

Jan. 12, 1954

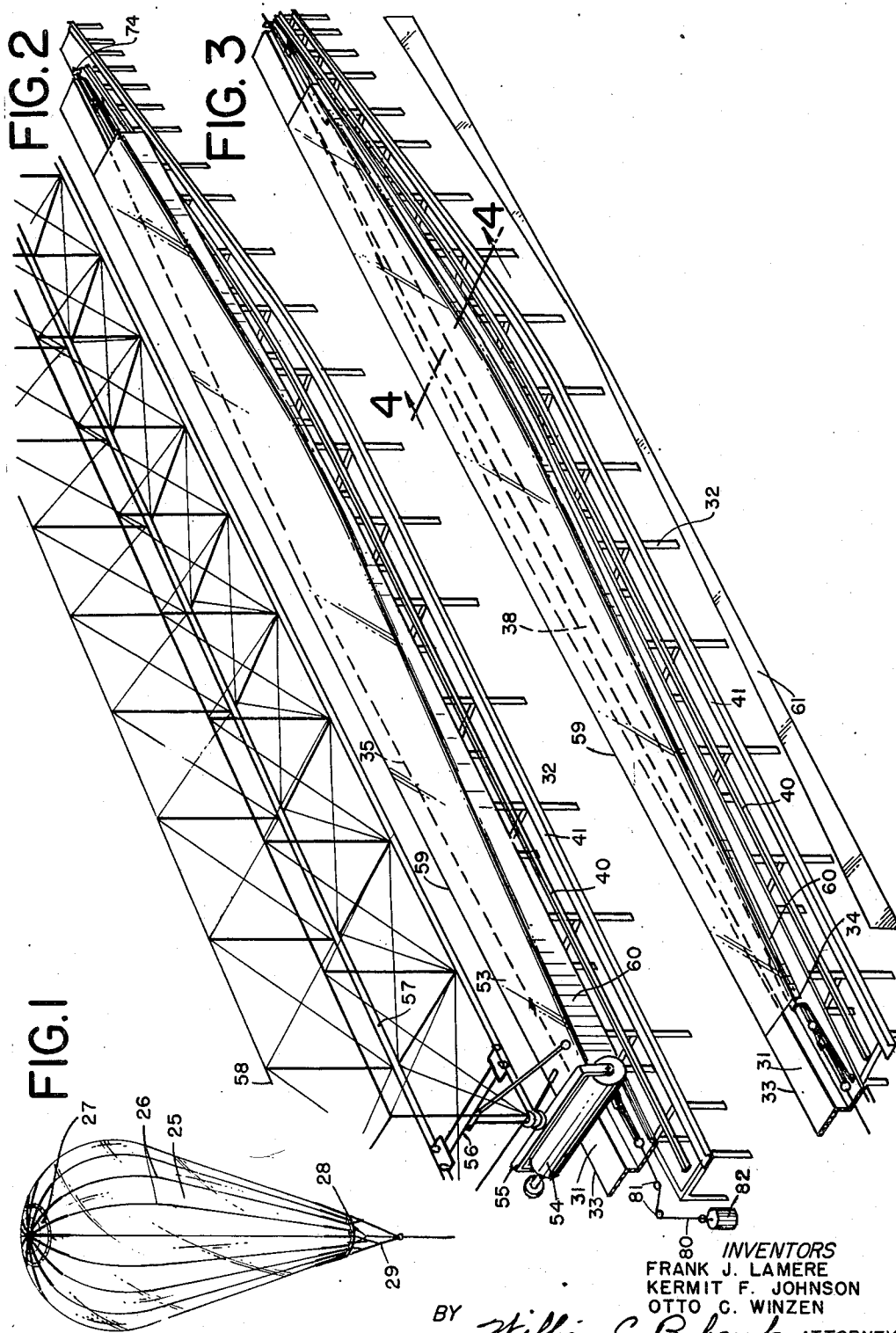
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2,666,006

METHOD OF BALLOON CONSTRUCTION

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FIG. 4

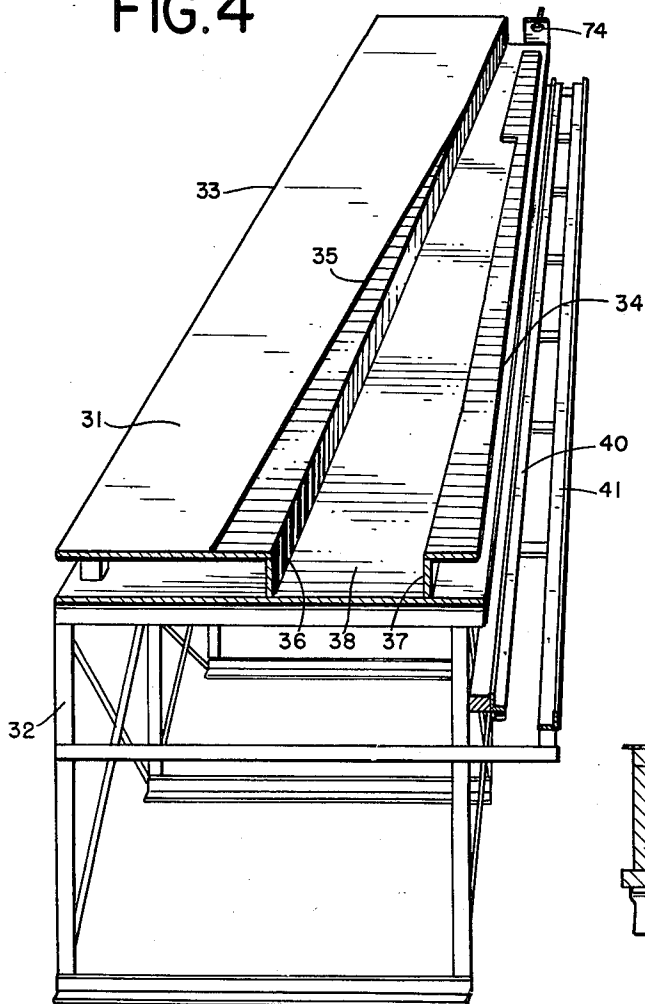
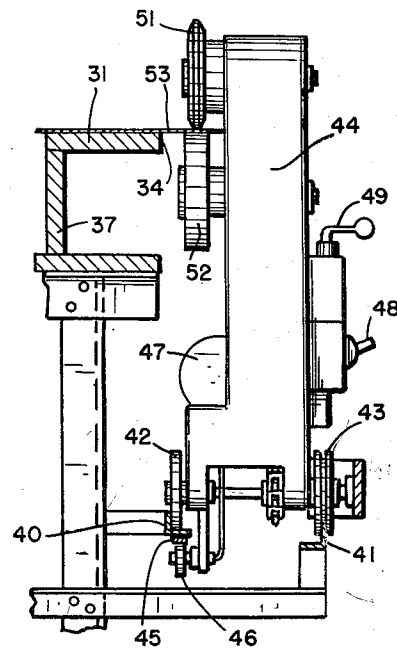


FIG. 5



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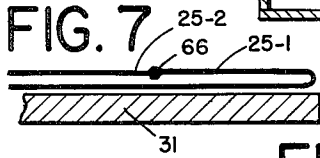
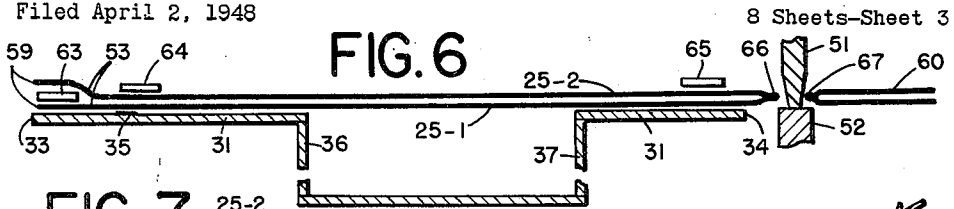


FIG. 8

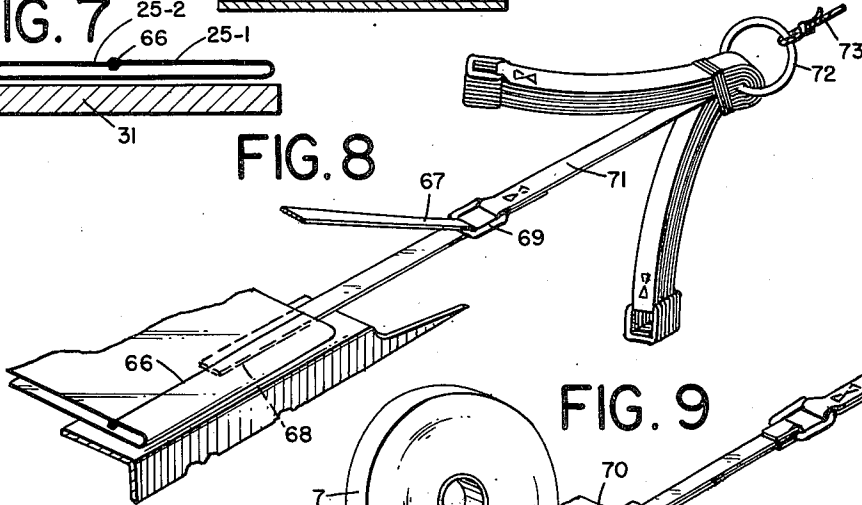


FIG. 9

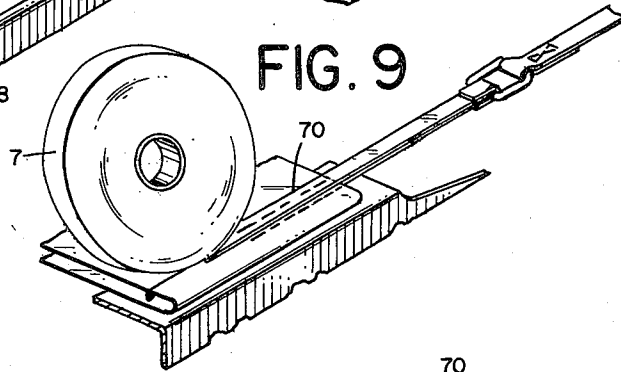
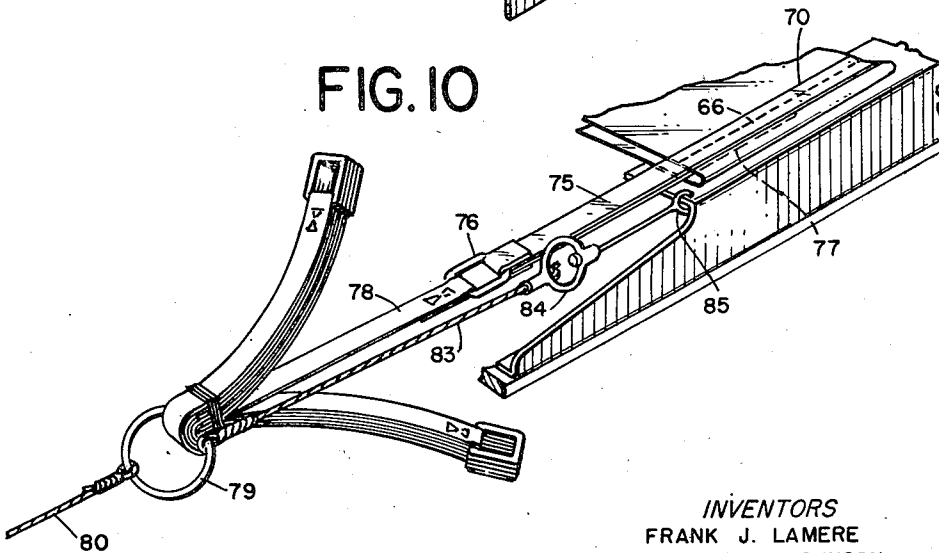


FIG. 10



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FIG. 11

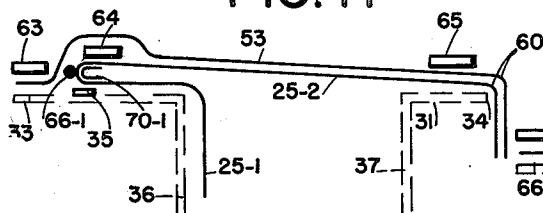


FIG. 12

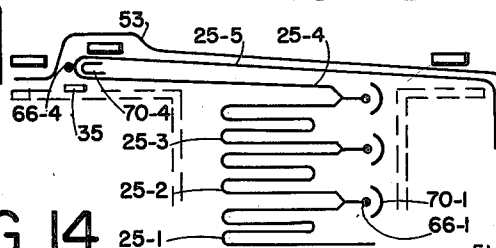


FIG. 14

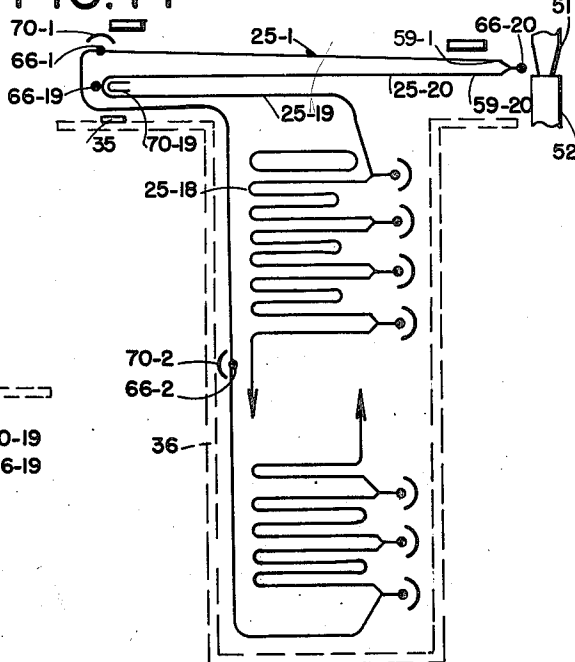


FIG. 13

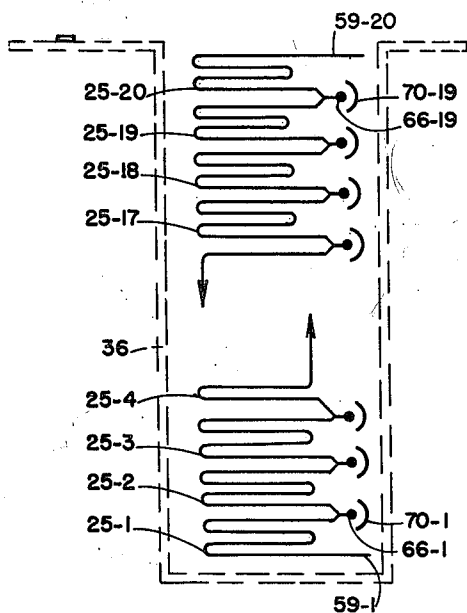
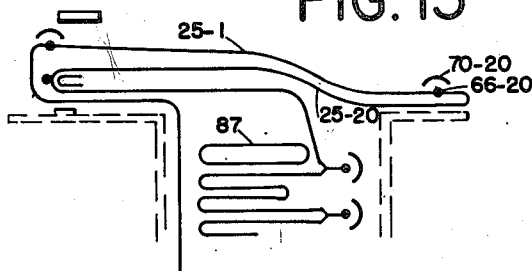


FIG. 15



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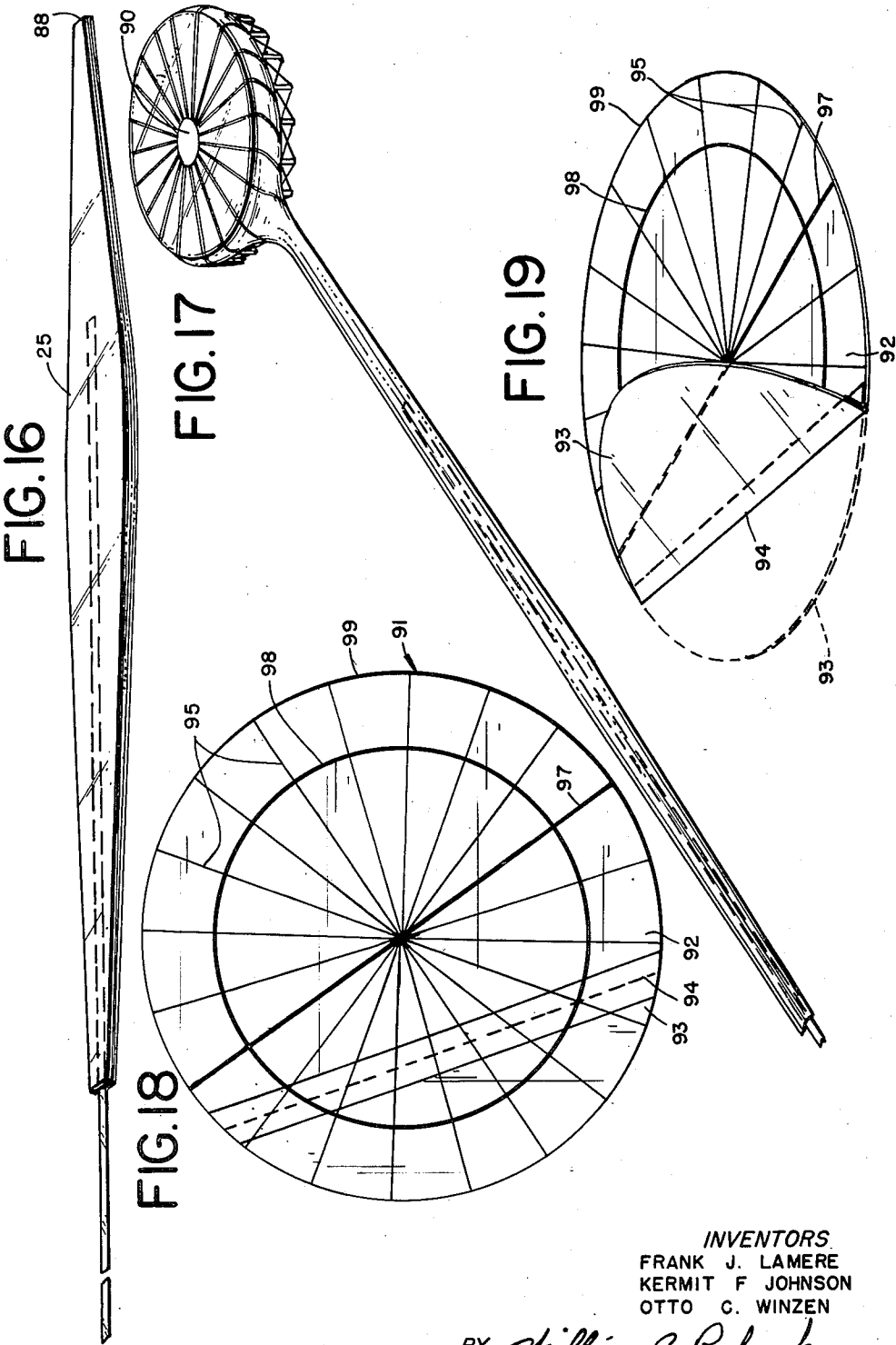
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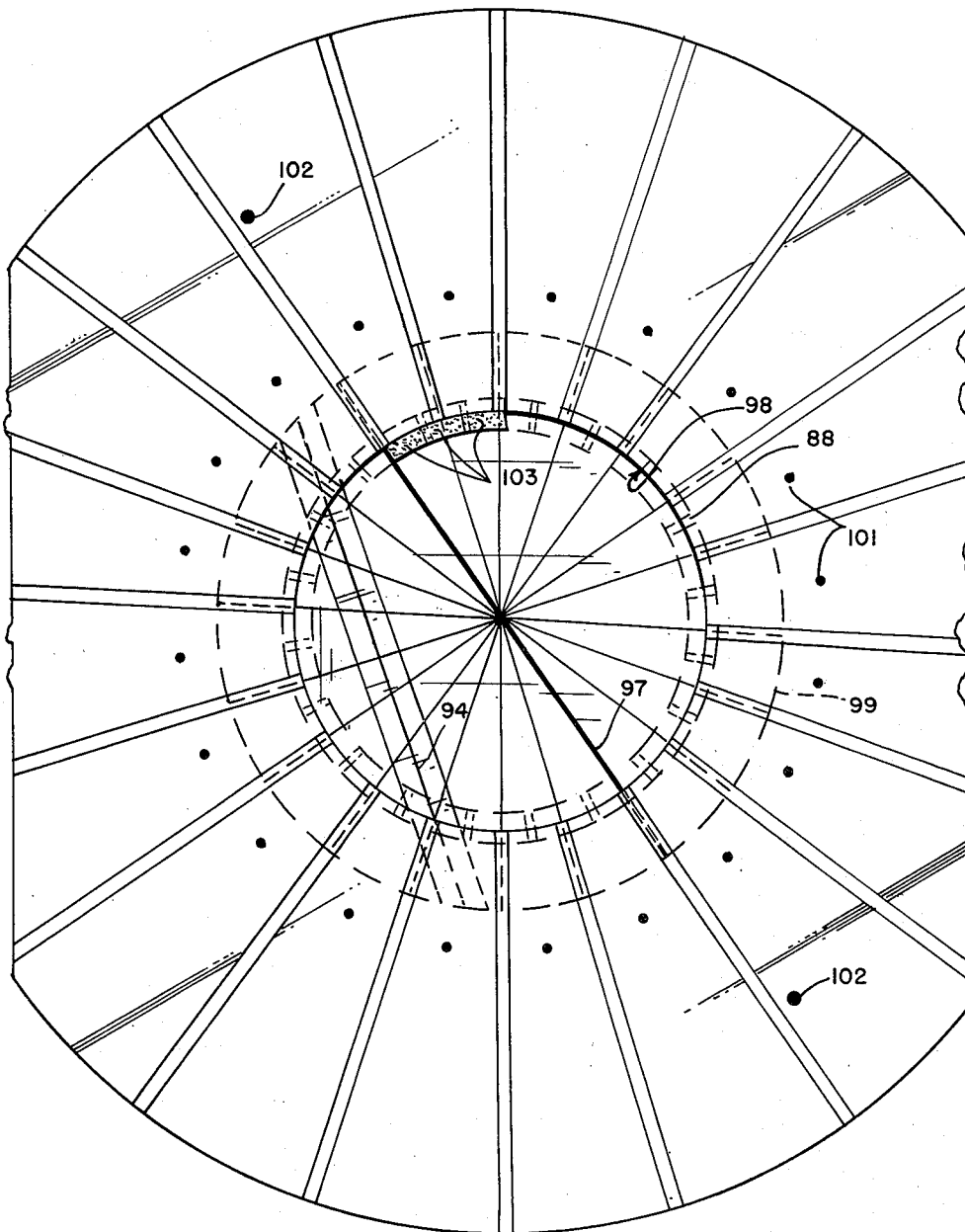
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FIG. 20



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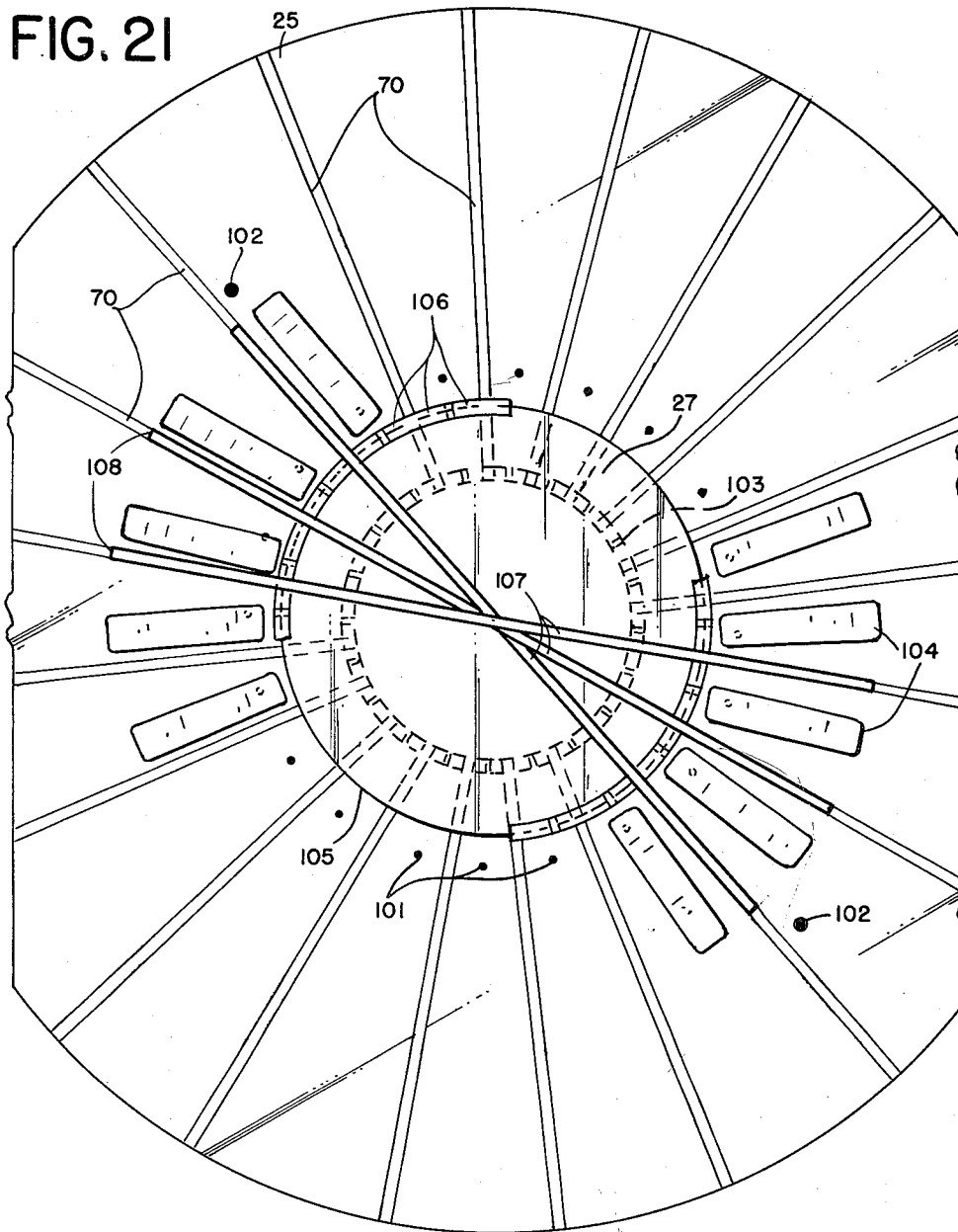
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FIG. 21



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FIG. 22

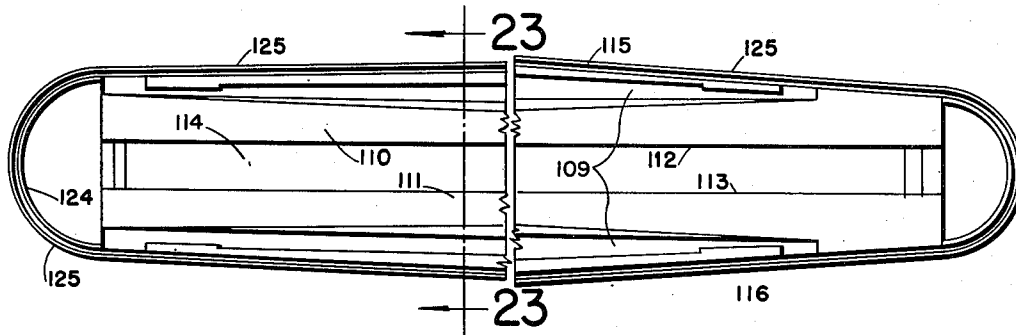
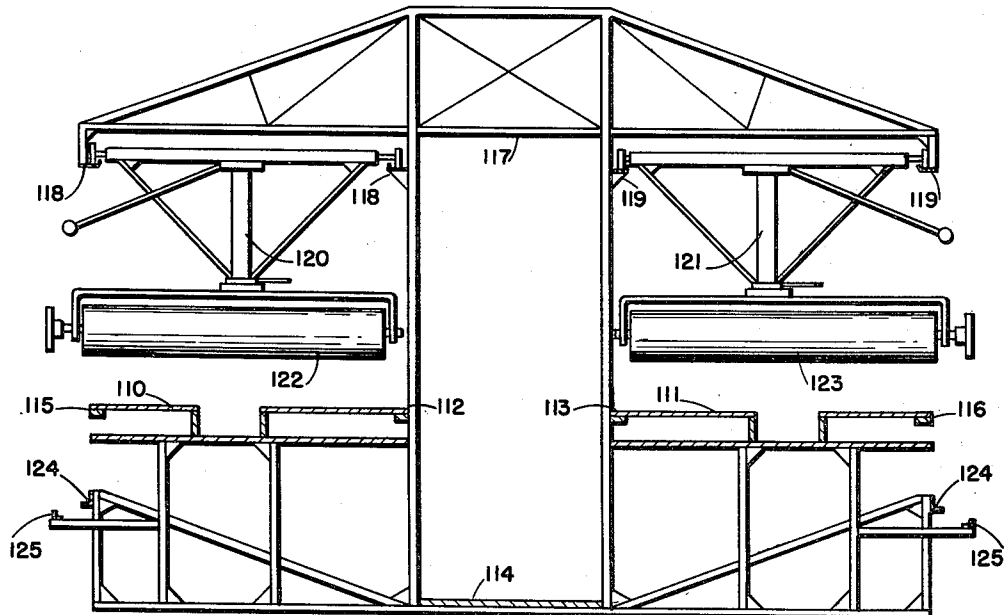


FIG. 23



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UNITED STATES PATENT OFFICE

2,666,006

METHOD OF BALLOON CONSTRUCTION

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Application April 2, 1948, Serial No. 18,585

15 Claims. (Cl. 154—85)

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This application relates to a method and apparatus for construction of high-altitude balloons.

One object of the present invention is the provision of an improved method for manufacture of balloons.

Another object is the provision of apparatus with which the improved method of construction may be carried out.

A further object is to provide a balloon table on which the material may be laid out and assembled with a minimum of handling.

Still another object is the provision of such a table in which an edge of the table is shaped to correspond to the shape of the gore edges in such a balloon.

A still further object is to provide such a table in which a cutting and welding unit is mounted for movement along one edge of the table to trim the balloon material to the desired shape and join adjacent gores of the material together.

An additional object is the provision of a balloon assembly table having at least one edge corresponding in shape to the gores of the finished balloon and having a central depression for accommodation of a portion of the gores during the assembly operation.

Another object is to provide an improved templet for trimming the top or apex of the balloon and assembling a suitable cap at said apex.

Other objects and advantages will be apparent from the following specification in which a preferred embodiment of the invention is described.

In the drawings which form a part of this application, and in which like reference characters indicate like parts,

Figure 1 is a perspective view of a balloon made by the present method and apparatus.

Fig. 2 is a perspective view of a balloon assembly table according to the present invention.

Fig. 3 is a view similar to Fig. 2 with certain portions omitted for clearness and with a sheet of balloon material in position on the table.

Fig. 4 is a perspective view of the apex end of the table of Fig. 3 taken from the section line 4—4 of that figure.

Fig. 5 is a schematic view, partially in section, showing the welding unit which forms a part of the balloon assembly table.

Fig. 6 is a partial sectional view showing the lay-out of the first two sheets of gore material as the assembly operation is started.

Fig. 7 is a similar partial view showing the position of the weld line prior to taping of the gore seam.

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Fig. 8 is a partial perspective view which illustrates the start of the taping operation at the apex of the balloon.

Fig. 9 is a view similar to Fig. 8 with the taping operation at a more advanced stage.

Fig. 10 is a partial perspective view showing details of the completion of the taping operation at the bottom of the balloon.

Fig. 11 is a schematic sectional view showing the arrangement of the gores and gore material prior to making the second gore seam in the series.

Fig. 12 is a view similar to Fig. 11 showing the gores after a number of seams have been joined.

Fig. 13 is a view similar to Fig. 11 after all the gore seams except the final seam have been made.

Fig. 14 is a view similar to Fig. 11 showing the method of laying out the material for the final joint between the first and last gores.

Fig. 15 is a similar view which illustrates the final taping operation of the last seam.

Fig. 16 is a perspective view of the assembled gores with an inflation tube in position within the balloon.

Fig. 17 is a perspective view of the lay-out of the apex of the balloon for application of the cap.

Fig. 18 is a plan view of a templet which facilitates the capping operation.

Fig. 19 is a perspective view of the templet with its hinged flap in partially folded position.

Fig. 20 is a top plan of the apex of the balloon with the templet in position beneath it.

Fig. 21 is a top plan showing details of the method of assembly of the cap.

Fig. 22 is a plan view of a modified form of apparatus in which two assembly tables are provided, and

Fig. 23 is a sectional view on the line 23—23 of Fig. 22.

With reference to Fig. 1 the balloon for which the present method of assembly and apparatus are designed is composed of a series of vertically extending gores 25 made of suitable gas-proof material. These gores are joined to each other at their vertical edges 26 to form the main body of the balloon. A suitable cap 27 is provided to seal the apex of the balloon. The lower ends of the gores 25 are fastened to a load ring 28 from which the desired load may be suspended by means of suitable load lines 29.

The assembly of such a balloon involves essentially two operations, namely the assembly of the longitudinal gores which form the main body of the balloon and the application of the cap at the

apex of said gores. These two steps and the apparatus for carrying them out are described separately below.

Assembly of the gores

To facilitate the cutting and joining of the gores to each other we have provided a balloon assembly table having a flat upper surface designated generally as 31. This table surface 31 is mounted on any suitable support 32. One edge 33 (Fig. 4) of the table is perfectly straight and is used to align one edge of the sheet of gore material. The opposite edge 34 of the table tapers at each end to correspond to the desired shape of the edge of an individual gore of the balloon. Thus edge 34 will serve as a guide or pattern for the trimming of the gore material and the joining of adjacent gores.

An index line 35 is provided on the top of table 31 to indicate the line of the opposite edge of each gore. Thus the shape of a single gore is defined on the one side by table edge 34 and on the other side by index line 35. Since the gores are symmetrical, the edge 34 and line 35 will taper symmetrically toward each end of the table corresponding to the apex and bottom of the balloon gores.

The intermediate portion of table 31 between edge 34 and index line 35 is recessed or depressed as shown in Fig. 4. This recessed portion has a bottom 38 and side walls 36 and 37 which form in effect a trough extending longitudinally of the table. The depth of this trough or recess is sufficient to accommodate the assembled gores as described below.

On one side of table 31 corresponding to edge 34 tracks 40 and 41 are connected to frame 32. These tracks are designed to support the wheels or rollers 42 and 43 respectively of a welding unit 44. An electric conducting strip 45 on the bottom of rail 40 is suitably insulated from said rail and cooperates with a contact roller 46 on the welding unit to supply current to a driving motor 47 for the unit. Track 41 and wheel 43 may serve as a ground return to complete the electrical circuit. A control switch 48 and clutch 49 enable the operator to start and stop the motor 47 and to control the movement of the welding unit 44 along edge 34 of the table.

The welding unit is provided with welding rollers 51 and 52, at least one of which is heated in any manner known in the art. These welding rollers are coupled to the motor 47 so that they will be rotated in coordination with the movement of the welding unit along tracks 40 and 41. Thus, the superimposed sheets of gore material 53 will remain in stationary position on table 31 while the welding unit 44 travels the length of the table and rollers 51 and 52 heat-seal the layers together. These rollers are so designed that they not only seal the superimposed gores to each other but also cut the surplus material away from the gores along the seam line. Details of a welding unit suitable for use in the present apparatus are described and claimed in our co-pending application Serial No. 18,584, entitled *Welding Apparatus*, filed of even date herewith.

As shown in Figs. 2 and 3 the gore material 53 may be laid out on the table from a suitable supply roll 54. This supply roll is rotatably carried in a U-shaped bearing 55 suspended from a traveling carriage 56. Carriage 56 is carried by overhead tracks 57 mounted on a suitable frame 58. Thus the carriage may be moved

longitudinally over the gore table while the material 53 is unrolled from the supply spool 54. In positioning the material 53 on the table, one edge 59 of material 53 will be aligned with the straight edge 33 of table 31. Thus the material at the other edge will be extended beyond table edge 34 as indicated at 60. If desired, the major portion of this extending material may be cut away by a preliminary trimming operation as indicated at 61 so that the edge of the material will correspond roughly to the shape of table edge 34. The final trimming of this edge of the gore will take place as part of the welding operation as described above.

While the apparatus described herewith involves a welding unit in which a single pair of rollers both cuts and welds the superimposed gores, it will be clear that the cutting and welding operations might be done by separate units, if desired. Also, instead of the additional tracks 40 and 41 attached to the table frame 32, it would be possible to use the shaped table edge 34 itself as the guide for the seaming machine.

Details of assembly method

The method by which the gores are assembled and for which the table described above is designed is as follows:

The first two sheets of gore material 53 are superimposed on the table as shown in Fig. 6 with one edge 59 of each sheet in alignment with the straight edge 33 of the table. A series of weights 63 is employed to hold the straight edge of the lower sheet in position and similar weights 64 hold the upper sheet in alignment. The sheets are smoothed across the table 31 so that they extend outwardly beyond edge 34 and another series of weights 65 is utilized to hold the edges in proper relation at this side of the table.

As the welding unit travels along the table the rollers 51 and 52 will both cut and weld the material 53 to form a heat welded seam 66 between the first gore 25-1 and the second gore 25-2. A similar seam 67 will be formed between the extending portions 60 of the respective sheets and these portions of the material will be discarded or utilized for scrap.

After the welding operation, the gore 25-2 is pulled back toward the edge 33 of the table so that the welded joint 66 will be located above a solid portion on the table top 31 as shown in Fig. 7. In this position a reinforcing tape 67 may be applied to the seam as shown in Fig. 8. One end 68 of tape 67 is located beneath the welded seam 66 as shown and the tape then extends outwardly from the apex end of the gores through a ring 69 and back onto the upper side of seam 66 as shown in Fig. 9. Ring 69 is carried by a strap 71 carried by a further ring 72 which is fastened to the table frame at 74 (Figs. 2 and 4) by a suitable connecting cord or wire 73. Similar rings 69 and straps 71 are provided as shown in Fig. 8 for each of the gore seams to be made.

The particular tape utilized for reinforcing the seams 66 is of a pressure-sensitive type so that it may be applied to the seam readily by rolling pressure either manually or by means of a suitable machine. The tape 67 is applied longitudinally of the seam 66 as at 70 all the way from the apex of the gores to the bottom thereof. As shown in Fig. 10, the tape extends beyond the bottom edge of the gores as indicated at 75 and is led through a holding ring 76 and turned back underneath the seam 66 as

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shown at 77. Ring 76 is fastened to a strap 73 which in turn is fastened to a main tensioning ring 79 in the same way as the straps 71 at the apex of the balloon. Ring 79 is fastened to a cord 80 which passes over pulleys 81 (Fig. 2) and is connected to a tensioning weight 82. It will be apparent that the weight 82 will tend to stretch the tape 67 and thus maintain both the welded joint 66 and the overlapping tape 70 under uniform tension throughout the assembly operation.

An anchor line 33 fastened to ring 79 and to an anchor ring 84 fastened to the table frame at 35 serves to limit the stretching action of weight 82 and thus limits the maximum elongation of the taped seams 70. Thus variations in the length of the tape along the seam due to changes in atmospheric conditions during the assembly of the balloon will tend to be equalized and will not cause serious discrepancies in the lengths of the respective seams which would produce an unsymmetrical shape or wrinkles in the finished balloon. This tensioning arrangement is of definite importance in connection with the assembly of the gores.

After the joint between the first gore 25-1 and the second gore 25-2 is completed and taped as described above, the gores will be shifted to the position shown in Fig. 11 and an additional layer of material 53 will be superimposed on gore 25-2. It will be noted that in the position shown, the first seam 66-1 is aligned with the index mark 35 on table 31 rather than with the edge 33 of the table. In other words, seam 66-1 has been cut to its final shape and therefore must be aligned with the tapering index 35 which corresponds to said final shape. The additional layer 53, since it has straight edges initially, will of course be aligned with the edge 33 of the table. Weights 63, 64, and 65 are again employed to hold the sheet 53 and gore 25-2 in position during the welding operation. In the course of this welding operation, the extending edges 60 of the two layers, which project beyond edge 34 of table 31, will be cut-welded in the manner just described to form a second seam 66-2 between gore 25-2 and the sheet which will constitute the adjacent gore 25-3. This seam will be covered with tape 70-2 in the manner described above in connection with Fig. 9.

It should be noted that in the position of the first two gores in Fig. 11 the tape 70-1 is on the inside of the fold of seam 66-1 when the latter is aligned with index 35. Thus application of the tape 70-2 to seam 66-2 in the manner previously described will result in a construction in which the tapes 70-1 and 70-2 will be on the same surface of the respective gores so that in the finished balloon all the tapes may be located symmetrically on the outside of the envelope.

The process just described is repeated with successive sheets of material 53 and Fig. 12 illustrates schematically the arrangement of the layers after the fourth seam 66-4 and its reinforcing tape 70-4 have been aligned with index 35 and a further sheet of material 53 has been laid out in preparation for the cut-welding of the next seam 66-5. The diagram shows clearly the manner in which the completed gores are gradually fed down into the recessed portion 33 at the center of the table where these completed strips can be accommodated without interfering with the laying-out of the upper layers which

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are to be welded. Thus, the material can be fed down into the recessed or interrupted portion of the table 31 in a series of accordion-like folds without the problem of manual handling of the partially completed series of gores each time an additional seam is to be made.

Fig. 13 shows schematically the arrangement of the gores after 20 such gores have been united by seams 66-1 to 66-19 inclusive. At this stage of the process the main longitudinal envelope of the balloon is substantially complete except for the trimming and joining of the straight edge 59-1 of gore 25-1 to the similar edge 59-20 of the last gore. To complete this final seam the leading edge 59-1 is pulled up out of the recess along wall 36 as shown in Fig. 14. Enough of the material is pulled up so that seam 66-1 may be aligned over index mark 35. Similarly, the seam 66-19 is aligned over the index mark and thus the two straight edges 59-1 and 59-20 will extend beyond the edge 34 of table 31 in position for the cutting and welding of the final seam 66-20.

In order to facilitate the inflation of large balloons of this type, we have found it desirable to incorporate a long inflation tube 87 in the body of the balloon. This tube serves to carry the gas with which the balloon is ultimately filled up to the apex of the balloon so that the balloon can be filled uniformly from the top. The tube is subsequently withdrawn before the balloon is released. Such a tube 87 is indicated in Figs. 14, 15, and 16 and may consist of a tubular strip or hose of the same material as the balloon envelope. This tube 87 is positioned on gore 25-13 as shown in Fig. 14 before seam 66-19 is pulled over into alignment with index 35. Thus, the inflation tube is readily incorporated in the balloon before the final seam 66-20 is made and there is no problem of how to introduce such a tube longitudinally from the bottom into a completed envelope.

After seam 66-20 is completed, the gores will be shifted to the position of Fig. 15 so that the final tape 70-20 may be applied. This completes the assembly of the main envelope of the balloon consisting of the longitudinal gores joined at their edges by a heat-sealed or welded seam reinforced by longitudinal tapes. This portion of the balloon in completed form is indicated in Fig. 16 which also shows the general position of the inflation tube. At the apex of the balloon the gores 25 have a definite width at 83 and do not taper to a point. Thus if the upper end of the balloon is flattened on a suitable circular table 90 as shown in Fig. 17, these upper edges 83 of the respective gores will define a suitable circular opening. This opening must be sealed by a suitable cap as described below.

Similarly at the bottom of the balloon the width of the gores at 89 is sufficient to provide a bottom opening of the desired size. The gores at this point will be fastened to the load bearing ring 28 in any desired manner, as, for example, by folding the lower ends of the gores around the ring from the inside out and then taping the folded-over portions in position.

Assembly of the cap

To facilitate the application of the cap 27 to the apex of the balloon, the completed body of gores is flattened on a circular table 90 as shown in Fig. 17. It would be possible to provide the top of this table with suitable indicia to assist in trimming the edges 83, positioning the cap and

fastening the cap in place. However, we have found it preferable to provide a templet as shown in Fig. 18 which may be inserted beneath the apex of the gores for this purpose. This templet, designated generally as 91, is substantially circular in form and includes a major portion 92 and a minor portion 93 hinged together along the line 94. Radial lines 95 are spaced equiangularly around the circumference of the templet to correspond to the number of gore seams in the main body of the balloon. Thus, in the illustration given there are 20 of these radial lines 95, each of which, of course, passes through the center 96 of the templet. Since the total number of gores is an even number, obviously the corresponding radial lines at opposite sides of the templet will constitute a common diameter passing through center 96. For convenience in starting the taping operation, one of these pairs of radial lines is made heavier than the others as indicated at 97.

After the apex of the balloon is flattened on the table as shown in Fig. 17, the hinged flap 93 of the templet may be folded over to the position of Fig. 19 so that the templet may be inserted through the opening 88 and beneath the gores. For this purpose the hinged line 94 is so located on the templet that the perpendicular distance from this hinged line to the farthest point of the periphery 99 of the templet is small enough to permit insertion of the templet through the apex opening.

It will be noted from Fig. 18 that a circular index line 98 is provided on the face of the templet. This index line 98 corresponds to the desired final size of the apex opening of the balloon. Thus after the templet is positioned beneath the balloon the ends 88 of the respective gores will be trimmed along the line 98 of the templet to provide a circular top opening which is symmetrical and accurately controlled in size as shown in Fig. 20. This trimming operation will take place only after the templet has been centered beneath the apex of the balloon with the radial index lines 95 substantially aligned with the respective seams and tapes 70. While the templet is in the position of Fig. 20 and after the trimming of the apex opening, suitable index marks 101 may be placed on the respective gores just outside the periphery 99 of the templet. These index marks 101 will facilitate the alignment of the cap when the cap is subsequently placed in position above the opening. Main or starting index marks 102 may be made adjacent the seams 70 which correspond to the main diametrical index line 97 of the templet. The purpose of these main index marks is described below.

After alignment of the templet and trimming of the apex opening, a series of tapes 103 will be overlapped with their adhesive side up against the under surface of the ends 88 of the gores. Thus an annular adhesive band will be provided around the inner edge of opening 88. The templet 91 may then be removed by folding the flap 93 and pulling the templet out through the opening 88.

After removal of the templet the apex of the balloon is again flattened on the table as shown in Fig. 21 and suitable weights 104 may be located to hold the respective gores in flat position. These weights are located with the assistance of the index marks 101 so as to define a circular area in which the cap 27 is to be placed. This cap 27 will have a diameter corresponding to the diameter of the templet 91 so that the periphery

of the cap 105 will lie in the same relative position with respect to the apex edges 88 of the gores as did the circumference 99 of the templet.

This cap 27 is centered over the apex with the assistance of the index marks 101 and the circular arrangement of weights 104 and the central portion of the cap is then placed smoothly onto the upwardly facing adhesive strips 103. These strips 103 form a suitable gas-proof seal between the gores and the cap.

After this inner seal is completed, additional sealing tapes 106 are pressed down so as to overlap the outer edge 105 of the cap and hold said edge firmly against the respective gores. Thus the two bands of tape 103 and 106 provide a double line of attachment between the cap and the body of the balloon.

To complete the capping operation, top reinforcing strips 107 are placed diametrically across the cap in alignment with the respective seam tapes 70. To assist the operators on opposite sides of the table in aligning the initial strip with the proper seams 70, the main index marks 102 are utilized. These marks indicate that the first tape should be positioned in line with the two seam tapes 70 at opposite sides of the apex adjacent said marks. After the first reinforcing tape 107 is placed in position, additional tapes, corresponding one to each diametrically opposite pair of side seam tapes 70, are placed in position successively around the cap. These top reinforcing tapes 107 thus overlap the cap 27 and also overlap a portion of the side seams 70 by extending from the apex of the balloon outwardly to points 108 which are a substantial distance beyond the periphery 105 of the cap. Thus strains carried by the cap of the balloon will be transferred to the side-reinforcing tapes 70 and through them to the bottom load ring previously described.

As the description indicates, this particular capping construction is readily carried out by the method indicated and is facilitated by the use of the templet 91.

Modified balloon assembly table

A modified construction for the balloon assembly table is shown in Figs. 22 and 23. In this case a pair of tables 110 and 111 respectively is employed and these tables are positioned parallel to each other so that their straight edges 112 and 113 respectively are separated by a runway 114 for use of the operators. The outer edges 115 and 116 of the respective tapes are shaped to correspond to the final gores of the desired balloon in the same manner described in connection with the single table above. Each of these tables has a recessed or interrupted central portion 109 just as in the previous case.

A suitable top frame 117 (Fig. 23) is provided with tracks 118 and 119 which support the traveling carriages 120 and 121. These carriages hold the supply rolls 122 and 123 of balloon material just as in the previous case and facilitate the initial lay-out of the material on the respective tables. Tracks 124 and 125 are provided at the outer edge of the tables for a welding unit which may be identical in construction with the welding unit 44. In this modified apparatus tracks 124 and 125 are continuous and extend along each table as well as around the ends of the tables. Thus it is possible with this construction to lay out the superimposed sheets of gore material on the two tables and to run the welding unit along the table 110 in one

direction and then back along the table 111 in the opposite direction. Thus a continuous welding process is possible in which the operators may lay out and align the material on one table while the welding machine is forming the seam along the opposite table. This continuous process has obvious advantages in economy of operation and is made possible by the novel arrangement of means to shift the welding roller from one table to the other. As indicated, this means is exemplified by the continuous arrangement of tracks 124 and 125 around the ends of the tables.

According to the foregoing description, a new and improved method for manufacturing balloons has been provided in which a series of longitudinal gores are joined successively at their longitudinal edges after which the leading edge of the first gore is joined to the trailing edge of the final gore to complete the main envelope or body of the balloon. This method of assembling the balloon may include the positioning of the inflation tube prior to completion of the final seam. Such a method is facilitated by the use of apparatus of the type described in which the assembly table has an edge shaped to correspond to the final gore of the balloon and has a recessed or interrupted central portion to accommodate the completed gores as the successive seams are made. The use of a cutting device and welding unit traveling along the gore shaped edge of the assembly table likewise offers advantages in carrying out the method of assembly by minimizing the manual handling of large pieces of gore material.

Finally, the use of a collapsible templet to facilitate the trimming and alignment of the apex of the balloon and the assembly of the balloon cap simplifies the capping operation particularly where relatively large balloons are involved.

Since various changes in the specific details of the method and apparatus will be readily apparent to persons skilled in the art, without departure from the teachings of the present specification, it is intended that this invention shall include all such changes and modifications as fall within the spirit and scope of the following claims.

Now, therefore, we claim:

1. The method of successively joining adjacent thermoplastic sections of a balloon envelope which comprises the steps of: (a) arranging two of the sections in face to face relation, (b) forming a seam between the sections by application of heat and pressure to soften and fuse the material together, (c) applying an adhesive reinforcing tape to the completed seam, (d) applying longitudinal tension to said tape and seam after said seam is complete, and (e) maintaining said longitudinal tension during subsequent formation of a similar seam between one of said first two sections and another section.

2. The method of assembling a balloon having a plurality of gores to be cut from sheets of material of uniform width and united to each other at their adjacent edges which comprises the steps of: (a) arranging two of the sheets in superimposed relation, (b) simultaneously cutting corresponding edges of each sheet to the desired shape and uniting these edges to each other to form a seam, (c) applying longitudinal tension to the seam, after said seam is complete, and (d) successively cutting and uniting additional layers of sheet material to the remaining

free edges of the previously united sheets in a similar seam while maintaining at least one prior seam under tension during subsequent formation of one of said similar seams with another section.

3. The method of assembling a balloon having a plurality of longitudinal gores of uniform size and shape which comprises the steps of: (a) superimposing in opposed face-to-face relation two sheets of gore material of uniform width, (b) cutting and uniting the sheets at one edge along a line corresponding to the desired shape of one edge of a gore, (c) similarly superimposing additional sheets of gore material and cutting and uniting one edge of each successive gore to the remaining free edge of each preceding gore along a line corresponding to the desired gore edge shape, each successive sheet being united to the preceding sheet before it is united to the next following sheet, and (d) superimposing the uncut edge of the first gore and the uncut edge of the final gore and cutting and uniting said sheets to form the final gore seam and complete a tubular body for the balloon.

4. The method of forming multiple gore balloons from thermoplastic sheet material which comprises placing first and second sheets of the material in superimposed relation with the first sheet on the bottom and with a first edge of the second sheet aligned above the corresponding first edge of the first sheet parallel to the center line of a desired gore; seaming together the remaining second edges of the first and second sheets by applying heat along a line corresponding to the desired gore edge shape; shifting the newly seamed second edges toward the position theretofore occupied by the aligned first edges and simultaneously shifting the free first edge of the second sheet across above the line along which the second edges were seamed, thereby reversing the second sheet and also the relative locations of the first and second edges of the second sheet; superimposing above the second sheet a third sheet having its first edge aligned generally above the original line of alignment of the first edges of the first two sheets; seaming together the superimposed second edge of the third sheet and the first edge of the second sheet by applying heat along a line corresponding to the desired gore edge shape and thereby completing the formation and seaming of a complete gore from the second sheet; reversing the newly seamed upper sheet and thereby reversing the relative location of its seamed and unseamed edges; successively superimposing, seaming and reversing additional sheets in like manner until the desired number of gores have been seamed; and finally superimposing and seaming together the remaining free edges of the first and last gores and thereby completing a tubular balloon body.

5. The method of forming multiple gore balloons from thin, gas proof sheet material of uniform width with the aid of a symmetrical pattern corresponding to the desired gore shape which comprises superimposing first and second sheets of the material on the pattern; seaming together one edge of the upper sheet and the corresponding edge of the lower sheet along a line corresponding to a first longitudinal edge of the pattern; reversing the upper sheet on its longitudinal axis and thereby placing the newly seamed edges in alignment with the opposite longitudinal edge of the pattern and with the free edge of the sheet extending across the first

pattern edge; superimposing a third sheet above the pattern and second sheet; seaming together one edge of the third sheet and the corresponding free edge of the second sheet along the first pattern edge; similarly reversing the third sheet; successively superimposing, seaming and reversing additional sheets in like manner until the desired number of gores have been joined; and finally superimposing and seaming the remaining free edges of the first and last sheets and thereby completing a tubular balloon body.

6. The method of forming multiple gore balloons from thin, gas proof sheet material of uniform width with the aid of a symmetrical pattern corresponding to the desired gore shape which comprises superimposing first and second sheets of the material on the pattern; seaming together one edge of the upper sheet and the corresponding edge of the lower sheet along a line corresponding to a first edge of the pattern; reversing the upper sheet and thereby placing the newly seamed edges in alignment with the opposite edge of the pattern and with the free edge of the sheet extending across the first pattern edge; superimposing a third sheet above the pattern and second sheet; seaming together one edge of the third sheet and the corresponding free edge of the second sheet along the first pattern edge; similarly reversing the third sheet; successively superimposing, seaming and reversing additional sheets in like manner until the desired number of gores have been joined; and finally superimposing and seaming the remaining free edges of the first and last sheets and thereby completing a tubular balloon body.

7. The method of forming multiple gore balloons from thin, gas proof sheet material of uniform width with the aid of a symmetrical pattern corresponding to the desired gore shape which comprises superimposing first and second sheets of the material on the pattern; seaming together one edge of the upper sheet and the corresponding edge of the lower sheet along a line corresponding to an edge of the pattern; superimposing a third sheet above the second; seaming together one edge of the third sheet and the remaining free edge of the second along a line corresponding to an edge of the pattern, superimposing additional sheets and seaming together one edge of each successive sheet and the remaining free edge of the preceding sheet before the next succeeding sheet is superimposed, until the desired number of gores have been joined; and finally superimposing and seaming together the remaining free edges of the first and last sheets and thereby completing a tubular balloon body.

8. The method of forming multiple gore balloons from thin, gas proof sheet material of uniform width with the aid of a symmetrical pattern corresponding to the desired gore shape which comprises superimposing first and second sheets of the material on the pattern; seaming together one edge of the upper sheet and the corresponding edge of the lower sheet along a line corresponding to an edge of the pattern; superimposing a third sheet above the second; seaming together one edge of the third sheet and the remaining free edge of the second along a line corresponding to an edge of the pattern, and superimposing additional sheets and seaming together one edge of each successive sheet and the remaining free edge of the preceding sheet before the next succeeding sheet is superimposed, until the desired number of gores have been joined.

9. The method of forming multiple gore balloons from thin, gas proof sheet material of uniform width with the aid of a symmetrical pattern corresponding to the desired gore shape which comprises superimposing first and second sheets of the material on the pattern; seaming together one edge of the upper sheet and the corresponding edge of the lower sheet along a line corresponding to an edge of the pattern; superimposing a third sheet above the second; seaming together one edge of the third sheet and the remaining free edge of the second along a line corresponding to an edge of the pattern, superimposing additional sheets and seaming together one edge of each successive sheet and the remaining free edge of the preceding sheet before the next succeeding sheet is superimposed, until the desired number of gores have been joined; superimposing a longitudinally extending inflation tube on the final upper sheet, with the tube projecting beyond one end of the pattern; pulling the free edge of the bottom sheet up along the edges of the sheets at the side opposite the free edge of the upper sheet and across the upper sheet and inflation tube, and finally superimposing and seaming together the remaining free edges of the first and last sheets and thereby completing a tubular balloon body with an inflation tube axially enclosed therein.

10. The method of forming multiple gore balloons from thin gas proof sheet material of uniform width with the aid of a table having thereon a symmetrical gore pattern narrower than said width and also having guide means thereon outside one edge of the pattern for alignment of one edge of the sheet material parallel to the axis of symmetry of the gore and with the material completely covering the gore pattern, which comprises: superimposing first lower and second upper sheets on the pattern, with one edge of each sheet aligned with the guide means; seaming together the other edges of the two sheets along one edge of the pattern; reversing the second sheet on the axis of symmetry of the gore and aligning the newly seamed edges with the opposite edge of the pattern, while the remainder of the second sheet completely covers the pattern; superimposing a third sheet, with one edge aligned with the guide means; seaming together an edge of the third sheet and the remaining free edge of the second sheet along said one edge of the pattern; reversing the third sheet and aligning its newly seamed edge with said opposite edge of the pattern; and thereafter successively superimposing and seaming additional sheets until the desired number of gores have been joined, each successive sheet, after being seamed to the preceding sheet, being reversed and aligned in like manner before the following sheet is superimposed.

11. The method of forming multiple gore balloons from thin gas proof sheet material of uniform width with the aid of a table having thereon a symmetrical gore pattern narrower than said width and also having guide means thereon outside one edge of the pattern for alignment of one edge of the sheet material parallel to the axis of symmetry of the gore and with the material completely covering the gore pattern, which comprises: superimposing first lower and second upper sheets on the pattern, with one edge of each sheet aligned with the guide means; seaming together the other edges of the two sheets along the edge of the pattern farthest from the guide means; reversing the second sheet on the axis

of symmetry of the gore and aligning the newly seamed edges with the edge of the pattern nearest the guide means, while the remainder of the second sheet completely covers the pattern; superimposing a third sheet, with one edge aligned with the guide means; seaming together the opposite edge of the third sheet and the remaining free edge of the second sheet along said edge of the pattern farthest from the guide means; reversing the third sheet and aligning its newly seamed edge with said edge of the pattern nearest the guide means; and thereafter successively superimposing and seaming additional sheets until the desired number of gores have been joined, each successive sheet, after being seamed to the preceding sheet, being reversed and aligned in like manner before the following sheet is superimposed.

12. The method of forming multiple gore balloons from thin gas-proof sheet material which comprises placing first and second sheets of the material in superimposed relation with the first sheet on the bottom and with a first edge of the second sheet aligned above the corresponding first edge of the first sheet parallel to the center line of a desired gore; seaming together the remaining second edges of the first and second sheets along a line corresponding to the desired gore edge shape; shifting the newly seamed second edges toward the position theretofore occupied by the aligned first edges and simultaneously shifting the free first edge of the second sheet across above the line along which the second edges were seamed, thereby reversing the second sheet and also the relative locations of the first and second edges of the second sheet; superimposing above the second sheet a third sheet having its first edge aligned generally above the original line of alignment of the first edges of the first two sheets; seaming together the superimposed second edge of the third sheet and the first edge of the second sheet along a line corresponding to the desired gore edge shape and thereby completing the formation and seaming of a complete gore from the second sheet; reversing the newly seamed upper sheet and thereby reversing the relative location of its seamed and unseamed edges; successively superimposing, seaming and reversing additional sheets in like manner until the desired number of gores have been seamed; and finally superimposing and seaming together the remaining free edges of the first and last gores and thereby completing a tubular balloon body.

13. The method of forming multiple gore balloons from thin gas-proof sheet material which comprises superimposing first and second sheets of the material; seaming together a first longitudinal edge of the second sheet and the corresponding edge of the first sheet along a line corresponding to the desired gore edge shape; shifting the second longitudinal edge of the second sheet across the longitudinal axis of the sheet toward the line along which the first edges were seamed, thereby at least partially reversing the second sheet; superimposing a third sheet above the second sheet; seaming together the superimposed first edge of the third sheet and the second edge of the second sheet along a line corresponding to the desired gore edge shape, thereby complet-

ing the formation and seaming of a complete gore from the second sheet; shifting the second edge of the third sheet across the longitudinal axis of the sheet and thereby at least partially reversing the third sheet; successively superimposing, seaming, and at least partially reversing additional sheets in like manner until the desired number of gores have been joined; and finally superimposing and seaming together the remaining free edges of the first and last gores, thereby completing a tubular balloon body.

14. The method of forming multiple gore balloons from thin gas-proof sheet material which comprises superimposing a plurality of sheets of said material, seaming together one edge of the first sheet and the corresponding edge of the second sheet along a line corresponding to the desired gore edge shape, shifting the newly seamed edges of the first and second sheets toward the opposite edge of the gore, similarly seaming together one edge of each successive sheet and the remaining free edge of the preceding sheet and shifting each set of seamed edges toward the opposite edge of the gore before the next edges are seamed, and finally seaming together the remaining free edges of the first and last sheets along a line corresponding to the desired gore edge shape and thereby completing a balloon body portion.

15. The method of forming multiple gore balloons from thin gas-proof sheet material which comprises superimposing a plurality of sheets of said material, seaming together one edge of the first sheet and the corresponding edge of the second sheet along a line corresponding to the desired gore edge shape, similarly seaming together one edge of each successive sheet and the remaining free edge of the preceding sheet, and finally superimposing and seaming together the remaining free edges of the first and last sheets along a line corresponding to the desired gore edge shape and thereby completing a balloon body portion.

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