June 29, 1965 A. L. COEN 3,191,421

METHOD OF MAKING LOUDSPEAKER FIELD STRUCTURE

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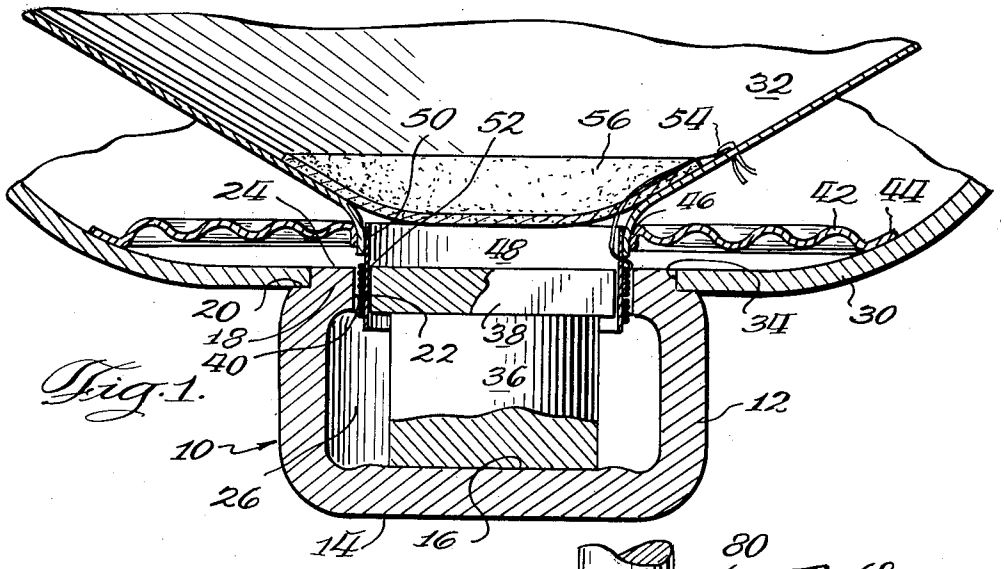


Fig. 1.

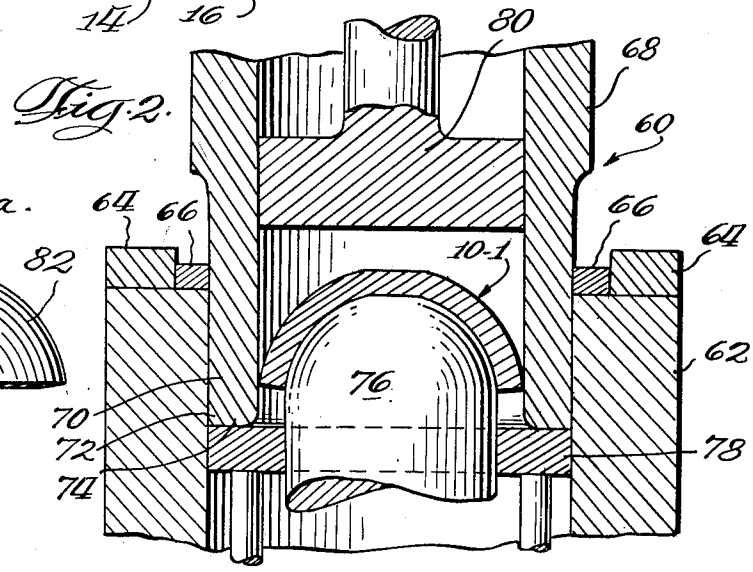


Fig. 2.

Fig. 2a.

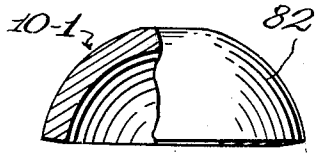
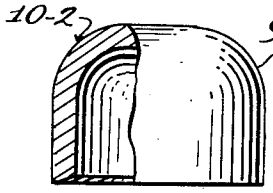


Fig. 3a.



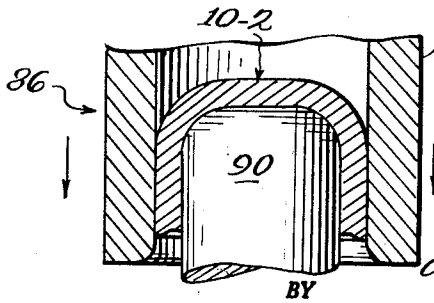


Fig. 3.

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Fig. 5-a

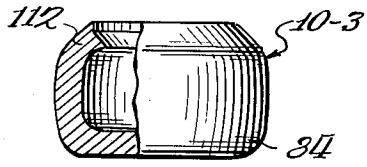
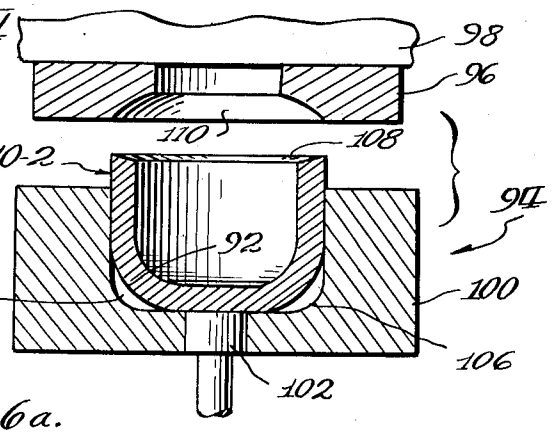


Fig. 4



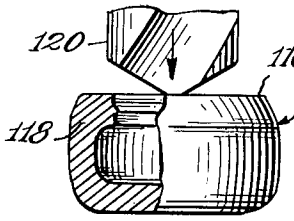


Fig. 6a.

Fig. 7.

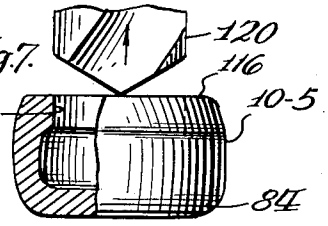


Fig. 5.

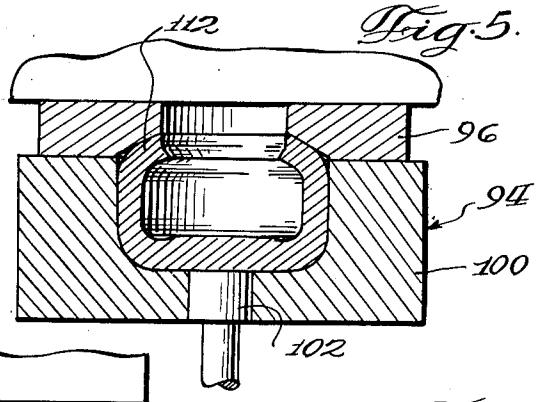


Fig. 6.

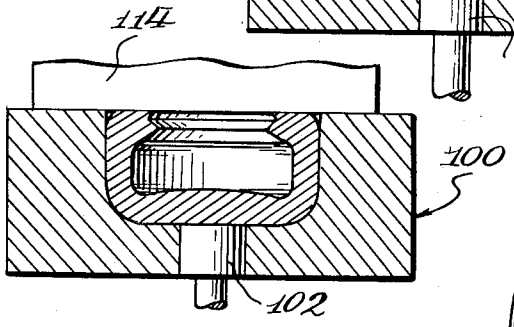
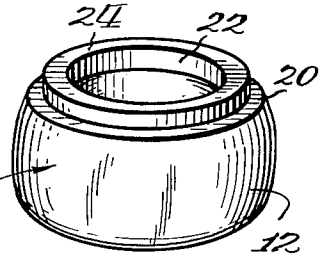


Fig. 9.



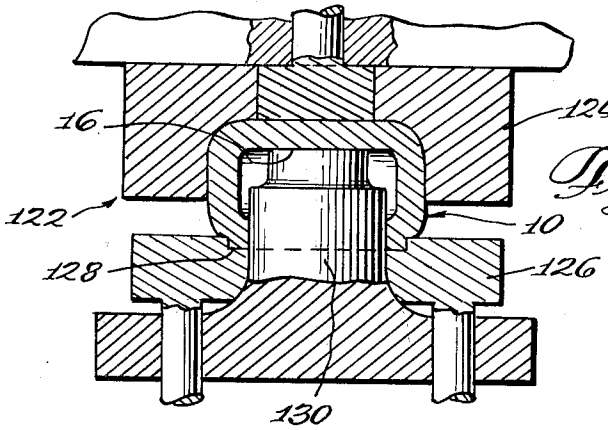


Fig. 8.

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METHOD OF MAKING LOUDSPEAKER FIELD STRUCTURE

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6 Claims. (Cl. 72—329)

This invention relates generally to loudspeakers, and more particularly, is concerned with a method of manufacturing the magnetic field structure of a speaker and the product resulting therefrom.

The so-called magnetic speaker of today is formed basically of a paper cone or diaphragm to which there is secured a voice coil. The output of a source of audio frequency energy is connected to cause the passage of alternating current through the voice coil, the amplitude of which varies with the intelligence carried by the said output. A magnetic field of very high flux density is established, and the voice coil is arranged so that the turns of wire are transverse of the principal lines of force of the magnetic field. In accordance with well known principles, the flow of current through the voice coil will tend to move the individual wires and hence, will move the entire voice coil, vibrating the same in accordance with the audio frequency. Since the cone or diaphragm is secured to the voice coil, the cone is also vibrated, thereby driving a column of air forwardly and rearwardly of the voice coil. This produces the sound waves which are heard from the usual speaker.

This invention is concerned primarily with the field structure of the magnetic circuit which establishes the high magnetic field within which the voice coil is adapted to oscillate. Such field structures in the past have been made of substantially U-shaped members. A typical structure consisted of a strip of low carbon steel bent in the form of a U and having a bridging bar or front plate secured across the free ends of the U. The speaker basket is secured to the bridging bar. In the center of the bridging bar there was a circular opening within which was disposed a steel disc. The diameter of the disc is slightly less than the inner diameter of the opening, and the disc was mounted to a powerful permanent magnet of lesser diameter than the disc, the permanent magnet extending from the disc down to the inner surface of the bottom of the U to which it is usually cemented. The flux path, as will be understood, extends generally along the axial length of the permanent magnet which is somewhat like the core of a transformer, dividing through the pole piece, passing thence across the gap established between the pole piece and the bridging bar, through the arms of the U-shaped field structure and back to the bottom of the magnet. A short section of a cylindrical paper tube is mounted for reciprocal movement in the gap and carries the voice coil usually as a layer or two of fine wire wrapped thereon and held in place by shellac or cement. To the upper end of this cylindrical section, otfen called the former, is secured a varnished buckram spider or diaphragm and the inner portion of the speaker cone. The spider in turn is cemented to the basket of the speaker which, of course, is in the form of a metal frame, and the outer ends of the speaker cone are suspended at the outer ends of the basket. The spider provides the resilient suspension for the apex of the cone.

This structure has been used for many years, especially in low cost speakers of relatively small size. There have been many disadvantages of such speakers. In the first place, the U-shaped field member uses the flux available from the magnet in a very inefficient manner. Since the sides of the U opposite its two legs are open, very

substantial fringing of flux from the magnet was created. This caused interference in the apparatus with which the speaker was associated. Another disadvantage was that only a faction of the voice coil was located in flux fields of strong and uniform density, thereby adversely affecting fidelity as well as rendering the vibration driving of the cone inefficient.

Another important disadvantage of the previous speaker pots, as the field structures were called, was that they were expensive to manufacture and there was difficulty in maintaining the proper dimensional relationships as required for efficient and proper operation.

Most of the above described disadvantages have been eliminated by the appearance recently of a field structure which completely encloses the permanent field magnet. This field structure consists of a cylindrical jar-like container in which the permanent magnet is coaxially mounted, and the pole piece substantially closes the top opening of the container but for the gap formed between itself and the upper rim of the container. The difficulty in making such a field structure was that because the upper rim of the container or pot was required to have a flange of substantially lesser inside diameter than the body of the container, an undercut was necessary. This meant that the field structure container had to be manufactured on a screw machine. Besides being wasteful of material in a structure of this kind, the screw machine operation is very expensive as well, but the advantages to be achieved over previous structures of this kind nevertheless made the machined device popular and successful.

The primary object of this invention is to provide a method of manufacturing a field structure for a speaker of the configuration described above in connection with the machined container, in a manner which enables the device to be made from sheet steel as a stamping or drawing with accompanying saving of material, labor and expense.

A still further object of the invention is the provision of a speaker field constructed in accordance with the method of the invention.

Many other objects and advantages of the invention will become apparent as a description of the method and resulting article proceeds hereinafter, in connection with which a preferred method and the preferred article are illustrated in the accompanying drawings.

In the said drawings:

FIG. 1 is a sectional view taken through a portion of a loud speaker in which the magnetic circuit of the said speaker includes a field structure constructed in accordance with the invention and manufactured by the method of the invention.

FIG. 2 is a diagrammatic sectional view taken through a punch press and showing the first step in the manufacture of the speaker field structure of the invention.

FIG. 2*a* is a side elevational view partially in section of the speaker pot after the operation illustrated in FIG. 2 has been performed.

FIG. 3 is another sectional diagrammatic view illustrating a second step in the manufacture of the speaker pot.

FIG. 3*a* is a side elevational view partially in section showing the structure resulting from the step of FIG. 3.

FIG. 4 is a diagrammatic sectional view taken through a press and showing the structure of FIG. 3*a* disposed in the press for the performance of the next step of operation thereon.

FIG. 5 is a view similar to that of FIG. 4, but in this case the upper portion of the press has come down upon the lower and the operation intended has been performed.

FIG. 5*a* is a side elevational view with portions in

section of the structure resulting from the step which has been completed in accordance with FIG. 5.

FIG. 6 is a diagrammatic view similar to that of FIG. 5 but in this case a different upper die member has been used to perform the next step upon the speaker pot while it is being formed.

FIG. 6*a* is a side elevational view partially in section showing the structure resulting from the step of FIG. 6, but also showing diagrammatically the beginning of the next step in the production of the speaker pot.

FIG. 7 is a view similar to that of FIG. 6*a*, but in this case the drill which is shown fragmentarily in FIG. 6*a* has entered the opening of the pot and cut the same and is now being removed.

FIG. 8 is a sectional diagrammatic view illustrating the last step in the manufacture of the speaker pot, the same being shown in a press.

FIG. 9 is a perspective view of the completed pot.

Generally the method of the invention is characterized by a series of forming operations which are executed in presses using substantially conventional dies, but in which at no time is any die required to perform an undercutting or underforming operation. The method is also characterized by the performance of several steps in which formation occurs without conventional support being provided by a mating die on the side opposite of the material upon which the step is being performed.

The structure of the invention is characterized by the fact that the same is formed of an integral sheet of steel as a stamping or drawing.

Looking first at FIGS. 1 and 9, the reference character **10** is used to designate generally the completed field structure itself, and as will be seen, the same comprises a generally cylindrical body portion **12** and an integral circular bottom wall **14** having an interior flat bottom surface **16**. At its upper end, the pot **10** (as it will often be called hereinafter) is provided with a radially inwardly extending flange **18** having an annular exterior shoulder **20**, an annular interior cylindrical surface **22**, and an axially facing end surface **24** of circular configuration. Because of the flange **18**, it will be appreciated that there is a substantial portion of the said flange which overhangs the interior cylindrical chamber **26** provided in the said pot.

The critical dimensions and relationships of the structure described are, substantially accurate parallelism between the inner bottom surface **16** of the pot and the upper surface **24** and accurate co-axial relationship between the cylindrical interior of the flange **18** at **22** and the shoulder **20**.

Before proceeding with a description of the manner in which the pot **10** is manufactured, attention is invited to FIG. 1 which shows how the pot is used in the construction of a loudspeaker.

The reference character **30** is the so-called speaker basket which is formed of sheet metal in the form of a framework or cage to protect the paper cone **32** and support the outer periphery thereof. The basket **30** is provided with a co-axial opening **34** that is of such dimension as to engage upon shoulder **20**. The basket **30** is secured in place upon the pot **12** in any suitable manner, and it is desirable that the pot and basket be rigidly connected. A cylindrical permanent magnet **36** is coaxially cemented to the surface **16**, and it has a disc-like pole piece **38** mounted to the top thereof. The diameter of the pole piece **38** is somewhat less than the inner diameter of the cylindrical surface **22**, thereby to provide a narrow gap or annular space between the pole piece **38** and the flange **18**. This gap or annular space **40** is very narrow, the narrower the better, and it will be obvious that from the axis of the pole piece **38** and radiating outwardly therefrom, there will be established a high flux density path for the magnetic flux created by the permanent magnet **36**. In FIG. 1, the size of the gap is exaggerated for purposes of clarity.

A varnished resilient buckram or linen suspension spider **42** of annular configuration and provided with molded concentric grooves is cemented to the interior of the basket at **44**. The inner end or apex of the cone **32** is cemented to the diaphragm **42** at **46**, and a short cylindrical tube **48** of relatively thin paper or cardboard is secured to the cone **32** at **50** and extends through the gap **40** co-axially of the pole piece **38**. This short tubular section **48** serves as the former for several turns of wire **52** which comprise the voice coil, the wire being arranged on the former **48** so that the field created by the wire as current passes therethrough will cut the lines of force extending across the gap **40** between the pole piece and the flange **18**. The wires from the coil are shown at **54** extending up through the interior of the cone and out through the walls thereof to the source of audio frequency current. **56** is a felt disc which protects the mechanism just described from dust. Obviously the suspension spider **42** serves as resilient means to oppose movement of the former **48** and the cone **32**.

The reasons for maintaining certain of the dimensions of the pot **10** will now be obvious. It will also be obvious that the entire cylindrical wall portion **12** comprises a low reluctance path for magnetic flux from the permanent magnet **36** and that the chamber **26** is required in order to prevent leakage across the intervening space.

Attention is now invited to FIGS. 2 and following, in order to understand the manner in which the pot **10** is formed. In FIG. 2 there is illustrated a sectional view through a mechanical press designated generally by the character **60**. The principal parts shown consist of the blower die **62** having guides **64** 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 at right angle to the direction in which the strip will move and the view shows that a piece has been punched out of the strip leaving edge portions at **66** which eventually will become scrap. The upper die member **68** performs two functions. It has a cylindrical body **70** provided on its lower edge with an outer sharp corner **72** and provided on its interior with a rounded corner **74**. On the interior of the lower die member **62** there is provided a rounded top punch **76** suitably suspended. **78** is a vertically reciprocable draw ring, and **80** is a knock-out plunger.

This particular step, as explained, is a preferred first step. The upper die member **68** comes down upon the strip of sheet metal, cuts a disc and the rounded inner edge **74** of the die forces the resulting disc to conform to the upper rounded end of the punch **76**. The resulting member as designated **10–1** signifying the pot **10**, first step. This step may be characterized as blank and draw, since the blanking and drawing occur at substantially the same time. Obviously, it is possible to blank and draw separately.

It will be noted that the radius of curvature **82** of the structure **10–1** is relatively much greater than the eventual radius of curvature of the completed pot **10**. Examine, for example, the final radius of curvature which is designated **84** in FIG. 7.

In the next step, the piece **10–1** is removed from the punch press **60** and is transferred to another punch press **86** either manually or automatically. The punch press **86** may have any suitable set-up consisting of die-shoes, stripper plates, knock-out plungers, etc., but the principal parts only are shown in FIG. 3. There is an upper die member **88** which is constructed not much differently from the upper die member **68** but of a decreased diameter, and a lower die member not shown but having an upwardly protruding punch **90** of lesser diameter than the punch **76** and of smaller radius. The piece **10–1** is placed upon the punch **90**, the upper die member **88** is brought down and the piece **10–1** is caused to conform to the configuration of the upper end of the plunger **90**. The resulting structure is designated generally **10–2**, signifying the pot **10**, second step in formation. It will be

noted in FIG. 3*a* that the radius of curvature **92** is substantially less than the radius of curvature **82** although not as yet as small as the radius of curvature **84**. It will be seen that the structure **10–2** is beginning to take the configuration of an open-ended cup or container although thus far the walls of the container are cylindrical and there is no reduced diameter entrance as eventually there will be.

The second step which has been described above may be called a redraw step, since the only thing that is done is to draw the structure smaller in diameter than it formerly was. Although this step is designated the second, it is conceivable that for some sizes of field structures it will be feasible to produce in one step a structure of sufficient dimensions and configuration to enable the following step to be performed thereon. Such following step may be designated curl or neck.

The curling or necking step is illustrated in FIGS. 4 and 5, and the resulting structure is illustrated in FIG. 5*a*. A third press **94** is utilized here, although nothing of the press is shown except the upper die member **96** and its support **98**, and the lower die member **100** with a knockout of some kind at **102**. The cavity which is formed at **104** in the lower die member has a diameter substantially the same as the diameter of the piece **10–2** so that no lateral deformation of any consequence is intended. The lower radius of curvature **106** of the cavity, however, is substantially smaller than radius of curvature **92** of the piece **10–2**. With the piece **10–2** seated in the cavity **104**, the upper die member **96** is brought down upon the upper edge **108** of the piece **10–2**. A suitable curling configuration **110** is provided in the upper die member **96**, and this engages upon the set edge **108** and curls the same inwardly as shown at **112** in FIG. 5. At the same time, the side walls of the piece **10–2** are pushed downwardly and into engagement with the bottom of the cavity **104** so that the lower radius of curvature of the resulting piece is caused to conform to the radius **106** of the cavity **104**. It will be seen that the curling or necking operation has bent the upper edge **108** inwardly and thereby considerably narrowing or necking the opening of the resulting piece.

In FIG. 5 the said piece is shown in partial section, and is designated **10–3** signifying the third step in the formation of the pot **10**. The new bottom radius of curvature of the piece **10–3** is now designated **84** since this is substantially identical with the radius of curvature of the final pot **10**. The upper edge **112** has a substantial overhang with respect to the interior of the piece **10–3**.

It has been found that the step and the formation of the pot **10** which is illustrated in FIGS. 4 and 5 is one which is readily performed with symmetry. There is no collapsing of the piece, no wrinkling and no distortion. Apparently, since the piece is confined on all sides and is usually of substantially thick material, the configuration shown in FIG. 5*a* is literally achieved without the need for mandrels or complex support pieces on the interior of piece.

The next step in the formation of the pot **10** is an additional, or flat curling and further necking operation illustrated in FIG. 6. In this case the work piece **10–3** is permitted to remain in the same press **94**. The same lower die member **100** is used but instead of the upper die member **96** a flat plate **114** is brought down upon the upper edge **112** of the piece **10–3**. This results in a flattening and curling of the upper edge producing thereby additional necking. The upper edge or surface **116** of the piece **10–4** produces a shell formation **118** which depends on the thickness of the material, the dimensions, etc. The outer lower configuration of the work-piece **10–4** has not materially been changed, although the upper exterior portion of the said work-piece may be somewhat rounded due to the movement of material radially inward, but this is of no consequence as far as the eventual structure is concerned.

The next step in the formation of the pot **10** is to form the entrance to the field structure within which the pole-piece will be disposed to provide the gap. This is done by cutting or grinding away a portion of the formation **118**. As an example, in FIG. 6*a* a large drill **120** is shown suspended over the work-piece **10–4** about to be moved into the work-piece. In FIG. 7 it may be assumed that the drill **120** has already been driven into the work-piece and cut a cylindrical opening therein trimming away some of the distorted portion of the formation **118**. The work-piece is here designated **10–5** and the resulting opening is designated **22** since this is identical to the inner surface **22** which is shown in FIG. 1. Chamfering of sharp corners may be accomplished at this point, usually at the circular junction of surfaces **22** and **116**.

For its next step, the work-piece **10–5** is placed in still another press **122** and in FIG. 8 the important parts are shown diagrammatically. There is an upper die portion **124** which has a cavity to seat the work-piece **10–5**. In FIG. 8 the pot **10** has already been shaped, but it will be appreciated that the shoulder **20** has been formed by virtue of the travelling ring **126** which coins the shoulder **20** without distorting the remainder of the work-piece. There is an annular groove in the ring **126** which seats and retains the trueness of the upper surface which becomes the surface **24**, such groove being designated **128**. A center punch **130** flattens the interior of the pot **10** to produce the accurate magnet seat **16** which is required and which has been previously described.

After the step of FIG. 8 the pot **10** is completed and is of the appearance shown in FIG. 9.

There are several important things which should be kept in mind with respect to the field structure described. This structure is formed from sheet material hence the scrap is a minimum. There are no machining operations other than that described in connection with the drilling of the opening in the pot to form the inner surfaces **22**. No annealing is needed throughout the entire process, since none of the steps thereof are of such radical nature as to require this.

It will be obvious that some variations in the method may be made in case it is desired to produce field structures of different sizes and different thicknesses. Basically, however, the process consists of forming a cylindrical wall cup such as **10–1** or **10–2**, confining the cup with the exception of its upper end, curling the upper end inwardly as in FIG. 5, then flattening the curl as in FIG. 6 and drilling out the mouth of the structure as in FIG. 7.

The final step may be considered basically seating the flattened end face **116** against a support and flattening the interior bottom of the cup to obtain true parallelism between the resulting upper face **24** and the bottom seat **16**. Simultaneously or thereafter the shoulder **20** is accurately coined to provide a seat for securement of the basket. This may be eliminated in some cases.

Obviously, throughout this description the words "upper" and "bottom" have been used to designate the opened and closed ends respectively of the pot **10** regardless of how the pot itself is arranged.

It will be appreciated that variations in the structure and in the method may be made without departing from the spirit or scope of the invention as defined in the appended claims.

What it is desired to secure by Letters Patent of the United States is:

1. A method of making a field structure for the magnetic circuit of a loudspeaker from sheet metal in the configuration of a cylindrical cup having a closed bottom and an open mouth of diameter substantially less than the inner diameter of said cup, which comprises blanking a disc and drawing same to cup configuration with a rounded bottom, confining the rounded bottom and curling the upper edge of the cup to neck the same inwardly to form an interior lip thereat, flattening the upper edge of the lip

with the rounded bottom confined, cutting the inside edge of the lip to a cylindrical configuration of predetermined internal diameter and flattening the interior bottom of the cup while confining the flattened upper edge in cylindrical configuration.

2. A method as claimed in claim 1 in which the flattening of the upper edge is accompanied by further inward curling of the resultant lip.

3. A method as claimed in claim 1 in which during the curling of the upper edge of the cup the rounded bottom is confined in a cavity preventing lateral movement but permitting axial movement and the step is accompanied by a flattening of the exterior of the rounded bottom in said cavity.

4. The method as claimed in claim 1 in which a shoulder is pressed into the exterior of said lip simultaneously with the flattening of the interior bottom of the cup.

5. A method of making a field structure for the magnetic circuit of a loudspeaker from sheet metal in the configuration of a cylindrical cup having a bottom wall joining the body with a relatively sharp radius, and having an overhanging interior flange at the top of the cup, the inner diameter of which is substantially less than the inner diameter of the cylindrical body which comprises, blanking a disc and drawing the same to an open-end cup configuration having cylindrical walls of substantially the same diameter as the completed product, curling the upper end of the cup from externally thereof whereby to form an interior lip, flattening the top of the lip, machining the interior of the lip, and then flattening the interior bottom wall of the cup while maintaining parallelism between said bottom wall and the upper end of the lip.

6. The method as claimed in claim 5 which includes coining a shoulder on the exterior of said lip.

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WILLIAM C. COOPER, ARTHUR M. HORTON, *Examiners.*

Disclaimer and Dedication

3,191,421.—*Aldo L. Coen*, Chicago, Ill. METHOD OF MAKING LOUD SPEAKER FIELD STRUCTURE. Patent dated June 29, 1965. Disclaimer and dedication filed Aug. 7, 1973, by the assignee, *Alpha Products, Inc.*

Hereby disclaims and dedicates to the Public the remaining term of said patent.

[*Official Gazette February 5, 1974*]