ing into the market either in the shape of hanks, on cops or bobbins, in chains, on dresser spools, etc., as the case may require. Yarn comes in the market, *i. e.*, is used by the textile manufacturer either in its single state, or twisted. By the latter is meant that two or more threads generally spun with a slight twist first are afterwards united into one thread by means of twisting, either to produce a stronger or a more perfect yarn, or, as the case may also require, produce a fancy yarn required for the ornamentation of special fabrics, etc. We will also meet with the union of two or three single threads, only slightly twisted, and which in this instance are known to the manufacturer as "doubled" yarns, in order to distinguish them from the "twisted" yarns previously referred to.

PERFECT YARN MUST POSSESS THE FOLLOWING QUALITIES: it must be even throughout its entire length, *i. e.*, free from knots, uneven or weak places, possess the proper amount of twist and breaking strength. The surface of the yarn is regulated by the use it is put to, whether the fabric for which it is to be used requires a rough or smooth finish. This will explain why, for example, the manufacturer of woolen yarns differs from that of worsteds; in the first instance, a rough velvety thread being desired, whereas in the latter instance, a smooth thread is the object aimed at, and when in order to increase this smoothness in the yarn, singeing of the latter is in many instances a final effort to obtain this result.

WITH REFERENCE TO TESTING YARNS by the textile manufacturers, the following points will come under his consideration: (*a*) An analysis as to the nature of the raw material, either by means of the microscope or by chemical tests. (*b*) Ascertaining the actual count of the yarn. In most instances, weighing a certain number of yards of yarn and testing them on a fine pair of scales is the procedure employed, whereas other manufacturers keep a sample card, containing all the various counts of the yarns they come in contact with, for handy reference in their office, and when then by means of examination of the yarn submitted, they then readily ascertain the count of a yarn submitted, at once to their satisfaction; this however, requires considerable experience on the part of the person. In keeping these sample cards, it is a good plan, provided the different counts of yarns are of a light color or white, to mount them on a black card for background, whereas if the sample yarns to go by and of which we know the counts are of a dark color, mount them on a white card, in order that the size of the threads may show up to the best of advantage. It will also be a good plan to have two sets of cards made for handy use, one light colors on a black background, and one containing dark colors on a white background, and when then, no matter whether light or dark yarn is submitted, we then can use the sample card most suitable for the purpose. (*c*) Test the amount of twist in the yarn as well as its breaking strength. In connection with silk, the original twist given to the cocoon fibre when reeling, as well as the secondary twist given in the process of throwing, has to be examined. (*d*) Examine the general appearance of the yarn if the same is up to the requirements; whether it refers to a smooth worsted thread or to a velvety woolen yarn, whether yarn in question has been singed or sized or if it refers to a wet or a dry spun yarn. (*e*) In connection with woolen yarns, the percentage of grease, oil or dirt, in the yarn has to be ascertained, since in connection with coarse, cheap, low classes of yarns of that kind, this may refer to a loss of 25% or more, 10% to 15% being common cases and considered a small loss to woolen yarns. In connection with worsted yarns, they also have to be tested as to their loss, although in this instance, the amount will be considerably less than with woolen yarn. Silk has to be tested with reference to the degree of its moisture, a test which more particularly, until now, referred only to silk, although it is beginning to be taken somewhat into consideration in connection with woolen and worsted yarns, the careful and consequently successful woolen or worsted manufacturer thus considering this point in his financial interest.

Textile fibres of commerce belong to two distinct varieties: (*a*) animal fibres, (*b*) vegetable fibres. Of these, the first variety comprises (1) wool, hair and fur, each having formed the covering of an animal, and (2) silk, as spun by the silk worm at its entry into the chrysalis stage. With reference to vegetable fibres, the first place (1) belongs to cotton, (2) flax, jute, ramie, etc. and (3) artificial silk as produced by treating cotton or other cellulose material chemically.

When required to determine the nature of the raw material used in the construction of a yarn or fabric, the naked eye being insufficient, then the compound microscope is perhaps the best and easiest test for distinguishing the various fibres, provided the party making these tests is fully acquainted with their appearance and characteristic markings. With reference to the microscope itself, yarns or fibres can be examined under a lens either by bringing them within or beyond focal length; in the first instance obtaining an enlarged picture on the side next the object, whereas in the other case, the enlarged picture is formed in an inverted position on the opposite side of the lens. In order to obtain high magnifying power, these two conditions are combined in THE COMPOUND MICROSCOPE, which consists in its main parts of a tube some six or seven inches in length, closed at the upper end by a large glass lens (of greater focal length—placed nearest the eye, hence termed "eye piece") and at the lower end by a smaller glass lens (of smaller focal length—placed nearest the fibres to be examined, hence "object piece"), both pieces being capable of vertical movement. This tube is blackened on the in-

side to exclude extraneous light. The total magnifying power of a microscope is thus the sum of the powers of the "object" and the "eye piece." The tube carrying the "eye" and the "object" piece, for adjustment in the regular microscope, is raised or lowered by a rack and pinion motion, while in connection with a high class microscope, an extra, *i. e.*, fine adjustment, is afterwards made by the micrometer screw, as provided to such microscopes. On the stand of the microscope we find fixed an arrangement for supporting the stage (pierced with a small circular aperture for the passage of the reflected light), as well as a small circular concave reflector, which is movable in any direction. The most important quality of a good microscope is, that its lenses produce a well defined, clear picture, distinctly showing every detail of structure in the object under examination.

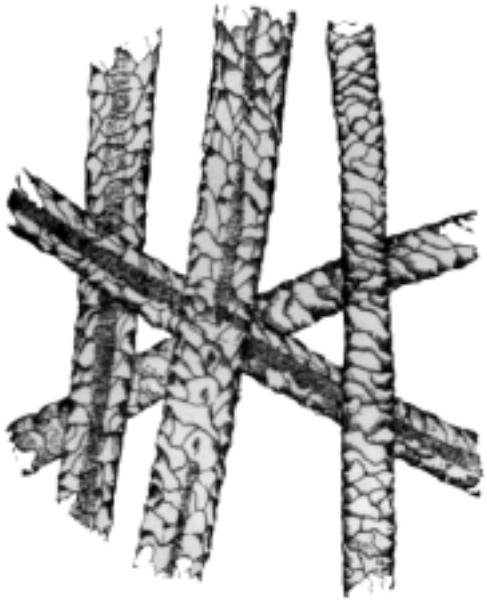

FIG. 1.

The best source of illumination for carrying on investigation by means of the microscope is diffused daylight, with a sky evenly covered with a white veil of clouds. In connection with artificial light, a glass bulb, filled with a dark blue solution of ammoniacal copper oxide, interposed between the source of light and the condenser, will be found of advantage.

Yarns to be examined under the microscope, whether in their pure state or liberated from a woven or knitted, etc. fabric, after proper removal of all dirt, so that the passage of the light will be unrestricted, are then untwisted by hand, in order to transfer the yarn back into a mass of loose fibres; selecting then a proper amount of these fibres for testing. Immersing the fibres thus to be tested in boiling water, or better still, in glycerine or Canada balsam, will increase their transparency. The fibres thus prepared are then separately laid, side by side, on a glass slide and covered with a thin cover glass and are then ready for testing.

Wool is the hairy covering of the sheep; it is softer than the actual hair, also more flexible and elastic, and besides having a wavy character, it also differs in certain details of surface structure. Although wool and hair are found in the fleece of the sheep, yet wool predominates in all cases, hair in the properly bred sheep being practically absent. The covering of certain other animals, such as the Cashmere goat, the Angora goat, the Llama, etc., are also classed as wool. Viewed under the microscope, wool appears as a solid rod-shaped substance, the surface of which presents a peculiar scaly appearance, being covered externally with small plates or scales, the edges of which either protrude from the body of the fibre, or are only surface markings. The cylindrical shape is best observed where two fibres cross one another. A central core of medullary matter, running longitudinally in the fibre is sometimes visible, particularly in the coarser types.

Fig. 1 shows five wool fibres as seen by means of the microscope, and of which three of the fibres show the central core of medullary matter, previously referred to, which however is missing in the other two; all five fibres being specimens of coarse long staple wool fibres In the better classes of wool, this medullary portion is entirely absent, its presence or absence depending upon the breed, health and care of the sheep and also the part of the body upon which the wool is grown. Wool fibres which contain this medullary portion are less suitable for manufacturing purposes than such where this portion is absent. Besides their scaly surface structure, wool fibres are characterised by their wavy structure, technically known as the "wave of the crimp" being another item depending upon the breed of the sheep; the finer the quality, the more of these waves to one inch of fibre.

Other animal fibres used in the textile industry are the covering or fur obtained from the Cashmere Goat, the Angora Goat (Mohair), the Alpaca, the Camel, the Common Goat and the Cow; besides Horse hair.

The fur of the Cashmere goat is of two sorts, *viz.:* a soft, woolly, white or grayish undercoat, and a coarse covering of long hairs. The woolly undercoat is the more valuable fibre and is wool fibre in its structure. These fibres vary in length from $1\frac{1}{4}$ to $3\frac{1}{2}$ inches and possess no medullary substance. They are plucked from the animal, exported, and used in the manufacture of some of the finest textiles, both on account of the fineness of the fibres as well as its high price. However, as a rule, the supply of this fibre is considerably intermixed with those long hairs of the outer fur of the animal, and which, according to amount present, reduce its value, since they must be separated from it. These outer hairs are of a length of from $3\frac{1}{2}$ to $4\frac{1}{2}$ inches, and possess the central or medullary substance, and are used in the manufacture of cheaper grades of yarns.

Mohair is the name given to the hairy covering of

the Angora goat. Besides our domestic supply, mohair is also imported. It is of a pure white color (more rarely gray) rather fine, more or less curly, of high lustre, and on an average of from 5 to 6 inches long, although in some cases as long as 12 inches. Their outer scales are extremely delicate, giving the fibres a spotted appearance all over their surface. Besides the mohair, there grows upon the Angora goat a short, stiff hair, which is technically known as "kemp", a relic of the common goat. Its presence depends entirely upon the kind of breed of Angora, being nearly nil in the pure animal. This kemp fibre in mohair always reduces its value, in proportion to the amount that is present.

Alpaca and similar wools are obtained from a group of animals indigenous to the highlands of the South American Cordilleras, where they are met with in a domestic as well as wild state. It is a lustrous fibre, although this lustre is inferior to that of mohair. The outer scales of the fibre are extremely fine and the central or medullary substance is present either throughout its entire length or in small elongated masses.

Camel Hair is obtained from the Camel and the Dromedary. Their hair is of two kinds, *viz.:* very fine curly, reddish or yellow brown hairs, about 4 inches in length and known in commerce as camel wool, and coarse straight, dark brown to blackish body hairs, about 2 to 2½ inches long. Both kinds of hair show under the microscope, faint scales. The medullary substance always appears in the coarse hair, whereas in the fine hair, it is either wanting or appears in insulated masses.

The Common Goat, when raised in the open air has a woolly fur, which is shed in the spring and which hair is adapted for spinning, with sheep wool, into coarse yarns.

Cow and calf hair is also used for textile purposes, and is the hair removed from the hides of these animals in the tannery, by means of subjecting the pelts to the action of lime, the same as practiced with the pelt of the sheep. They are coarse, stiff fibres of a white, reddish brown or black color, possessing a slight lustre, and in turn are spun, mixed with low grades of sheep wool into coarse yarns, used for rugs, horse blankets, and similar coarse fabrics, as well as for backing yarns in cheap grades of overcoating, cloakings, etc.

Horse Hair. Of this, two kinds are met with in commerce, *viz.:* tail hair, or the long hair, measuring at least 23 inches, though it occasionally attains a length of 32 to 34 inches, and mane hair, or the short hair, and which rarely exceeds 19 inches in length. White and black are the colors most esteemed, whilst red, gray, etc., hair is less valuable.

Artificial Wool. The same are re-manufactured products from old or new wool waste, or recovered from rags, and according to their source are divided into four classes, *viz.:* Shoddy, Mungo, Extract and Flocks. Of these

Shoddy is the best, being the wool fibre recovered from worn, but all wool materials, which had never been fulled, or if so, only slightly. Amongst these materials, we find knit goods, shawls, flannels and similar fabrics, also the yarn and fabric waste made in the process of manufacturing them. The fact that these materials, known in the market as "softs" are readily disintegrated, causes the resulting fibres to be comparatively long and sound, they varying in length on an average of from ⅔ to 1⅓ inches, according to the original length of the staple in the fabric from which the shoddy is made. Shoddy is occasionally worked up alone into heavy counts of yarn, but more generally is mixed with new wool and thus used in the manufacture of a great quantity of good average grades of yarns for all classes of all wool fabrics.

Shoddy fibres are sometimes found to be spoiled by scales being worn off or the ends of the fibres broken, and which may be caused during the process of rag picking or garnetting (coarse carding). In most instances, dyed shoddy can be detected from similarly dyed new wool, in the yarn, for the reason that the color of the former will betray the inferior article compared to wool, since the rags or waste, previous to the re-dyeing, except when coming from white softs, had been dyed different colors and which will consequently influence the final shade of color obtained from re-dyeing accordingly.

Mungo is obtained by reducing to fibre pure woolen rags, from cloth originally heavily fulled, and when the natural consequence of the strong resistance to disintegration offered by felted fabrics, results in that short fibres, about ⅕ to ⅘ of an inch in length, are obtained. Mungo, for this reason, is never worked up again alone into yarn, but is mixed with new wool or cotton and spun into low counts of filling yarn. On account of mungo referring to a fibre once before having been felted, the same has lost its capacity for further felting.

Extract wool is the product obtained by disintegrating fabrics composed of animal and vegetable fibres, chiefly wool and cotton, instead of wool only.

Flocks will only come into consideration when testing fabrics, since the same are added to the woven cloth during fulling, whereas shoddy, mungo and extract are introduced into the yarn, during the mixing, picking and carding processes. Flocks are woolen rags ground in the flock cutter into minute portions of fibres, which then during fulling the cloth are made to adhere to, *i. e.,* felted onto the back of the fabric, as well as working their way more or less into the body of the latter.

(*To be continued*)