Dec. 3, 1968 J. E. FOIST 3,413,880

METHOD AND APPARATUS FOR PRODUCING HOLES IN SIDEWALLS OF MEMBERS HAVING CHANNEL-LIKE CROSS SECTIONS

Filed March 4, 1965 2 Sheets-Sheet 1

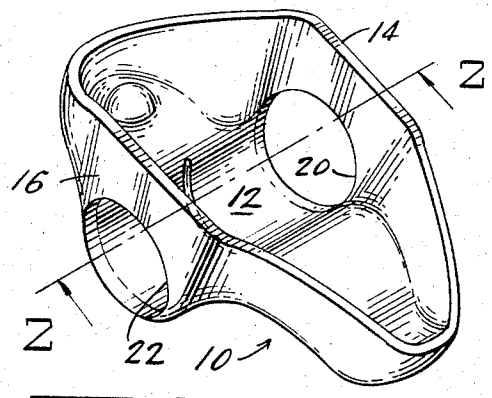


FIG-1-

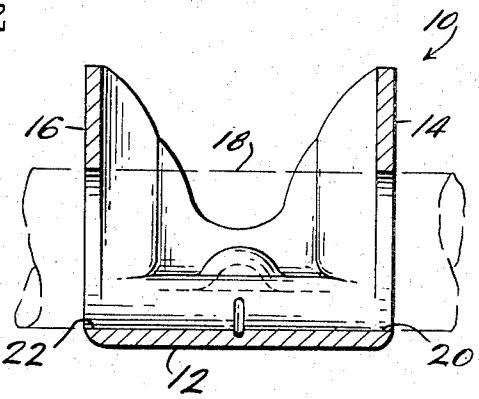


FIG-2-

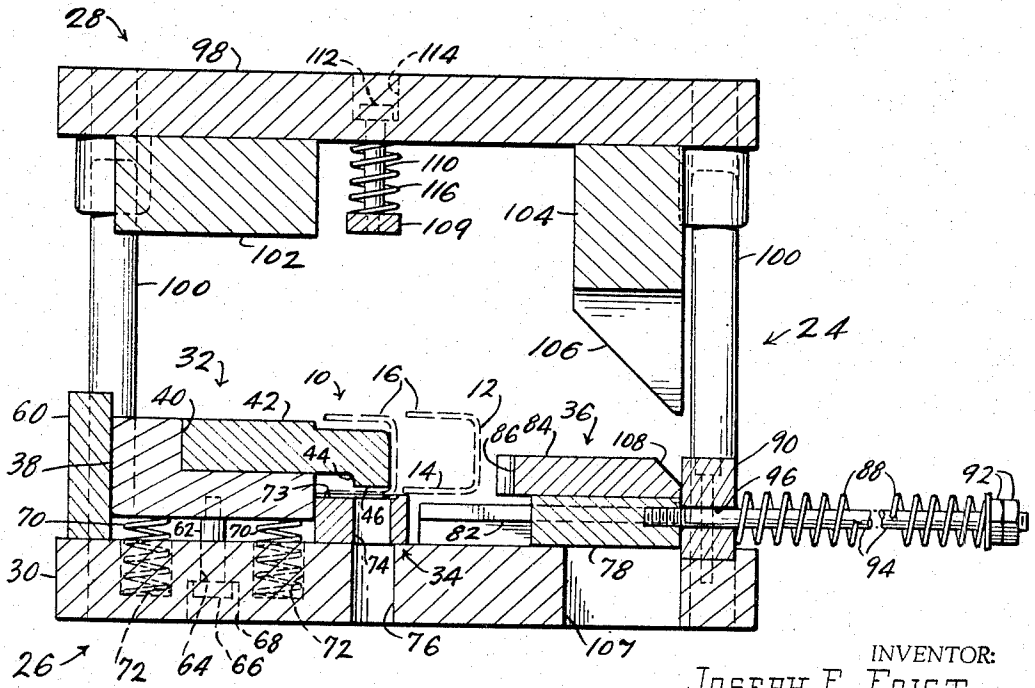


FIG-3-

INVENTOR:
JOSEPH E. FOIST.
BY
Owen & Owen
ATT'YS.

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Filed March 4, 1965 2 Sheets-Sheet 2

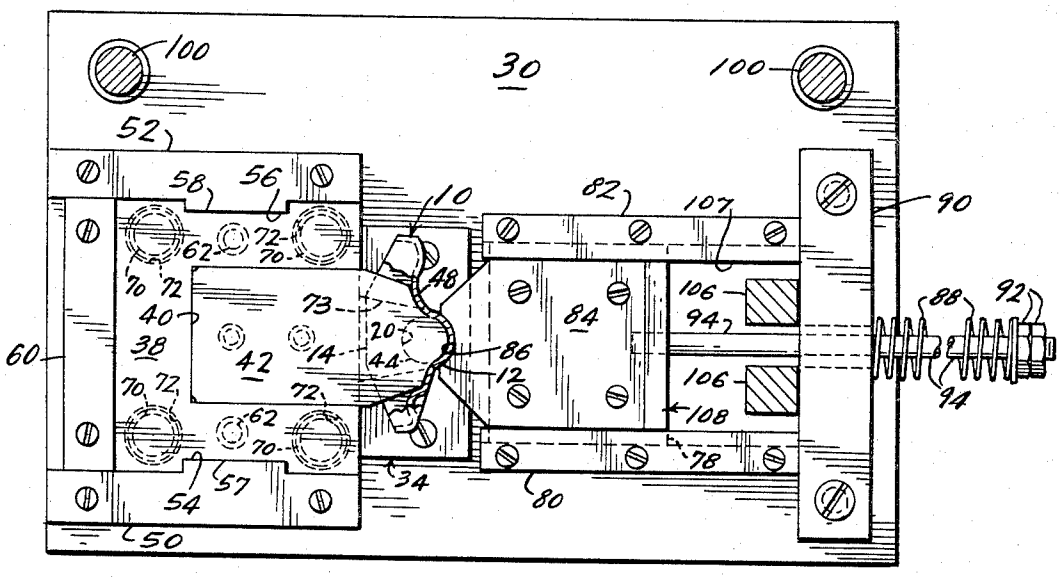


FIG-5-

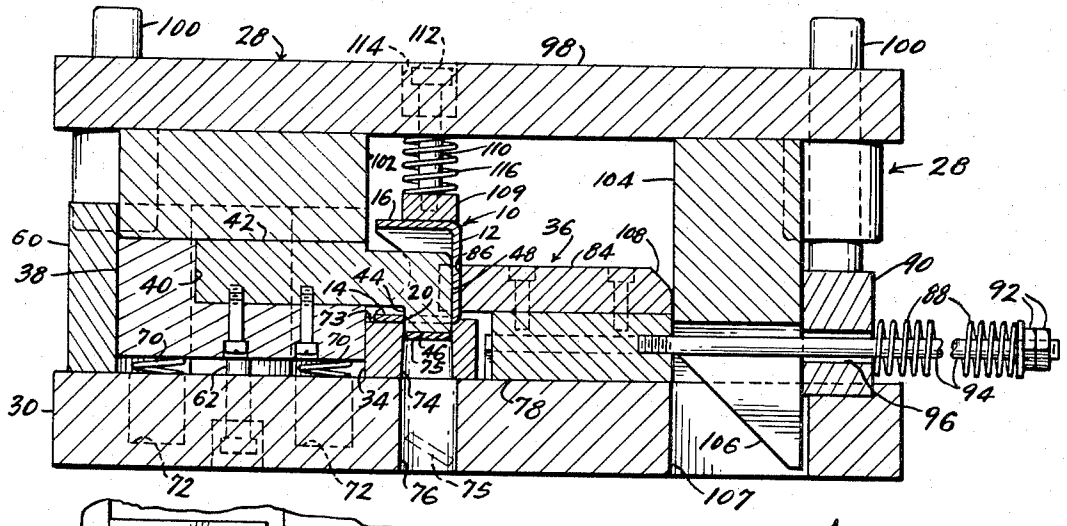


FIG-4-

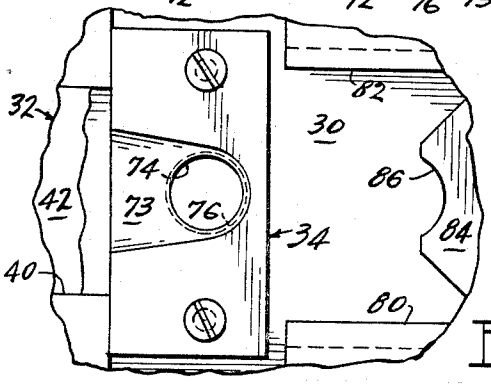


FIG-6-

INVENTOR:
JOSEPH E. FOIST.
BY
Owen & Owen
ATT'YS.

United States Patent Office 3,413,880
Patented Dec. 3, 1968

3,413,880

METHOD AND APPARATUS FOR PRODUCING HOLES IN SIDEWALLS OF MEMBERS HAVING CHANNEL-LIKE CROSS SECTIONS

Joesph E. Foist, Toledo, Ohio, assignor to Toledo Stamping & Manufacturing Company, Toledo, Ohio, a corporation of Ohio

Filed Mar. 4, 1965, Ser. No. 437,031
6 Claims. (Cl. 83—54)

This invention relates to a method and apparatus for producing openings in walls of workpieces or bodies adjacent surfaces extending transversely of the walls, and more particularly to a method and apparatus for piercing holes in sidewalls of rocker arms.

The instant invention primarily is directed to the piercing of holes in stamped rocker arms having generally channel-shaped transverse cross sections. Rocker arms of this type can be made without employing separate bushings which must subsequently be assembled with the rocker arms, resulting in extra operations and relatively high cost. The rocker arm of the type under consideration is discussed more fully in U.S. Patent Re. 24,941. When in operating position, the rocker arm is located with the open portion extending upwardly so that the rocker arm, in effect, forms a container for lubricating oil supplied through a hollow supporting shaft for the rocker arm. In this type of rocker arm, the openings in the sidewalls through which the supporting shaft extends must be close to or substantially tangential with the bottom or transverse wall of the rocker arm since a portion of this wall forms a bearing surface for the shaft. Heretofore, it had been necessary to form these holes by using a diagonally-disposed punch extending through the open portion of the rocker arm and toward the junction of the sidewall and bottom wall, as shown in more detail in U.S. Patent 2,917,033. The openings in the sidewalls of the rocker arms produced with this technique, however, were less than satisfactory in several respects. For one thing, the holes were not circular but tended to assume an oval shape so that the rocker arm would not fit closely with the supporting shaft. This resulted in excessive leakage of the oil held by the rocker arm, and also tended to cause excessive noise or clatter, particularly when an engine using the rocker arms was first started.

The present invention provides a novel method and apparatus for producing holes in walls of bodies closely adjacent or tangential to a transverse surface thereof. The invention is particularly useful for producing openings in rocker arms of the type discussed above, but need not necessarily be limited to such.

In accordance with the invention, a punch of a shape corresponding to the desired shape of the opening to be produced in the wall of the body is rigidly held at the end of a supporting arm which is affixed to a supporting and driving member effective to drive the punch through a fixed path parallel to the axis thereof. With this arrangement, the punch is capable of being inserted into the body or rocker arm and pierce the hole in the sidewall from the inside out. The outer surface of the sidewall of the body is backed up by a suitable back-up die having an opening to receive the punch, which opening is similar to that to be formed in the sidewall of the workpiece or body. Additionally, a supporting block having an end engageable with the outer surface of the transverse portion of the body or rocker arm is provided to prevent the body from moving away from the punch as the punch moves toward the sidewall and the back-up die. This is particularly important since a fillet is commonly formed between the transverse surface and the sidewall and this surface otherwise tends to cam or force the body away from the punch as the punch moves toward the sidewall and engages the fillet.

It is, therefore, a principal object of the invention to provide an improved method and apparatus for producing openings in the walls of bodies adjacent transverse surfaces thereof.

Another object of the invention is to provide an improved method and apparatus for producing supporting shaft openings in sidewalls of channel-like rocker arms, tangential to the bottom wall thereof.

Other objects and advantages of the invention will be apparent from the following detailed description of a preferred embodiment thereof, reference being made to the accompanying drawing, in which:

FIG. 1 is a view in perspective of a body or rocker arm having holes pierced therein in accordance with the invention;

FIG. 2 is a view in transverse cross section taken along the line 2—2 of FIG. 1, and further showing a rocker arm supporting shaft in dotted lines;

FIG. 3 is a view in vertical cross section of apparatus for producing openings in sidewalls of the rocker arm of FIGS. 1 and 2;

FIG. 4 is a view similar to FIG. 3 but with the die units closed and with a hole being pierced;

FIG. 5 is a plan view of the lower die unit, with the upper die unit removed; and

FIG. 6 is a fragmentary view of a portion of the lower die unit of FIG. 5 showing certain parts of the apparatus in a retracted position.

Referring more particularly to FIGS. 1 and 2, a body or rocker arm **10** is shown after holes are produced therein by means of the method and apparatus according to the invention. The rocker arm **10** includes a bottom wall or web **12** forming a transverse surface to sidewalls **14** and **16**. Part of the bottom wall **12** is arcuate in longitudinal cross section and has a radius substantially similar to that of a rocker arm supporting shaft **18**. The bottom wall **12**, being closely adjacent the shaft **18**, provides an effective bearing surface for the rocker arm which is pushed upwardly against the shaft **18** by the push rod and valve stem (not shown) with which it is engaged when assembled in an engine. The rocker arm **10** has openings **20** and **22** in the sidewalls thereof which are closely adjacent or tangential to the bottom wall **12** so that the lower edges of the openings substantially form continuations of the inner surface of the bottom wall **12** lying transversely to the sidewalls **14** and **16**. As such, these edges of the openings **20** and **22** constitute extended bearing surfaces for the rocker arm. The openings **20** and **22** are truly circular and fit closely with the rocker arm supporting shaft **18**. Hence, there is no problem of noise or chatter particularly when the engine is first started, and the close fit also enables the rocker arm to retain oil therein much more effectively than heretofore possible with rocker arms of this general type.

Referring more particularly to FIGS. 3–5, a die set indicated at **24** includes a lower die unit **26** and an upper die unit **28**. While the die set **24** is shown as having only one station, two stations can be used to advantage to form the openings in opposite sidewalls of two of the rocker arms at the same time.

The lower die unit **26** includes a supporting table or base **30** upon which are located a punch assembly **32**, a back-up die **34**, and a supporting block **36**. The punch assembly **32** includes a clamping block **38** having a recess **40** in which is received a shank **42** of a punch **44** having a horizontal cross-sectional shape equal to that of the opening **20** or **22**.

The punch **44** can be equipped with a replaceable hardened steel insert, if desired, as is known in the art. The punch **44** is moved in a direction perpendicular to

a face **46** thereof to engage the sidewall **14** and pierce the hole **20** therein. The punch shank **42** includes a contoured outer end **48** which fits with the inner surface of the bottom wall **12** and helps maintain the body **10** in position and retains the shape thereof during the piercing operation. The clamping block **38** moves in the described manner, being controlled by tracks or ways **50** and **52** (FIG. 5) having raised portions **54** and **56** cooperating with grooves **57** and **58** in the block **38**. The ways **50** and **52** are supported and spaced apart by a rear wall **60**.

The maximum downward movement of the punch **44** can be determined by the limits of downward movement of the upper die unit **28** or by contact of the clamping block **38** and the upper surface of the table **30**. The limit of upward movement of the punch **44**, on the other hand, is determined by bolts or stop pins **62** affixed to side portions of the block **38** and extending through passages **64** in the table **30**. Heads **66** of the bolts **62** are located in lower recesses **68** with the heads **66** abutting the upper ends of the recesses **68** to determine the upper limit of movement. The block **38** also has four springs **70** at the corners thereof, positioned in recesses **72** of the table **30**. The springs urge the punch **44** and the block **38** upwardly, moving the blocks in this manner until the bolt heads **66** contact the ends of the recesses **68** when the upper die unit **28** is raised.

The back-up die **34** has a shallow recess **73** which is contoured to receive a portion of the rocker arm **10**, as shown in FIG. 6. The recess **73** helps position the rocker arm **10** and also helps support the arm at the junction of the sidewall **14** and the bottom wall **12**. The die **34** also includes a passage **74** having a cross-sectional shape and size similar to those of the shaft opening **20** of the arm **10**. The passage **74** receives a slug **75** from the rocker arm opening **20** with the slug **75** being disposed of through a suitable opening **76** in the base **30**.

The assembly **36** includes a cam-operated slide **78** guided between ways **80** and **82** for reciprocable movement toward and away from the punch **44**. A supporting block **84** is mounted on the slide **78** and includes a contoured end portion **86** which engages and backs up an arcuate portion of the wall **12** during the piercing operation. The supporting block **84** is important to the operation in order to assure that the opening **20** in the sidewall **14** will be tangential to the inner surface of the wall **12**. Without the supporting block **84**, the edge of the punch **44** would engage the small fillet between the bottom wall **12** and the sidewall **14** immediately prior to piercing the sidewall and push the bottom wall of the rocker arm away from the punch. This would cause the hole to be pierced farther from the inner surface of the wall **12** than would otherwise occur with the supporting block **84**.

The slide **78** and the supporting block **84** are urged away from the punch **44** by a coil spring **88** maintained in compression between a spring bar **90** mounted on the table **30** and nuts **92** affixed to the end of a threaded rod **94** extending through a passage **96** in the bar **90** and threadedly engaged in an end of the slide **78**. When the slide **78** is not acted upon by other forces, it is maintained in a retracted position away from the die **34** by virtue of the spring **88**.

Referring now more particularly to the upper die unit **28**, a mounting plate **98** is supported parallelly to the base **30** and is driven in a vertical path by suitable means (not shown). The mounting plate **98** is guided by a pair of guide posts **100** affixed to the base **30** at one side of the die components. A drive block **102** is affixed to the mounting plate **98** near one end thereof and is positioned to engage the clamping plate **38** and the shank **42** when the plate is driven downwardly. The block **102** moves the punch **44** downwardly and causes it to pierce the hole **20**, as shown in FIG. 4. When the block **102** is raised, as shown in FIG. 3, the punch **44** is moved upwardly to a position in which the body **10** can be slipped off the punch.

The mounting plate **98** also carries a depending cam member **104** having a pair of cam fingers **106** positioned on opposite sides of the rod **94**. The fingers **106** extend into slots **107** in the base **30**.

When the plate and the fingers **106** move downwardly, they engage a slanted rear surface **108** of the back-up block **84** and force the block **84** and the slide **78** forwardly against the rocker arm **10**. The block **84** is then held locked in the forward position as the cam member **104** moves downwardly with the fingers **106** below the rearward end of the block **84**, as shown in FIG. 4. The cam member **104** is arranged to force the block **84** forwardly before the punch **44** begins the piercing operation to assure that the rocker arm **10** will remain in position and not be forced away from the punch as it engages the fillet.

The mounting plate **98** includes a third component, a hold down block **109** supported by a bolt **110**, a head **112** of which is located in a recess **114** on top of the mounting plate **98**. A spring **116** is located between the block **109** and the mounting plate **98** and urges the block downwardly. The hold down block **109** engages the upper sidewall **16** of the arm **10** as the mounting plate **98** moves downwardly before the other components come into contact to assure that the rocker arm **10** will be positioned properly on the die block **34** before the piercing operation begins.

While a preferred embodiment of the invention has been described in the preceding specification, it is to be understood that the invention is capable of numerous modifications without departing from the scope of the invention as defined in the accompanying claims.

I claim:

1. Apparatus for producing an opening in a sidewall of a rocker arm which has a U-shaped transverse cross section with the opening adapted to receive a rocker arm supporting shaft adjacent a bottom wall of the rocker arm, said bottom wall being arcuate in a direction longitudinally of the rocker arm and having a radius substantially equal to a radius of a substantial edge portion of said opening adjacent said bottom wall, with the centers of radius being superimposed, said apparatus comprising a supporting and driving member, a connecting arm extending outwardly from said supporting and driving member and held thereby, a punch having a circular cross-sectional shape of a size similar to the opening to be produced, said punch being functionally integral with the outer end of said connecting arm and movable with said connecting arm in a direction substantially perpendicular to a face of said punch and to the wall, the face of said punch also being substantially parallel to the longitudinal extent of said connecting arm, the total height of said connecting arm and said punch being less than the distance between the sidewalls of said rocker arm to enable said punch and said connecting arm to fit therein, a back-up die having an opening aligned with said punch for receiving same, said back-up die having a recessed surface facing said punch which is contoured to the shape of an edge portion of the sidewall of said rocker arm through which the opening is to be made, a supporting block having an end engageable with the bottom wall of said rocker arm to prevent said bottom wall from moving away from said punch when said punch is moved toward said back-up die, and means for moving said supporting block toward and away from the rocker arm.

2. Apparatus for producing an opening in a sidewall of a rocker arm which has a U-shaped cross section with the opening adapted to receive a rocker arm supporting shaft adjacent a bottom wall of the rocker arm, said bottom wall being arcuate in a direction longitudinally of the rocker arm with a substantial portion of the bottom wall and a substantial edge portion of said open-

ing having equal radii, with the centers of radius being superimposed, said apparatus comprising a supporting and driving member, a connecting arm extending outwardly from said supporting and driving member and held thereby, a punch having a cross-sectional shape similar to the opening to be produced, said punch being functionally integral with the outer end of said connecting arm and movable with said connecting arm in a direction substantially perpendicular to a face of said punch, the total height of said connecting arm and said punch being less than the distance between the sidewalls of said rocker arm to enable said punch and said connecting arm to fit therein, a back-up die having an opening aligned with said punch for receiving same, said back-up die having a surface facing said punch which is contoured to the shape of the sidewall of said rocker arm through which the opening is to be made, a supporting block engageable with the bottom wall of said rocker arm to prevent said bottom wall from moving away from said punch when said punch is moved toward said back-up die, and means for moving said supporting block toward and away from the rocker arm and for rigidly supporting said block against said wall.

3. Apparatus for producing an opening in a sidewall of a rocker arm which has a U-shaped cross section with the opening adapted to receive a rocker arm supporting shaft adjacent a bottom wall of the rocker arm, said bottom wall being arcuate in a direction longitudinally of the rocker arm and having a radius substantially equal to a radius of a substantial edge portion of said opening adjacent said bottom wall, with the centers of radius being superimposed, said apparatus comprising a supporting and driving member, a connecting arm extending outwardly from said supporting and driving member and held thereby, a punch having a circular cross-sectional shape of a size similar to the opening to be produced, said punch being functionally integral with the outer end of said connecting arm and movable with said connecting arm in a direction substantially perpendicular to a face of said punch and to the wall, the face of said punch also being substantially parallel to the longitudinal extent of said connecting arm, the total height of said connecting arm and said punch being less than the distance between the sidewall of said rocker arm to enable said punch and said connecting arm to fit therein closely adjacent the bottom wall, and a back-up die having an opening aligned with said punch for receiving same, said back-up die also having a recessed surface which is contoured to the shape of an arcuate edge portion of the sidewall of said rocker arm where said edge portion meets said bottom wall and through which the opening is to be made to aid in locating the rocker arm with respect to said punch.

4. A method for producing a substantially circular opening in a sidewall of a rocker arm with a substantial edge portion of said opening being substantially coextensive with an arcuate bottom wall thereof extending transversely of the sidewall, said method comprising supporting a punch within said rocker arm and substantially tangentially to the bottom wall of the rocker arm, backing up said sidewall around a portion through which said opening is to be produced, moving said punch toward and through said sidewall, and firmly supporting a substantial portion of said bottom wall of said rocker arm adjacent which the opening is made to prevent movement of said bottom wall away from said punch as said punch approaches said sidewall adjacent said bottom wall.

5. Apparatus for producing an opening in a sidewall of a rocker arm which has a generally U-shaped transverse cross section, with the opening adapted to receive a rocker arm supporting shaft adjacent a bottom wall of the rocker arm, said apparatus comprising a supporting member, an arm extending outwardly therefrom, a punch having a cross-sectional shape similar to that desired for said opening, said punch being functionally integral with the outer end of said arm and movable with said arm in a direction transversely of a face of said punch, the punch face being substantially parallel to the longitudinal extent of said arm, at least a substantial part of the outer end of said arm having the same contour as part of the inner surface of the bottom wall of the rocker arm, a back-up die having an opening aligned with said punch and having a surface facing said punch which supports a portion of the outer surface of the sidewall of the rocker arm while the opening is being made therein, supporting means engageable with the outer surface of the bottom wall of the rocker arm to prevent the bottom wall of the rocker arm from moving away from said punch when said punch is moved toward said back-up die, and means for moving said supporting means toward and away from the bottom wall of the rocker arm.

6. Apparatus for producing an opening in a sidewall of a rocker arm which has a generally U-shaped, transverse cross section, with the opening adapted to receive a rocker arm supporting shaft adjacent a bottom wall of the rocker arm, said bottom wall being arcuate in a direction longitudinal of the rocker arm and having a radius substantially equal to a radius of a substantial edge portion of said opening, with the centers of the radii being superimposed, said apparatus comprising a supporting and driving member, an arm extending outwardly from said supporting and driving member and held thereby, a punch having a cross-sectional shape similar to that desired for said opening, said punch being functionally integral with the outer end of said arm and movable with said arm in a direction substantially perpendicular to a face of said punch, the punch face being substantially parallel to the longitudinal extent of said arm, a back-up die having an opening aligned with said punch, said back-up die having a surface facing said punch which supports a portion of the outer surface of the sidewall of the rocker arm while the opening is being made therein, supporting means engageable with the outer surface of the bottom wall of the rocker arm to prevent the bottom wall of the rocker arm from moving away from said punch when said punch is moved toward said back-up die, and means for moving said supporting means toward and away from the rocker arm.

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ANDREW R. JUHASZ, *Primary Examiner.*