This invention relates to machinery for covering playing balls. It finds practical application in the covering of tennis balls. The tennis ball of today is a highly refined product, and in form, dimensions, and structure is minutely standardized. The object of this invention is a machine adapted to produce such articles with great accuracy and with great rapidity.

In the accompanying drawings Fig. 1 is a view in perspective of the machine of the invention; Fig. II is a view in plan of one of the two duplicate blanks of material that, applied to the ball, together constitutes the cover; Fig. III is a fragmentary view in perspective, showing a portion of the machine and illustrating a particular coordination of parts; Fig. IV is a fragmentary view in vertical section, illustrating another particular coordination; Fig. V affords further illustration of the parts shown in Fig. IV, after they have advanced to an ensuing position in their coordinated operation; Fig. VI is a view in perspective of a covered ball, as it comes from the machine; Figs. VII and VIII are views in elevation of the machine when closed and as viewed, severally, from the side (approximately the view of Fig. I) and from the rear (to the right, Fig. I). In Figs. VII and VIII certain details are shown in section. Fig. IX is a fragmentary view in section, on the plane indicated by the line IX—IX, Fig. VII; Fig. X is a view in axial section of a certain cylinder that is included in the structure of the machine; and Fig. XI is a view in axial section of an electromagnetic motor that may be used in lieu of the pneumatic motors for the operation of the machine.

In an application for Letters Patent filed by me January 25, 1939, Serial No. 252,775, I have described apparatus for covering balls that includes two press members, each member consisting of two blocks of spherical concavity hinged together, the two press members adapted to be brought to cooperative positions. In the specification of that earlier application I have said that suitable means would be provided for carrying the press members and for effecting their cooperation. Such carrying and operating means constitute the present invention. The present invention further involves certain refinements in the structure of the press members themselves and contemplates the provision of additional cooperating parts, all as will hereinafter particularly appear.

The tennis ball of today consists of a spherical shell of vulcanized rubber enclosing a segregated body of air (with which other gas may be mingled) under a pressure somewhat exceeding atmospheric, and a cover of woven fabric of character and quality known in industry as "felt" or "felt cloth," cemented upon its outer surface. The felt cloth is woven in a plane; that is to say, in sheet-like web. For the covering of a ball two identical blanks are cut from the web of cloth, and these are shaped and applied to the ball. When applied they meet edge to edge, to form a continuous cover. The two identical blanks are of Cassinian outline, with symmetrical, approximately semi-circular ends, connected by a narrower reversely curved waist. If, as is usual, the cloth be woven, the blank is cut on the bias, so that the threads of warp and of woof extend obliquely to the major axis of the blank. Such a blank is illustrated in Fig. II of the drawings, and in this figure the warp and the woof are diagrammatically indicated by dotted lines.

Two such blanks are applied to the ball, each with its major axis on a great circle of the sphere of the ball, the two great circles being in planes perpendicular to one another, and each blank extending with its major axis in continuity with the minor axis (that is to say, the axis perpendicular to the major axis at a point midway in the length of the major axis) of the other.

As shown in the drawings, the two press members A and B of the machine of the invention are duplicates, in that each consists of two blocks 1 and 2 (1a, 2a), hinged together, and capable of swinging between the open positions of Fig. I and the closed positions of Fig. V. The two blocks of each pair are formed with faces 11, 12 of spherical concavity, the spherical curvature being that of the covered ball; the peripheral outline of each concave face is exactly that of a cover part (Fig. II) when shaped and compressed upon the ball; the line of division of the two halves of each press member is that of the minor axis (defined above) of the Cassinian outline of the cover part. The blocks 1 and 2 may be brass castings; their spherical concavities are accurately machined, finished, chromium plated, and highly polished.

Referring to Fig. I, and considering particularly the press part A, the two blocks consist of the concave body portions, to which the numerals 1 and 2 are immediately applied, and beam-like extensions 3 and 4 (cf. Fig. III) upon which the concave body portions are rigidly borne. These two beam-like extensions are, by the provision of terminal perforated angles, mounted...
pivotally upon a suitable fixed standard 6. The axis of this pivotal mounting extends in that equatorial plane (of an engaged ball) in which the press member, carrying a cover part 7, is closed upon a ball 2; the minor axis of the so carried cover part lies, and it is substantially tangent to the covered ball within the closed press.

The press part B is similarly formed, but its blocks 1a, 2a are pivotally mounted, not immediately upon the specified standard, but upon an arm 1. The arm 7 in turn is pivotally mounted upon the fixed standards 8, 9.

Centrally beneath the press part A a pneumatic cylinder 10 is set, and to the stem 11 of the piston of this cylinder the beams 3 and 4 are by the toggle connections 13 and 14 united. By the shifting of the piston within this cylinder the blocks 1 and 2 are swung in simultaneity between the open position (Figs. I and III) and the closed position (Fig. V). Similarly, a pneumatic cylinder 15, borne by the arm 1, affects the swinging of the blocks 1a and 2a between open and closed positions.

The arm 7 extends from a idchief 16 that is rotatable on an elongate bearing 17A secured upon a shaft 17 (Fig. IX). Shaft 17 rests upon and is secure against rotation in standards 8 and 9 (Fig. VIII). It includes passages 17c generally communicating with the circumferential ports or grooves 17b in the bearing 17, and outlets 17c in sleeve 16 serve to establish communication between the passages 17c and flexible tubes 17a, that the cylinder 15 (and other pneumatic parts, presently to be described) carried by the arm 7 may be connected to the pneumatic system by which the machine is operated. A pinion 18 is integrated with sleeve 16, and a rack 19 is in mesh with the pinion. The rack is borne by a frame 20 that is mounded for reciprocation on standard 9, so that as the frame is reciprocated the sleeve 16 is rotated. A pneumatic cylinder 21 is fixed in the bed of the machine, and to the stem 22 of the piston within cylinder 21 the frame 20 is secured. Reciprocation of the piston within cylinder 21 effects rotation of sleeve 16. A segmental collar 23, here shown to be of 180° extent, is borne integrally by sleeve 16; and a stop 24 rigidly borne by a stationary part of the structure, but adjustable in position, limits the range of turning of the sleeve 16 in one direction (counter-clockwise, Fig. VII). A stop 25 is movable, when the sleeve 16 has advanced counter-clockwise to the limit fixed by stop 24, to the position shown in Fig. VII, and in that position stop 25 holds the sleeve against retrograde turning. A full stroke of the piston within cylinder 21 effects rotation of the sleeve 16 through substantially 180°; and, as has been said, stop 24 cooperating with collar 23 arrests turning in one direction at an accurately defined point, and in so accurately defined position the sleeve 16 and the parts borne by it are by stop 25 secured.

Movement of the stop 25 is effected by constituting it the tip of a lever 26, normally held by a spring 27 to operative position, and swung by the piston within a pneumatic cylinder 28 to sleeve-releasing position.

The cylinder 21 and the piston 40 within it are adapted to afford in large measure a cushioning effect as the piston approaches the ends of its stroke. See Fig. X. The cylinder chamber at its ends is reduced in diameter, to form extensions 41, and the piston is provided with corresponding extensions 42, that as the piston advances fits snugly within the extensions of the chamber. The higher degree of compression thus attained of a cover part 7, the spring 27 at the piston approaches the limit of its stroke affords enhanced cushioning effect.

A coiled spring 29 (Fig. VIII) is effective, to absorb momentum as the piston 40 within cylinder 21 approaches either limit of its stroke; thus the spring serves not merely as an additional cushioning device, but as a motor element, aiding in the overcoming of inertia when, after completion of a stroke in one direction, the piston 40 begins its reverse stroke. The structure in this particular is shown in Fig. VIII. The standard 8 carries a sleeve-like casing 30. The casing at one end is provided with a head in which is formed an axial orifice and at the other end is open. A shaft 31, journalled in the orifice in the head of the casing, carries a collar 32, which, overlapping the otherwise free end of the casing, affords a second bearing for the shaft. The shaft 31 carries a gear-wheel 33 that is in mesh with the pinion 18. The helical spring 39 is arranged within the casing 30, encircling the shaft 31. At one end (the left-hand end, Fig. VIII) the shaft is anchored to the casing: at the other end it is anchored to the shaft. As the sleeve 16, rotating in either direction, approaches the limit of its range, the momentum of the moving parts is in part absorbed either in contracting or in expanding the coil of spring 39; and when thereafter the piston in cylinder 21 begins its reverse stroke the energy so stored in the spring is effective in aiding in overcoming the inertia of the parts to the reversal.

In my prior application, Serial No. 252,775 I have shown the blocks that carry the cover parts and apply them to the ball to be equipped around the peripheries of their concavities with thin, discontinuous rims. These rims serve to confine the applied cover blanks accurately in position. In the improved machine of this application these discontinuous rims are retained, but they are differently organized and they are made subject to further refinements of machine operation.

Each of the blocks 1, 2 and 16, 2a carries a step 44 (cf. Fig. IV), and the stem of a piston 35 within a pneumatic cylinder 36. The stem extends radially outward with respect to the sphere of the ball within the closed press (cf. Fig. V), and the centre of the small circle to which the rim of the concavity of the block in part conforms lies in that radial line; that is to say, the stem extends from the centre of the block radially outward. The cylinder is mounted on a block 37 that is so connected with the block 2a (and so also of blocks 1, 2, 16a) as to permit of its reciprocation upon block 1a in the direction of the radial line in which the stem 34 extends. Pneumatic pressure is applied, so that in the sequence of machine operation the block 37 is reciprocated upon block 2a through a small but sufficient range. The rims of the blocks 1, 2, 16a are of radial extent; that is, the faces of the rims are surfaces defined by a radius moving along the line of the seam of meeting of the two parts of the cover of the ball. The block 37 is equipped with a plurality of spaced-apart fingers, in the form of thin leaf springs 38, that extend from block 37 and overlie the rim of block 2a. By the reciprocation of the block 37 the tips of these fingers may be extended beyond the rim of the block, as shown in Fig. IV, or retracted from such position of extension, as shown in Fig. XIV.
V. The pneumatic control of the cylinders is so related that, while the press members A and B remain open, the fingers 33 are extended; and in such extended position they serve to define the position of the cover blanks, and to aid in the engagement of the cover blank in the open press members. When, however, the press tips close upon the ball, applying to it the cover parts, the fingers are retracted, and the two cover blanks upon the ball come to abutment, meeting edge to edge, throughout all the extent of their peripheral edges.

In my earlier application I have asserted the desirability of closing the hinged-together blocks 1, 2, and 1a, 2a of the two press members simultaneously upon the ball. In the machine as I have made refinement of structure I have provided means for sustaining the ball accurately in position until the blocks of the press members are in position to close upon it. The ball-sustaining means alluded to are withdrawn when press member B completes its orbital swing; the blocks 1a, 2a of press member B continue in the open position (see Fig. IV) until retraction of the fingers has completed its swing. Thereupon the blocks of both press members close (Fig. V).

The means for sustaining the ball in accurate position until the press members are about to close come from four fingers shown in Figs. I and III. These fingers support upon their tips the uncovered ball (indicated in Fig. III by a broken-line circle). The fingers extend radially with respect to the sphere of the ball that they support. They are borne in pairs by the pistons of two pneumatic cylinders 44; and are by the operation of the pistons within such cylinders movable between the advanced position, shown in Fig. III, and the retracted position, shown in Fig. V. The fingers of the two pairs are arranged on opposite sides of the pair of pivoted blocks 1, 2, and their spacing is such that in their advanced position the ball is firmly supported.

In Fig. III the broken-line circle indicates the position of an uncovered ball sustained on fingers 44; and in this figure, in full lines, is shown a portion of cover blank C in place in the open press member.

Operation is as follows. The machine being in the open position shown in Fig. I, two blanks of felt cloth C (Fig. II), coated over one surface and on all of their edges with rubber cement, are applied to and shaped within the concavities of the press members A and B. The blanks are applied, coated surfaces upward or outward. In this applying of the cover blanks to and shaping them within the press members, the fingers 33 projecting beyond the edges of the concavities serve to define accurately the position of the blanks. A ball to be covered is then placed upon the cooperating tips of the extended fingers 43.

The machine then is set in motion. The piston 48 within cylinder 21 makes its traverse, and in so doing the effects the orbital swing of press member B from the position shown in Fig. I, through the position shown in Fig. IV, to the position shown in Figs. V, VII, and VIII. The press member B, having been moved counter-clockwise (Figs. I, IV and V) into position of cooperation, is by stop 26 arrested, and it is locked in this position by the swinging of stop 28 in response to the tension of spring 27, pneumatic pressure within cylinder 28 having at the appropriate moment been relieved.

When press member B has been thus locked in position of cooperation, the pistons in cylinders 75 44 operate and retract the fingers 43 from the engaged ball; the pistons in cylinders 10 and 15 operate and close the blocks of press members A and B; and the cylinders 33 operate and retract fingers 33 from overlapping positions upon the rims of the blanks C within press members.

It will be understood that press members A and B close upon the ball, there is a small but adequate clearance between the peripheral edges of the press blocks, to admit of movement of the fingers 33 from extended positions (in which they engage at their tips the edges of the cover parts C, Fig. VII) to retracted positions (in which the tips of the fingers lie between the edges of the blocks, Fig. V). This clearance between the edges of the press blocks in no way interferes with the desired edge-to-edge assembly of the cover parts upon the ball. The material of which the cover parts are formed, and the plastic cement that has been applied to such cover parts, yield under the pressure of the closing press blocks, with the consequence and effect that the edges of the cover parts (tending upon separation to spread laterally) are brought to abutment in seams that are continuous throughout all their extent.

I have found it advantageous, after the blocks 1, 2 and 1a, 2a have closed, applying both of the two cover parts to the ball, to hold them closed for a brief interval, of a second or two, and then, by manipulation of the pneumatic cylinders 10 and 15, to open and close the blocks in simultaneity a number of times, holding them closed each time for a brief interval. Then at length, opening them for a last time, to operate cylinders 28 and 21, swing stop 28 to reposition, rotate sleeve 16, and bring press member B again to the initial position shown in Fig. I. The covered ball D (Fig. VI) then remains, resting in the opened press member A.

In the drawings I have shown pneumatic connections, and in the specification I have indicated the organization of pneumatic cylinders with the moving parts and their coordination for effecting particular ends. My invention is fully described, and the details of control, to effect properly timed and sequent operation of the parts, are matters of engineering.

In describing the machine I have characterized the operating cylinders as pneumatic cylinders. Compressed air will ordinarily be found to be the most suitable driving fluid, but manifestly other fluids, gaseous and liquid, may be made serviceable; and I mean to include in the field and contemplation of my invention hydraulic as well as pneumatic drive. Additionally, it will be understood that electromagnetic plungers may be used as the means for effecting the operation of the machine, and in Fig. XI I have illustrated a typical organization. The operating stem 15a of the press (B) carried by arm 1 may be integral with the reciprocating armature 16b of a solenoid 18, and by the proper electric-energizing of such solenoid the armature may be powerfully reciprocated in alternate directions, carrying the stem 16a through its working strokes. The structure may include vented air pockets 15d at the two ends of the solenoid, adapted to cooperate with portions 15c at the two ends of the armature in cushioning the movements of the parts.

Referring particularly to Fig. I of the drawings, it will be observed of the organized press members that when in open position, ready to receive the two blanks that together form the cover, they are in positions of horizontal extension; that is to
4 2,800,096 say, they have been spread apart laterally and they are open to access from above. In such positions the attendant may readily apply to the open press members the cover blanks. From such positions of horizontal extension open to access from above, the blocks by relative movement are brought to the co-operative positions of Figs. V and VII in which they are closed upon the ball, having brought the cover blanks that they carry to assembly with the ball.

1. A press member for applying a fabric cover to a ball consisting of two pivoted-together blocks adapted to swing between open and closed positions, each block provided with a concave face shaped to the sphere of the finished ball, and the concave faces of the two blocks when swung to closed position extending in a continuous spherical surface, and having together an outline corresponding to that of a cover blank of Cassinian outline when shaped to the sphere of the ball, the axis of pivoting extending, when the blocks are in closed position, substantially in tangency to the covered ball and in common plane with the minor axis of the contained blank, and blank-positioning fingers extensible and retractable upon the rims of the blocks.

2. A press member for applying a fabric cover to a ball consisting of two pivoted-together blocks adapted to swing between open and closed positions, each block provided with a concave face shaped to the sphere of the finished ball, and the concave faces of the two blocks when swung to closed position extending in a continuous spherical surface, and having together an outline corresponding to that of a cover blank of Cassinian outline when shaped to the sphere of the ball, the axis of pivoting extending, when the blocks are in closed position, substantially in tangency to the covered ball and in common plane with the minor axis of the contained blank, and a second block reciprocably borne by each of the said pivoted-together blocks, such second block being equipped with fingers overlying the edges of the pivoted together blocks and extensible and retractable as the second blocks reciprocate upon the blocks by which they are borne.

3. In apparatus for covering balls the combination of a standard, a pair of concave-faced blocks pivotally mounted upon the standard, an arm pivotally mounted upon the standard, a second pair of concave-faced blocks pivotally mounted in the said arm and in the range of the swinging of said arm moving in orbital course to and from cooperative position with respect to the pair of blocks first named, fluid-pressure means borne by the standard for pivotally swinging the blocks of the first-named pair, fluid-pressure means borne by the standard for swinging said arm, and fluid-pressure means borne by the arm for pivotally swinging the blocks of the second-named pair.

4. The structure of claim 3, the said arm being pivotally mounted on a shaft including a plurality of passages, conduits for fluid leading severally to the passages within the said shaft, the means borne by the arm for swinging the blocks being a fluid-operated cylinder, and fluid connection being provided between the passages in said shaft and the said fluid-operated cylinder.

5. In a machine for applying to a ball a plurality of complementary cover parts, which machine includes a plurality of press members relatively movable between open and closed positions, in open position adapted severally to receive the cover parts, and in closed position to apply the cover parts to a ball; the refinement herein described that consists in a plurality of fingers arranged with each press member and adapted marginally to engage the cover part introduced to the press member, and means for retracting the fingers from such cover-part-engaging position when the press members move into cover-applying position.

6. A press member for applying a cover to a ball, said press member including two body members, one borne by the other and movable in right-line reciprocation upon the member that bears it, one member adapted to receive a cover part, and the other equipped with means adapted to engage peripherally a cover part positioned in the first member, and means for shifting the two members relatively to one another to retract said means from engagement with a positioned cover part.

7. In apparatus for applying to a ball two complementary cover parts, the combination of two press members each consisting of a plurality of pivoted-together parts adapted to open and close and adapted, when in open position, to receive a cover part and in closing to apply the received cover part upon a ball, means for closing the press members upon a ball, ball-supporting means consisting in a plurality of fingers extending radially with respect to a supported ball and adapted to sustain a ball in position for closure of the cover-bearing press members upon it, and means for retracting the fingers of the ball-supporting means on the lines of their radial extent in co-ordination with the closing of the press members upon the ball.

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