Linen [orig. an adj. <O. Eng. *līnen*, made of flax, deriv. of *līn*, flax; Germ. *lein*: Goth. *lein*, linen; cf. Gr. λίνον: Lat. *lī'num*, flax, linen]: one of the earliest of textile manufactures. Its origin is lost in the cloudland of history. Pieces are still in existence which were woven 4,000 years ago. In the days of Herodotus it was an article of Egyptian export. The mummies are wrapped in cere-cloths of this material. Sir Gardner Wilkinson has fully described the linen-manufacture of Egypt. The term *linen* is a generic name for

cloths woven from the fibers of the flax-plant and hemp. (See FLAX.) The raw material of linen proper is the flax-plant (*Linum usitatissimum*), which thrives in latitudes ranging from Egypt to Russia. From the seed is expressed the linseed oil so much used in commerce. Cloth made from the hemp-plant was worn by the Thracians. This plant is extensively grown in various parts of Europe, and has been cultivated in Bengal from remote ages. The use of hemp in the linen-manufacture is smaller now than formerly. JUTE (*q. v.*) may also be commercially considered as a sort of linen, as it affords a cheap substitute for flax, the cultivation of which has not kept pace with the requirements of the makers. Of other substitutes which have been employed with varying degrees of success the nettle, china-grass, rhea, New Zealand flax, and Manilla hemp (*Musa textilis*) may be named. The garments of the Hebrew priests were chiefly of linen, and in the Bible there are many allusions which show the esteem in which this fabric was held. In Homer we read that the mother of Nausicaa in the early dawn spun by the hearth soft fleeces dyed with red purple. In many parts of the ancient world the manufacture of linen —chiefly, it may be presumed, carried on by the women as a household occupation—was common. Some parts of Spain and Italy were celebrated for the culture of flax and its subsequent conversion into textile fabrics. Linen has been made in England from an early date. The garments of the Anglo-Saxons were linen and woolen. The daughters of Edward the Elder were famous for their skill in spinning, weaving, and embroidering. The Bayeux tapestry is a linen cloth, with designs worked in wool. Although the flax-plant had been cultivated by the Saxons, it is not found in a list of tithable produce drawn up in 1070. Fine linen is said to have been first made in Wilts and Sussex in 1253. In 1272 Irish linen was used at Winchester. Flemish weavers were introduced into England in 1331, and in 1386 a guild of linen-weavers was established in London, but does not seem to have been very prosperous. Indeed, the manufacture was still in its infancy in the reign of Charles II. Yarranton, writing in 1677, proposed the establishment of spinning-schools, such as were then common in Germany. In these places perhaps 200 girls from six years old upward were assembled under the supervision of a woman who sat in a pulpit, and with a long white wand tapped any of the little workers who flagged in their attention. If this were not sufficient she rang a bell, and the offender was taken away and chastised. From the introduction of the cotton-manufacture until about 1773, while the weft was of cotton the warp was of linen yarn. Arkwright's invention changed this. In Ireland the history of linen-manufacture is mixed up with that of sectarian feeling, for the woolen-manufacture of the Roman Catholic S. and W. was ruined by heavy export duties, while the Protestant interest of Ulster was protected in 1699 by the act for the encouragement of the linen trade. A board was constituted which held sovereign sway over the trade until 1828, when its obsolete regulations and procedure led to its extinction. As early as the eleventh century linen was woven in Ireland, but it was Louis Crommelin, a refugee driven from France by the Revocation of the Edict of Nantes, who set it on a firm footing. The Duke of Ormonde in 1711 ordered linen hatbands and scarfs to be used for funeral purposes; fourteen years later machinery began to be used. Improvements in bleaching were introduced by Dr. Ferguson in the middle of the century. It was not until 1828 that flax-spinning machinery was started at Belfast. The pioneers were Messrs. Mulholland. For eighteen years there was a society for the promotion of the growth of flax in Ireland, but it came to an end in 1859. Linen was made in Scotland in the reign of Charles I., but on a very small scale and in a rude style. In 1688 Morer styles it the most noted and beneficial manufacture of the kingdom. As showing the unfriendly feeling between North and South, it may be mentioned that the Scotch packmen who traveled into England to sell linen were, about 1684, sometimes whipped as malefactors, and obliged to give bonds that they would discontinue their traffic.

On the Continent traces of the use and manufacture of linen are found at early dates. Charlemagne, who dressed after the manner of the Franks, had linen underclothes. In mediæval Italy it was an important article of commerce. In Spain the Moors paid great attention to textile manufactures, and linen was exported to India and Constantinople. In the fifteenth century Seville had 16,000 looms; a century later they had diminished to 300. Flanders, Brabant, and some of the German towns were notable for their linen-manufactures in the eleventh century. Louvain had 150,000 linen and woolen weavers in the fourteenth century. In Flanders, by the middle of the thirteenth century, the manufacture was very flourishing, and its products were largely exported to England and other countries. Ypres, which dates from 960, has left its impress in the word *diaper* (i. e. d'Ypres, cloth of Ypres), still used for table-linen. The soil of France is suitable for flax-growing, and since the time of the Roman rule linen has been made in that country. In 1394 it is said the king sent fine linen of Rheims to the sultan in ransom of some noble prisoners who had fallen into the hands of the paynims. The Revocation of the Edict of Nantes was disastrous in its effects on French industry, and the linen-trade suffered in common with all others from the loss of the Huguenots. Russia has long been the greatest flax and hemp growing country of the world.

There are more linens used in the U. S. in proportion to the population than in almost any other country.

We turn now to the history of the processes of the linen-manufacture. The flax-fiber is made up of a number of smaller filaments bound together. The primary operation in their separation was termed heckling. The heckle is a many-toothed steel comb which removes the coarser fibers of the tow and partially divides the filaments of the flax. The fineness of the flax depends upon the number of hecklings it receives by instruments of increasing delicacy. Machine heckling is now most commonly used, and there are various patented inventions for this purpose. The fibers require to be united into a continuous thread before they are capable of being woven. The earliest method of doing this was by the spindle. One was found at Thebes by Sir Gardner Wilkinson which had still some linen thread upon it. They were about 15 inches in length, usually of wood, with a circular head of gypsum, or composition. They were bulbous near one end, tapering to a point, while the other end lengthened into a handle. The thread was attached to the handle; and the spindle resting upon the right thigh, the right hand was drawn quickly over it, causing it to revolve or spin like a top. To this was afterward added the distaff, a piece of wood round which the flax to be spun was wrapped. The spinning-wheel was the next step forward. One was invented at Brunswick in 1553. That called Saxon had on the spindle a bobbin round which the thread was wound, a flyer going round faster than it, giving the requisite twist to the thread. The flax was loosely wrapped round a distaff or rock above the spindle. A treadle moved by the foot gave a rotatory motion to the wheel. It was only by slow degrees that this supplanted the older instrument, and a two-spindled wheel had not been very long in use when Arkwright's cotton-spinning machinery must have turned attention to the possibility of a similar revolution in other branches of human labor. In 1787 John Kendrew and Thomas Porthouse, both of Darlington (Durham), England, took out a patent for this purpose. Various mills in Scotland were worked under licenses from the patentees. It was long before the hand-made yarn was superseded by the machine-made article. In 1788 Alexander Robb invented a loom to be driven by water, and in 1810 Joseph Crompton, of Dundee, one to go by water or steam, but it is doubtful if they were brought into use. The first manufactory for weaving flax by power was set up in London about 1812 by Charles Turner & Co.

According to the modern method of treatment, the fibers are first *scutched* or combed; *broken* into three pieces, the inner section being the best; *heckled*, now usually done by a rotatory machine, the flax placed on the periphery being drawn through or against a series of teeth; the short fibers *drawn* into one continuous thread; after having been *roved* it is *spun*. The flax, however, has to be kept wet during this process, for which purpose warm water is now used. The spun yarn is used either for thread or for weaving, and such yarn is called wet-spun, but in modern times Dundee, in Scotland, and Lille, in France, produce a yarn made without the use of water. This is called dry-spun and is used principally for heavy fabrics such as sail-canvas, heavy sheetings, towelings, crashes, glass-cloths, etc. The quantity of *leas* (300 yards) contained in a pound is a method of indicating the quality of yarns. For information as to the processes of SPINNING, WEAVING, and BLEACHING, see the articles with those titles.

The greatest spinning centers for wet-spun yarns are Belfast, Ghent, Silesia, Bohemia, Westphalia, and Moravia.

The principal varieties of linens are *lawn* (Fr. *linon*), the finest qualities of which are now made in Ireland, for handkerchiefs, etc. Scotland furnishes sheetings, ducks, Osnaburgs, towelings, canvas, paddings, etc. *Diapers* are fabrics with patterns of geometrical regularity such as are produced by the kaleidoscope. *Dowlas* is a strong, coarse fabric, formerly much used by working people for shirts and trousers, and also made in jackets for soldiers. Large quantities of this cloth are exported to South America. *Damasks* are fabrics with figures of print and flowers, and free-hand ornament as opposed to the geometrical severity of diaper. The name is supposed to be taken from Damascus, an ancient seat of the art, which until the introduction of the Jacquard machine (see LOOM) was a secret confined to a few localities. The towns of Dunfermline and Kirkcaldy, and the whole county of Fife, in Scotland, are the greatest centers of damask or Jacquard weaving in the world. Lately Belfast, Germany, and Austria have appeared as strong competitors, while Barnsley and France have both lost ground. Courtrai and Ghent are famous for sheetings and fine shirting linens. *Cambric*, which takes its name from Cambrai, once famous for its production, is the finest and thinnest of linen fabrics. Handkerchiefs made from this cloth range in price from $1 to $20 per dozen. The so-called Scotch cambric is a cotton fabric with the fiber twisted very hard.

Some velvets or plushes are also made from flax, and used in the printed state as curtains, table-covers, and upholstery goods. France furnishes most of these velvets.

Hessians or burlaps are made from jute, and are used for all kinds of bags, for packing purposes, and for making tarpaulins, and foundations for floor-cloth. *French canvas* is a coarse variety, much used by tailors for stiffening, etc. *Crumb-cloth* is made in Scotland on Jacquard looms, and is used for covering carpets in rooms and stairs; it is woven as wide as 4 and 5 yards.

The modern process of bleaching has somewhat lessened the durability of linen, but a greater destroyer is the prevailing system of laundry-work. The lessened cost of linen, however (50 per cent.), compensates for these evils.

For a time the rapid increase of cotton-manufactures endangered the prosperity of the linen-trade (and to some extent they are antagonistic), but, although the manufacture of linens has not kept pace with that of its cheaper rival, it has exceeded its former proportions as one of the great staple industries of the world.

The U. S. has not made any appreciable progress in the manufacture of linens, save a few coarse crashes and towelings. Practically, the manufacture of linens has not begun, and the outlook is not encouraging for many reasons, such as climate, unprofitable returns for very hard work in the preparation by the farmer of the flax fiber for market, and the difficulty of grass bleaching under a scorching sun. At present the flax is raised for the seed only. The imports of flax and flax-manufactures into the U. S. for the year 1891 had a value of $24,000,000. This included burlaps, about $6,000,000.

Revised by FREDERICK S. PINKUS.