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3,367,165

METHOD FOR FORMING A FIELD STRUCTURE FOR MAGNETIC LOUDSPEAKER

Filed July 20, 1965

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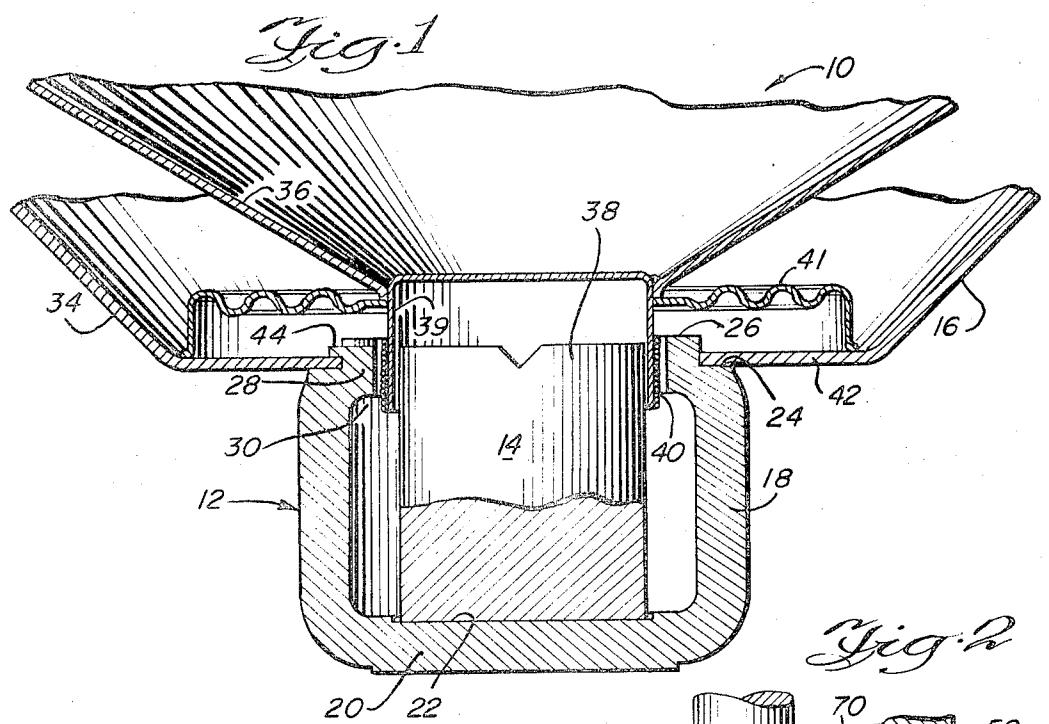
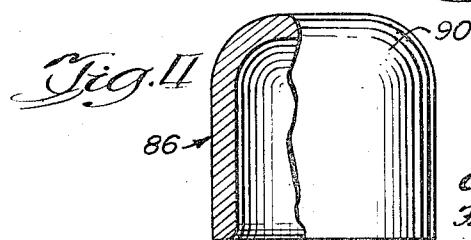
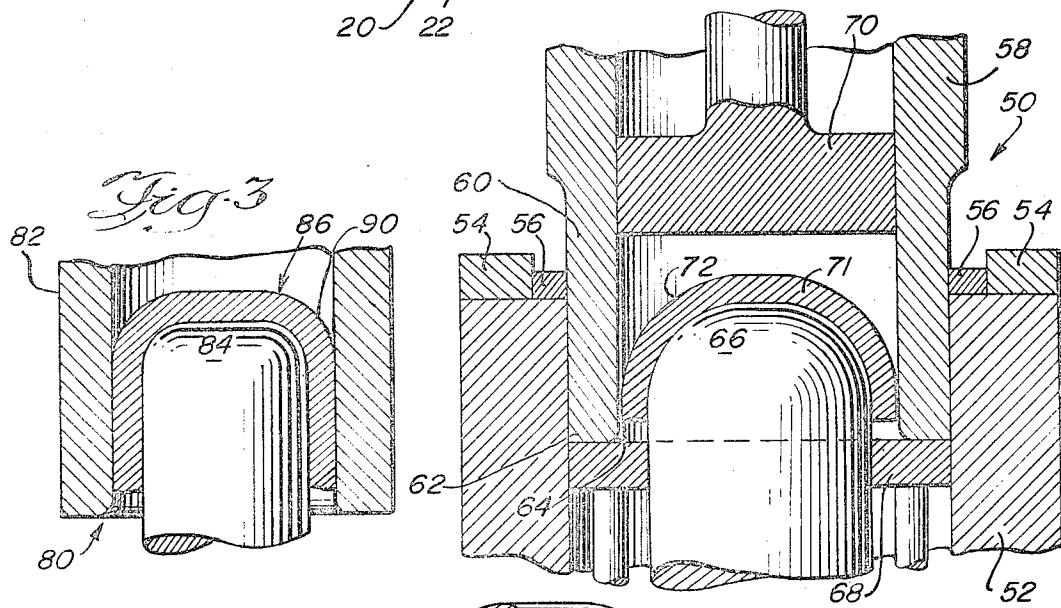


Fig. 2



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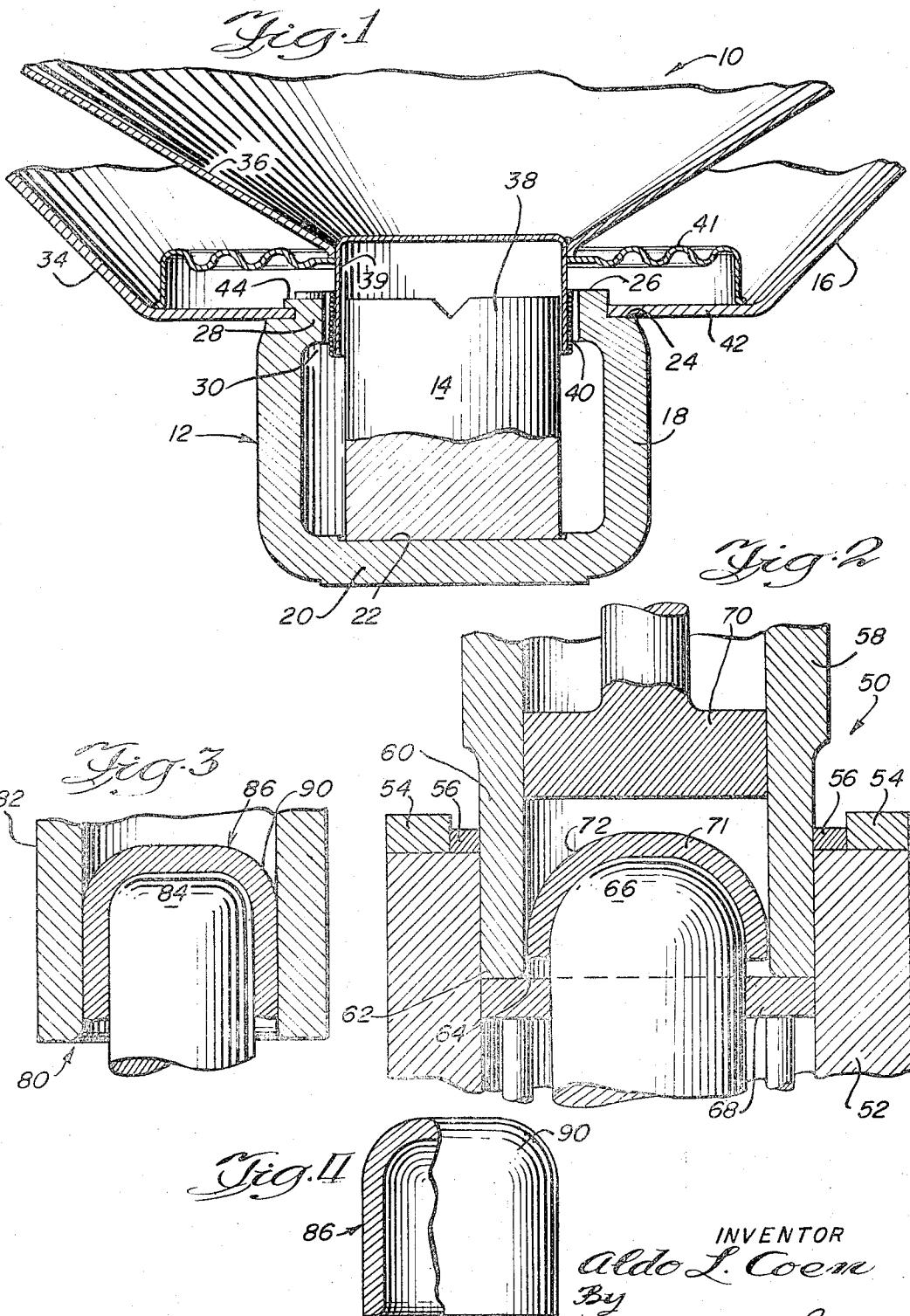
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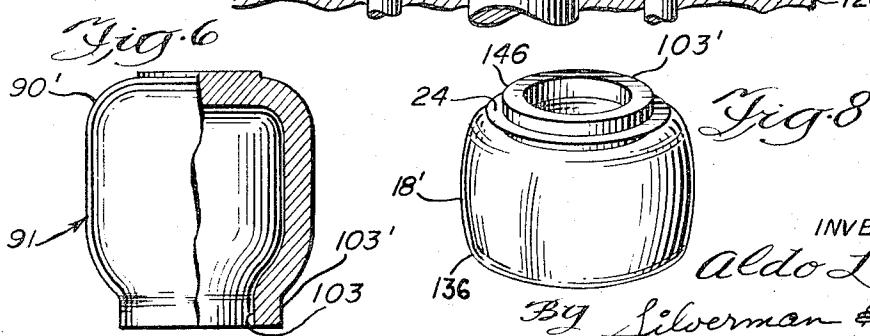
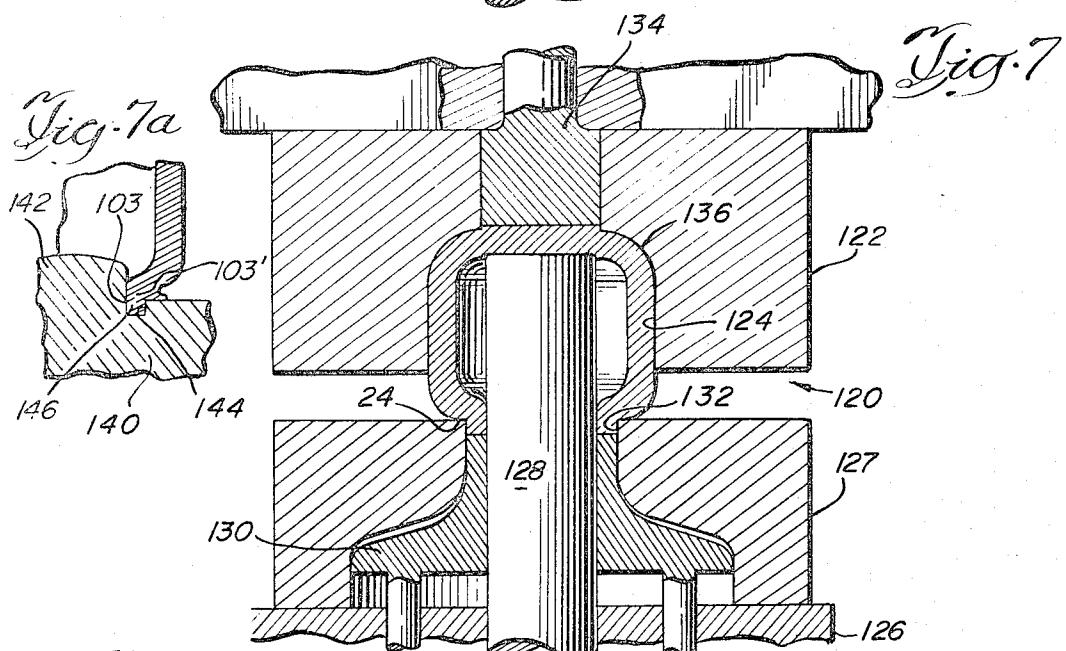
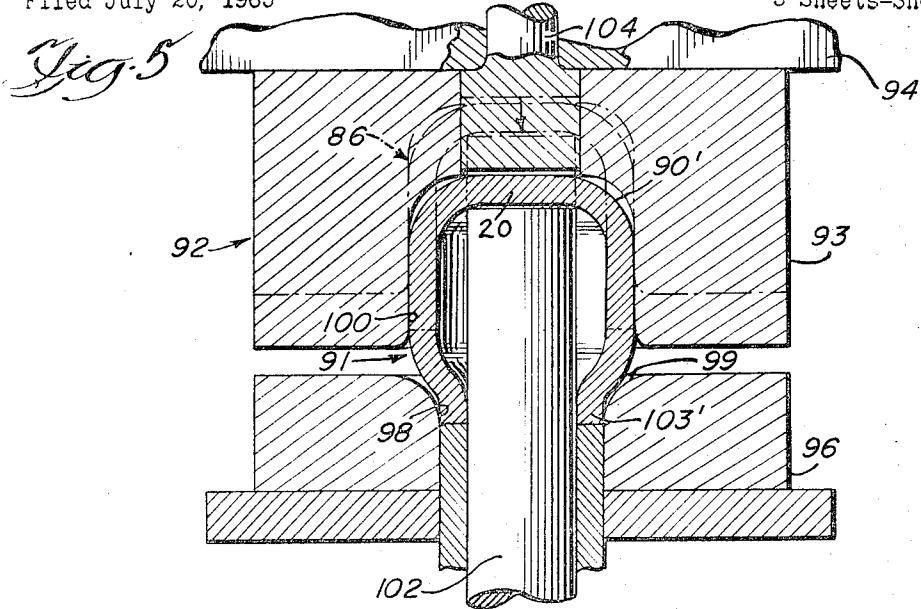
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Fig. 9

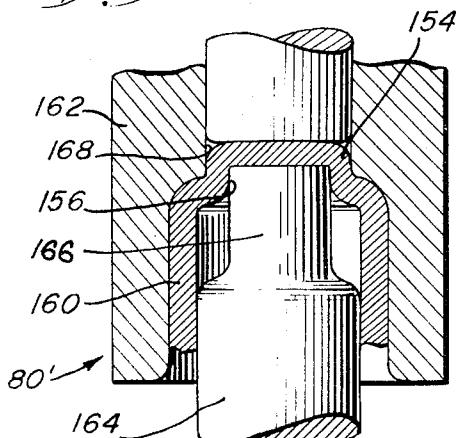


Fig. 10

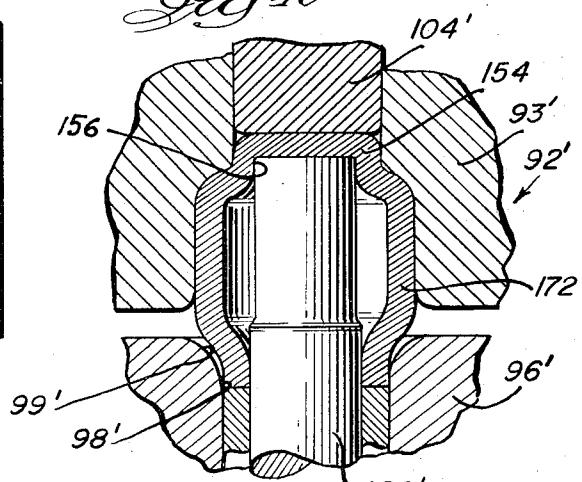


Fig. 11

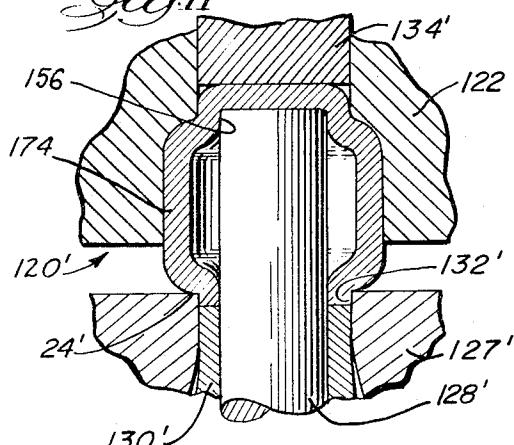


Fig. 12

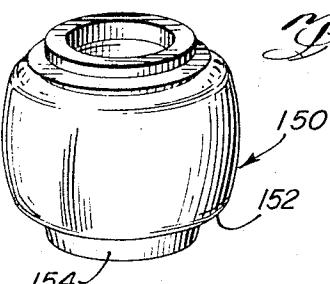
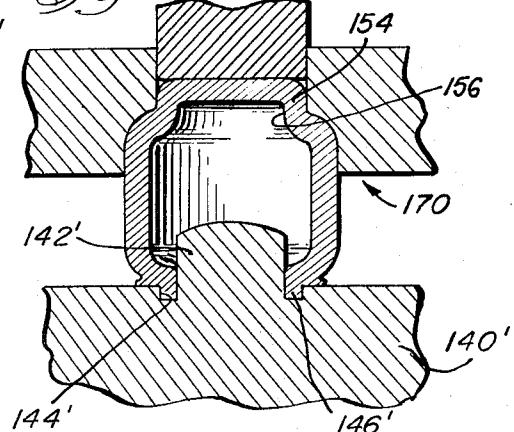


Fig. 13

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METHOD FOR FORMING A FIELD STRUCTURE
FOR MAGNETIC LOUDSPEAKER
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13 Claims. (Cl. 72—348)

ABSTRACT OF THE DISCLOSURE

A method of making a magnetic field structure for a loudspeaker in the form of a unitary cylindrical member having a closed bottom end and an open end defined by an inwardly extending annular lip formation; the inner periphery of which provides a cylindrical surface adapted to cooperate with a permanent magnet positioned in said pot to define the air gap for the magnetic circuit of the speaker. The method envisioning the forming of a cup-like metal blank by forming sheet stock over a mandrel or otherwise so producing said cup-like configuration; deforming the open end of said blank to define said inwardly extending lip formation, while simultaneously sizing the inner periphery of the lip formation to provide a substantially smooth cylindrical surface suited for cooperation with said permanent magnet in defining the air gap; and further sizing the resulting structure, if necessary, to the desired final configuration. As an additional or supplementary feature, if desired, the simultaneous sizing and deforming step may be performed in conjunction with the preventing of radial inward curling of the open end of the cup-shaped blank, such that said cylindrical, air gap defining surface is formed from a portion of the blank other than the end face of the open end of said blank.

This invention relates generally to audio reproducing devices and more particularly, is concerned with a novel method of manufacturing the magnetic field structure for a permanent magnet type of loudspeaker.

In my Patent No. 3,133,162 granted May 12, 1964, there is disclosed a magnetic loudspeaker which uses a field structure consisting of a cylindrical jar-like magnet housing in which a permanent magnet is coaxially mounted including a pole piece substantially closing the top opening or mouth of the housing except for the gap between itself and the upper rim of the housing. Such a field structure is known in the trade as a "pot," said pot having a re-entry opening which is smaller in diameter than the internal diameter of the pot. As explained in said patent, there are certain critical dimensions and dimensional relationships between designated portions of the magnet housing which must be attained in order to assure proper operation of the speaker. My Patent No. 3,176,086 also is material in this regard.

In my Patent No. 3,138,864 granted June 30, 1964, there is described and claimed a method of working metal for producing a magnetic housing for a magnetic loudspeaker of the type with which the herein invention is concerned. Likewise, in my co-pending application, Serial No. 99,414 filed March 30, 1961, now Patent No. 3,191,421 there is described another method of making such a field structure or pot. In each of these instances, the disclosed method of producing such a pot required some form of drilling, punching or cutting operation to provide the proper re-entry opening of smaller diameter than the inside diameter of the pot. Thus, in said co-pending application, the re-entry opening of smaller diameter was produced by cutting or grinding away a portion of the ring or neck formation surrounding the desired re-entry opening by means of a drill. Further, drilling was required so as to trim away any distorted portions of the

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neck formation and chamfer corners at the re-entry opening. In my Patent No. 3,138,864, a proper re-entry opening was obtained using a punch which simultaneously with the punching deformed the ring portion so punched out in order to permit subsequent withdrawal thereof through the re-entry opening.

Notwithstanding the important advantages derived from these inventions, one disadvantage was the recourse to such a drilling, punching or grinding operation to form the re-entry opening in the pot. Such a step required removal of the pot from the punch press used to blank and draw the pot structure so that an automatic mechanical transfer press could not be used. Also, such a drilling, punching or grinding operation was more time consuming and required more specific attention and skill of the operator than a mere blanking or drawing operation performed by a punch press. Consequently, it would be highly desirable to eliminate such a drilling, punching or grinding step in the mass production of such pots where the same proper dimensions and dimensional relationships for the magnetic housing are realized.

Accordingly, it is a primary object of the invention to provide a method of forming a field structure for a magnetic loudspeaker which enables the pot to be made from sheet steel as a stamping or drawing without recourse to a drilling, punching or cutting step so that substantial savings of material, labor and cost of manufacture are realized.

An important object of the invention is to provide a method of forming a field structure for a magnetic loudspeaker which consists of a series of three major steps comprising a blanking and drawing operation to form a cup, a curling and bulging operation to achieve a reduced diameter re-entry opening into the cup and a coining and sizing operation thereafter to complete the cup without recourse to any drilling, punching or cutting.

Another object of the invention is to provide a method of forming a field structure of the character described which comprises a sequence of steps especially suitable for an automatic mechanical transfer press with attendant economies in mass production for producing such field structures in a variety of magnet housing configurations with equal facility and advantage.

Many other objects and advantages of the invention will become apparent as a preferred embodiment of the method is described in detail in conjunction with the drawings accompanying this specification. It is contemplated that minor variations in the steps of the method may occur to the skilled artisan without departing from the scope or sacrificing any of the advantages of the invention.

In the drawings:

FIG. 1 is a sectional view taken through a portion of a magnetic loudspeaker using a field structure manufactured by the method of the herein invention, said field structure being representative of one configuration for the magnet housing or pot.

FIG. 2 is a diagrammatic sectional view taken through a punch press and showing one of the initial steps in the manufacture of the said field structure.

FIG. 3 is another sectional diagrammatic view illustrating the next succeeding step in the manufacture of the field structure.

FIG. 4 is a side elevational view of the field structure resulting from the step of FIG. 3 with portions broken away to show details.

FIG. 5 is a diagrammatic sectional view taken through a press and showing the field structure of FIG. 4 in the press being subject to the next succeeding step of the method embodying the invention.

FIG. 6 is a side elevational view, partially in section, of the speaker pot after the operation illustrated in FIG. 5 has been performed.

FIG. 7 is a diagrammatic sectional view taken through a press and showing the field structure of FIG. 6 being subject to the next succeeding step of said method which can complete the same, and FIG. 7a is a fragmentary diagrammatical sectional view showing a final coining step to which the work piece of FIG. 7 can be subjected for completing the same.

FIG. 8 is a perspective view of the completed field structure or pot.

FIGS. 9 through 12 are diagrammatical sectional views taken through presses respectively for making a field structure or pot having a different configuration by means of the steps of the invention.

FIG. 13 is a perspective view of the completed field structure or pot.

Referring now to the drawings, in FIG. 1, the reference character 10 designates generally a loudspeaker of the permanent magnet type with which the invention is generally concerned. The reference character 12 identifies generally a completed field structure which includes the permanent magnet 14 and the reference character 16 designates generally the speaker basket to which the field structure is connected. The field structure includes a generally cylindrical magnet housing or pot 18 having an integral circular bottom wall 20 provided with an interior flat surface 22. The upper end of the magnet housing or pot is provided with an annular exterior shoulder 24. Said upper end of the pot 18 has an axially facing end surface 26 of circular configuration and a ring or neck formation 28. Said ring formation has a circular re-entry opening 30 therethrough, the diameter of which is less than the inner diameter of pot 18.

The speaker basket is generally formed of sheet metal in the form of a framework or cage 34 in which the paper cone 36 is supported. Magnetic core 14 is coaxially mounted on the bottom surface 22 of the housing 18 and the diameter of the notched pole end 38 is somewhat less than the inner diameter of the ring formation 28 so as to provide a narrow gap or space between the core and ring formation. The cone 36 is secured at its inner or smaller diameter end to a short tube 39 which serves as the "former" for the voice coil 40 which is positioned in the gap between pole end 38 and the ring formation 28. A resilient fabric diaphragm 41 of corrugated configuration is secured between the metal basket 34 and cone 36 to retain the proper relative position between the inner appex of the cone and the former 39 and to center the cone. In assembling the speaker basket to the pot, the perforated flange 42 of said speaker basket is inserted over the ring formation 28 to coaxially seat on the shoulder 24 and is staked into position on said shoulder as represented at 44. In the staking operation, portions of the end face 26 of said ring formation can be deformed, for instance, as described and claimed in my Patent 3,133,162.

Proceeding now to FIG. 2 and following for a description of the method of making the pot 18.

In FIG. 2, there is illustrated a mechanical press designated generally 50. The press is shown to consist of a lower die 52 having guides 54 provided on the upper surface thereof between which a flat strip of sheet metal is adapted to ride. FIG. 2 is a transverse section taken perpendicular to the direction in which the strip will move. This view shows that a work piece has been punched out of the strip leaving edge portions at 56 providing scrap. The upper die member 58 has a cylindrical body 60 provided on its lower edge with an outer sharp corner 62 and on its interior with a rounded corner 64. On the interior of die member 52 is provided a rounded top punch 66 suitably suspended. A vertically reciprocal draw ring is designated 68 and a knockout pusher is designated 70 movable in cylindrical body 60.

In operation, the upper die member 58 is moved down-

wardly to cut a disc 71 from a strip of sheet metal and the rounded inner corner 64 of the upper die forces the resulting disc to conform to the upper rounded end of the punch 66. This step may be characterized as a blank and draw step which occurs at substantially the same time although the several steps may be accomplished separately. It will be noted that the radius 72 of the structure of the pot in said press 58 is much greater than the eventual radius of the completed pot.

In the next step, the work piece 71 from the punch press of FIG. 2 can be transferred to another punch press designated generally 80 in FIG. 3. However, it will be understood that work piece 71 can be transferred either automatically or manually to another die adjacent die 52 on press 50 for the next operation thereon. In fact, it is preferred to use the same press 50 although for ease of description, the press of FIG. 3 disclosure has been assigned a different reference character. The punch press 80 may have any suitable setup consisting of die shoes, stripper plates, knockout pushers, etc., but the principal parts only are shown in FIG. 3. There is an upper die member 82 but of a smaller diameter and a lower die member not shown having an upwardly protruding punch 84 of lesser diameter than the punch of FIG. 2 and of smaller radius. The work piece is placed upon said punch 84. The upper die 82 is brought down to cause the work piece to conform to the configuration of the upper end of said punch 84. The resulting structure or work piece 86 is seen in FIGS. 3 and 4 showing the pot in this stage of manufacture. It can be seen from FIG. 4 that the radius 90 is substantially less than the radius 72 of the work piece 71 of FIG. 2 and that of the completed pot. Notably, the structure of FIG. 4 is similar to the configuration of an open-ended cup or container although thus far the circumferential wall of the container is cylindrical, and there is no reduced diameter re-entry opening such as identified at 30 in completed pot 18.

The next step of the method is illustrated in FIG. 5 and may be characterized as "strangulation." The field structure designated 91 resulting from the strangulation step is illustrated in FIGS. 5 and 6. A third press 92 is employed of which upper die 93 and its support 94 and the lower die 96 is shown. The lower die 96 has a special cavity 98 formed therein which has a convergently tapered annular entrance 99. The work piece 86 of FIG. 4 is inverted in a cavity 100 of suitable dimensions and configuration and held in said upper die 93. The upper die is lowered from the position represented in broken outline in FIG. 5 to engage the work piece over a center block or a mandrel 102 protruding upwardly through the cavity 98 and outwardly of entrance 99. The work piece is lowered or pressed against the lower die into said tapered annular entrance 99 causing the strangulation or deduced dimension neck 103' at the open end 103 of the work piece. The inner dimension of the field structure purposely is maintained by proper dimension of said center block and curling of the field structure is prevented while simultaneously the mouth 103 of the work piece 91 is brought into conformation with said tapered annular entrance 99. The diameter of said entrance 99 is selected to enable the strangulation to be realized without distorting the pot or damaging the same. A pusher device 104 in the upper die 93 is available for withdrawal of the work piece 91 from the upper die.

Referring to FIG. 5, the inside diameter of the work piece 91 is maintained unchanged during said strangulation step and likewise, the radius 90' at the bottom end wall 20 is unchanged from radius 90 of work piece 86. This step is a preparatory sizing operation for subsequent finishing sizing of the pot in the final step of the method.

The next step of the method is carried out by means of the punch press 120 seen in FIG. 7. Said punch press includes an upper die 122 having an internal cavity 124, a lower die 126 having a traveling ring 127. The press 120 performs a sizing and coining operation. The work

piece 91 of FIG. 6 is placed in said press 120 to form the shoulder 24 by means of the traveling ring 127 which coins the shoulder without distorting the remainder of the mouth of said work piece. The proper dimensions are maintained between the bottom of the pot and the upper edge or end face by means of the center block or mandrel 128 and the pusher 130. The traveling ring has an annular groove 132 which seats and retains the trueness of the upper surface of the pot. Likewise, said press 120 has a pusher member 134 associated with the upper die member to help maintain the proper dimension between the inside bottom surface of the pot and the upper end face thereof.

Another step which can be taken to complete the pot is shown in FIG. 7a. With the work piece 91 remaining in the upper die 122 of press 120, the piece 91 can be moved to or be operated upon at another station by a lower die member 140. The member 140 has an upwardly extending pedestal 142 which is received in the mouth 103 to coin the inner entrance wall of the neck 103'. There is an annular recess 144 surrounding the base of the pedestal 142. The neck 103' is received in said recess 144 by reason of a coining which forms the narrow lip 146 of a specific size to pass through the opening in flange 42. The cooperation between the lip 146 and the flange 42 of the speaker basket well enable the speaker basket to be secured on shoulder 24 by staking over portions of the lip 146, as shown in my Patent 3,176,086. It will be noted that this last coining operation was not applied to the pot 18 of FIG. 1, although it can be done so readily as explained, after the operation of FIG. 7.

The pot is shown in this completed form after the final coining operation is shown at 18' in FIG. 8. The radius 136 is then radius 90'. The pot 18' is the same as pot 18 of FIG. 1 with the exception of the resulting coining effected by the operation discussed for FIG. 7a.

Referring to FIG. 13, there is shown a magnet housing or pot 150 which is identical to the pot 18' of FIG. 8 with the exception of the bottom wall thereof. The bottom wall 152 of the pot has been formed with a crimp 154 to provide a socket 156 seen in FIGS. 9-12. The socket 156 is of cylindrical configuration having a diameter selected to enable the lower end of a core such as 14 of FIG. 1 to be friction-fitted therein to be held in place on the interior of the pot or magnet housing 150 without use of cement as would be the case for the core 14 installed in pot 18 or 18'.

Referring to FIG. 9, the press 80' corresponds to press 80. The work piece 160, prior to being worked on by the press 80, was subjected to the same steps as described in connection with FIG. 2 which resulted in stamping out of a blank which thereafter was drawn in a preliminary manner to form the work piece 71. This same work piece 71 would then be placed in press 80' to form the work piece 160 therefrom. The differences between the presses 80' and 80 reside in the upper die members 162 and 82 and the lower punches 164 and 84. The punch 164 has a reduced diameter end 166, the diameter of which is the diameter of the socket 156. The upper die 162 has a reduced dimension bore at 168 which forms the crimped formation 154 on the bottom wall of the work piece 160. The operation of press 80' in all other respects is the same as press 80.

After the work piece 160 is formed in press 80', the piece is subject to the strangulation step illustrated in FIG. 10 by a press 92'. The press 92' is similar to press 92 except for specific construction of its upper and lower die members to accommodate the crimped formation 154. To simplify the disclosure, the same reference characters, albeit primed have been assigned to corresponding parts of the presses.

In FIG. 11, the press 120' corresponds to the press 120 in terms of the operation performed, namely, the coining and final sizing of the pot. The press FIG. 12 designated 170 corresponds to the press equipment dis-

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cussed in connection with FIG. 7a in which only the lower die 140 was shown. For purposes of clarity, the work piece 172 in FIG. 10 will correspond to the work piece 91 and work piece 174 will correspond to the work piece 91 after operation of press 100.

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The method heretofore described may be seen to eliminate any drilling, punching or cutting as utilized in previous methods of my patents and patent application aforesaid. The pot 18, pot 18' or pot 150 is formed as a single piece member without curling, punching, grinding or the like for forming the reduced diameter re-entry opening. Some variations in the method may be made in order to produce field structures of different sizes and different thicknesses. However, the method embodying the invention consists of forming a cylindrical wall cup such as shown in FIG. 4, or FIG. 9, then working said work piece of FIG. 4 or FIG. 9 in a suitable die for strangulating the same to provide the proper sizing of the cylindrical cup and the reduced dimension re-entry opening and finally coining the outer surface of that pot to provide the shoulder on which the speaker basket will be supported. This method may be performed progressively in a single press with the several dies set up in sequence such as in a rotating table arrangement. Thus, the operation is faster and thereby less expensive. There is a material savings in metal because of elimination of punching out of a ring or grinding and drilling for obtaining the re-entry opening using the prior known methods.

It will be appreciated that variations in the method may occur to the skilled artisan without departing from the import of the invention. What is desired to secure by Letters Patent of the United States is:

1. A method of making a magnetic field structure for a transducer having a substantially cylindrical closed bottom body provided with an inwardly extending annular lip formation, the inner periphery of said lip formation defining a re-entry opening in the open end of said body, the diameter of which is substantially less than the internal diameter of said body; said method comprising the following steps:

- forming a cylindrical cup-like member from a metal blank, said member having a closed bottom and an open end of substantially uniform diameter;
- deforming the open end of said cup-like member to provide a reduced diameter section, a portion of which defining an inwardly extending lip formation, simultaneously sizing the inner periphery of said lip formation to a diameter closely approximating that desired of said re-entry opening;
- sizing said cup-like member and said lip formation to the final desired configuration for the completed field structure.

2. A method as defined in claim 1 wherein said last mentioned step of sizing said cup-like member and said lip formation includes the step of sizing the inner peripheral surface of the lip formation to the desired final diameter.

3. A method as defined in claim 1 wherein said last mentioned step of sizing the cup-like member and the lip formation includes the step of coining said lip formation to reduce the outer diameter thereof to define an axially facing shoulder.

4. A method of forming a field structure for a magnetic loudspeaker in the form of a cylindrical cup having a closed bottom end and an inwardly extending lip at the opposite, open end thereof, said lip defining a re-entry opening of a diameter substantially less than the internal diameter of the cup, said method comprising the steps of:

- forming a metal blank into a generally cylindrical body member having a closed bottom end and an open upper end,
- deforming the open end of said body member to thereby define an inwardly extending annular lip, and simultaneously sizing the inner periphery of said lip

formation to a diameter approximating that desired of said re-entry opening;

(iii) confining said deformed body member in the cavity of a die member and sizing the lip formation and the external configuration of said body member to the desired shape of said field structure.

5. A method of forming a field structure as defined in claim 4 wherein said last mentioned step of confining and sizing the previously deformed body member further includes an additional step of sizing the inner peripheral surface of said lip.

6. A method of forming a field structure as defined in claim 4 wherein said step of deforming the open end of the body member includes the step of strangulating the open end of said body member to provide a reduced diameter portion while preventing radial inward curling of the open end of said body member such that the inner peripheral surface of said lip formation is defined by a portion of the metal blank other than that which formed the end face of the open end thereof.

7. A method as defined in claim 4 wherein the simultaneous steps of deforming and sizing include the step of engaging the lip formation therein defined against a forming mandrel.

8. A method as defined in claim 4 wherein the simultaneous deforming step includes strangulation of the open end of said body member to provide a reduced diameter portion which in turn defines the inwardly extending lip formation.

9. A method as defined in claim 4 wherein the step of sizing the previously deformed body member and lip formation includes coining of said lip formation to reduce the outside diameter thereof to define an axially facing annular shoulder.

10. A method for making a field structure for the magnetic circuit of a loudspeaker, said field structure being in the configuration of a cylindrical cup having a closed bottom end and an inwardly extending lip formation at the open end thereof, the inner peripheral surface of said lip formation defining the re-entry opening that is adapted to cooperate with a permanent magnet to define an air gap in said magnetic circuit, the inner diameter of said peripheral surface being substantially less than the inner diameter of the cup, said method comprising the steps of; forming a metal blank into a cylindrical cup-like configuration with a closed bottom and an open end; confining said cup-like blank in the cavity of a die; strangulating the open end of said cup-like blank to form a reduced diameter neck portion while simultaneously therewith preventing radial inward curling of the open end of

said blank; sizing the reduced diameter neck portion to define an inwardly extending lip formation having an inner peripheral surface defining said re-entry opening; confining the strangulated cup-like blank in the conforming cavity of a die and sizing said blank to the desired final configuration for the completed field structure.

11. A method as defined in claim 10 wherein the step of sizing the reduced diameter neck portion to form an inwardly extending annular lip includes the step of engaging the inner circumferential surface of said lip against a forming mandrel.

12. A method of making a magnetic field structure for a transducer having a substantially cylindrical closed bottomed hollow body provided with a neck formation defining an inwardly extending annular lip, the inner peripheral surface of which defines a re-entry opening in the open end of the body, the diameter of said re-entry opening being substantially less than the internal diameter of said body; said method comprising the following steps:

20 (i) forming a cylindrical cup-like metal blank having a closed bottom end and an open end opposite said bottom end;

(ii) strangulating said open end of the blank to form a reduced diameter neck formation and an inwardly extending lip, simultaneously preventing radial inward curling of the open end of said cup-like blank thereby forming the inner peripheral surface of said lip formation from a portion of the cup-like metal blank other than the end face of the open end thereof;

30 (iii) sizing the strangulated cup-like blank to provide a desired configuration for the completed field structure.

13. A method as defined in claim 12 wherein said step of sizing the strangulated blank includes the step of coining said reduced diameter neck formation to define an axially facing annular shoulder while simultaneously sizing the inner peripheral surface of the annular lip to the final, desired diameter.

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