the action of falling stampers. From this treatment they are taken to the cold-water washing machine, where they are treated with a continuous spray of pure water whilst revolving in the tub under the action of falling stampers, as in the hot-water machine. Next the cocoons are rinsed in a spray of pure water, then the moisture is expelled in a hydro-extractor, and so, thoroughly degummed and softened, they are allowed to dry. For further treatment they are damped with a sprinkling of weak solution of Marseilles soap, then beaten either with the hand or by means of a machine. This machine has a series of leather straps attached to an endless band, which by its rapid revolution causes the straps to hit with a quick whipping stroke against the surface of a revolving tray on which are placed the washed cocoons. The beating serves to free the fibres fully from each other, and expels in the form of a fine dust the remains of chrysalides from the interior of the cocoons. It now remains only by the operation of the cocoon opener to tease out and separate the fibres into a kind of lap. The cocoon-opener is a modified carding machine, the drum or cylinder of which is covered with strong card teeth. On this drum the fibres collect as they are opened and teased out, and when the teeth are full the lap so formed is stripped off by the attendant. The silken fibres are now ready for the operations preparatory to spinning.

To bring raw waste other than cocoons to this point a different series of operations are necessary. The removal of the gum is first usually effected by a process of fermentation or maceration instead of washing with soap, whereby a great saving of soap is secured. Into a large tank a quantity of waste is packed, and soaked with a weak soapy solution which is maintained by steam at about 170°. The tank is closed over, and in the course of a few days fermenta­tion begins, and according to circumstances is allowed to go on from two to three weeks. From time to time proof samples are withdrawn to observe the progress of the rotting, as over-fermenta­tion would result in the same injury which arises from over-scouring, —weakness of fibre, loss of lustre, and waste of substance. By maceration the silk loses from 20 to 30 per cent. of its weight. From the maceration vat the silk is conveyed to the hot-water washing machine, where with a weak soapy solution it is washed under the influence of stampers for about five minutes. Great care is necessary to prevent the silk from cooling before this washing, as thereby the macerated slime would form an almost insoluble deposit on the silk fibre. From the hot soap solution the silk is taken to the cold-water machine, where, with the aid of stampers, it undergoes a thorough and prolonged washing. After being hung over hurdles to dry it is sprinkled with a weak solution of Marseilles soap, and then dried by means of the hydro-extractor and subsequent exposure in a heated well-ventilated chamber. At this point both cocoon waste, as already described, and floss waste are in the same condition.

The spinner has now to deal with a mass of entangled fibres of all lengths, which he must render even, parallel, and comparatively uniform in length before it can be spun. The fibres are slightly damped with a weak soapy solution and taken to a filling drum, which consists of a large cylinder having set into it, parallel with its axis, from twelve to twenty rows of strong steel spikes. A feeding apron of cloth covered with card-teeth is provided to the machine, and, as the fibre is carried forward towards the drum, a similar card-teeth-covered band travels close over the surface of the apron, so that the fibre is presented to the drum from between two sets of card-teeth. The rows of spikes catch the fibre as presented to them, draw it through the card-teeth, and carrying it with them lap it around the drum in regular combed-out order. When the spikes are sufficiently filled, the lap is cut at each set of spikes, and so stripped from the drum it forms a definite number of “stricks,” of the breadth of the drum itself and the length of the space between the sets of spikes. These stricks are caught in wooden clamps or “books,” which are fastened in the bed of the flat dressing frame. Over them an endless band travels, having on it at short intervals belts of heckle-teeth, called combs, which comb out doubled and short fibres, and, acting first on one end of the strick and next on the other, leave the silk in the condition of beautifully parallel and comparatively uniform flakes. The pro­duct of the first combing, called the first draft, is the longest and purest fibre. The material combed out as it fills the comb teeth is caught in books, and when itself combed out forms second drafts, shorter and less valuable than the first ; and again the combings of second drafts, when combed, form third drafts still shorter. In this way five or six separate drafts or combings from the original lap are obtained, all increasingly short and impure. The final combed waste is treated by a different process for making noil or bourette yarn.

A new form of dressing-frame is now coming into favour, in which the stricks of silk have their ends rolled round wooden rods, and so secured between wooden clamps on the surface of a huge cylinder which revolves so slowly that the attendant can change and fill the clamps as the drum goes round. In its revolution the exposed portion of the silk is first combed on one side by a rapidly revolving card-toothed cylinder, from which it passes

onwards to meet a second similar cylinder revolving in a contrary direction, which combs the opposite side. In the second revolu­tion of the cylinder the portion of the strick which was previously wound on the rod is similarly combed on both sides, and thus the entire strick is rendered smooth and parallel.

The above is an outline of the ordinary process of preparing silk waste as practised in Switzerland and in the United Kingdom, &c., the range of machines being that of Messrs Greenwood and Batley of Leeds. In the great Manningham silk mills at Brad­ford, Mr S. C. Lister, the well-known inventor of wool-combing machinery, while using machinery of the class described, treats by patented methods peculiar to himself a great proportion of his material. According to his original process, scoured, teased, and opened waste is first drawn into a lap on a screw gill box. These laps, containing all the fibres both long and short, are taken to the circular nip combing machine, where the “ top ” of long fibre is drawn out as a continuous sliver and separated from the “noil" or short fibre, which according to its length is delivered at separate points. In his most recent mode of working, Mr Lister forms his waste into a broad lap on the large drum of a kind of carding engine, the drum being stripped when its teeth are filled with the prepared fibre. These laps are laid on the feeding table of a machine which has an oscillating or rocking filling head. At each oscillation the end of the lap in front of the table is “ filled ” on to a row of heckle-teeth parallel with it, and just as the feeding-table recedes a knife comes down between the heckles and the table with a sudden stroke and separates from the lap such fibres as have been placed or filled on to the heckle-teeth. These heckle-teeth in the meantime, being fixed on an endless band, are continuously moving forward in a horizontal direction parallel with the front of the feeding machine, and a set of three such machines place a portion of their laps on to the heckle-teeth in their progress, thus filling the teeth with a fair “bite” of silk. Immediately the heckles have passed the machines, the silk is caught and cleaned off the endless comb by pairs of endless revolving nips rising from under and descending from above, and between these nips the stricks are carried forward in the same horizontal line in which they travelled on the heckle-teeth, which here begin their return journey to be again filled. The stricks in their progress are now submitted to the combing action of revolving card-covered cylinders and card-covered cloth. Half way on in its horizontal path a second set of endless nips seize the combed portion of the silk, the uncombed portion held between the first set is released, and it in its turn is submitted to the combing action of cylinders and endless card-bands. In the end the fully dressed stricks of silk fall on a narrow feeding cloth, which has a combined reciprocating and forward motion, so that the material is spread with the utmost regularity and evenness. It passes through a set of screw gills, and is delivered into cans in the form of a most uniform and equal continuous sliver. The great advantage of these machines is the small amount of tending they require and the large quantity of dressed silk they deliver with unerring regularity.

The spinning proper of dressed waste is done precisely as in the spinning of flax yarn. The flakes are formed into a broad sliver on the spreading frame, and further attenuated and equalized on the set frame and the drawing frame, from which last the silk passes to the roving frame, where it receives its first preliminary twist and is sufficiently condensed to wind on a bobbin. The rovings are finally elongated and spun on the ordinary spinning frame, and for twisting into thread the yarns in two, three, or more strands are wound together on the doubling frame, and finally twisted as in dealing with raw silk spinning.

Spun silk, as it comes from the spinning frame, shows a good many nibs and irregularities and some roughness of surface. To remove these it is wound from one bobbin to another over an improving or cleaning and gassing machine, which consists of a frame having attached to it a number of small cone rollers, around which the yarn passes in a way which makes the entering portion of the thread rub against the portion running off. In this way, with considerable rubbing, the yarn cleans itself ; and in its course over the rollers it rapidly passes through a gas flame, which singes off the fine projecting fibres, leaving the yarn clean, round, and compact. It is submitted to a further examination by eye and hand after being wound into hanks ; and some yarns are finally dressed with albumen and gum solutions.

In the combing of waste silk as much as from 25 to 30 per cent. of waste in a second degree arises, much of which is very short, full of nibs and dust. From this a lower quality of yarn is spun, called noil yarn, and on the Continent “ bourette ” silk, to distinguish it from the “floret” silk made from first waste. On account of the shortness of staple it is worked up by machinery different from that used in the floret manufacture, being prepared by carding, and combed out with a modification of Heilmann’s or Lister’s combing machines. The finished noil yarn is very lumpy, and requires severe improving and singeing.

Spun silk lacks the smoothness, brilliance, and strength of raw silk yarn, but still it is an extremely valuable and useful material,