works as follows:—The mixed rubber is warmed up and run into thin sheets which are filled into the hopper fitted over the cylinder at the after-end of the screw (this hopper is, in some forms of machine, substituted by feeding-rolls), and is then forced through the screw towards the box in the front. It will be clear that during the operation the rubber mass is powerfully kneaded, and a breaking-down of the rubber molecule may readily occur—first, if the cylinder be too strongly heated; and secondly, if its length be too great, since the mass is then worked for too long a time before reaching the die. Tube machines with short cylinders and powerful screws of great depth are to be preferred for the production of a suitable pressure. The extent to which the machine must be heated up in order to obtain a smooth surface — the so-called "mirror" (*Spiegel*)— is greater or less according to the quality of the rubber mixing. This warming-up refers less to the cylinder than to the box of the machine, and better results are obtained by using a gently-heated cylinder and a hot box than if the reverse plan be adopted. Very tough qualities, which cannot be run smoothly, are mixed with from 1 to 5 per cent. of vaseline or paraffin wax; surprising results are obtained in this way. The cord or tube leaving the machine passes through French chalk, carbon black, or other powder, according to its colour, and is either run into the vulcanising chamber in front of the machine, or on to wooden trays. In the latter case it may be either worked up for use in the manufacture of moulded goods, or vulcanised direct. These articles are laid in French chalk just as they are made, the chalk serving to keep them in shape and prevent them from getting flattened, and also to prevent the direct penetration of moisture; the goods must therefore be made from qualities which can be cured in the open without becoming rough on the surface. Many qualities, especially those which contain soft rubbers and a large proportion of softening ingredients, such as vaseline, paraffin wax,

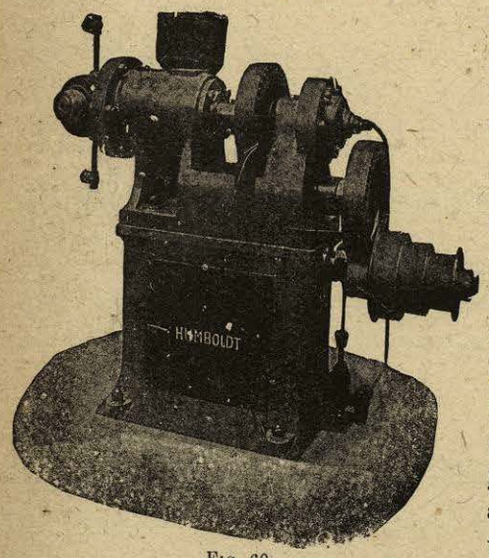

FIG. 60.

fatty substitute, etc., need a suitable addition of magnesia usta to enable them to be cured in chalk in the open; only those makes of magnesia which consist of oxide alone, and do not contain carbonate or hydrate, are to be recommended for this purpose.

In the case of large cord care must be taken to have a perfectly homogeneous mixing; otherwise these goods become porous from the centre outwards, a result produced in many cases by faults in mixing or by the use of unsuitable ingredients.

Linings for canvas hose are, as already mentioned, also made on the tube machine. For this kind of tubing either a machine with a hollow screw or one with a transverse end is used, so that chalk can be introduced by blowing it through by means of an air-blower attached to the machine. Inner tubes are run on the machine in a similar manner. In order to be able to regulate the pressure of the rubber, a cock is fitted into the box of the machine through which the excess of rubber is allowed to pass out; this is a point which must be specially observed if one desires to produce tubing with uniform thickness of wall.

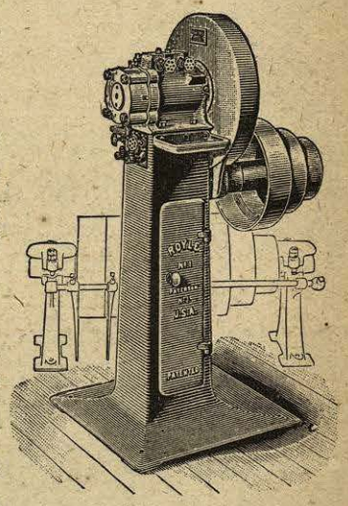

FIG. 61.

For the manufacture of flower-tubing (covering for the stems of artificial flowers) machines are used with very small cylinders and with a special arrangement of the box (fig. 61), enabling tubes up to three in number to be run at the same time. The use of hydraulic pressure in tube machines does not seem to have met with approval. Experiments initiated some years ago have not yielded satisfactory results, for it is hardly possible to keep the temperature of the rubber constant, and defective places are easily produced. On the other hand, there has recently been a leaning towards two-spindled machines, which consist, in principle, of two tube machines fixed opposite to one another, and united in the middle by the box, so that the rubber is forced both from the right and from the left into the box and die.

4. **Preparation of Sheet for "Mechanicals."**—For the manufacture of these articles, which constitutes an important branch of the rubber industry, calendered sheet and the proofed fabrics for insertion form the central point, as the basis for making up. Packing-sheet

with insertion is generally prepared by rolling the rubber coating on to the proofed fabric. This process can be simplified by uniting the proofed insertion and the coat of rubber direct while the latter is being run on the calenders, thus preparing the finished

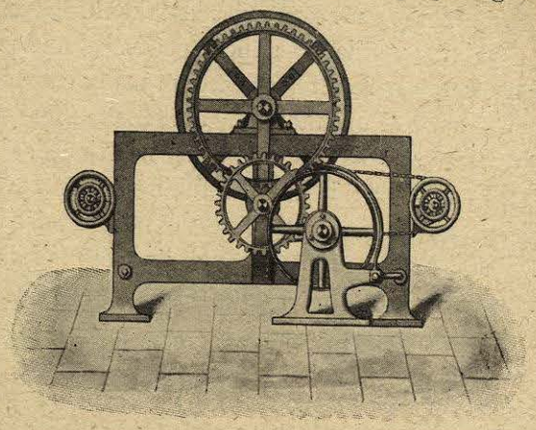

Fig. 62, A.

sheet, firmly doubled, in the same time as would be necessary merely to run the coating of rubber. The whole process is exactly similar to that employed in the preparation of sheet rubber which has to be doubled, and has been fully dealt with in the chapter on the calenders. Before curing, the finished sheet is tightly wrapped

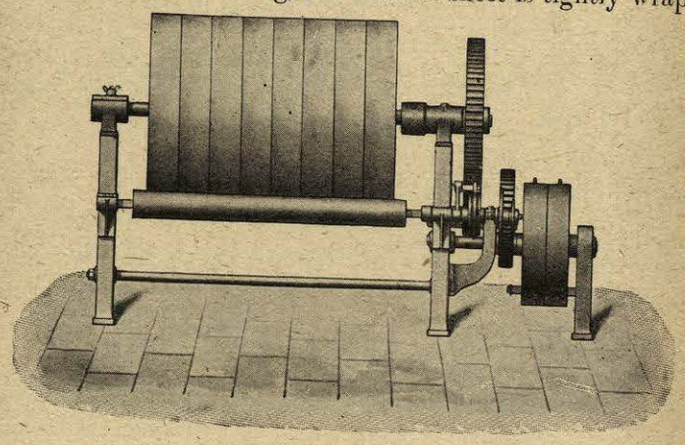

Fig. 62, B.

between cloths on a wrapping-machine (of which fig. 62, A and B, illustrate an improved form), in order to prevent its blistering, and to cause the various layers of rubber and insertion to become firmly united during vulcanisation. Packing-sheet may also be cured under the press, but the cost of vulcanisation then comes out considerably higher.

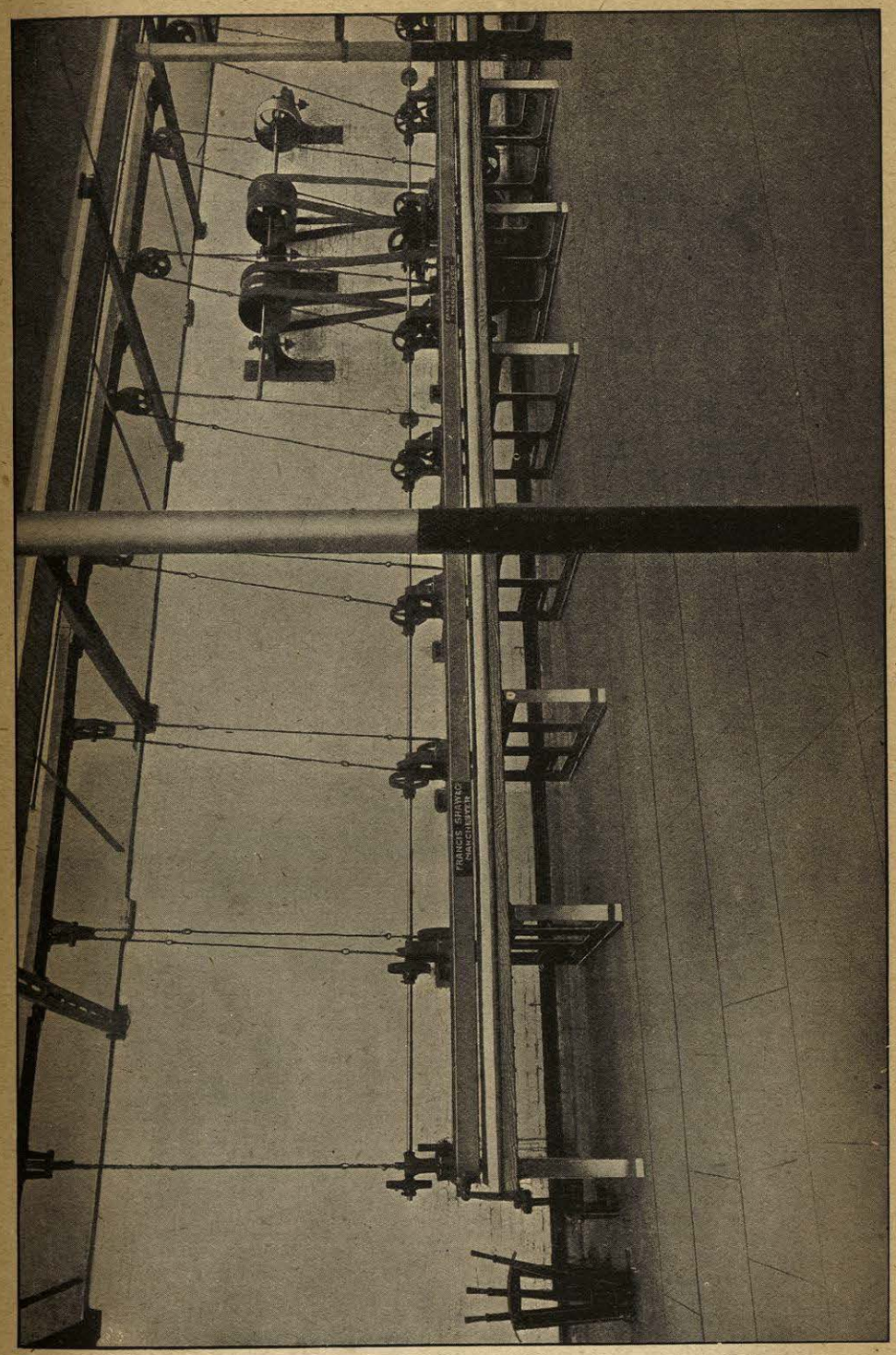

Fig. 63.

Manhole washers, and flat rings made up of strips, are cut from uncured sheet by means of a band saw, and the strips joined up together, covered with cloth where necessary, and cured on sheet-iron moulds. The manufacture of round cord is carried out cheapest and best by means of a machine made by Francis Shaw of Manchester (fig. 63). The separate sheets, united with their inser-

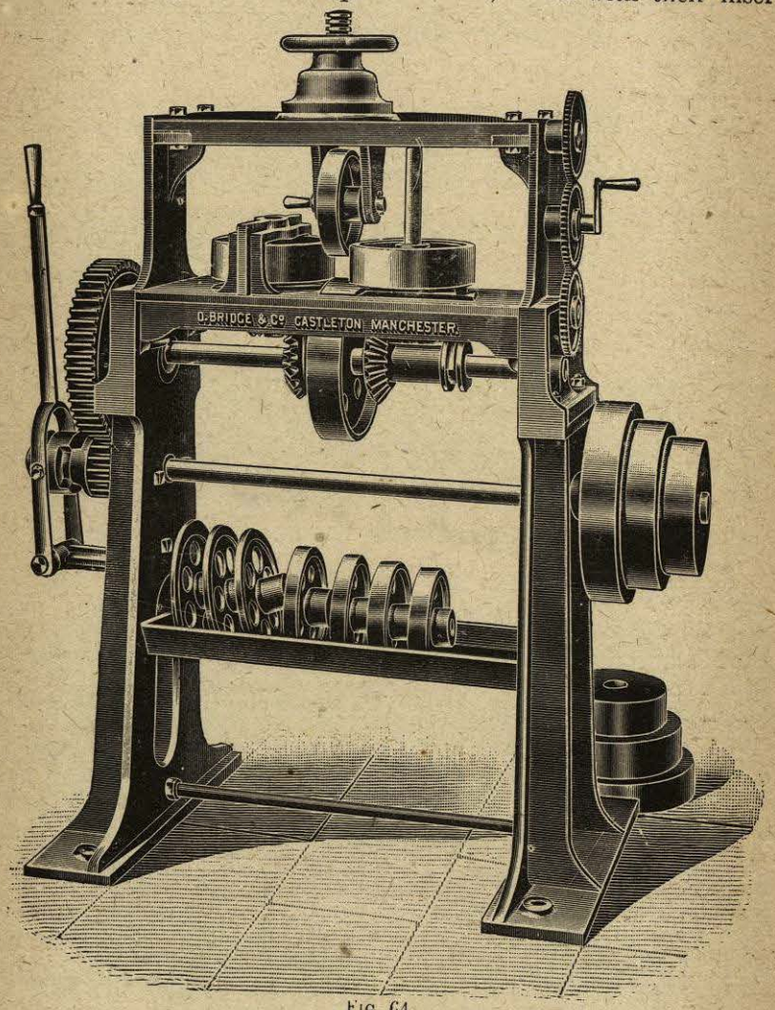

FIG. 64.

tions, are rolled up, and any number of such strips up to twelve are put under the rolling machine, formed of two bench-tops. The upper bench-top, tilting increasingly as it advances, presses on the strips in its forward motion and rolls them into the form of round cord; insertion and covering can be rolled up in one operation. Where smooth cord is desired the covering is left out, and, if necessary, a layer of rubber is run on to the cord by means of

the tube machine. The cord is vulcanised in a straight length, in a hose-heater, after having been previously wrapped in the same machine. Square and flat Tuck's cord is first made up in the form of round cord in the same way, and is afterwards passed through the shaping-machine (fig. 64) and pressed into shape. This machine possesses the great advantage over the ordinary grooved rolls, that by means of it cord of any dimensions can be made by merely changing the upper wheel. Tube-rings and similar articles are made of the required size on the tube machine, and are then drawn on to mandrels of corresponding size, wrapped in cloths, and vulcanised.

5. Press-cured Goods.—Under this heading press-cured sheets and pump valves first of all claim our attention. These articles are made by doubling sheet up to the required thickness, care being taken to get rid of all air-bubbles, and then cutting it down to the required sizes. Lengths of 3 metres by 1½ metre wide are what are generally asked for in the case of press-cured sheet, and such sheet is built up on the press-table and vulcanised in one piece of that size. In the case of circular valves, and valves of other shapes, planed wrought-iron rings and frames of corresponding shapes are used; by these the rubber is supported during vulcanisation, which is carried out under suitable pressure. In calculating the sizes of moulds it must be remembered that rubber contracts somewhat on vulcanisation, as a result of the shrinkage of the raw rubber and the way in which it has been stretched by the processes previous to vulcanisation. Pure qualities contract to the extent of from 2·65 to 2·9 per cent., lower qualities proportionately less, and the latter decrease in thickness, whereas the former thicken up slightly; in preparing moulds these facts must be specially taken into consideration. Another article which is cured under the press is dealt with in the following section.

6. Rubber Belting.—The manufacture of this special article necessitates special machinery, if it is to be carried out in a rational manner and durable, serviceable goods are to be produced. The belting is prepared in the following way:—The cotton fabric, spread on the calenders, and into which a highly adhesive layer of rubber is frictioned, is folded, on a folding machine, into belts of the requisite thickness and the desired number of ply. The excess of fabric is cut off on the machine; or, if it is too narrow, another piece is stuck on. In this way a considerably more even product is obtained than by hand-folding, a process in which, for example, it is impossible to get rid of air-blisters. Unfortunately, German manufacturers are

not yet very familiar with this machine, and therefore prefer hand-work. When the insertion has been folded the belt is run through the belting calenders (fig. 65) in order to press it and straighten it

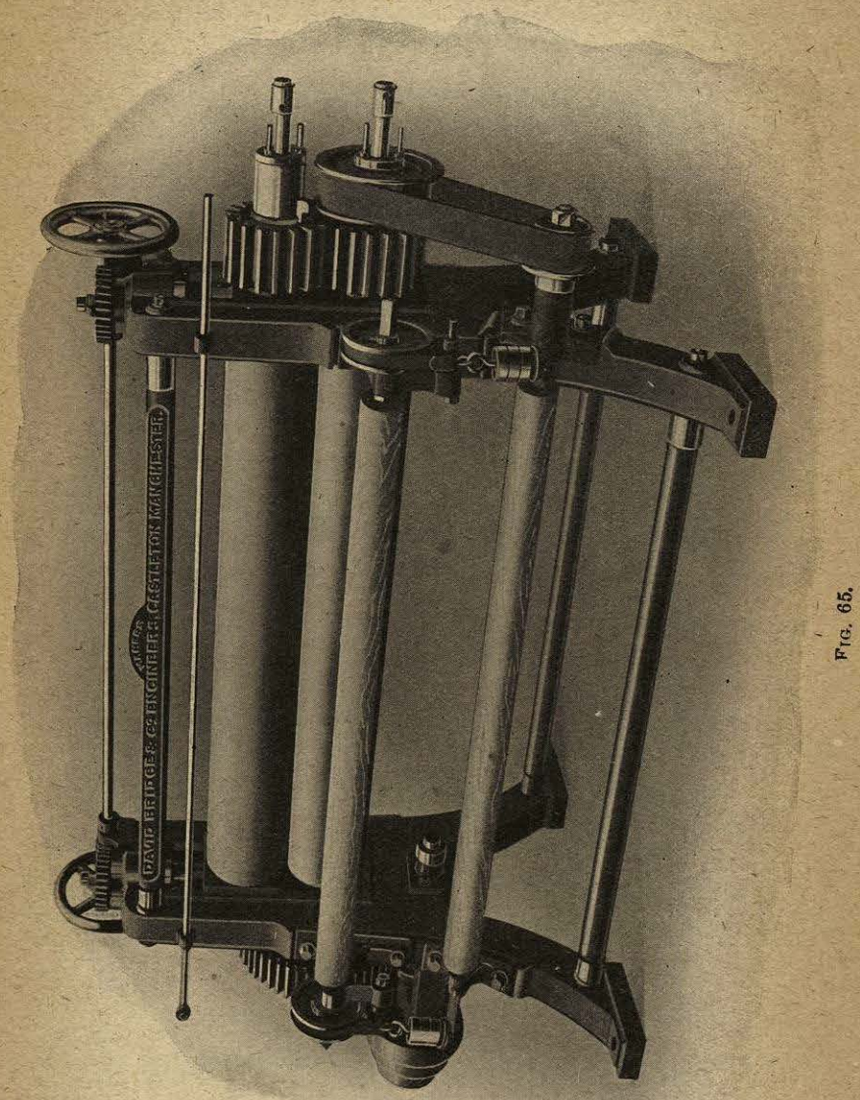

FIG. 65.

out. If the method of making up necessitates it, a covering sheet of rubber may now be put on, but on properly spread cotton fabric this is not at all necessary. The belting is vulcanised either with squared edges, in moulds, or with rounded edges, free under the

hydraulic press. In order to prevent the belting from stretching while in use, it is necessary to stretch it while it is under the press being cured, and this also is done by means of hydraulic power, the necessary apparatus being attached to the press. To produce a good solid article a pressure of at least 20 kilograms per sq. cm. should be put on the belting by means of the press while it is being cured, and the temperature should not be raised above 140° C. so that the fabric may not be weakened. This temperature is quite high enough to bring about rapid vulcanisation with the particular mixing employed, which contains litharge, and to render the article firm and stiff; at higher temperatures the belting would become too hard. A particularly suitable mixing is one of the following composition:—

		Sheet for cover.	
West Indian	10,000 gms.	Congo	10,000 gms.
Sulphur	1,500 ,,	Sulphur	1,500 ,,
Litharge	1,800 ,,	Litharge	1,000 ,,
Whiting	15,000 ,,	Reclaimed waste	10,000 ,,
Pitch	1,000 ,,	Whiting	15,000 ,,
Barytes	5,000 ,,	Talite	7,500 ,,
Carbon black	200 ,,		

It is advisable to employ considerable hydraulic pressure, because the fabric, although previously dried, always contains a certain amount of moisture, which is given off in the form of steam during vulcanisation, and may be the cause of the belting splitting into layers later on.

7. Rubber Rollers.—The preparation of rubber rollers is a department of manufacture demanding great experience and knowledge, for the uses of rubber rollers are so diverse that a particular method of manufacture and a special mixing are demanded for each particular class. In the case of all rollers, however, there is one point of great importance which is seldom observed, viz. that the workshop should be free from dust and kept at a uniform temperature. Convenient lifting apparatus (overhead travelling cranes) should be provided, so that the rollers, which are often very heavy, may be easily handled. The stands upon which the rollers are supported, as well as the wrapping apparatus, are made of galvanised ironwork. Wooden supports and trestles should be avoided as far as possible. Paper rollers—so called "wet-press" rollers—which need special treatment on account of their size, constitute a special department. All rollers have iron cores, which may be either solid castings, or made hollow of sheet iron, according to what the roller is to be used for, or, as in wringer rollers, the core may be simply a turned iron spindle. Large solid cast-iron cores

are not well adapted for covering with rubber, on account of the unevenness of the heating-up.

Before anything further is done with the core it must be warmed up in order to remove any traces of moisture that may be present. After this operation has been carried out—it may be done in a hot-air oven, or over a charcoal fire, etc.—the iron roller is cleaned. Any pores found in it must be either plugged or filled with lead, to prevent the formation of air-bells between the inner coat of rubber and the iron core. If the rollers to be covered are large hollow ones it is advisable to connect them up with a steam pipe so that they can be kept warm while the roller is being made up; by so doing even a very slight formation of air-bubbles is provided against. When the core has been examined it is washed with benzine, and is then repeatedly brushed over with hard-rubber solution in thin layers. The coating of hard rubber to be put on the top of this should be hard and tough in order to unite well with the metal; a rubber insufficiently so might result in the rubber coming away from the iron, a tendency which is assisted by the unequal expansions of rubber and iron within the limits of temperature dealt with. The layer of hard rubber which is put round this innermost coating, and the thickness of which varies according to circumstances, sometimes reaching as much as 15 mm., is in its turn covered by a mass of hard rubber of a firmer quality, to form the junction with the soft outer layer of rubber, and serve as a firm foundation for it. Single sheets of rubber are doubled up to about 1·5 mm. thick, and are then worked on with a roller, and the seams pressed well together. It is best to dry-wrap the hard-rubber layer firmly over-night, and to prick any bubbles which are evident on the following day. A preliminary heating of the hard-rubber layer is not necessary in good work. The process of doing so often brings about a loosening of the innermost coating from the iron during the second vulcanisation. The best way of rolling on the outer coatings is without doubt in the form of sheet which has been carefully crossed and doubled up to 1·5 mm. in thickness. The method according to which the layers of rubber are put on in the form of a spiral band is uncertain in its results.

In doubling the sheets and rolling the different layers of rubber on to the core, the roller should be kept continually at a uniform temperature, so that any air-bubbles can be seen to be driven off. When completely built up the roller is wrapped, on the power-driven wrapping apparatus provided for the purpose, in a close-woven cotton fabric, capable of standing a great strain, and is then

first heated up very gradually during three to six hours, according to the size of the roller or the thickness of rubber, being afterwards slowly vulcanised at 135° C. for from eight to twelve hours. The temperature should not, however, be allowed to drop before vulcanisation sets in, or the outer coatings may become porous or spongy, places of unequal hardness being formed. After vulcanisation the roller should be allowed twelve hours to cool down, or more, according to its size, after which it can be unwrapped and turned up and buffed on the lathe.

It may here be mentioned that the process of manufacture has

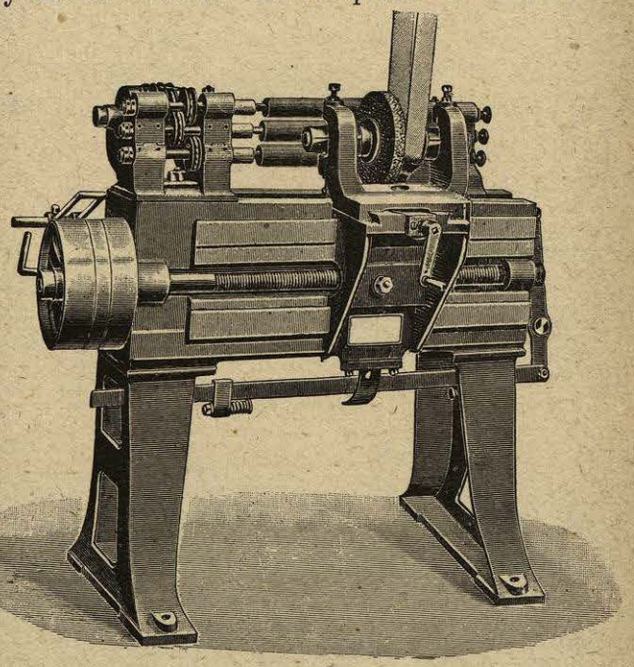

Fig. 66.

latterly been rendered much simpler and quicker by suitable additions of magnesia to roller mixings. The magnesia is added to the hard rubber as well as to the soft rubber of the roller covering, and its use is quite permissible in rollers which are to be used in the manufacture of food stuffs.

In the case of large rollers the lathe-tool is used until the roller has been turned quite true, when the buffing is finished off with an emery-wheel; wringer-rollers, on the other hand, are finished off direct upon specially constructed buffing lathes, on which three articles can be buffed at a time. Fig. 66 illustrates one of the newest forms of this machine.

The compositions of the mixings used are determined by the