This invention relates to the manufacture of so-called double-cone diaphragms for loud speakers.

Many of the radio loud speakers now in use have a paper diaphragm formed by cementing together the base edges of two cones, or a cone and a cone frustum. This type of diaphragm is usually referred to as a double-cone diaphragm.

One object of this invention is to provide a simple piece of apparatus which facilitates the assembling and uniting of the two sections of a double-cone diaphragm.

Another object is to provide an improved process of assembling or uniting the two sections of a double-cone diaphragm.

In the type of double-cone diaphragm with which this invention particularly deals, the edges of the cone sections are not cemented directly to each other but by a narrow ring, whose axis is parallel with the cone axis, is interposed between the edges in such a way that the edge portion of each cone section extends slightly beyond the ring to form a peripheral groove which is later filled with an ornamental filler such as a twisted cord or the like.

The apparatus by which the cone sections are assembled and united comprises a group of holding devices for receiving the cone sections and the above-mentioned ring and holding them in proper relation while they are being cemented together and while they are being dried.

The accompanying drawing illustrates the improved process of assembling or uniting the cone sections and also illustrates one form of apparatus in which the process may be carried out.

In the drawing:

Fig. 1 is a top plan view of the apparatus;

Fig. 2 is a vertical section taken on the line 2--2 of Fig. 1;

Fig. 3 is an enlarged partial vertical section showing the upper ring partly removed;

Fig. 4 is a detail perspective view of the split ring that is utilized to facilitate the formation of the groove at the periphery of the diaphragm;

Fig. 5 is a partial vertical section of the diaphragm in the condition in which it leaves the apparatus; and

Fig. 6 is a partial vertical section of the diaphragm showing the ornamental cord applied to the groove at the periphery of the diaphragm.

The description of the apparatus and the purpose of its various parts will be more readily understood if the construction of the diaphragm is first explained. Fig. 2 shows the general shape of the double-cone diaphragm. It comprises a cone section 1 and a frusto-conical section 2. Fig. 5 more clearly shows the construction at the meeting edges of the cone and cone frustum. A relatively narrow ring 3 which may be made of heavy paper or card board has its axis parallel with the axis of the cone and cone frustum, and is cemented to both sections of the diaphragm by the adhesive represented at 4. The ring 3 is spaced back a slight distance from the extreme edges of the cone and cone frustum so as to form a peripheral groove 5 which is intended to receive an ornamental filler such as a twisted cord as shown at 6 in Fig. 6. The cord conceals the joint between the two sections of the diaphragm and adds to the ornamental appearance of the finished diaphragm.

The apparatus in which the cone sections are united comprises a lower ring 7 supported on a suitable table 8 by means of the legs 9. The ring 7 has a beveled seat 10 adapted to accommodate the edge portion of the cone section 1. A second continuous ring 11 is adapted to be positioned on and removed from the ring 7 by means of handles 12. The ring 11 also has a beveled under surface 13 the inclination of which is the same as the inclination of the cone frustum 2. A ring 14, split at 15 is adapted to be contracted by a handle 16 against a shoulder 17 formed on the ring 7. The ring 11 is adapted to nest within the ring 14. When the ring 11 is in place it is adapted to
be pressed downwardly toward the ring 7 by a plurality of hand clamps each of which comprises an angle member 18, the vertical leg of which is adapted to rest on the ring 7, and the horizontal leg of which is adapted to project over the ring 11. Each clamp has a pin 19 which is rigidly attached at its lower end to the ring 7 and which passes at its upper end loosely through the horizontal portion of the angle 18. A nut 20 is threaded on the upper end of each pin 19 and may be turned by handles 21. It will now be noted that the angles 18 may be turned so that the horizontal portions either

clear the ring 11 or project over it. When it is desired to clamp the ring 11 in place the angles are turned so that their horizontal portions project over the ring 11, then the nuts 20 are turned to force the angles
down against the ring 11. A spring 22 preferably encircles each pin 19 and reacts at its lower end against the ring 7 and at its upper end against the angle 18 so as to yieldingly hold the horizontal portion of the angle in a raised position.

A heating coil 23 is clamped to the lower surface of the ring 7 by means of clamps 24. A suitable heating medium such as steam or hot water may be supplied to the coil at 25 and discharged at 26.

The diaphragm sections are assembled and united in the apparatus as follows. The cone 1 and the frustum 2 previously receive their shape either by hand or in a suitable machine. The ring 11 is removed and the split ring 14 is loosened. The cone 1 is then positioned in the ring 7 as shown in Figs. 2 and 3 after which a temporary expansible metal ring 27, shown in Fig. 4, is placed around the edge of the cone 1 and against the inner surface of the ring 14. The cardboard ring 3, preferably in two or more sections, is then positioned against the inner surface of the ring 27. The cone

frustum 2 is next positioned so that its edge overlaps the upper edges of the metal ring 27 and cardboard ring 3. The ring 11 is then positioned within the ring 14 so that it rests upon the entire diaphragm structure.

The handle 16 is then turned to contact the ring 14 and the ring 11 is clamped down by means of the angles 18. The operator now takes a brush, dips it in adhesive such as liquid celluloid and reaches in the interior of the diaphragm. With a circular motion he "paints" the adhesive against the inner surface of the cardboard ring 3 and against the adjacent inner surfaces of the cone and cone frustum. The adhesive penetrates into the crevices between the ring 3 and the diaphragm sections as shown in Fig.

5. The diaphragm is allowed to remain in the apparatus until the heat from the coil 23 sets, or at least partially sets the adhesive, after which the ring 14 is loosened, the ring 11 is removed and the diaphragm structure is removed from the apparatus. When the diaphragm structure is removed from the apparatus the metal ring 27 comes with it. This ring is then removed leaving in its place the peripheral groove 5. The ring 3 remains permanently cemented in place by the set adhesive thus uniting the cone 1, the frustum 2 and the ring 3 into a unitary structure. It will be understood of course, that the ring 27 is really part of the apparatus and is used over and over again.

The metal ring 27 and the cardboard ring 3 are of such relative widths that when the ring 11 is clamped in place the metal ring 27 prevents the cardboard ring 3 and the diaphragm sections from being crushed but at the same time it allows the edges of the diaphragm sections to be pressed into close contact with the upper and lower edges of the cardboard ring 3. The ring 27 not only acts as a stop to properly space the ring 11 with respect to the ring 7 and thereby prevent the diaphragm parts from being injured, but it also acts as a spacer to properly space the cardboard strip 3 in such a way that when the ring 27 is removed a recess or groove of the size of the ring remains in its place at the periphery of the diaphragm.

The metal ring 27 and cardboard ring 3 are of such a size that the peripheral groove 5, which finally exists at the periphery of the diafragm is the proper size to receive the cord 6. The cord may be positioned in the groove 5 wholly by hand or by a suitable machine and may be held in place by adhesive represented at 28.

The diaphragm structure itself is covered in other copending applications.

We claim:

1. Apparatus for use in the manufacture of double-cone diaphragms comprising two members at least one of which is removable with respect to the other, each of said members having a beveled surface forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diafragm, and means for supplying heat to the diaphragm parts while held between said members.

2. Apparatus for use in the manufacture of double-cone diaphragms comprising two members at least one of which is removable with respect to the other, each of said members having a beveled surface forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diafragm, and means associated with at least one of said members for heating the same.

3. Apparatus for use in the manufacture of double-cone diaphragms comprising two members at least one of which is removable
with respect to the other, each of said members having a beveled surface forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, and means for detachably clamping said members together.

4. Apparatus for use in the manufacture of double-cone diaphragms comprising two rings at least one of which is removable with respect to the other, each of said rings having a beveled surface forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, and a third ring encircling at least a part of each of the first mentioned rings.

5. Apparatus for use in the manufacture of double-cone diaphragms comprising two rings at least one of which is removable with respect to the other, each of said rings having a beveled surface forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, a split ring encircling at least a part of each of the first mentioned rings, and means to contract said ring.

6. Apparatus for use in the manufacture of double-cone diaphragms comprising a lower ring, an upper ring, said rings having beveled surfaces forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, a third ring encircling at least a part of each of the first mentioned rings, and a plurality of clamps for clamping the upper ring to the lower ring with the edge portion of the diaphragm interposed between them.

7. Apparatus for use in the manufacture of double-cone diaphragms comprising a lower ring, an upper ring, said rings having beveled surfaces forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, a third split ring encircling at least a part of each of the first mentioned rings, means for contracting said third ring, and a plurality of clamps for clamping the upper ring to the lower ring with the edge portion of the diaphragm interposed between them.

8. Apparatus for use in the manufacture of double-cone diaphragms comprising a lower ring, an upper ring, said rings having beveled surfaces forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, said lower ring having an annular shoulder immediately below the upper edge of its beveled surface, a third split ring encircling at least a part of each of the first mentioned rings, and means to contract said third ring against said shoulder.

9. Apparatus for use in the manufacture of double-cone diaphragms comprising a lower ring, an upper ring, said rings having beveled surfaces forming between them an annular opening converging towards its periphery for accommodating the angular edge portion of the double-cone diaphragm, said lower ring having an annular shoulder immediately below the upper edge of its beveled surface, a third split ring encircling at least a part of each of the first mentioned rings, means to contract said third ring against said shoulder, a plurality of clamps for clamping the upper ring to the lower ring with the angular edge portion of the double-cone diaphragm interposed between them, and means for applying heat to the parts of the diaphragm while clamped between the rings.

10. The process of assembling and uniting the sections of a double-cone diaphragm which comprises placing a temporary ring between the extreme base edges of the sections, positioning a permanent ring between the sections at the inner side of the temporary ring, cementing the permanent ring to the diaphragm sections, applying heat to the diaphragm sections and said permanent ring, and thereafter removing said temporary ring.

11. The process of assembling and uniting the sections of a double-cone diaphragm which comprises placing a temporary ring between the extreme base edges of the sections, positioning a permanent ring between the sections at the inner side of the temporary ring, cementing the permanent ring to the diaphragm sections, applying heat to the diaphragm sections and said permanent ring, and thereafter removing said temporary ring.

12. The process of assembling and uniting the sections of a double-cone diaphragm which comprises placing a temporary ring between the extreme base edges of the sections, positioning a permanent ring between the sections at the inner side of the temporary ring, cementing the permanent ring to the diaphragm sections, applying pressure to the peripheral portions of the diaphragm sections axially of said rings, and thereafter removing said temporary ring.

13. The process of assembling and uniting the sections of a double-cone diaphragm which comprises placing a temporary ring between the extreme base edges of the sections, positioning a permanent ring between the sections at the inner side of the temporary ring, cementing the permanent ring to the diaphragm sections, applying pressure to the peripheral portions of the diaphragm sections axially of said rings so that it will not move radially outward, applying heat to the dia-
phragm sections and said permanent ring, and thereafter removing said temporary ring.

14. The process of assembling and uniting the sections of a double-cone diaphragm which comprises placing a temporary ring between the extreme base edges of the sections, positioning a permanent ring between the sections at the inner side of the temporary ring, cementing the permanent ring to the diaphragm sections, thereafter removing the temporary ring and positioning a permanent filler in the groove formed by the removal of the temporary ring.

In testimony whereof we affix our signatures.

CLAIRE L. FARRAND.

EUREST ROSS.