to the foreman in charge of the vulcanisation, in room G, and he sees by the indicator which heater is to be put on. He ascertains the length of the "cure" from the ticket given to him, which shows the quality and nature of the goods to be vulcanised, and by referring to his list of temperatures and times for the various articles. The times of vulcanisation are arranged alphabetically according to qualities, kind of goods, and substance. After the charge of the heater has been entered in the vulcanisation book, and the time of putting on the heater also filled in, these particulars are also marked up on the controlling table in the column corresponding to the heater being used. This table is then hung up; on it is shown which qualities are being vulcanised at the same time. As soon as the steam pressure exceeds the number of atmospheres to which the apparatus has been adjusted the attention of the foreman is called to the fact by the ringing of a bell, if he has not already noticed it on the manometer; by this means the foreman is helped to keep a strict watch, and no prolonged excess of pressure can escape his notice. This whole business consists simply and solely in turning steam on and off the heaters, and in seeing that the manometers and valves are working accurately. When the time of vulcanisation is completed, the valve is shut down, the electric alarm is taken out, and the foreman signals to the man in room A, who sees by the indicator which heater is referred to, to open the outlet valve. On a further signal, when the pressure has dropped to zero, he opens the heater door. The time at which the cure was completed is entered by the foreman in his book, and the department concerned in the further manipulation of the goods is rung up to fetch them away from room A or D.

The above scheme provides for subdivision of labour, and does away with the opportunities which otherwise occur for the man in charge of putting on and regulating the heater to concern himself with other jobs. In his separate room he has nothing to do but look after the valves and manometers, while the man in room A has only to see to the opening and closing of the heaters. The men employed in these two rooms are, under this arrangement, not troubled by dust, or by intense heat, which would tend to distract their attention from their duties.

It has already been stated that the chief things to be sought after in vulcanisation are the use of dry steam and the maintaining of the proper temperature, the pressure of the steam not coming into account as far as the cure itself is concerned. Pressure is, however, by no means an unimportant factor.

The heater shown in fig. 31 is the ordinary type of simple heater. As a rule the steam is not led in from a single opening, but is distributed by means of a spray-pipe, which is laid along the bottom of the heater; this pipe is closed at the end and provided with small holes at intervals along its walls. The pipe is covered by a perforated iron plate. Considerable advantages follow from the use of a jacketed heater for vulcanisation, not so much for hot-air vulcanisation as for getting the outer jacket hot before letting steam into the interior of the heater, and so to a large extent

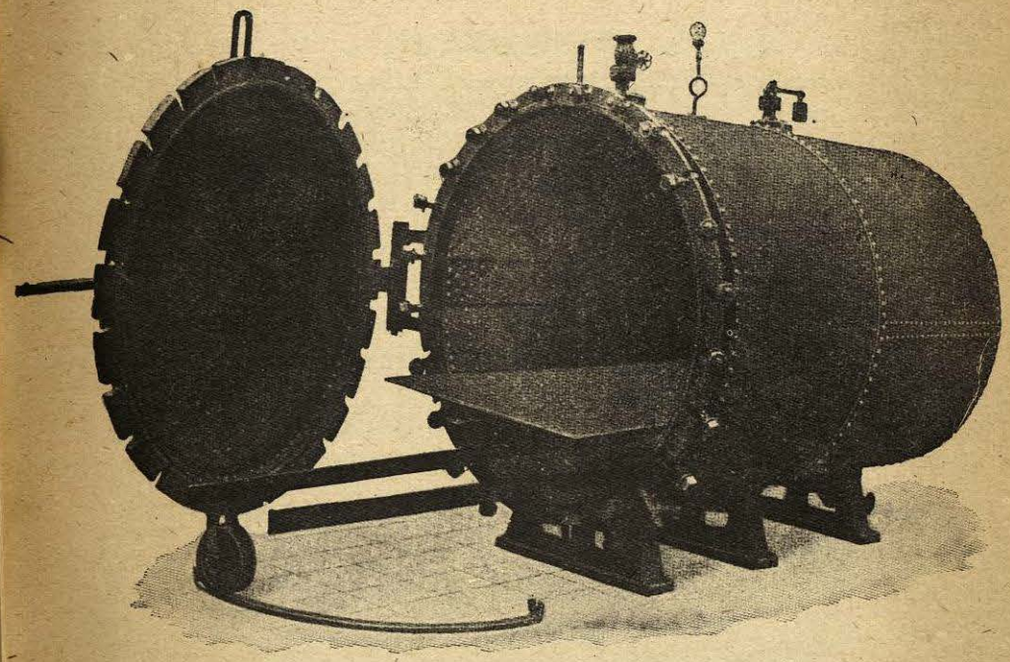

Fig. 31.

preventing condensation and maintaining a uniform temperature. To achieve this end the pressure in the outer jacket must be half an atmosphere above that inside the heater itself.

The dimensions of single heaters are very various, and depend upon those of the goods to be cured in them. Heaters from 80 cm. to 3 metres in diameter are used; for special purposes, indeed, such as cable manufacture, the diameter is sometimes as great as $3\frac{1}{2}$ metres; the length or height of the heater varies from 1 metre to 5 metres. For hose, heaters are used which are as much as 51 metres long, with a standard diameter of 85 cm. The trolley is in this case provided with shelves, and is run in and out automatically. By this means a considerable economy is effected, for in order to

move such a trolley some eight to ten men were always required, in addition to which the uneven, jerky, one-sided pulling often resulted either in the trolley being run off the rails, or in the rails, which lie on segments inside the heater, being jolted out of position. On the other hand, the operation can be carried out mechanically with great smoothness in from two to three minutes, with the aid of a single man. To ensure an even distribution of steam, at least

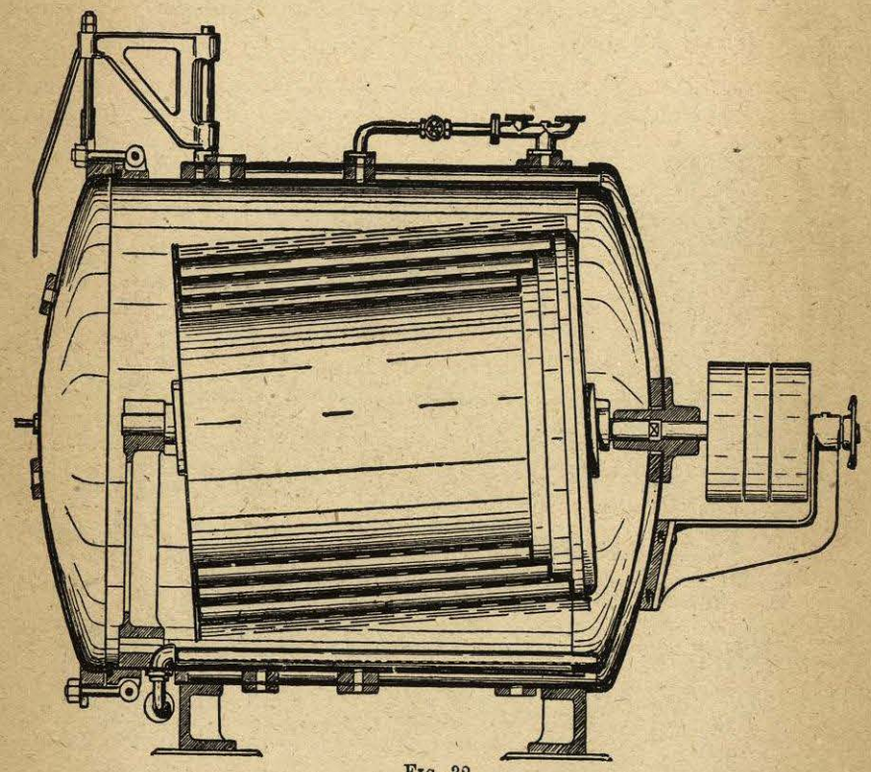

FIG. 32.

four inlets should be provided; the introduction of the steam is in principle the same as in the other heaters.

In all ordinary heaters, without exception, there is a tendency to the formation of steam banks; to do away with this, and to ensure getting steam at a uniform temperature in every part of the heater, a new apparatus has been constructed (fig. 32). This new autoclave (Heil's patent) contains a drum, which revolves slowly backwards and forwards, and on which the goods to be vulcanised are wrapped. The angle at which the drum is inclined, together with its backward and forward motion, results in the complete uniformity of the steam, and prevents the accumulation of wet steam in the lower part of the heater. All surfaces of the goods

are therefore subjected to a uniform vulcanising temperature, and a uniform combination of sulphur is brought about throughout, a fact which has been established experimentally by determinations of the coefficient of vulcanisation in the diffierent layers of the vulcanised goods. In connection with the drum-movement is the innovation of the blow-off cock for condensed water, the circulation of steam being also regulated by this, and overheating by too

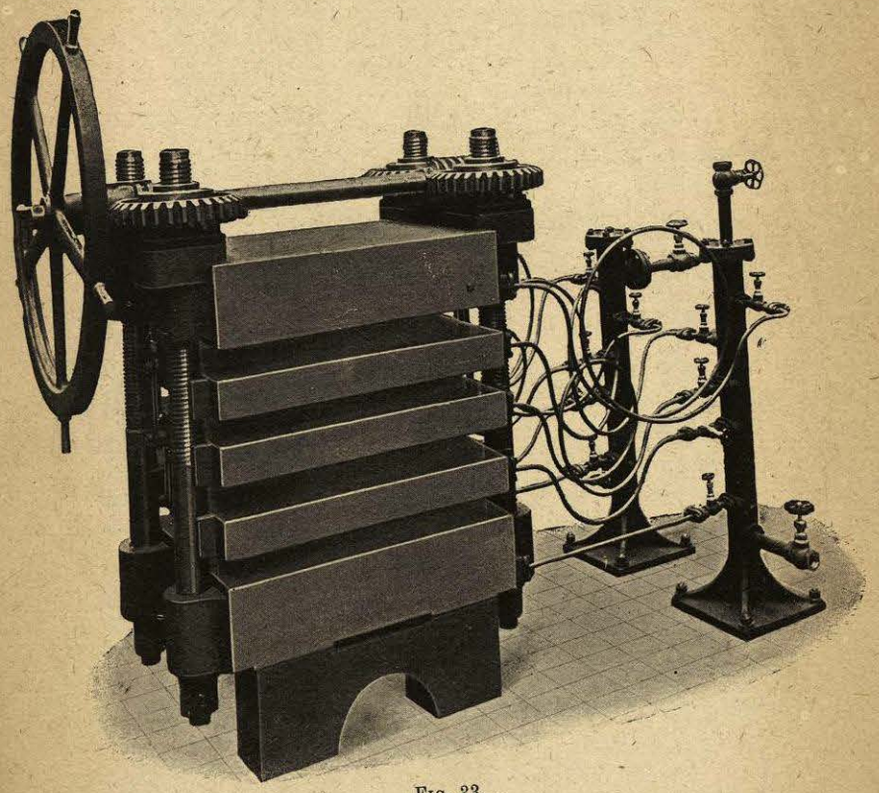

FIG. 33.

sudden an increase in pressure prevented. A complete description of this apparatus has already been published.[1]

The Press Shop.—This department is housed in room F (fig. 1), and separated from the boiler-house by the moulding shop. Vulcanisation is here carried out in steam-heated presses. Steam is turned on, and manometers controlled from the second steam pipe in control-room G, in exactly the same way as described in the case of the heaters.

The vulcanising press consists of upper and lower hollow plates, heated by steam and capable of standing pressures up to five atmos-

[1] *Gummi-Zeitung*, 1905, xix. p. 1027.

pheres. The plates are traversed by heating channels so arranged that the condensed water can easily run away, a point of very great importance, especially in the case of the upper plate. The upper plate is worked by central screws, by which the plate is raised and

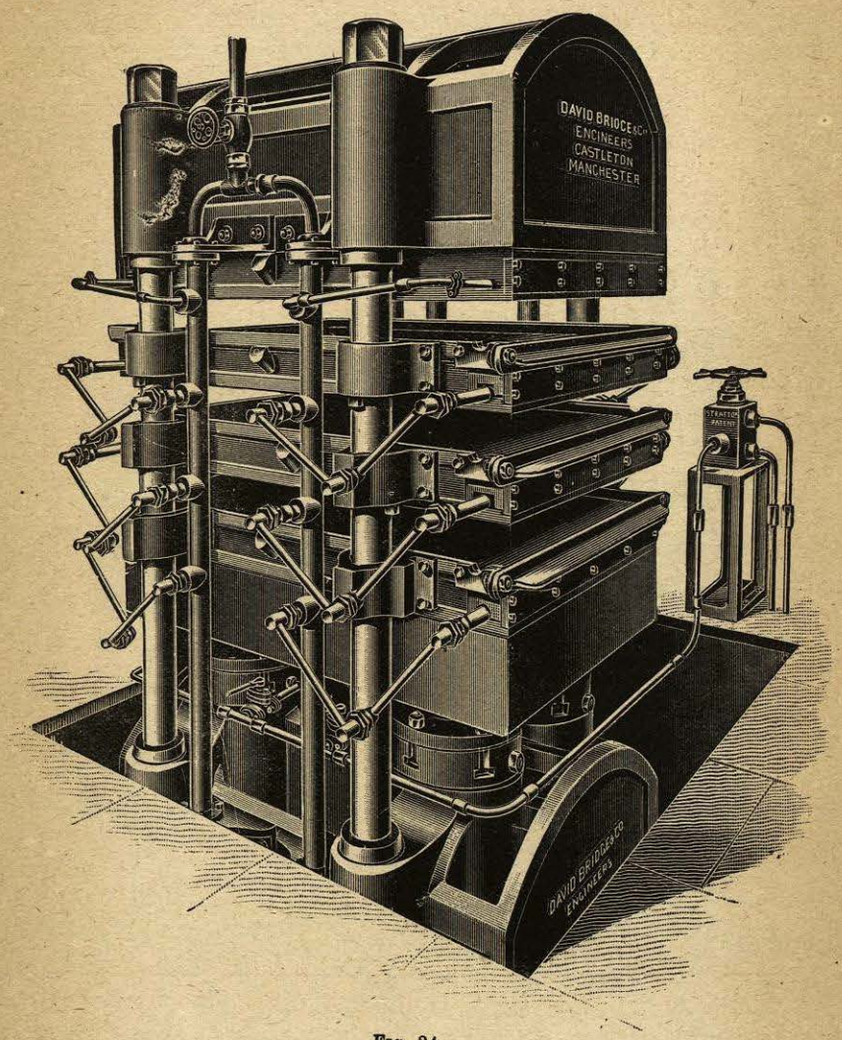

FIG. 34.

lowered. The lower plate is firmly fixed upon the iron base and is jointed to the top cross-piece, through which the spindle passes, by means of standards which serve as guides.

Larger presses are constructed on the principle illustrated in fig. 33. Latterly, presses worked by hydraulic pressure have been given a preference over others, since more can obviously be accomplished with them. For an up-to-date factory the following

sizes are necessary, in addition to a few small screw-presses:—A hydraulic press with plates 60 cm. wide for moulded goods; and for sheet and similar goods, which are pressed on moulding

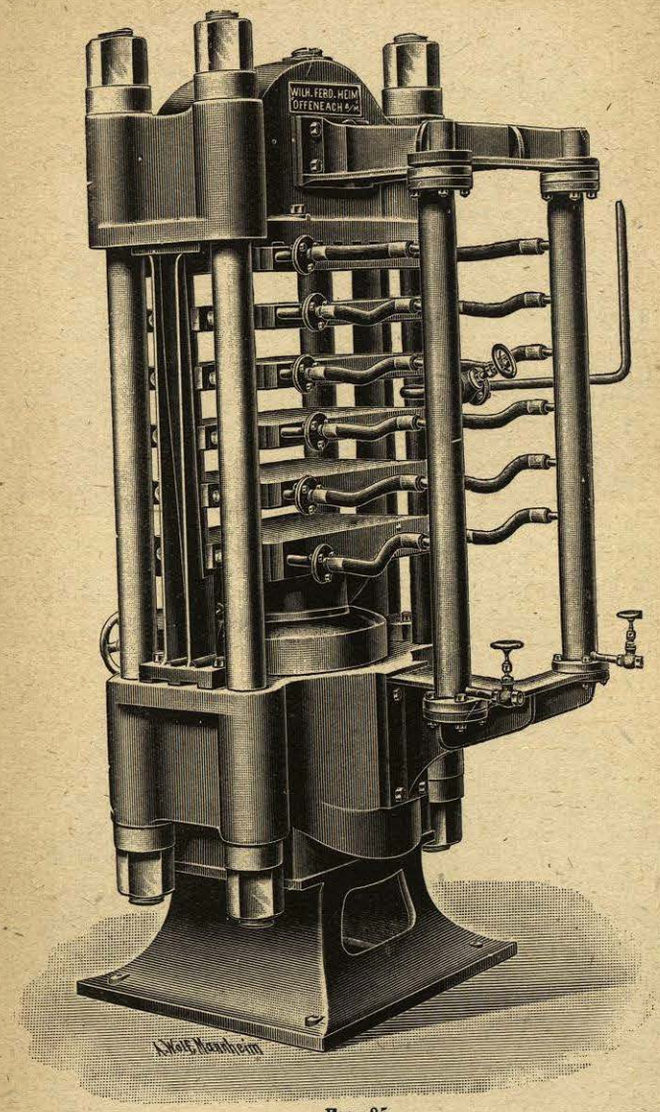

FIG. 35.

plates, an 80 cm. press, with four to six heating-plates, so that from three to five vulcanisations can be carried out in it at the same time; such presses are shown in figs. 34 and 35. For larger sheets a press with 120 cm. plates is required. All these presses are furnished with a single pressure cylinder, and work at a water pressure of 250 atmospheres or 20 kilograms per

sq. cm. For vulcanising press-plates, sieve-plates, etc., presses

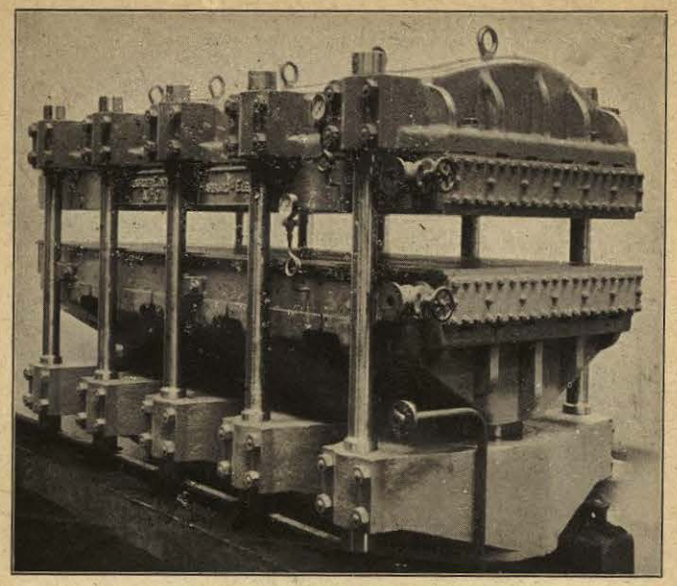

Fig. 36.

4 metres long by 1½ metre wide, and provided with five pressure cylinders, are necessary; a press of this description is shown in

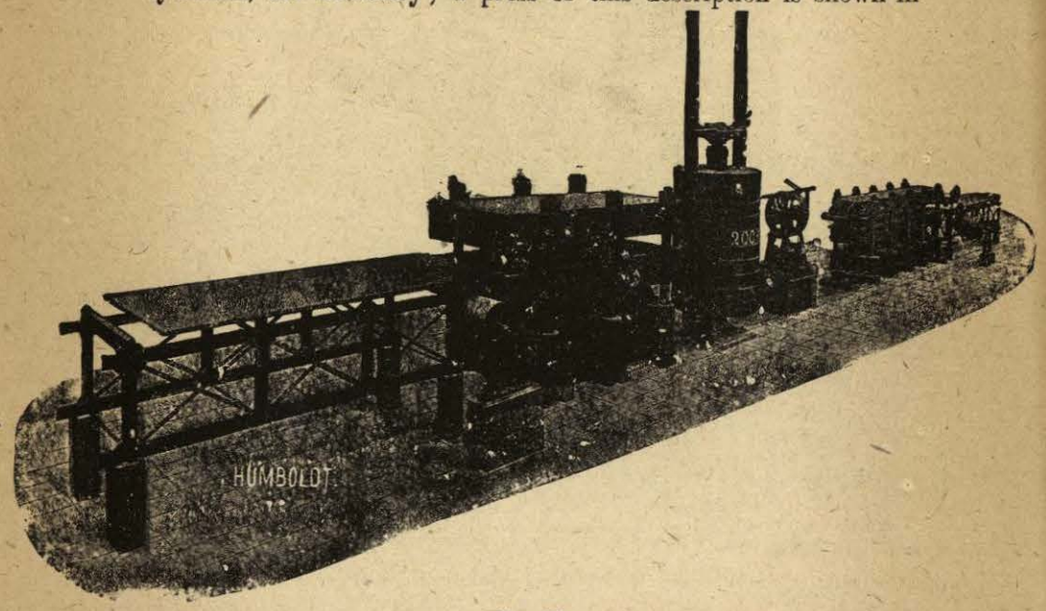

Fig. 37.

fig. 36. A draw-plate for withdrawing the sheet, as supplied with the presses already described, is, in this case, a prime necessity.

Whereas the smaller presses are worked entirely by accumulators, in the case of the two last mentioned a pump (fig. 38) must be used to provide the pressure, accumulators being also used, both in this case and in the case of the presses still to be described, in order to compensate for any variation of pressure in the individual pressure cylinders, which are all in communication with one another at the pump. For rubber belting a press is used which

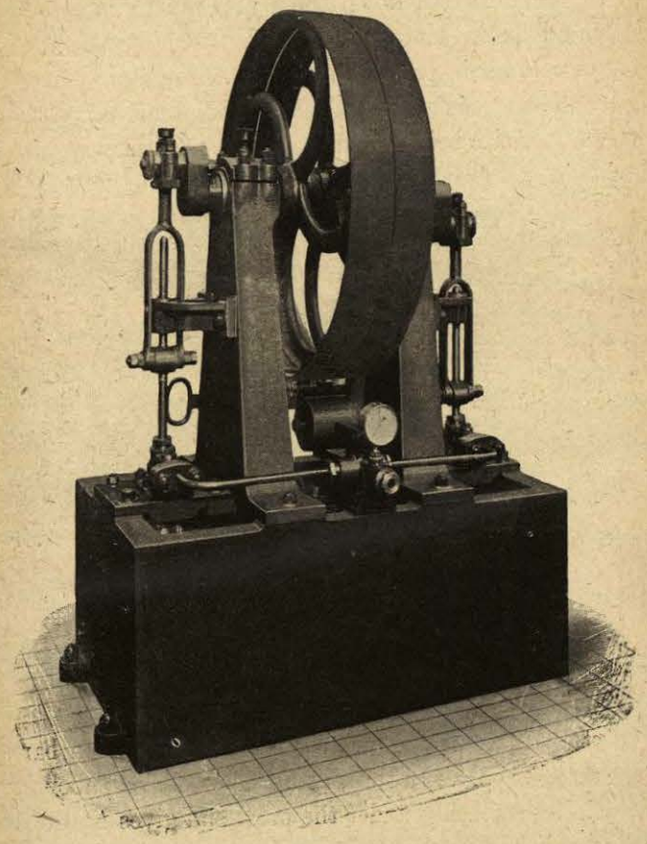

Fig. 38.

measures as much as 7 metres long by 1 metre wide, and which, as shown in fig. 39, has attached to it a separate hydraulic stretching apparatus. For billiard-strip, deckle-straps and similar articles which are vulcanised in moulds, a press about 2 metres long and 60 cm. wide is used. The two last-mentioned presses have no draw-plate connected with them; the belts or the moulds are introduced immediately under the press-plate. In the construction of hydraulic presses the steam-plates, by which the pressure is applied to the articles, and which must be absolutely smooth and

true, should not be cast in one piece with the top plate, but should be mounted separately, and insulated from it by means of asbestos. In the large presses the top-casting is preferably built up of separate parts, and not in one single piece as in fig. 37, for with this form the plate may easily be fractured, when heated and under pressure, owing to uneven expansion. The upper and lower plates are independently heated, each being provided with a separate pressure gauge. In order to cool down the plates rapidly, after steam has been blown off, an apparatus may also be used by means of which a current of cold air is passed into them through a pipe from an exhauster. The goods to be vulcanised are built up on the press-table, the proper size being secured and the necessary support given

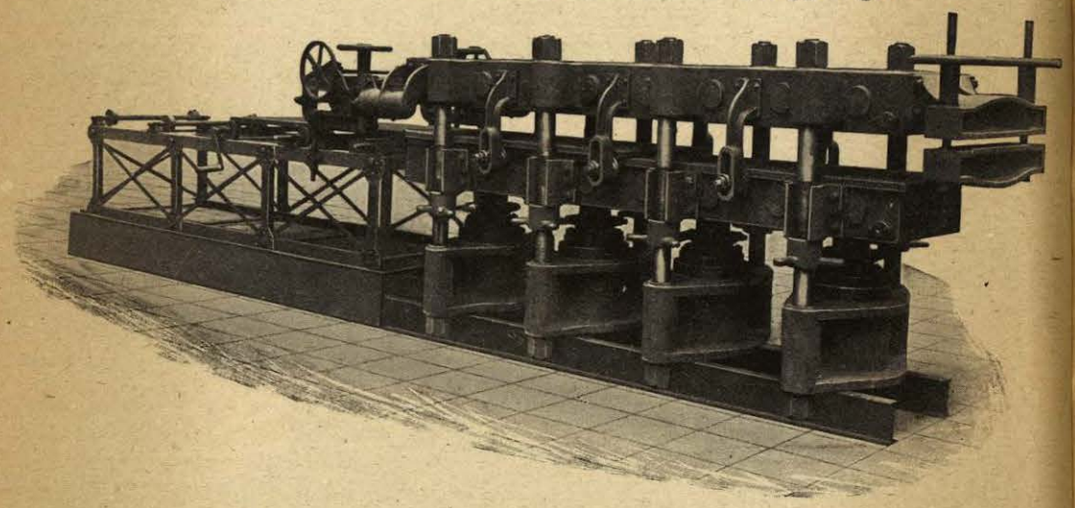

Fig. 39.

to the sheet by means of accurately planed square-iron bars. On top of the article is placed a thin enamelled steel sheet about $\frac{3}{10}$ mm. thick, which lies smoothly under the press and gives to the rubber sheet a fine polished upper surface. It should also be mentioned that the draw-plate should be of sufficient size, in order that when it is under the press its ends may project to a distance of about 25 cm., so that in the case of long articles, such as mats, the ends of the separate pieces may be easily joined together and cured up into one piece. In the large presses, particularly those used for belting, the side rods should be adapted for easy removal, so that endless belts and conveyors may, if necessary, be put in from the side. The large belt presses with an intermediate plate are not to be recommended, since, owing to the length of the press, an uneven strain is produced in it by expansion.

Plant for Sulphur-bath Vulcanisation.—The apparatus which is used for the vulcanisation of cut-sheet or dipped goods by heating in molten sulphur, consists of a wrought-iron heating-vessel, about 1 metre in depth and $1\frac{1}{2}$ metres in length and breadth. The sulphur-bath may be heated by means of steam or hot gases, or by direct firing. In putting up a direct-firing plant, the greatest care must be taken with the setting of the heating-vessel, only the best material being employed. The arch of the furnace, with which the flame comes into direct contact, as well as the fire-bridge, are made of good firebrick held together by means of the best chamotte powder. The adjacent faces of the bricks are carefully made smooth, so that only a very thin layer of the chamotte is necessary to cement them together. By this means a very strong joint is made, and the bricks cannot get loose and drop out.

The bottom of the heating-vessel rests on an arch, a course of bricks which protects it from the direct heat of the flame. The hot gases pass under the vessel, then upwards and along one side of it, round the back and along the other side, and thence are led away to the chimney. The outside walls must be well insulated and plastered. The mass of sulphur can also be heated by steam, but only if superheated, or the hot gases from the furnace of a steam boiler, as they pass from the flue to the chimney, may be utilised for the purpose. Direct firing is preferred in many factories. To hinder the formation of sulphide of iron by the action of the sulphur on the iron of the heating-vessel, which results in the formation of an incrustation on the bottom of the latter, and tends to destroy it, the inner surface of the heater is periodically covered with lead. The temperature of the sulphur bath is measured by means of thermometers, protected by iron tubes, and with their bulbs reaching to about the middle of the heater, the scales being at a convenient height above the top. The most convenient form of thermometer to use is one which can be set to the desired temperature, and so arranged that when that temperature is exceeded a bell is rung to warn the man in charge that it is necessary to look to the fire. Soft rubber articles are generally vulcanised at 135° C., cut-sheet goods at 135° to 140° C., while for hard-rubber shaped objects, temperatures as high as 160° C. can be employed.

The sulphur vapours given off during the heating are carried away by a powerful exhauster. To this end a metal hood is fixed over the heating-vessel, galvanised iron being the most suitable material to use. The front and back walls of this can be raised to