WOOLLEN AND WORSTED MANUFACTURES. The spinning and weaving of wool was practised from an early period in Asia Minor, Greece, Italy, and some other countries. It is very probable that the first lessons which our ancestors received in this art were got from the Romans after the Conquest; but the origin of the manufacture as a great staple is generally supposed to date from the time of William the Conqueror, when some Flemish weavers came to England, and obtained the patronage of the queen. The trade, however, fell off during the troubles of succeeding reigns. In 1581, it revived again by another supply of Dutch weavers brought over by Edward III. In 1539, the introduction of the spinning-wheel gave a new impetus to the trade. French workmen, driven to England by the revocation of the Edict of Nantes in 1685, still further aided it by their skill in the making of fine cloth, and from that time to the
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present it has steadily prospered. It is hardly necessary to state that the woollen trade has shared, in common with other leading textile manufac-
tures, the great advancement they have received from the spinning-jenny, the mule, and the power-
looms.

There are two great classes of manufactures using wool as a raw material: in the one where carded wool is employed, the goods are called 'woollen fabrics'; in the other, where combed wool is used, the goods are called ‘worsted fabrics.’ We shall first treat of the Woollen Manufacture.

As our articles on Spinning and Weaving are general, we shall here briefly state the chief stages in these processes, as applied to the manufacture of woollen cloth. A fleece of wool is first sorted by experienced sorters into several qualities, as first sort, or 'pick-locks'; second sort or quality; third sort or quality; and so on. Sometimes, it is only divided into several sorts, and graded into as many as six kinds. The 'scouring' is the next step, and consists in immersing the wool in an alkaline lye, which forms a soap with the natural grease of the fleece. This of course acts as a detergent, and cleans the wool thoroughly when it is washed in water. Upon the perfection with which the scouring is performed, depends in great part the beauty of the dye. It is often dyed at this stage, and is then said to be ‘wood-
dyed'; if not dyed till it is woven, the cloth is said to be 'piece-dyed.' For some purposes, it is dyed in the
yarn.

Scoured wool, whether dyed or not, next under-
goes the operation of 'willing.' The 'willy' is a
machine used to clean the wool from dust and other loose impurities. In many cases, seeds with hooked scales like bars are so thickly entangled in the wool, that it requires to be passed through a 'burring-machine, and afterwards examined by 'pickers.' This is especially the case with South American wool, including that of the alpaca. After this, the wool is sprinkled with olive oil, which renders the fibres soft, flexible, and better fitted for later operations. The next process consists in tearing open the matted portions, and separating the wool into small tufts by means of a machine called a 'teaser, turner, or dead.' It has a large cylinder studded over with iron spikes, which performs from 1000 to 2000 revolutions per minute, teasing the wool as it revolves, and throwing it out like flakes of snow.

The two next operations are called scrubbing and carding, and are performed by two somewhat similar machines, the essential parts of which will be under-
stood by referring to figs. 6, 7, and 8 in the article Spinning. Each machine consists of a large cylin-
der surrounded by several small rollers, all covered with wire cards or brushes. These, acting like fine
toothed combs, open out, mix, and blend the fibres into a uniform and continuous sheet or lap, in which state it leaves the 'scrubber,' but in the carder, the sheet is at length converted into small rolls, say from a quarter to half an inch in diameter, which are afterwards joined together, and form the basis of the thread. In the next machine, called the slab-
bing-billy, these rolls are drawn out, slightly twisted, and, in short, half converted into yarn. The spindles upon which these slubbs or slubbings are wound pass them to the 'spinning-mule, where they are con-
verted into finished yarn.

Comparatively recent improvements have made the operations of scrubbing, carding, and slubbing continuous, mainly through the introduction of Apperly's patent feeder, and of a modification of the carding-machine called a 'condenser,' which does away with the use of the slubbing-billy; so that what with the older machines is three separate pro-
cesses, with the newer may be said to be only one.

Each of the foregoing operations has its own amount of 'waste' wool, which is worked up again into inferior goods. It was, in fact, to such waste that the name 'shorty' was originally applied. In the spinning process, the warp yarns, having to bear the strain of the loom, are made in a different way from those for the weft, and they are besides hard-
ened with size.

The difference between woollen and worsted fabrics is owing in great part to the way the yarn for each is spun. Yarn for woollen cloth is very slightly twist to, so as to leave the fibres as free as possible for the forming process; worsted yarn, on the contrary, is hard spun, and made into a much stronger thread. On account of the fineness of woollen yarn, it is more difficult to weave it by power-looms than either worsted, cotton, linen, or silk.

Woollen cloth is now woven chiefly by power-
looms. See Loom and Weaving. When the cloth is taken from the loom, it has a bare look, and is
called the 'rust thread.' It first requires to be 'broined' or 'scoured, to remove the oil added to the wool before spinning, and the size added to the warp. This is done by immersing it in some ammonical detergent liquid, such as urine and hog's dung, and squeezing it between rollers, or beating it in the fulling-stocks, and then rinsing it in clear water. The cloth then passes to the currier, who removes any knots or burrs, and helps any imperfections. The next pro-
cess to which it is subjected is the 'milling or fulling, and it is a very important one. In some mills, this is still done by beating the cloth in the fulling-stocks, which are heavy wooden mallets, raised by wheels with projecting cams; but a newer, fulling-
machine has come into use, in which the cloth is felted by passing it in a confined space between heavy rollers. With either machine, a thick solution of soap is used, and in the fulling-stocks an ordinary broadcloth will take 60 hours to mill, but a considerably shorter time suffices in the fulling-
machine. The result of the operation is, that the fibres of wool become so interlocked — so thoroughly felted — as to leave no appearance of thread. The shrinkage of the cloth in the milling is sometimes nearly a half in the width, and about a fourth in the length. Another scouring follows the milling, and after that the nap or pile of the cloth is raised by Teasels (q.v.). These curious thistle-like heads are set in frames, which are arranged upon a large cylinder—the whole apparatus being called a 'gig-
nail. As the cylinder revolves, the spines of the teases raise the nap, which is afterwards cut by a process termed 'shornring.' For this purpose, a cutting-
machine with spiral blades arranged round an iron cylinder, is used; and when it revolves, the spiral cutters, acting against a straight steel blade, shear off the nap of the fabric like scissors. The cloth is then boiled, or 'scalded,' to impart a lustre to it, and to prevent spotting with rain. After this it is dyed (if this is not previously done in the wool), and finally it is pressed between polished iron plates in a powerful hydraulic press. With respect to the dyeing of black cloth, it may be as well to explain that the term 'woollen colours, so commonly used in the trade, originally meant that Woad (q.v.) was used in conjunction with indigo as the basis of the colour—a combination which produces the best and most durable colour. Of late years, however, the name has been applied to the colour of the fabric when indigo itself has been used as its basis. It is only the finest cloths that are now dyed in either of those ways—logwood, a salt of iron, and galls being much more generally employed to pro-
duce a black.
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Names are given to various kinds of woollen cloths according to the style in which they are finished, the special material of which they are made, and the method for which they are intended. Broadcloths are classed into 'superfine,' running from 34 to 62 inches wide; 'mediums' from 34 to 56 inches; 'double middled' from 34 to 66 inches; and Venetians, which are twilled fabrics, from 54 to 68 inches. The general term broadcloth also includes the following varieties, which, for the most part, have less highly-finished surfaces—viz., meltons, beavers, pilotes, clockings, china striped cloths, India cloths, elastics, lustres, and union cloths which have cotton warps and woolen wefts. "Narrow cloths," which average about 22 inches wide, include casimises, a thin, fine, twilled fabric; doekskin, also twilled, a strong, smooth-finished, sometimes trowelled, cloth, usually dyed black for trousers; Tweeds (q.v.), which have very much taken the place of fancy doekskins; and several other varieties. Then there are special kinds both broad and narrow—such as army cloths, rife cloths, police cloths, ulster cloths, carriage cloth, coffin cloths, and many more. Flannels, blankets, and some kinds of shaws, are also included among woolen goods.

The public taste has changed very much of late years with respect to the finish of woolen cloths. Formerly, a firm, close, and hard fabric, with a highly-dressed or glossy surface, was in demand; now, a softer and more pliable finish, without gloss, is in favour. Foreign manufacturers think, however, that a soft, rich, elastic cloth is apt to lose in strength what it gains in appearance, and do not finish so highly as the English. The desire for fancy woollens is another marked feature of the taste of the present day, and some manufacturers to expend considerable sums in the preparation of designs and colours. It has also led to the enlargement of old, and the establishment of new art-schools in both the woollen and worsted centres in Yorkshire.

Of all the changes, however, which the present generation has witnessed in this trade, the most remarkable is doubtless the production of cheap cloths by the use of shoddy; although cotton warps have also been used in the same direction. Prepared shoddy is obtained, for the most part, by tearing up woollen rags by a swift, with ten or twelve thousand iron spikes upon it, revolving inside an iron cylinder. Shoddy now enters to a great or less extent into the composition of all but the very finest woolen cloths. It began to be used about 60 years ago, but the prejudice against it is scarcely yet overcome. In spite of this feeling, it has become so necessary, that to stop the supply, would be to shut one-third of the woolen mills in the kingdom. The excellent finish now given to woolen cloths containing a large proportion of shoddy, and also cloths with cotton warps, is quite surprising; and, moreover, their cheapness has brought comfortable clothing within the reach of the humblest classes. Cloths with too large an amount of shoddy in them are easily torn; but if a judicious admixture of shoddy and pure wool has been employed, they wear comparatively well. Formerly, the only use of woolen rags was to make flocks for wall-papers, for saddler’s stuffings, and some minor purposes—the greater part being used as manure.

In the British Isles, the various branches of the woolen manufacture are very extensively diffused. According to a fact laid on before made in 1751, it was carried on in 22 counties of England, 12 of Wales, 27 of Scotland, and 16 of Ireland. The principal seat of the manufacture of superfine broad cloth is the west of England—Gloucestershire and Wiltshire especially—where it has existed for centuries. But Yorkshire is the great seat of the woolen manufacture, if we take in all the kinds, Leeds and Huddersfield being the great centres. One-half of all the operatives in the woolen factories of the kingdom are employed in Yorkshire, and here, too, the trade has increased most rapidly, both in the last and in the present century, owing mainly, it is believed, to the success of the manufacturers in producing cheap goods. Blankets are made chiefly at Witney, in Oxfordshire; at Dawsbury, in Yorkshire; and some places in the south of Scotland. Halifax and the surrounding district is the chief centre for flannels, but they are also made largely in Wales. In Scotland, the woolen manufacture is a very extensive one, but it has, for the most part, been already described under Tweeds.

The following statistics of the woolen industry of the United Kingdom are for the year 1875:

**NUMBER AND EFFECTIVENESS OF WOOLEN FACTORIES.**

<table>
<thead>
<tr>
<th>England and Wales</th>
<th>Number of Factories</th>
<th>Total Number of Spindles</th>
<th>Total Horse Power in Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>410</td>
<td>563,513</td>
<td>1,915</td>
</tr>
<tr>
<td>Wales</td>
<td>143</td>
<td>2,812,005</td>
<td>40,205</td>
</tr>
<tr>
<td>Scotland</td>
<td>102</td>
<td>228,119</td>
<td>7,336</td>
</tr>
<tr>
<td>Ireland</td>
<td>105</td>
<td>378,444</td>
<td>4,432</td>
</tr>
</tbody>
</table>

**NUMBER OF OPERATIVES EMPLOYED.**

<table>
<thead>
<tr>
<th>England and Wales</th>
<th>Scotland</th>
<th>Ireland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males—under 16,</td>
<td>4,398</td>
<td>579</td>
<td>7</td>
</tr>
<tr>
<td>13 to 20,</td>
<td>10,726</td>
<td>2,770</td>
<td>194</td>
</tr>
<tr>
<td>above 20,</td>
<td>30,002</td>
<td>8,407</td>
<td>581</td>
</tr>
<tr>
<td>Total,</td>
<td>84,119</td>
<td>11,855</td>
<td>783</td>
</tr>
<tr>
<td>Females—under 16,</td>
<td>2,941</td>
<td>448</td>
<td>2</td>
</tr>
<tr>
<td>above 15,</td>
<td>40,411</td>
<td>15,466</td>
<td>722</td>
</tr>
<tr>
<td>Total,</td>
<td>51,352</td>
<td>15,912</td>
<td>724</td>
</tr>
<tr>
<td>Total, Males and Females,</td>
<td>100,471</td>
<td>27,767</td>
<td>1,506</td>
</tr>
</tbody>
</table>

This does not give a full idea of the vast number of persons to whom this great industry gives employment, but only those engaged in spinning and weaving. A very large number are occupied in sorting and stapling, and other operations before the wool goes to the mills and factories, and also in dyeing and scouring it. It is wool or as woolen yarn and cloth; and in many districts much work is done by handloom workers in their cotages.
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None of these come under the operations of the Factory Act, and are consequently omitted in the returns.

The imports of woollen and worsted yarns (not distinguished in the returns) were in 1861, 1,677,000 lbs.; in 1877, 14,109,584 lbs. The exports of woollen and worsted goods in 1872 and 1877 were as follows: Woollen and worsted yarns, 33,734,924 lbs. in 1872, and 26,972,536 in 1877; woollen and worsted cloths, &c., 385,703,913 yards in 1872, and 235,003,940 in 1877; flannels, blankets, carpets, &c., 26,830,022 yards in 1872, and 23,588,860 in 1877. The total value was £37,028,629 in 1872, and £20,962,639 in 1877. The progress of the woollen manufacture has been less rapid and extensive than that of other textile fabrics, which is believed to be owing to its processes being more numerous and complex, to the greater variety of machines and of people required, and to the high price of the raw material.

Worsted Manufacture.—Worsted yarn, as has been already said, is spun in a different way from woollen yarn. In the former, the fibres are arranged as parallel as possible; in the latter, they are crossed in every direction, so as to assist the felting or milling of the cloth. For worsted the wool is first combed, and this was formerly done by hand-combs, a process which has only recently been entirely given up. The introduction of machines for combing wool has formed quite an epoch in the worsted trade. They are of two kinds—those used for combing long, and those used for combing short wool. Heilmann’s machine, made in 1846, was the first which did its work successfully. Lister’s machine, now much used for combing long-stapled wool, is an improvement upon Heilmann’s. It is shown stripped of some of its details in the annexed cut. At G there is a series of gill-combs, which, by means of a screw on the upper gill shaft S, travels from left to right, and as each gill-comb

Wool-combing Machine.

reaches the jaws J, J, it drops to the lower shaft S, which has also a screw. On this the gill-combs travel in the opposite direction, each being in turn raised to the upper gill-shaft by a cam. These gill-combs, which are heated by gas, are thus travelling in a circuit so to speak. The arrangement of toothed gearing by which the movements of the machine are regulated, we shall pass over, and trace the course of the wool. It is fed to the grooved rollers R, R, from which it passes to the gill-combs at G. As each gill travels forward to the jaws J, J, these close, detach from it a ‘handful’ of wool, and move forward on their frame F to the position shown by the dotted lines. At the same instant, the carrier-comb N takes up the position shown also by dotted lines, lifts from the now opened jaws the ‘handful’ of wool, and carries it forward to the large circular comb G, into the teeth of which it is pressed by the brush B. The comb C moves slowly round to the right till leather bands and rollers at Z, Z, remove the combed wool or ‘top’ in a continuous sliver. Another arrangement strips the comb of the ‘noll’ or short wool.

The remaining processes in worsted spinning closely resemble those for cotton, and are sufficiently described under Spinning; the products of these are: 1. Fleece (Lincoln wool). 2. Combed ‘top’. 3. Nolls, or short wool. 4. Sliver from first drawing-frame. 5, 6, 7, 8, 9, and 10. Slubbings from second, third, fourth, fifth, sixth, and seventh drawing-frames. 11. Roving from roving-frame. 12. Spun Yarn.

Figure worsted yarns are woven by various kinds of looms (see Jacquard Loom and Loom); plain kinds are woven in looms like those for woollens. Unlike woollens, when worsted goods leave the loom, they require only a superficial dressing.

Worsted stuffs are usually classified according to the materials of which they are composed, viz.: 1. Fabrics composed entirely of wool. 2. Fabrics
WOOLLET—WOOLSAK.

Composed of wool and cotton. 3. Fabrics composed of wool and silk. 4. Fabrics composed of wool, silk, and cotton. 5. Fabrics composed of alpaca and mohair mixed with cotton or silk. The first of these classes includes the fabrics so well known under the name of “merinos,” and so called because they were first made of Spanish wool; for the “double-twilled” kinds, the French still maintain their superiority; but for the “single-twilled,” the Yorkshire makers are considered the best. This class also comprises shawls, saya, serges, lasting—all stout and heavy fabrics—besides durants, hunting, moroena, damasks, reps, Russells, camlets, and many others, both for dress and furniture. Mouseline de laine was, as its name implies, originally all wool, but it is now more generally mixed with cotton, and printed.

The second class includes two fabrics, of which the consumption for female dress has been immense—viz., Coburg and Orleans cloths, the former being twilled, and the latter plain. Many of the names used in the all-wool class are retained in this, with the addition of the word “union,” as union merino, union shalloon, union damask, &c. Wineys, now so popular for ladies’ winter dresses, on account of their warmth, are made of wool and cotton, from yarins of a heavier and coarser kind than those used for cloths like Coburgs. Wineys are largely made at Aberdeen, Perth, Glasgow, and other places in Scotland, as well as in Yorkshire.

The third class includes the rich Poplina (q. v.) and Tabinettes (q. v.), made chiefly in Dublin, and giving employment there to about 1200 hands. Paramatta or Henrietta cloth, Canton cloth, and others, are made both of silk and wool, and cotton and wool. Some Coburgs, Orleans, Russells, and Damasks are likewise made with silk yarns.

The fourth class—viz., mixed goods, in which silk, wool, cotton, and sometimes linen are used—includes peculiar kinds of some of the fabrics named above, and also vestings, linings, crevate, shawls, scarfs, quiltings, boot and shoe cloths, barges, &c.

The fifth class includes alpaca lustres and mixtures—plain, twilled, and figured; alpaca poplins, umbrella and parasol cloth; mohair lustres, glacés, Verona serges, barges, &c.

The term “worsted” is said to have derived its origin from a village of that name in Norfolk, where this manufacture was first carried on. Up to the end of last century, worsted goods were a staple trade of Northwich; but the neglect of the factory system there led to its being transferred to Bradford, which has become renowned as the metropolis of the worsted manufacture. It is also extensively carried on at Halifax and other places in Yorkshire.

The following statistics of the worsted manufacture are gathered from the government inspectors’ reports for 1875, and refer to that year:

<table>
<thead>
<tr>
<th>Number of operatives employed.</th>
<th>England and Wales</th>
<th>Scotland</th>
<th>Ireland</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males—under 15, 12 to 15, above 15</td>
<td>14,074, 10,614, 2,307</td>
<td>85,005</td>
<td>3,003</td>
<td>57,000</td>
</tr>
<tr>
<td>Females—under 15, above 15</td>
<td>15,354, 6,641</td>
<td>15,629</td>
<td>69,888</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29,428, 17,245</td>
<td>57,624</td>
<td>98,891</td>
<td></td>
</tr>
</tbody>
</table>

The same remarks apply here as in the case of the return of persons employed in the woollen manufactories, given under that head, and with still greater force, for there are a very great number of small trades connected with the worsted manufacture. As the numbers at the top of page 272 show, the imports of both worsted and woollen yarns have greatly increased of late years, and is no doubt greatly owing to the ingenuity of the Belgians in spinning good yarns from cheap wool, Belgium being the country from which by far the greater portion comes. In 1877, woolen and worsted cloths to the value of about £5,292,000 were imported.

With respect to the exports, the following will show the increase which has taken place from 1860 to 1874: 1860—Worsted yarn, 26,455,000 lbs. (£537,800); worsted stuffs, 148,655,000 yards (£7,013,000). 1865—Worsted yarn, 30,221,000 lbs. (£5,074,000); worsted stuffs, 233,078,000 yards (£133,351,000). 1874—Worsted yarn, 34,203,016 lbs. (£5,472,612); worsted stuffs, 261,155,081 yards (£11,588,072).

In 1877, the exports had seriously declined—worsted yarn, 26,972,586 lbs. (£3,600,450); worsted stuffs, 194,772,034 yards (£7,725,414).

The rapid increase of the worsted manufacture as compared with the woolen, is no doubt to be ascribed to the greater simplicity of the processes, to the recent introduction of combing-machines, but most of all to the introduction of cotton-wars in 1835, which not only cheapened the goods, but vastly increased their variety.

Information regarding such special branches of the woollen and worsted industries as carpets, shawls, hosiery, tartans, bonnets, &c. will be found under their separate heads. We may state here that the Scotch bonnet-trade, carried on at Kilmarnock and Stewarton, employs from 2000 to 3000 hands, and sends out about 500,000 bonnets annually.