May 1, 1934. B. A. ENGHOLM 1,956,826

METHOD OF MAKING A VOICE COIL

Filed June 16, 1932 2 Sheets-Sheet 1

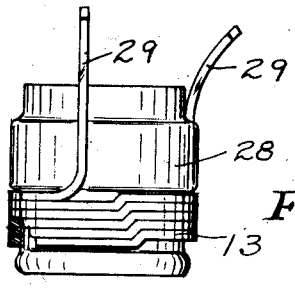


FIG. 2

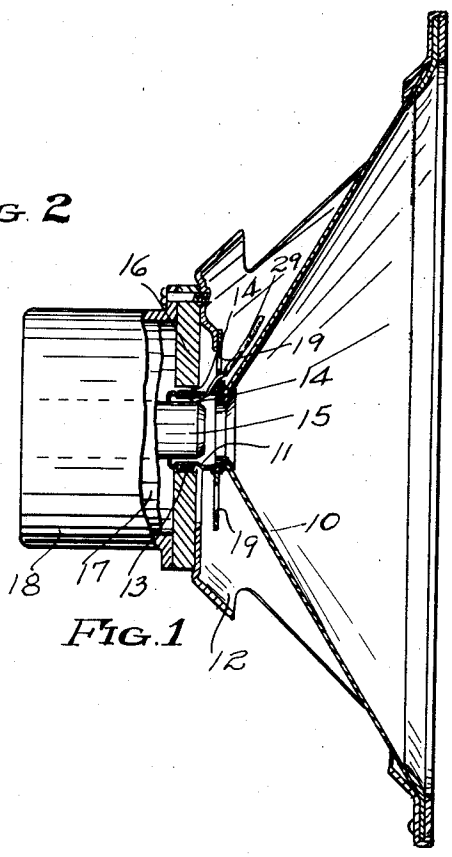


FIG. 1

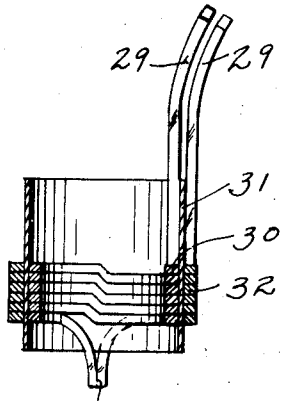


FIG. 3

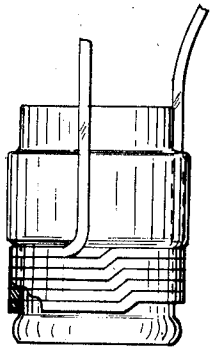


FIG. 7

Inventor

Bernard A. Engholm

By Bates Golrick & Teare

Attorneys

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METHOD OF MAKING A VOICE COIL

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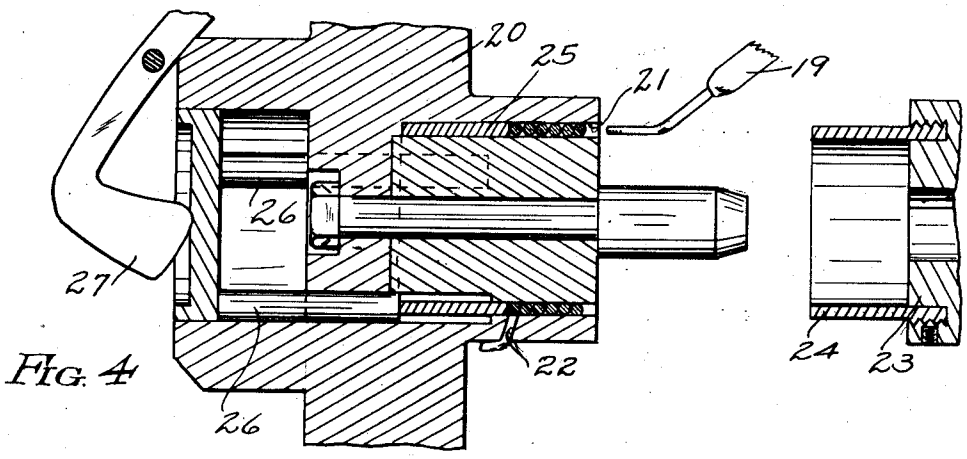


FIG. 4

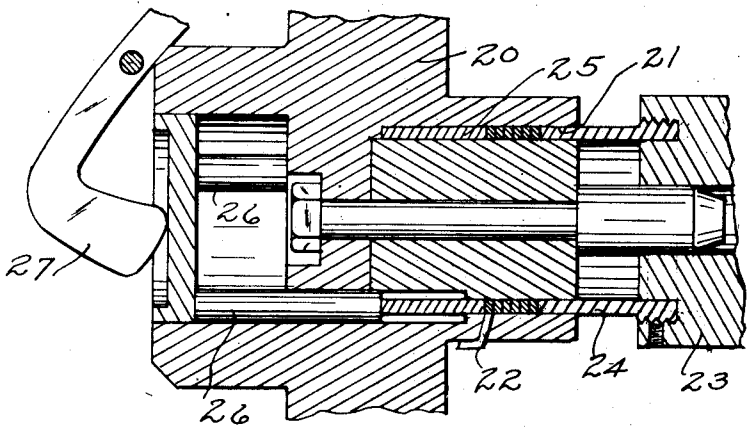


FIG. 5

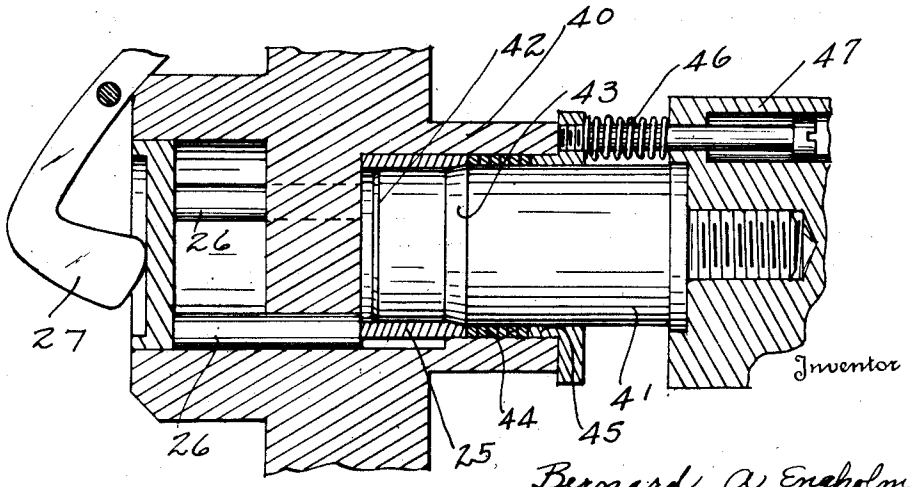


FIG. 6

Inventor

Bernard A. Engholm

By Bates Golrick & Teare

Attorneys

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UNITED STATES PATENT OFFICE

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METHOD OF MAKING A VOICE COIL

Bernard A. Engholm, Lakewood, Ohio, assignor to The Rola Company, Cleveland, Ohio, a corporation of Ohio

Application June 16, 1932, Serial No. 617,526

1 Claim. (Cl. 175—21)

This invention relates to electro-dynamic devices and particularly to a coil that is known in the trade as a "voice coil", and to a method of making the same. As applied to loud speakers, wherein a light piston-type diaphragm is driven by a light movable coil which is connected to the diaphragm near the center portion thereof, the construction of the coil has an important bearing on the operating efficiency of the diaphragm. I have found, for example, where round wire is used for the coil construction and particularly where a plurality of layers of turns are utilized that there is relative a low space factor, which lessens the efficiency of the coil.

An object of the present invention therefore, is to provide a method of making a coil which may comprise either one or more layers of turns, and which has a relatively high space factor. An effort to solve this problem has heretofore been made by utilizing flat ribbon-type wire which is wound edgewise on a core form or on a mandrel, and subsequently transferred to the coil form. So many difficulties have arisen in efforts to wind a coil of such character however, that the resulting coil structure is far from an even cylindrical unit. These difficulties are enhanced by reason of the fact that the wire, which must be used for this purpose is necessarily small, thus making it difficult to keep the flat sides of the wire in strict parallel relationship. The wire has a tendency to incline toward the adjacent turn with the result that the finished coil has an uneven contour.

A further object of my invention is to provide a coil, as well as a method of making it, by means of which the turns are absolutely true in alignment, and the resulting coil accurately cylindrical. Thus, a maximum amount of metal may be used in the coil for a given size of air gap in which the coil is intended to operate.

Referring now to the drawings, Fig. 1 is a side elevation, partly in section, of a loud speaker embodying my invention; Fig. 2 is an elevation on an enlarged scale of a coil made in accordance with my invention; Fig. 3 is a section through a coil embodying a modification of my inven ion; Fig. 4 is a section through part of a machine that is used for winding the coil; Fig. 5 is a section through the machine of Fig. 4 but showing the punch in the coil compressing position; Fig. 6 is a section through a modified form of deforming machine, and Fig. 7 is a side elevation partly in section of a coil that is formed by the machine of Fig. 6.

An electro-dynamic device with which a coil made in accordance with my invention is adapted to be used is illustrated in Fig. 1 on a loud speaker, which has a diaphragm 10, one end of which is attached to a movable coil form 11, and the other end of which is attached to the outer end of a housing 12. A voice coil 13 is mounted on the form 11 and is disposed in an air gap 14, between an inner pole piece 15 and an outer pole piece 16. The stationary field coil is indicated at 17 wi hin a shell 18, and the movable coil is shown as being flexibly supported by a spider 19.

To make the voice coil, I wind preferably round enameled wire into a coil form, and then press the form into suitably formed dies with sufficient pressure to eliminate all of the space between the turns of wire. This makes the wire assume substantially a square-shape in cross-section, and causes each turn to squarely abut the adjacent turn and to align axially and accurately with all of the other turns, whereby the outer and inner resulting surfaces are accurately cylindrical.

One method of making the coil, comprises the utilization of a die 20 which has a cylindrical groove 21 therein, and which is adapted to be rotated as on the live spindle of a lathe. The end of the wire to be wound, and preferably round wire is used for this purpose, is suitably fastened to the bottom of the groove, such as by threading it through a passageway 22 to the outerside of the die and then bending it backwardly upon itself, and then while the die is rotated, the wire is fed into the groove and pressed down with a tool 19 which can be inserted into the groove. After the desired number of turns are made in the groove, the wire is cut off and the punch 23 having an annular skirt 24 is moved axially into engagement with the coil and with sufficient pressure to compress it until all of the space between the turns and the walls of the groove is filled with metal. Since the die is accurately formed, it follows that the coil will be correspondingly formed with true cylindrical inner and outer surfaces.

After the coil has been compressed, the punch is withdrawn, and the coil is ejected from the groove. This may be accomplished by the ejector ring 25, which is disposed at the bottom of the groove and is arranged to be moved axially by ejector pins 26 in any suitable manner, such as by a hand or machine operated member 27. After the coil is removed, it is placed upon a coil form 28, which is preferably made of paper shaped to provide a coil receiving groove, and the leads 29 are brought out through suitable perforations in the form.

A coil which I have described embodies a single

layer of wire, but if desired, a plurality of layers may be used. For example, a two-layer coil is illustrated in Fig. 3, wherein the outer layer 30 may be positioned on the outer-surface of the form 31 and the inner layer 32 may be positioned on the inner layer of the form. Cement may be used to hold the coils in proper relationship, and to this end, one coil may be welded or soldered, as at 33, to the end of the other coil.

In Fig. 6, I have shown a modified form of deforming machine, which may be used to produce a coil having turns of exactly square cross-section. To this end, the coil formed on the machine shown in Figs. 4 and 5 may be inserted into the die 40 and may then be engaged by a punch 41 and compressed by the exertion of pressure radially against the inner side of the coil. To this end, the punch has a reduced forward end 42 which may be cylindrical in shape and which acts as a pilot during the compressing action.

The punch may also have a tapered portion 43 which gradually and progressively comprises the coil indicated at 44, thus causing it to assume a flatter shape than that which it possessed at the time it was inserted into the die. The remaining part of the punch has a diameter equivalent to that required by the internal diameter of the finished coil. To hold the coil during this operation, I have shown a skirt 45, which may be an annular member that is urged forwardly into engagement with the end of the coil by springs 46, which are disposed between the skirt or sleeve and the punch holder 47. After the coil is deformed to the proper extent, the punch is withdrawn and the coil is ejected, as by operation of the member 27, which acts on the ejector ring 25.

From the foregoing description, it will be apparent that a coil made in accordance with my invention has the accuracy of die constructed articles and has the added advantage of a high space factor between the turns. Thus, the coil can operate with less clearance in the air gap. This cannot be done with a coil which is wound in ordinary manner, for the turns cannot be made to align with any degree of accuracy that is comparable to die work. Accordingly, I obtain a core wherein the maximum amount of metal may be used in an air-gap of a given size, and I obtain a construction, wherein the turns are not subjected to distortion or to a tendency to unwind after the coil has been in use for an appreciable length of time.

I claim:

A method of making a voice coil for an electrodynamic device comprising progressively inserting the turns of round wire into an annular recess which has a close fitting engagement with the inner and outer peripheral edges of the wire, and then while the turns are so confined, exerting pressure in an axial direction upon them until each is deformed, and all of the space between them is occupied by the wire, and then ejecting the coil and mounting it on a coil form.

BERNARD A. ENGHOLM.