which was formerly treated in the same manner as cotton.

As the gills are used in the spreading, the drawing, and the roving machines, and as it is in the use of the gills that flax machines differ from the machines for spinning cotton, we have given in figs. 10, 11, and 12, the two kinds inordinary use.

Fig. 10 shews the common chain gill. A A are the gill rollers ; B the gill chain, consisting of a series of links, jointed together at their lower extremity, as is better seen in the separate representation of them at C. There is one of these gill chains at each side of the machine, and they arc connected together by the guard bars *d d,* which ex tend across the machine. The gills are attached to the gill stocks *e* *e*, which stretch across the machine, and whose ends work through the slit in the links of the gill chain, and extend beyond the links into the slit of the guide frame *f* of which there is one on each side of the machine. These slits are called the gill slides, and perform the office which we will immediately see. As the gill stocks are carried round by the links of the gill chain, it is evident that they will be elevated or depressed according as the path of the links agrees with the line of the slides. Their path and the slides are so made to agree from *a* to *b,* that the stocks occupy the highest point of the links, and the hackles are protruded to their greatest extent, and work through the sliver in its passage between the retaining and drawing rollers. At the point *b,* the slides suddenly diverge from their former line, and nearly at right angles, by which divergence the gill stocks’ ends are suddenly moved from the highest to the lowest point of the link, and the hackles arc withdrawn from the sliver nearly at right angles. In following further the course of the guides, it will be seen that the circles of the slides are of the same size as those of the inner ends of the links, and consequently the gills are retained at the inner end of the links until the divergence of the slide at *a* again protrudes the hackles through the sliver in a direction nearly at right angles to its course. When the gills are withdrawn, their points fall just beneath the level of the guard bars which sustain the sliver, and in the case of entanglement, prevent it from being drawn down along with the gills.

Such is the common flax gill; and its defects are, first, that the teeth of the gills cannot be made to approach close enough to the drawing rollers, or to enter the sliver immediately after leaving the retaining rollers; and, second, that they do not leave and enter the sliver at right angles to its course. To remedy these defects, the screw gill has been introduced. Of this a longitudinal section is given at fig. 11, and a transverse section at fig. 12. *a a, a a,* are four screws ; the two upper screws have their threads lying in the reverse directions of the under ones ; *bb* are the gill bars, stretching across between the opposite pairs of screws, and having their ends working in the screw threads. When the upper screws are moved round their axis, the gill bars are carried forward through the sliver, being supported in their position by the bracket pieces *cc,* under the screws. These bracket pieces and the threads of the screw terminate, just at the drawing roller, so that when the gill bar has arrived at that point, it is no longer supported by the bracket, and falls down to a lower bracket *dd,* which guides it in the same manner for the under screws. In its fall the gill bar is aided by a cam or, the screw-shaft striking it when it has reached the termi­nation of the screw, and it is guided in its descent, and press ed into the thread of the lower screw, by a strap of iron forced against it by a lever. The threads of the lower screws are so arranged as to carry the gills along on its bracket piece towards the retaining rollers, and when it has reached the termination of the screw, a cam on the screw-shaft, with a guiding apparatus as before, raises the gill again to the upper bracket, to be acted on again by the upper screws.

As an introduction to the description of Mr. Smith’s self­

acting mule, it is necessary to give the reader a general idea of the hand-made jenny, a representation of which will be found at Plate CLXXVIII, fig. 12. By consulting that figure, the reader will see that the mule consists of two distinct parts ; first, the beam at the right hand of the figure carrying the drawing rollers; and, second, the carriage upon which the spindles are mounted for the purpose of giving twist, the beam being stationary, and the carriage capable of moving upon iron races along the extent of the machine, as may be seen by the dotted lines on the figure. Motion is communicated to the different parts by mechanism, mounted on a framework placed across the mule, either at one end or in the centre. This framework, with its appa ratus, is called the headstock.

When the mule is put in motion to perform the operation of spinning, the rollers are moved by wheel-work from the headstock, and the carriage is gradually moved outwards, keeping pace with the delivery of the rollers; and while this process is going on, the spindles are put into a rapid motion by belts and bands proceeding from the flywheel of the headstock, and which can be adjusted to give such an amount of twist as may be necessary. The whole of the twist may be thrown in during the outcoming of the carriage, as is generally done in spinning wefts, or as in twist-spinning, when part is thrown in during the slubbing, and the remainder after the carriage has reached its limit, and the rollers have stopped. In the outward movement of the carriage, the mule is driven by power communicated from the main gear to the flywheel shaft of the headstock, by a belt with a fast pulley, and when the stretch or draw has been completed, the machine is entirely stopped, by the belt being thrown on a loose pulley adjoining. The spinner then lays hold of the flywheel with one hand, and turns it back so far as to throw off all the coils from the stems of the spindles, which is technically called *backing off,* while with the other hand he puts down the faller or guide to the proper position for winding the threads on the copes. He then pushes the carriage towards the beam, directing the faller with one hand, so as to guide the threads in proper form on the cope, while with the other hand he turns forward the flywheel with such force, as to cause the threads to be wound upon the copes with a uniform and proper tension. When the carriage has arrived at the beam, he lifts up the faller wire, so as to throw the threads in coils from the copes to the points of the spindles, thus completing the draw or stretch, as it is called, and leaving the whole in proper order to commence a new draw. The driving belt being then thrown on the fast pulley, the ma chine is again put in motion, and so goes on successively.

All these motions are in Mr. Smith’s machines performed at the proper instant by the machines themselves. Plate 466 fig. 1, shews a side elevation of the headstock, and an end elevation of the carriage. Fig, 2 is a bird’s eye view of the carriage, race-rods, &c. The other figures in the same plate exhibit details of the mechanism, which will be referred to in their proper place.

The same letters refer to the same parts in all the figures. A A A A is the framing of the headstock, B the beam upon which the rollers are mounted, C the race-rods upon which the carriage runs, D the framework of the ends of the carriage, E the wooden rails of the carriage.

The motion of all the parts of the machine is derived by belts and pullies from the driving shaft F, which is itself driven by a belt from the main gearing acting on its fast pulley G, and when it is necessary to stop the whole machine, the belt is thrown on the loose pulley H. The driving shaft carries two pullies ; a belt from the larger one I drives the pulley K of the speed-shaft T, and a belt from the smaller one L drives the pulley of the change-shaft M. These two shafts also carry loose pullies, on which the belts are thrown at the proper instant for stopping the motion of the shafts,