Nov. 9, 1948. L. S. M. LEJEUNE 2,453,143

TENNIS BALL

Filed Nov. 24, 1941 5 Sheets-Sheet 1

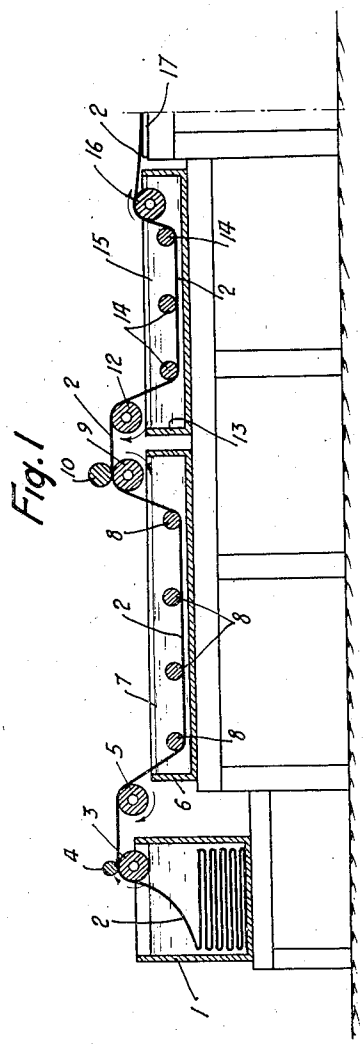


Fig. 1

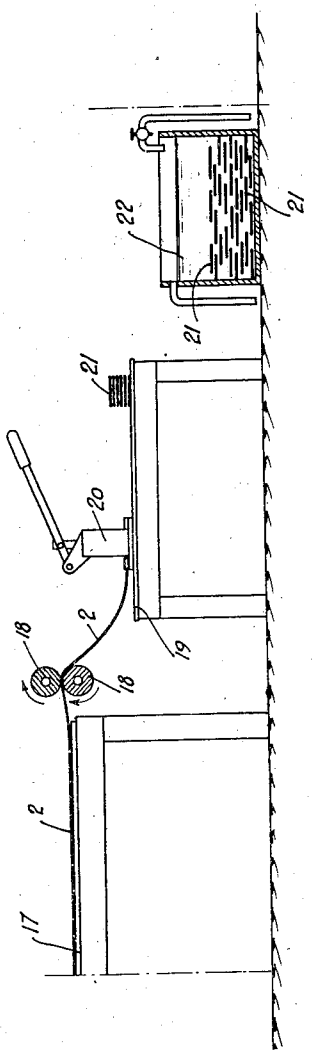


Fig. 2

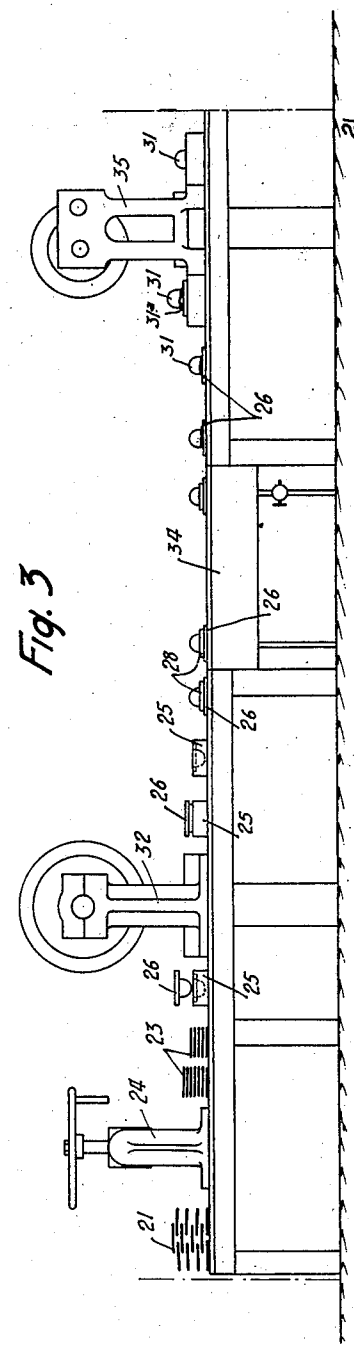
Inventor
L. S. M. Lejeune

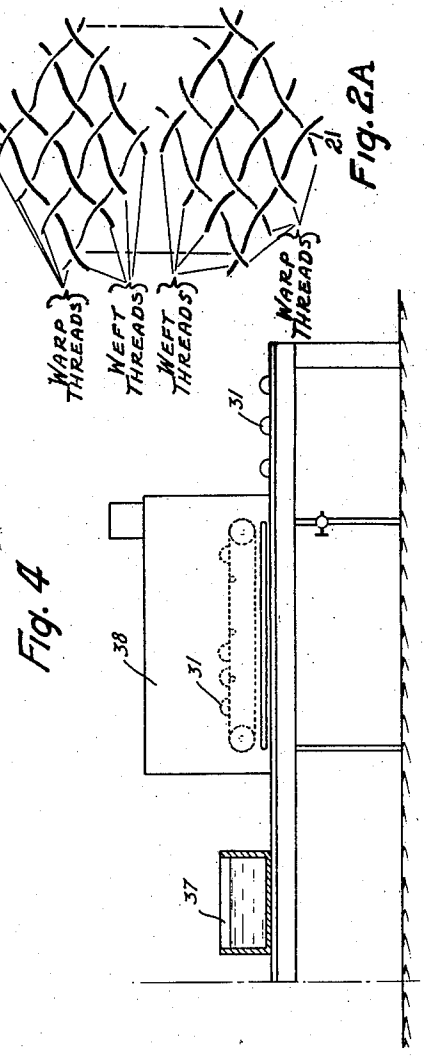
By: Glascock Downing & Seebold
Attys.

Nov. 9, 1948. L. S. M. LEJEUNE 2,453,143

TENNIS BALL

Filed Nov. 24, 1941 5 Sheets-Sheet 2





Inventor,
L. S. M. Lejeune
By: Glascock Downing & Seibold
Attys.

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TENNIS BALL

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Fig. 5

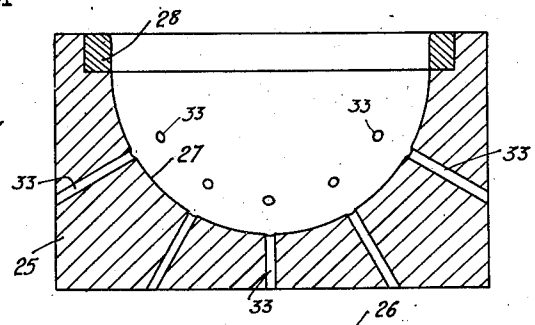


Fig. 6

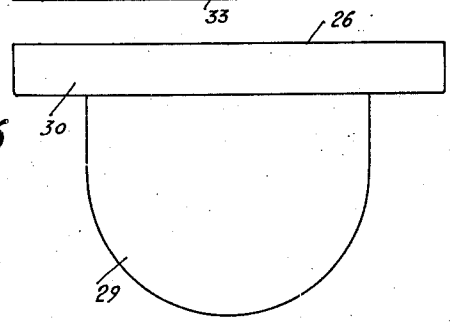


Fig. 7

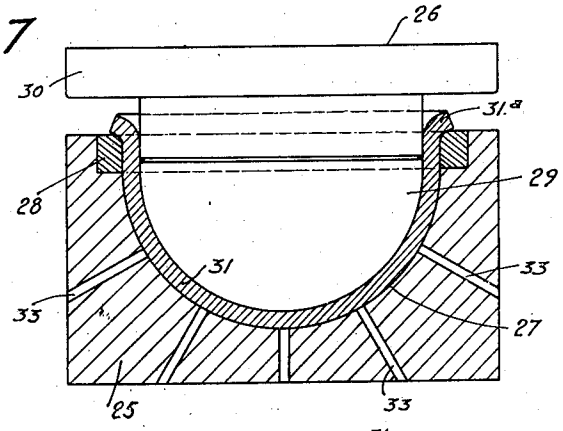
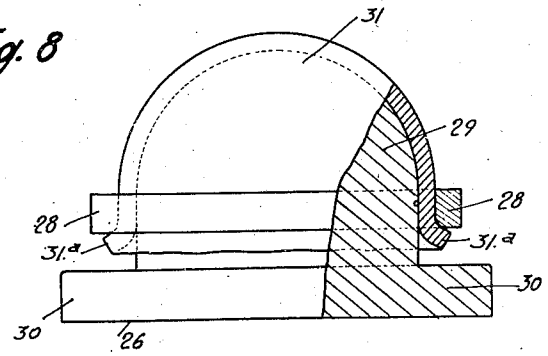


Fig. 8



Inventor:
L. S. M. Lejeune
By: Glascock Downing & Seibold
Attys.

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Fig. 9

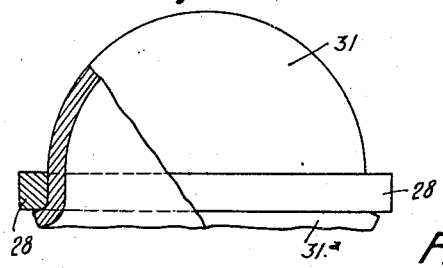


Fig. 10

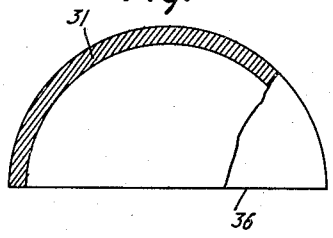


Fig. 11

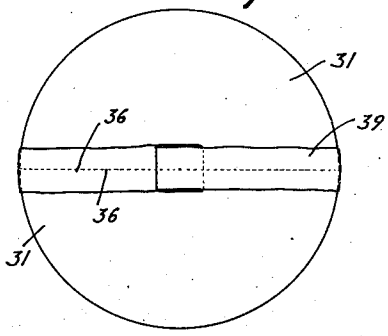
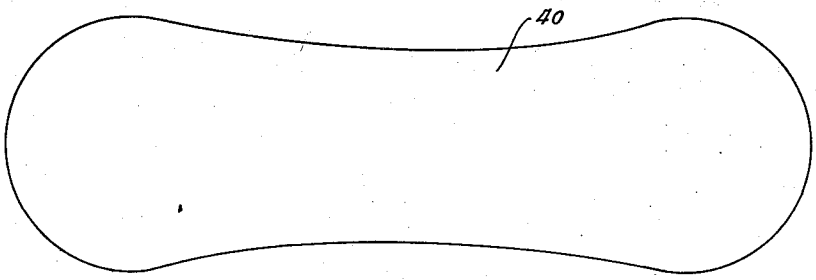


Fig. 12



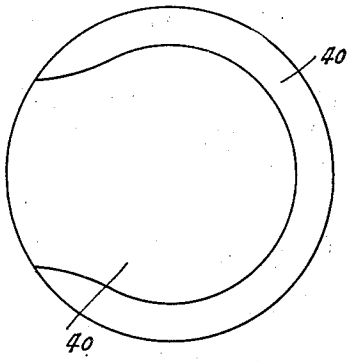


Fig. 13

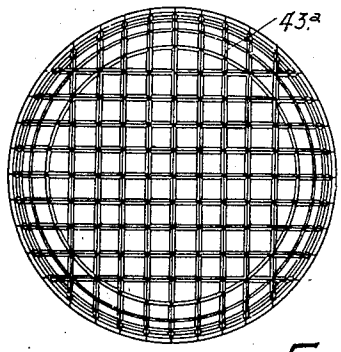


Fig. 15

Inventor;
L. S. M. Lejeune
By: Glascock Downing & Seebold
Attys.

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TENNIS BALL

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Fig. 14

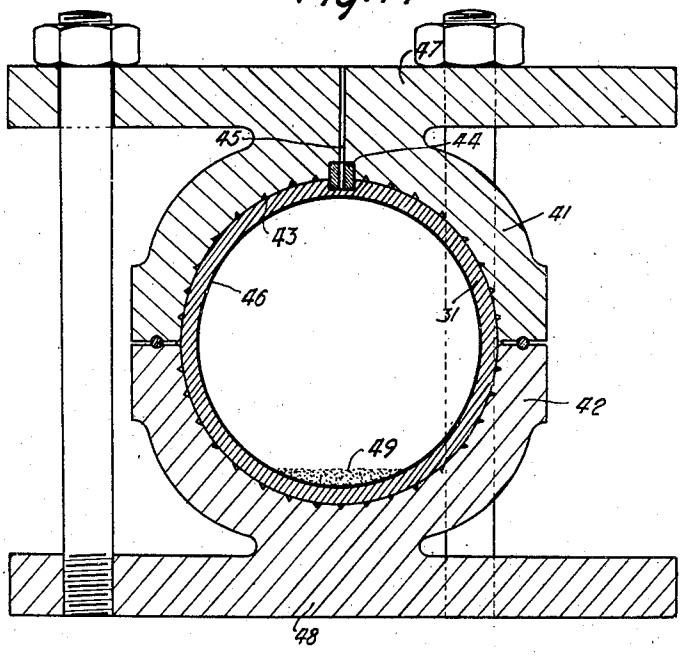


Fig. 17

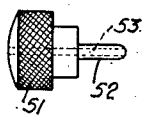


Fig. 16

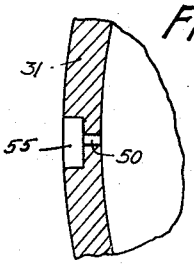


Fig. 18

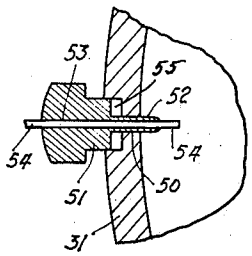


Fig. 19

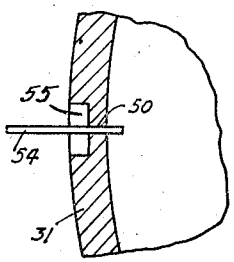
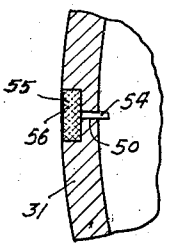


Fig. 20



Inventor,
L. S. M. Lejeune

By: Glascock Downing & Seibold
Attys.

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UNITED STATES PATENT OFFICE

2,453,143

TENNIS BALL

Léon Sylvain Max Lejeune, Paris, France; vested in the Attorney General of the United States

Application November 24, 1941, Serial No. 420,292
In France August 9, 1938

3 Claims. (Cl. 273—61)

1

The present application relates to tennis balls and is a continuation-in-part of my prior application, Serial No. 250,617, filed on January 12, 1939 (abandoned).

The invention concerns a tennis ball complying with the conditions prescribed by the International Lawn-Tennis Federation as regards the balls used in international lawn-tennis matches, i. e. the conditions which define the maximum and minimum limits of the diameter of the ball, its weight, its height of rebound for a given height of fall, and its degree of compression under a predeterminated stress applied during a given period of time.

The invention has also for its primary object the provision of a tennis ball of the character indicated which is not subject to losing its inner pressure after a more or less long lapse of time.

Another object of the invention is to provide a tennis ball which practically does not wear out.

Another object of the invention is a tennis ball which possesses a regular rebounding capacity which does not substantially vary with changes in temperature.

Still another object of the invention is to provide a tennis ball the initial launching velocity of which can be very high and remain the same during the whole life of the ball.

A further object of the invention is to provide a tennis ball upon which the ground produces no damping or deadening effect (such as that which is observed with the usual felt-covered tennis balls), so that the rise of the ball from the ground to the receiving racket can accordingly be very rapid.

A still further object of the invention is to provide a tennis ball which is not sensitive either to cold or to heat or to moisture whereby the playing characteristics of the ball remain the same regardless of atmospheric conditions.

A further object of the invention is to provide a tennis ball which can be washed.

The tennis ball according to the invention comprises a body filled with air substantially at atmospheric pressure, this body being formed of two hemispherical calottes united by vulcanized rubber, each of which is made of a uniform fabric impregnated with vulcanized rubber so as to form a homogeneous mass of textile elements impregnated throughout and firmly united by means of vulcanized rubber.

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The fabric which is used for forming the hemispherical calottes can be composed of vegetable or animal fibres or threads. As above mentioned, this fabric must be a uniform fabric, i. e. a fabric in which the composition of the threads as well as their tension and degree of twisting are the same for the warp and the weft, so that the fabric has substantially equal tensile strength in all directions. Such a fabric can be made by having uniform weft and warp threads subjected to the same tension, or, if these conditions are not complied with, by superposing two or more layers of a fabric which are so arranged that the unevennesses of their weaving are mutually compensated. To this effect it is possible, for example, to use to advantage a cotton melton formed of a very fine and twisted warp and of a thick and very slightly twisted weft—or an equivalent fabric—and to superpose two pieces of such a melton so that the weft threads of the one are at 90° with respect to those of the other. Such a unit can be impregnated with rubber in a uniform manner and its elasticity is the same in all directions.

The body of the ball formed in the above mentioned manner is advantageously covered inwardly and outwardly with an impervious layer of vulcanized rubber and it is furthermore covered with a layer of canvas on the outer surface to which a layer of rubber, also vulcanized, is applied. This latter layer of rubber, which forms the outer surface of the ball, is provided with relief patterns adapted for regulating the velocity of the ball and ensuring the regularity of the direction it takes in the air.

In order to make a tennis ball according to the invention, one preferably proceeds in the following manner:

Cotton melton having a weight of preferably 450 to 500 grams per square meter is first treated so as to facilitate its impregnation with rubber, for example by dipping it in water to which a "wetting" agent has been added. The prepared melton is then impregnated with rubber latex by being passed through a bath of concentrated latex, for example a latex containing 50% of rubber, the said bath containing the vulcanizing products, accelerators and other products usually

used in the rubber industry. The fabric thus impregnated is then freed, by light pressure, from the excess latex which it may have absorbed, and is coagulated, for instance by passing it through a bath of diluted acetic acid, and then, after having been freed from an excess of the coagulating bath, for instance by light pressure, it is cut into pieces or discs after which two of the impregnated pieces or discs are laid one upon the other so as to obtain a uniform textile unit. This operation is carried out, preferably, by first laying one of the pieces upon the other with their warp threads arranged at 90° and then pressing them one upon the other so as to cause them to adhere, by expelling a part of the coagulating bath remaining in the melton, after which the desired discs are cut out of the resultant material.

After washing with water during a sufficiently long time to eliminate the excess acid as well as the other substances soluble in water remaining in the discs, the latter are pressed into the shape of a hemispherical calotte. This operation is preferably effected by putting one of these discs of impregnated, double layer melton into a cylindro-hemispherical die the rim of which is formed by an annular ring embedded in the die and by stamping the disc by means of a cylindro-hemispherical punch which leaves between the die and the said punch a space corresponding approximately to the final thickness which the hemispherical calotte must have. The die can advantageously be provided with grooves or holes which permit of the escape of a certain amount of the water which is exuded from the discs under the action of the stamping pressure.

The punch and the die are then separated one from the other, leaving the calotte on the punch with, surrounding it at its base, the annular ring which maintains the calotte on the punch.

The resultant is then allowed to dry until the water which is still contained in the hemispherical calotte has been practically removed. The ring is then removed from the calotte and the excess material which remains about the base of the calotte is cut away so as to give the calotte its exact hemispherical shape, the edge of the calotte terminating in a diametral sectional plane. This calotte is then dipped into a bath of rubber solution so that the entire surface of the calotte is covered therewith. As soon as the solution is dry, two of these calottes are united together to form a sphere by bringing their diametral sectional planes into contact, after having introduced into one of these calottes a predetermined amount by weight of a chemical compound capable of decomposing under the action of heat and emitting a gas, while leaving a minimum amount of solid residue. This chemical may be, for example, carbonate of ammoniac which decomposes at a temperature of about 80° C. The quantity of this compound introduced will be such that during its decomposition under the action of a rise in temperature such as has just been indicated, a high pressure of the order, for instance, of 2 to 3 kilogs per square centimeter, is created in the sphere formed by the assembly of the two calottes.

After shaping the sphere containing the substance utilized for the purpose of giving off gas under the action of heat, a strip of gum may be applied onto the joint of the two hemispherical calottes. The width, the thickness and the length of this strip are so determined that a previously fixed weight is obtained for the so formed roughed-out ball. This roughed-out ball is then covered with pieces of canvas impregnated with

rubber, cut out in such a manner that when joined edge to edge they completely cover the entire surface of the sphere. This will be obtained, for instance, by means of two pieces of canvas each of which has the form of a lemniscate similar to the form of the two pieces of felt which cover tennis balls as usually made. Each roughed-out and canvas covered ball is then placed into a spherical mould preferably formed of two parts applied one against another, this mould being provided with a small hole to allow the outside of the die to communicate with the inside. If the ball must be provided on its outside surface with projections or hollows, the die is provided, on its inner surface, with hollows or projections forming the counterpart of the configuration which the outer surface of the ball must finally have. Eventually, in order to obtain a better final appearance of the ball and also to obtain an indelible marking of the same, the inward portion of the opening of the hole with which the die is provided will be provided with a projection, for instance a circular projection which, accordingly, will produce in counterpart a hollow in the ball.

The mould containing the roughed-out ball is then placed into a vulcanization autoclave where it is brought to the desired temperature for the period necessary for the vulcanization of the rubber components of the ball, this temperature being, in every case, sufficiently high for ensuring the decomposition of the gas-producing chemical compound in the inside of the ball. The resultant evolution of gas within the ball presses the spherical wall of the ball against the die, and eventually gives rise to the formation of projections or hollows on the outer surface of the ball. This vulcanization ensures a thorough union of the different elements and ingredients forming the wall of the ball and homogenizes in a certain measure the mass which forms this wall.

As soon as the vulcanization is completed, a needle is introduced into the hole of the mould and the ball is perforated in order to permit the gases contained in the ball to escape and consequently to allow the inner pressure of the ball to balance with the outer pressure. For this purpose the perforating needle is preferably hollow and made in the form of a trocar. As soon as this balance of pressures is obtained, the mould is opened and the ball removed, after which the hole in the ball is sealed. This is advantageously effected by introducing into this hole a rubber thread coated with a rubber solution which thread is cut at the outer surface of the wall of the ball, if the mould is smooth at this place, or at the level of the bottom of the small circular cavity provided in the outer wall of the ball if the mould is provided there with the above mentioned projection. In this latter case a lozenge of vulcanized rubber coated with a rubber solution is finally placed into the cavity in question.

To introduce the rubber thread into the hole which was made in the ball in order to balance the inner pressure with the pressure of the surrounding air, a tool is used which is formed, for example, of a punch or a hollow needle into which the rubber thread coated with a rubber solution is inserted, so that the said thread is flush with the point of the needle. The so equipped needle is introduced through the hole in the ball into the inside of the latter, carrying with it the rubber thread. This thread is then maintained in its position with respect to the ball, and the needle is removed until it leaves

the wall of the ball. Since the rubber thread has remained stationary with respect to the ball itself during this movement, the walls of the hole close again onto the rubber thread. Thus the hole is stopped and the only thing remaining to do is to cut the rubber thread flush with the outer surface of the ball in one or the other of the above mentioned conditions. This having been done, the above mentioned lozenge is then eventually applied and stops the cavity in the outer surface of the ball. Upon drying, the rubber solution which covers the thread unites the latter to the wall of the ball and thus tightly and definitely closes the hole.

The appended drawing shows by way of example, on the one hand, a diagram of a plant adapted for making tennis balls according to the invention and, on the other hand, the ball during various steps of its manufacture.

In this drawing:

Figure 1 is a view in elevation of the first part of such a plant up to the coagulation of the latex in the impregnated fabric.

Figure 2 is a similar view showing the subsequent steps of the manufacture up to the preparation of the pieces of impregnated fabric from which the discs which serve for making the balls are to be cut out.

Figure 2A is a perspective schematic view showing the relative positions of the warp and weft threads of two adjacent fabric pieces preparatory to forming the latter into a calotte.

Figure 3 is another similar view of the plant up to and including the operation of making the hemispherical calottes ready for joining to make the balls.

Figure 4 is, in the same manner, a view in elevation of the subsequently used parts of the plant up to the production of calottes ready to be united for producing the roughed-out balls.

Figure 5 is a cross sectional view of the die for the molding of a hemispherical calotte.

Figure 6 is a view of the corresponding punch.

Figure 7 shows the result obtained by punch pressing a circular blank by means of the die and punch of Figures 5 and 6.

Figure 8 is a view in elevation, partially sectional, of the calotte mounted on its punch.

Figure 9 is a view, partially sectional and partially in elevation, of a calotte during the drying operation.

Figure 10 is a view in elevation, partly in section, of a calotte ready for assembly.

Figure 11 is a view of the roughed-out ball comprising two calottes assembled together with a rubber layer applied over the joint.

Figure 12 is a view of a calendered canvas element adapted for being applied onto the roughed-out ball.

Figure 13 is a view in elevation showing the ball provided with two canvas elements according to Figure 12.

Figure 14 shows a vulcanizing mould with the roughed-out ball therein.

Figure 15 is a view in elevation of the ball after vulcanization.

Figure 16 is a partial sectional view showing the pressure equalizing hole in the ball.

Figure 17 is a view in elevation of the punch for the purpose of inserting the stopping thread in the pressure equalizing hole.

Figure 18 is a sectional view showing the punch in operation for the insertion of the stopping thread in the said hole.

Figure 19 is a similar view showing the sealing thread inserted and the tool removed.

Figure 20 is also a sectional view of the pressure equalizing hole stopped by the stopping thread with a finishing plug in place.

In the example of the plant shown for making the ball, the said plant comprises a vat 1 in which is placed a stack of cotton melton. In this vat which is filled with water to which a wetting agent has been added, the melton 2 is impregnated with moisture. It is then carried on by a rotating roll 3 above which is a compressing roll 4 which expels the excess water carried by the melton. Then the melton passes over another driving roll 5 and from there into a vat 6 containing a bath of latex 7. After having passed under the rolls such are are indicated at 8, which maintain it under the surface of the latex, the melton passes between a driving roll 9 and a weighted roll 10 which is sufficeintly heavy for expelling the excess latex as well as the air contained in the melton. From there, the melton, carried by the rotating roll 12, passes into a coagulation vat 13 under rolls such as are indicated at 14 whence, after having been coagulated by contact with a bath of acetic acid 15, the melton is carried forth by a rotating roll 16 onto a table 17 where its coagulation is completed. Carried by the set of rolls 18, it comes in a damp condition onto a table 19 where it is cut, by means of the cutting press 20, into square pieces 21 of sufficiently large size to permit of subsequently cutting therefrom circular blanks of a suitable size for making hemispherical calottes.

The operator then lays two of the pieces of impregnated and coagulated melton one upon the other so that the weft and warp threads of the one are at 90° with respect to the corresponding threads of the other (see Figure 2A). By means of a roll he presses these pieces one against the other in order to cause them to stick together and in order to expel the excess of coagulating liquid remaining in the impregnated fabric. The resultant pieces are then washed with water in a vat 22 whence they are taken and cut into circular discs 23 by means of the cutting press 24.

The discs 23 are then stamped out into hemispherical calottes in the dies 25 by means of punches 26. The cavities in the said dies (see Figure 5) have as indicated at 27, the shape of the outer surface of the calotte to be formed, and the cavities terminate at their upper part in an annular groove in which a ring 28 is removably seated. The punch 26 (see Figure 6) has externally a surface 29 corresponding to the inner surface of the hemispherical calotte to be formed, an annular part corresponding to that of the ring 28, and a base 30. Figure 7 shows the stamped out calotte 31 the edge of which is clamped between the ring 28 and the punch 26. When removed from the stamping press 32, the punch 26 is separated from the die and carries with it the hemispherical calotte 31 and the ring 28 (see Figure 8). During the stamping operation the liquid and the air which are in excess in the impregnated blank are expelled through passages such as indicated at 33 in the die.

The formed calotte blank is placed with its punch and its ring on a heating table 34 for evaporating the water contained in the blank. As soon as the blank is dry, the ring 28 is removed and the excess 31a of material is cut away by means of the press 35 so as to form a calotte 31, the edge 36 of which is in the diametral plane of the geometrical sphere of which the calotte is a

segment (see Figure 10). The calottes 31 so formed are then removed from the punch and dipped into a bath of rubber solution 37 and then dried in a drying-room 38. After drying, both calottes are united together by their rims 36 after introducing into one of them a certain quantity of carbonate of ammoniac, or other equivalent compound, capable of producing a gas at a temperature which is lower than or equal to the temperature of vulcanization. Thus a sphere is formed (see Figure 11). Over the joint formed by bringing together the rims 36 of the calottes a strip of gum 39 is placed, the thickness, the width and the length being determined so as to produce a roughed-out ball of a weight equal to that of the other balls so formed when completed, so that all balls have a weight within the limits fixed by the International Lawn-Tennis Federation regulations.

On the roughed-out ball, two pieces 40 (see Figures 12 and 13) of canvas of uniform texture are applied which are coated on one of their faces with vulcanizable gum, calendered on the canvas. The shape of each of these pieces is such, that, when two of them have been applied onto the ball, they completely cover its surface without overlapping one another, the gum being on the outside. It is advantageous to give the pieces the shape of a lemniscate in the usual manner.

The canvas covered ball is then placed into a mold (see Fig. 14) formed of two sections 41 and 42 which define a spherical cavity when symmetrically registered. The inner surface of each section of the mould is provided with a series of grooves such as indicated at 43 adapted to produce projections 43a on the outer surface of the finished ball (see Figure 13) capable of producing the same playing effects as the felt which covers the usual balls. In the embodiment shown in the drawing, the said grooves are circular and are shaped as if generated by a substantially equilateral triangle lying in a diametrical plane of the sphere and the vertices of which move in a series of parallel planes perpendicular with the plane of the triangle. There are provided in this case three sets of projections which are at right angles to each other.

One of the sections of the mould is provided with a barrel 44 slightly projecting into the interior of the section and provided with a passage 45. The unfinished ball formed by the impregnated calottes 31 covered with pieces of gummed canvas 40 and coated with a coating 46 of rubber solution is placed into the mould. Then pressure is exerted on the plates 47 and 48 so as to force the sections together around the ball. The temperature of the mould is then brought to the temperature at which the vulcanization of the rubber components of the ball takes place. At this temperature, the chemical compound 49 which was introduced into the ball, before the joining of the halves thereof, vaporizes and exerts on the inside of the ball a sufficient pressure which firmly presses the walls of the ball against the interior of the mould, thereby causing the gum which impregnates the cover pieces 40 to penetrate into the grooves 43 and to fill them. As soon as the vulcanization has been completed the ball is perforated by means of a trocar introduced through the passage 45, to cause the pressure in the ball to subside to atmospheric pressure. Then the mould is opened and the ball removed therefrom. The only thing remaining to do then is to seal the hole 50 in the ball. In the embodiment described and shown, this is effected by means of a hollow punch 51 terminating in a hollow point 52 in which a passage 53 is provided. A rubber thread 54 coated with a gum solution is then introduced into the passage 53. The point 52 is then inserted through the hole 50 and the rubber thread 54 is pushed so as to slightly project into the interior of the ball; then, while the thread 54 is maintained stationary with respect to the ball, the punch 51 is withdrawn from the hole 50. The thread is held fast by the drawing together of the edges of the hole 50. The thread is then cut flush with the bottom of the recess 55 which was formed in the ball by the barrel 44 of the die. This recess is filled with a lozenge 56 covered with a rubber solution which covers the exposed end of the sealing thread 54, said lozenge being stuck in position. Thus thread and lozenge are firmly united to the ball.

The lozenge 56 can be of any desired colour so as to permit an identification of the balls, for example in the course of the game.

While the foregoing specification and the appended drawings illustrate an embodiment of the invention, other embodiments of the invention can be made without departing from the scope of the invention. Thus, for example, to obtain a uniform fabric by laying one upon another two meltons or equivalent fabrics at 90° with respect one to another, instead of impregnating the said meltons separately as in the above described embodiment before sticking them together, it would be possible to apply them one upon the other at 90° before the impregnation, and impregnate them thereafter.

What I claim is:

1. A tennis bell comprising a hollow body confining air at substantially atmospheric pressure, said body being composed of a pair of hemispherical calottes joined together, each calotte being shaped out of fabric of uniform linear tensile strength in substantitally all directions and impregnated with rubber, the rubber and the fabric of the calottes being together moulded and vulcanized to define the shape and substance of said hollow body, said hollow body being formed with a perforation closed by a plug, said plug comprising a rubber thread secured in the perforation and a rubber lozenge applied on the outer end of the thread.

2. A tennis ball comprising a resilient hollow sphere confining air under atmospheric pressure, said sphere comprising a moulded and vulcanized self-supporting body consisting of a pair of assembled hemispherical calottes resistant to radial deformation to normally assume a spherical shape, said calottes each individually consisting of reinforcement composed of two rubber impregnated pieces of fabric coextensive with the entire wall structure of the associated calotte, the pieces being superimposed on each other with the warp and weft threads of one of the pieces arranged at right angles to those of the other piece whereby the wall reinforcement has substantially equal linear tensile strength in all directions.

3. A tennis ball comprising a hollow body confining air at substantially atmospheric pressure, said body being composed of a pair of hemispherical calottes joined together, each calotte being shaped out of fabric of uniform linear tensile strength in substantially all directions and impregnated with rubber, the rubber and the fabric of the calottes being together moulded and vulcanized to define the shape and substance of said hollow body, said hollow body comprising a perforation and an outer recess coaxial therewith, a

rubber thread stuck in the said perforation and a plug stuck in the said recess and made even with the outer periphery of the ball.

LÉON SYLVAIN MAX LEJEUNE.

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