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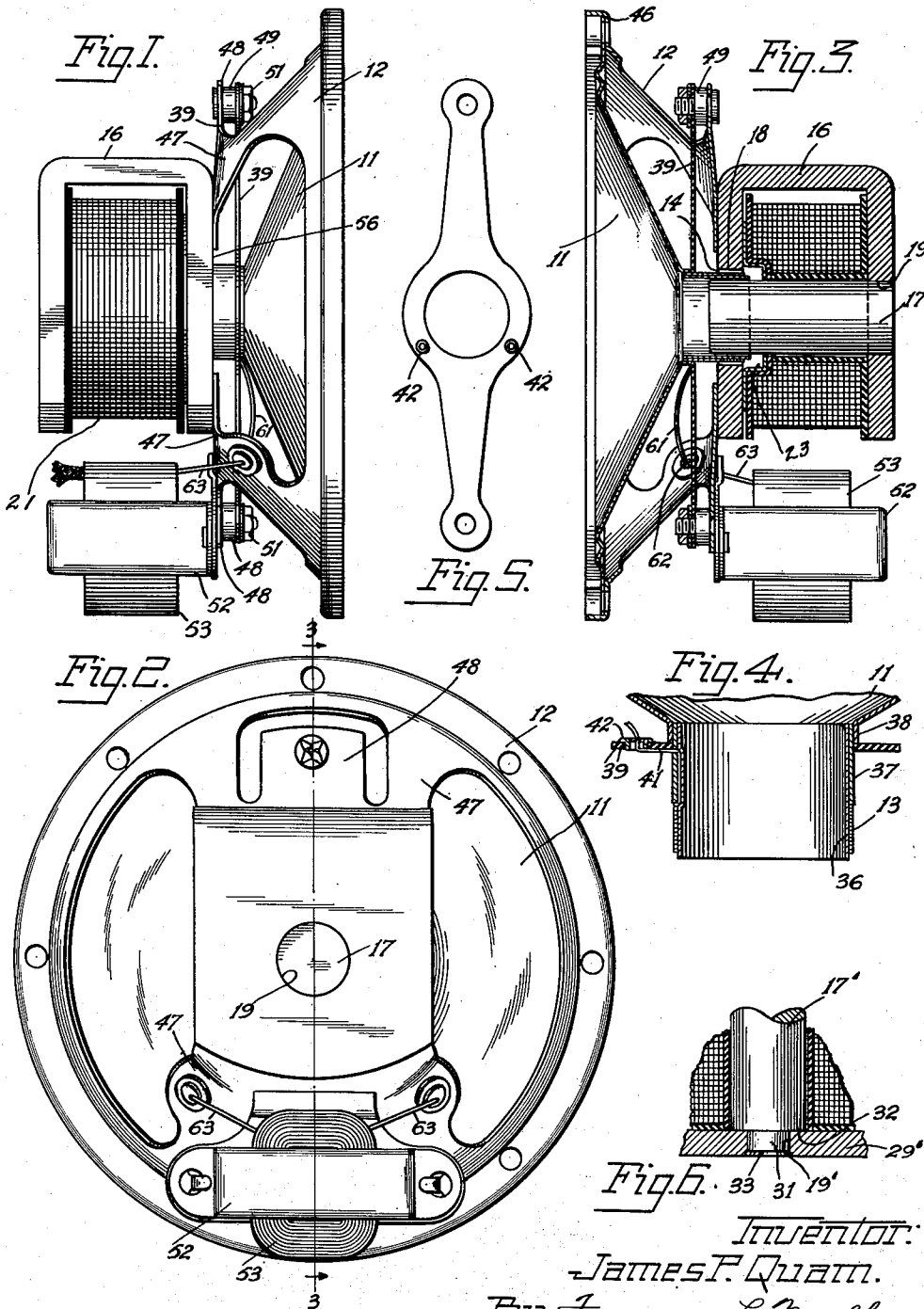
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2,020,212

METHOD OF MAKING DYNAMIC SPEAKERS

Filed Sept. 6, 1935

2 Sheets-Sheet 1



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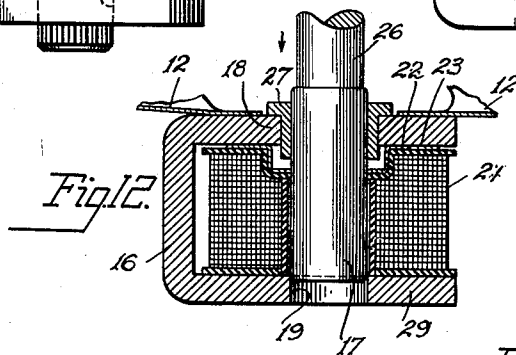
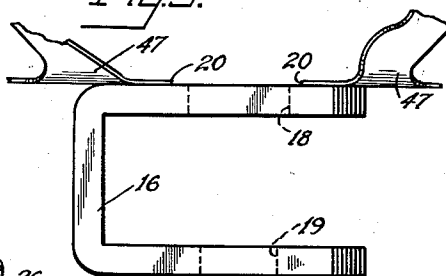
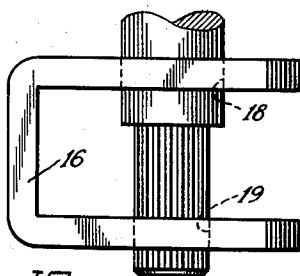
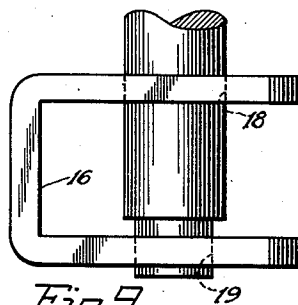
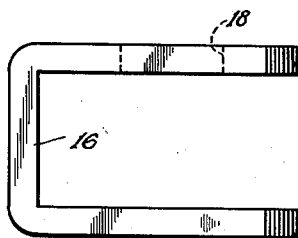
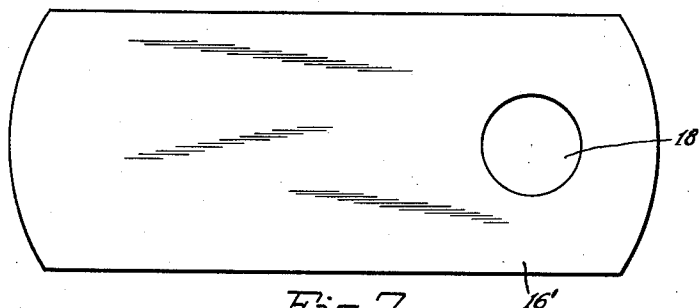
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METHOD OF MAKING DYNAMIC SPEAKERS

Filed Sept. 6, 1935

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,020,212

METHOD OF MAKING DYNAMIC SPEAKERS

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Application September 6, 1935, Serial No. 39,459

12 Claims. (Cl. 29—155.5)

This invention relates to loud speakers and more particularly to the method of making dynamic speakers of the type ordinarily employed with radio receiving sets. Dynamic speakers are those in which the cone or other diaphragm generating the sound waves is actuated by a small coil, called the voice coil, which operates in an intense magnetic field in an annular gap formed around one end of the core of an electro-magnet by the magnetic yoke of the magnet. The voice coil carries the telephonic current which is translated into sound.

The present application is a continuation in part of my three co-pending prior applications having Serial Numbers 670,865, 723,034 and 750,429, filed respectively May 13, 1933, April 28, 1934, and October 29, 1934. It is the purpose of the present application to cover certain important features disclosed in but not patented by said prior applications, and in this connection to disclose these features in the combination in which they are most advantageous.

In this form of the invention now considered most advantageous the voice coil is secured directly to the cone and the cone is supported by a frame welded to the yoke of the field magnet to insure accurate alignment, and a flexible spider is secured to said frame guiding the voice coil in its movement. The formation of the field electro-magnet is an important feature, the yoke being formed without joints by bending a flat bar to a U-shape, and the core being driven into a hole in one leg of the U while being guided with respect to the voice coil hole in the other leg. This insures accuracy of centering of the core in the voice coil hole irrespective of parallelism of the legs of the yoke. The annular voice coil gap may be very narrow, since very little tolerance is necessary to allow for errors either in the centering of the core or the alignment of the voice coil.

The joint-free yoke, its intimate contact with the core, and the narrow voice coil gap all contribute to provide an extremely strong magnetic field in the gap. The strong field and the light cone and voice coil construction both contribute to provide exceptional volume of reproduction. This exceptional volume is obtained not at great cost but rather with great simplicity and much less cost.

It is apparent from the foregoing that one object of the invention is to provide a speaker of greater volume, with quality reproduction, and another object is to provide a speaker which can be made commercially at less cost. In the

preferred form of the invention illustrated, both objects are attained.

For a better understanding of my invention, reference is made to the accompanying drawings, in which:

Fig. 1 is a side view of the preferred form of speaker.

Fig. 2 is a rear view of the same.

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary detailed view showing the mounting of the voice coil on the cone.

Fig. 5 is a face view of the spider used for guiding the coil.

Fig. 6 is a fragmentary view illustrating a slightly modified form of core structure.

Figs. 7 to 12 are diagrammatic illustrations of the method of forming the speaker.

Referring now more in detail to the preferred form of construction illustrated, it will be seen that the speaker includes a cone 11 carried by a cone support 12 and actuated by a voice coil 13 positioned in an annular gap 14 of an electro-magnetic field magnet.

Field magnet

The preferred form of field magnet includes a U-shaped yoke or outer pole piece 16 and a core 17 having one end driven into a hole 19 in one leg of the yoke and having its other end centered in a hole 18 in the other leg of the yoke to form the annular gap 14. U-shaped permanent magnets have long been known, but prior to my invention the use of a simple U-shaped member as the yoke of an electro-magnet for dynamic speakers was not known. Perhaps it was assumed that to carry the flux of the field coil a cup-shaped member, or something similar to it and having magnetic paths on more than one side of the coil, was necessary. Or, perhaps, any one who got beyond this assumption was blocked by the difficulty of centering the core in the voice coil hole in commercial practice when the legs of the U are likely not to be truly parallel. This difficulty is overcome by the present invention.

The yoke 16 is formed from a flat bar 16' of a suitable malleable iron capable of being spot welded. The hole 18 may first be punched in the flat bar, the punched bar being illustrated in Fig. 7. This punched bar is then bent to the U-shape shown in Fig. 8, this step preferably being performed by a suitable stamping press. Next, the hole 19 is punched in alignment with the hole 18, the punching plunger being guided thereby,

as diagrammatically illustrated in Fig. 9. Next, the holes 18 and 19 are line-reamed to insure their accurate alignment and to bring them to the exact size desired, the reaming of hole 19 being diagrammatically illustrated by Fig. 10. At this stage the ears 20 of cone support 12 are welded to the yoke, the resulting structure being illustrated in Fig. 11.

Next, a coil 21, wound on a suitable spool or cover 22, and a closed ring 23 of a good conductor such as copper are inserted between the legs of the yoke. Then the core 17 is passed through the hole 18 and through the coil 21 and ring 23 and staked (driven) into the hole 19. The driving is preferably performed by a press plunger 26. While the core 17 is being driven into the hole 19, it is centered accurately in the hole 18 by means of a ring gauge 27, as diagrammatically illustrated in Fig. 12.

It might be assumed that the final position of core 17 would be controlled entirely by the accuracy of alignment of holes 18 and 19 and that the ring gauge 27 would not be effective if there remained a slight inaccuracy of alignment, but apparently this is not the case, and even if the holes were accurately aligned this would not reliably prevent a slight eccentricity of the core 17 in hole 18 unless ring gauge 27 were used. However, since the hole 19 was substantially accurately aligned with the hole 18, accurate centering of the core 17 with respect to the hole 18 is possible, and this result is in fact accomplished by the use of the ring gauge 27 during the insertion of the core. Even when the ring gauge 27 is removed, the core remains accurately centered in the hole 18. The dependability of this centering permits the use of a narrower air gap, since it is unnecessary to provide large tolerance to allow for inaccuracies of the centering of the core within the hole 18.

Since the core 17 is secured in place by staking, this of course means that it should be slightly oversize with respect to the hole 18, so that when it is in place in said hole it will be in a state of elastic compression. This not only insures rigidity but also insures a force-fit of intimate high pressure contact between the core 17 and the leg 28 of the yoke. The step of driving an oversize core into a hole inevitably scrapes the core and the wall of the hole clean, so that the joint is clean as well as under high pressure. This clean force-fit, together with the fact that the gap 14 is very small (much smaller than can be illustrated) and the remainder of the magnetic circuit is of one piece, results in a magnetic circuit of very high permeability. It follows that with a given number of ampere turns in the coil 21, the magnetic flux in the gap 14 will be unusually strong. In this connection it should be noted that the yoke 16 has a large cross-sectional area, the dimensions of the yoke and core being substantially as illustrated. It is desirable that this cross-sectional area of the yoke be at least as great as the cross-sectional area of the core 17. Contrary to what might have been supposed, this yoke can carry the magnetic field of the coil 21, as commercially used, without undue loss of magnetic force due to reluctance. Apparently this is because the yoke is of such large cross section, both around the ends of the core and in the intermediate portion, that it does not come too close to the saturation point to be efficient.

In Fig. 6 is illustrated a slight modification of the invention in which the yoke 17' is provided

with a reduced portion 31 of smaller diameter, so that an annular shoulder 32 is provided on the yoke. When the core 17' is driven into the leg 28' of the yoke, the annular shoulder 32 will seat on the leg 28'. The outer end of the stub 31 may or may not be upset in the flared portion 33 of the hole 19'.

If the inner face of leg 28' and the shoulder 32 both happen to be exactly perpendicular to the axis of the core 17', as controlled by the ring gauge 27, the leg 28' will contact the annular shoulder 32 throughout its area. Since such absolute perfection is rarely obtained in commercial production, the engagement between the shoulder 32 and the leg 28' will usually be firm only at one point, although of course there may not be a visible air gap at any point. The provision of the shoulder 32 is therefore of doubtful value, and in the preferred form of the invention, as shown in the other figures, the core 17 is of cylindrical shape from end to end, except for a very slight rounding or beveling of its corners. If the ring gauge 27 were not used during the staking operation, the shoulder 32 would be harmful, since it would tend to tilt the core out of its intended position whenever the leg 28' was the least bit out of perpendicular to this intended position. The centering of the core independently of its being seated on the leg 28 or 28', whether the shoulder 32 is provided or not, may be referred to as "free-centering".

Cone and voice coil mounting

The cone 11 is secured at its periphery to the cone support 12 in any suitable manner, as by being glued thereto. The cone support 12, which may be stamped from sheet metal, preferably non-magnetic includes the rim 46 and upper and lower brackets 47 extending therefrom, as shown, and terminating in the welding ears 20. An outwardly-extending ear 48 is formed on each of these brackets. A sheet may first be punched to form a flat blank including the rim 46, brackets 47 and ears 20. Then this blank may be stamped to the shape shown. On each ear 48 is riveted a support stub 49. On these stubs the spider 39 is suspended, being secured in place by the nuts 51. On one of the brackets 48 there may also be secured a plate 52 on which is mounted a transformer 53.

The voice coil 13 is wound on the usual thin paper cylinder 36 which, according to the preferred form of this invention, is secured directly to the cone 11, as is illustrated best in Fig. 4. The upper part of the cylinder 36 includes an outer layer 37 which is glued or otherwise secured to a flange 38 formed integrally on the cone 11. The guide spider 39 is also secured to the cone 11 and the cylinder 36 at this point, as illustrated. The wire 41 forming the voice coil is soldered to a terminal eyelet 42 in the spider 39, and therein is soldered to flexible lead 51. Wire 41 passes inside the outer layer 37 of the cylinder 36 to the bottom thereof where it is wound around the inner layer of the cylinder 36 and extends back in the same manner to another terminal eyelet, shown only in Fig. 5.

The cone 11 may be made of the usual paper corrugated annularly to make it flexible and permit its vibrations. The spider 39 is of the usual thin linen reinforced material stiff enough to act as a support or guide but permitting free vibration of the cone and voice coil when the spider arms are fastened at their ends. Because the ears 48 extend outwardly beyond the edges of

the magnet yoke, and beyond the adjacent portions of the brackets 47, the spider 39 may be unusually long, thus permitting unusually free movement of the voice coil and cone, without danger of misalignment since the brackets 48 are welded in the proper positions. The spider is cut at an angle of 45° with the grain of the material for greater strength and to prevent warping.

To insure permanent and accurate alignment of the cone 11 and the spider 39, and therefore the voice coil 13, with respect to the voice coil gap 14, the brackets 47 of the cone support 12 are spot welded to the yoke 16, while the support is held exactly concentric with the hole 18 by a suitable jig.

Another simplified construction which I have provided is in the method of supporting the ends of the flexible conductors 61 of the voice coil.

For this purpose I provide eyelets 62 passed through lower bracket 47 and insulatingly supported by this bracket through the use of a pair of insulating washers, as shown, one of which is secured against each face of the ear 28 and through which the eyelet 29 is passed, after which it is curled over. A voice coil conductor 61 is then passed into the eyelet 62 and soldered thereto, after which the corresponding conductor 63 from the transformer is soldered to the outside of the eyelet 62.

The combination of features

Although each of the above described novel features is in itself useful in speakers not embodying the other features, it is when all of the features are combined that the best results are obtained. There is a chain of interrelations whereby each feature not only adds its own advantages but also enhances the advantages of the other features.

Thus the jointless yoke structure and its intimate joint with the core increase the magnetic potential at the gap, and it is increased still further on account of the reliable free-centering of the core in the pole which permits a reduction in the excess length of the gap provided for tolerance. This increased flux is especially effective in view of the light weight of the moving parts resulting from mounting the voice coil directly on the cone. The mounting of the voice coil on the cone without increasing the width of the gap to accommodate variations and without adjustments difficult in commercial production is made possible by the substantial elimination of variations, first by the welding of the cone support to the yoke, and secondly by securing the spider 39 to this accurately positioned cone support. The light weight of the movable parts and the strength of the flux in the voice gap result in an unusual volume and fidelity of reproduction. At the same time the extreme simplicity of the structure results in lower cost of production. Thus, the two general objects of the invention are both accomplished at the same time.

Although I have described and illustrated my invention in its preferred embodiments, it is understood that I am not limited thereby, but limit my invention only by the scope of the appended claims.

I claim:

1. The method of producing a field magnet for a loud speaker which consists of piercing a hole in one end of a single bar of metal, shaping said bar to provide a one-piece U-shaped outer pole piece with said hole in one leg thereof, piercing

a hole in the other leg axially aligned with the hole in the first leg, line-reaming the two holes, inserting a field coil between the legs of the pole piece, inserting one end of a complete permanently rigid one-piece core through one hole in the outer pole piece and through the field coil, applying a ring gauge between said core and said hole, and permanently securing said end of the core in the other hole of the outer pole piece with a force-fit by driving it therein with the ring gauge centering said core during the pressing operation to position the core irrespective of the parallelism of the legs of the outer pole piece to which the core is secured.

2. The method of attaching a complete permanently rigid core to a bent-to-shape outer pole piece of a dynamic speaker with said pole piece having outer and inner face portions substantially parallel over their length, which method comprises forming aligned voice coil and attachment openings in the face portions of said pole piece, the attachment opening being smaller in diameter than an end of said core for the outer pole piece, passing said end of said core through said voice coil opening, centering said core in said voice coil opening with a ring gauge, and while maintaining it centered driving its said end into the attachment opening thereby placing said core in a state of elastic compression in said opening and positioning it in said centered position independently of any inaccuracies in the shape of the outer pole piece to which the core is secured.

3. The method of producing the outer pole-piece of a field magnet for a loud speaker and attaching said pole-piece to a diaphragm supporting frame for said speaker, which method comprises forming a pole-piece to have a pair of substantially parallel face portions, positioning said pole-piece at the rear of said diaphragm frame and aligning said pole-piece with relation to said frame, and welding one face portion of said pole-piece at the rear of the frame with the two face portions substantially parallel to the plane of the face of the diaphragm supporting frame, and with said welded fastening such as to make possible an original alignment of said pole piece and frame and then maintain the same in permanent alignment.

4. The method of producing a field magnet for a loud speaker which consists of punching an opening in one portion of a single bar of metal, shaping said bar to provide a one-piece outer pole-piece having a pair of substantially parallel sides with said opening in one side thereof, providing an opening in the other side axially aligned with the opening in the first side, inserting a field coil between the sides, providing a complete permanently rigid core for said magnet, inserting one end of the core through one opening in the pole-piece and through the field coil, centering said core in said opening with a ring gauge and permanently securing the end of said core in the other opening of the outer pole-piece with a force-fit by driving it therein with the ring gauge centering said core during the driving operation to position the core irrespective of the parallelism of the sides of the pole-piece to which it is secured.

5. The method of producing a field magnet for a loud speaker which consists in providing aligned openings in two opposite face portions in an outer pole-piece, line reaming one of said openings with respect to the other opening, inserting a field coil between said face portions of

the pole-piece, inserting one end of a complete permanently rigid core through one opening in the pole-piece and through the field coil, providing centering means for said core in said one opening, and permanently securing said end of the core in the other opening of the pole-piece with a force-fit by driving it therein with the centering means centering said core during the driving operation to position the core irrespective of the parallelism of the face portion of the outer pole-piece to which it is secured.

6. The method of producing a field magnet for a loud speaker which consists of punching a hole in one end of a single bar of metal, thereafter shaping said bar by stamping to provide a one-piece U-shaped pole-piece with said hole in one leg thereof, punching a second hole in the other leg axially aligned with the hole in the first leg, line-reaming the second hole with respect to the first hole, inserting a field coil between the legs of the pole-piece, inserting one end of a complete permanently rigid core through one hole in the pole-piece and through the field coil, centering said core in said hole by means of a ring gauge, and permanently securing said end of the core in the other hole of the pole-piece with a force-fit by pressing it therein with the ring gauge centering said core during the pressing operation to position the core irrespective of the parallelism of the legs of the pole piece to which it is secured.

7. The method of attaching a core to a pressed-to-shape outer pole-piece of a field magnet of a dynamic speaker with said pole-piece having outer and inner face portions substantially parallel over their length, and a core therefor consisting of a one-piece round post, which method comprises providing aligned voice coil and attachment openings in the face portions, the attachment opening being smaller in diameter than an end of the core, inserting a field coil between the face portions, passing said end of the core through said voice coil opening and through said coil, centering said core in said voice coil opening with a ring gauge, and while maintaining it centered driving its said end into the attachment opening thereby placing said core in a state of elastic compression in said opening and positioning it in said centered position independently of any inaccuracies in the shape of the outer pole-piece to which the core is secured,

8. The method of producing a dynamic speaker which includes providing a frustum-like diaphragm supporting frame having attaching portions at the rear thereof, forming an outer pole-piece to have a pair of substantially parallel face portions, providing an opening in one face portion aligned with an opening in the other face portion, positioning said pole-piece with respect to said diaphragm frame at the rear thereof, and welding one face portion at the rear of the frame to provide a permanent alinement of the pole-piece with respect to the frame identical with the original positioning, inserting a field coil between the face portions, inserting one end of a core for said pole-piece through one opening and through the field coil to the other opening, centering said core in said one opening with a ring gauge, and while maintaining it centered, driving its end into said other opening to permanently maintain said core in said pole-piece, removing said ring gauge and applying a diaphragm with an attached voice coil to said diaphragm supporting frame.

9. The method of producing a dynamic speaker

which includes providing a diaphragm supporting frame having a rimmed face and attaching portions at the rear thereof, providing a field magnet for the speaker with an outer pole structure having two substantially parallel sides one of which has a voice coil opening therein and including a re-shaped member, providing an attachment opening in the other of said parallel sides aligned with the voice coil opening, line reaming one of said openings with respect to the other opening, securing a complete permanently rigid core in the attachment opening by passing one end of said core through said voice coil opening and while centering the core in said opening by means of a ring gauge driving said end into the attachment opening, mounting said field magnet on said frame, and mounting a diaphragm on said frame having a voice coil thereon for positioning in said voice coil opening.

10. The method of producing a dynamic speaker, which includes providing a diaphragm supporting frame with a plurality of attaching portions, providing a pressed-to-shape outer pole-piece for a field magnet with said outer pole-piece including a pair of substantially parallel sides and an opening in each side with one opening substantially aligned with the other opening, securing said pole-piece to the attaching portions of said frame at one side of said pole-piece in a permanent and irremovable fastening independently of any securing formations on the joined members, positioning a field coil in said pole-piece, inserting a one-piece core through an opening in one side of the pole-piece, and through said field-coil to the opening in the other side, centering said core in said first opening by means of a ring gauge and while maintaining it centered, pressing said core into said second opening to be retained therein, and mounting a diaphragm and diaphragm driving means on said frame.

11. The method of producing a dynamic speaker which includes forming a one-piece diaphragm supporting frame from a sheet of metal to have a rimmed face and attaching portions at the rear, providing a pressed-to-shape outer pole-piece for a field magnet with said outer pole-piece including a pair of substantially parallel face portions with a voice coil opening in one face portion and a core attachment opening in the other face portion, with said openings substantially aligned with one another, positioning said face portion of the pole-piece having the voice coil opening therein at the attaching portions of the frame and in alinement with the frame such as to make possible subsequent centering of the voice coil in the voice coil opening, mounting said face portion at the attaching portions in a permanent fastening such as to preserve said original alinement and maintain the same permanently, positioning a field coil in said pole piece, inserting a one-piece core through the voice coil opening, and through said field coil to the attachment opening, centering said core in said voice coil opening with centering means, and while maintaining said core centered, pressing it into said attachment opening to maintain it therein under elastic compression between the core and edges of the attachment opening, and mounting a diaphragm and voice coil on said diaphragm frame with said voice coil positioned in said voice coil opening.

12. The method of producing a dynamic speaker with the diaphragm frame and outer pole-piece as a unit, completing the field magnet struc-

ture and then mounting the diaphragm and voice coil on the diaphragm frame, which method comprises providing a frustum-like diaphragm supporting frame, shaping a metal bar to have a pair of substantially parallel face portions, providing an opening in one face portion alined with an opening in the other face portion, alining the pole piece at the rear of the diaphragm frame with respect to said frame, and while alined, spot welding the pole-piece to the frame in a unit in permanent alinement, and thereafter completing the field magnet for said speaker by

inserting a field coil between the face portions of the outer pole-piece of the unit, inserting one end of a core for said outer pole-piece through one opening and through the field coil to the other opening, centering said core in said one opening with a ring gauge, and while maintaining it centered, driving its end into said other opening to permanently maintain said core in said pole-piece, removing said ring gauge and mounting a diaphragm and a connected voice coil on said diaphragm frame.

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