called the swifts, he winds it on bobbins with a rapid reciprocating motion, so as to lay the fibre in diagonal lines. These bobbins are then in general taken to the first spinning frame, and there the single strands receive their first twist, which rounds them, and prevents the compound fibre from splitting up and separating when, by the subsequent scouring operations, the gum is removed

which presently binds them into one. Next follows the operation of cleaning, in which the silk is simply reeled from one bobbin to another, but on its way it passes through a slit which is sufficiently wide to pass the filament but stops the motion when a thick lump or nib is presented. In the doubling, which is the next process, two or more filaments are wound together side by side on the same reel, preparatory to their being twisted or thrown into one yarn. Bobbins to the number of strands which are to be twisted into one are mounted in a creel on the doubling frame, and the strands are passed over smooth rods of glass or metal through a reciprocating guide to the bobbin on which they are wound. Each separate strand passes through the eye of a faller, which, should the fibre break, falls down and instantly stops the machine, thus effectually calling attention to the fact that a thread has failed. The spin­ning or throwing which follows is done on a frame with upright spindles and flyers, the yarn as it is twisted being drawn forward through guides and wound on revolving bobbins with a reciprocat­ing motion. From these bobbins the silk is reeled into hanks of definite length for the market. Numerous attempts have been made to simplify the silk-throwing by combining two or more operations on one machine, but not as yet with much success.

According to the qualities of raw silk used and the throwing operations undergone the principal classes of thrown silk are—(1) “singles,” which consist of a single strand of twisted raw silk made up of the filaments of eight to ten cocoons ; (2) tram or weft thread, consisting of two or three strands of raw silk not twisted before doubling and only lightly spun (this is soft, flossy, and comparatively weak) ; (3) organzine, the thread used for warps, made from two and rarely three twisted strands spun in the direction contrary to that in which they are separately twisted. Silks for sewing and embroidery belong to a different class from those intended for weaving, and thread-makers throw their raw silks in a manner peculiar to themselves.

*Numbering of Silk.—*The numbering (*titrage)* of raw and thrown silks, by which the size or fineness of the yarn is stated, is deter­mined by constant length with variable weight, whereas other yarns are indicated by constant weight with variable length. The original standard length was 9600 Paris ells = 11,400 metres, the number being the weight in deniers of 24 grains = 1∙275 grammes. This still remains the most common standard, and in practice the number is ascertained by the weight in grains, 1/24 of a denier of a hank containing 476 metres (properly 475 j metres = 400 Paris ells). According to this standard a single cocoon filament weighs 2 to 3∙5 deniers, a 3 to 4 cocoon strand ranges from 7 to 10 deniers, and a 16 or 17 cocoon strand is numbered from 48 to 52. Spun silk is numbered on a different principle. In the United Kingdom it is determined by the cotton standard, the number of skeins of 840 yards per lb. In Continental manufacturing centres generally the standard is the number of écheveaux of 500 metres contained in a half kilogramme, or, more simply, the number of kilometres per kilogramme. According to the resolution of the international congress for promoting uniformity in the numbering of yarns, held at Vienna in 1873 and at Brussels in 1874, the grade of silk ought now to be expressed by ten times the number of grammes given by a hank of 1000 metres.

These methods of indicating grades of silk give, however, only the most imperfect idea as to the quality of the thread ; and specially they convey no information as to uniformity of diameter and strength. To test the raw material in respect of uniformity a most ingenious American invention, the serigraph, has been introduced, and is now largely used. The serigraph has two reels mounted on one spindle, or at least so arranged that they make precisely the same number of revolutions. The reels are covered with india-rubber, and No. 2 is 3 per cent. greater in circum­ference than No. 1. The silk to be tested is placed on No. 1 reel and from that wound on No. 2, which, being of greater diameter, puts a certain amount of strain on the elastic fibre. In passing from the one reel to the other the silk is carried over an agate hook attached to the bob of a pendulum, so that the strain on the yarn is communicated to the pendulum. The strain caused by the 3 per cent. tension of course varies with the strength of the yarn to which it is applied, being greater with increased strength and thickness, and falling away just as the strength of the yarn decreases. Thus the yarn in passing over the agate hook keeps by its tension the pendulum at one particular position while it is uniform, but when it increases in strength it raises the pendulum higher, and when it becomes weaker the pendulum falls. To the extremity of the pendulum is attached a pencil or marker, which traces on a web of paper, travelling at a rate in fixed proportion to the winding, the changes in the pendulum, and thus is obtained a graphic record in a most distinct manner of every variation in the strength of the silk. The precise spot where any imperfection occurs is shown on the tracing, which thus not only absolutely certifies the quality of the yarn, but also automatically measures the quantity reeled.

*Conditioning.—*Silk in the raw and thrown state, as has already been pointed out, absorbs a large amount of moisture, and may contain from 20 to 30 per cent. of water without being manifestly damp. As it is largely sold by weight it becomes necessary to ascertain its condition in respect of absorbed water, and for that purpose official conditioning houses are established in all the con­siderable centres of silk trade. In these the silk is tested or con­ditioned, and a certificate of weight issued in accordance with the results. The silk is for four hours exposed to a dry heat of 230°Fahr., and immediately thereafter weighed. To the weight 11 per cent. is added as the normal proportion of water held by the fibre.

*Scouring.—*Up to this point the silk fibre continues to be com­paratively lustreless, stiff, and harsh, from the coating of albumin­ous matter (gum or *gres)* on its surface. As a preliminary to most subsequent processes the removal of the whole or some portion of this gum is necessary by boiling-off, scouring, or *decreusage.* To boil off say 300 lb of thrown silk, about 60 lb of fine white soap is shred, and dissolved in about 200 gallons of pure water. This solution is maintained at a heat of 195°, and in it the hanks of raw silk are immersed, hung on a wooden rod, the hanks being con­tinually turned round so as to expose all portions equally to the solvent influence of the hot solution. After being dried, the hanks are packed in linen bags and boiled for three hours in a weaker soapy solution, then washed out in pure warm water and dried in a centrifugal hydro-extractor. According to the amount of gum to be boiled off the soap solutions are made strong or weak ; but care has to be exercised not to overdo the scouring, whereby loss of strength, substance, and lustre would result. For some purposes—making of gauzes, crapes, flour-bolting cloth, and for what is termed “souples”—the silk is not scoured, and for silks to be dyed certain dark colours half-scouring is practised. The perfect scouring of French silks removes from 25 to 27 per cent. of their weight, and Chinese silks lose from 30 to 31 per cent. Scouring renders all common silks, whether white or yellow in the raw, a brilliant pearly white, with a delicate soft flossy texture, from the fact that the fibres which were agglutinated in reeling, being now degummed, are separated from each other and show their individual tenuity in the yarn. Silks to be finished white are at this point bleached by exposure in a closed chamber to the fumes of sulphurous acid, and at the close of the process the hanks are washed in pure cold water to remove all traces of the acid.

*Spun Silk Manufacture.—*The materials of the spun silk trade are—(1) the floss or loose outer fibres which surround ordinary cocoons ; (2) the remains of cocoons after the reelable silk has been removed ; (3) waste from throwing processes and from all the stages through which reeled silk passes in manufacturing ; (4) unreelable cocoons, *i.e.,* those which are pierced, torn, or cut, stained by dead chrysalides, &c., and double cocoons ; (5) cocoons of various wild silks, which are either unreelable or most profitably worked by carding. The waste spinners’ first duty is to bring these diverse materials into uniform fibrous condition for spinning. In dealing with cocoons and cocoon husks, the fibres, which are gummed together into a dense compact mass, must be so washed, softened, and freed from each other that they can be readily teased and torn into a tow-like mass. For this purpose they are washed with a strong hot soap solution in a revolving washing machine, in which they are continuously subjected for three or four hours to