April 11, 1961 M. CLAR 2,978,791

ASSEMBLING AND FINISHING METHOD AND APPARATUS

Filed Feb. 27, 1958

4 Sheets-Sheet 1

FIG 1.

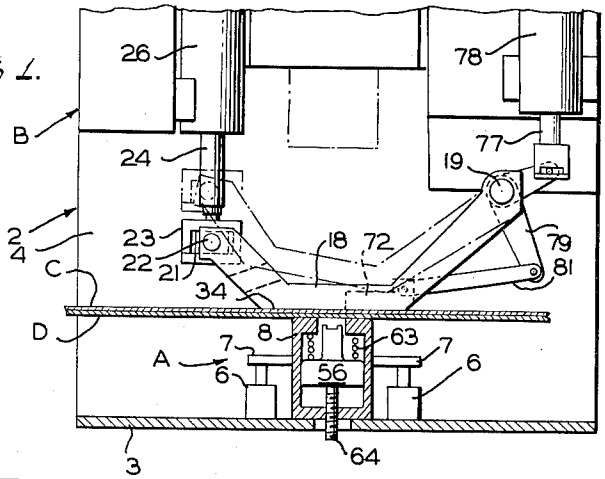


FIG 2.

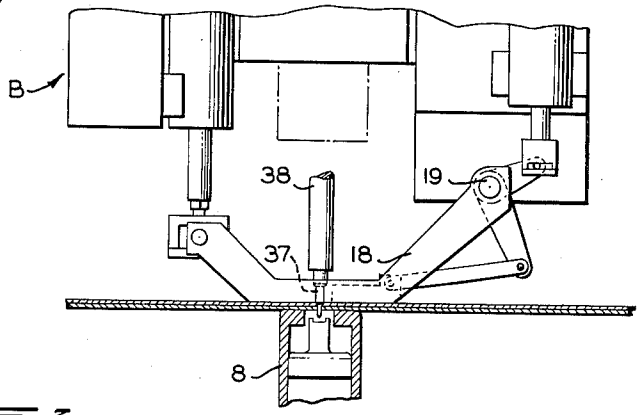


FIG 3.

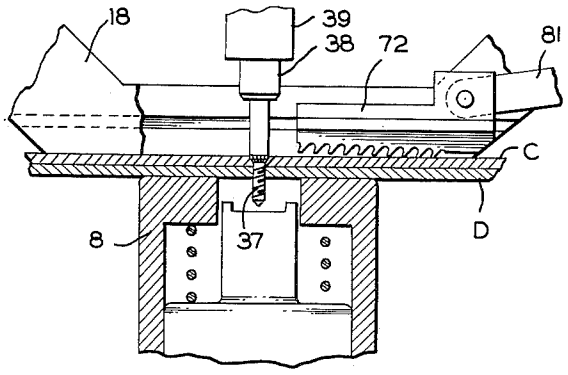
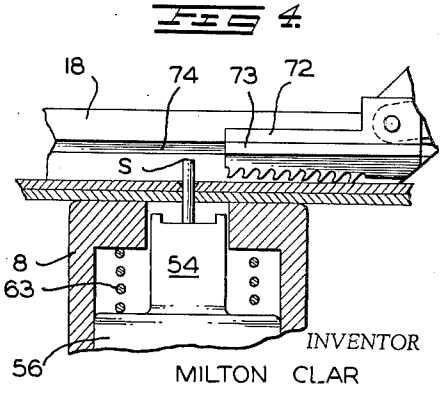


FIG 4.



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ASSEMBLING AND FINISHING METHOD AND APPARATUS

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Fig 5.

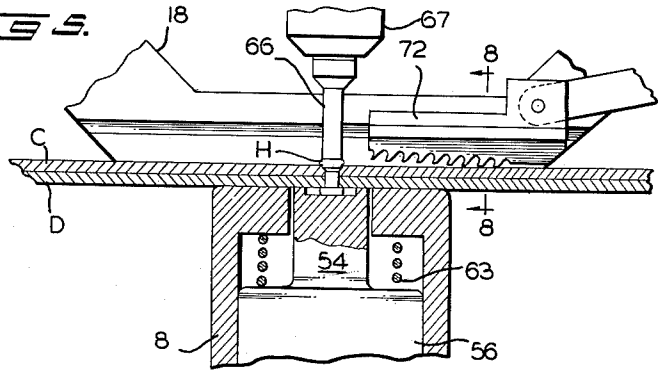


Fig 6.

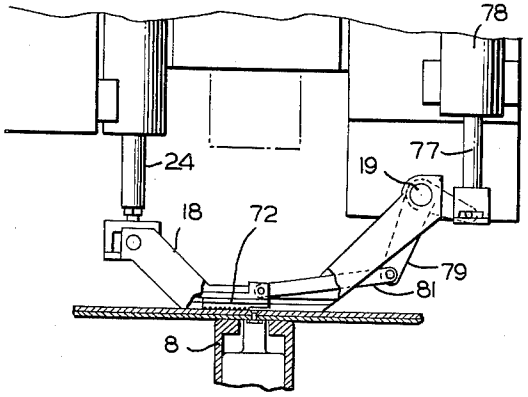


Fig 7.

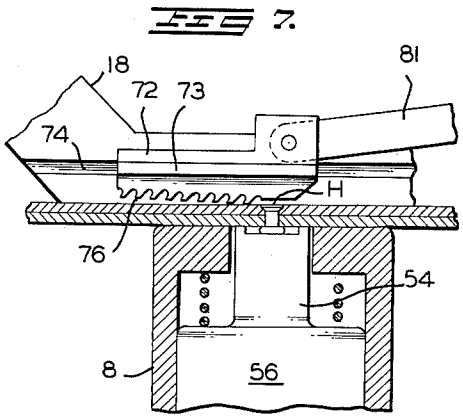


Fig 15.

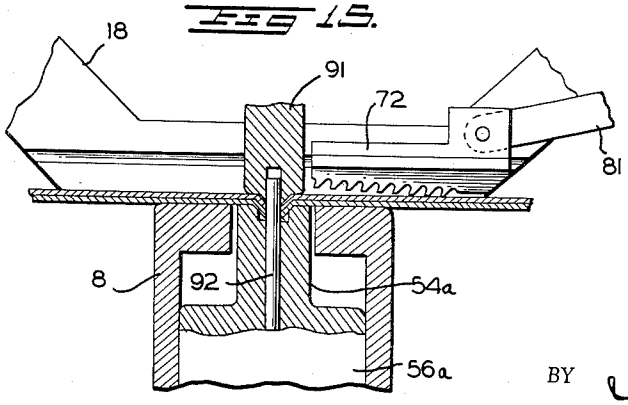
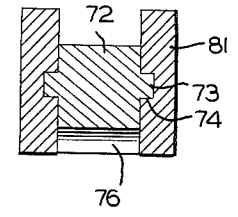


Fig 8.



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April 11, 1961 M. CLAR 2,978,791

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Fig 9.

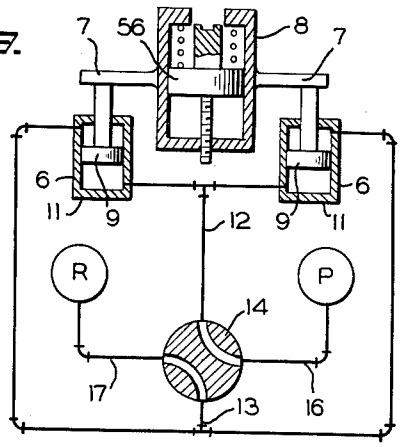


Fig 10.

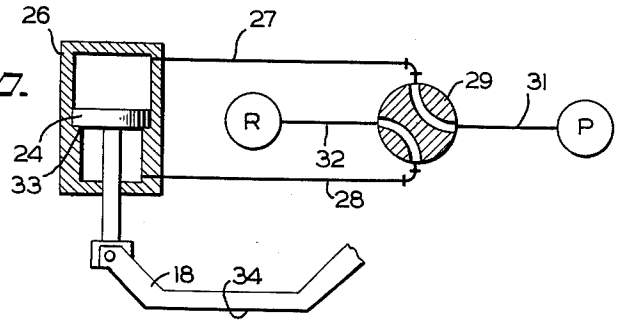
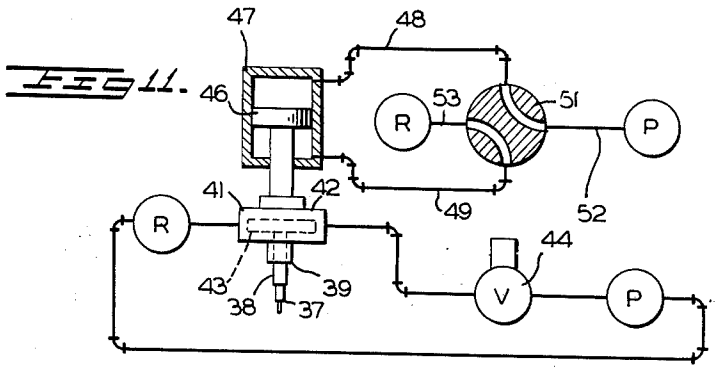


Fig 11.



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ASSEMBLING AND FINISHING METHOD AND APPARATUS

Filed Feb. 27, 1958

4 Sheets-Sheet 4

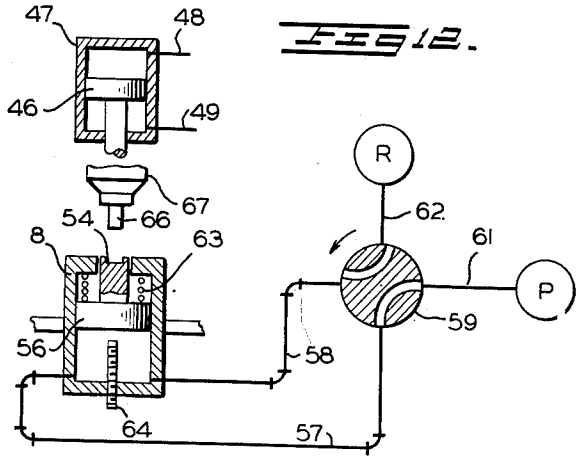

FIG 12.

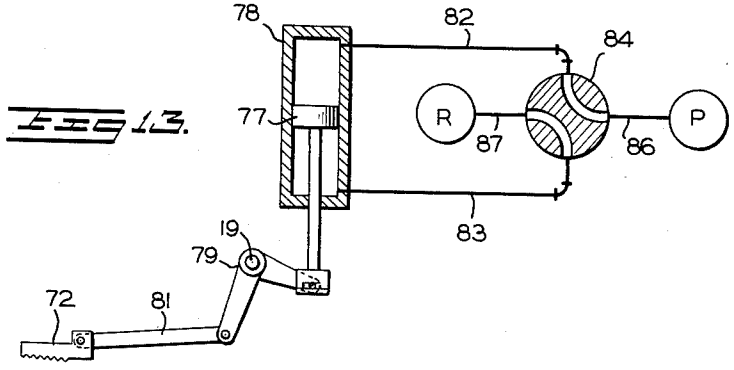

FIG 13.

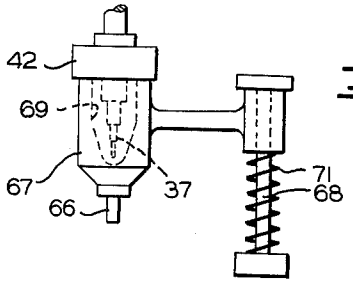

FIG 14.

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United States Patent Office 2,978,791 Patented Apr. 11, 1961

2,978,791

ASSEMBLING AND FINISHING METHOD AND APPARATUS

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Filed Feb. 27, 1958, Ser. No. 717,934

3 Claims. (Cl. 29—34)

This invention relates to methods and apparatus for assembling and finishing structures and is more particularly concerned with structures wherein the several parts thereof are secured together by means of rivets.

In the fabrication of structures such as, for example, an airplane wing, the several parts thereof have heretofore been secured together by means of rivet slugs or countersunk head rivets having their heads engaged in dimples or countersunk openings formed in the sheet metal plates to provide a substantially smooth outer wing surface. As the dimples or countersunk openings are often not of uniform size and do not always correspond in size and shape to the heads on the slugs or rivets, the outer surface of the wing does not have the desired smoothness to provide minimum air friction.

It is, therefore, an object of the present invention to provide a method and apparatus for assembling and finishing structures, such as airplane wings, to provide such structures with a smooth outer surface to reduce air friction to a minimum.

Another object of the invention resides in the provision of a method and apparatus adapted to reduce the cost of fabrication of riveted structures, such as airplane wings.

A further object of the invention resides in the provision of a method and apparatus wherein airplane wing components, or the like, are first secured together by means of slugs or rivets formed with head portions which fill and project outwardly from their respective countersunk openings, said head portions being then cut away flush with the outer surface of the wing structure to form a smooth outer surface offering minimum frictional resistance to the passage of air thereover.

Another object of the invention resides in the provision of a method and apparatus for clamping parts of an assembly in fixed position during the several assembly operations, such as drilling or punching of the rivet holes, forming countersunk openings for the holes, inserting and heading the slugs or rivets, and shaving excess metal from the portions of the heads projecting outwardly from their respective countersunk openings.

Another object of the invention resides in the provision of means including a pair of clamping members to secure parts of an assembly in fixed position, and guide means formed on one of said members to receive a cutter for reciprocative movement during trimming of excess metal from heads of the slugs or rivets.

Another object is to provide an apparatus which is inexpensive in construction and reliable in operation.

The invention embodies other novel features, details of construction and arrangement of parts which are hereinafter set forth in the specification and claims and illustrated in the accompanying drawings, forming part thereof, wherein;

Fig. 1 is a fragmentary front elevation, partly in section, illustrating an assembling and finishing apparatus embodying features of the invention.

Fig. 2 is a view corresponding to Fig. 1, showing means

for drilling and countersinking an assembly of work pieces.

Fig. 3 is an enlarged fragmentary vertical sectional view illustrating the position of parts of the apparatus during the drilling and countersinking operation.

Fig. 4 is a fragmentary sectional view illustrating a rivet slug positioned in the rivet opening formed in the work pieces.

Fig. 5 is a fragmentary sectional view illustrating means for heading the rivet slug.

Fig. 6 is a view corresponding to Fig. 1 illustrating means for trimming a rivet head flush with the outer surface of the adjacent work piece.

Fig. 7 is an enlarged fragmentary sectional view of the rivet head trimming means.

Fig. 8 is an enlarged transverse sectional view taken along the line 8—8 of Fig. 5.

Figs. 9, 10, 11, 12 and 13 are schematic views illustrating hydraulic means for the operating of the apparatus.

Fig. 14 is a detail view illustrating means for supporting the rivet heading member.

Fig. 15 is a vertical sectional view illustrating a modified form of the invention.

Referring now to the drawings for a better understanding of the invention, the apparatus is shown as comprising base and head mechanisms, indicated generally at A and B, respectively, adapted to engage work pieces C and D therebetween. If desired, said mechanisms may be supported on a common frame structure 2 comprising a base plate 3 and an upright back wall 4.

A pair of hydraulic motors 6—6 are mounted on the base plate 3 for engagement against arms 7—7 provided on opposite sides of a work supporting cylinder 8, each motor being shown as comprising a piston 9 mounted for reciprocative movement in a cylinder 11 provided with conduits 12 and 13 leading to a four-way control valve 14 which is connected to a pressurized fluid source P and a reservoir R by conduits 16 and 17, respectively.

A work clamping arm 18 is pivotally mounted at one end thereof on a pivot pin 19 provided on the head B. The other end of the arm is bifurcated to receive a bearing block 21 which is fixed on a pin 22 journaled at its ends in apertures formed in the arm. The bearing block 21 is engaged in a slide bearing 23 secured on the lower end of a piston 24 mounted in a cylinder 26. As shown in Fig. 10, the cylinder 26 is secured on the head B and provided with conduits 27 and 28 leading to a four-way valve 29. Conduits 31 and 32 lead from the valve to a pressurized fluid source P and a reservoir R, respectively. The cylinder 26 is provided with a stop shoulder 33 to limit downward movement of the piston 24 to insure that the flat work engaging face 34 on the arm 18 will always stop in a horizontal plane parallel to the flat surface 36 on the upper end of the cylinder 8. After movement of the arm 18 to its lower position, the cylinder 8 is raised to clamp the work against the face 34.

After the work pieces C and D are thus clamped in fixed position between the cylinder 8 and the clamping arm 18, they are drilled and countersunk, as illustrated in Figs. 2, 3, and 11 to receive a rivet slug S. A combined drill and countersink 37 is mounted on a spindle 38 journaled in a bearing 39 provided on the housing 41 of a conventional fluid motor 42. A rotor 43, journaled in the housing 41 and secured to the spindle 38, is adapted to rotate responsive to a flow of pressurized fluid through the housing from a pressurized fluid source P to a reservoir R when a solenoid actuated valve 44 is opened.

The motor housing 41 is connected to a piston 46 mounted for reciprocative movement in a cylinder 47 responsive to the flow of fluid through conduits 48 and 49 leading to a four-way valve 51. Conduits 52 and 53

lead from a pressurized fluid source P and a reservoir R, respectively, to the valve 51.

After the drilling and countersinking operation, a rivet slug S is placed in the rivet opening to rest upon anvil 54 carried by a piston 56 in the work supporting cylinder 8, as illustrated in Fig. 4. As shown in Fig. 12, conduits 57 and 58 lead from the cylinder 8 to a four-way valve 59 which is connected to a source of pressurized fluid P and a reservoir R by conduits 61 and 62, respectively. A helical compression spring 63 is provided in the cylinder 8 to bias the piston 56 to its inner position against an adjustable stop screw 64.

A rivet heading member 66 is actuated by the piston 46 to coact with the anvil 54 to simultaneously form heads on opposite ends of the rivet slug S, as illustrated in Figs. 5, 12 and 14. The heading member 66 is fixed on a bracket 67 mounted for pivotal and axial movements on a shaft 68, as illustrated in Fig. 14. One side of the bracket 67 is formed with a recess 69 to receive the drill 37 and spindle 38 to dispose the heading member 66 in axial alignment under the drill during the heading operation. After the heading operation, the bracket 67 is pivoted laterally from the spindle 38 to an inoperative position. A compression spring 71 is provided on the shaft 68 to maintain the bracket 67 in engagement against the motor 42 during the heading operation.

After the heading operation, the head H on the rivet projects outwardly from the countersunk opening above the outer surface of the workpiece C. To provide a smooth outer surface on the work assembly, the present invention contemplates the provision of finishing means for trimming excess metal from the outer end of the rivet head H.

The rivet head finishing means is shown in Figs. 6, 7 and 13 as comprising a cutter 72 mounted for reciprocative movement on the work clamping arm 18 in a plane parallel to the work engaging face 34 on the arm, the cutter being provided with tongues 73 on opposite sides thereof for sliding engagement in grooves 74 formed in the clamping arm. The cutter is formed with teeth 76 of progressively increasing length from the tongue 73 to successively trim excess metal from a rivet head H during one stroke of the cutter.

The cutter 72 is reciprocated along the clamping arm 18 by means of a piston 77 which is mounted in a cylinder 78 and connected to one arm of a bell crank lever 79 mounted for pivotal movement on the pin 19, the other arm of the lever being connected to the cutter by a link 81. Conduits 82 and 83 lead to a four-way valve 84; and conduits 86 and 87 lead from said valve to a source of pressurized fluid P and a reservoir R, respectively.

In the operation of the apparatus thus shown and described, the work pieces C and D are first placed upon the flat upper face 36 of the cylinder 8. The work clamping arm 18 is then pivoted downwardly by the piston 24 to dispose the flat lower surface 34 of the arm in a horizontal plane parallel to the face 36 of the cylinder 8. The cylinder 8 is then moved upwardly toward the arm 18 by the pistons 9—9 to clamp the work pieces C and D between the cylinder and the arm.

After the work pieces have been clamped in fixed position, the combined drill and countersink 37 is rotated by the fluid motor 42 and moved axially by the piston 46 to form a countersunk rivet aperture in the work pieces to receive a rivet slug S for abutting engagement against an anvil 54.

During heading of a slug S, the bracket 67 is first pivoted into position under the fluid motor housing 41. The anvil 54 and plunger 66 are then moved toward each other by their respective pistons 56 and 46 to simultaneously upset and head the ends of the slug S, as illustrated in Fig. 5. After the heading operation, the bracket 67 is pivoted away from the fluid motor 42 to its inoperative position.

After the heading operation, the head H projects outwardly from the countersunk opening, as shown in Fig. 5. To provide a smooth outer surface on the assembly, it is necessary to remove excess metal from the head H. This is acomplished by moving the cutter 72 across the head H to cause the teeth 76 to act successively in shaving excess metal from the head to provide a smooth outer surface thereon flush with the outer surface of the work piece C, as illustrated in Fig. 7.

Fig. 15 illustrates a modified form of the invention in which a punching and dimpling operation may be substituted for the drilling and countersinking operation heretofore shown and described. In this form of the invention, work pieces C and D are first clamped between the arm 18 and cylinder 8, as heretofore described. A die 91 is secured on the piston 46, in place of the motor 42 and drill 37, to coact with a punch 92 and anvil 54*a* to form a dimpled rivet aperture in the work pieces. Any suitable mechanical or hydraulic power means may be provided to actuate the punch 92. After the punching and dimpling operation, the rivet or slug is headed and excess metal cut from the head thereof by the cutter 72, as heretofore described.

Having described a preferred embodiment of the present invention, it is to be understood that although specific terms and examples are employed, they are used in a generic and descriptive sense and not for purposes of limitation; the scope of the invention being set forth in the following claims.

What is claimed is:

1. In an apparatus for shaving protruding rivet heads flush with the smooth outer surface of a riveted structure, work clamping means including an arm for direct planar engagement against said outer surface of the riveted structure, a surface broach directly slidably mounted on said arm for movement in a plane parallel to said outer surface, said broach having teeth of progressively increasing length to act successively in shaving a rivet head flush with said outer surface in one stroke of the broach, means to move said broach along said arm, said work clamping means including a valve, a pressurized fluid source controlled by said valve, a cylinder mounted upon a frame and connected to said fluid source and having a stop shoulder and piston therein whereby opening of the said valve causes the piston to move to a position against the shoulder, linkage means interconnecting the said piston with the said arm so as to impart movement to the arm whereby the arm moves to a reference position against said outer surface of the riveted structure.

2. In an apparatus for shaving protruding rivet heads flush with the smooth outer surface of a riveted structure, work clamping means including an arm for direct planar engagement against said outer surface of the riveted structure, a surface broach directly slidably mounted on said arm for movement in a plane parallel to said outer surface, said broach having teeth of progressively increasing length to act successively in shaving a rivet head flush with said outer surface in one stroke of the broach, and means to move said broach along said arm, said means including a pressurized fluid, a piston mounted in a cylinder and connected to one arm of a bell crank lever mounted for pivotal movement about a pin, the other arm of the lever being connected by a link to the said surface broach whereby release of the pressurized fluid to the piston causes movement of the broach.

3. In an apparatus for assembling components having aligned rivet apertures provided with a flaring opening, means including an arm to clamp said components to-

gether, means movable relative to said clamp means to upset the ends of a rivet element positioned in said apertures to form heads projecting from remote surfaces of said components, guide means provided on said arm, a cutter having teeth of progressively increasing length, said cutter being slidably mounted on said guide means for reciprocative movement transversely of said rivet element, and means to move said cutter to progressively remove excess metal from the outer end of rivet head seated in said flaring opening in one stroke of the cutter to provide a smooth outer surface on the component assembly, the last stated means including a pressurized fluid, a piston mounted in a cylinder and connected to one arm of a bell crank lever mounted for pivotal movement about a pin, the other arm of the lever being connected by a link to the said cutter whereby release of the

pressurized fluid to the piston causes movement of the cutter.

References Cited in the file of this patent

UNITED STATES PATENTS

355,274	Manly et al.	Dec. 28, 1886
560,610	Davidson	May 19, 1896
655,424	Versten	Aug. 7, 1900
820,330	Amidon	May 8, 1906
1,063,640	Behan	June 3, 1913
1,437,190	Oxley	Nov. 28, 1922
1,570,090	Simpson	Jan. 19, 1926
1,588,716	Ferris	June 15, 1926
2,216,403	Oeckl	Oct. 1, 1940
2,314,656	Morton	Mar. 23, 1943