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MAY 11, 1943.
BY A. P. C.

L. S. M. LEJEUNE

PROCESS FOR MAKING TENNIS BALLS

Filed Dec. 27, 1941

Serial No.
424,624
5 Sheets-Sheet 1

Fig. 1

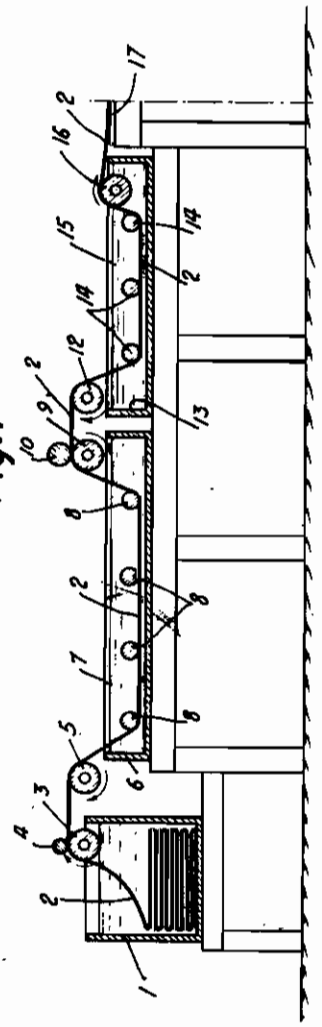

Fig. 2

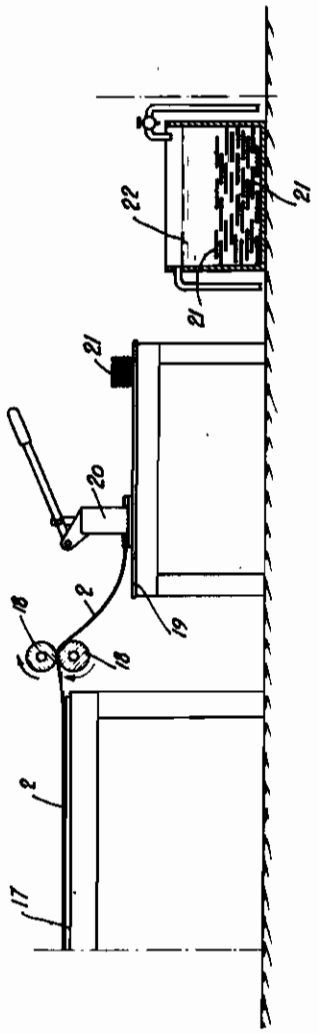

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Fig. 3

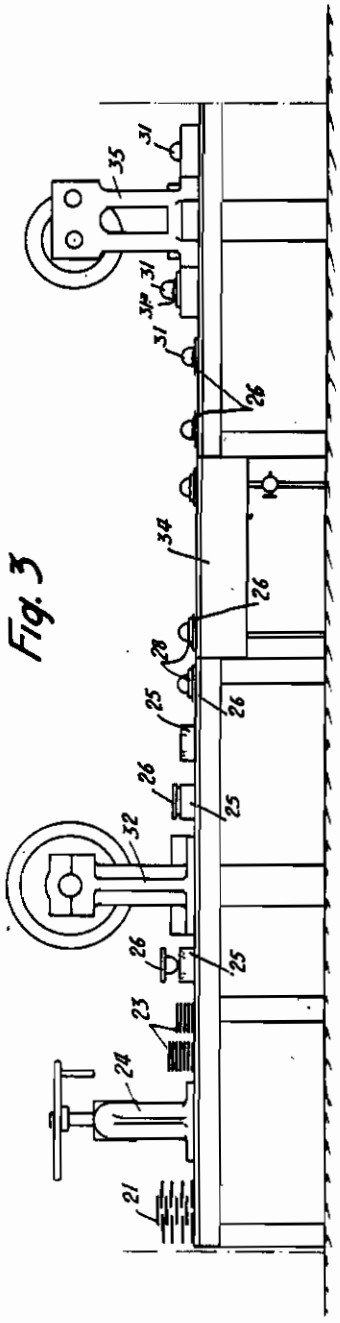

Fig. 4

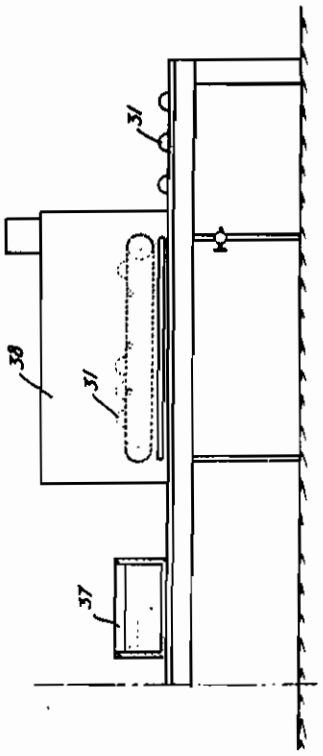

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Fig. 5

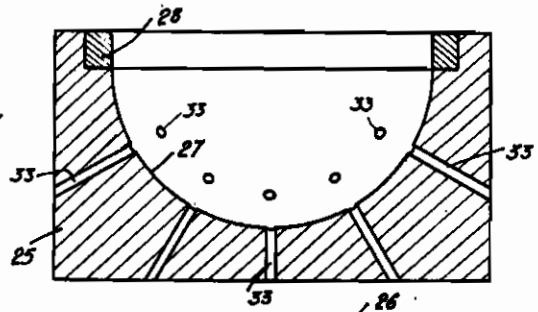

Fig. 6

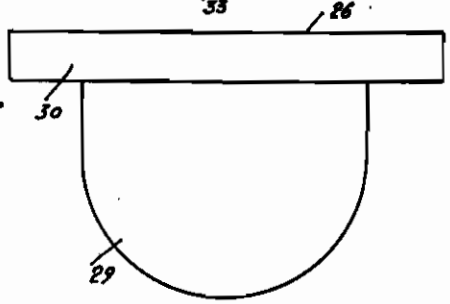

Fig. 7

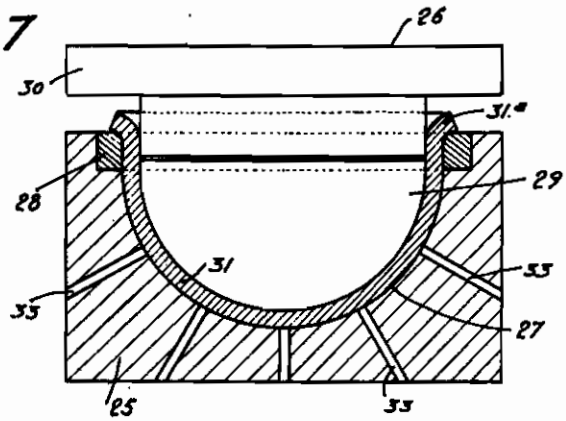

Fig. 8

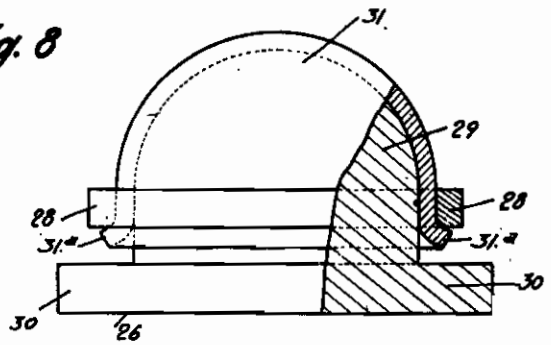

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Fig. 9

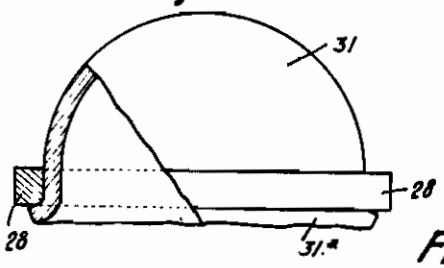


Fig. 10

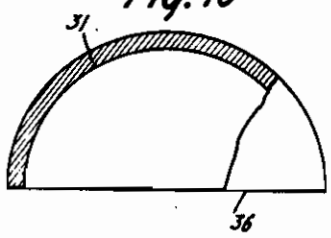


Fig. 11

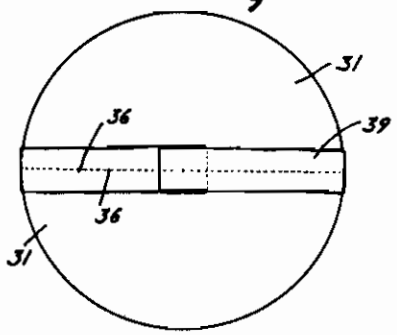
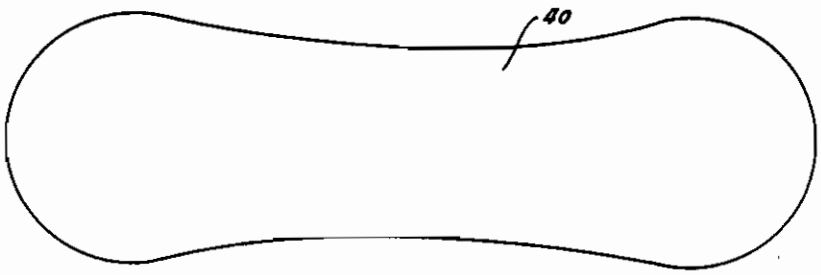


Fig. 12



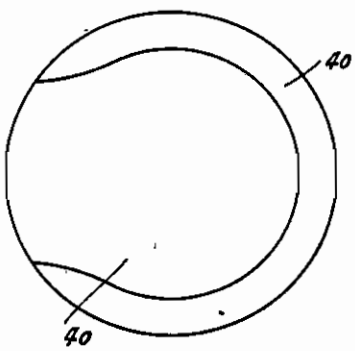


Fig. 13

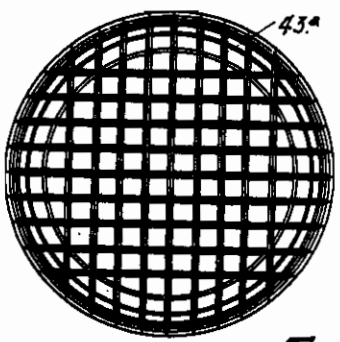


Fig. 15

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Fig. 14

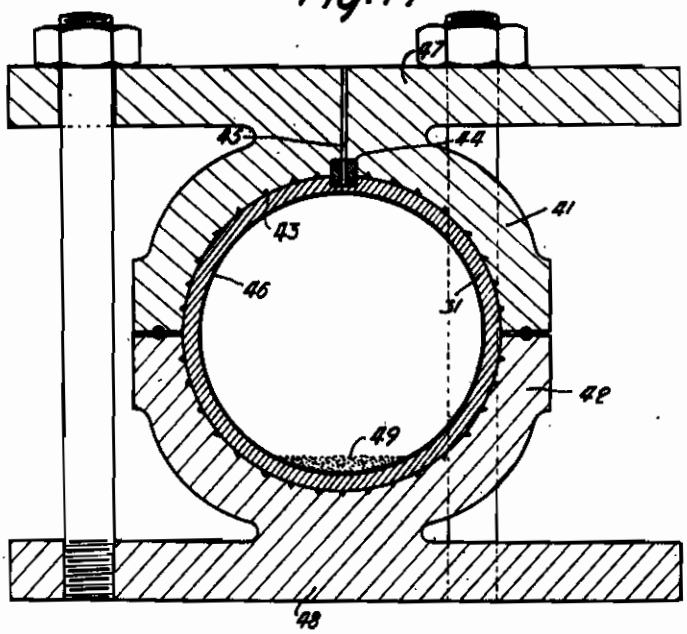


Fig. 17

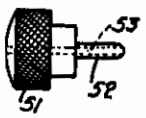


Fig. 16

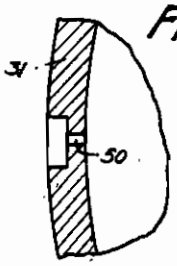


Fig. 18

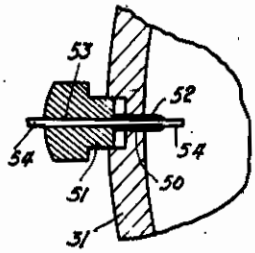


Fig. 19

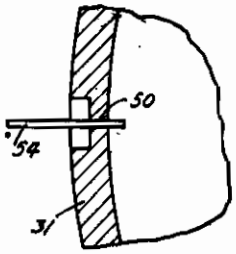
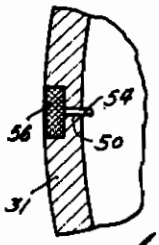


Fig. 20



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ALIEN PROPERTY CUSTODIAN

PROCESS FOR MAKING TENNIS BALLS

Léon Sylvain Max Lejeune, Paris, France; vested in the Alien Property Custodian

Application filed December 27, 1941

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

The object of my invention is a process for making tennis balls complying with the conditions prescribed by the International Lawn-Tennis Federation as regards balls used in international tennis matches. As known these conditions consist in maximum and minimum limits for the diameter of the ball, its weight, its rebounding height for a given height of fall and its degree of compression under a predetermined stress applied during a given time. Such balls are a fortiori suitable for training for such matches, and all the more so for the use of ordinary players.

Another object of the invention is a process which permits to obtain tennis balls which are not liable to let out their air after a more or less long period of time.

Still another object of the invention is a process which permits to obtain tennis balls which practically do not wear out.

A further object of the invention is a process for making tennis balls having a regular rebounding capacity which does not substantially vary with changes in temperature.

Still a further object of the invention is the manufacture of tennis balls the initial launching velocity of which can be very great and remains the same during the whole life of the balls.

Another object of the invention is the manufacture of tennis balls upon which the ground produces no damping or deadening effect (as has been observed with usual balls covered with felt) and the rise of which from the ground to the receiving racket can consequently be rapid.

Still another object of the invention is the manufacture of tennis balls which are sensitive neither to cold nor to heat or to moisture and the properties of which thus remain the same regardless of the weather.

Another object of the invention is the manufacture of tennis balls which can be washed.

Still a further object of the invention is a process which permits of making balls having the above mentioned properties under remarkable conditions of regularity and economy.

The tennis balls the manufacture of which forms the object of the invention comprise substantially a body filled with air substantially at atmospheric pressure, this body being formed of two hemispherical calottes united by vulcanized rubber and each of which is made of a balanced 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.

The fabric which is used for forming the hemispherical calottes can be composed of vegetal or animal fibres or threads. As above mentioned, this fabric must be a balanced 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 is in equilibrium 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 molton 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 molton 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 of 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.

The process of manufacture according to the invention essentially consists in impregnating a balanced fabric such as the above defined fabric with an aqueous emulsion or solution of natural, synthetic or regenerated rubber, in cutting out, in this impregnated fabric, pieces of suitable shape and in pressing them into hemispherical segments after coagulation but while the mass is still wet so as to expel a part of the coagulation water, in drying the hemispherical segments, after which two of these segments are united by sticking them together along their edges in order to form a ball by means of a rubber solution, after which the ball is covered with a coating formed of a fabric stuck through calendering to an external layer of non-vulcanized rubber, the

whole being then vulcanized in a mould the inside of which reproduces the external form which the finished ball must have.

The impregnation may be effected by any known means but so as to uniformly and regularly distribute the same weight of emulsion or of solution on an equal surface for a determined thickness.

The coagulation is also obtained by any known methods. The fabric is cut out and stamped in the form of spherical segments immediately after the coagulation, that is to say when the rubber is fixed in the fabric, but still surrounded by its coagulation water. In the course of the compression due to the stamping a part of this water is expelled, but a certain quantity of water remains therein which is removed by drying.

During this drying operation a deformation of the hemispherical calottes necessarily takes place. For this reason, in a manufacturing process requiring such a precision as that of a tennis ball, the drying is effected, according to the invention, on a hemispherical punch having exactly the form and the dimensions desired for the calotte. During the whole drying operation, the rim of the calotte is maintained on the hemispherical punch for instance by means of a ring which tightly holds down the rim of this calotte against the punch in order to avoid any irregular shrinking.

After the assembly of both hemispherical calottes, the spherical body thus obtained is covered with a layer of fabric stuck by calendering to vulcanized rubber and the whole is vulcanized in a mould the wall of which is provided with suitable asperities for giving to the outer surface of the ball the desired roughness in order to regulate the velocity in the air. It is advantageous, for this vulcanization, to introduce previously into the ball a substance capable of producing gases at the temperature of vulcanization in order to obtain during the vulcanization an inner pressure adapted to ensure a better application of the walls of the ball against the cavity of the mould and a more rapid vulcanization. After the vulcanization, the wall of the ball is perforated while the latter is still contained in the mould in order to balance its inner pressure with the pressure of the surrounding air, and then the so formed hole is stopped.

According to a preferred embodiment of the process according to the invention, the different above mentioned operations are effected in the following manner.

Cotton molton having a weight of preferably 450 to 500 grams per square meter is first treated so as to facilitate its impregnation with rubber of natural latex or regenerated or synthetical rubber, for example by previously dipping it in water to which a "wetting" agent has been added, after which this so prepared molton is impregnated with rubber of 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 a slight 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 the excess of the coagulating bath, for instance by a slight pressure, it is cut into pieces or discs after which two so impregnated pieces or discs are laid one upon another so as to obtain a balanced textile unit. The operation is carried out, preferably, by first laying one upon another with their warp threads at 90° two pieces of molton impregnated with rubber coagulated in the above mentioned manner, and then by applying them upon one another so as to cause them to adhere by expelling a part of the coagulating bath remaining in the molton, after which discs are cut in the soformed, double layer, impregnated pieces of molton.

After washing with water during a sufficiently long time for eliminating the excess acid as well as the other substances soluble in water remaining in the discs, the latter are pressed into a hemispherical calotte. This operation is preferably effected by putting one of these discs of impregnated double layer, molton into a cylindro-hemispherical die the rim of which is formed by an annular ring embedded in the die and by stamping the disk 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 evacuation of a certain quantity of water under the action of the stamping pressure.

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

The so formed unit 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 definite 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 whole surface of the calotte is covered. As soon as the solution is dry, two of these calottes are united together to form a sphere by bringing their diametral sectional planes in contact, after having introduced into one of these calottes a predetermined weight of a chemical compound capable of decomposing under the action of heat and emitting a gas, leaving no solid residue as far as possible. This body will 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 centimetre, 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 covered with pieces of canvas impregnated with rubber and cut out in such a manner that when joined side by side they completely cover the whole 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 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 during the time necessary for the vulcanization of the rubber entering into the constitution 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. This evolution of gas presses the spherical wall of the ball against the die due to the pressure developed, 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 pressure is obtained, the mould is opened and the ball removed, after which the hole which had been bored is stopped. This is advantageously effected by introducing into this hole a rubber thread coated with a rubber solution which thread is cut at the level of the outer wall of the ball, that is to say at the level of the outer surface 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 has been bored 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 latter. 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 being done, the above mentioned lozenge is then eventually applied and stops the cavity of the outer surface of the ball. When drying, the rubber solution which covers the thread unites the latter to the wall of the ball and thus tightly and definitively closes the hole which had been bored in the latter.

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 following steps of the manufacture up to the preparation of the pieces of impregnated fabric in which the discs which serve for making the balls are to be cut out.

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

Figure 4 is, in the same manner, a view in elevation of the following parts of the plant up to the production of calottes ready to be united in view of obtaining roughed out balls.

Figure 5 is a cross sectional view of the die for the production 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, partially sectional, of a half-calotte ready for assembly.

Figure 11 is a view of the roughed out ball comprising two calottes assembled together with a rubber layer applied onto 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 vulcanization mould with the roughed out ball in the inside of same.

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

Figure 16 is a partial sectional view showing the pressure-balancing hole.

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

Figure 18 is a sectional view showing the perforation of the ball and the punch in operation for the insertion of the stopping thread.

Figure 19 is a similar view of the stopping thread inserted.

Figure 20 is also a sectional view of the balancing 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 molton. In this vat which is filled with water to which a wetting agent has been added, the molton 2 is impreg-

nated with moisture. It is carried forth by a rotating roll 3 above which is a compressing roll 4 which expels the excess of water carried forth in the molton. Then the molton 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 as 8 which maintain it under the surface of the latex, it passes between a driving roll 9 and a weighted roll 10 which is sufficiently heavy for expelling the excess latex as well as the air contained in the molton. From there the latex, carried forth by the rotating roll 12, passes into a coagulation vat 13 under rolls such as 14 where, after having been coagulated by contact with a bath of acetic acid 15, it is carried forth by a rotating roll 16 and placed onto a table 17 where its coagulation is completed. Carried forth 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 of sufficiently large size to permit of subsequently cutting therein circular blanks of a suitable size for making calottes, each forming a half-ball.

The operator then lays two pieces of impregnated and coagulated molton one upon another so that the weft and warp threads of the one are at 90° with respect to the corresponding threads of the other. By means of a roll he presses these pieces one against the other in order to cause them to stick and in order to expel the excess coagulating liquid remaining in the impregnated fabric. The so impregnated and double layer pieces of molten are then washed with water in a vat 22 whence they are taken again in order to be cut into circular discs 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 said dies (see Figure 5) have internally, at 27, the outer shape of the calotte to be formed, and terminate at their upper part in a cylindrical ring 29 which is freely adapted to them. The punch 26 (see Figure 6) has externally a surface 29 corresponding to the inner shape of the hemispherical calotte to be formed, a cylindrical part corresponding to that of the ring 29, 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 leaving the stamping press 32, the punch 26 is removed from the die, carrying 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 have been evacuated through passages such as 35 provided in the die.

The so formed half-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 31*a* of impregnated molton is cut away by means of the press 35 so as to form a half-calotte 31 the edge 38 of which is in the diametral plane of the geometrical sphere of which the calotte is a part (see Figure 10). The so formed calottes 31 which have been removed from the punch are then 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 38 after introducing into one of them a certain quantity of carbonate of ammoniac, of 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). On the joint formed by bringing together both rims 36 of these hemispheres, a strip of gum 39 is placed, the thickness, the width and the length of which are determined so as to give the roughed out ball which has been so formed a weight which is equal from one ball to another and which is so established that, when completed, all the balls have a weight comprised between the limits fixed by the International Lawn-Tennis Federation regulations.

On the so formed roughed out ball two pieces 40 (see Figures 12 and 13) of canvas of balanced 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 the surface of the latter without overlapping one another, the gum layer being on the outside. It is advantageous to give them the shape of a lemniscate in the usual manner.

The so formed blank is placed into a mould (see Figure 14) formed of two parts 41—42 forming inwardly a sphere when they are symmetrically united one to another. The inner face of each of these pieces is provided with a series of grooves such as 43 adapted to produce on the outer surface of the finished ball projections 43*a* (see Figure 15) capable producing the same effect as the felt which covers the usual balls. In the embodiment shown on the drawing, the said grooves are circular and are generated by a triangle which is substantially an equilateral triangle lying in a diametral plane of the sphere and moving along a series of parallels to this sphere. There are provided in this case three sets of projections which are perpendicular one to another.

One of the pieces of the mould is provided with a barrel 44 slightly projecting into the inside of the piece and provided with a passage 45. The blank 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 die 41—42—43—44. Then a pressure is exerted by means of the plates 47—48 for pressing both parts of the mould one against another; the temperature of the latter is then brought to the temperature at which the vulcanization of the latex takes place as well as the vulcanization of the rubber solution and of the gum which enter into the composition of the blank. As above mentioned, the chemical compound 49 which has been introduced into the blank vaporizes at the temperature in question and exerts in the inside of the said blank a pressure which firmly presses the blank against the walls of the mould, thus causing the gum which impregnates the cover pieces 40*a* 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, which causes the pressure in the ball to drop, the inside of the latter then being at atmospheric pressure. Then the mould is disassembled and the ball removed from the same. The only thing remaining to do, then, is to stop the hole 550 for communication with the outside air. 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 caused to penetrate into the hole 50

and the rubber thread **54** is pushed so as to slightly project into the inside of the ball; then, while the thread **54** is maintained stationary with respect to the ball, the plug **51** is then drawn backwards. Then the thread **54** is held fast by the drawing together of the edges of the hole **50**. It is then cut at the level of the bottom of the recess **55** formed in the ball by the barrel **44** of the die, and in this recess a lozenge **56** is stuck which covers the end of the stopping thread **54**. Thus thread and lozenge are firmly stuck 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.

The preceding specification and the appended drawings correspond to an embodiment of the invention. Other embodiments of the invention can also be imagined without departing from the scope of the invention. Thus, for example, to obtain a balanced fabric by laying one upon another two moltons or equivalent fabrics at 90° with respect one to another, instead of impregnating the said moltons separately as in the above described embodiment, and then applying them one against another, it would be possible to apply them one upon another at 90° before the impregnation, the so formed unit being then impregnated.

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