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P. RIETHMÜLLER ET AL
PROCESS FOR MANUFACTURING SHELLS FOR SPARK
PLUGS AND THE LIKE
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2,874,460

FIG. 1

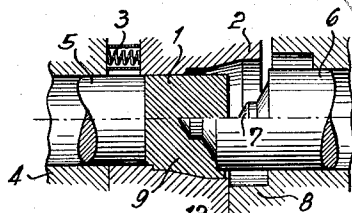


FIG. 2

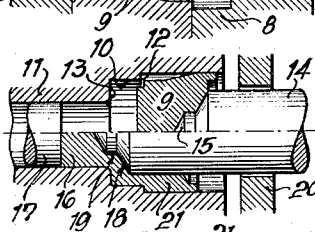


FIG. 3

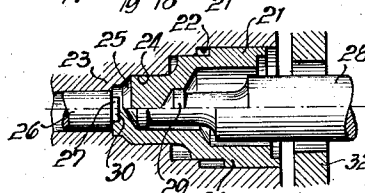


FIG. 4

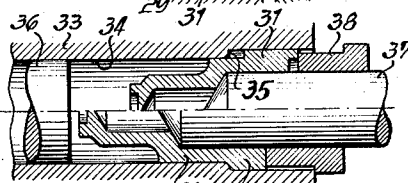


FIG. 5

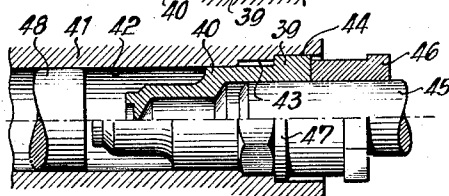


FIG. 6

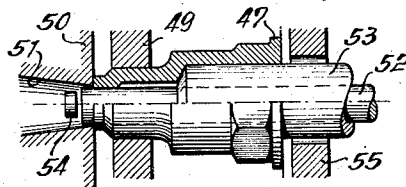
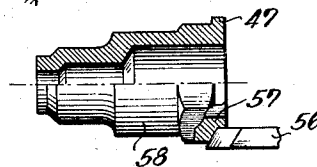


FIG. 7



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PROCESS FOR MANUFACTURING SHELLS FOR SPARK PLUGS AND THE LIKE

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6 Claims. (Cl. 29—535)

The present invention relates to a process for manufacturing metallic housings, such as shells for spark plugs and the like.

It is conventional to form housings of the above type in die presses from a blank in a series of steps during which the blank progresses from its original shape to the final shape of the housing. When working with metal the material of the blank is required to flow in a given direction, and very often the material of the same part of the blank is required to flow in one direction during one step of the process and in another direction in another step of the process. As a result the material is subject to such great stress, according to conventional processes, that it is impossible to carry out these conventional processes without interrupting the working of the blank in order to anneal the same after one or two steps of the process.

It is an object of the present invention to overcome the above drawbacks by shaping a blank into a shell of desired configuration according to a process which does not require any annealing between the several steps of the process of the invention which are used to form a blank of special configuration into the final desired shape.

Another object of the present invention is to provide a process according to which a section of cylindrical bar stock, for example, may be shaped into a shell of desired configuration with only one interruption for annealing required when the original bar stock is formed into a blank of predetermined configuration.

Still another object of the present invention is to provide a process of the above type according to which a minimum amount of the material of the work piece is constrained to flow in more than one direction and in a manner which requires no annealing.

Also, it is an object of the present invention to provide a process according to which some steps are performed simultaneously so that the time and equipment required to perform the process of the invention are reduced to a minimum.

A still further object of the present invention is to provide in a process of the above type a step for accurately forming a hole of a desired size in the wall of the shell.

With the above objects in view, the present invention mainly consists of a process for manufacturing a spark plug shell or the like, this process including the steps of die pressing a substantially cup-shaped blank into a configuration having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than the intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than the intermediate portion on the other side of the latter. A ramming member is then axially advanced through the head and intermediate portions into the solid foot portion, while constraining the material of this foot portion to flow rearwardly along the ramming member to convert the solid foot portion into a hollow tubular foot portion, and

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then the material of the head portion is axially compressed while constrained to flow toward the foot portion of the blank.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Figs. 1-7, respectively, show in sequence successive steps of the process of the invention, each of these figures showing above the horizontal center line thereof and in a diagrammatic manner the position of the parts at the beginning of the step shown in each figure, and below the center line the position of the parts at the end of the step in each figure.

As may be seen from the part of Fig. 1 located above the center line thereof, a relatively short section 1 of a cylindrical rod of suitable metal is placed within the female die member 2 which is resiliently urged away from the stationary support 4 by the springs 3. An ejector member 5 is slidable within the stationary support 4, and it will be noted that the female die member 2 is adapted to slidably receive the ejector member 5 whose right end face, as viewed in Fig. 1, forms the bottom of the chamber in which the rod section 1 is shaped. A ramming member 6 is coaxial with die member 2 and ejector 5 and is movable toward and away from the latter, this ramming member 6 having a conical stepped front end 7 as shown in Fig. 1. The ramming member 6 extends slidably through an annular moving member 8 which is shiftable in any known way along the axis of the ramming member 6 for moving the die member 2 toward the stationary support 4. Although the common axis of the parts is shown as being horizontal in Fig. 1 and the remaining figures, it is to be understood that this axis could also extend vertically or at any other desired angle with the stationary support 4 located beneath the other parts and forming a base plate therefor. As may be seen by comparing the position of the parts shown above the center line of Fig. 1 with that below the center line of Fig. 1, the ramming member 6 is urged toward the ejector 5 which is held stationary during the step shown in Fig. 1, and the moving member 8 is simultaneously shifted to the left, as viewed in Fig. 1, to move the die member 2 to the position shown at the lower part of Fig. 1, and the ramming member 6 then cooperates with this die member to form the rod section 1 into a blank 9 having a substantially cup shape, being relatively shallow, and having an outer diameter which is substantially larger than the original diameter of the rod section 1.

After the rod section 1 is formed into the blank 9, the latter is annealed and phosphated and then the blank 9 may be processed through all the succeeding steps of the process of the invention without any further annealing. Thus, according to the present invention it is possible to provide a number of blanks 9 and to keep a supply of these on hand so that the blanks 9 may then be shaped in rapid succession, according to the process of the invention, into the final desired configuration.

As may be seen from Fig. 2, the blank 9 is then placed within a stationary die member 11 having an intermediate cylindrical surface 10 limited on one side by a shoulder 13 located at the end of the tubular portion of die 11 which is of smallest diameter and in which the ejector 17 is slidable. The other side of the intermediate portion 10 of the die member 11 is limited by a shoulder 12 which is located at an end of the tubular portion of die 11 which is of maximum diameter and which slidably receives the

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blank 9 as indicated at the top part of Fig. 2. A ramming member 14 provided with a stepped conical front end 15 having a configuration similar to the front end 7 of ram 6, is coaxial with the stationary die member 11 and is adapted to advance and return along its axis. It will be noted that the outer diameter of ramming member 14 is smaller than ram member 6.

The structure of Fig. 2 is completed by an annular stripping member 20 which surrounds the ramming member 14 for stripping the work piece therefrom when the ramming member 14 is retracted, the ejector 17 then moving the work piece out of the die 11. Of course, when this is done the stripping member 20 is moved away from the die member 11 to a distance sufficient to prevent any interference with the removal of the work piece from the die member 11.

As may be seen by comparing the upper and lower parts of Fig. 2 with each other, the advancing of the ramming member 14 into the die 11 while the ejector 17 is maintained stationary causes the material of the blank to flow to the left, as viewed in Fig. 2, in the same direction as the advancing ramming member in order to produce in the blank 9 an intermediate portion which includes an inner shoulder 18 and a cylindrical inner surface portion 19 extending forwardly from shoulder 18 slightly beyond the plane of the shoulder 13 of the die 11 which forms a corresponding outer shoulder in the intermediate portion of the work piece 21 into which the blank 9 has been converted. This intermediate portion of work piece 21 has a solid foot portion 16 of smaller diameter located on one side thereof in engagement with the ejector 17, and a tubular head portion of a larger diameter than the intermediate portion located on the opposite side of the latter. The inner shoulder 18 of the work piece 21 and the outer shoulder thereof which is formed by the surface 13 of the die 11 have their final configuration after the step shown in Fig. 2 is performed. Thus, the intermediate part of the blank is never subject to any more stresses than that required for forming the inner and outer shoulders of the intermediate portion of the final shell.

The work piece 21 after it is removed from the structure shown in Fig. 2 is then placed in the structure shown in Fig. 3 in order to have the next step of the process performed. The structure of Fig. 3 includes a stationary die member 23 having an inner cylindrical portion 22 which slidably receives the tubular head portion of the work piece 21. Also, the stationary die 23 is formed with a cylindrical portion 24 which slidably engages the outer surface of the solid foot portion 16 of the work piece 21, and between the cylindrical portions 22 and 24 the die member 23 is stepped to have an intermediate cylindrical portion which slidably engages the outer cylindrical surface of the intermediate portion of the work piece 21. The die member 23 is formed with a converging portion 25 beyond the cylindrical portion 24 and an ejector 26 is slidable within the part of the die 23 which has the smallest diameter. A ramming member 28, coaxial with the die 23, is surrounded by a stripping member 32 which performs the same function as the stripping member 20. Of course, during the step illustrated in Fig. 3, the ejector 26 is maintained stationary and after this step is finished the ejector 26 is shifted to the right to eject the work piece 31 into which the work piece 21 is converted.

The ramming member 28 is provided at its front end portion with a conical tip, and the ramming member 28 is undercut behind the cylindrical annular portion 29, in the manner shown in Fig. 3. Also, it will be noted that the ejector 26 is provided at its right end face, as viewed in Fig. 3, with a projection 27 which may be circular and which has a predetermined diameter.

As may be seen by a comparison of the upper and lower portions of Fig. 3 with each other, the ramming member 28 is advanced to the left, as viewed in Fig. 3, in order to cause the material of the work piece 21 to

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become located within the converging portion 25 of the die 23 so as to form the solid foot portion 16 of work piece 21 into a hollow tubular foot portion as indicated in the lower portion of Fig. 3. Moreover, the work piece 31 into which the work piece 21 is converted by the step illustrated in Fig. 3, is formed in its left end face, as viewed in Fig. 3, with a recess 30 of predetermined diameter corresponding to that of the projection 27 for a purpose described below.

A particular feature which is to be noted with respect to Fig. 3 is that the material of the work piece 21 during its conversion to the work piece 31 flows in a direction opposite to the direction of movement of the ramming member 28. As is evident from a comparison of the upper and lower portion of Fig. 3, while the solid foot portion 16 is formed into a hollow tubular foot portion the material of the foot portion 16 flows to the right, as viewed in Fig. 3, so that the intermediate and head portions of the work piece are slidably shifted to the right in a direction opposite to that in which the ramming member advances. This is the only step of the process of the invention during which the material of the work piece flows in a direction opposite to that in which the ramming member advances. As a result, no annealing of the work piece is required, and the only annealing required is that mentioned above after the rod section 1 is formed into the blank 9.

The work piece 31 which is received from the structure shown in Fig. 3 is then placed within the die member 33 in which an ejector 36 is slidable, this ejector 36 remaining stationary during the step of the process illustrated in Fig. 4 and being shifted only to remove from the die member 33 the work piece 49 into which the work piece 31 is converted by the step illustrated in Fig. 4. The structure of Fig. 4 further includes a ramming member 37 in the form of a cylindrical bar having a simple conical front end, and the ramming member 37 is slidably surrounded by an annular compressing member 38 which cooperates with the shoulder 35 of the die 33 to compress the head portion of work piece 31 in order to form the work piece 40 with a head portion 39. It will be noted that the conical end of the ramming member 37 engages the inner shoulder 18 of the intermediate portion of the work piece, this inner portion of the shoulder 18 remaining unchanged.

Thus, as may be seen by a comparison of the upper and lower portions of Fig. 4, the work piece 31 is placed within the die 33 with the head portion of the work piece slidably engaging the cylindrical surface of the die 33 to the right of shoulder 35 and with the intermediate portion of the work piece 31 slidably engaging the inner cylindrical surface 34 of the die member 33, the tubular foot portion formed by the step of Fig. 3 remaining out of engagement with the die 33 and the ejector 36 during the entire step illustrated in Fig. 4, this ejector 36 engaging the foot portion only in order to eject the work piece 40 from the die 33. In performing the step illustrated in Fig. 4, the annular compressing member 38 is advanced to the left, as viewed in Fig. 4, to compress the head portion of the work piece 31 between member 38 and shoulder 35 in order to convert work piece 31 into work piece 40 having the head portion 39. It will be noted that the ramming member 37 simply moves along with the work piece while the material thereof flows to the left, as viewed in Fig. 4, and this ramming member actually performs no ramming function in the step illustrated in Fig. 4. It serves only to move along with the flowing material in order to maintain the desired inner diameter of the head portion of the work piece.

The work piece 40, which is obtained from the step illustrated in Fig. 4, is then placed within a stationary die 41 having an inner cylindrical surface 42 of the same diameter as the cylindrical surface 44 of die 33 and having slidable within itself the ejector 48 which, in the same way as ejector 36, does not in any way par-

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ticipate in the actual step of the process and only serves to eject the work piece from the die. Just to the right of the inner cylindrical surface 42, the die member 41 is provided with an inner surface 43 of hexagonal configuration, and just to the right of the latter the die 41 is provided with an inner cylindrical surface 44 and slidably receives the head portion 39 of the work piece 40. A cylindrical member 45 which acts in the same way as member 37 only to maintain the inner diameter of the work piece, is slidably surrounded by an annular compressing member 46, and in the step illustrated in Fig. 5 this compressing member 46 is advanced to the left, as viewed in Fig. 5, to press the head portion 39 into the part of die 41 which includes the hexagonal inner surface 43 and thus, with the step shown in Fig. 5, the work piece 40 is provided in its head portion with a hexagonal annular surface at the right of which is located an annular flange 47 which extends radially beyond the hexagonal surface to a small extent.

The shell is now in its final configuration. In the step illustrated in Fig. 6, the foot portion of the shell is held in a plate 49 with its left end face against a stationary cutting member 50 having an opening 51, as indicated in Fig. 6. A tubular sleeve 53 engages the inner surface of the head portion of the shell to hold the latter against the stationary cutting member 50 and a punch 52 is slidable within the sleeve 53 and is advanced to the left, as viewed in Fig. 6, in order to punch from the left wall of the foot portion of the shell the material 54 in cooperation with the stationary cutting member 50, as indicated in Fig. 6. The diameter of the punch 52 corresponds to that of the projection 27 and recess 30 so that it is a simple matter for the punch 52 to form in the left wall of the shell, as viewed in Fig. 6, an opening of desired size. The shell is removed from the structure of Fig. 6 with a stripping member 55, diagrammatically indicated in Fig. 6, and then the final step indicated in Fig. 7 is taken, this final step simply being turning off from the shell 58 with a suitable cutting tool 56 the annular flange 47. Moreover, the cutting tool 56 shapes the head portion of the shell 58 into the stepped configuration shown at the lower right portion of Fig. 7 to provide the shell 58 with a projection 57 which may be easily rolled inwardly in order to properly locate a spark plug insulator within the shell 58, as is conventional.

Thus, the shell 58 is substantially complete. It need only be provided with a thread along the outer portion of its foot portion, and any desired indicia may be placed on the shell and, if necessary, the outer surface of the shell may be further treated.

It will be noted that after the blank 9 is formed, only the five steps illustrated in Figs. 2-6 are required according to the process of the invention, and these five steps need not be interrupted for annealing.

The invention is, of course, not limited to the details described above. The shapes of the structural members used to form the shell can vary from those illustrated, and in particular the ratio between the lengths of the foot, intermediate and head portions of the shell may vary.

As a further step of the process, it is also possible to perform the step of calibrating the shell, particularly simultaneously with the step shown in Fig. 5 where the hexagonal surface is provided at the head portion of the shell.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of processes for manufacturing shells differing from the types described above.

While the invention has been illustrated and described as embodied in a process for manufacturing spark plug shells, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

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Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a process for manufacturing a spark plug shell or the like by cold extrusion, the steps of die pressing a substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimension of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow tubular foot portion; and axially compressing the material thereof to flow toward the foot portion of the work piece and while maintaining the wall thickness of said intermediate portions and the inner and outer shoulders thereof unchanged.

2. In a process for manufacturing a spark plug shell or the like, the steps of axially compressing a relatively short rod section into a substantially cup-shaped blank having an outer diameter greater than that of the original rod section; annealing the thus formed blank; forming the finished shell by cold extrusion without further annealing by die pressing the thus-formed substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimensions of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow tubular foot portion; and axially compressing the material of said head portion while constraining the material thereof to flow toward the foot portion of the work piece and while maintaining the wall thickness of said intermediate portions and the inner and outer shoulders thereof unchanged.

3. In a process for manufacturing a spark plug shell or the like by cold extrusion, the steps of die pressing a substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders of the finished shell, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimensions of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow tubular foot portion; and axially compressing the material of said head portion while constraining the material thereof to flow toward the foot portion of the work piece and while maintaining the wall

thickness of said intermediate portions and the inner and outer shoulders thereof unchanged.

4. In a process for manufacturing a spark plug shell or the like by cold extrusion, the steps of die pressing a substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimensions of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow tubular foot portion; pressing a recess of predetermined diameter into the outer surface of the end wall of the thus-formed hollow foot portion at least during part of the time that said ramming member is advanced; axially compressing the material of said head portion while constraining the material thereof to flow toward the foot portion of the work piece and while maintaining the wall thickness of said intermediate portions and the inner and outer shoulders thereof unchanged; and punching out that part of the end wall of the hollow foot portion which is surrounded by the rim of said recess to form at the foot end of the shell an opening of a size equal to that of the recess.

5. In a process for manufacturing a spark plug shell or the like by cold extrusion, the steps of die pressing a substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimensions of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow

tubular foot portion; simultaneously pressing a recess of predetermined diameter into the outer surface of the end wall of the thus-formed hollow foot portion; axially compressing the material of said head portion while constraining the material thereof to flow toward the foot portion of the work piece and while maintaining the wall thickness of said intermediate portions and the inner and outer shoulders thereof unchanged; and punching out that part of the end wall of the hollow foot portion which is surrounded by the rim of said recess to form at the foot end of the shell an opening of a size equal to that of the recess.

6. In a process for manufacturing a spark plug shell or the like by cold extrusion, the steps of die pressing a substantially cup-shaped blank into a work piece having an intermediate annular portion provided with inner and outer shoulders, a solid foot portion of a diameter smaller than said intermediate portion on one side of the latter, and a tubular head portion of a diameter larger than said intermediate portion on the other side of the latter; axially advancing a ramming member through said head and intermediate portions into said solid foot portion without changing the dimensions of or stressing said head and intermediate portions while constraining the material of said foot portion to flow rearwardly along the ramming member to convert said solid foot portion into a hollow tubular foot portion; and axially compressing the material of said head portion while advancing a ramming member slidably engaging the inner face of said head portion and said inner shoulder toward said foot portion without deforming said intermediate portion to maintain the inner diameter of said head portion unchanged while constraining the material of said head portion to flow toward the foot portion of the work piece and while maintaining the wall thickness of said intermediate portion and the inner and outer shoulders thereof unchanged.

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