CHAPTER VI.

OF ADJUSTMENTS.

257. **Adjustments Defined and Classed.**—The word "adjustments" was introduced by Professor Willis, in order to comprehend under one general term all contrivances for varying at will the comparative motions in a machine. Every adjustment may be regarded as an aggregate combination in which the action is temporary or intermittent; and the various kinds of adjustments might have been classed under the head of "Aggregate Combinations," in the preceding chapter; but it is more convenient to treat of them by themselves. Various contrivances which belong to the class of adjustments have already been described under the head of "Elementary Combinations," as well as of aggregate combinations: these will be specified in their order further on. Other contrivances belonging to the class of adjustments involve the application of the principles of dynamics and of the strength of materials, to such an extent that their description, at all events in detail, must be reserved for later divisions of this book.

When adjustments are classed according to the purposes to which they are applied, they may be arranged as follows:—

Traversing-Gear and Feed-Motions;
Engaging, Disengaging, and Reversing-Gear;
Gear for varying Speed or Stroke.

258. **Traversing-Gear and Feed-Motions in General.**—By *traversing-gear* is meant the mechanism by means of which a machine, consisting of framework and moving pieces, is shifted from place to place without being thrown out of connection with the driver from which it receives its motion; such, for example, as the mechanism by which the truck in a travelling crane, that carries the hoisting machinery, is made to move to different positions on a travelling platform, which itself is capable of being moved to different positions on a fixed framework; or the mechanism by which the arm in a drilling machine is made to move to various positions, carrying with it the boring-tool and the machinery by which that tool is driven; or that by which the tool-holder in a shaping machine is turned into various positions, according to the varying directions in which the strokes of the tool are to be made. By a *feed-motion* is meant the mechanism in a machine-tool by

means of which, after a stroke has been made, either the cutting-tool or the *work* (that is, the piece of material operated upon) is shifted into a new position, preparatory to making the next cut;—for example, in a lathe for turning axles, the feed-motion causes the tool to shift, at each revolution of the axle that is being turned, through a certain distance in a direction parallel to the axis of rotation; and in a sawing machine, the feed-motion causes the log of wood that is being sawn to advance through a certain distance either during or after each cut of the saw. Some feed-motions are continuous in their action; others are intermittent.

It is obvious that the general principles of traversing-gear, and of those feed-motions in which the tool is shifted, are those of *shifting-trains*, already stated in Article 228, pages 235 to 238. The consideration of traversing-gear and feed-motions in detail belongs to the subject of the construction of machinery, and must therefore be deferred.

SECTION I.—*Of Engaging, Disengaging, and Reversing-Gear.*

259. **General Explanations.**—Engaging and Disengaging-Gear, or sometimes Disengaging and Re-engaging-Gear, is the name given to those contrivances by means of which the connection between a follower and its driver can be begun and stopped at will;—in other words, by means of which the combination can be thrown *into gear* and *out of gear* when required. For brevity's sake, such contrivances may be called simply *Disengagements.* Disengagements may be classed in different ways. According to one mode of classification, they are distinguished into those which, in the communication of motion, act by *pressure*, and those which act by *friction*. Disengagements which act by pressure are precise and definite in their action; that is, the connection between the pieces that are thrown into gear at a given instant is established at once, in a certain definite position of the pieces, and with a certain definite velocity-ratio. Disengagements which act by friction are to a certain extent indefinite in their action; that is, the velocity-ratio corresponding to the complete establishment of the connection is produced by degrees; and the relative position of the pieces when the connection is completely established is uncertain. In certain cases the definite action of the former class of disengagements is necessary: in other cases it is unnecessary; and in these the frictional class of disengagements have a great advantage, because of their avoiding the shocks and straining actions which accompany sudden changes of velocity. The principles upon which such straining actions depend belong to the dynamics of machinery.

By another mode of classification, disengagements are arranged

according to the kind of mechanism of which they consist, as follows:—

I. *Disengagements by means of Couplings;* where two pieces that turn about one axis are coupled or uncoupled at pleasure; so that when coupled, they turn as one piece. These may transmit motion either by pressure or by friction.

II. *Disengagements with Rolling Contact.*—These always transmit motion by friction.

III. *Disengagements with Sliding Contact.*—These transmit motion by pressure; and in most cases they act by throwing toothed wheels or screws into and out of gear.

IV. *Disengagements by Bands* transmit motion by friction.

V. *Disengagements by Linkwork* transmit motion by pressure.

VI. *Disengagements with Hydraulic Connection* transmit motion by the pressure of a fluid; and they are made to act by the opening and shutting of valves.

Reversing-Gear usually consists simply of a double set of engaging and disengaging-gear; that is to say, an arrangement of mechanism by means of which the follower can, when required, be thrown into gearing with one or other of two drivers that drive it in opposite directions, or may be disengaged from both.

It is obvious that all the combinations in which the connection is intermittent (enumerated in Article 219, page 231) are examples of self-acting disengagements; and that some of them (such as the escapements described in Article 164, pages 176 to 179) are examples of self-acting reversing-gear.

260. **Clutch.**—A clutch is a sort of coupling, in which one rotating piece drives another piece that turns about the same axis, by means of two or more projecting claws or horns, that fit into corresponding recesses, or lay hold of corresponding horns, on the second piece. In a disengaging clutch the driving piece is a cylindrical box or collar with suitable horns, which is capable of easily sliding lengthwise upon a rotating shaft, and is made to rotate constantly along with the shaft, by having in its internal cylindrical surface a slot or longitudinal groove, fitting a longitudinal key or feather that projects from the shaft. In the outer cylindrical surface of the clutch is a circular groove, into which there fit easily the rounded ends of the prongs of a forked hand-lever, by means of which the clutch can be shifted lengthwise on the shaft through a distance sufficient to engage its horns with or disengage them from those of the following piece. The following piece may be another length of shaft, turning about the same axis; or it may be a wheel or a pulley, loose upon the same shaft with the clutch.

Sometimes the acting faces of the clutch, instead of being planes traversing the axis of rotation, are inclined backwards as regards the

direction of motion at an angle of 15°, or thereabouts. The effects of this are, that a certain forward pressure must be continually exerted by the lever on the clutch when in gear, in order to make it keep its hold; and that any sudden acceleration of one of the parts of the coupling causes the clutch to lose its hold, and thus prevents the transmission of a shock to the machinery which is driven by means of it.

261. **Friction-Clutch—Friction-Cones—Friction-Sectors—Friction-Discs.**—In the *friction-clutch* the following piece is a circular disc, having a hoop which grasps it, and which can be tightened or slackened by means of screws until the friction between the hoop and the disc is just sufficient to transmit the required power. The hoop has two projecting horns, corresponding to those of the clutch. When this combination is thrown into gear, the clutch instantly communicates its own velocity to the hoop; but the hoop at first slips on the disc, which is set in motion by degrees; and thus dangerous shocks are avoided.

In the *friction-cones* the driver, as in the case of the clutch, is a cylindrical box, turning along with the shaft, and capable of being shifted lengthwise by means of a hand-lever; but instead of horns, it has a disc with a rim turned to a very accurate and smooth convex conical surface. The follower is a disc whose rim is turned to a concave conical surface, exactly fitting that of the driver. When the driver is pushed forward by means of the lever, so as to press the two conical surfaces together, it gradually imparts its rotation to the follower by means of the friction of those surfaces. On drawing back the driver by means of the lever, the connection immediately ceases.

The angle of obliquity of the conical surfaces should be just great enough to prevent any risk of their becoming jammed against each other, so as to prevent disengagement; and for that purpose an angle of 10° or thereabouts is sufficient.

In the *frictional sector* coupling (invented by Mr. ~~Bodmer~~) the follower is a cylindrical box, loose on the shaft, and carrying a circular disc-plate with a hoop-shaped rim. The inner cylindrical surface of that rim is turned true and smooth. The driver consists of a boss fixed on and turning with the shaft, and carrying an expanding disc composed of two sectors, with true and smooth cylindrical rims, fitting the inner surface of the rim of the followers. Those sectors can be simultaneously moved from or towards the shaft by means of right and left-handed screws, turned by levers and links; the links lie parallel to the shaft, and are jointed to a collar which is shifted by means of a forked lever, as in the ordinary clutch. When the sectors are moved outwards, they fit tightly to the inside of the hoop-shaped rim of the follower, and by their friction communicate to it the rotation of the shaft.