requirements which they have to satisfy. The following are a few examples:—

Hard rubber inside-coating for hard-press rollers.

(1) Congo	6,000	gms.
Canvas waste	2,000	,,
Reclaimed	3,000	,,
Sulphur	1,500	,,
Magnesia usta	1,250	,,
Litharge	1,000	,,
Barytes	5,000	,,
Pitch	500	,,
(2) Congo	10,000	,,
Reclaimed	10,000	,,
Sulphur	5,000	,,
Magnesia usta	1,000	,,
Litharge	2,000	,,

Covering sheet.

(1) Para	10,000	,,
Zinc white	8,000	,,
Barytes	2,000	,,
Sulphur	1,000	,,
Magnesia usta	300	,,
(2) Para	6,000	,,
Lopori	4,000	,,
Golden sulphide (17 %)	3,000	,,
Barytes	7,000	,,
Magnesia usta	250	,,

Leather press-rollers.

(1) Para	10,000	,,
Pitch preparation	1,000	,,
Zinc white	10,000	,,
Litharge	3,500	,,
Barytes	6,000	gms.
Sulphur	1,000	,,
(2) Para	5,000	,,
Mozambique	5,000	,,
Litharge	4,000	,,
Barytes	7,000	,,
Sulphur	1,500	,,
Ceresin	500	,,

Lacquering rollers, for lacquer and turpentine.

(1) Para	10,000	gms.
Sulphur	900	,,
Magnesia usta	150	,,
(2) Para	10,000	,,
Golden sulphide	1,100	,,
Magnesia usta	100	,,
Vermilion	600	,,
(3) Para	1,000	,,
Litharge	3,500	,,
Sulphur	800	,,
Pitch	500	,,

Sleeves for printing-machines.

Kassai (Congo)	10,000	,,
Substitute, white	6,000	,,
Zinc white	10,000	,,
Barytes	3,000	,,
Talite	5,000	,,
Sulphur	1,500	,,
Magnesia usta	200	,,
Paraffin wax	250	,,

8. Pneumatic Inner Tubes and Tyres, Pedal and Brake Rubbers and Cab Tyres.—In the manufacture of inner tubes, which can be carried out with comparatively simple plant, attention must be chiefly directed towards producing mixings which are absolutely clean and free from grit. Such a mixing for ordinary inner tubes would consist of rubber, which has been very carefully washed, and sulphur; for second qualities a cheaper compound can be used, but then it becomes a question of reducing the porosity of the rubber to a minimum. Mixings containing ingredients which when added on the mixing rolls are likely to flake, or to become granular, should be rejected; on the other hand, the following mixings have been tried and can be recommended for the purpose:—

A. (suitable for motor-cycle inner tubes only).		
Para	10,000	gms.
Sulphur	900	,,
Pitch	50	,,
B. Para	5,000	,,
Columbian	5,000	,,
Sulphur	1,250	gms.
Pitch	75	,,
C. Columbian	5,000	,,
Manaos	5,000	,,
Sulphur	1,000	,,
Substitute	4,000	,,
Pitch	200	,,

Inner tubes, which are cut out of sheet and made up on a mandrel, should be made from sheet doubled on the calenders; this is placed round the mandrel and cut from end to end of the latter

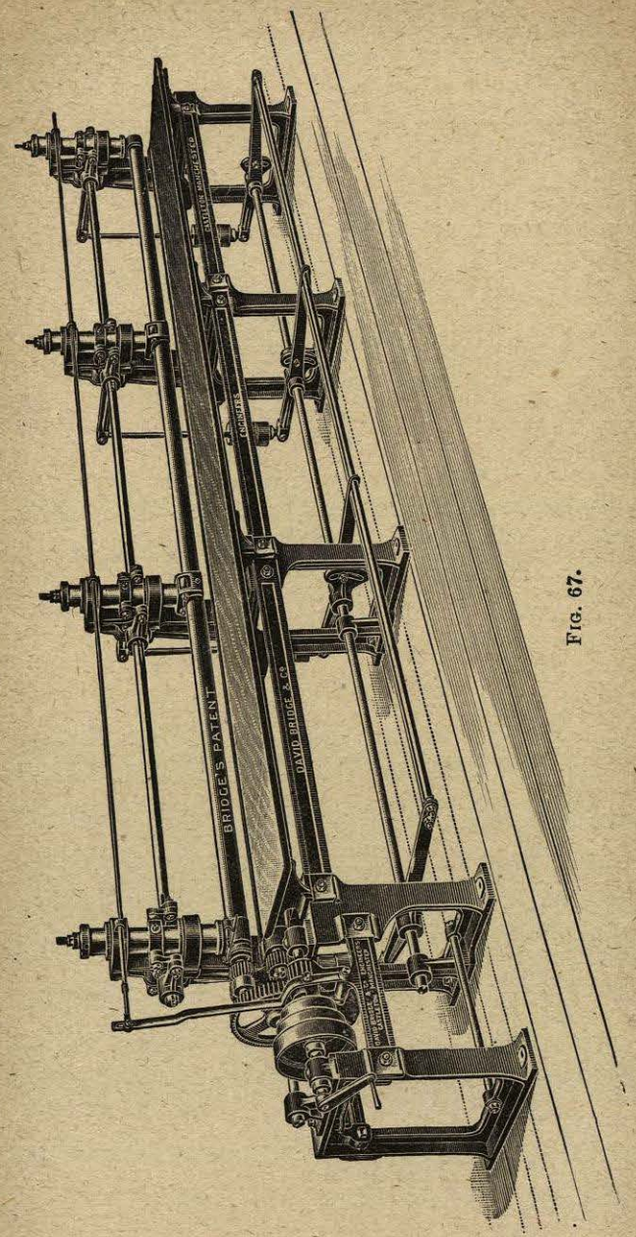

FIG. 67.

by means of a special cutting machine, the cut edges being at the same time pressed together so as to form an absolutely tight seam. The inner tubes are wrapped, just as they are made up, on the wrapping-machine (fig. 67), and are then vulcanised at 135° C. The

tubes are drawn off the mandrels with the aid of compressed air, being at the same time turned; holes are made for the valves, and the tubes are then cut to the right length, the ends solutioned with a pure Para solution, moistened with chloride of sulphur solution, and united. Motor tubes are often moulded, in which case the necessary amount of gas-producing materials is put inside the tube; a mixture of bicarbonate of soda and tartaric acid in tabloid form being the most convenient agent to employ.

The manufacture of pneumatic tyre outer-covers, on the other hand, necessitates the use of considerable mechanical arrangements; in particular, a large number of moulds which are best made of cast steel. Of these there are two kinds to be considered—drum moulds and core moulds, which latter are used especially for motor tyres. The manufacture of drum-cured covers is in principle as follows:—Cotton fabric, proofed on the calenders, is cut on the bias, and two layers are then rolled down on to the drum. The first layer of fabric carries the rubber cover known as the tread, which lies on the side next the mould. The strip is rolled into the cavity which forms the beaded edge, this being filled up with a cord of a hard-rubber mixing, and the second layer of fabric is then put on. The drum is now wrapped round with a cotton cloth on the machine depicted in fig. 68, and then with wire, and is run into the heater on a large trolley. It should be noted that vulcanisation should not set in before the layer of rubber has had time to spread itself evenly over the surface of the mould, otherwise markings similar to air-markings will result. These are not, however, to be attributed to the shrinking of the rubber, but rather to the fact that when it was rolled on to the drum the layer of rubber was not evenly spread out, and that this could not be remedied once vulcanisation, which proceeds energetically even at 130° C., had set in. For this reason, in the case of drum-cured covers, care should be taken to heat up the moulds slowly, after which the vulcanisation may be carried through more rapidly. Tyre covers which used to be made of pure Para, to-day consist of mixings similar to, or even of lower quality than, the following:—

Congo	10,000 gms.	Whiting	3,000 gms.
Pitch or asphalt	1,000 ,,	Sulphur	1,500 ,,
Reclaimed rubber	8,000 ,,	Dark substitute	10,000 ,,
Litharge	750 ,,		

The manufacture of motor-tyres was built up on the principle of the pneumatic core-tyre, and in course of time has developed into its present degree of perfection.

The principal conditions to be observed are, first and foremost, to see that the fabric to be employed is carefully proofed. The rubber should not be liable to after-vulcanisation, nor become tacky, and must be able to withstand the heat and vibration brought about by friction and blows. The covers are made up on solid iron cores made in several pieces, and consist of the layers of fabric—the details of which are determined by the shape and

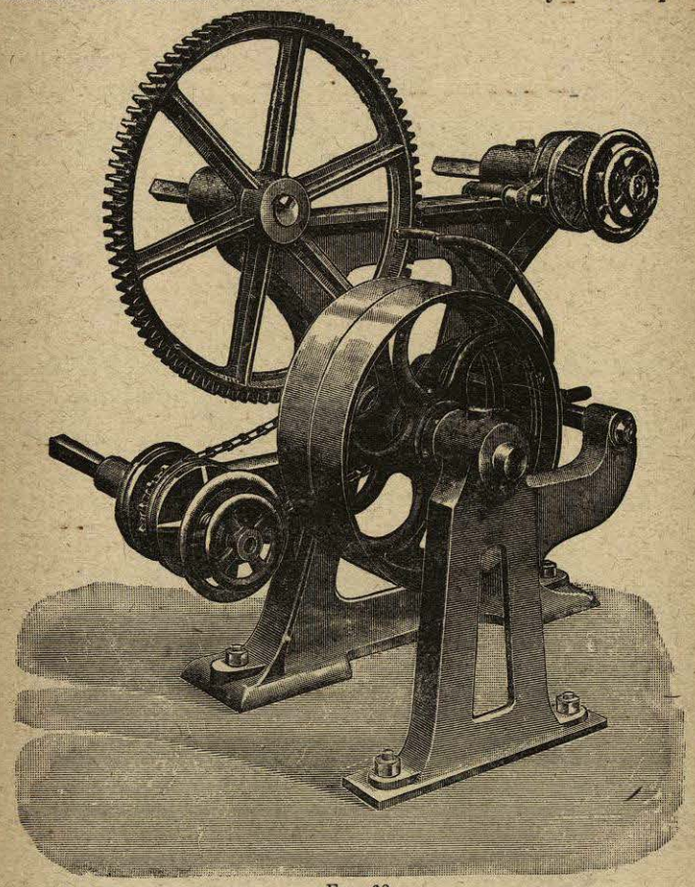

Fig. 68.

size of the tyre, and between which there should be neither dust nor air-holes—of the attached beaded edge and of the cover (tread). The latter is either built up from single strips, or the complete section is run out on Tröster's special tyre calenders. The compressing and vulcanisation are carried out either in the closed nest of moulds (fig. 69, A and B) or, better still, in hydraulic autoclave presses.

Moulds vulcanised in the above-named autoclave are subjected to a continuous pressure, which increases with the opposing pres-

sure of the tyre inside the mould, and so ensures that the separate layers are vulcanised together into a solid mass free from air-holes.

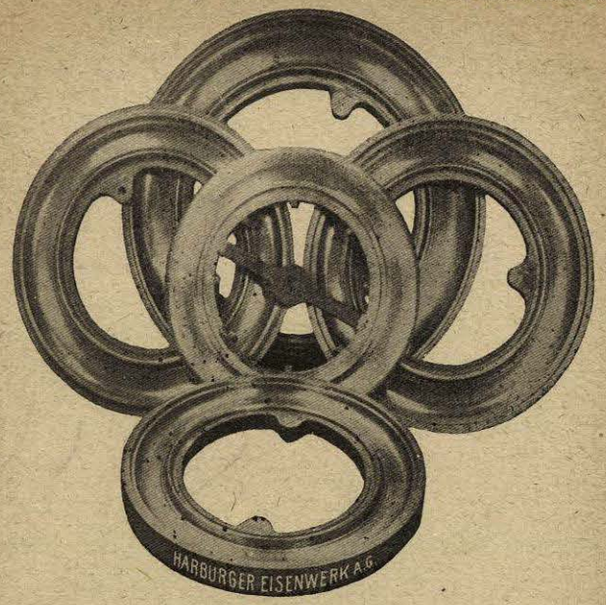

FIG. 69, A.

At the same time the moulds are entirely surrounded by the steam necessary to effect vulcanisation,[1] at a uniform temperature.

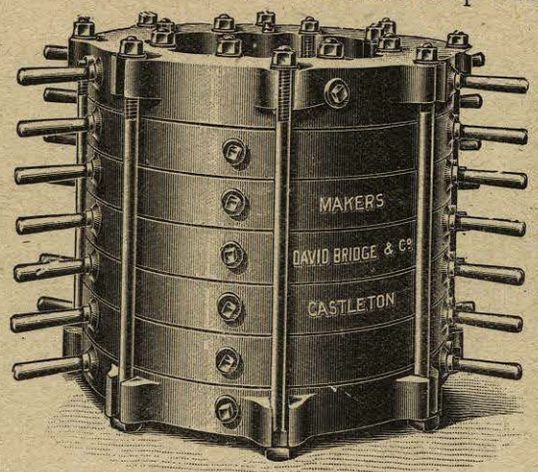

FIG. 69, B.

Pedal- and brake-rubbers are for the most part run on the tube machine in the form of shaped strips, corresponding with the die used, vulcanised in French chalk, and subsequently cut to the

[1] See also the article "Kombinierte hydraulische Kesselpresse" in the *Gummi-Zeitung*, 1905, vol. xix. p. 1001.

proper size by means of an eccentric punch, holes being at the same time punched in them. The matrix which holds the knife and the punch can be adjusted to take all sizes. One man can punch on an average 8000 flat pedals in a day. Curved brake-rubbers with a hard-rubber inner layer are run on the machine in the two different qualities, joined together by means of solution, cut up into pieces of the proper size, and vulcanised in French chalk. The curved surface is buffed into shape on the lathe by means of a shaped emery-wheel. Complicated rubbers must be made up and vulcanised in moulds.

Solid bicycle-tyres are run on the tube machine and then vulcanised in moulds (fig. 70) under the hydraulic vulcanising press, endless tyres being made in suitable closed moulds, as also are cushion tyres.

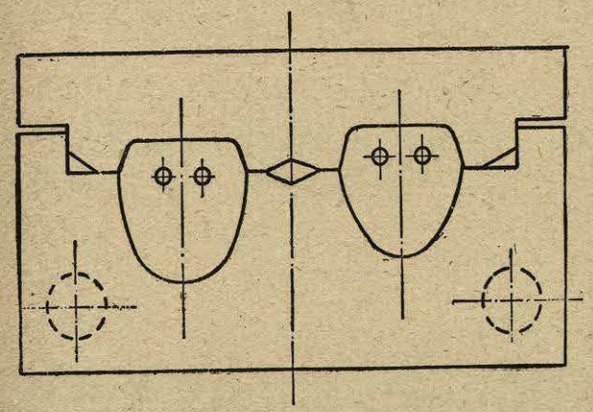

FIG. 70.

Perambulator tyres are also machined, and are then joined up and vulcanised in chalk in the open, or in moulds under the press.

9. **Manufacture of Soft-Rubber Surgical Goods, etc.**—The manufacture of air-cushions, water-cushions, mattresses, hot-water bottles, and also of gas-bags, constitutes another department of the industry, to which it is now proposed to direct the reader's attention.

The three chief factors for success in this branch are: (1) clean, dense mixings, free from grit; (2) calendered sheet of uniform thickness, and fabric closely proofed; (3) careful hand labour.

The mixings in most frequent use are white ones.

For cushions, *e.g.*, the following mixings may be recommended:—

Mozambique	10,000 gms.	China-clay	3,500 gms.
Sulphur	1,200 ,,	Ceresin	200 ,,
Zinc white	6,500 ,,	Magnesia usta	200 ,,

The mixing is in part run into lengths of doubled sheet on the calenders, and made up into cushions with cloth-impression; and in

part made into smooth sheet to be used for smooth-surfaced cushions and other articles; for this purpose short lengths of sheet are run on the calenders, and after being cut up are pressed smooth between zinc plates under the press. If sheets with a cloth-impression (twill-impression, etc.) are selected, the calendered sheet is rolled up at once in the damp cloth and allowed to remain under pressure over-night. Sheet of this kind has the advantage that its surface is free from chalk, which is not the case with the sheet pressed between zinc plates. The sheet to be worked up is slightly warmed, so as to shrink it, then cut out with the corresponding templates, the two layers being cut out with one cut. The edges of the two layers are carefully separated from one another and a little chalk introduced between the layers to prevent them from sticking together. The seams are moistened with solution, and when dry are pressed together. All surgical goods of soft rubber are generally made up in this manner if they are to be vulcanised in the open without moulds. Such goods are evenly embedded in French chalk, so as to leave no air anywhere between the two, which would result in the surface being marked. The goods are firmly covered with chalk, then the trays are covered over and run into the heater, and vulcanisation is at once started with a rapid rise, and carried through.

Enamelling.—Hollow articles, such as balls and syringes, which are cured in moulds in the usual way, are coated with red, green, white, and black enamels in the following manner:—The enamel mixing, which may have one or other of the under-mentioned compositions, is dissolved in benzine, filtered through the press illustrated in fig. 71 (of which 71A represents a form worked by hydraulic power), and then poured into a rectangular containing-vessel, care being taken to avoid the formation of blisters.

	Red.	Yellowish-red.	Green.	Black.	White.
Para	750	750	750	1000	1000
Golden sulphide, yellow	...	800	...	...	...
Ochre, yellow	...	200	...	...	...
Carbon black	...	...	...	300	...
Snow-white	...	...	...	...	800
Chrome green	...	...	550	...	...
Vermilion	300	100	...	...	...
Golden sulphide, carmine	600	...	..	...	...

The articles to be enamelled are dipped into the solution on pegs fixed in wooden laths, withdrawn, and allowed to drain, and

then put to dry on a face-plate which is kept in eccentric motion so as to enable the solution, while still thin, to distribute itself evenly over the surface. When the enamel has dried off, the last traces of solvent are removed by drying in a dust-proof room,

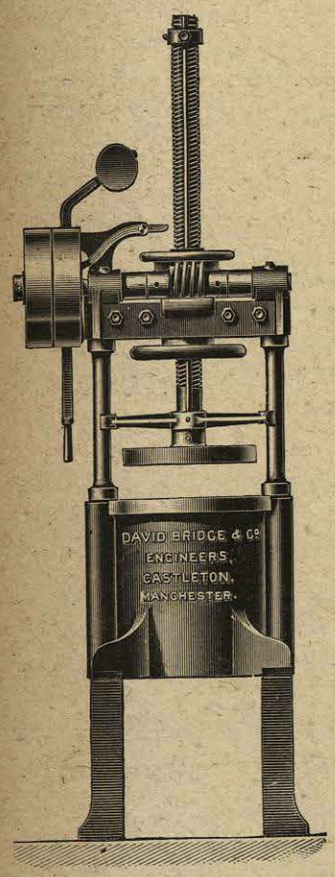

Fig. 71.

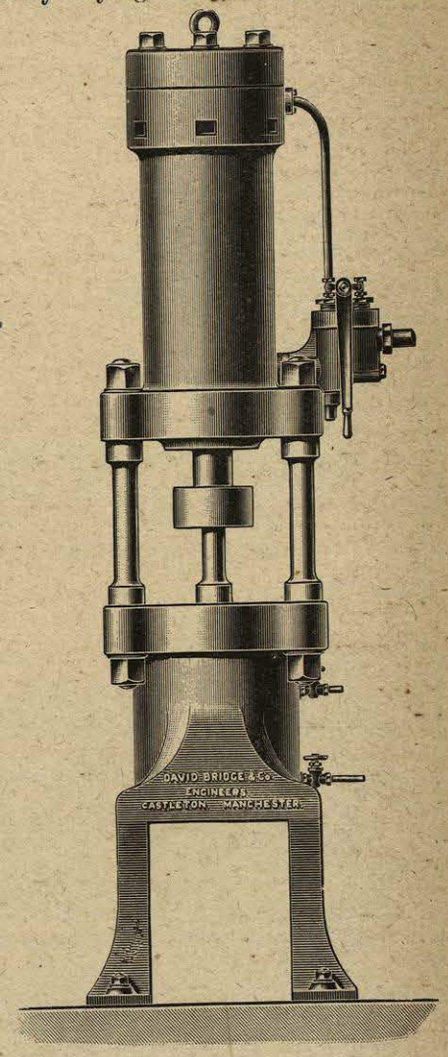

Fig 71A.

heated with hot air, and the goods are then vulcanised by means of a dilute solution of chloride of sulphur (1:600), and dried off again. Finally, they are polished with a carefully filtered solution of shellac, a fine brush being used for the purpose. Care should be taken that the solution does not skin over and that quite a thin coating is put on, otherwise it will flake off and crease.

10. **Bands and Rings.**—These small articles form, like eraser rubber, important articles of commerce. The manufacture of them is not at all difficult, but it is essential that the goods should not become brittle should they remain unused for a considerable time.

Most red bands, in their various sizes, have to stand considerable stretching, and this must be borne in mind from the very beginning of the manufacture. In no case should the mixing be overworked, but should be run into sheet as rapidly as possible. Suitable compositions are as follows:—

A. Para	10,000 gms.	Vermilion	500 gms.
Golden sulphide	2,500 ,,	Brown substitute	3,500 ,,
Vermilion	500 ,,		
B. Para	7,500 ,,	C. Lopori	10,000 ,,
Kassai	2,500 ,,	Golden sulphide	3,000 ,,
Golden sulphide	2,500 ,,	Barytes	4,000 ,,

It is not advisable to run the sheet round and round the calender roll until it is smooth, but it should be run on the three-roll calenders, and doubled, as already described, from 0·5 mm. sheet, and finally rolled up tightly on the roller and allowed a whole day to cool down. This method has the advantage of giving a much tougher sheet, and any small air-blisters that may have been present will have been got rid of by bursting. When the sheet has been unrolled the separate pieces are gently warmed and pressed between zinc plates. The polished sheets are put through a cutting machine which cuts them into bands of a definite width, lays the ends together to form a tube, and at the same time presses the seams together. In order to make the seam quite secure this tube now passes under two mallets, working one behind the other, which hammer the seam. The tubes are vulcanised on glass mandrels, on which they fit tightly, and the heat is applied by means of a water-bath preferably to laying the goods in chalk, the temperature being raised rapidly and the cure completed at a pretty high temperature. The coupon bands and rings are cut from the tubes on automatic lathes.

Series rings are made up like tubing on mandrels. It is best to use thin sheet for this purpose; the tube is wrapped and vulcanised as such, and from it the rings, 0·3 mm. in width, are afterwards cut on an automatic lathe.

If tinned steel tubing be used for the mandrels, a smooth glossy appearance is imparted to the inside of the ring, and no French chalk need be used on the mandrel. The rubber used for these rings contains a very low percentage of sulphur, and the rings have

therefore little tendency to bloom; it is therefore hardly necessary to boil them up after curing; they are, however, cleaned with soap and water, and then, in order to give them a polish, rubbed over with a very weak solution of glycerine to which a few drops of oil of roses have been added in order to mask the smell of the rubber.

If the rings become tender, this is probably due, assuming that vulcanisation has been properly carried out, to excessive working of the rubber on the mixing- and calender-rolls.

11. **Rubber Stamps.**—The manufacture of rubber stamps may be subdivided into the following series of operations:—

1. The preparation of the matrix.
2. Pressing the matrix in contact with unvulcanised sheet rubber.
3. Vulcanisation.
4. Mounting up the finished stamp.

The second and third of these operations are the most important parts of the manufacture. The type is first of all composed as in ordinary printing, and the composition is then tightly closed and a proof is pulled to see if it is correct. The composition is then levelled so that the tops of the letters are all in the same plane, after which it is transferred to the chase, closed up tightly together, so that none of the letters can get displaced, and the matrix, in which the letters are to appear sunk, is now prepared for casting. Formerly the surface of the type used to be painted over with oil or graphite, and plaster poured over it, care being taken that the whole of the type was evenly covered with plaster, and that all the intricacies were filled up. The surface of the plaster was kept smooth as long as it could be worked, and was then allowed to set, after which the plaster matrix, which had taken the impression of all the hollows, was lifted out and dried off. It was then given a thin coating of shellac, in order to produce a smooth surface and to impart greater durability, and a positive impression could now be taken on the sheet of rubber. The surface of the matrix was dusted over with chalk; a piece of unvulcanised stamp-rubber of suitable size, also chalked, was laid on the matrix and vulcanised under the press. The rubber sheet, while still soft, found its way into every depression in the matrix, then became vulcanised, and when the press was raised a reproduction of the original type was obtained. Finally, each separate rubber stamp was cut out and mounted on a suitable support.

This old and complicated process, which did not always give