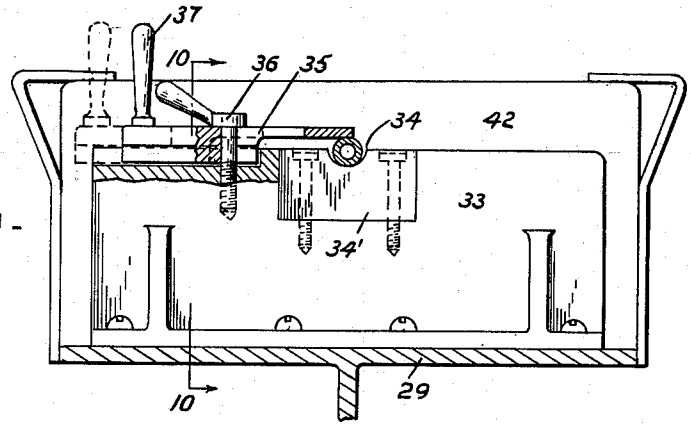


Fig. 9.

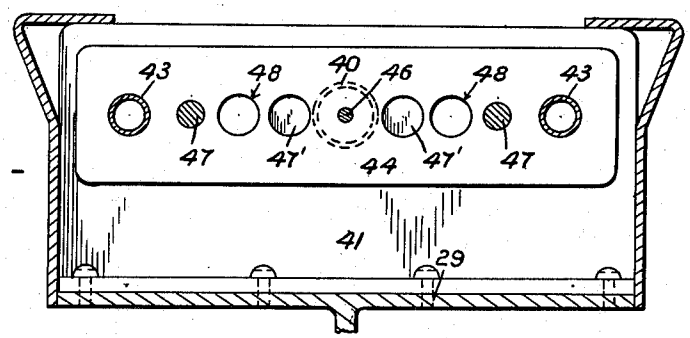


Fig. 10.

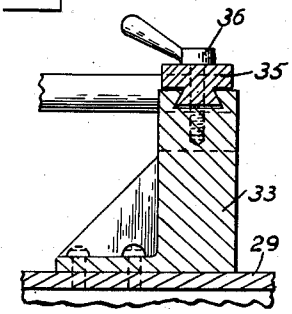


Fig. 11.

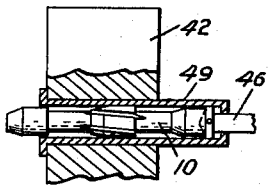


Fig. 13.

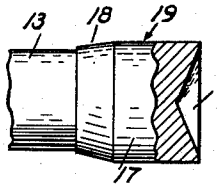
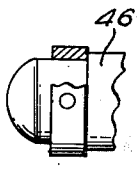


Fig. 12.



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Patented June 16, 1953

2,641,822

UNITED STATES PATENT OFFICE

2,641,822

SWAGE RIFLING METHOD

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Application August 21, 1945, Serial No. 611,851

2 Claims. (Cl. 29—1.1)

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The object of the invention is to enable practicable use of a gun rifling method heretofore proposed and to some extent used abroad corresponding to that shown in the patents to Hatcher, U. S. No. 1,789,308; Voigt, German 356,817, and others.

The principal purpose is to minimize the cost for operations required between the rolling of the bar stock and the production of a barrel with a correctly rifled and finely finished bore, and to enable rapid production with a minimum number of machines. It is particularly sought to enable use of "as rolled" stock, and after boring to cold swage the rifling therein without special annealing.

A specific object is to perfect the use of a rifling swage tool with a minimum of complication in the handling of the work, and enabling the use of a cheap tool without maintenance cost.

Elimination of high pressure coolant supply machinery is another valuable attainment in view.

A goal of the invention is to eliminate tendency of the grooving tool to yaw or chatter, or to vary in its angular rate around the bore axis in relation to its progress in the work.

A further motive for the invention is to enable the use of a pushing bar for forcing a swage rifling tool through a barrel with a minimum of buckling, breakage, feed rate variation, or vibration during progress of the rifling operation.

It has been heretofore a practice to rifle a barrel by drawing a swaging tool through the barrel by a tension member, to avoid tendency of a push bar to buckle and break, but the elastic function of the draw member manifest under the great force applied, variations in friction on the tool, the influence of temperature and other factors, tend to produce irregularities of both longitudinal and twist rate in the tool, affecting the quality of the work. In addition there are complications in the coupling of the tool to a draw member, and in connecting the latter to a press. Among advantages attained by the present invention are: elimination of requirement of connecting the tool to the forcing bar; reduction to nullity of variation of rate in the tool movement; elimination of lost motion in a train of connections; accurate axial relation of the tool to the bore axis of the barrel; elimination of intermediate members between the tool and ram; maintenance of uniformity of twist in the rifling; reduction of finishing operations; ease of standardizing; availability of less skilled operatives.

Variation of longitudinal rate in the tool operation will result in variations of density and hardness of the surfaces at each such change, which will affect the manner of wear of the gun tube in use, decreasing the resistance to erosion in some parts and resulting in increased tendency to "balling," which will accelerate deterioration of the weapon. Where simple push members are used, slight buckling and recovery of the push bar during a rifling operation will produce irregularities of rate as well as irregularities of direction of the tool and rifling which are serious factors in shortening the useful life of the weapon produced, and such functional deficiencies in the machine have been here overcome.

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A highly important attainment in view is to obviate in a novel way need for maintaining a supporting matrix around a barrel blank during a swage rifling operation, without requiring inclusion in the blank of additional material beyond that in blanks for the prior practice in conventional cutter rifling.

A highly important aim of the invention is to enable the cold working of rifling by a swage tool in steel of a composition suitable for the most effective and efficient service in the severe requirements of military service, and particularly to enable use of prior and current steel specifications heretofore employed for barrels with conventionally cut rifling.

A special purpose of the invention is to devise a novel tool having peculiar values in preventing axial deviations of the tool from the ideal concentric position in the barrel during the rifling operation and to utilize certain novel elements for these and additional functions of importance in the production of a barrel of high effectiveness. Thus, experience has shown that a tool as shown by Voigt or Hatcher has a tendency to deviate from its proper axial course by slight yawing or displacements of its forward end from the true course. When this is corrected by extending an integral pilot part fitting the unrifled bore in advance of the rifle tool, and the tool is pushed through the bored work, there is still a tendency for the rear end of the tool to be pressed laterally from a true position coaxially in the bore, due to the great force required to press the tool forward. These objections are overcome by a novel use of a work-shaping part on the present tool, supplementing the grooving means, additionally maintaining the latter in its true course, and at the same time burnishing surfaces not finally shaped before.

Tool and maintenance cost by conventional practice has been in the neighborhood of $0.14255

per barrel, while with the present invention this has been estimated at $0.00486, a saving in this item of $0.13759 per unit or approximately a saving of 97 per cent. In addition, by reason of the fact that a single pass with low price labor produces a completed rifling of high polish, there is a large saving for labor in the rifling operations, as well as a large saving in factory space by reason of the use of fewer machines and personnel. Comparatively unskilled labor may be employed in the rifling operation.

A novel attainment of the invention is the coordination of the form and proportions of the tool, on the one hand, with the elastic limit, tensile strength, and ductility of the blank.

I am aware of a wide and various development of broaching practices in prior use which have effected some economy in rifling, but these have involved a much greater cost for the tool and its maintenance, as well as making it imperative to draw the tool through the work. At the Rock Island Arsenal, after one of the best developments of broaching, it has been estimated that the cost for the broach tool per unit is $0.1050, and for conventional rifle boring tools $0.0816; the advantage in broaching being in reduction of labor and overhead in rifling from $0.1516 to $0.0284. My invention will effect comparable saving in rifling, but avoids the high cost for the tool, the saving in the latter respect being approximately 96 per cent of the per unit cost.

In addition to the benefits in manufacture, the resulting arm is improved by greater resistance to erosion, abrasion, and "gas cutting"; the surface being peculiarly hardened, especially at the corners of the lands.

Additional objects, advantages and features of invention are represented or involved in the construction, arrangement and combination of parts involved in the embodiment of the invention, the methods of procedure and other practices, and in the improved product produced, as hereinafter described, all of which will be apparent or understood from the following description and accompanying drawings wherein:

Fig. 1 is a perspective of the complete swage tool for rifling and finishing a gun barrel such as heretofore used in small arms, for instance, the .30 caliber carbine, .30 caliber rifle, and .50 caliber machine gun;

Fig. 2 is a fragmentary longitudinal section of a barrel with my tool in position therein;

Figs. 3 and 4 are cross sections respectively on the lines 3—3 and 4—4 of Fig. 2;

Fig. 4–*a* is a fragmentary cross section of the finished rifling;

Fig. 5 is a plan of the swaging machine in initial position with a barrel in position for rifling;

Fig. 6 is a similar view partly in section of the machine at full stroke position;

Fig. 7 is a vertical longitudinal section of the machine in initial position;

Fig. 8 is a section on the line 8—8 of Fig. 5;

Fig. 9 is a section on the line 9—9 of Fig. 5;

Fig. 10 is a section on the line 10—10 of Fig. 8;

Fig. 11 is a section on the line 11—11 of Fig. 5;

Fig. 12 is a detail of the end of the pusher rod;

Fig. 13 is a fragmentary longitudinal section of the trail button.

Referring to the drawings, there is illustrated tool 10 formed integrally from tool steel stock, hardened.

It comprises a central swage bit 11 of generally cylindrical form from which extend longitudinal coaxial forward and rear shanks 12 and 13 of slightly reduced diameter. Formed integrally at the extremity of the forward shank there is a pilot button 14, of cylindrical form over the major portion of its length, its forward part being bevelled at 15 for ready entry into the prepared bore of a barrel blank 10*a* and to slide therethrough. The cylindrical surface 16 of this button has a diameter nearly equal to the diameter of the prepared bore of the blank to be rifled. It has been made 0.001 inch less for small caliber barrel blanks. The length of the shank in this instance is approximately two calibers between the bit and the button. The rear shank 13 is approximately the same length as the shank 12 and terminates at a trailing, forming and burnishing die and guide button 17, somewhat similar to the lead button, but having a more gradual taper 18 at its forward part, and a cylindrical body face 19. The diameter of the latter is larger than that of the pilot button, and greater than that of the desired finished bore diameter of the rifled barrel, that is, the diameter at the tops of the lands 50 to an extent proportionate to the ductility, elasticity, and tensile strength of the blanks. This takes cognizance of the degree to which the metal of the blank will be expanded while this button is passing therethrough, and the extent of recovery of the blank from deformation. Deformation of the tool is not manifest.

In the present instance the bit 11 suitable for a firearm or machine gun is a swage member, constructed so as to form four grooves and intervening lands in the rifling of the gun, the grooves formed being somewhat more than twice the width of the lands; but the number and the named proportions of these may be varied without materially affecting the function of the tool, and without materially affecting the diametrical proportions hereinafter specifically named, provided the sum of the quantities of material displaced to form the grooves remains the same.

The bit has four polished runners 20 and four intervening channels 21, the runners being substantially segments of a solid cylinder of a suitable length. The runners include forward integral bezels 22 of properly gradual slope or taper, being simple conic sections in the present instance. The diameter of the bit at the top faces of the runners, as in the case of the trailing button 17, is substantially greater than the bore of the blank, and greater than the diameter of the finished rifling at the bottoms of the grooves to an extent proportionate to the ductility of the metal of the blank, its tensile strength and elasticity, or the extent to which the blank will be expanded during movement of the tool therein in forming the groove, and the degree of permanent strain suffered by the material of the blank. The latter factor is not as great in determining the dimensions of the trailing button since in the functioning of the latter less material is required to be displaced, and the blank is subjected to less radial stress thereby, as will be understood from the description hereinafter.

The tool is produced by shaping a tool steel bar to the circular section forms of the buttons shanks and bit, and then cutting the channels 21 by hobbing, using conventional practices for mounting and screw feeding and/or rotating the tool at the same time.

The rear termination of the bit (though not essentially) may be an abrupt shoulder 23, and the same is true of the rear end of the pilot button 14. The rear end of the trail button 17 may

be a planiform or slightly recessed seat face **24** extending entirely across the end of the tool and may be ground to a true surface. It may be variously shaped to coact in any special way with the butted or stepped pushing device by which the tool is pressed through the work, or an interposed anti-friction device which may be interposed.

In prior conventional rifling practice barrel metal for military use has been made up to specifications well known in the steel trade as No. 1350, or No. 4150, both high carbon, high manganese steels, and both of these have been found practicable with my invention. The last mentioned differs from the first in having relatively less manganese and having in addition a percentage of chromium and of molybdenum, but has closely similar tensile strength and elastic limit values. It is also practicable to use some of the so-called stainless steels (wherein a higher proportion of chromium is used) in producing rifling by the practice of my invention.

The last-named steel is difficult if not impracticable to work with conventional tools and it is an advantage of my invention that such steels may be easily worked, and possibly more easily worked with my invention than the simple carbon manganese steel (No. 1350). An example of a steel heretofore used for firearms barrels under specification 1350 involved the following range of required or permissible components; percent:

Carbon	0.45 to 0.55
Manganese	1.60 to 1.90
Phosphorus, maximum	0.40
Sulphur, maximum	0.050

An example of qualities of a prior barrel steel which can be swage rifled by my invention is as follows:

Tensile strength	110,000 lbs. per square inch.
Elastic limit	75,000 lbs. per square inch.
Elongation	20 per cent.
Contraction of area	50 per cent.

The elongation quality involves a measure of ductility.

These qualities are more than ample for use in my invention, and, in fact, it has been found practicable to use the "as-rolled" (hot rolled or forged) barrel stock without intervening heat treatment when the handling of the rolled stock is standardized and reasonably free from spotty cooling or chilling.

For producing a .30 caliber carbine or rifle barrel, contrary to conventional practice, the blank is not turned down before rifling, but is mill-rolled to a standard outside diameter of approximately 0.910 inch with a tolerance of plus or minus 0.001 inch. The hole after boring is carefully reamed to a diameter of .298 inch.

The diameter of the pilot button for this blank has been 0.297 inch, the outside diameter of the bit 0.312 with tolerance of plus 0.0001 inch; and the diameter of the trail button 0.301 inch with a tolerance of plus 0.001 inch. After one pass of this tool a rifled bore is produced with highly polished surfaces having these dimensions: groove diameter, 0.308 inch with tolerance of plus 0.002 inch; bore diameter, 0.300 inch with tolerance of plus 0.002 inch (which is conventional, no special tolerance in rifling dimensions being required for my invention).

In the rifling of small arms, the conventional practice has been to form the side faces of the lands at an angle of in the neighborhood of 100 to 102 degrees to the adjacent intersecting bottom face of the groove, and the cutting of the sides of the runners **20** on my tool is carried out in a definite relation to this angle. However, in my invention a novel manner of attaining this final angle is involved, by which the angle at the land of the blank is changed during production, accompanied by a peculiar hardening of the corners at the tops of the lands, and imparting of a high density, by which the wear value of the arm is materially enchanced as compared to one with conventionally tooled or broached rifling, or rifling which is finished by cutting or scraping after initial swaging of the grooves.

In this connection it is noted that the pass of the bit **11** through the hole in the blank causes a flow of metal laterally toward the sides **25** of the runners **20**, where it is forced against material of the lands **50** left in and near the face of the hole of the blank in the channels **21**, with a consequent flow into this material, this flow being so opposed by the molecular cohesion of the blank material that it becomes progressively less as the distance from the rifle groove increases. The result is a slightly raised edge along the corners of each land **50**, the height of which decreases gradually in a direction normal to the longitudinal diretcion of the land. The middle parts of the lands do not seem to be affected in this way.

These raised edges—and, to a lesser degree, the middle parts of the rifle lands—are pressed, ironed and burnished down to the finished top level of the land **50** by the trail button **17**. At the same time, there is a lateral somewhat plastic flow and partial extrusion of the excess metal toward the sides of the lands, which is greatest immediately at the top of the land and progressively less toward the base of the land and bottom of the groove. This results in a molecular rearrangement of the material apparently subject in an immaterial degree to return by elastic values, and manifesting great density and hardness. If the angle of the side face of the land as first formed is at a proper angle to the bottom face of the groove of the rifling, this flow will produce a new position of the side face of the land, which will approximate a flat at an angle to the groove bottom much less than the original angle there. In the present instance we have found that for the stock material indicated an angle of approximately 122 degrees more or less between the side face **25** of the runner **20** and top face **26** thereof will produce a land form which will accommodate this last-mentioned flow of metal under the trail button **17** so that a finished side face **27** will be produced on the land approximating the desired angle, generally as indicated in Figs. 4 and 4*a*. As the height of the land from the bottom of the groove is only 0.004 inch standard, an exact form in the side face is not a critical requirement. It is important however, that the angle between the side face and the top of the land should not be acute, in which event it would be subject to excessively rapid wear by friction of rotating bands or corresponding parts of projectiles, erosion, and corrosion. It will be appreciated and can be demonstrated that if the angle between the side and top of the land as first formed be small the resultants of molecular opposition to lateral flow of the metal at the land corner will decrease progressively toward the

top of the land, and that as the original angle decreases the ratio between metal flow at top and bottom will increase in such manner that at a small angle an outwardly curved overhang would result, whereas, with a great enough initial angle, there will be tendency for the material to be pressed down and be so opposed in lateral movement that excessive distension of the barrel would occur. An angle has been chosen for the runner top and side faces between the extremes above mentioned which will tend to result in a straight-side form on the land at the desired angle, after operation of the button 17, and still attain sufficient lateral flow of land material to accommodate the excess material raised by the runners without too great radial pressure on the blank.

The swaging machine

For the swaging of a small arms barrel, a machine is provided as in Figures 5 to 9 wherein is shown a bed 29 on which a mounting or work holder is provided, consisting of an anvil 30 which is a heavy cross plate member suitably framed and anchored to the bed 29, in which a bore 31 is formed coaxial with the work axis on which the barrel blank is to be held while being worked, and threaded, a seat piece 32 being screwed thereinto, in and against which the end of a barrel may be inserted and butted. A hole in the tail end of the seat piece 32 is cylindrical and enough larger in diameter than the diameter of the bit 11 to permit the tool 10 to be thrust therethrough after passing through the barrel.

Spaced toward the head of the machine from the anvil there is a heavy saddle block 33 with an inset renewable saddle piece 34' having therein a saddle slot 34 open on its top side. The bottom of this slot is semi-circular and concentric with the blank or work piece axis and adapted to fit the end of the blank snugly when rested therein. At the front end of the block 33 a clamp bar 35 is arranged movably thereover to lie with one end over the slot 34 at one position and slidable toward the front to clear the slot. For this purpose it is longitudinally slotted from top to bottom and receives therethrough a headed clamp screw 36 set in the top of the block 33, which is at a level somewhat below the top of a barrel blank resting in the slot. When the screw is loosened the bar 35 is free for sliding movement or rotary movement around the screw. To facilitate manipulation of the clamp bar an upstanding handle 37 is set rigidly in the front end of the bar.

At the head of the machine a hydraulic ram 40 is mounted, coaxial with the blank axis determined by the anvil block and saddle block 33. The ram is guided in a rigid stationary guide block 41 fixed in relation to the anvil 30 and saddle block 33. Adjacent the saddle block there is an anchorage block 42 and set rigidly in this and the guide block 41 there are two parallel horizontal cross-head guides 43 consisting of rectilinear shafts fixed between the guide block and anchorage block at a level with and spaced from the axis of the blank and ram at opposite sides. On these guides there are slidably mounted a number of cross heads 44, six being shown in the present instance. On the ram 40 there is fixed a chuck or pusher mount 45, on which there is fixed or otherwise mounted the base end of a push rod 46 of a length exceeding that of the barrel blank plus the aggregate of the thicknesses of the cross heads and anchorage block, it being assumed that the ram 40 has a corresponding range of movement. The cross heads are each bored on the blank axis to receive and fit slidably the push rod 46. The mount 45 and each of the cross heads except the last at the tail end of the series, has two horizontal pins or stud link connections 47 set therein at their tail sides. These pins are parallel to the guides, arranged symmetrically at the same level as the guides and push rod, but each pair offset with respect to the next and second adjacent pairs toward the tail end of the series. All of the studs are also engaged slidably through close fitting bores in the next adjacent cross heads, and each of the latter are counterbored at the tail sides concentrically with the studs, the counterbores being substantially larger than the heads of the studs forming shoulders 48' against which the stud heads 47' may engage under retracting movement of the ram, and so that the heads 47' may slide freely forward in the counter bores. The next cross head toward the tail of the machine from each of these counterbores is also bored through as at 48 in alignment with respective counter bores, and the anchorage 42 is correspondingly bored for the heads of one pair of stud links.

The distance between the guide anchorage 42 and seat ring 32 is somewhat greater than the length of the barrel blank, so as to enable ready placement and removal of blanks, and set slidably in the anchorage block 42 concentric with the blank axis there is a tool starter 49 which is a supporting sleeve slidable through the block 42. At its head end it is bored to fit the push rod slidably as a guide and brace therefor, and at its trail end it is concentrically bored to a larger diameter to receive slidably the tool 10 for the major part of its length so as to support the tool in coaxial relation to a barrel blank mounted in the saddle block. The tool starter 49 initially projects toward the ram from the block 42, and the push rod may remain engaged in the starter 49, with a collar or other means thereon to draw the sleeve to its initial position when the ram is retracted. The sleeve 49 may be flanged at its forward end to limit its return movement.

At the tail end of the machine a tool receiver 51 in the form of a tubular horizontal cup is mounted coaxially with the barrel with its open end toward the barrel seat 32. This will receive the tool passing through the seat 32 after clearing the barrel upon completion of a pass. Preventing dropping of the tool and saving it from liability of chipping or rolling out of ready reach of the operator. It should be understood that the ratio between the tool dimensions the work blank and the finished diameters of the rifling may be different for different caliber and may require correction for changes in steel specifications. It has been found practicable to make the tool proportions the same in relation to the finished refling for different blank materials, and to compensate for any variance from the finished standard by experimentally decreasing or increasing the thickness of the wall in the bored blank, slight variation being sufficient to meet the requirements without changing the mill procedure except to modify the roll adjustments slightly. This has not affected the test qualities of the stock appreciably. The determination of the proper size must guard against making the wall too thin, which would permit the material to yield elastically to the tool to an excessive degree and so result in too shallow

grooves, while if the wall is too thick the increased stresses on the tool may produce excessive wear or fracture of the tool, and possibly excesses in measurements beyond minimum tolerances.

Due to the fact that no acute advancing edges are presented to the work, the heat developed in the tool is not a critical factor, and it may be passed through the blank at a greater speed than used in drawing broaches through the work. This enables a material increase of production as compared to broaching even to a single pass broach. However, two tools have been used for broaching in some instances requiring two passes. The instant tool has been effective for 300 passes or more before appreciable variation from standard. On account of its low cost, it is economical to discard the tool after a predetermined maximum number of passes, rather than attempt reforming thereof. Thus, no tool maintenance cost such as regrinding is involved as is the case with conventional hook tools or broaches, which has been a material cost factor. It is practicable to produce this tool with largely automatic machines. An anti-friction bearing may be provided between the push rod **46** and the rear end of the tool **10**, or at the mounting of the push rod **46** on the member **45**, these details not being illustrated, since they involve merely a selection of suitable devices available for the use.

For lubricating the work, a moderate electrolytic deposit of copper throughout the length of the bore after final reaming has been found more effective than oleaginous lubricants or the latter including intermixtures of graphite, although the latter may be practiced as an alternative.

The operating means for the ram **40** may be of conventional construction of which numerous forms are available suitable for the use and therefore its details are not shown. A control valve therefor may be located as most convenient or any other control means employed as may be available and expedient.

In the practice of the invention uniformity of external dimension of the blank is an important factor in its effectiveness, as small minus variations in diameter may cause serious variances in the rifling diameter. Likewise the rolling treatment must be uniform and smooth and the cooling of the rolled or forged stock should be more carefully attended than would be the case where heat treatments intervene between rolling or forging and machining.

In the operations of rifling, the plain, round stosk blanks are square cut to a proper length, bored and reamed to the required size, and the machine being in readiness with the ram retracted, one of my tools is inserted butt first into the tail end of the tool starter which, if not connected to the push rod may be at the same time pushed to its retracted position by manual pressure on the tool after being inserted. The screw **36** being loosened, the handle **37** is grasped and the clamp bar **35** drawn forwardly to clear the slot **34**.

The barrel blank is then taken in one hand and either end inserted in the anvil **30** and against the seat ring **32**, while its opposite end is lowered into the saddle slot **34**, and the other hand grasps the handle **37** and moves the bar **35** to position with its inner end extended over and upon the barrel blank, after which the screw **36** is tightened to press the bar end firmly down upon the end of the blank.

The control of the ram is then operated to cause the push rod to be advanced against the butt of the tool **10**. The latter, being supported in close approximation of exact coaxial alignment with the blank bore, and having a conically bevelled forward extremity, readily centers and itself in the hole in the blank after slight longitudinal movement by the push rod.

As the tool **10** enters the work, the bezels **22** force their way against the bore face of the blank straining the latter and setting up distension stresses which increase until they are sufficient to cause the runners to be embedded in the metal of the blank to a depth which, after passage of the bit and recovery of the material of the blank by its elastic reaction, will present highly polished grooves of the desired diametrical measurement. The tool is caused by its penetration of the material to rotate in accordance with the pitch of the runners. Metal flowing toward each side of each runner in this operation produces raised side portions on the lands which are left between the rifle grooves; these raised portions being of much less radius than required. Each side of a land **50** at this time forms a rather flat or oblique angle at its junction with the bottom of the groove which is a much greater angle than desired in the finished barrel rifling, substantially as shown in dotted lines in Fig. 4*a* and also apparent in full lines in the cross section of the bit and work in Fig. 3.

The trail button **17** now encounters the lands, bearing upon them throughout their width, including the raised side portions, and the blank again is subjected to strain and radial stresses, the latter increasing to a degree sufficient to cause a reforming of the raised material and to increase its density, its final form being changed toward the angular relation indicated at **27** in Figs. 4 and 4*a*. The intermediate face portions of the lands intervening between the raised edge portions left by the runners also are worked slightly, at least to the extent that they are polished by the passage of the button.

The pitch of the runners due to their helicoidal form causes the tool to rotate as it advances in the work, with an angular rate which is uniform in relation to the longitudinal movement of the tool in the work. The tool may rotate directly against the end of the push rod **46**, or anti-friction means may be interposed (not shown). Completion of the one pass of the tool leaves a highly finished rifling which firing tests have shown to function with high efficiency, producing patterns meeting or exceeding prior strict requirements for conventionally rifled barrels.

I claim:

1. The method of producing rifled gun barrels, consisting in producing a cylindrical barrel blank of metal conforming to conventional requirements as to tensile strength, elasticity and a measure of ductility in a ratio proportionate to the width and depth of material to be displaced and a given radial measurement of wall in the blank, forming a bore in the blank of less than finished standard, forcing through the bore a forwardly tapered swage tool having helicoidal groove-forming runners thereon of a radius exceeding that of the radius of the finished rifle groove in the barrel by an amount proportionate to the resultant of the radial pressure required to displace material of the blank to the desired groove depth, the extent of distension of the blank under said pressure and its capability of elastic recovery, forcing through the grooved bore

thereafter a cylindrical swage of a diameter exceeding the desired finished bore diameter by an amount similarly proportionate to said factors of the swaging and material of the blank to reform the material between the swaged grooves to a predetermined contour and finished diameter.

2. The method of claim 1 wherein the grooves are swaged with side faces at an angle with the groove bottom faces greatly exceeding the desired angle of said faces in the finished bore, and swaging the inner diameter face of the material between the grooves so that material is displaced toward the grooves and forced to a position at said side face approximating a lesser angle corresponding to a predetermined desired angle in the finished work.

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