CHAPTER IV.

THE MANUFACTURE OF SOFT-RUBBER ARTICLES.

1. Manufacture of Hose.—(*a*) **Vacuum and Pressure Hose, with and without Insertion, for Conveying Purposes.**—In the following pages our intention is to describe the manufacture of hose as carried out to-day in modern works. As may be gathered from the plan of the factory, the hose department is located in the largest shop, the whole breadth of which is available for use, no obstructing columns or pillars being present. This is a great advantage, because the metal mandrels, 40 metres long, on which all large-size hose and all tubing with insertion has to be made up, can then be carried without hindrance from the working bench to the wrapping machine, and from there to the trolleys on which it is run into the vulcanising pipes.

The method of manufacture formerly adopted, and which is still employed in many works, was to lay the calendered sheet of rubber round the metal mandrel, which had previously been rubbed over with French chalk, press the overlapping edges closely together, and then cut along the tube from end to end. The cut edges were moistened with benzine, and were then pressed together and kept in position by a strip of rubber which was laid on top. This is the method of manufacture still employed in the case of hose of large dimensions and of qualities which do not lend themselves to being dealt with on the machine. In the case of good qualities, where the cut edges adhere together well, this method is also less risky; on the other hand, in the case of qualities in which the cut edges do not adhere well together it is better to use the tube machine method, which was first introduced in America, but which has since been adopted almost universally.

The manufacture of hose is generally carried out in the following three stages:—

1. Running the inside and outside coatings on the tube machine.

2. Wrapping on the insertion.
3. Wrapping the hose prior to vulcanisation.

There still exist many factories in which the machining of the inside coat of rubber is still done on the ordinary tube machines, and the sleeve obtained then drawn on to the mandrel. But this method has the following disadvantages: in the first place the rubber gets contaminated with French chalk; and secondly, thin places are formed, owing to the uneven stretching which it receives during the process of pulling it on to the mandrel; small particles of compounds, also, the presence of which is due to careless mixing, form weak spots through which the liquid can find its way into the insertion, perforating this and making the hose unfit for use. The contamination with French chalk causes a bad join to be made, unless the chalk is washed off quite clean with benzine. But if the manufacture is to be carried out on thoroughly business-like principles, tube machines must be used through which the mandrel can be driven and the rubber squeezed out round it. Besides the reduction in the amount of labour required to make hose by this method, one has, in addition, the advantage of obtaining a uniform thickness of wall, even in the case of the very thinnest-walled tubing.

The construction of this machine has been so greatly improved that it now forms a perfect type, as illustrated in fig. 50. The mandrels are introduced through the hollow screw, and with their coating of rubber are carried forward, more or less rapidly, immediately on leaving the machine, by an endless conveyor with grooves on its working surface to take the mandrels. The speed of the conveyor is regulated by means of a friction driving-pulley fitted on to the machine. In order to prevent the rubber from sticking to the mandrel, the latter is finely powdered with French chalk after entering the hollow screw, by means of a blowing apparatus attached to the machine, and supplied with air from a small fan. Instead of the usual feeding-hopper, this machine has a pair of feeding-rolls, which force the rubber into the screw at a uniform rate, and uniformly heated. Should the screw receive a little too much rubber at any time, the rolls are raised by springs and do not carry any more forward until the screw has worked off the excess. By this arrangement the troublesome choking-up of the machine is done away with and inequalities in the thickness of the rubber tube are avoided. As the mandrel leaves the nozzle of the machine it passes on to the conveyor in front of it, by which it is carried along at a speed corresponding to that of the machine.

As soon as the whole length of mandrel is covered with rubber it is laid on a bench near at hand, and in the case of hose with insertion the second stage of manufacture is begun, namely, the wrapping round it of the insertion.

The best way of doing this is still by hand, for all the insertion wrapping-machines hitherto constructed have the disadvantage that the layers of cloth must not overlap, for if they do the pressure of

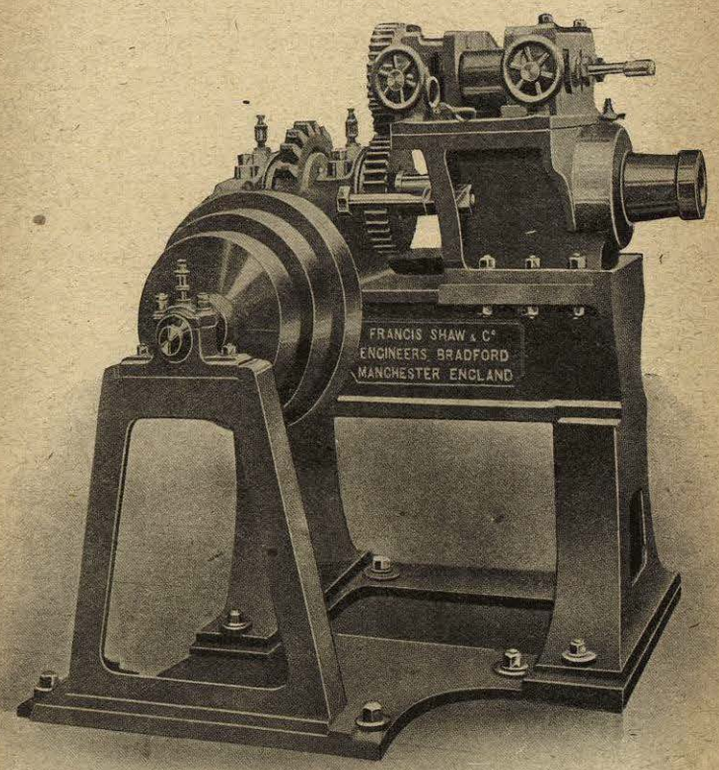

Fig. 50.

the top roller will tend to cause the inside coating to be penetrated by the cloth where the extra thickness, due to the overlap, occurs. On the other hand, attempts to butt the edges of the canvas are attended by the danger of leaving the hose liable to be easily burst. The safest plan is, therefore, in the case of hose with hemp or cotton insertion, to proceed as follows:—The proofed canvas is cut on the bias into strips of such a width that they will go round the hose the required number of times; these strips are united by overlapping their ends to the extent of about 12–15 mm. and firmly

rolling them together, and the long strip thus produced is now laid over the rubber sleeve (on the mandrel) and gradually rolled on to it, by means of small hand-rollers, round the whole circumference, until the beginning and end of the canvas are in superposition, after the required number of turns have been made round the circumference. When this part of the process is completed the hose is tightly stretched on the mandrel and bound on to it at both ends. The whole then passes through the hose machine again, when the outer coat or cover is put on; during this process, however, the chalking apparatus is not brought into action. As soon as the outside coat has been put on, the hose is ready to be wrapped, a necessary preliminary to vulcanisation.

Before going into the details of the third stage in the manufacture of hose, it will be as well to get a clear idea of the object of the wrapping process; this is essentially as follows:—As made upon the mandrel the hose is not yet sufficiently compactly bound together as a whole, and it may therefore easily happen that places are left between the insertion and the rubber coating where these two do not adhere together well. For this reason, this kind of hose is wrapped, before being vulcanised, with one or more strips of cotton, wide or narrow according to circumstances. The whole length of rubber being now tightly bandaged, it is shaped, during vulcanisation, into a perfectly cylindrical tube. The cloth impression visible on the surface is produced of course by the wrapping-cloths, which are removed after the hose has been cured. If the wrapping is badly and unevenly done, or if the tube is not drawn on tightly enough, air blisters may be formed during vulcanisation, which may rupture the cloth and make the hose unsaleable, if the damage cannot be repaired by cutting a piece out, making the place good, and curing once more. In insertions spread with solution the presence of moisture is a factor which may give rise to porosity or blistering, and bad mixings may also cause the whole of the inside and outside coats to blow and become porous. As a rule the wrapping is done, in the case of a hose 40 metres long, by a gang of fifteen to eighteen hands, twelve to fourteen of whom give to the hose, which is lying on a bench, a forward rolling motion, while a man at the upper end pulls at the mandrel; three more hands are necessary to hold the wrapping-cloth and roll it on. With the mechanical wrapping-machine (fig. 51) the method of procedure is much simpler. The hose is supported on the two lower rolls. A strip of cloth of the right width having been wrapped round the end of the hose at a sharp angle, the upper pressure-

roller, which is of just the same length as the under rollers (the actual length of roller for a 40-metre length of hose being 42 metres), is lowered, and the machine set in motion. The wrapping process is now accomplished automatically, the hose rotating about its own axis on the two rollers, while the upper roller presses the cloth tightly on to the hose; meanwhile the man in charge of the wrapping-cloth has only to see that it is kept tightly stretched.

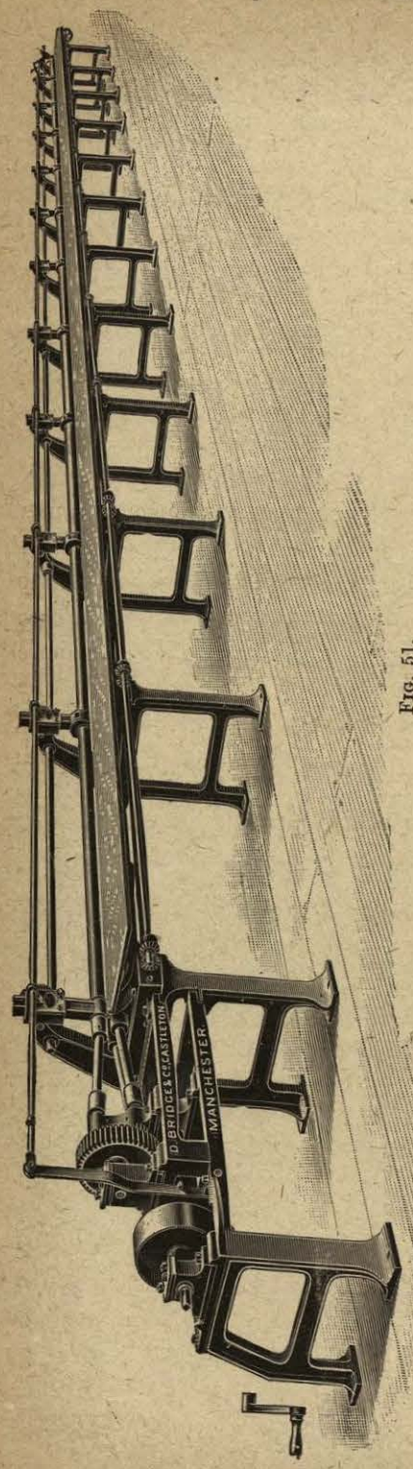

FIG. 51.

In purchasing a wrapping-machine it is of importance to select one constructed on such a system as permits of the upper roller being automatically lifted, by eccentric action, whenever the wall of the hose runs a little stouter. Machines which are not provided with some such contrivance are of doubtful value, since the variable pressure which they exert tends to rub through the hose. A very serviceable and entirely new kind of wrapping-machine is illustrated in fig. 52; this machine has met with great approval during the short time it has been working, and it embodies the simplest of principles. The hose is driven by means of a chain and chain wheel in connection with a variable-speed friction drive. The elements of the latter can be adjusted to run alternately in either direction, and the output of the machine is exceeded by no other make. In the case of hose up to 19 mm. in diameter, made from suitable mixings, a single binder is sufficient, but when this diameter is exceeded the hose is wrapped twice, up to a diameter of 28 mm. Hose of greater dimensions still must be wrapped three and often four times. If, however, it is found necessary, in any given instance, to wrap a hose of normal dimensions (say about 40 mm.) six or eight times in order to produce a perfect article, it is pretty certain that there is some great mistake in the composition of the rubber. At the same time, it may be mentioned that hose with cloth insertion is also made with a smooth surface, with false seam-markings running the length of the hose, so-called "hose made by the English method." This

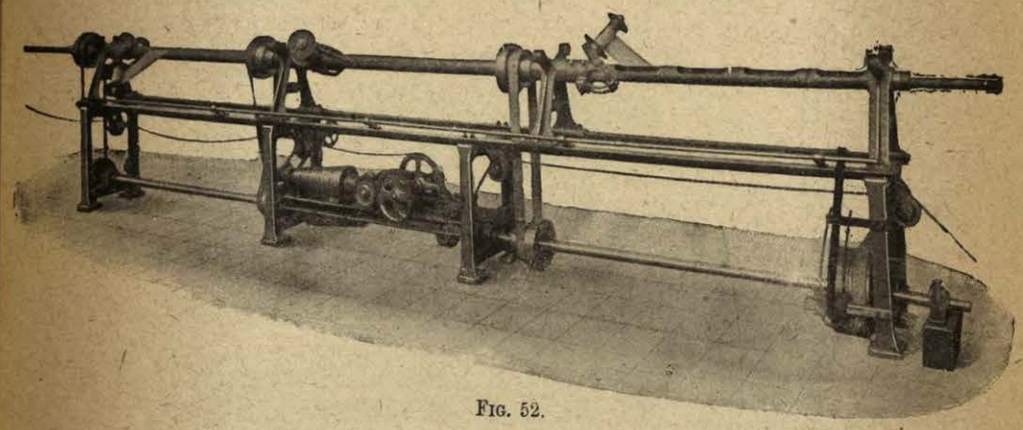

FIG. 52.

kind of hose is not wrapped, but is cured in chalk in the open. The proofed insertion cloth used in the manufacture of such hose must have powerful adhesive properties. This class of hose also can best be made on the hose machine nowadays, the separate coats being run out from it, through a nozzle shaped so as to form the imitation seams. In order to make the outside coating of rubber adhere firmly and closely to the insertion, the tubular mandrel as it comes through the machine is caused to travel a little faster than the rubber emerges from the nozzle.

Another article for which a great demand has arisen is the so-called

(*b*) **High-pressure hose (hose with braided insertion of hemp, cotton, or brass-wire).**—High pressure, or, as it is briefly called, braided hose, is the ideal hose for conveying water, and for conveying purposes in general. Over ordinary canvas insertion hose it has the great general advantage of being able to withstand enormously

high pressures, and can therefore be used of a relatively thinner substance than ordinary hose.

The process of manufacture of this high-pressure hose, the demand for which is constantly on the increase, is the same in principle as already described, with the exception that in place of the ordinary cotton insertion, an insertion made on the braiding machine is used. The method of procedure is as follows:—The tubular mandrel, covered with the inner coating of rubber, on leaving the hose machine, passes over a short conveyor belt, which serves rather the purpose of pushing the mandrel along, into the braiding machine (fig. 53). The speed of this machine is regulated in exact accordance with that of the hose machine behind it.

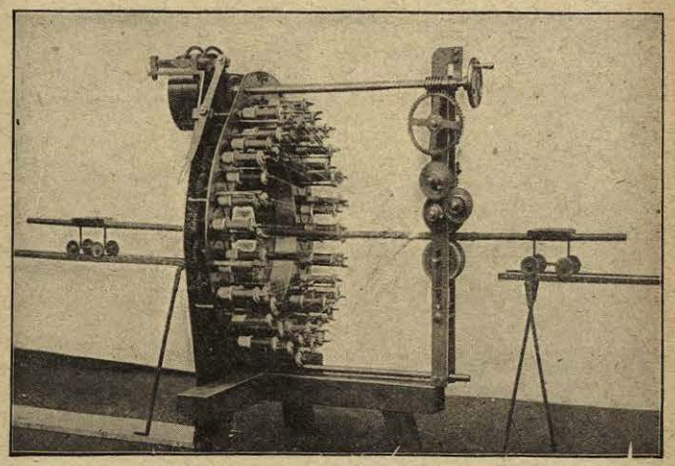

FIG. 53.

Between the hose machine and the braiding machine, and fitted on to the latter, is a small apparatus for covering the rubber coating on the mandrel with a rubber solution of medium thickness; during the braiding process which follows, this solution penetrates into the fibre of the hemp or cotton yarn, and brings about a very intimate union at every point. This small apparatus, as shown in fig. 54, consists of a small storage vessel with an automatic stirrer to prevent the solution from settling, and a mouthpiece connected with the outflow, beneath which a sheet-iron tray is fixed in order to catch any excess of solution. The mouthpiece or nozzle must be one of an interchangeable series, and is varied according to the size or outside diameter of the hose. Inside the nozzle is a jet for the supply of solution, and in front of this a celluloid spreading-knife is fixed. When the insertion has been braided on to the hose the mandrel passes through a larger solutioning apparatus, filled

with thicker solution, which is spread all round the insertion. In order to dry this off rapidly, by evaporating the benzine, a cast-iron heating jacket of about 100 mm. diameter is used, which can be provided with suitable nozzles at each end. The drying-jacket is heated to about 45° C. and the hose is driven through it—air being blown through at the same time by a fan. On leaving the drying cylinder the mandrel rests on the conveyor placed in front of it, and is carried forward at the same speed as it travels through the two machines, until the whole length of 40 metres has been coated with the inner coating, covered with the braided insertion, and spread with a coat of solution.

Three hands are, as a rule, sufficient for the whole of this piece of work: one to look after the hose machine, a girl to look to the

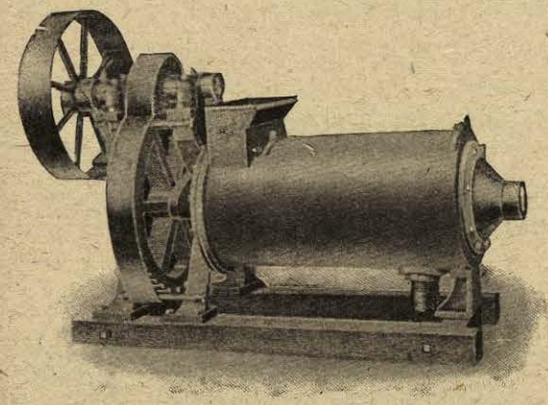

FIG. 54.

braiding machine, and the third to superintend the working of the whole plant.

This hose is generally made with two layers of braided insertion, often with several layers, the method of procedure being the same as above described, except that the hose machine runs empty in the intermediate stages. The outer coating of the hose is also run from the machine, and, as a rule, a slightly higher speed is given to the conveyor, so as to cause the layer of rubber to adhere firmly to the braiding. The braiding machines are mounted on movable trolleys which can be run along rails lying transversely in front of the hose machine, so that for the different sizes of hose, different braiding machines can be used in conjunction with a single hose machine. For diameters of from 10 to 28 mm. a 48-bobbin machine will do; for larger sizes, on the other hand, a machine with sixty bobbins should be used. It is not advisable to use the same braiding machine for all sizes, or the braiding will be in some cases

too close- or too wide-meshed, and too long in spite of the adjustable transport. On the other hand, if some of the bobbins be left out, the mesh becomes too open.

It is possible to make hose which will withstand a pressure of 200 atmospheres: in attempting this the number of ply of insertion must be correctly selected with reference to the internal diameter. For specially high pressure work it is advisable to carry out the penultimate braiding with brass wire, which is followed by a final braiding of hemp, this being in turn secured by a spiral wire.

(*c*) **Manufacture of "Spiral" Hose.**—The process is, in this case, the same as for ordinary hose, except that in arranging the spiral wire one must be guided by the purpose for which the hose is to be used, whether for suction or for high internal pressures, or whether it is to be adapted for both purposes, and the spiral wire must be arranged according to requirements.

In the case of hose up to 30 mm. in diameter, the inside coating is run directly on to the metal mandrel from the hose machine; in the case of the larger sizes, on the other hand, it is usual to proceed according to the older method, by laying the sheet round the mandrel, cutting down from end to end, pressing the seams well together, and covering them, as a safeguard, with a narrow strip of the same quality rubber, so that one may be doubly sure of the seams holding. If the hose is to be used as a suction hose, the spiral wire must be inserted immediately round the inside coating. On the other hand, when it is to be used as pressure hose it is an advantage to first of all roll the insertion down on to the inside coating, and then to slip the spiral on. The spiral is generally made of hard galvanised iron wire. Whereas the spiral used formerly to be run on to the hose by hand, special machines have come into use more recently, which coil the wire into suitable spirals. The size of the spiral is regulated by the adjustment of the matrices, so that it is only necessary to slip the ready-made spiral over the inner coating. This method is a far more rational as well as a more certain one than the old method. If the spiral is wound on to the inside coat the latter gets greatly twisted, and often torn, by the coiling on and expanding of the spiral. The ends of the spiral are soldered and held in position by a strip of unvulcanised rubber. On the top of the spiral there is always placed a coat of rubber, and over this the insertion. On the other hand, in the case of smooth-surface spiral hose, the interspaces between successive coils of the wire are filled up with strips of rubber, and then covered over. The making up is carried out in

the way previously described, according to the number of ply of insertion, and finally the hose is surrounded with the cover. In wrapping spiral tubing great care must be taken to see that all the parts are perfectly tightly pressed together, so that no blisters can be formed during vulcanisation. For this purpose a specially constructed machine is employed, the principle of which may be briefly explained. When the hose has been wrapped, it must be well corded with strong hempen cord. In a slide in front of the bench runs a winder, 2 metres long, with three cylinders, over which the cord runs with one turn round each, and is thereby braked. Above this the cord passes through a guide on to the hose, and, the mandrel having been set in motion, is allowed to run on to it under tension from the cylinders; thus directed by the guide it is laid tight in the interspaces between the successive turns of the spiral. As soon as the cord has reached the end of the winder this is moved forward along the slide according to the length of the hose, and there fixed, so that the cord can be wound round still further along. This operation can be performed with a good deal more power than by the workman passing the cord round his own body and exerting the braking force by leaning on it.

Vulcanisation follows the cording process, and is carried out in a long pipe, as in the case of all other hose. In conclusion, it is worth mentioning that after the hose has been vulcanised and unwrapped, it is best drawn off the mandrel by blowing compressed air between the mandrel and the hose through a conical nozzle. A few twists of the hose are sufficient to start it, and to enable it to be drawn off the mandrel. In dealing with strong spiral hose of large dimensions it is, however, necessary to make use of a forcing apparatus; this is brought into contact with one end of the hose, which it pushes along slightly towards the other end, at the same time giving it a twist against the tension of the spring. In this way hose up to 500 mm. in diameter can be easily drawn off. For large-size hose it is advisable to use as mandrels sheet-iron tubes, which can be allowed to spring, or be drawn inwards. The most suitable mandrels for hose manufacture are smooth-drawn steel tubes the ends of which are united by screw couplings. These tubes last much longer than brass mandrels, and on account of their absolutely smooth surface make the inner surface of the tube as smooth as glass. Steel tubes have yet another advantage over other metal mandrels, in that the rubber does not adhere so firmly to them.

(*d*) **Canvas Hose with Rubber Lining.**—Although the manufacture of canvas hose really constitutes an industry in itself, it