the distance between them. One important advantage of the pulley and band arrangement is, that if, through accident or otherwise, any sudden strain is thrown on, which might cause breakage in wheelwork, the band will *slip* on the pulley; by adjusting the band any required degree of tension may be obtained.

55. The band or other connecting piece between the pulleys is made of various materials and of two principal forms—flat and round. As the flat band (belt or strap) is the one chiefly used, we shall confine our examples to this form. The material commonly used is leather, as it possesses several important qualities suitable for the purpose; there are, however, several composite materials used for the purpose.

56. In figs. 109, 110, S_1, S_2 represent two parallel shafts, of which S_1 is the driver; they are to be connected by pulleys and belt, so that for every revolution of S_1, S_2 shall also make a revolution, and the direction in which they turn shall be the same, as shown by the arrows in fig. 109. The diameters of the pulleys on S_1 and S_2 will therefore be equal, as would be the case if they were toothed wheels. The amount of belt surface in contact with the pulley on S_1 is equal to *aa*, and that on S_2 to *bb*; and as the pulleys are of the same diameter $aa = bb$.

This is termed the *open belt* arrangement.

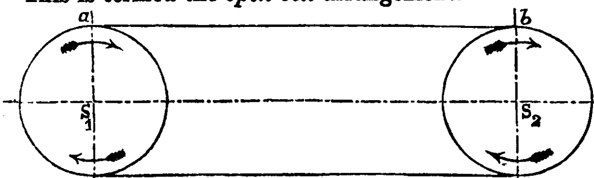

Fig. 109.

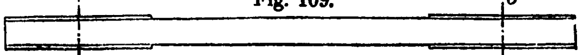
Fig. 110.

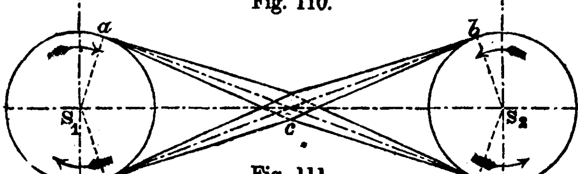

Fig. 111.

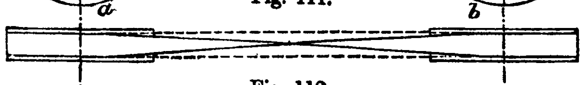
Fig. 112.

57. If the shafts are required to turn in opposite directions the belt is *crossed*, as shown in figs. 111. 112: not only is a difference produced in the direction of the motion of the shafts, but also a greater amount of belt surface is brought into contact with the pulleys than in the open belt, as shown at *aa*, *bb*, fig. 111. The belt, in passing from *a* to *b*, turns through two right angles; at *c*, where the two portions of the belt, *ab*, *ab*, cross, they are at right angles to the position in which they leave the pulleys at *aa*, *bb*.

58. In the two examples shown in figs. 109-112 the pulleys are of equal diameter, therefore the number of revolutions of each pair of shafts will be the same; but by varying the diameters of the pulleys in the same manner as in a pair of toothed wheels, we can give any ratio of number of revolutions to the two shafts within certain limits; for example, if the pulley on $S_1 = 24''$ diameter, and that on $S_2 = 8''$ diameter, then S_2 will make three revolutions to one of S_1.

When a very great difference in the number of revolutions of two shafts is required, one, two, or more intermediate shafts and pulleys may be employed.

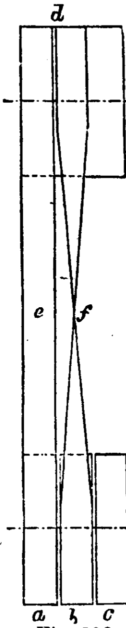

Fig. 113.

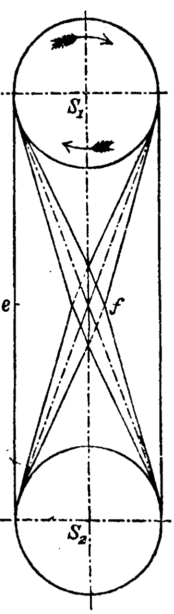

Fig. 114.

59. Pulleys are generally curved on the outer surface, as at *pq*, fig. 119, Plate XII., which tends to keep the belt on the pulley. The greatest diameter of the pulley is in the middle of its breadth *pq*; and as the tendency of the moving belt is to rise to the highest part of the pulley, the belt is thereby kept central on the pulley; the convexity $= \frac{1}{2}''$ per foot of the breadth of the pulley.

60. The two arrangements shown in figs. 109-112 are often combined and employed as a reversing motion, which is illustrated in figs. 113, 114, where S_1, S_2 are two shafts, S_1 being the driver and S_2 the follower; *a, b, c* are three pulleys on the shaft S_2; *a* and *c* are keyed to the shaft, but *b* is loose upon it, so that it may turn without turning the shaft; *d* is a pulley keyed to the shaft S_1. Two belts are used, an *open* one *e* and a *crossed* one *f*, and they are so arranged that one of them is always upon the loose pulley. In the position shown in fig. 113 the open belt is on the fast pulley *a*, and the crossed one on the loose pulley *b*, so that S_2 turns in the same direction as S_1; if now the two belts are moved so that *e* is upon the pulley *b*, and *f* upon the pulley *c*, then S_2 will turn in the opposite direction to S_1. By this means a *reversing motion* is obtained for the shaft S_2. It is employed in planing machines, screw-cutting lathes, &c.

61. By using a fast and a loose pulley on the shaft S_1 and a single belt, the shaft may be stopped and started at pleasure; this is termed the *fast* and *loose* pulley arrangement.

62. Cone or Speed Pulleys are employed where a limited change in the rate of motion (number of revolutions per minute) of two shafts is required. Figs. 115, 116, Plate XII., represent an arrangement of speed pulleys; S_1 and S_2 are the two shafts, on each of which are fixed speed pulleys A and B respectively. Each pulley is made up of three pulleys or *speeds*, *b, c, d*, of different diameters, increasing in radii by a common quantity *a*. The pulleys are arranged as shown in the figures, so that the smallest speed of the set on A is connected with the largest of the set on B; and as the diameters *b, c, d* of the pulleys A and B are equal, the length of the belt is constant for each of the three positions in which it may be placed when connecting the speeds *b—d*, *c—c*, *d—b*. Let A be the driver, then when the belt is in the position shown (on *b—d*), S_1 rotates a greater number of times in a given time (a minute) than S_2; when the belt is on *c—c*, S_1 and S_2 rotate the same number of times per minute; and when the belt is on *d—b*, S_1