the sides, up to the heel or "seat, ” and the maker proceeds to " in­seam,” by passing his awl through the holes already made in the insole, catching with it the edge of the upper and the thin edge of the welt, and sewing all three together in one flat seam, with a waxed thread. He then pares off inequalities and “levels the bottoms, ” by filling up the depressed part in the centre with a piece of tarred felt ; and, that done, the boots are ready for the outsoles. After the leather for them has been thoroughly condensed by ham­mering on the “lap-stone,” they are fastened through the insole with steel tacks, their sides are pared, and a narrow channel is cut round their edges ; and through this channel they are stitched to the welt, about twelve stitches of strong waxed thread being made to the inch. The soles are now hammered into shape ; the heel lifts are put on and attached with wooden pegs, then sewed through the stitches of the insole ; and the top-pieces, similar to the outsoles, are put on and nailed down to the lifts. The finishing operations embrace pinning up the edge of the heel, paring, rasping, scraping, smoothing, blacking, and burnishing the edges of soles and heels, scraping, sand-papering, and burnishing the soles, withdrawing the lasts, and cleaning out any pegs which may have pierced through the inner sole. Of course, there are numerous minor operations connected with forwarding and finishing in various materials, such as punching lace-holes, inserting eyelets, applying heel and toe irons, hob-nailing, &c. To make a pair of common stout lacing boots occupies an expert workman from fourteen to eighteen hours.

The principal difficulties to overcome in applying machinery to shoemaking were encountered in the operation of fastening together the soles and uppers. The first success in this important operation was effected when means other than sewing were devised. In 1809 David Meade Randolph obtained a patent for fastening the soles and heels to the inner soles by means of little nails, &c. The lasts he used were covered at the bottom with plates of metal, and the nails, when driven through the inner soles, were turned and clinched by coming against the metal plates. To fix the soles to the lasts during the operation the metal plates were each perforated with three holes, in which wooden plugs were inserted, and to these the insoles were nailed. This invention may be said to have laid the foundation of machine boot-making. In the following year (1810) the inventor Μ. I. Brunel patented a range of machinery for fastening soles to uppers by means of metallic pins or nails, and the use of screws and staples was patented by Richard Woodman in the same year.

Apart from sewing by machine or hand, three principal methods of attaching soles to uppers are in use at present. The first is “pegging” with small wooden pins or pegs driven through outsole and insole, catching between them the edges of the upper. The points of the pegs which project through the insole are cut away and smoothed level with the leather either by hand or by a machine pegging rasp. The second is the system of “ riveting or clinching ” with iron or brass nails, the points of the nails being turned or clinched by coming in contact with the iron last used. The third method, screwing, has come into extensive use since the standard screwing machine was introduced in America by the Mackay Associa­tion of Boston, Massachusetts, and in Europe by the Blake & Good- year Company of London. The standard screw machine, which is an American invention, is provided with a reel of stout screw- threaded brass wire, which by the revolution of the reel is inserted into and screwed through outsole, upper edge, and insole. Within the upper a head presses against the insole directly opposite the point of the screw, and the instant screw and head touch the wire is cut level with the outsole. The screw, making its own hole, fits tightly in the leather, and the two soles, being both compressed and screwed firmly together, make a perfectly water-tight and solid shoe. The surface of the insole is quite level and even, and as the work is really screwed the screws are steady in their position, and they add materially to the durability of the soles. The principal disadvantage in the use of standard screwed soles is the great diffi­culty met with in removing and levelling down the remains of an old sole when repairs are necessary.

The various forms of sewing-machine by which uppers are closed, and their important modifications for uniting soles and uppers, are also principally of American origin. But the first suggestion of machine sewing was an English idea. The patent secured by Thomas Saint in the English Patent Office in 1790, while it fore­shadowed the most important features of the modern sewing- machine, indicated more particularly the devices now adopted in the sewing of leather. After the introduction of the sewing-machine for cloth work its adaptation to stitching leather both with plain thread and with heated waxed thread was a comparatively simple task. The first important step in the more difficult problem of sewing together soles and uppers by a machine was taken in the United States by Lyman R. Blake in 1858. Blake’s machine was ultimately perfected as the Mackay sole-sewing machine,—one of the most successful and lucrative inventions of modern times. Blake secured his first English patent in 1859, his invention being thus described : " This machine is a chain-stitch sewing-machine. The hooked needle works through a rest or supporting surface of the

upper part of a long curved arm which projects upwards from the table of the machine. This arm should have such a form as to be capable of entering a shoe so as to carry the rest into the toe part as well as any other part of the interior of it ; it carries at its front end and directly under the rest a looper, which is supported within the end of the arm so as to be capable of rotating or partially rotat­ing round the needle, while the said needle may extend into and through the eye of the looper, such eye being placed in the path of the needle. The thread is led from a bobbin by suitable guides along in the curved arm, thence through a tension spring applied to the arm, and thence upwards through the notch of the looper. The needle carrier extends upwards with a cylindrical block which can be turned round concentrically with it by means of a handle. The feed wheel by which the shoe is moved along the curved arm during the process of sewing is supported by a slider extending downwards from the block, and applied thereto so as to be capable of sliding up and down therein. The shoe is placed on the arm with the sole upwards. The feed wheel is made to rest on the sole. ” Blake’s original machine was very imperfect and was incapable of sewing round the toe of a shoe ; but a principal interest in it coming into the hands of Gordon Mackay, he in conjunction with Blake effected most important improvements in the mechanism, and they jointly in 1860 procured United States patents which secured to them the monopoly of wholly machine-made boots and shoes for twenty-one years. On the outbreak of the Civil War in America a great demand arose for boots, and, there being simultaneously much labour with­drawn from the market, a profitable field was opened for the use of the machine, which was now capable of sewing a sole right round. Machines were leased out to manufacturers by the Mackay Company at a royalty of from 1/2 to 3 cents on every pair of soles sewed, the machines themselves registering the work done. The income of the association from royalties in the United States alone increased from $38,746 in 1863 to $589,973 in 1873, and continued to rise till the main patents expired in 1881, when there were in use in the United States about 1800 Blake-Mackay machines sewing 50,000,000 pairs of boots and shoes yearly. The monopoly secured by the Mackay Company barred for the time the progress of invention, notwith­standing which many other sole-sewing machines were patented. Among the most important of these is the Goodyear & Mackay machines for welted shoes,—the first mechanism adapted for sewing soles on lasted boots and shoes. These machines originated in a patent obtained in 1862 in the United States by August Destory for a curved-needle machine for sewing outsoles to welts, but the mechan­ism was not successful till taken in hand by Charles Goodyear, son of the well-known inventor in india-rubber fabrics. The Goodyear & Mackay Company make two machines for welted goods, one for sewing the inseam and the second for stitching on the outsole. A large number of the latter form of machine are in use, many manu­facturers preferring to secure the welt or a midsole by the standard screw machine, sewing to that the outsole with the Goodyear-Mackay machine. The same company adapt a circular-needle machine to the sewing of turn shoes, and this, with other similar machines, is in extensive use.

The range of machinery used in a well-equipped shoe-factory is very extensive, embracing machines for cutting leather, pressing rollers for sole leather, and presses with cutting-dies for stamping out sole and heel pieces. There are also, in addition to many kinds of sewing-machine, blocking or crimping appliances for moulding uppers or vamps, vamp-folding machines, eyeleting machines, lasting machines, trimming and paring machines for planing and smoothing the edges of soles and heels. For finishing there are scouring, sand-papering, and burnishing machines for the soles, and stamping machines for marks and monograms, with peg-cutting and nail-rasping machines for smoothing, cleaning out, and dress­ing the surface of the insole. In short, there is not a single opera­tion necessary in shoemaking, however insignificant, for which machinery has not been devised.

The manufacture of india-rubber goloshes, shoes, and fishing- boots, &c., forms an important branch of the india-rubber industry rather than a department of shoemaking (see India-rubber, vol. xii. p. 842). A very considerable trade exists in boots and shoes with outer soles of gutta-percha (see vol. xi. p. 339) in place of leather, the headquarters of that trade being in Glasgow. (J. PA.)

SHOES, Horse. The horny casing of the foot of the horse and other Solidungulates, while quite sufficient to protect the extremity of the limb under natural conditions, is found to wear away and break, especially in moist climates, when the animal is subjected to hard work of any kind. This, however, can be obviated by attaching to the hoof a rim of iron—a simple device which has been probably not surpassed in its beneficial effects by the intro­duction of steam-power locomotion. The animal itself has been in a very marked manner modified by shoeing, for without this we could have had neither the fleet racers nor