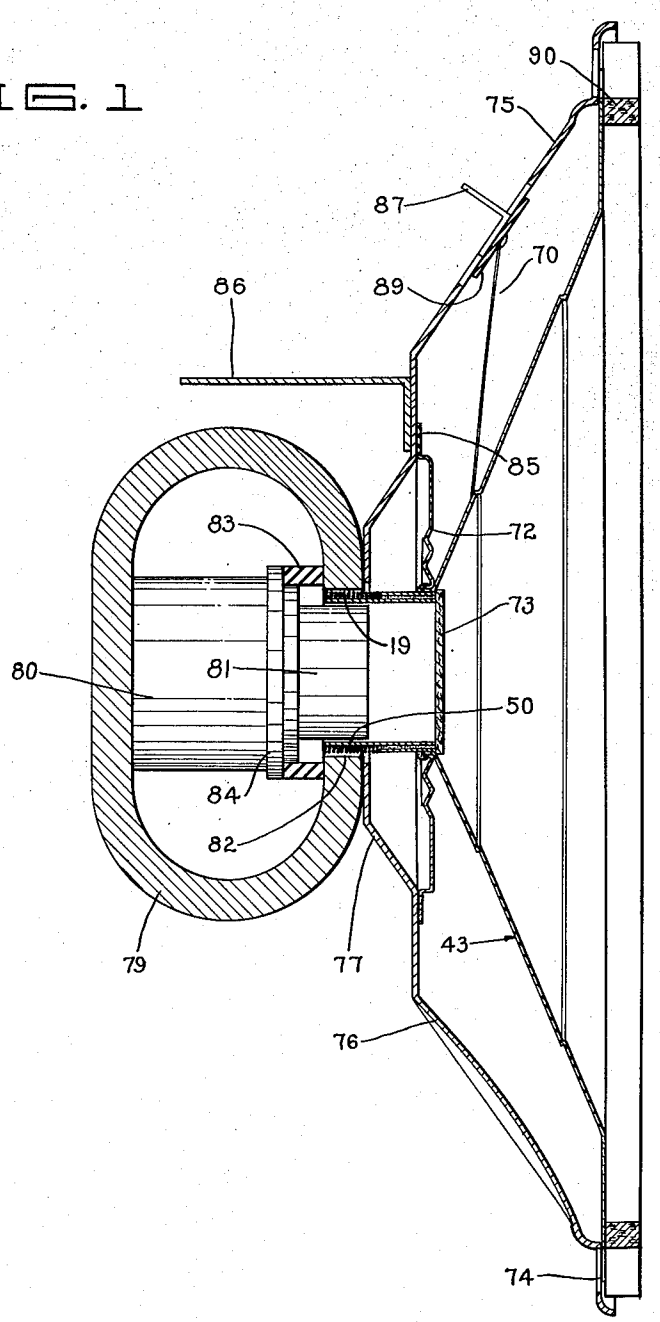
April 8, 1952 B. T. SETCHELL 2,591,881

METHOD OF MAKING RADIO SPEAKERS

Filed Feb. 28, 1947 4 Sheets-Sheet 1

FIG. 1



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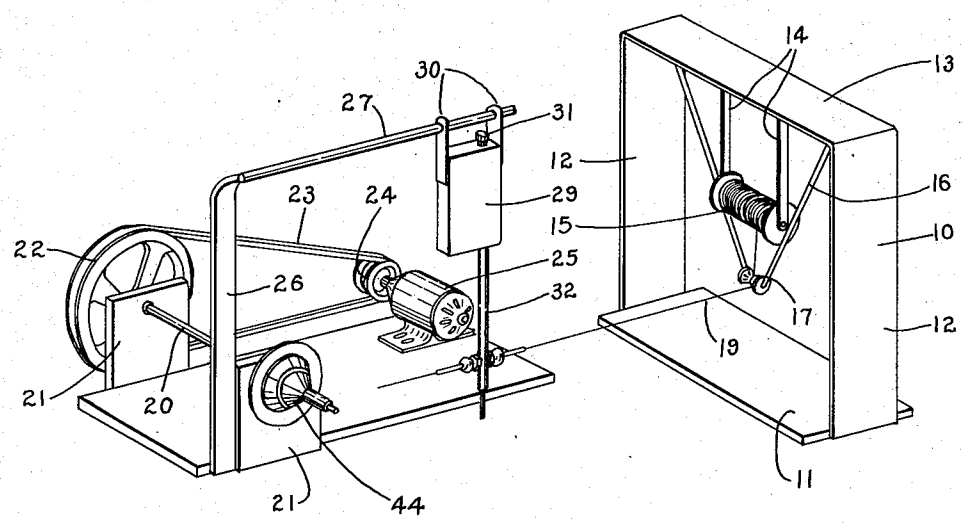
Attorney

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METHOD OF MAKING RADIO SPEAKERS

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FIG. 2



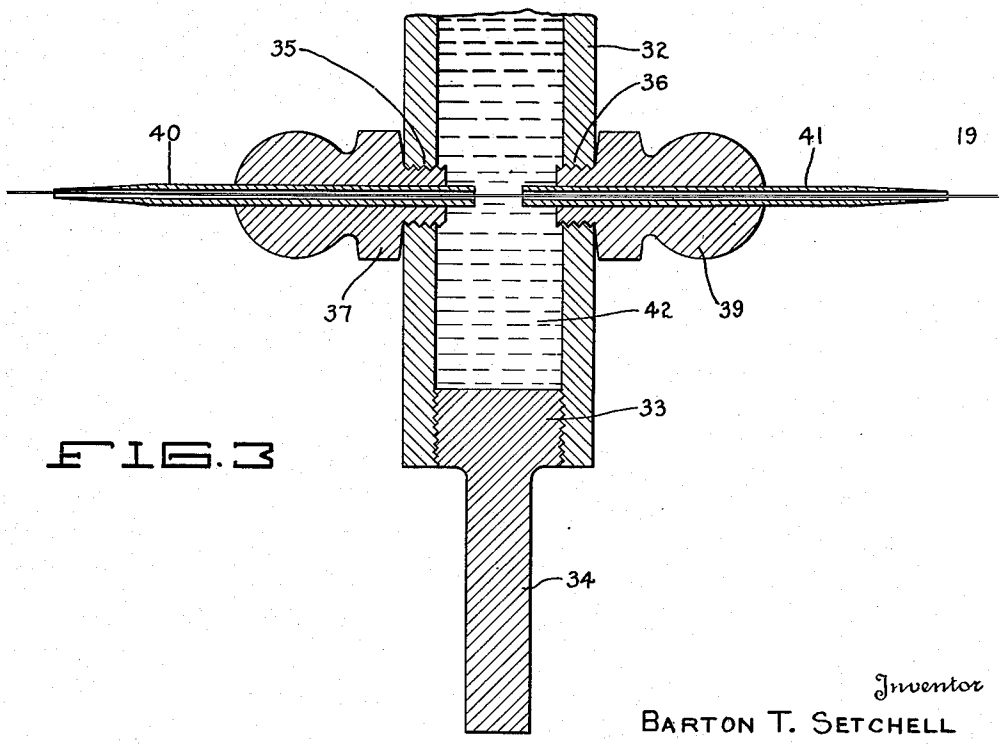


FIG. 3

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METHOD OF MAKING RADIO SPEAKERS

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FIG. 4

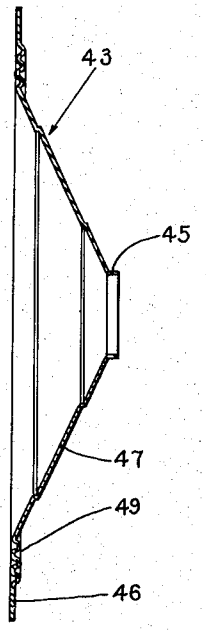


FIG. 6

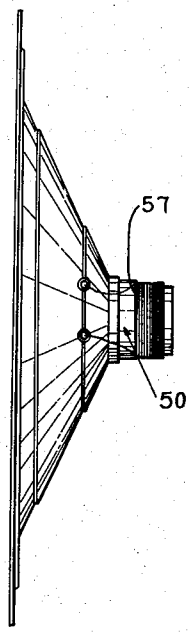


FIG. 5

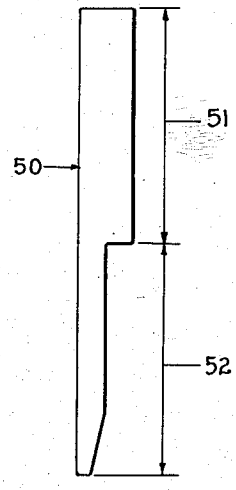
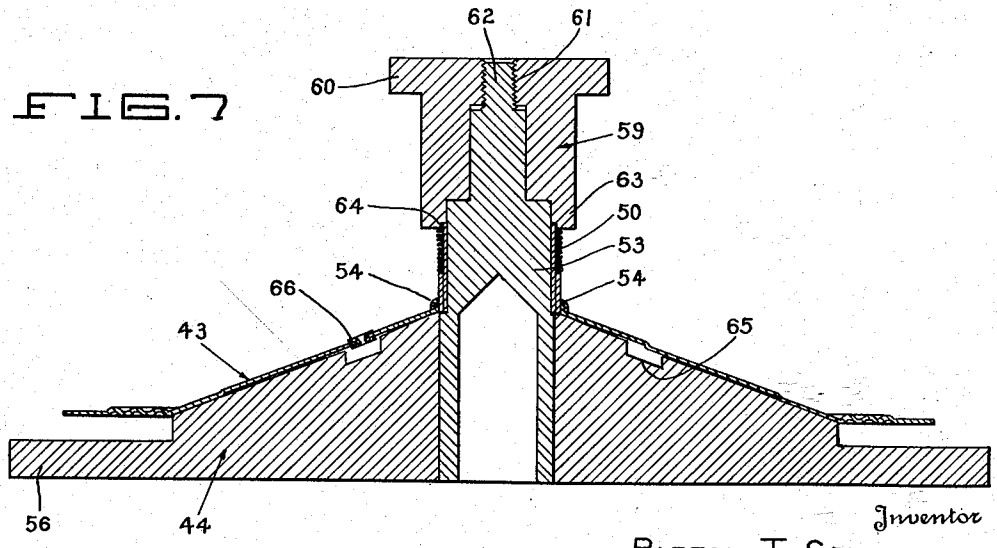


FIG. 7



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METHOD OF MAKING RADIO SPEAKERS

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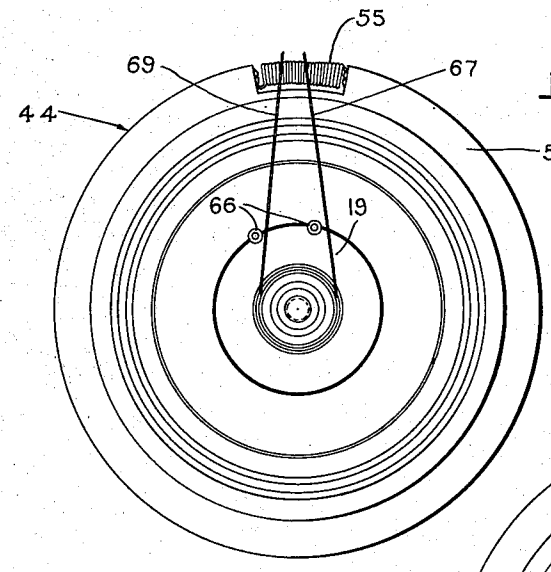


FIG. 8

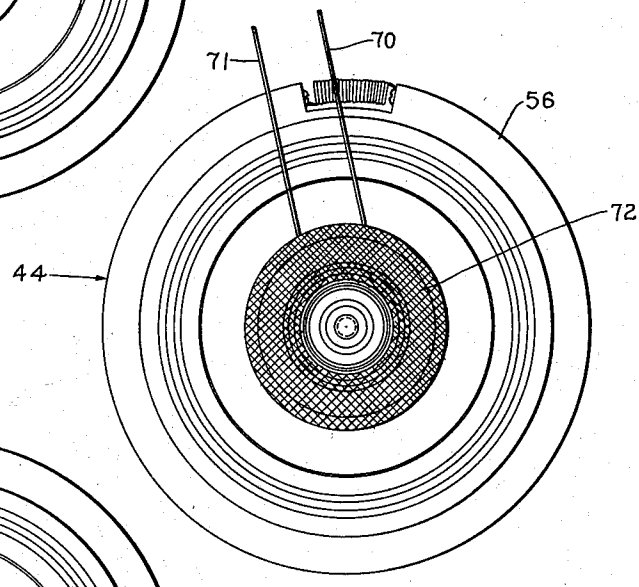


FIG. 10

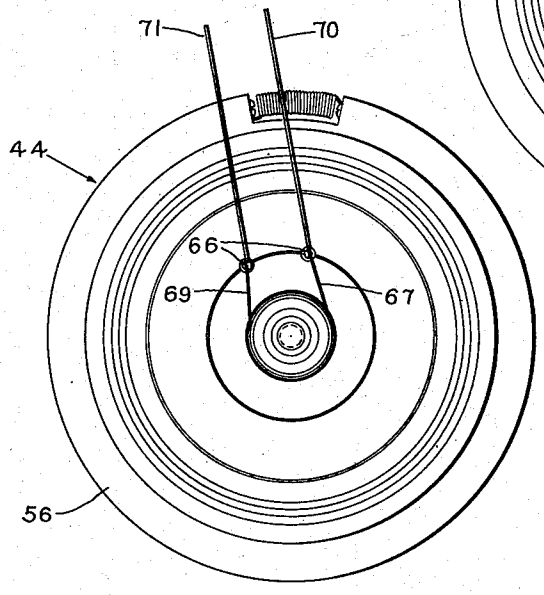


FIG. 9

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UNITED STATES PATENT OFFICE

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METHOD OF MAKING RADIO SPEAKERS

Barton T. Setchell, St. Paul, Minn.

Application February 28, 1947, Serial No. 731,579

2 Claims. (Cl. 29—155.57)

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My invention relates to an improvement in apparatus for making radio speakers and the like, wherein it is desired to reduce the cost of manufacture of these articles.

In the manufacture of radio speakers, it is common practice to employ a diaphragm formed of fibrous material and to secure to this diaphragm a paper core having a wire coil encircling the same. This coil must be positioned and formed with extreme accuracy if the speaker is to operate properly in view of the fact that the coil must be received in a narrow circular gap between the pole piece and an encircling aperture in the speaker pot. Considerable difficulty is experienced in properly forming these coils and in properly positioning the coils on the speaker diaphragm.

It is an object of the present invention to provide a means of applying a coat of adhesive to the surface of the coil wire during the formation of the coil. In the past it has been usual practice to apply a coating of adhesive to the ring shaped paper core on which the coil is wound, to wind the coil on this core, and to apply a second coat of adhesive over the surface of the coil. By applying the adhesive directly to the wire, the necessity of stopping to apply successive coats of adhesive to the paper and coil is obviated, thus saving considerable time. Furthermore by applying an even coating to the wire, a coil is produced which is always of the same diameter thus permitting the gap between the pole piece and the speaker pot to be of minimum width.

An added feature of the present invention lies in the provision of a means for automatically applying a film of liquid adhesive to the surface of a wire as the wire is used. As the wire is removed from the spool it is directed through a chamber filled with adhesive, thereby coating all surfaces of the wire with the adhesive. As the wire travels from the adhesive chamber, it passes through an aperture slightly larger in diameter than the wire, thus removing excess adhesive.

A feature of the present invention resides in the provision of a liquid adhesive compartment and in providing aligned apertures in this compartment through which wire may be drawn. The apertures are so small in size that the adhesive will not run or flow from the adhesive compartment even though the apertures are substantially below the adhesive level in the compartment. In preferred form I employ hypodermic needles on opposite sides of the adhesive compartment through which the wire is guided during its entrance to and exit from the adhesive chamber.

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An added feature of the present invention resides in the provision of a rotatable spindle on which the speaker diaphragm may be mounted during the formation of the paper core. This spindle is provided with a core about which the paper sleeve supporting the coil may be wrapped. This paper sleeve is wrapped about the mandrel and adhered to the surface of the diaphragm with a suitable cement. Means are provided for regulating the length of the coil wrapped thereabout so that the desired number of turns is provided on the coil.

A further feature of the present invention lies in the provision of a movable adhesive chamber through which the wire is drawn before it is wrapped about the paper sleeve. The adhesive chamber is movable so that the wire may follow a substantially straight path while travelling from the source of supply into winding position.

One of the primary difficulties experienced in the formation of the loud speakers lies in the proper formation of the voice coil and in maintaining this coil in proper shape during the assembly of the speaker. It is usual practice to form the voice coil over a collapsible mandrel either with or without its paper core and to apply a suitable adhesive to the surface of this coil after the formation thereof. Some time is required for this adhesive to set and the adhesive has somewhat of a tendency to contract as it dries. Furthermore the wire itself is stretched during the formation of the coil and tends to return to its original shape, thus tending to distort the coil. It is usually impractical to maintain the coil on the mandrel until the adhesive has dried due to the time element involved. As a result the moist adhesive, the resilience of the wire, and the movement of the mandrel tend to distort the coil as it is removed from the mandrel. Furthermore the handling of the coil while supported only by its thin paper sleeve tends to distort the coil between the time it is formed and the time it is attached to the diaphragm. If the coil is out of round it does not properly fit between the pole piece and the speaker pot unless an unusually wide gap is provided, thus impeding the efficiency of the speaker.

It is an important feature of the present invention to form the coil on a mandrel and to hold the coil thereupon until the adhesive is entirely dry. The coil is formed about the paper sleeve after the attachment of this sleeve to the diaphragm and the sleeve is held in cylindrical form by the mandrel about which it is wrapped during a large part of the speaker assembly operation. Before the diaphragm and coil are removed

from the supporting mandrel the adhesive is completely dried by infra red lamps or other suitable means, thus insuring the proper shape of the coil and minimizing the handling thereof before the speaker is completely assembled.

An added feature of the present invention resides in the provision of a means for reversing the direction of wind of the wire so that a coil of two thicknesses of wire is provided. The paper sleeve which forms the core is so formed as to be thicker on one end than on the other. The wire is wrapped about this sleeve or the portion thereof of lesser thickness. When the wire reaches the end of the coil, means is provided for reversing the direction of the wire so as to provide a layer of wire overlying the innermost layer.

An added feature of the present invention lies in the provision of a mandrel on which the speaker may be assembled to insure the proper relationship of the parts and to prevent fracturing of the diaphragm during the assembling operation. This mandrel is designed to support the diaphragm so that the paper sleeve can be attached thereto at the center thereof. The coil is next wound about the sleeve so that the coil is properly positioned at the center of the diaphragm. Means is provided near the periphery of the mandrel and externally of the diaphragm for holding the ends of the wire coil to insure the drying of the adhesive. The mandrel may also be used to hold the diaphragm while the ends of the coil are anchored and soldered to suitable leads.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of my specification:

Figure 1 is a sectional view through a speaker showing the construction thereof at the completion of the forming operation.

Figure 2 is a perspective view of an apparatus for applying adhesive to a wire and for supporting the speaker diaphragm during the coil winding operation.

Figure 3 is an enlarged sectional view through the adhesive chamber showing the manner in which the adhesive is applied to the wire as it passes through the chamber.

Figure 4 is a sectional view through the speaker diaphragm at the beginning of the assembly operation.

Figure 5 is a diagrammatic view of a paper strip which may be used to form the core of the coil attached to the diaphragm.

Figure 6 is a side elevation view of the speaker diaphragm with the paper coil, core and coil attached thereto.

Figure 7 is an enlarged view showing the mandrel on which the diaphragm is mounted during the formation of the coil thereupon.

Figure 8 is a front elevational view of the diaphragm and mandrel at the completion of the coil winding operation.

Figure 9 is a view similar to Figure 8 showing the manner in which the ends of the coil are anchored to suitable leads or conductors.

Figure 10 is a view similar to Figure 9 showing the completion of the coil forming operation, and showing a flexible disc connected to the diaphragm at the base of the core.

The apparatus employed in the manufacture of speakers is diagrammatically illustrated in

Figure 2 of the drawings. In this figure is illustrated a supporting standard 10 mounted upon a base or table 11 and including a pair of spaced uprights 12 connected at their upper extremity by a cross member 13. A pair of arms 14 are supported in any suitable manner by the cross member 13 to rotatably support a spool 15. A substantially V-shaped brace 16 having a roller 17 at its lower extremity acts as a guide for the wire 19 in its movement from the spool 15 to winding position.

The coil winding apparatus also includes a shaft or spindle 20 mounted on spaced supports such as 21 and provided with an operating pulley 22 on one end thereof. The pulley 22 is driven by a belt 23 extending over a suitable pulley 24 on the drive shaft of a motor 25. When the motor 25 is in operation the belt 23 acts to rotate the shaft or spindle 20.

An upright 26 is provided adjacent the support 21 which upright supports a rearwardly extending shaft or pivot 27. An adhesive conductor 29 is provided with a pair of upwardly extending brackets 30 which pivotally engage about the shaft 27. A filling opening 31 is provided at the top of the conductor 29 and a tubular sleeve 32 extends downwardly from the conductor 29 and is closed at its lower extremity by a plug 33 having a guide arm 34 integral therewith.

The tubular member 32 is provided with a pair of aligned opposed apertures 35 and 36 therein which are tapped to receive the externally threaded end of a suitable hypodermic needle fitting 37 or 39. The fittings 37 and 39 respectively support the hollow hypodermic needles 40 and 41 which extend in aligned opposed relation in opposite directions from the tubular member 32.

The hypodermic needles 40 and 41 are of proper internal diameter to receive the wire 19 and to allow the wire to pass freely therethrough. At least the needle 40 is of sufficient internal diameter to permit the wire to be carried from the adhesive chamber 42 within the tubular member 32 without scraping all of the adhesive from the surface of the wire.

It will be seen that as the wire 19 is drawn from the spool 15 it is carried through the adhesive chamber 42 and coated on all surfaces with liquid adhesive. The wire 19 then passes through the needle 40 where just sufficient adhesive remains on the wire to properly adhere the wire to the coil and in coiled formation. The uniform coating of adhesive is not sufficient to greatly increase the diameter of the coil and all of the coils are of similar diameter in view of the even coating of adhesive on the wire. Either or both of the needle fittings 37 and 39 may be removed before the start of the coating operation so that the wire 19 may be threaded therethrough without difficulty. In usual practice the wire 19 is threaded through the needle 41 and through the opposed aperture 35 in the tubular member 32 while the needle fitting 37 is removed. The wire is then inserted through the hypodermic needle 40 from the inner end thereof, thus providing a continuous path for the wire through the body of adhesive.

In the formation of speaker units the diaphragm 43, best illustrated in Figure 4 of the drawings, is mounted upon a mandrel 44 illustrated in Figure 7 of the drawings. The diaphragm 43 usually includes a central flange 45 which is centered in respect to a circular periph-

eral flange 46. The body of the diaphragm 43 is generally cone shaped between the flange 45 and the flange 46 comprising a tapered body 47 having a series of circular corrugations 49 extending thereabout between the cone-shaped body 47 and the flange 46. Additional steps may be provided if desired in the cone shaped body to render the cone properly flexible to produce the desired sound.

A paper sleeve or tab is secured to the diaphragm 43. This sleeve is formed of a paper strip 50 best illustrated in Figure 5 of the drawings. The strip is of proper length to form a sleeve of two laminations throughout half its length, and of a single thickness throughout the remainder of its length. The portion 51 of the strip forms the inner lamination and the portion 52 forms an outer lamination throughout part of the length of the sleeve. The double thickness or reinforced end of the sleeve 50 is secured to the diaphragm, with the single thickness portion on the free end of the sleeve to support the wire coil.

In attaching the paper core or sleeve 50 to the diaphragm 43, the paper sleeve is wrapped about the projecting shank 53 of the mandrel 44. After the sleeve is in place on the shank 53, the diaphragm 43 is inserted over the sleeve to hold the sleeve in coiled relation. Adhesive is applied at 54 at the juncture between the paper sleeve and the flange 45 of the diaphragm. This is usually accomplished by wrapping the paper about the shank 53 during rotation of the shank, inserting the diaphragm 43 in place, forcing adhesive by any suitable means at the juncture of the sleeve and diaphragm during rotation thereof. The sleeve is thus attached to the diaphragm and the coil is in readiness to be formed. The wire 19 is then anchored in a coil spring 55 mounted near the periphery of the flange 56 at the outer margin of the mandrel 44. The wire is drawn adjacent the shoulder 57 formed between the single thickness portion of the sleeve 50 and the double thickness portion thereof and the mandrel 44 is rotated to wind the wire 19 about the single thickness portion of the sleeve 50.

Prior to the coil winding operation a coil limiting sleeve 59 is engaged on the end of the shank 53. The sleeve 59 is provided with a peripheral flange 60 by means of which the sleeve may be rotated, an internally threaded portion 61 to engage on the externally threaded portion 62 of the shank 53, and a projecting sleeve portion 63 which is undercut to engage over the end of the sleeve 50. This projecting sleeve portion 63 limits the length of the coil. As a result when the wire 19 has been wound about the single thickness portion of the sleeve 50 until the wire engages the projecting sleeve portion 63, the wire will build up on the first layer and start a reverse winding overlying the first winding mentioned. This reverse winding is continued until the wire reaches the double thickness portion of the sleeve 50 whereupon rotation of the mandrel 44 is stopped, the coil wire broken off at a point spaced from the core and the end of the wire anchored in the spring 55 as illustrated in Figure 8 of the drawings.

In other words, a coil of two layers of wire is formed in a continuous operation, the coil including a predetermined number of turns. The limiting sleeve forms a shoulder which will automatically terminate the inner coil layer and start the second coil layer. It is only necessary for the operator to guide the wire during the coiling

operation and to stop the rotation when the second coil layer reaches the double thickness portion of the paper core. As a result the task of forming the coil on the diaphragm is greatly simplified and the speed of operation is greatly increased. Furthermore, the coil may be properly wound by a relatively unskilled worker. In the past considerable skill was required for this task.

As will be noted in Figure 7 of the drawings the mandrel 44 is provided with a circular groove 65 therein which underlies a portion of the supported diaphragm 43. A pair of eyelets 66 extend through the diaphragm 43 at spaced points in registry with the groove 65. As a next step of the process the ends 67 and 69 of the coil wire 19 are cut off and inserted into these eyelets 66. Lead wires or conductors 70 and 71 are likewise inserted into the eyelets 66 and a drop of solder or similar material is placed upon each eyelet to electrically connect the coil ends 67 and 69 to the lead wires 70 and 71 and to anchor the ends of the coil. The lead wires 70 and 71 are connected in the proper circuit so as to produce electrical impulses through the wire coil 19. As soon as the lead wires have been properly attached a spider of fabric or the like, indicated by the numeral 72, is inserted over the sleeve 50 and coiled to encircle the joint between the paper core and the diaphragm 43. Adhesive is applied about the inner periphery of the fabric spider 72 to adhere this member to the diaphragm 43.

During the preceding process, the tab or sleeve 50, the diaphragm 43, the voice coil, the coil leads, and the spider are applied in sequence. In volume assembly, the various steps are followed by different workers, so that the adhesive holding the coil tab or sleeve to the diaphragm and the adhesive on the coil wire have some time to set before the spider is applied. In order to insure proper drying of the adhesive, infra-red heat bulbs are directed toward the assembly at one or more points during or after the process described. When the adhesive has set, the assembly is removed from the mandrel 44, the empty mandrels returned to the first stage of the assembly process, and the diaphragm voice coil assembly mounted in the speaker basket.

The peripheral flange 74 of the speaker basket 76 supports the rim 46 of the diaphragm 43. A gasket 75 overlies the diaphragm rim, and these elements are adhered together. The remaining assembly process is generally conventional. A pad 73 of felt or the like is adhered to the center of the diaphragm to close the end of the coil sleeve 50. The spider 72 is adhered to the speaker basket 76 at 85 to seal the voice coil from dust and dirt. The speaker coil extends into the gap 82 between the pole piece 81 of the magnet 80 and the speaker pot 79. The coil leads 70 and 71 are connected to spaced terminals 87 projecting from the speaker basket.

A shoulder 84 on the pole piece is sealed with respect to the speaker pot 79 by a resilient washer 83. This washer, the pad 73, and the spider 72 completely seal the coil when it is in the gap 82. The mounting bracket 86 and insulation plate 89 are additional accessories.

The advantage of the present method of forming speakers lies in the simplicity thereof, the speed with which the speakers may be assembled, and the quality of the voice coils formed. The diaphragms are formed of molded pulp or similar material and are ready for use as supplied. The

paper strips 50 forming the sleeves designated by the same numeral are stamped out of paper of proper thickness and strength. By holding the sleeves 50 and coil wound thereon firmly upon the mandrel 44 during the entire assembly operation, the coils are prevented from distorting as the adhesive dries.

In accordance with the patent statutes, I have described the principles of construction and operation of my apparatus for making radio speakers, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that obvious changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. The method of connecting a coil to a diaphragm through the use of a rotatable mandrel, the method comprising the steps of wrapping a sleeve of relatively thin, flexible material about the rotatable member, forming a shoulder circumjacent one end of the sleeve, inserting the diaphragm over the shoulder, attaching the diaphragm to the shoulder, applying adhesive to a wire, and wrapping said wire about the sleeve without removing said sleeve from the mandrel to form a coil on said sleeve.

2. The method described in claim 1 in which said flexible material is a strip of paper and said shoulder is formed by wrapping more turns of said paper adjacent said one end.

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