Dec. 22, 1959 W. BRAATZ 2,917,809

METHOD OF FORMING GUN BARRELS

Filed Sept. 14, 1955 2 Sheets-Sheet 1

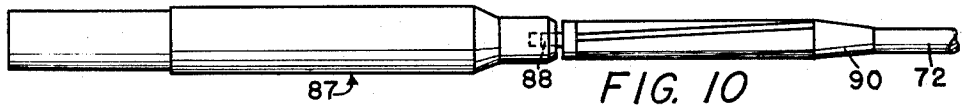

FIG. 10

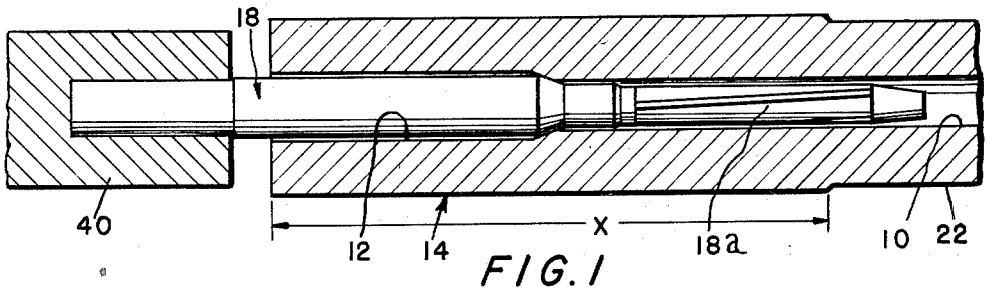

FIG. 1

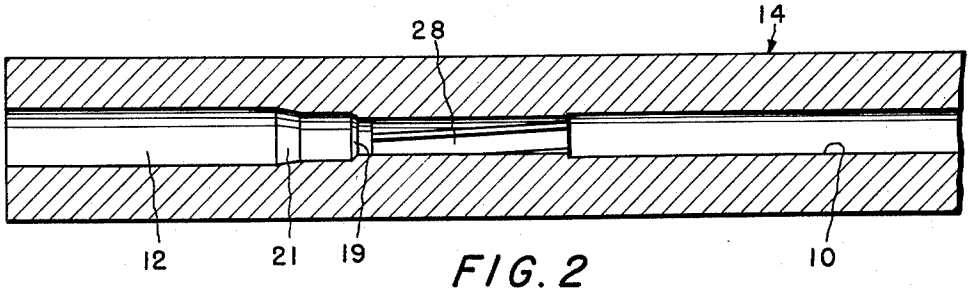

FIG. 2

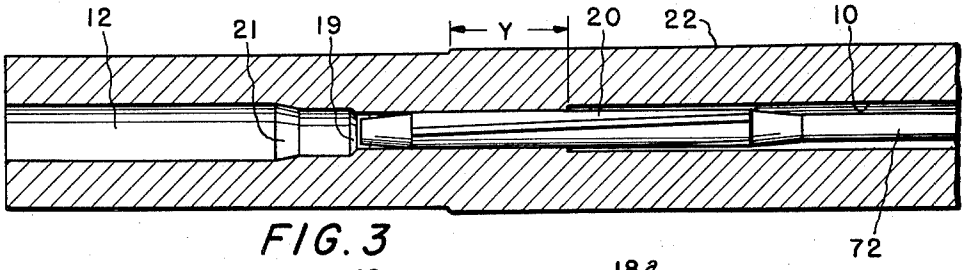

FIG. 3

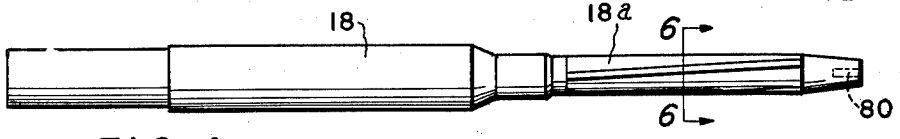

FIG. 4

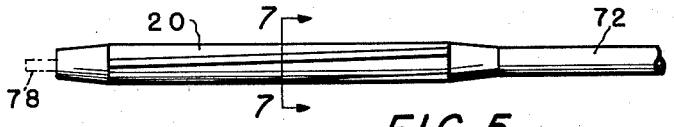

FIG. 5

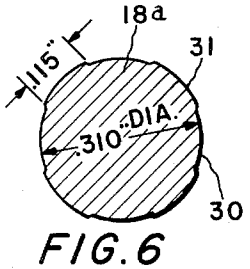

FIG. 6

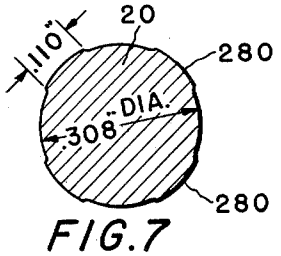

FIG. 7

INVENTOR
WILLI BRAATZ
BY
HIS ATTORNEY

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METHOD OF FORMING GUN BARRELS

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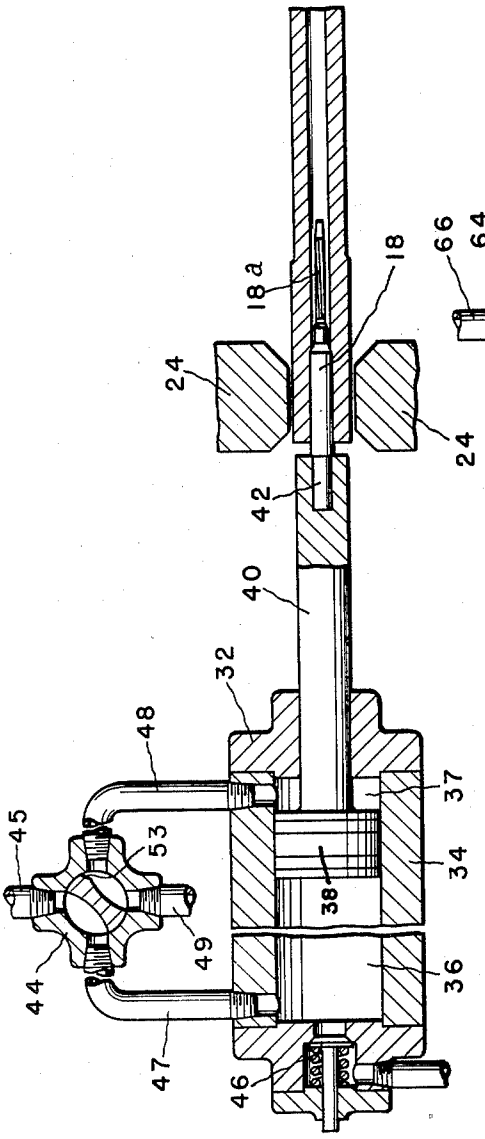

FIG. 8

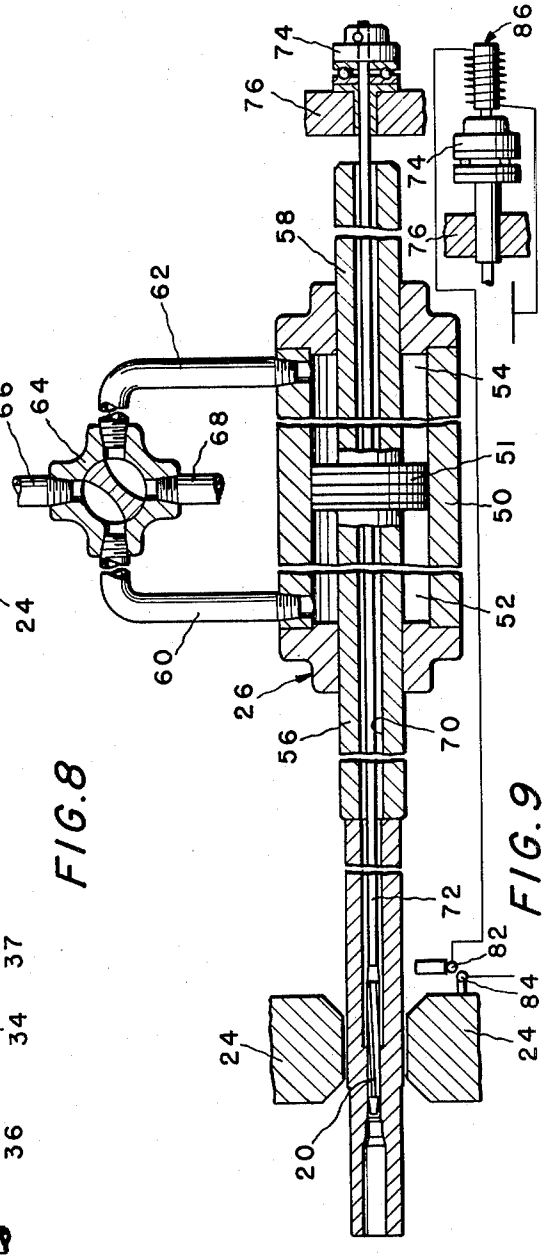

FIG. 9

INVENTOR
WILLI BRAATZ
BY
HIS ATTORNEY

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METHOD OF FORMING GUN BARRELS

Willi Braatz, Sherbrooke, Quebec, Canada, assignor to Canadian Ingersoll-Rand Company Limited, Montreal, Quebec, Canada, a corporation of Canada

Application September 14, 1955, Serial No. 534,181

10 Claims. (Cl. 29—1.1)

This invention relates to gun barrels, and more particularly to the process of forming a gun bore and cartridge chamber in a cylindrical member by cold swaging.

The more conventional way of forming a gun bore and chamber includes the step of drilling first the bore and then counterboring the cartridge chamber. With this process it is extremely difficult to maintain the center line of the chamber exactly concentric with that of the rifle bore. Another disadvantage with this process is that if the bore is drilled slightly oversize, then it is necessary to discard the barrel.

These disdavantages are overcome in the present invention by swaging both the bore and chamber of the barrel. With this process concentricity of the chamber and bore is ensured, and in the event the bore is drilled slightly oversize, indeed to the extent of .04 inch or more, it can be swaged down to the desired diameter. Moreover, experience has shown that by employing the swaging process, a rifle barrel having a spiral rifled bore can be formed in one quarter the time required to form a barrel by the conventional process.

It is accordingly one object of this invention to form the bore and cartridge chamber of a rifle barrel by means of cold swaging.

The second object of this invention is to form such a barrel in which the proper alignment between the cartridge chamber and bore is assured.

The further is to form such a barrel in which one or more taper shoulders are provided in the cartridge chamber.

Other objects will become obvious from the following specification and drawings, in which:

Fig. 1 is a longitudinal view, partly in section, of a chamber and lead in portion of the bore of a rifle barrel in which is located a chamber mandrel preparatory to cold swaging of this section of the barrel,

Fig. 2 shows the same barrel section after being swaged,

Fig. 3 is a view similar to Fig. 2 in which the rifling, or bore, mandrel is positioned preparatory to swaging the bore section of the barrel,

Fig. 4 is a longitudinal view of the chamber mandrel and associated lead in portion,

Fig. 5 is a longitudinal view of the rifling mandrel,

Fig. 6 is a cross sectional view of Fig. 4 taken along the line 6—6 looking in the direction of the arrows,

Fig. 7 is a cross sectional view of Fig. 5 taken along the line 7—7 looking in the direction of the arrows,

Fig. 8 is a longitudinal view, partly in section, showing a hydraulic means for positioning the chamber mandrel in the barrel during the swaging operation of that portion of the barrel,

Fig. 9 is a longitudinal section of a hydraulically operated push rod for feeding the barrel into a swaging machine, and

Fig. 10 is a longitudinal view of a composite separable chamber and bore mandrel.

The process for forming the bore and cartridge chamber of a gun barrel by cold swaging comprises, in general, the steps of first forming an oversize axial bore **10** and a relatively enlarged cartridge chamber portion **12** through a cylindrical member **14**. The member **14** is then reduced in diameter through its length except for that section containing the cartridge chamber and adjacent lead in portion of the bore, as for example the section *x* (Fig. 1). This reduction in diameter is accomplished by removing material from the cylindrical member as by grinding or cutting. Thereafter a chambering mandrel **18** is inserted in the breech end of the barrel and pressure is repeatedly and rapidly applied on the circumference of the unreduced barrel section *x* over a relatively short longitudinal area and of sufficient magnitude to compress and cold form the barrel material on the mandrel **18**. This pressure is applied progressively along the barrel section *x* moving from the breech end toward the bore **10** and may be obtained by feeding the barrel into a swaging machine such as disclosed in my copending application Serial No. 301,772, filed July 30, 1952.

Thereafter the chamber mandrel **18** is removed and the swaged or previously unreduced section of the barrel is reduced in diameter to something less than the diameter of the first reduced section, and preferably to the desired final diameter. The rifling mandrel **20** is then inserted in the bore from the muzzle end and extending into the previously swaged portion of the bore. The first reduced or unswaged section of the barrel is now cold formed, or swaged, along its length. During this swaging step of the process, the rifle mandrel is held longitudinally stationary within the sphere of action of the swaging hammers **24** and the barrel is fed through the swaging machine by a suitable feed mechanism such as the hydraulic feed **26** shown by way of illustration only (Fig. 9). Preferably the original degree of oversize of bore of the member **14** and the amount of reduction in diameter of the two sections are chosen such that when the first swaged section is cut to its final diameter, the remaining section after being swaged is of the same final diameter.

It is to be known that the purpose of reducing the diameter of one section of the barrel and swaging the larger section and then cutting down the larger section and swaging the remaining or first reduced section is done to ensure that only the desired length of barrel is swaged during each process step. That is, the section of reduced diameter cannot be inadvertently swaged because with the swaging machine set to swage the larger diameter section, it cannot effectively swage the smaller diameter section. If desired, the barrel can be swaged without first cutting the barrel to reduce the diameter of the member **14**, by providing suitable stops or indicating means (not shown) to limit the longitudinal extent of swaging during each step specified.

A process by which the barrel member may be formed without cutting is to provide an interlocking connection between the ends of the mandrels (e.g. the key **78** and slot **80** shown) such that the spiraling of the portion **18***a* matches the flutes **280** on the rifling mandrel **20**. Both mandrels are inserted in the barrel at the beginning of the swaging operation, then after a relatively short portion of the lead in rifling is formed, the rifle mandrel is actuated to push the chamber mandrel **18** out of the sphere of action of the dies **24** during the period the dies are not applying pressure to the barrel. The locked connection between the mandrels insures proper threading of the rifle mandrel in the rifled portion of the bore formed on the chamber mandrel portion **18***a*. In this way the entire swaging operation may be carried out without stopping the swaging machine.

The changeover from one mandrel to the other may be accomplished by means of any suitable control. By way of illustration an electrical contact 82 is mounted on the barrel and a second contact 84 is mounted on the die 24. Thus when the barrel is swaged to the extent to form the chamber 12 and a relatively short section of the lead in rifling the contacts 82 and 84 engage as the dies start to retract, thereby energizing a solenoid 86 connected to the mandrel to quickly shove the rifling mandrel into sphere of action of the dies before the dies 24 again apply pressure to the barrel. The contact 82 is to be mounted such that it can be moved along the barrel after the solenoid is energized. Of course, if the chamber mandrel 18 is being held in the chamber by the device 32, to be described hereinafter, this device must be operated to release the chamber mandrel 18 after completion of swaging the chamber 12 and prior to the action by the solenoid 86.

It is also possible to form the bore and chamber of the rifle barrel by utilizing a two-piece mandrel 87 such as shown in Fig. 10 and which is substantially identical in form to the mandrel shown in Fig. 4 except that a driving rod 72 is connected to the end 90 of the mandrel and the mandrel is formed with a sliding interlocking connection at 88. Thus the chamber form is on one section of the mandrel and the desired finished rifling form is on the other section of the mandrel. With this mandrel form, the swaging operation of the chamber is identical to the previously described step, and when the dies reach the rifled portion of the mandrel, the rifled portion of the mandrel is maintained in position within the sphere of action of the dies and the chamber portion of the mandrel is separated therefrom in moving with the barrel.

In the particular barrel form disclosed, the bore of the rifle is formed with spiral rifling and the chamber contains two longitudinally disposed tapered shoulders 19 and 21. With this rifled construction the lead in portion 28 of the bore 10 is formed during the step of the process in which the chamber 12 is swaged. This is done to permit forming a rifled portion adjacent the chamber of greater bore size than the bullet and to ensure proper alignment of the flutes of the rifling when the remaining portion of the bore is swaged during the later step of the process. More particularly this permits the insertion of the rifling mandrel 20 into the lead in portion of the bore prior to swaging the rifle bore (see Fig. 3).

In order to ensure easy insertion of the rifling mandrel 20 in the swaged lead in portion of the bore, the diameter of the rifled portion 18^a of the chamber mandrel and the width of the flutes 31 of this mandrel are made slightly larger than the corresponding dimensions on the rifling mandrel 20 (see flutes 31 and 280 Figs. 6 and 7). In connection with the particular barrel form shown it is to be known that the rifle mandrel portion 18^a is provided with a relatively slight longitudinal taper along the lands 30 (the portion that forms the spline surface of the rifling) to provide a gradual lead in for the bullet. In furtherance to this end, when the barrel section x is ground down, a relatively short portion y is not reduced in diameter so that it becomes part of the previously unreduced, and now larger, section 22. Thus when the section 22 is swaged to form the rifled bore, all of the rifled portion 28 formed in the first swaging step is reswaged to the smaller final diameter and land width, except for a relatively short portion adjacent the end of the cartridge chamber 12. In the finished barrel this relatively short section provides a tapered lead for the bullet such that it is rifled gradually rather than abruptly.

When a tapered shoulder such as shoulder 21 is formed in the cartridge chamber 12, it is necessary to hold the chamber mandrel 18 firmly in position within the bore during the swaging operation. The reason for this is that during the swaging operation of the barrel section containing the tapered shoulder, there is a longitudinal component of force exerted on the mandrel tending to eject the mandrel. The magnitude of this force is determined by the swaging pressure applied to the barrel and the angle of the tapered shoulder. By way of example, if the dies 24 exert a fifty ton force on the barrel surface, a ten ton force must be applied by the feed 26 to push the barrel through the swaging machine and with an approximately twenty degree shoulder 21, a force of around 45,000 pounds is required to hold the mandrel in position. If the mandrel is not held in position then this longitudinal force will result in slight movement of the mandrel relative to the barrel and the shoulder formed will be of greater longitudinal length than the length of the shoulder of the mandrel and, moreover, the surface of the bore shoulder is formed with a series of minute steps in the surface thereof.

Where two or more longitudinally displaced shoulders are provided in the bore, such as shoulders 21 and 19, it is necessary to swage the barrel in a direction toward the feeding device 26 i.e., in the direction from the chamber 12 toward the bore 10, and more particularly in the direction from the larger portion of the bore toward the smaller portion. When the chamber is swaged from the opposite direction experience has shown that the elongation of the barrel due to swaging results in the formation of shoulders displaced a greater distance apart than the distance between the shoulder forming sections of the mandrel.

The machine for holding the chamber mandrel 18 in the barrel during the swaging operation may be of any type capable of applying a relatively constant but yielding force against longitudinal movement of the mandrel. The machine 32 shown by way of illustration is hydraulic and includes a casing 34 with a piston chamber housing a reciprocatory piston 38 having a rod 40 engaging the end 42 of the mandrel 18. Fluid under pressure is admitted to and exhausted from the rearward and forward end portions 36 and 37 of the chamber through pipes 47 and 48, respectively, controlled by a four-way valve 44. At the start of the swaging operation, the four-way valve 44 is turned to supply pressure fluid to the chamber portion 36 from inlet 45 and simultaneously exhaust chamber 37 through pipe 49 so a force is applied by the piston on the mandrel 18. The valve 44 is then moved to the shut-off position thereby trapping pressure fluid behind the piston 38 and providing a suction bleed in for chamber 37 through the valve notch 53.

The barrel 14 in moving through the swaging dies 24 exerts an oppositely directed force on the piston 38 tending to compress fluid in the chamber 36. A relief valve, or reducing valve, 46 acts to maintain the pressure in the rearward portion of the chamber 36 at a relatively constant valve by permitting fluid to escape from the chamber 36 as the piston 38 is moved rearwardly by the motion of the barrel 14. Thus a relatively constant, but yielding force, is applied to the chamber mandrel 18 to maintain the mandrel in a fixed position relative to the barrel. At the completion of this step of the swaging operation the four-way valve 44 is turned such that chamber 36 is exhausted and pressure fluid is conducted to chamber portion 37 for actuating the piston 38 rearwardly for removal of the mandrel 18 from the bore. It is to be noted that the connection of the mandrel end 42 with the rod 40 permits free rotation of the mandrel with the barrel so that the rifled portion of the barrel may be formed.

The feeding mechanism for forcing or pushing the barrel through the dies 24 may be of any suitable type capable of exerting a relatively constant force on the barrel and feeding the barrel through the swaging machine at a relatively constant rate. For example a worm or cam type drive (not shown) may be utilized. For the purpose of simplicity a hydraulic system is shown comprising a casing 50 defining a chamber divided into portions 52 and 54 by a reciprocatory piston having piston rods 56 and 58 extending from its opposite sides through the ends of the casing 50. Pressure fluid is supplied and

exhausted from the chamber portions 52 and 54 through pipes 60 and 62, respectively, connected to a four-way valve 64 having an inlet 66 and an exhaust 68. The valve is arranged such that when pressure fluid is conveyed from the inlet to one of the chambers 52 or 54, the other chamber is communicated with the exhaust 68 so that the piston moves in the direction of the chamber being exhausted.

The free end of the piston rod 56 is arranged to abut against the end of the barrel 14 for pushing the barrel into the swaging machine by merely setting the four-way valve to communicate the chamber portion 54 with the inlet 66 and the chamber portion 52 with the exhaust 68. If desired, any conventional type of regulating device may be provided to control the rate of flow of pressure fluid through the conduit 62 in accordance with a desired feed rate of the barrel 14. On the completion of the swaging operation, the four-way valve is merely reversed to retract the piston 51. In order to conserve the space on the drawing and maintain the size of the figures, the feeding device 26 has been broken in several places, but it is to be understood that the stroke of the piston 51 must be at least equal to its length of the barrel 14. It is to be noted also that the size of the piston 51 is shown as being substantially the same as the size of piston 38 and hence the pressure of fluid used to actuate the piston 51 is substantially higher than that supplied the device 32. If it is desired to use the same pressure fluid supply for both machines 26 and 32, the piston 38 could then be reduced in diameter as the feeding mechanism must exert almost five times the force exerted by the holding device 32.

During the swaging operation of the bore 10 it is necessary to hold the rifling or bore mandrel 20 in a fixed position (see Fig. 9) relative to the swaging dies 24. In furtherance to this end, the piston 51 and rods 56 and 58 have an axial bore 70 therethrough to accommodate a rod 72 attached to the bore mandrel 20. The opposite end of the rod 72 is keyed in a thrust bearing 74 mounted in a stationary plate 76. This connection permits free rotation of the mandrel 20 with and relative to the barrel. Such free rotation of the mandrel is required because as the barrel moves longitudinally of the mandrel, the spiral rifling on the mandrel causes a screw action resulting in relative rotation between the mandrel and barrel.

While I have shown and described a specific form of my invention, it is to be understood that various changes and modifications may be made without departing from the spirit of the invention as set forth in the appended claims.

What I claim is:

1. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming an axial bore in the cylindrical member, reducing one end section of the member by removing material to a diameter less than the diameter of the remaining section, forming a cartridge chamber in the bore portion contained within the larger section by cold swaging the larger section, reducing the larger section by removing material to a diameter less than the diameter of the first reduced section, and forming the bore by swaging the first reduced section.

2. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming an axial bore in the cylindrical member, reducing one end section of the member by removing material to a diameter less than the diameter of the remaining section, forming a cartridge chamber and the adjoining lead in portion of the bore by cold swaging the larger section, reducing the larger section by removing material to a diameter less than the diameter of the first reduced section, and forming the bore by swaging the first reduced section.

3. The process claimed in claim 2 in which when said larger section is reduced in diameter it is reduced to the

desired final diameter which is less than the diameter of the first reduced section and in which the member section last swaged is swaged to the desired final diameter.

4. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming an axial bore through the member having an enlarged portion joined to the smaller portion of the bore by a tapered shoulder, reducing the diameter of the cylinder except for a section containing at least the enlarged bore portion and tapered shoulder, forming a cartridge chamber by cold swaging the larger section of the member on a mandral positioned in the enlarged bore portion and on said shoulder and simultaneously holding said mandrel firmly against said shoulder, reducing the larger section by removing material to a diameter less than the diameter of the first reduced section, and forming the bore by swaging the first reduced section.

5. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming an axial bore in said member with an enlarged substantially coaxial chamber portion; forming the cartridge chamber and a relatively short lead in spirally rifled portion of the bore with at least the forward muzzle end section of the rifled portion of slightly larger bore diameter and rifling groove width than the desired final diameter and width, by cold swaging on a mandrel the member section containing such chamber and lead in; and removing the mandrel and forming the bore to the final size by cold swaging the member along at least said muzzle end section of said lead in portion and along the remainder of the unswaged member on a mandrel initially piloted in said lead in portion.

6. The process claimed in claim 5 in which prior to the first swaging step the member is reduced in outside diameter except for said member section, and in which prior to the second swaging step the member section to be swaged in the second swaging step is reduced in diameter to something less than the first said diameter.

7. The process defined in claim 6 in which a tapered shoulder is formed in the chamber and the mandrel is held firmly in position in the chamber and bore during the first swaging step.

8. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming an axial bore in said member with an enlarged substantially coaxial chamber portion; forming the cartridge chamber and a relatively short lead-in spirally rifled portion of the bore with the muzzle or forward end section of such portion of a slightly larger bore diameter and rifling groove width than the desired final diameter and width, by cold swaging on a mandrel the member part containing such chamber and lead-in portion; removing the mandrel and reforming at least such section of the lead-in to the final size and forming a spirally rifled remainder of the bore by cold swaging the member along the part containing such section of said lead-in and along the remainder of the unswaged member on a mandrel initially piloted in said lead-in portion.

9. The process of forming a gun bore and cartridge chamber in a cylindrical member comprising the steps of forming in said member an oversize axial bore and an enlarged substantially coaxial oversize chamber portion; forming the cartridge chamber to the desired size with a pair of longitudinal displaced shoulders tapered inwardly in the direction of the muzzle and a relatively short lead-in spirally rifled portion of the bore with the muzzle end section of such portion of a slightly larger bore diameter and rifling groove width than the desired final diameter and width, by cold swaging on a mandrel the member part containing such chamber and lead-in portion, the pressure applied by the swaging action being over a longitudinal area greater than the longitudinal distance between said shoulders; removing the mandrel and reforming at least such section of the lead-in to the final size and forming a spirally rifled remainder of the bore by cold swaging the

member along the part containing such section of said lead-in and along the remainder of the unswaged part of the member on a mandrel initially piloted in said lead-in portion.

10. The process claimed in claim 9 in which the first said mandrel is held immovable relative to the member during the time the chamber portion is formed, and in which the member is moved relative to the second said mandrel during at least part of the step of forming the remainder of the bore.

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