lap. The machines used are comparatively simple and consist substantially of a pair of rolls of more or less irregular surface. During the sizing operation the fibers are bent by the rolling and spring back when the pressure is relaxed, thus creeping root foremost and entwining around each other in inextricable confusion, and compacting the entire mass into the close felt fabric.

The next operation is shaving the bodies to remove the protruding hairs which, notwithstanding the previous cleansing processes, sometimes remain in the fur. This was formerly done by hand, but to-day a machine in which a knife, moving back and forth with great rapidity, is passed over the surface of the body, is usually employed. After the shaving the body is ready for the so-called second-sizing, which still more compacts the felt, as the shaving has left it more open and porous and consequently prepared for further shrinkage. The second-sizing and pinning-out is done by hand at so-called batteries, but instead of doing three at a time wrapped in cloth, only one body is manipulated, being rolled on a board with an instrument not unlike an ordinary rolling-pin. The battery is a large tub surrounded octagonally by planks sloping slightly inward, and filled with water kept hot by condensed steam. Eight men usually work at one battery.

When the moisture has been thoroughly removed from the felt at the completion of the second-sizing the body is ready for the stiffening. The stiffening substance is shellac conveyed to the body by a solvent, which may be either alcohol or an alkali, the first method being more expensive than the latter, and consequently confined to the manufacture of high-priced hats. The body is repeatedly dipped in the solution and passed between rollers to force the stiffening substance into the fibers, and when the body is sufficiently impregnated the solvent is either evaporated or neutralized by a dilute acid. When the bodies are thoroughly dried they are placed in a metal chest and live steam is admitted. This liquefies the shellac which, by capillary attraction, is partially drawn from the surface into the interior of the fabric. After that operation the stiffener is entirely cleared from the surface by quickly dipping the body into a hot alkaline solution and then allowing it to remain for a period in tepid water. Great care must be exercised during the stiffening, as poor workmanship or inferior materials may cause the manufacturer great loss.

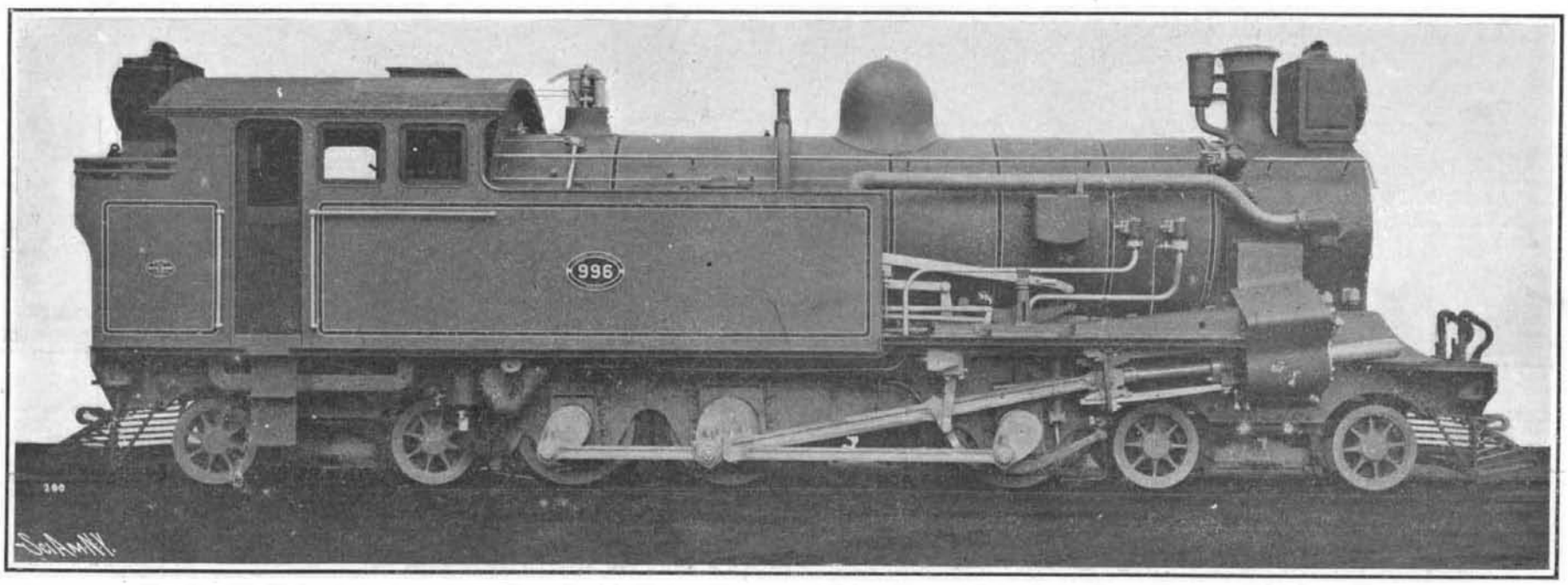
After the stiffening process is completed the hats undergo various shaping and stretching operations in machines which give them their initial forming and prepare them for the hand-blocking. The latter operation is performed at batteries similar to those in use during the sizings, and consists in immersing the hat in boiling water and shaping it by hand over a wooden or metal block of suitable form. This, of course, affects only the crown. The hats are now dyed in the usual manner common to many industries. While vegetable coloring matter was formerly used exclusively, the introduction of the aniline dyes was eagerly welcomed by the hat manufacturer, who at once recognized their value, and to-day they are used to the exclusion of all others. After the hat is dyed it is again hand-blocked, and then it is allowed to dry out thoroughly before undergoing the next or finishing operation.

To finish the hat, it is placed in an iron case and steamed to make it soft and pliable and is then placed in an hydraulic press to give the crown its final shape. After this the condensed steam is thoroughly dried out in gas ovens, the hat is pressed to remove all inequalities, and finally pounced with very fine sand-paper. The brim is now cut to the right dimensions and then, softened by means of hot sand bags and a heated metal bench, is curled by hand irons to the proper shape. Most of the operations in the finishing process are performed by hand, but here, too, machine work is being introduced, and before long the manual operations will probably be in the minority. At present, machines are partially used for the ironing of brims and crowns and for the cutting and curling of the former. The final trimming is done by girls and is a manual operation. This consists of sewing on the bindings, bands and leathers and fastening in the linings, after which the hat is ready for the market.

With the exception of the amount of shellac used in the stiffening process, the procedure in the manufacture of soft felt hats differs very little from that of the derby. However, before being finished the tourist hats undergo a separate pouncing process, an additional step which is a distinct branch of the business, performed by operators called pouncers. The soft hat finisher does very little pouncing, in fact just enough to surface the felt.

COMBINED RACK AND ADHESION LOCOMOTIVE FOR SOUTH AFRICA.

In the accompanying photograph we illustrate a unique type of powerful locomotive which has quite recently been completed by the Vulcan Foundry, Limited (Newton-le-Willows, England) for the Central South African Railway system, and the first of these engines, the largest and most powerful of their special type ever built, is to be shortly introduced for assisting the heavy corridor express trains over the exceptionally severe gradients which are encountered between Waterval Onder and Waterval Boven on the stretch of railway separating Laurenco-Marques from Pretoria.



Cylinders: 2 outside adhesion; 2 inside rack; diameter, 18 inches; stroke, 20 inches; steam ports, 1⅜ inches by 16 inches; exhaust, 2½ inches by 16 inches. **Boiler:** Barrel, 12 feet 2⅝ inches long; diameter outside, 5 feet 1⅜ inch. **Firebox:** Outside shell, 10 feet 3⅛ inches long by 5 feet 4 inches, 4 feet 3 inches wide; inside copper box, 9 feet 4⅛ inches long by 3 feet 9 inches, 3 feet 6⅜ inches wide; height, 4 feet 7¼ inches. **Tubes:** No. 197; diameter, 2 inches; length, 12 feet 7 inches between tube plates. **Heating surface:** Tubes, 1298.13 square feet; firebox, 140.2 square feet; total, 1438.33 square feet. **Area of fire grate,** 33.5 square feet. **Wheels:** Bogie, 2 feet 6 inches; coupled, 3 feet 6¼ inches; rack on pitch circle, 3 feet ⅜ inch. **Water capacity of tanks,** 1,200 gallons. Coal space for 2½ tons. **Working pressure,** 200 pounds per square inch. **Tractive force,** 80 per cent; adhesion engine, 22,085 pounds; rack engine, 25,636 pounds; total, 47,721 pounds.

COMBINED RACK AND ADHESION LOCOMOTIVE FOR SOUTH AFRICA.

It was required of these locomotives that they should be able to assist, with an adhesion engine in front, a train of 350 tons over a 1-in-20 gradient for a distance of about 3½ miles, and that they should condense their own exhaust steam while passing through a tunnel situated at the top of the incline. It will thus be seen that not only was high tractive force and efficient steaming capacity called for, but also effective brake power, and in the engine illustrated herewith these requirements would appear to have been very completely met. The engines, it may be pointed out, have two entirely distinct pairs of cylinders, 18 inches in diameter by 20 inches stroke, the inner pair driving a coupled pair of cog wheels, carried upon a frame suspended from the leading and driving coupled axles. The connecting rods of the inside engine are connected to projections of the coupling rods of the rack gear and not directly to the crank pins—a method which has been rendered necessary by the restricted width available between the tires. The rack axle bearings are adjustable vertically so as to compensate for the wear of the adhesion wheel tires, and for this reason also the teeth are of involute form, so as to insure correct action between the adjustments. The cranks are of the disk type, having triangular circumferential grooves in which the cast-iron blocks of a hand-power band brake work. The teeth of the rack driving wheels are cut from steel rings and driven through spring keys from the axles so as to compensate for slight irregularities in the pitch of the rack. The main frames of the engine are outside the wheels and are of cast-steel plate, 1¼ inches in thickness. The six-coupled wheels driven by the outside cylinders are 3 feet 6 inches in diameter and carry a load of 45 tons, while the bogie wheels have a diameter of 2 feet 6 inches. The valve motion is Joy's and that of each engine is separately reversed by its own screw gear. There are no fewer than five distinct brakes: (1) Steam brake on all coupled wheels and on both bogies; (2) hand brake on coupled wheels; (3) hand-worked band brake on crank disks of rack engine; (4) Le Chatelier counter-pressure brake on pistons of rack engines, and (5) the counter-pressure air brake on the pistons of the rack engine. This last-named brake consists of a valve in the base of the blast pipe which isolates the cylinders from the smokebox and prevents the entrance of hot gases and cinders when the motion is reversed, while there is a pair of non-return valves, through which air is drawn from outside the smokebox into the exhaust ports and thence compressed into the steam pipe. A graduating discharge valve is fitted and through this the compressed air is allowed to escape into the atmosphere through a silencer carried on the chimney, while a small water jet delivers a cold spray into the exhaust space, which serves to take up the heat of compression and prevent overheating of the cylinders. The boiler is built of mild steel plates with a copper firebox, and has its center line 7 feet 6 inches from rail level. The working pressure is 200 pounds per square inch, and there is an abnormally large water capacity in order to assist the supply of steam through the short tunnel, previously referred to, in traveling through which the blast pipes will not be working. There are 197 charcoal and iron tubes, 2 inches diameter and 12 feet 7 inches in length, while the heating surface amounts to 1,438.33 square feet, to which the tubes contribute 1,298.13 square feet and the firebox the remaining 140.2 square feet. The grate area is 33½ square feet and the combined capacity of the side and bunker tanks is 1,200 gallons of water, while there is space provided for 50 hundredweight of coal. In addition to the engine brakes, the locomotives are fitted with a combination ejector and pipes for working the vacuum brakes of the train, when necessary. The engines, when empty, weigh 70½ tons, and, in running order, 84½ tons, and in appearance conform largely with the other powerful types of locomotives built for the Central South African Railways by the Vulcan Foundry, Limited, with as many parts as possible of which the rack and adhesion engines have been designed to interchange.

Preparation of Caoutchouc in Africa.

The French administration in western Africa has undertaken the improvement of the quality of caoutchouc by initiating the natives in suitable methods. The adulteration of caoutchouc is entirely forbidden. Incisions in the rubber trees and plants are prohibited, except under limitations prescribed, and they are entirely forbidden during those months when the sap is rising. Professional schools are to be established, where the best processes for the harvesting and coagulation of the caoutchouc will be taught.