Howe on weekly wages to adapt the machine for his manu­facturing purposes. The career of the inventor in London was chequered and unsuccessful ; and, having pawned his American patent rights in England, he returned in April 1849 in deep poverty to America. There in the mean­time the sewing machine was beginning to excite public curiosity, and various persons were making machines which Howe found to trench on his patent rights. The most prominent of the manufacturers, if not of inventors, ultimately appeared in the person of Isaac Merritt Singer, who in 1851 secured a patent for his machine (fig. 2), and immediately

devoted himself

with immense en­

ergy to push the

fortunes of the

infant industry.

Howe now became

alert to vindicate

his rights, and,

after regaining

possession of his

pawned patent,

he instituted suits

against the in­

fringers. An enor­

mous amount of litigation ensued, in which Singer figured as a most obstinate defendant, but ultimately all makers became tributary to Elias Howe. It is calculated that Howe received in the form of royalties on machines made up to the period of the expiry of his extended patent— September 1867—which was also the month of his death, a sum of not less than two millions of dollars.

The practicability of machine-sewing being demonstrated, inventions of considerable originality and merit followed in quick succession. One of the most ingenious of all the inventors—who worked also without knowledge of previous efforts—was Mr Allan B. Wilson. In 1849 he devised the rotary hook and bobbin combination, which now forms the special feature of the Wheeler & Wilson machine. Mr Wilson obtained a patent for his machine, which included the important and effective four-motion feed, in November 1850. In February 1851 Mr William O. Grover, tailor, of Boston, patented his double chain- stitch action, which formed the basis of the Grover & Baker machine. At a later date, in 1856, Mr James A. E. Gibbs, a Virginia farmer, devised the improved chain- stitch machine now popularly known as the Willcox & Gibbs. These together—all American inventions—form the types of the various machines now in common use. Several thousands of patents have been issued in the United States and Europe, covering improvements in the sewing machine ; but, although the efficiency of the machine has been greatly increased by numerous accessories and attachments, the main principles of the various machines have not been affected thereby.

In machine sewing there are three varieties of stitch made,—(1) the simple chain or tambour stitch, (2) the double chain stitch, and (3) the lock stitch. In the first variety the machine works with a single thread ; the other forms use two, an upper and an under thread.

The structure of the chain stitch is shown in fig. 3. The needle first descends through the cloth, then as it begins to ascend the friction of the thread

against the fabric is suf­

ficient to form a small

loop into which the

point of a hook operat­

ing under the cloth

plate enters, expanding

and holding the loop

while the needle rises to its full height. The feed then moves the fabric forward one stitch length, the hook with its loop is also

projected so that when next the needle descends its loop is formed within the previous loop. The hook then releases loop No. 1, seizes and expands loop No. 2, and in so doing draws up the previous loop into a stitch, chain-like on the under side but plain on the upper surface of the fabric. The seam so made is firm and elastic, but easily undone, for if at any point a thread is broken the whole of the sewing can be readily run out backwards by pulling the thread, just as in crochet work. To a certain extent this imperfection in the chain-stitch machine is overcome in the Willcox & Gibbs machine, in which each loop is, by means of a rotating hook, twisted half a revolution after it has passed through its pre­decessor.

The double chain stitch is made by machines associated with the name of Grover & Baker. The somewhat complicated course of the threads in this stitch

is shown in fig. *4.* The under thread in this machine is supplied from an ordinary bobbin and is threaded through a circular needle of peculiar form. The machine is wasteful of thread, and the sewing forms a knotted ridge on the under side of the fabric. Except for special manufacturing and ornamental purposes the machine is now in little use.

The lock stitch is that made by all ordinary two-thread sewing machines, and is a stitch peculiar to machine sewing. Its structure is, as shown in fig. 5, very simple, and when by proper tension the threads interlock with­

in the work the stitch shows the same on both sides and is very secure.

When, however, the ten­sion on the upper thread is weak, the under thread runs along the surface as at *b,* held more or less tightly by the upper loops. It will be seen that to make the chain stitch the under thread has to be passed quite through the loop of the upper thread. That is done in two principal ways. By the first plan a small metal shuttle, holding within it a bobbin of thread, is carried backward and forward under the cloth plate, and at each forward movement it passes through the upper thread loop formed by each succeeding stroke of the needle. Such is the principle devised by Hunt, introduced by Howe, and improved by Singer and many others. The second principal method of forming the lock stitch consists in seizing the loop of the upper thread by a rotating hook, expanding the loop and passing it around a stationary bobbin within which is wound the under thread. The method is the invention of Mr A. B. Wilson, and is known generally as the Wheeler & Wilson principle. The rotary hook seen at *b, fig. 6,* is so bevelled and notched that it opens and expands the upper thread loop, causing it quite to enclose the bobbin of under thread, after which it throws it off and the so-formed lock stitch is pulled up and tightened either by an independent take-up motion as in recent machines, or by the expansion of the next loop as in the older forms. The bobbin A, lenticular in form, and its case B,

fig. 6, fit easily into a circular depression within the hook, against which they are held by the bobbin holder *a,* fig. 6.

Intermediate between the shuttle and the rotary-hook machines is the new oscillating-shuttle machine introduced by. the Singer Co. The shuttle is hook-formed, not unlike the Wilson hook, and it carries within it a capacious circular bobbin of thread *h,* fig. 7. This shuttle is driven by an oscillating driver *db* within an annular raceway *a a,* and, instead of revolving completely like the Wilson hook, it only oscillates in an arc of 150°, so far as serves to catch and clear the upper thread. The oscillating-