June 11, 1940. J. H. GETTIG ET AL 2,203,956

APPARATUS FOR REDUCING TUBULAR BLANKS

Original Filed May 22, 1937 5 Sheets-Sheet 1

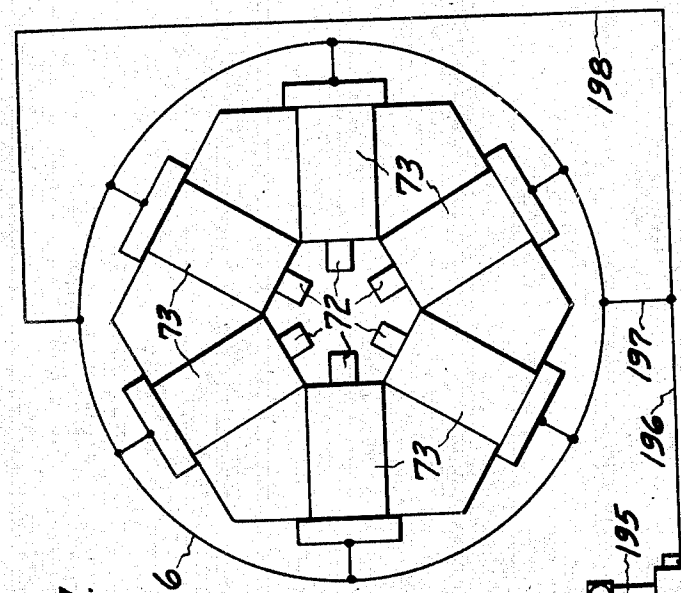


FIG. 1.

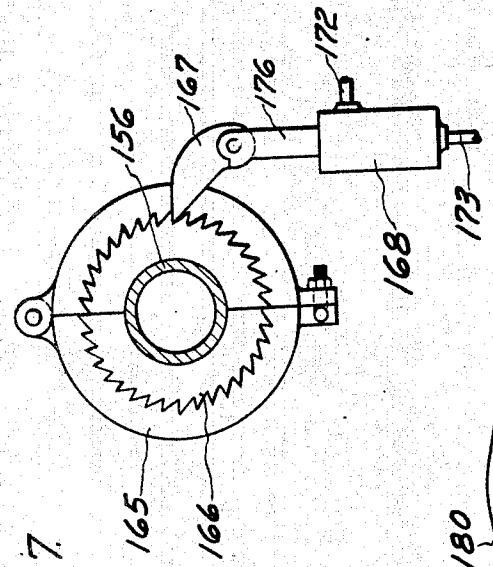
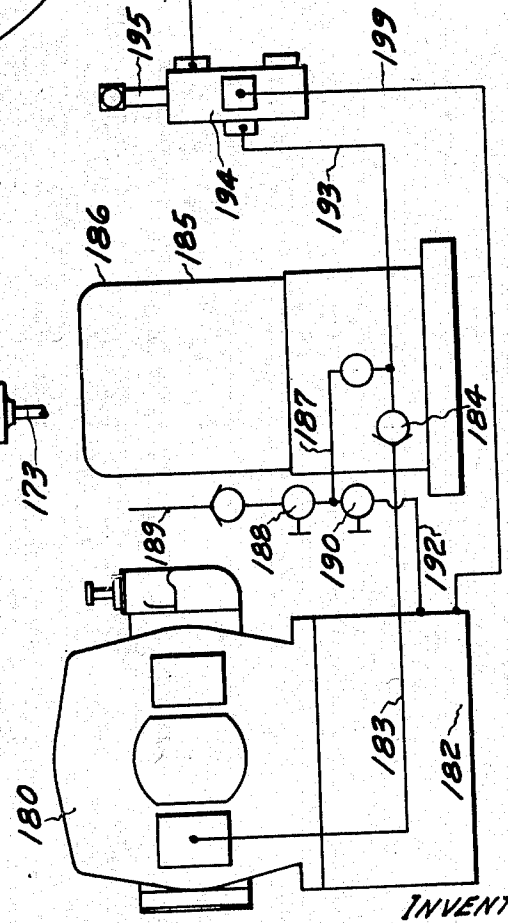


FIG. 7.



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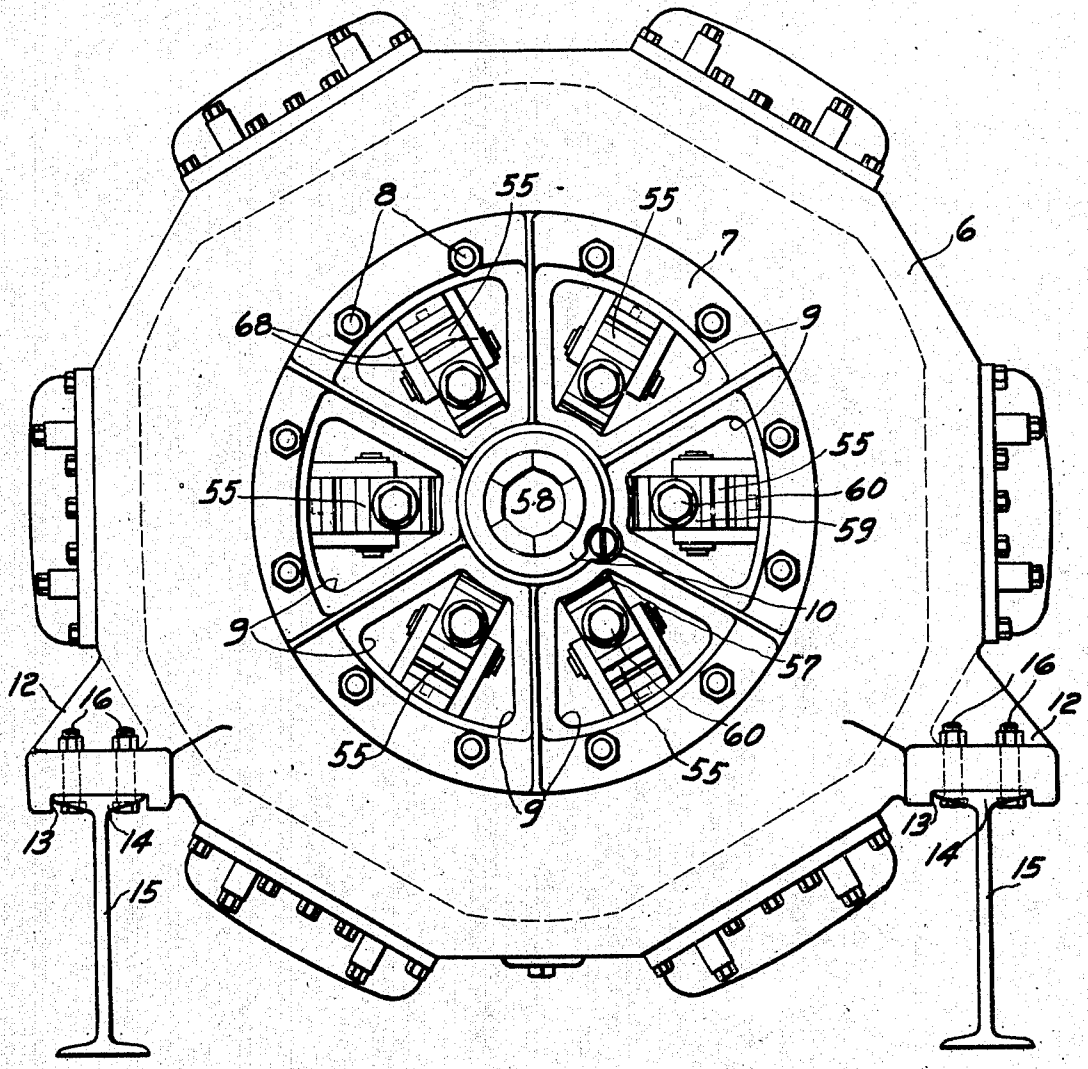
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APPARATUS FOR REDUCING TUBULAR BLANKS

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FIG. 2.



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APPARATUS FOR REDUCING TUBULAR BLANKS

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FIG. 3.

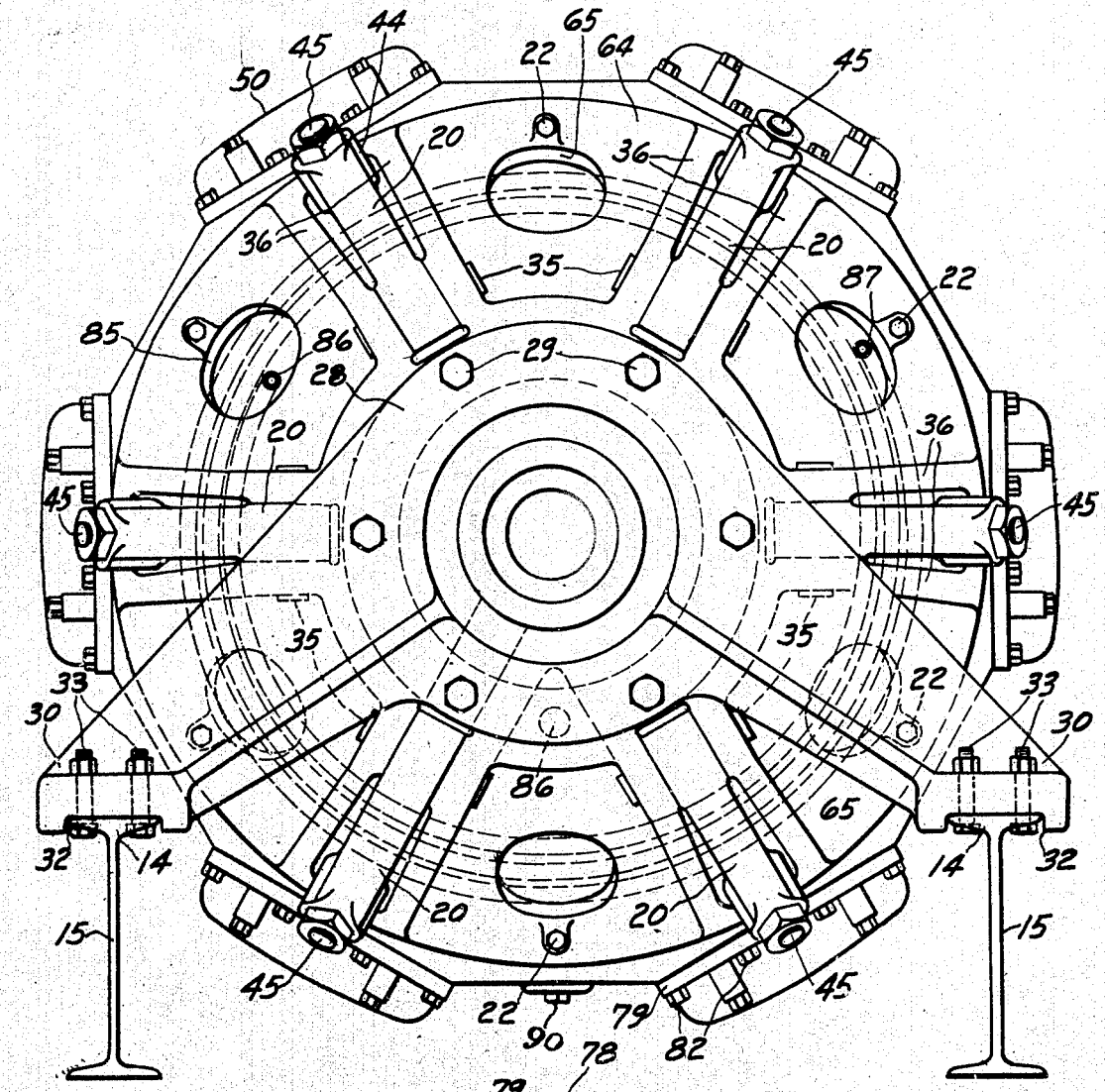


FIG. 5.

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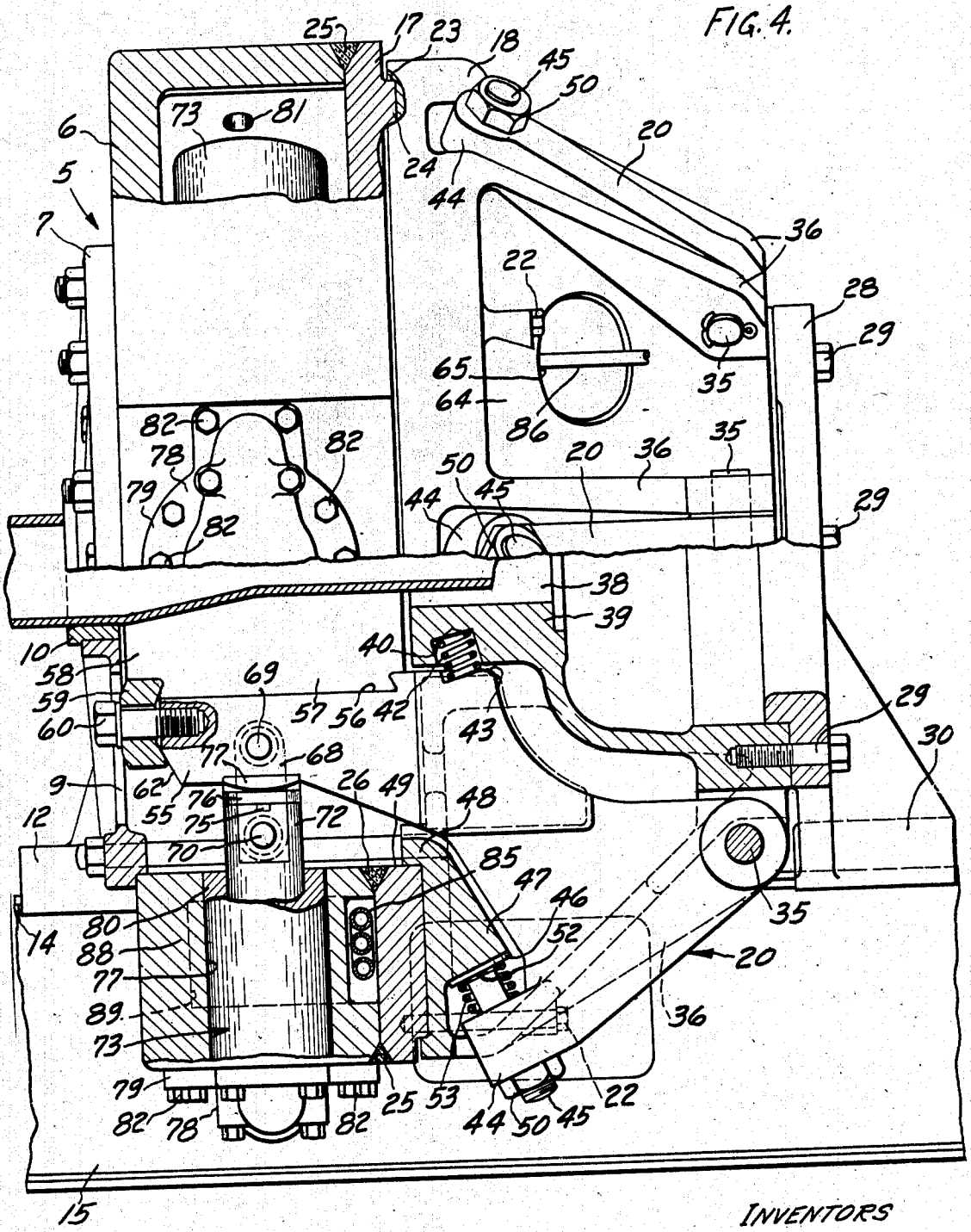
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APPARATUS FOR REDUCING TUBULAR BLANKS

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FIG. 4.



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APPARATUS FOR REDUCING TUBULAR BLANKS

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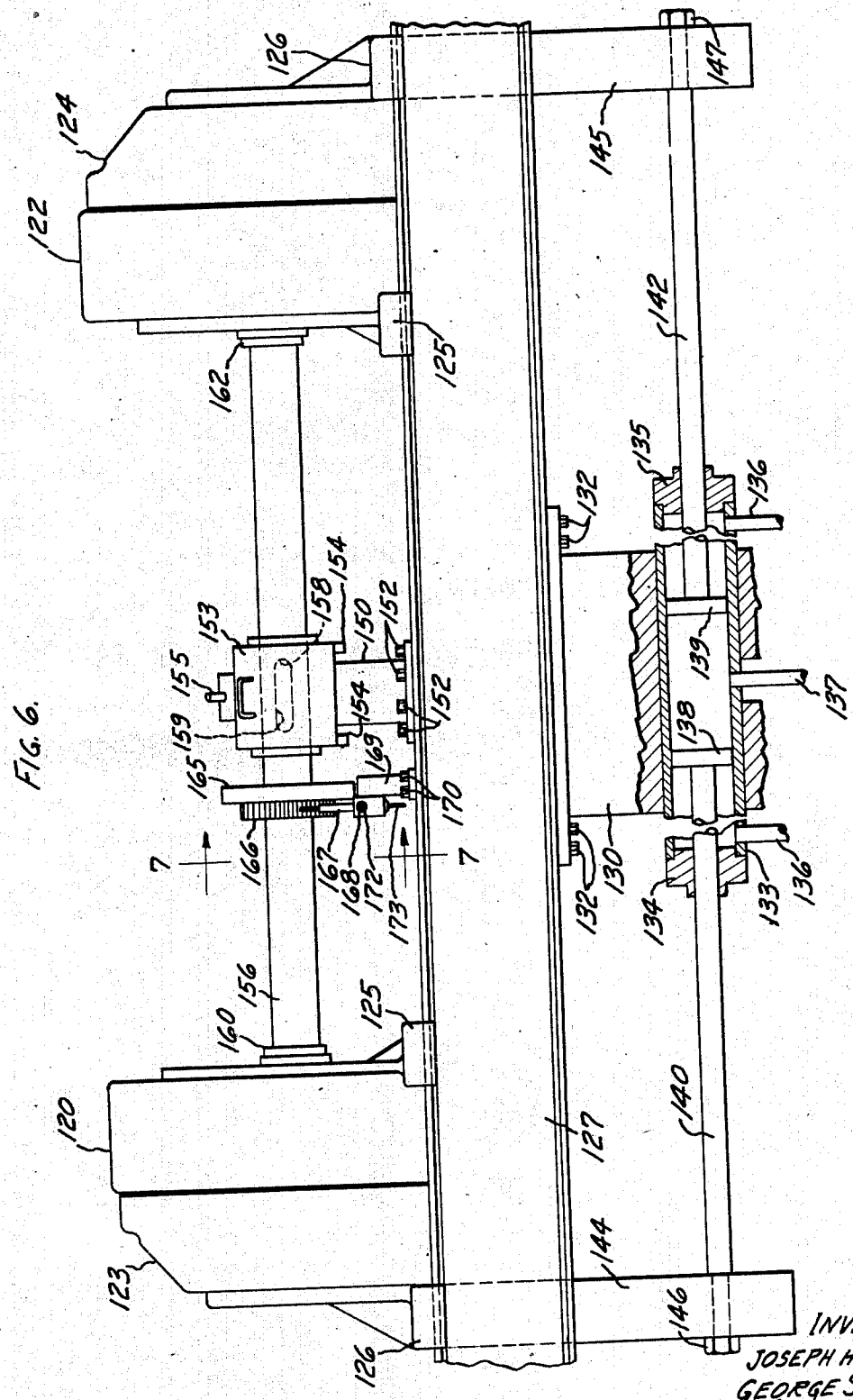


FIG. 6.

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Patented June 11, 1940 2,203,956

UNITED STATES PATENT OFFICE

2,203,956

APPARATUS FOR REDUCING TUBULAR BLANKS

Joseph H. Gettig and George Spatta, Buchanan, Mich., assignors to Clark Equipment Company, Buchanan, Mich., a corporation of Michigan

Original application May 22, 1937, Serial No. 144,181. Divided and this application January 29, 1938, Serial No. 187,581

3 Claims. (Cl. 78—42)

This invention relates to apparatus for reducing tubular blanks, being more particularly directed to means operated hydraulically for reducing the tubular arms of an axle housing of the banjo type used for automotive vehicles and the like, and constituting a division of our copending application, Ser. No. 144,181, filed May 22, 1937.

In the formation of an axle housing from a tubular blank, whether the blank comprises seamless tubing or flat strip stock rolled into tubular form and longitudinally welded, it has heretofore been the practice to swage the arm portions of the housing to reduce the external diameter thereof and to increase the wall thickness, one extremity of the arm portion being further swaged to provide wheel bearing seats or being upset, and the other extremity flaring outwardly into the banjo frame section.

The swaging operations have, so far as we are aware, usually been performed in apparatus of the type disclosed in the Spatta Patent No. 1,962,944 of June 12, 1934.

It is old to construct a rear axle housing or casing from tubing. According to the present invention, the blank which is first formed comprises tubing of substantially uniform diameter and wall thickness in which the wall thickness is substantially the same as the final thickness required in the banjo frame. In order to form such a housing, the ends of the tube extending from the banjo outwardly to the wheel bearing seats must be shrunk to reduce the diameter to the desired size. This increases the wall thickness of the arms, which provides a slightly greater strength than is required through a part of the length, but is advantageous at the extreme outer ends of the arms where the wheels are to be mounted, and where the flange for attaching the brake drum and spring pads must be disposed.

The present invention is particularly directed to a machine for performing the reduction of diameter of the arm sections of the blank to the diameter required in the finished housing without affecting the thickness of metal in that portion of the blank which is to be expanded into a banjo frame.

The diameter of the tube used in the manufacture of housings of this type is determined by the amount of metal required in the critical sections of the housing in accordance with the principles set forth in Spatta Reissue Patent No. 20,103, of September 8, 1936. This diameter is substantially larger than is required in the end sections of the finished housing, and therefore the blank is swaged to reduce its diameter. This operation lengthens the blank and also gathers the metal of the wall to increase the thickness thereof. This method of construction is advantageous in that it produces a housing having thick walls at the points where the greatest strain occurs, and thinner walls at the points that are subjected to lesser strain. In carrying out the instant invention, we may provide either a double or single acting swaging apparatus for operating on either one or both arms of an axle housing. The double acting machine is of some advantage in that it provides that the operations on one end of the blank oppose the reactions set up in the blank by the pressure of the die operating on the other end thereof, thereby balancing the stresses to a considerable extent.

The present invention contemplates broadly, the provision of a hydraulic swaging head carrying a plurality of radially disposed dies mounted on suitable rocker arms and actuated by hydraulic surge pressure to contact the external surface of the housing about the larger portion of the periphery thereof and to force the same inwardly, thereby reducing the diameter of the arm and simultaneously thickening the walls thereof. This swaging head is operated from a suitable pump and surge control assembly so that all of the dies are simultaneously rocked into and out of engagement with the surface of the blank, and as the blank is moved relative to the die surfaces, it is successively reduced in diameter. In order to produce a substantially uniform reduction of the blank, it is preferably rotated during the swaging operation so that a true cylindrical reduction is obtained.

One object of the present invention is to swage a blank by a multiplicity of cooperating dies which are successively moved inwardly and outwardly with respect to the axial center of the blank by hydraulic pressure, the action being such that a smooth uniform reduction of the blank is produced.

In the preferred form of the invention, we preferably provide for a rate of operation of about 400 pulsations per minute in the pressure system to produce a corresponding reciprocation of the die members for effecting the required reduction.

Another object of the present invention is to so design the swaging head that uniform pressure is exerted upon the blank by each of the swaging dies, and the dies all operate simultaneously in effecting a reduction in the diam-

eter of the blank. We preferably provide six dies spaced 120° apart, and provided with arcuate concave surfaces flaring outwardly from the rear end thereof to receive and guide the blank therebetween, and to simultaneously produce upon the blank a tapered reduction which, as the blank moves through the head, is formed into a cylindrical reduced arm. By employing hydraulic pressure, a smooth and uniform operation is obtained insuring that the blank will be uniformly reduced. Suitable cooling means is provided for maintaining the oil or other fluid at the proper temperature to prevent its deterioration and to preserve its volume so that uniformity is insured.

Another feature of the present invention is the provision of a swaging head having a common manifold connection to each of the die operating plungers, whereby a surge of pressure of the fluid in the manifold will produce simultaneous movement of each of the die plungers. Suitable adjusting means is provided for insuring that the dies will return to the proper position after each operating impulse to allow free feeding of the blank through the dies between alternate impulses and to permit rotation of the blank during this interval.

Another feature of the present invention is the provision of means for insuring rotation of the blank as it is fed through the swaging head in order that all surfaces of the blank will be uniformly acted upon by the dies to insure a uniform reduction and the reduction of a direct cylindrical arm of smaller diameter and increased wall thickness.

Still another feature of the present invention is the provision of apparatus having interchangeable parts, and so assembled that the dies and the operating mechanism therefor may be readily removed when necessary for inspection, replacement or repair. In this connection we provide a novel type of clamping arrangement for holding the die firmly in position upon the rocker arm, and for insuring restoration of the rocking arm to die opening position after each successive impulse.

Other objects and advantages of the present invention will appear more fully from the following detailed description which, taken in conjunction with the accompanying drawings, will disclose to those skilled in the art the particular construction and operation of a preferred form of the present invention.

In the drawings:

Figure 1 is a diagrammatic view showing the hydraulic connections for operating the swaging apparatus of the present invention;

Figure 2 is a front elevational view of the swaging head;

Figure 3 is a rear elevational view of the head shown in Figure 2;

Figure 4 is a side elevational view of the head partly in section;

Figure 5 is an elevational view of the hydraulic plunger assembly for operating the die rocker arms;

Figure 6 is a somewhat diagrammatic view showing the use of two swaging heads which are relatively movable to effect a double swaging action upon opposite ends of the tubular blank; and

Figure 7 is a side elevational view of the rotating mechanism for the blank.

Referring now in detail to Figures 2, 3 and 4, the die head is illustrated generally at **5**, and comprises an annular manifold portion **6** having a front plate **7** bolted thereto by a series of circumferentially spaced stud bolts **8** tapped into the rear spider member of the head. The plate **7** is provided with openings **9** therein through which access may be had to the die mounting mechanism.

The plate **7** is also provided with a central bushing member **10** through which is guided the tubular blank to be operated upon. The forward face of the manifold frame member **6** is provided with two laterally extending foot portions **12** which are channelled on their under surface as indicated at **13** for support upon the upper flange **14** of sill members **15**, which may take the form of I-beams or the like. If a single swaging head is to be employed and the tubular blank is to be fed thereinto, the foot portions **12** are provided with bolts **16** by which they are secured to the flanges **14** to mount the head rigidly upon the supporting I beams **15**.

Secured to the rear face of the plate **17** forming the end closure for the manifold **16** is the rear spider **18** providing the pivotal supports for the die rocker arms, indicated generally at **20**. The spider **18** is secured to the manifold **6** by the cap bolts **22** which extend therethrough and are threaded into the rear face of plate **17**. The spider itself is provided with a suitable piloting flange **23** adapted to center the pilot upon the shoulder **24** formed on the rear face of the plate **17**.

The plate **17** is welded by circumferential outer welds **25** and inner welds **26** to the manifold **6** and forms a fluid tight closure for the interior of the manifold.

The spider **18** is provided at its rear surface with a bracket member **28** bolted thereto by the bolts **29**, and having laterally offset foot extensions **30** which are suitably channeled, as at **32**, on their under surface for mounting on the flanges **14** of the I-beam members **15**, and suitable securing means **33** may be provided for rigidly mounting the bracket on the I-beams.

Considering now Figure 4 in detail, the die rocker arms **20** which, in the present embodiment of the invention are six in number, are pivoted on suitable pins **35** carried by the oppositely extending webs **36** which extend angularly outwardly from the rear end of the spider **18** to the forward end thereof, and provide suitable slots within which the rocker arms **20** are adapted to move. The spider is open at its central portion, having the annular opening **38** formed therein by the central cylindrical portion **39** of the spider. Angularly offset recesses **40** are provided in the outer periphery thereof, these recesses **40** being adapted to contain springs **42** biased at one end against the inner base of the recess and at the opposite end engaging the inclined shoulder **43** formed on the rocker arm **20**.

The arm **20** is also provided with a shoulder portion **44** at the outer extremity thereof, which shoulder portion is apertured to receive the bolt **45** therein, this bolt being adapted to have abutting engagement with the inclined shoulder **46** formed on the inner portion of the spider indicated at **47**. This inner portion is also provided with a pilot flange **48** piloted within the inner periphery of the opening **49** formed in the plate member **17**. The stud or bolt **45** is provided with a suitable lock nut **50** which limits its inward movement with respect to the arm **20**, and at its opposite end is provided with a flared head portion **52** engaging the inclined seat **46**. Suitable spring means **53** encircling the inner pro-

jecting portion of the stud **45** is biased between the inner surface of the shoulder **44** and the head **52** of the stud, normally maintaining the stud **45** in position with the nut **50** engaging the outer surface of the shoulder **44**.

The inner end of the rocker arm **20** is provided with a laterally extending portion **55** having the undercut surface **56** formed therein and machined to receive the base portion **57** of the die block **58**. The base portion **57** of the die block is of transverse dove-tail formation, and is clamped to the arm **20** by means of the clamping lug **59** engaging the outer surface of the base portion **57** and secured to the arm **20** by means of the bolt **60**. It will be noted that the arm portion **55** is provided with the tapered surface **62** whereby the lug is prevented from radial movement, and consequently upon tightening of the bolt **60**, the lug will be drawn axially inwardly to fix the die block securely in position on the inner end portion **55** of the arm **20**.

The spider **18** intermediate the radial webs **36** is provided with transverse web portions **64** which have oval shaped openings **65** formed therein, these openings being formed intermediate each of the pairs of webs **36**.

Disposed on opposite sides of each of the inner extending portions **55** of the arms **20** are a pair of connecting links **68** which are pivotally secured to the arm portions **55** by means of the pin **69** extending transversely therethrough. These links are also pivotally connected to a pin **70** carried in the operating plunger **72** of the plunger assembly members indicated generally at **73**, and shown more in detail in Figure 5.

The plunger **72** is provided with flatted sides **74** which are engaged by the inner lateral surfaces to the links **68**, and the plunger itself is provided with a recessed opening **75** and adapted to receive the bearing block member **76** cooperating with a corresponding bearing block **77** carried by the outer peripheral surface of the arm portion **55** to take the reaction when the die arm is moved inwardly by axial inward extension of the plunger **72**. The plunger **72** is suitably guided within a cylinder **77** formed integral with an end cap member **78** having the flange portion **79** bolted to the surfaces of the manifold member **6** at spaced intervals about the periphery thereof. The manifold is provided with spaced boss portions **88** for receiving and supporting these assemblies in position and intermediate the bosses form manifold chambers **89**. The plunger assemblies **73** are retained in position and adjacent the inner end **80** of the cylinders, suitable oil grooves are provided for lubricating the plunger surfaces. The assembly is secured to the polygonal surface of the manifold by the bolts **82** extending thereinto through the flanges **79**.

On opposite sides of the openings in the manifold **6** through which the plunger assemblies **73** extend, there is provided ports **81**, shown in Figure 4, which communicate with a common port **83** disposed at the outer end of the cylinder **77**, through opposite lateral openings **84** formed in the head flange **78**. The manifold itself is filled with fluid which communicates through these ports with the outer end of the plunger **72**, so that upon successive pulsations in pressure in the manifold the plungers move inwardly to actuate the swaging dies. The plungers are restored to die open position by springs **42** and **53** upon release of the pressure surge in the manifold, as will be hereinafter described. The fluid is introduced into the manifold through suitable ports indicated at **90**.

In order to maintain the fluid used for the actuation of the plungers cool, so that it will retain its body and volume, we provide a series of cooling coils **85** disposed in the manifold **6** adjacent the rear plate **17**. This cooling means has inlet and outlet connections extending outwardly as indicated at **86** and **87**, respectively, leading to a source of coolant, such as water or the like. These connections preferably extend outwardly through the openings **65** in the web portion **64** of the spider **18**. In cases in which the swaging head moves along the beams **15**, suitable flexible connections may be provided to accommodate this movement.

Considering now in detail Figure 6, the two swaging heads for a double acting swaging operation are indicated generally at **120** and **122** having the rear spiders **123** and **124**, respectively, and provided with foot extensions **125** and **126** adapted to have sliding movement longitudinally along the extending rail members **127**. Supported below the rail members **127** by the member **130**, which may be bolted thereto as indicated at **132**, is a power cylinder **133** shown more or less diagrammatically, and provided with end closure members **134** and **135**. The power cylinder **133** is provided with two inlet ports **136** and with a central outlet port **137**. The cylinder is adapted to contain a pair of pistons **138** and **139** having outwardly extending connecting rods **140** and **142**, respectively, guided within the cap members **134** and **135**. Each of the swaging heads **120** and **122** is provided with downwardly extending bracket members **144** and **145**, respectively, which are adapted to receive the outer ends of the rods **140** and **142**, the rods being secured thereto by the nuts **146** and **147**.

The brackets **144** and **145** extend between the parallel rails **127** and move conjointly with the piston rods **140** and **142** to produce a corresponding movement of the swaging heads **120** and **122**.

Mounted substantially centrally of the assembly on the upper surface of the rails **127** is a supporting member **150** which may be bolted, as indicated at **152**, or otherwise secured to the top flanges of the rails, and which is adapted to support a journal member **153** having hinge portions **154** whereby it may be opened by release of the locking engagement indicated at **155** to permit the insertion and support of a tubular blank **156** therein. After the blank has been disposed in the clamp **153** and the clamp has been closed and locked as indicated at **155**, the blank **156** is free to rotate within the journal, but is held against endwise movement therein by the engagement of suitable tongue portions **158** in the slotted portions **159** at the center of the tube. The ends of the tubes are adapted to extend into the openings defined by the bushings **160** and **162** of the heads **120** and **122**, and to be guided for movement thereinto as the heads move toward the center of the blank. Suitable clamping means **165** is secured to the surface of the blank **156** adjacent the journal clamp **153**, and includes a ratchet **166** adapted to be engaged by a pawl **167** actuated by a piston working within the cylinder **168** supported in fixed position upon the block **169** bolted as at **170** to the top flanges of the rails. The cylinder **168** is provided with ports **172** and **173** at opposite ends thereof, which ports are connected to the pressure system shown

in Figure 1 as will be described in detail hereinafter.

In the operation of the mechanism shown in Figure 6, pressure is admitted through the ports 136 to the power cylinder 133 resulting in inward movement of the pistons 138 and 139 toward each other, thus producing corresponding relative movement of the swaging heads 120 and 122 toward each other to produce reduction of the extending portions of the blank 156, being fed into the interior of the swaging heads. When the pistons reach their inner point of movement, which can be determined by suitable stop means controlled by the foot extensions 125, the pressure in the outer ends of the cylinder 133 is released and pressure is applied through the port 137 to the space between the pistons. This results in separating movement of the pistons and consequent separating movement of the swaging heads 120 and 122, thereby withdrawing these heads from the ends of the blank 156 after which the rotating mechanism 165 is released from the blank and the journal clamp 153 is opened to allcw removal of the blank from the apparatus.

Referring now more particularly to the pressure connections for the swaging mechanism which are shown diagrammatically in Figure 1, there is provided a pump 180 mounted on a suitable base 182 forming a reservoir therefor, and provided with the outlet pressure line 183 extending through the ball check valve 184 to a gas accumulator indicated generally at 185.

The accumulator is provided with a pressure dome or head 186 within which is confined a gas suitable for maintaining positive pressure on the system. This gas, in a preferred embodiment of the invention, consists of nitrogen or similar gas which will not be absorbed by the fluid employed in the pressure system. A system by-pass line 187 is provided leading upwardly through the valve 188 to an air bleed line 189 which is also connected through the valve 190 with the reservoir 182 through the line 192. This provides for bleeding any accumulated air out of the pressure system to prevent air interlocks or the like, as is the usual practice in connection with pressure systems of the pulsating type.

From the accumulator the fluid under pressure is conducted through the line 193 to a control valve assembly 194, this assembly having an operating member 195 which may be reciprocated in any suitable manner to effect pulsations of pressure on the fluid, and which is operated at a relatively high rate of speed, such as 400 reciprocations per minute in one form of the invention. From the control valve 194 the fluid under pressure is led through the line 196 and the branch lines 197 and 198 to the ports 90 of the manifold 6 containing the pressure cylinders, diagrammatically shown at 73 in Figure 1. The cylinder plungers 72 are thereby reciprocated with each reciprocation of the control member 195. The control valve 194 is provided with an outlet connection 199 which leads back into the reservoir 182.

The ball check valve 184 prevents the pulsating pressure effect from being transmitted back to the pump pressure connection 183, and insures that the pulsations will be effective on the fluid in the manifold 6 and the line 196. Any fluid other than that required for the pulsation effect on the actuating cylinders is returned through the line 199 to the reservoir, and as air is bled out of the system the ball check valve 184 admits additional fluid through the pump into the accumulator and thence to the cylinders. If desired, separate accumulators may be employed for each actuating cylinder, and separate control valves may also be provided having means for producing conjoint actuation thereof. In order to effect proper actuation of the rotative mechanism 165—170, the cylinder 168 has its pressure connection 172 connected to the pressure line 196 so that upon a pulsation effect being produced in the line 196, the piston rod 176 is drawn downwardly within the cylinder to move the cam member 167 downwardly with respect to the ratchet 166. Upon the return of the control member to its upper position, the pressure in the valve 194 is transmitted through the exhaust line 199 to the sump 192, and a portion of this pressure is connected to the cylinder 168 through the connection 173 to produce upward movement of the piston 176 and consequent rotation of the ratchet 166 for rotating the housing 156 as the pistons 72 are moved to retracted position, thereby insuring that the housing will only be rotated during the interval in which the die members are out of engagement therewith.

It is therefore apparent that the tubular blank is rotated as it is fed through the swaging mechanism, thereby insuring a maintenance of its cylindrical form while it is being reduced in diameter and the arms are being thickened. We are aware that various changes may be made in details of certain of the mechanisms shown herein, and therefore do not intend to be limited except as defined by the scope and spirit of the appended claims.

We claim:

1. Swaging apparatus comprising supporting rails, a swaging manifold of generally cylindrical form supported on said rails and adapted to be filled with fluid under pressure, means for producing high frequency pressure pulsations in said fluid, a spider secured to the rear face of said manifold and supported on said rails, a plurality of radially disposed rocker arms pivotally carried by said spider, die members carried at the free ends of said rocker arms within the center of said manifold, said die members having concave tapered surfaces defining a frusto-conical opening receiving a tubular blank and terminating in arcuate portions defining a cylindrical opening of smaller diameter than the normal diameter of said blank, hydraulically operated means within said manifold having common connection to said fluid therein and having radially movable pistons extending in a common plane inwardly of the manifold for simultaneously actuating said rocker arms to reciprocate said die members radially inwardly and outwardly upon operation of said pressure pulsating means, and means operable in response to pressure pulsations in said manifold for rotating said blank relative to said die members between each successive inward movement of said rocker arms.

2. Swaging apparatus for reducing a tubular blank comprising a plurality of swaging dies arranged to define a cylindrical opening and mounted for reciprocatory movement toward and away from the center of said openings, spring means normally holding said dies in outer limiting position, a manifold adapted to contain fluid under pressure surrounding said dies, a plunger means in unvalved communication with the fluid in said manifold and connected to said dies, means for producing high frequency pulsations in said manifold sufficient to move said plungers against the pressure of said spring means for

forcing said dies against the lateral surface of said blank whereby said dies are reciprocated at high frequency to reduce the diameter of said blank, and means responsive to pressure pulsations in said manifold for effecting partial relative rotation between said blank and said dies during the period between alternate pressure engagement of said dies with said blank.

3. Swaging apparatus for reducing a tubular blank comprising a plurality of swaging dies arranged to define a cylindrical opening and mounted for reciprocatory movement toward and away from the center of said openings, spring means normally holding said dies in outer limiting position, a manifold adapted to contain fluid under pressure surrounding said dies, plunger means in unvalved communication with the fluid in said manifold and connected to said dies, means for producing high frequency pulsations in said manifold sufficient to move said plungers against the pressure of said spring means for forcing said dies against the lateral surface of said blank whereby said dies are reciprocated at high frequency to reduce the diameter of said blank, and means responsive to pressure pulsations in said manifold for partially rotating said blank between successive engagements of said dies with said blank.

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