sharp impressions, has had to give way recently to a simpler and more rapid method of stamp manufacture. In this method the type is prepared and set up in the same way as described above. A negative plate is then made in a moulding-box, with matrix material stirred up with glue-water to a thick paste, by pouring the mass into the moulding-box, spreading it evenly, working it with a spatula until it is free from air-bubbles and lumps, and then carefully levelling the surface. The surface of the matrix-plate should be as smooth as glass, and should feel waxy to the touch. The type is now covered with a strip of rubber or fabric, firmly clipped in a mould press, and the matrix plate pressed tightly on it. An impression of the type in the sunk form is thus produced, but it is not yet deep enough nor sufficiently sharp. The strip is removed, the type moistened with benzine, thin pressing-strips of tinfoil or paper inserted, and the type repeatedly pressed into the matrix in order to deepen the impression. From three to five such pressings are enough to produce sharp, accurate impressions of the type in the matrix. The matrix is trimmed with a sharp, flexible knife, and carefully dried in an oven. This renders it as hard as stone, and suitable for taking impressions from in the actual unvulcanised stamp rubber. Thin strips of rubber are laid over the matrix so as completely to cover the impressions, and the two are now pressed together in the autoclave press. The rubber sharply and accurately fills up all the crevices in the matrix, and is fixed by vulcanisation, so that when the cure is complete the type is reproduced in rubber in sharp uniform outlines. The separate pieces of rubber type are finally cut off with scissors, and fixed in some suitable manner on the stamp handle. Vulcanisation is regulated according to the thickness of the sheets and the mixing employed, and is complete in, for example, fifteen to twenty minutes at 160° C. Another method which has been introduced in America may also be described. Instead of working with a matrix-mass, which has its drawbacks, and cannot be used more than once, the casting is poured with type-metal, and a metal matrix is thus obtained; this is very durable, and can be melted down after it is done with, and the metal used over again for other castings. From this metal-matrix the rubber stamp is prepared direct in the way already described. By the use of machines for composing, casting, and printing, large quantities of stamps can be automatically produced; such stamps turn out very accurate. In addition to letterpress, designs of all kinds can be equally well produced in rubber stamps, and up to considerable sizes. The finished rubber stamps are cut into circular, oval, or

angular shapes, and are fastened on to the handles with pure Para solution, lightly vulcanised with a very weak solution of chloride of sulphur before the two parts are stuck together. Since with fixed rubber stamps it is only possible to print the actual letterpress or the design of the one particular stamp, attempts have been made to improve upon them by introducing movable ones, by the aid of which one is able to make a number of different impressions with the same apparatus. Rubber bands on which the type is fixed work over rollers enclosed in a case; by the rotation of these bands a series of different arrangements of the type can be obtained to print from. The most practical form of rubber stamp to manufacture is the wheel stamp, in which the individual symbols or letters are carried on the teeth of the wheel, and which are very rapidly vulcanised in steel matrices in which the various teeth and symbols are engraved.

In order to get an accurate stamp impression on vulcanisation, the unvulcanised rubber on exposure to heat should first become sufficiently soft, and then cure rapidly without becoming stiff and inelastic in the process. Further, the mixing should not contain too large quantities of substitute, which have a tendency to cause the rubber to stick to the mould, and care must be taken to avoid porosity, to which revolving rubber stamps are especially liable, on account of the thickness of the rubber used.

The following mixing may be recommended for revolving stamps:—

Kassai or Mozambique	10,000 gms.	Litharge (free from peroxide)	14,000 gms.
Substitute (brown, rape oil)	8,500 ,,	Whiting	5,000 ,,
Magnesia usta (heavy)	2,200 ,,	Zinc white	10,000 ,,
		Sulphur	4,000 ,,

and for ordinary stamps one may use:—

Para	10,000 gms.	Sulphur	3,000 gms.
Substitute (brown, rape oil)	1,000 ,,	Zinc white	7,500 ,,
Magnesia usta (heavy)	2,000 ,,	Litharge (free from peroxide)	2,000 ,,

Cheaper quality:—

Para	5,000 gms.	Litharge (free from peroxide)	3,000 gms.
Columbian	5,000 ,,	Zinc white	8,000 ,,
Talite or atmoid	2,000 ,,	Vaseline	500 ,,
Magnesia usta (heavy)	2,000 ,,		
Sulphur	3,500 ,,		

Only glycerine inks are suitable for use with rubber stamps; a blue ink is composed of the following ingredients:—100 gm. distilled water; 100 gm. wood vinegar; 100 gm. methyl alcohol; 700 gm. glycerine; 30 gm. methylene blue, pure, free from dextrin and starch.

The methylene blue is dissolved first, and the glycerine then added, the solution being filtered if necessary. If the methylene blue used is pure there should be no insoluble residue. From the point of view of durability of the stamp, inks free from acetic acid are preferable.[1]

12. **Waterproof Cloth.**—The manufacture of waterproof fabrics is one of the oldest branches of the rubber industry. The proofed fabric may either be used as it is, without being further dealt with, for a variety of purposes, or it may be used, in the making up of other rubber goods, in the form of insertions or as an outside covering to them. Attention was directed towards the coating and impregnating of fabrics with rubber shortly after the appearance of raw rubber in Europe, on account of the imperviousness of such fabrics to water, and, after the discovery of methods of vulcanisation, waterproof cloth became an article of very considerable importance. But with the lapse of time, methods of proofing have been subject to fundamental changes. In the early days the rubber solution was applied to the cloth by means of a brush, this painting process being repeated until the coating of rubber was thick enough. Oil of turpentine was at first the solvent employed, and this was later on used in admixture with a somewhat crude coal-tar oil; later still petroleum came into use, and finally benzine and benzol. Not only was such a method accompanied by great loss of solvent, but it was an extremely defective one from the point of view of the unevenness of the resulting coating, due to the employment of hand labour. This unevenness was brought about by the circumstance that in scarcely any solvent is rubber completely soluble; as a general rule a quantity of incompletely dissolved, swollen particles remain in the solution, and show up very prominently as streaks, spots, and lumps in the rubber. This method of proofing has, however, been discarded, as machines have been perfected which do the same thing more efficiently.

When necessary the nap of the fabric is removed by means of a specially constructed singeing machine.

Spreading-machines (fig. 72) have long been in use for the production of proofed cloths for technical purposes, or for use in the factory itself, and to-day most of the proofed material turned out is produced on similar machines, though these have already been superseded to some extent by the spreading-calenders (fig. 73).

[1] See also "Die Herstellung von Kautschuk-stempeln," *Gummi-Zeit.*, 1906, xx. p. 1000.

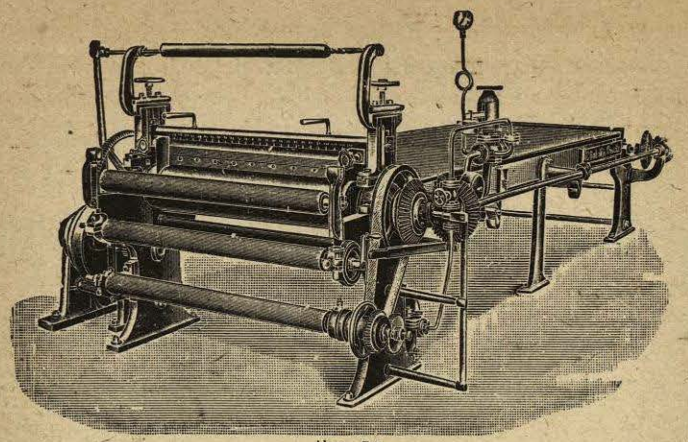

FIG. 72.

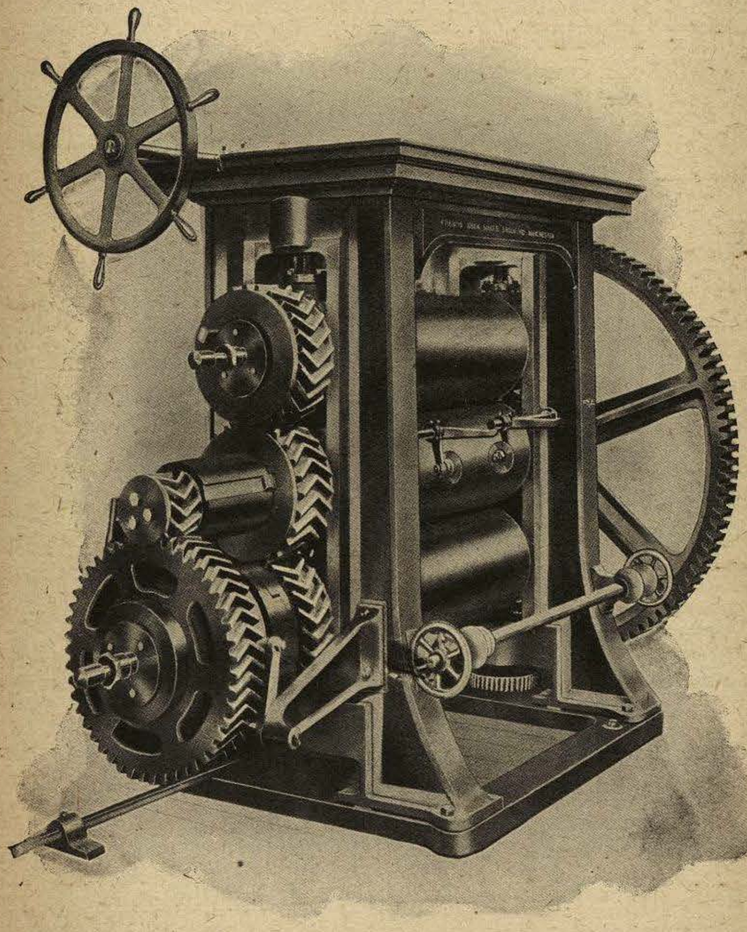

FIG. 73.

The general design of the spreading-machine is clearly shown in the illustration, and only those special points about it need, therefore, be referred to which require the most careful attention in order that perfect goods may be turned out. In the first place, it should be remembered that different mixings behave very differently on the spreading-machine, and bearing in mind what a multiplicity of such mixings exists, the need for great experience in the management of a spreading-shop will be admitted without hesitation. Difficulties are not at an end, however, when the variety of the mixings has been dealt with; the fabrics used also differ very widely in the raw material of which they are made, in thickness of thread, and in the readiness with which they take up the rubber dough. In order to realise the great differences that exist, it is only necessary to compare a web material with a belting cloth, and, on the other hand, a Para mixing with a mixing such as is used for ordinary Tuck's packing. Mixings to be spread must first of all be worked up with a suitable solvent. Petroleum benzine is the one most frequently used, on account of the comparatively slight smell attached to it; solvent benzol is used less frequently, because the persistent odour which clings to articles in the preparation of which it has been used is often an objection. In works where the evaporated solvent is not recovered, the injurious effect of the benzol vapours, which cannot be altogether prevented, is against its use as a solvent. In most cases, also, when everything is taken into account, there is a marked difference of price in favour of benzine. The first and most important requirement for good spreading consists in the addition of the right quantity of benzine to the rubber. The actual proportions used are regulated by the kind of raw rubber employed in the mixing, and by the percentage of rubber present, as well as by the kind of fabric used. First of all, the proportion of 1 part of benzine to 1 part of rubber may be taken as a general guiding rule, the proportion of benzine increasing with the quality of the rubber and decreasing as the quality of the mixing becomes lower. A larger proportion of benzine should also be added when a coarse fabric is to be spread, so that the dough may be able easily to penetrate into the meshes. The highest proportion of solvent is, however, necessary when proofing very thin hat-cloths.

The fabric with its coating of rubber dough, after leaving the adjustable spreading-knife fixed over the spreading-roller, passes over a heating-table, where the solvent is evaporated. The steam-heated sheet-iron table is generally about 4 metres long by 1·6 metres wide. Even if the solvent used boils practically between the same limits, the rate of evaporation varies with the raw rubber used, and is greater in the case of mixings containing little rubber than in the case of those which contain more. Solvent left in the rubber is detrimental to it, and if it is not completely removed before vulcanisation is effected, the durability of the proofing is considerably lessened. The spread fabric should therefore pass so slowly over the heating-table that the last traces of solvent are driven off. The actual speed will vary according to the kind of proofing being dealt with; hence every machine is arranged to work at three, sometimes at four, different speeds. Petroleum benzine is preferable to solvent benzol also in this matter of evaporation from the proofing, since benzol often contains an appreciable quantity of constituents boiling above 130° C. which can only be removed by unduly prolonged heating. Petroleum benzine should, however, also be tested by fractional distillation, and if it contain an appreciable amount of constituents boiling above 130° C. it should be rejected as unsuitable. It is by no means necessary that the benzine should consist chiefly of constituents boiling below 100° C.; on the contrary, a solvent boiling between 90° and 130° C. is a much better solvent. But the benzine should contain nothing boiling above 130° C., because its evaporation would then be too slow, whereas a solvent boiling between 90° and 130° C. evaporates quite rapidly enough. It is well known that temperatures considerably below the boiling-point suffice to bring about the complete evaporation of benzines.

With a view to rapidity of working, the evaporation is often forced. Such a method of procedure is to be entirely condemned, for whenever rapid evaporation is resorted to blisters are formed, and defective places in the article result from the loosening of the rubber coating from the cloth. These blisters are productive of the greatest injury in the case of the so-called balloon silk fabrics, because this material has to withstand a high internal gas-pressure.

This defect also assumes far-reaching importance if the material is to be used as a waterproof fabric.

It should be seen, therefore, that the proofing is absolutely homogeneous, the number of coats varying, according to the nature of the material and the purpose for which it is to be used, up to as many as six, and each coat should be spread as thin as possible.

Not only can fabrics be spread in one colour, but in different colours, forming very beautiful patterns. This particular branch of manufacture was very thoroughly worked out by the late John Minder, and the originality of his process justifies a careful description of it. The general idea is as follows. If a piece of stout paper be evenly folded together several times, and the corners then cut off with the scissors, together with a few triangular and curved pieces, a design is obtained, when the paper is unfolded,

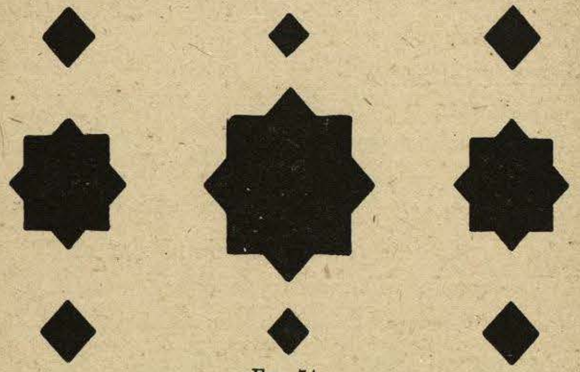

Fig. 74.

somewhat similar to that shown in fig. 74. A piece of cotton fabric, as generally used for bed-sheeting, is now spread with white dough until an even coating is obtained. Then when the next coat is put on, the perforated paper is put between the roller and the fabric (see fig. 75). The rubber-covered roller *a* of the spreading-machine carries the paper *c* through smoothly, and the perforations

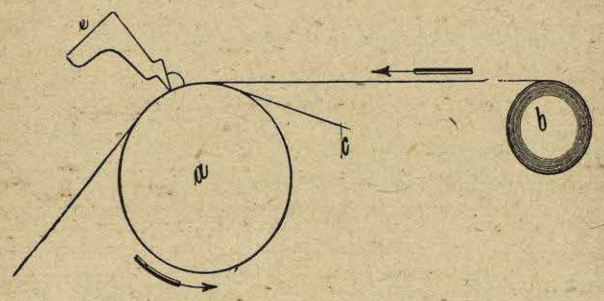

Fig. 75

of the paper are shown in relief in the corresponding positions on the proofed cloth. The thicker the paper and the stiffer the consistency of the dough, the higher will be the relief of the pattern. If a coloured dough—*e.g.*, a pink rubber dough—be used for the last coat instead of a white one, the perforated portions of the paper will be represented by pink patterns on a white ground, but only if the following conditions are observed:—The spreading-knife must rest firmly on the partly-proofed material so as actually

to press into the rubber roller a little. The spreading-machine should then be run very slowly. By working in this way what happens is that the coat of white rubber in front of the knife has time to get softened, and that then the knife scrapes off a very thin layer of white rubber instead of spreading on a coat of pink, except in the places over the perforations of the sheet of paper, where the spreading-knife exerts no pressure; in these places a coat of pink rubber is left on, and the design so produced appears in slight relief. The pieces of paper which were originally cut out of the sheet are now taken and stuck on to the same sheet of paper in suitable positions, and the sheet so prepared is used in the same way as before. The design now obtained is the same pink on white arrangement as before, only in those places where the extra thickness of paper has come a counter-sunk appearance will be observed; this is, of course, produced by the additional pressure of the knife brought about by the extra thickness of paper. The sheet of paper can now be employed in another way. Another piece of material is put on the spreader, and spread with yellow dough, about three coats being put on. On the yellow a white layer is spread until a smooth coating, completely hiding the yellow, is obtained. Pink dough is now put before the spreading-knife, when on passing the material through, with the paper between it and the roller, a design in three colours is obtained. The places corresponding to the perforations appear in pink; from the places over the double thicknesses of paper the increased pressure of the knife causes the white coating to be completely removed, showing a pattern in yellow, and the groundwork of the whole remains white. It will now be clear that in this manner, by putting on several layers of rubber of different colours, and by building up or lessening the thickness of the paper in varying degrees, patterns can be produced on waterproof cloth in different colours and shades of colour, which have a very fine appearance and a characteristic effect. When it comes to proofing a piece of material with a continuous pattern, the simplest way would be to imprint the design on the rubber-covered roller. Such a roller would, however, be very difficult, if not impossible, to make, for it would have to be done with extreme accuracy, as an error of $\frac{1}{10}$ mm. in printing the material, if one may so describe the process, would result in faulty places. This can be got over, however, in the following way:—A piece of cloth of a certain length is coated to a thickness of 2 mm. with a rubber dough, not too soft. The design is then impressed continuously in the rubber coating, and the material is vulcanised by heat. Fig. 76 shows the arrangement of the spreading-machine for producing the coloured design on the proofed material. *b* is the wooden roller carrying the material

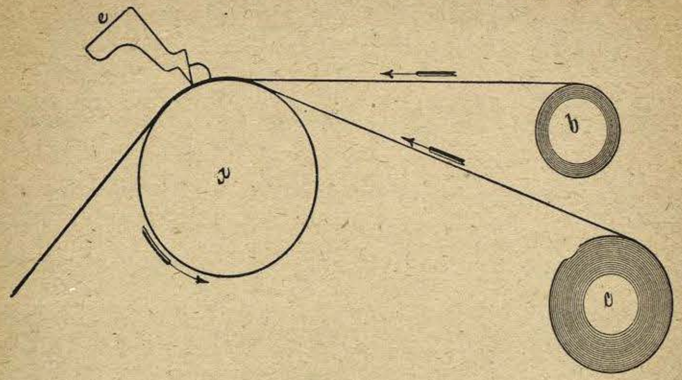

Fig. 76.

which has been already spread with the different-coloured layers of rubber. *c* is a similar roller carrying the material on which the design in relief has been impressed. In "printing," the two cloths run, one over the other, between the roller *a* and the spreading-knife *e*, the cloth which is to be printed in colour being above that which carries the design in relief. After passing over the heating-table each cloth is rolled up on a separate roller under the machine, in the usual way. The "printed" cloth exhibits fine effective designs in a kind of relief. The raised parts of the under-cloth are subject to greater pressure than the hollows, and the intermediate steps are gradual. The copy reproduces all the gradation of the original design, and stands out in the plastic state from the ground-work.

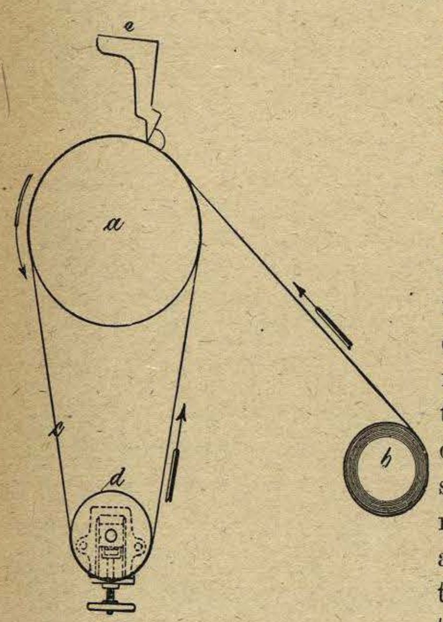

Fig. 77.

There is yet a third method of covering the proofing with a pattern. Figs. 77 and 77A illustrate the arrangement. *a* is the rubber roller of the spreading-maching, *b* the roll of material to be printed, *d* a wooden roller with its iron axle resting in bearings,

which can be raised or lowered by means of screws. Round the wooden roller *d* and roller *a* runs a cloth *c*, on which is the impressed design, in the form of an endless band. The ends of the cloth must be joined together very neatly, otherwise, on printing, a stripe will be produced in that particular place every time it passes under the spreading-knife. Further, the joint should be made in such a way that it can be easily undone, and the cloth removed readily from the machine after use. In this method the piece of proofed cloth is also printed continuously, but only a comparatively short piece of printing-cloth is necessary. The rubber roller carries the printing-roll—*i.e.* material *c*—continuously through under the

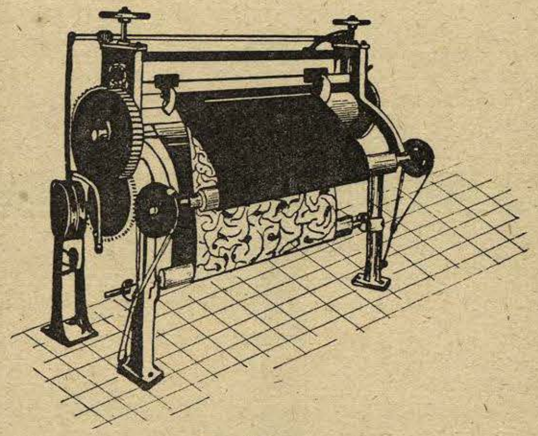

Fig. 77A.

knife. This cloth is always kept taut by means of the adjusting screws on roller *d*.

In order to get good results on the spreading-machine with patterned cloths it is most important that the roller should be buffed absolutely true. In the case of patterns consisting of simple figures, such as stars, dots, flowers, etc., a comparatively cheap printing-cloth can be made by punching the individual figures out of a stiff proofed material. When the design is a continuous one, however, it will have to be impressed in the way already described.

One does not yet very often meet with spreading-machines which are fitted with apparatus for recovery of the solvent, though such machines are made in Germany. Their construction was first described by Minder.[1] In this arrangement heating-coils take the place of the usual steam-chest, and these are contained in a long shallow chamber with a false bottom which is kept cool. The cloth passes through between the steam pipes.

[1] *Gummi-Zeit.*, 1898, viii. No. 7.