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(54) **ROLLER FINGER FOLLOWER**

ROLLENSCHLEPPHEBEL

POUSSOIR A GALET POURVU D'UN ROULEMENT

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(56) References cited:
EP-A- 0 849 436
EP-A- 0 907 008
DE-A- 19 710 867
US-A- 5 048 475
US-A- 5 535 641

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Description

[0001] This invention relates to a roller finger follower for use in an internal combustion engine.

[0002] Rocker arms and finger followers have been employed for internal combustion engines since around the time four stroke engines were invented. As technology of the engines increased, rollers began to appear in various points of movement of the followers. Until very recently, engines typically had ample room for roller finger followers of any desired dimension and configuration. The arms of the prior art roller finger followers tended to be wide, thick and long. In the contemporary environment of ever increasing pressure from governmental regulations and environmental organizations, internal combustion engine designers and manufacturers have been striving to reduce weight and size of engine components in an effort to reduce fuel consumption and emissions while concomitantly retaining or increasing horsepower and torque output of the engine. To at least some extent, these parameters are affected by the strength and accuracy of the rocker arm. In some cases, it is also necessary to reduce the size of the roller finger follower to fit into the available space in the engine. However, reducing the size and weight of many components leads to the problem of strength reduction. Particularly difficult to overcome has been the strength and tolerance problems associated with reducing the size of the roller finger follower.

[0003] It is known to those of ordinary skill in the art that stamping a narrow part out of sheet stock material is not feasible because of the width associated with folding the sheet about itself. Therefore in order to make such a part comply with width specifications, the stock would have to be so thin that the strength characteristics would be substandard by a large degree.

[0004] Those of skill in the art have generally turned to casting as an alternative to create roller finger followers which could fit the space limitations. While space limitations can be met by the casting process, the casting process suffers from the drawback of being markedly expensive. Moreover, casting suffers from the additional drawback of not reliably holding its accuracy from rod socket to pallet and requires secondary machining.

[0005] Despite great industry efforts, a solution better than casting has been elusive until the present invention was conceived.

[0006] Before describing the preferred example of the present invention, a brief consideration of a typical prior art stamped roller finger follower, shown in FIGURES 1 and 2 will help to better understand the importance of some of the example features of the present invention.

[0007] As can be seen from FIGURES 1 and 2, a typical prior art stamped roller finger follower 10 has a relatively large overall width W1 compared to wall material thickness t. Also, the front guide walls 12 at the end of the part which contacts the engine valve stem are formed by two layers of material joined in a tight bend. The lash adjuster socket 14 (at the end of the part removed from the legs 12) is an open spherical segment (not seen) facing the bottom of the part to receive the lash adjuster pivot, and the top side of the socket is a full spherical segment 16 located between the side walls 18. It is to be noted that the walls 18 are formed of one layer of material of thickness t, and the legs 12 are each formed of two layers of material of thickness t. Also the walls 18 must be spaced apart so as to accommodate the full dimension of spherical segment 16. All of this contributes to a wide part with flat guide walls that have relatively short flat surfaces for guidance on the valve for the typical prior art stamped roller finger follower. Also, to minimize the overall width W1, the width W2 of pallet space 19 available to receive the valve stem is only a wall material thickness t or slightly more. Accordingly, the minimum width W1 for this prior art configuration is at least five wall material thicknesses t, and the ratio W2:W1 is about 1:5. Since pallet space 19 must be wide enough to accept the tip of the valve stem, the relationship between W2 and W1 is that W2 cannot exceed more than about 20% of W1 in order to minimize W1.

[0008] Another prior art roller finger follower is disclosed in EP 0 573 674A1. That patent discloses a configuration in which the pallet 14 is welded between the legs 11b and 11c. As with the prior art of FIGURES 1 and 2, the legs defining the pallet area are each twice the thickness of the walls 11b, 11c, and the overall width is dictated by the pallet width. As shown in EP 0 573 674A1, the pallet width may be greater than 20% of the overall width of the part, but that is achieved only at the expense of enlarging the overall width to more than five wall material thicknesses. Note, also, that the pallet end of this part is the full width of the part, so this pallet end can only be accommodated in an engine space which is wide enough to accept the entire roller finger follower.

[0009] Still another prior art configuration is shown in U.S. Patent No. 5,535,641. In this patent, the pallet end 7 is narrower than the main body of the part. However, there are no retaining legs at the sides of the pallet area to prevent the rocker arm from disengaging from the valve stem, i.e., there is no dimension W2. Also, the design of this part requires that each side wall be spaced the distance D from the back side of the pivot recess 6, thus increasing the minimum width of the part by 2D.

[0010] The above discussed and other problems of the prior art are overcome or alleviated by the roller finger follower of the present invention, as defined in claim 1.

[0011] An advantage of the present invention is a new and improved roller finger follower having improved size and strength characteristics. While not limited thereto, the improved roller finger follower is particularly suitable for use in

engines where space considerations limit the size of the roller finger follower.

[0012] Known competitive stamped roller finger follower concepts are formed by either folding flat stock, relative to the orientation of the part in the engine,

1. Upward to form the side walls (standard channel configuration) or
2. Downward to form the side walls (reverse channel configuration)

Depending on the width and length requirements of the stamped finger follower, the above conventional methods for forming the part may result in a design with width constraints, low stiffness, and/or low strength.

[0013] The roller finger follower is produced by a process of stamping and cold extrusion, and a preferred embodiment has four important features.

[0014] The manufacturing process starts with flat stock material. A blank and a preform part are formed by a series of stamping steps. The preform has a pair of spaced apart sidewalls, each of thickness equal to the thickness of the original flat stock material. The stamped preform is then cold extruded to thicken the sidewalls and form retaining legs at the pallet end which is intended to receive the valve stem.

[0015] The first of the features of the example roller finger follower of this invention is an overall channel configuration, with the side walls being folded up and the roller pocket area being drawn down to have a high ratio of height-to-width at the location of the bores which house the roller shaft. This configuration allows greater design and process freedom in that a narrower overall part width requirement can be achieved without sacrificing strength or stiffness. Also, the ratio of height to width in the vicinity of the shaft bores is greater than the prior art.

[0016] The second feature of the example roller finger follower of this invention is the solid and thin legs which are formed by cold extrusion and which extend down from the vertical side walls at the front (pallet) end of the channel structure where the roller finger follower contacts the tip of the engine valve. The legs provide structure to prevent disengagement between the valve stem and the roller finger follower. This contrasts markedly with the prior art stamped roller finger followers where these front guide walls are formed by two layers of material formed in a tight bend. A preferred channel stamped roller finger follower could have an overall width of about three (3) times the side wall material thickness in the pallet area, whereas prior art standard and reverse channel configurations would require approximately five (5) times the side wall material thickness for a minimum width. Some prior art cast roller finger followers may have solid front legs, but these cast parts are much more expensive to produce. Because the depending legs are thin, the width W2 available to receive a valve stem can approach the overall width W1 in the pallet area of the part (see FIGURE 6). The narrow valve end of this roller finger follower minimizes effective valve end reciprocating mass, in turn minimizing system loads and friction.

[0017] The third feature of the example roller finger follower of this invention is the use of a truncated spherical hydraulic lash adjuster socket. The socket is truncated on the nonfunctional side, i.e., the side removed from the side contacting the pivot of the hydraulic lash adjuster, while the side contacting the pivot of the hydraulic lash adjuster retains its sphericity. Part of the nonfunctional surface of the socket is merged by cold extrusion into the side walls. This strengthens the side walls and contributes to the narrow width of the part.

[0018] The fourth feature of the example roller finger follower of this invention is the use of noncircular shaft bores for the roller shaft. This locks and retains the roller shaft in the part during the joining process.

[0019] The present invention will now be described by way of example with reference to the following drawings in which:

FIGURE 1 is a perspective view of a typical prior art roller finger follower;
FIGURE 2 is a front view of the prior art roller finger follower of FIGURE 1;
FIGURE 3 is an exploded perspective view of an example roller finger follower of the present invention;
FIGURE 4 is a top plan view of an example roller finger follower of the present invention;
FIGURE 5 is a side elevation view of the roller finger follower of FIGURE 4;
FIGURES 6 and 7 are, respectively, a front elevation and a rear elevation of the roller finger follower of FIGURE 5;
FIGURE 8 is a bottom plan view of the roller finger follower of FIGURE 4;
FIGURE 9 is a section elevation view along line 9-9 of FIGURE 4;
FIGURES 10a - 10c illustrate a comparison between the example manufacturing process of the present invention (FIGURE 10a) and the prior art (FIGURES 10b and 10c); and
FIGURES 11a - 11c show examples of noncircular configurations for the roller shaft and bore.

[0020] Referring now to a combined consideration of FIGURES 3-9, the improved stamped roller finger follower 20 is shown. Roller finger follower 20 has side walls 22 separated by an interrupted web 24 to form, in effect, a channel. Web 24 has a stamped opening 26 formed therein to provide an operating space or pocket for a roller assembly 28 which is mounted on a shaft 30 housed in pierced or pierced and shaved bores 32 in side walls 22.

[0021] Roller finger follower 20 is characterized by a high H/W ratio (see FIGURES 4, 5 and 6). This high height to width ratio allows for taller vertical walls 22 in the vicinity of the shaft bores than in the prior art, which improves the stiffness and strength of the part, while still meeting a narrow package width requirement.

[0022] A second important feature is the configuration of the pallet end of the part which contacts the tip of the engine valve stem. This part is defined by a pair of spaced apart solid legs 34 which form guide walls defining a pocket 36 to receive the tip of the valve stem. Solid legs 34 extend downwardly from their respective side walls 22, and the legs are formed in the manufacturing process by folding the flat stock upward to form the side walls and then cold extruding material downward to form the solid legs 34. It is to be noted that the legs 34 are considerably thinner than the material thickness t1 of the walls 22 from which the legs depend.

[0023] Referring particularly to FIGURE 6, in accordance with an example of the present invention, the overall width W1 of the part at the pallet end (i.e., the right end in FIGURES 3, 4, 5, 8 and 9) is in the range of about 2.5t1 to about 4.0tl, where t1 is the material thickness of a wall 22. Furthermore, the minimum dimension (i.e., W1 being about 2.5t1) is limited only by the size of the valve stem that must be received in pocket 36, and by manufacturing considerations, one of which is that the punch forming the upper space between walls 22 at the pallet end be about 0.5t1. Therefore, the following relationships exist:

$$W1(min) \geq 2.5t1 \quad (1)$$

$$W2(min) \geq 0.7t1 \quad (2)$$

Relationship (2) results from the manufacturing consideration that the punch forming pocket 36 must extend at least 0.1t1 on each side beyond the upper space between walls 22 to prevent shearing of material during manufacture. Therefore, when W1 is at the minimum of 2.5t1, and W2 is also at its minimum of 0.7t1, the following relationship also exists for the width t2(max) of each extruded leg 34

$$t_{2(max)} = \frac{W_{1(min)} - W_{2(min)}}{2} = \frac{2.5\,t_1 - 0.7\,t_1}{2} = 0.9\,t_1 \quad (3)$$

Relationship (3) states the maximum value for t2. Also in accordance with an example of the present invention the minimum value for t2 is 0.2t1, which leads to the following relationship when W1 = 2.5 t1:

$$W2(max) = 2.1t1 \quad (4)$$

and also

$$t2 \text{ ranges from about } 0.2t1 \text{ to about } 0.9t1 \quad (5)$$

That is, when W1 is at its minimum of about 2.5t1, the largest W2 for pocket 36 is about 2.1t1. Thus, as distinguished from the prior art where the ratio W2:W1 is about 1:5, in an example of the present invention even for the smallest W1, the ratio W2:W1 can be as high as

$$W_2 : W_1 = \frac{2.1\ t1}{2.5\ t1} = 0.84 \quad (6)$$

Accordingly, with an example of the present invention the ratio W2:W1 can approach 1 while still providing the valve stem retaining structure of the depending walls 34.

[0024] From the foregoing it can also be seen that for a part where W1 = 4t1, W2(max) can be 3.6t1 and W2(min) can be 2.2t1. Thus, for a maximum W1 of 4t1, the ratio W2:W1 is

$$\frac{W_2}{W_1} = \frac{3{,}6\ t_1}{4.0\ t_1} = 0.9 \tag{7}$$

and the following relationship also exists for t2(max)

$$t_{2(\max)} = \frac{4\ t_1 - 2.2\ t_1}{2} = 0.9\ t_1 \tag{8}$$

That is, for the maximum W1, the ratio W2:W1 also approaches 1, and the ratio W2:W1 is almost the same regardless of whether W1 is the minimum of about 2.5t1 or the maximum of about 4.0t1.

[0025] Referring particularly to FIGURES 3, 5, 8 and 9, details of the socket for receiving the hydraulic lash adjuster are shown. This socket includes a spherical (i.e., a portion of a sphere) recess 38 on the bottom side to receive the top of the hydraulic lash adjuster. However, the top or nonfunctional side 40 of the socket is not a full spherical segment. Rather, the nonfunctional side 40 is truncated along the inner portions of side walls 22. This truncation is effected by drawing material from the nonfunctional side 40 of the socket up into side walls 22 during the manufacturing process; and this is accomplished without reducing the size or shape of the spherical portion 38 which receives the hydraulic lash adjuster. The use of the truncated spherical portion 40 results in reducing the width W of the roller finger follower. This is in distinction from the prior art where the minimum possible width of prior art roller finger followers is determined by the required socket diameter and depth.

[0026] Referring now to FIGURES 11a - 11c, the shaft bore in the side walls 22 may be noncircular. By way of example, the bore may be octagonal as in FIGURE 11a, oval as in FIGURE 11b or splined as in FIGURE 11c. These noncircular bore shapes are pierced and/or shaved into the side walls 22 as part of the forming process to aid in retention of the roller shaft 30. The ends of the roller shaft are relatively soft, and when these soft ends are staked or riveted in the bores, they are deformed to correspond to the shape of the bore, thereby locking the ends of the roller shaft into the shaft bores.

[0027] In operation of the stamped roller finger follower, a cam, not shown, bears against roller 28 to transmit the lift of the cam to the engine valve stem. The lift of the cam is multiplied by the rocker arm ratio of the roller finger follower. That ratio is the ratio of instantaneous valve lift to instantaneous cam lift, and this ratio varies throughout one rotation of the cam and is dependent on the geometry of the roller finger follower and how it is oriented in the valve train.

[0028] The roller finger follower 20 pivots about a spherical head of a hydraulic lash adjuster (HLA) or stud. The spherical head mates in spherical socket 38 in the roller finger follower 20. The roller finger follower contacts the cam with a roller bearing assembly 28, supported on a roller shaft 30. The roller shaft is housed in and supported by the roller shaft bore 32 in the roller finger follower. The valve pallet (defined by legs 34 and pocket 36) of the roller finger follower contacts the valve tip of the valve stem of an engine valve.

[0029] The shape of the vertical side walls 22 and the roller pocket 26 are formed from a flat piece of stock material by a process of forming a blank and a preform part from a coil of stock material by a series of stamping steps. The stock material is then folded upward in a further stamping step, and the material is then cold drawn downward in the roller pocket area to enlarge the side walls 22 around the openings 32 to prevent weakening of the side walls in the vicinity of the openings 32. Roller pocket 26 is subsequently formed by punching, and bores 32 are formed by piercing or piercing and then shaving. This manufacturing process allows greater design and process freedom than the standard channel or standard reverse channel configurations of the prior art where the wall height below or above the roller shaft bores is limited based on the allowable follower width, which can decrease the strength and/or stiffness or require a wider package width than the example of the present invention.

[0030] FIGURES 10a - 10c illustrate a comparison of the example manufacturing process for the present invention as compared to the prior art. Each of FIGURES 10a, b and c shows a starting piece of flat stock material for forming a stamped roller finger follower. FIGURE 10a depicts the starting configuration and various parameters for the example roller finger follower of the present invention; FIGURE 10b depicts the starting configuration and various parameters for a standard channel prior art stamped roller finger follower; FIGURE 10c depicts the starting configuration and various parameters for a reverse standard channel prior art stamped roller finger follower. Referring to FIGURE 10a

A = Roller Pocket Width

B = Distance from bottom of shaft bore to fold line; determined by relative location of shaft bore to socket center

E = overall width before folding, which defines the location of the top of the vertical walls, can be maximized to maximize stiffness. The limiting factor is interference with the cam lobe or something else in the cylinder head. It is typically not constant for the length of the part, but is shown constant here for simplicity.

F = general area that is drawn down after folding to create required distance for putting in the shaft bores and to

support the load. While being extruded down, material from above is forced in so that the wall thickness is not thinned out excessively. This allows for the roller pocket width to be quite narrow, while still having sufficient material below the shaft bores to support the load.

[0031] Referring next to FIGURE 10b for comparison,

A = Roller Pocket Width
B = Distance from bottom of shaft bore to fold line; determined by relative location of shaft bore to socket center
G = Shape to be punched out for roller pocket before folding
C = Minimum width that can be punched out (i.e., minimum allowable punch thickness)
D = Distance below shaft bore to house shaft bore and support load

$$D = \tfrac{1}{2}(A - C) + B \qquad \text{(Eqn. 1)}$$

As can be seen from Eqn. 1 above, the value for D is limited by A, B and C. As A and B become smaller, for narrower followers with shorter vertical distances between the shaft bore and the socket center, the value D becomes smaller until it is not large enough to support the load. Therefore, for certain values of A and B, the Standard Channel will not be strong enough due to small values for D, while the example of the present invention will be.

[0032] Referring next to FIGURE 10c for comparison,

A = Roller Pocket Width
J = overall width before folding, which defines the location of the bottom of the vertical walls, can be maximized to maximize stiffness. The limiting factor is interference with the HLA, valve, spring cap or something else in the cylinder head.
K = distance from top of shaft bore to fold line on far side of material; determined by relative location of shaft bore to socket center.
T = Material thickness

Despite the fact that the widths J (for the Reverse Standard Channel) or E (for the example of the present invention) are typically not constant, the comparison of the height to width ratios of the Reverse Standard Channel and the example of the present invention can be represented as shown below:

Reverse Standard Channel-Prior Art	Present Invention Example
½(J-(A+2T))/(A+2T) typically <	½(E-(A+2T))/(A+2T) (Eqn.2)

because J is typically less than E. This is because, in general, there is more open space in the upward direction (toward the cam) than in the downward direction (toward the HLA and valve). This result indicates that the example of the present invention will be stiffer.

Claims

1. A roller finger follower including:

a stamped and cold extruded length of metal (20) having a general channel shape in cross section with first and second spaced apart side walls (22) joined by a web section (24);
each of said side walls being of thickness t1;
a pair of depending legs (34), one each of said legs extending downward from each of said side walls adjacent a first end of said side walls, each of said depending legs being of a thickness t2 less than the thickness t1 of the side wall from which it depends;
a pallet section (36) at said first end of said side walls between said depending legs, said pallet section being adapted to receive an engine valve stem;
a recessed socket (38) in said web section adjacent a second end of said side walls for receiving the end of a rod;
said roller finger follower having a narrow section at the end including said pallet section and a wider main

body section, the width of said narrow section being in the range of about 2.5t1 to 4.0t1; and
the width of said pallet section between said depending legs being in the range of about 0.7t1 to about 3.6t1.

2. A roller finger follower as in claim 1 wherein:

the width t2 of each of said depending legs is about 0.2 to 0.90 the width t1 of each of said side walls.

3. A roller finger follower as in claim 1 wherein:

said recessed socket has a functional spherical segment (38) at the bottom side open to receive the end of a rod; and
a nonfunctional top side (40) positioned between said side walls, said back side being truncated by cold extrusion to less than a spherical segment between said side walls.

4. A roller finger follower as in claim 1 including:

opposed bores (32) in each of said side walls for receiving a roller mounting shaft, the ratio of the height H of said side walls to the width W of the roller finger follower is maximized for high stiffness in a narrow package by folding the sidewalls up and then drawing down in the roller pocket area.

5. A roller finger follower as in claim 4 wherein:

each of said bores is formed by piercing, and the shape of each of said bores is non-circular.

6. A roller finger follower as in claim 4 wherein:

each of said bores is formed by piercing and shaving, and the shape of each of said bores is noncircular.

Patentansprüche

1. Rollenschlepphebel, mit:

einem gestanzten und kalt stranggepressten länglichen Metallteil (20), das einen allgemein kanalförmigen Querschnitt aufweist und erste und zweite beabstandete Seitenwände (22) umfasst, die durch einen Stegabschnitt (24) miteinander verbunden sind;
wobei jede der Seitenwände eine Dicke (t1) aufweist;
einem Paar von abhängigen Beinen (34), wobei sich jeweils eines der Beine von jeder der Seitenwände benachbart eines ersten Endes der Seitenwände abwärts erstreckt, wobei jedes der abhängigen Beine eine Dicke (t2) aufweist, die kleiner als die Dicke (t1) der Seitenwand ist, von der sie abhängt;
einem Trägerabschnitt (36) an dem ersten Ende der Seitenwände zwischen den abhängigen Beinen, wobei der Trägerabschnitt derart ausgebildet ist, dass er eine Motorventilschaft aufnehmen kann;
einem ausgenommenen Sockel (38) in dem Stegabschnitt benachbart eines zweiten Endes der Seitenwände zur Aufnahme des Endes einer Stange;
wobei der Rollenschlepphebel einen schmalen Abschnitt an dem Ende, das den Trägerabschnitt umfasst, und einen breiteren Hauptkörperabschnitt umfasst, wobei die Breite des schmalen Abschnittes im Bereich von etwa 2,5 t1 bis 4,0 t1 liegt; und
wobei die Breite des Trägerabschnittes zwischen den abhängigen Beinen im Bereich von etwa 0,7 t1 bis etwa 3,6 t1 liegt.

2. Rollenschlepphebel nach Anspruch 1, wobei die Breite (t2) von jedem der abhängigen Beine das etwa 0,2- bis etwa 0,90-fache der Breite (t1) von jeder der Seitenwände beträgt.

3. Rollenschlepphebel nach Anspruch 1, wobei der ausgenommene Sockel ein funktionelles kugelförmiges Segment (38) an der unteren Seite aufweist, das zur Aufnahme des Endes einer Stange offen ist; und
eine nicht funktionelle obere Seite (40) zwischen den Seitenwänden positioniert ist, wobei die Rückseite durch Kaltstrangpressen auf weniger als ein kugelförmiges Segment zwischen den Seitenwänden abgestumpft ist.

4. Rollenschlepphebel nach Anspruch 1, mit gegenüberliegenden Bohrungen (32) in jeder der Seitenwände zur Aufnahme einer Rollenbefestigungswelle, wobei das Verhältnis der Höhe (H) der Seitenwände zu der Breite (W) des Rollenschlepphebels aus Gründen einer hohen Steifigkeit in einem schmalen Paket maximiert ist, indem die Seitenwände aufwärts gefaltet und dann in den Rollentaschenbereich heruntergezogen sind.

5. Rollenschlepphebel nach Anspruch 4, wobei jede der Bohrungen durch Stanzen ausgebildet ist und die Form von jeder der Bohrungen nicht kreisförmig ist.

6. Rollenschlepphebel nach Anspruch 4, wobei jede der Bohrungen durch Stanzen und Nachschneiden bzw. Hobeln ausgebildet ist, und die Form von jeder der Bohrungen nicht kreisförmig ist.

Revendications

1. Poussoir à galet de roulement, comportant :

une longueur de métal emboutie et extrudée à froid (20) ayant une forme générale de canal en coupe transversale, des première et seconde parois latérales espacées (22) étant réunies par un tronçon de toile(24), chacune desdites parois latérales étant d'une épaisseur t1,
une paire de pattes suspendues (34), chacune desdites pattes s'étendant vers le bas à partir de chacune desdites parois latérales en un endroit adjacent à une première extrémité desdites parois latérales, chacune desdites pattes suspendues étant d'une épaisseur t2 inférieure à l'épaisseur t1 de la paroi latérale à partir de laquelle elle est suspendue,
un tronçon de palette (36) au niveau de ladite première extrémité desdites parois latérales entre lesdites pattes suspendues, ledit tronçon de palette étant adapté pour recevoir une tige de soupape de moteur,
une douille évidée (38) dans ledit tronçon de toile en un endroit adjacent à une seconde extrémité desdites parois latérales pour recevoir l'extrémité d'une tige,
ledit poussoir à galet de roulement ayant un tronçon étroit au niveau de l'extrémité incluant ledit tronçon de palette, et un tronçon de corps principal plus large, la largeur dudit tronçon étroit étant dans la plage d'environ 2,5 t1 à 4 t1, et
la largeur dudit tronçon de palette entre lesdites pattes suspendues étant dans la plage d'environ 0,7 t1 à 3,6 t1.

2. Poussoir à galet selon la revendication 1, dans lequel la largeur t2 de chacune desdites pattes suspendues est d'environ 0,2 à 0,90 de la largeur t1 de chacune desdites parois latérales.

3. Poussoir à galet selon la revendication 1, dans lequel ladite douille évidée présente un segment sphérique fonctionnel (38) au niveau du côté inférieur ouvert pour recevoir l'extrémité d'une tige, et
un côté supérieur non-fonctionnel (40) positionné entre lesdites parois latérales, ledit côté arrière étant tronqué par extrusion à froid jusqu'à moins qu'un segment sphérique entre lesdites parois latérales.

4. Poussoir à galet selon la revendication 1, comportant des alésages opposés (32) dans chacune desdites parois latérales, destinés à recevoir un arbre de montage de galet, le rapport de la hauteur H desdites parois latérales sur la largeur W du poussoir à galet étant rendu maximal pour une rigidité élevée dans un ensemble étroit en pliant les parois latérales vers le haut et en les étirant ensuite vers le bas dans la zone de poche de galet.

5. Poussoir à galet selon la revendication 4, dans lequel chacun desdits alésages est formé par perçage, et la forme de chacun desdits alésages est non-circulaire.

6. Poussoir à galet selon la revendication 4, dans lequel chacun desdits alésages est formé par perçage et arasage, et la forme de chacun desdits alésages est non-circulaire.

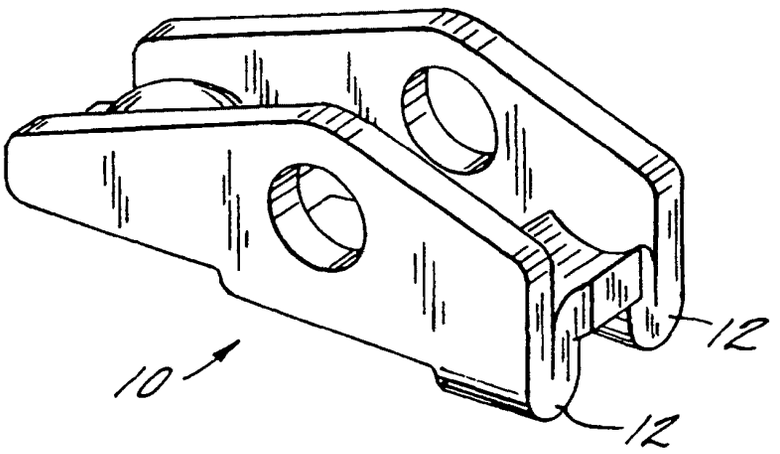

FIG. 1
(PRIOR ART)

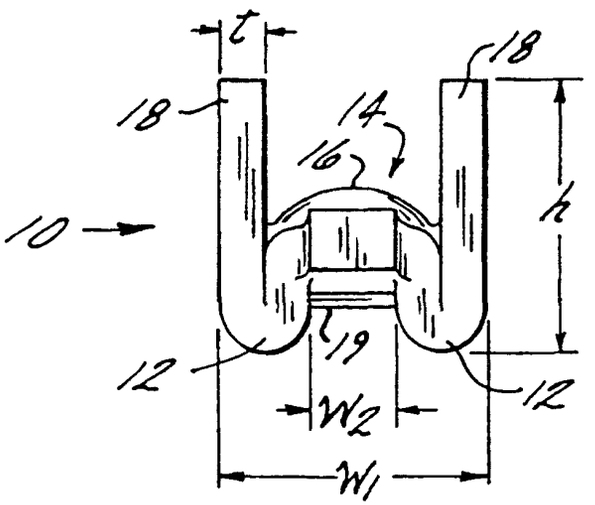

FIG. 2
(PRIOR ART)

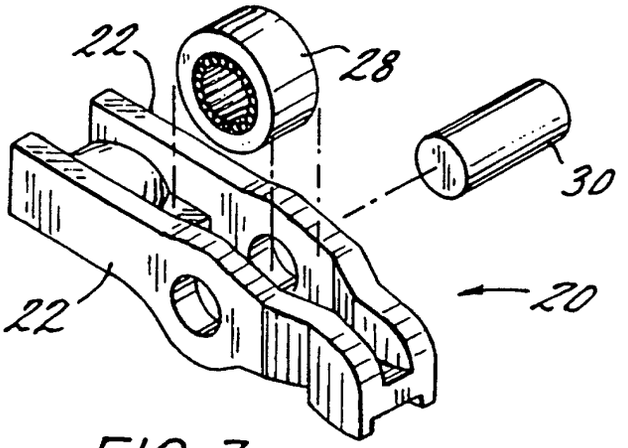

FIG. 3

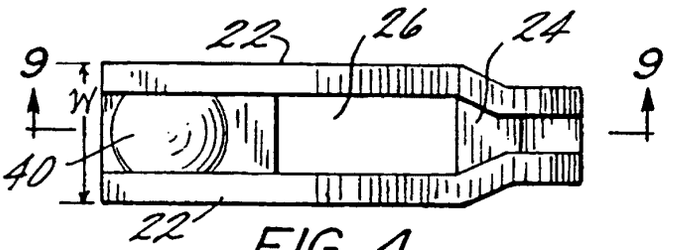

FIG. 4

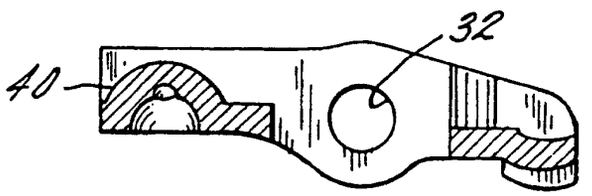

FIG. 9

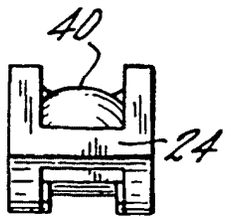

FIG. 7

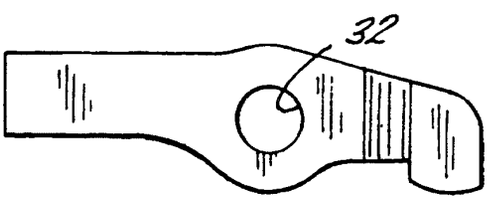

FIG. 5

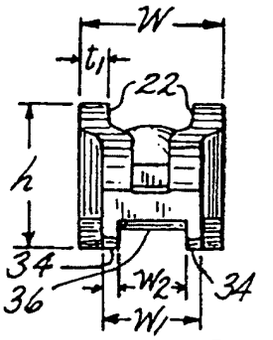

FIG. 6

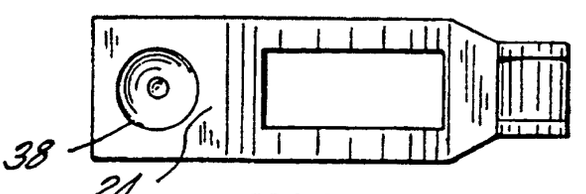

FIG. 8

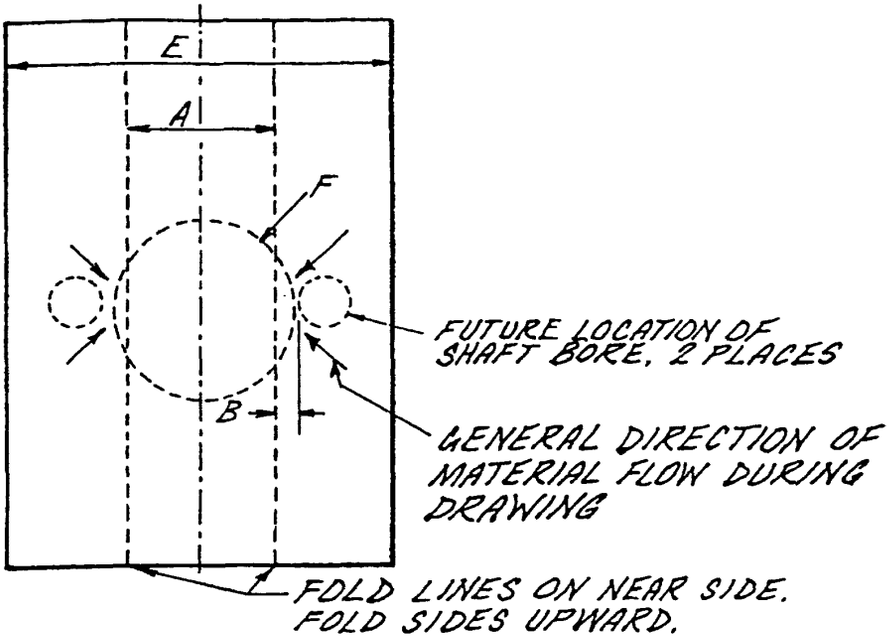

FIG. 10a

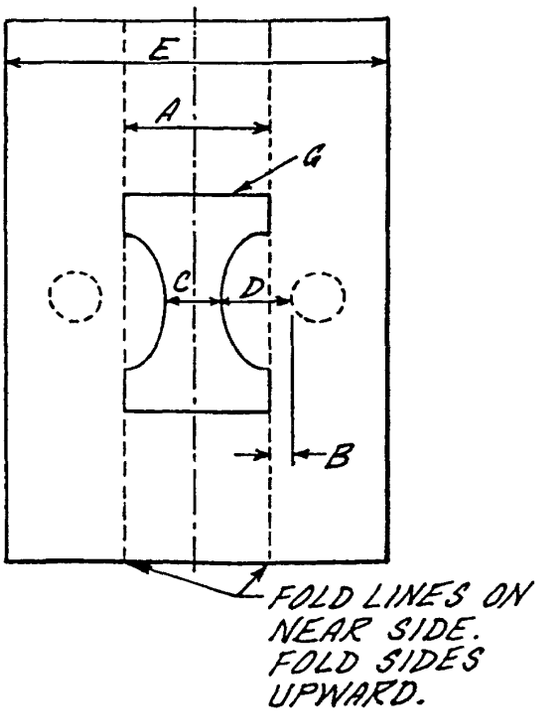

FIG. 10b
(PRIOR ART)

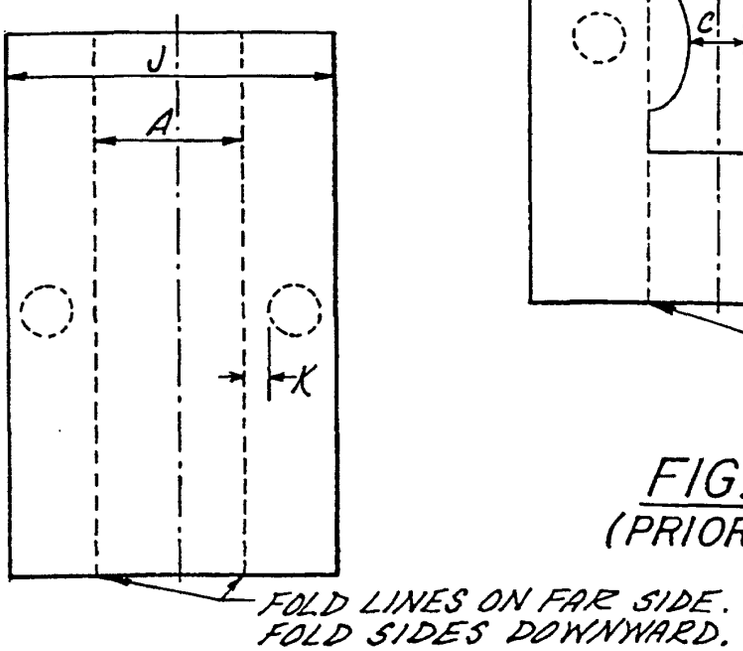

FIG. 10c
(PRIOR ART)

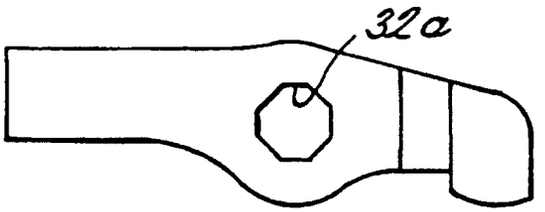

FIG. 11a

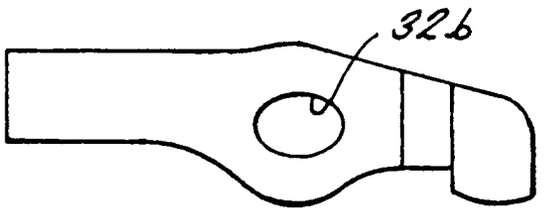

FIG. 11b

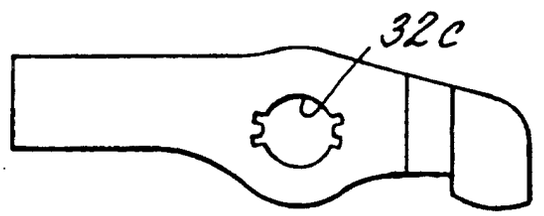

FIG. 11c