2.1 Introduction

The box motion or box mechanism is a special arrangement used in looms for the production of fabric with weft threads of varying colour, count or quality. Robert Kay of Bury, England invented the first box system, known as the drop-box system, for the handloom in 1760. Several years later Diggle, also of Bury, successfully applied this box mechanism to the power loom.

In a loom with a box motion more than one shuttle is used. The number of shuttles required depends upon the number of colours or types of weft thread to be inserted. A set of shuttles carrying the required range of weft threads is arranged in a box that has individual compartments to hold each of them. Any of the shuttles can be brought into the picking area by means of specific mechanisms.

2.2 Types of Box Motions

Two types of box mechanisms have been in use:

1. The circular-box or revolving-box mechanism and
2. The drop-box mechanism.

2.2.1 Circular-box Mechanism

In a circular-box mechanism the shuttles are contained in separate compartments in a cylindrical box. The box is rotated in such a manner that the required shuttle containing the weft thread to be inserted is brought in line with the race board for the picking motion.

A circular-box mechanism is manipulated by a peg-and-hook arrangement or by a ratchet system operating at the end of the cylindrical box containing six compartments to hold the shuttles. The box may be rotated one way or the other, as required. In the simpler type of circular-box mechanism called the "non-skip type" only one box change is possible. In the complex revolving-box mechanism, called the "skip-box mechanism", one, two or three box changes are possible.

Circular box motions have limitations in comparison with the regular drop-box motions. The circular-box motions are usually operated with loose reed and overpick mechanism and not with fast reed warp protector with underpick motion. They are therefore suitable for weaving only light and medium fabric.

Fitting an automatic weft-replenishing device in a circular-box loom presents difficulties. This is due to the presence of the overpick stick and the need to verify which of the boxes is in use at any given time.

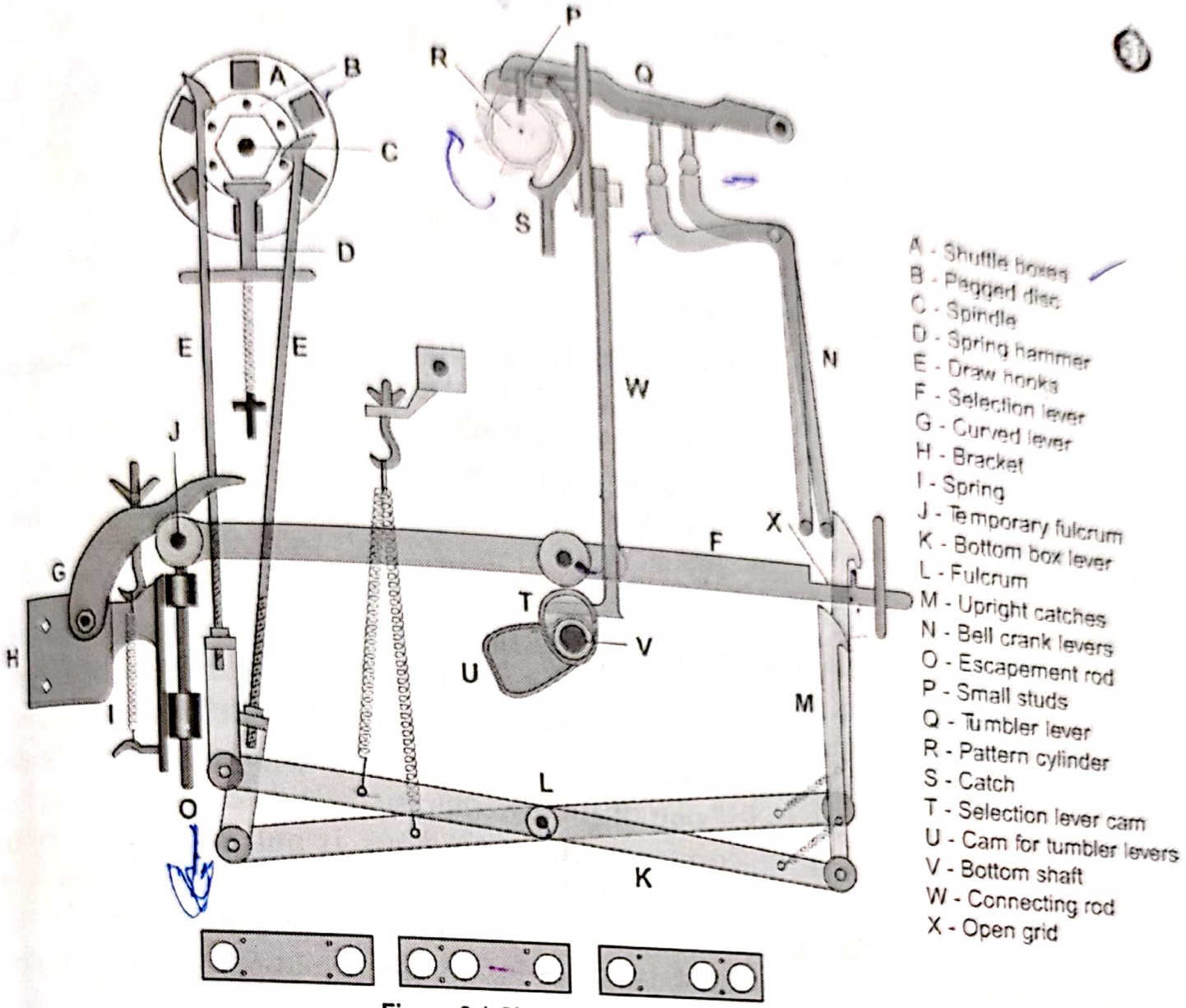

Figure 2.1 Circular-box mechanism

Another problem associated with the non-skip, circular-box motion is that the box movement is limited to only the adjacent box. This means that when a box change is required, only a shuttle in one of the adjacent boxes can be brought to be level with the race board and made use of for picking. Therefore, though this system has the capacity to accommodate six shuttles, it is practicable to use only if three different colours of weft yarn are to be introduced in sequence in the fabric. The possibility of introducing six different colours of weft yarn in any desirable order is vastly reduced.

In a situation that requires the box unit to rotate in one direction only, the weft yarn wraps around the spindle quite often, with the result that there are long broken threads hanging from the selvedge of the cloth. Yarn too tends to accumulate on the spindle, making it difficult for the barrel to rotate freely. As the size of the shuttle box is fixed, it is difficult to select shuttles that match the shuttle box. Modification of the shuttle box settings to accommodate shuttles larger than the average size is virtually impossible.

Construction of the circular-box mechanism

The circular-box motion is illustrated in Figure 2.1. The six shuttle boxes A are arranged as six compartments in a drum mounted on a spindle C. A pegged disc B is also fixed to the spindle. There are six pegs on the disc, equidistant from each other, one for each shuttle box. The pegged disc can be made to rotate by means of two draw-hooks E, that are kept in easy contact with the pegs by springs (not shown in the Figure 2.1). Attached to the lower ends of the draw-hooks are the bottom box levers K, which have a common fulcrum at L.

At the other ends of the bottom box levers are fixed two upright catches M, mounted on the bottom box levers, as seen in the figure. The catches also fit neatly into a rectangular slot of the selection lever F. The selection lever extends to the front of the loom, where it is pivoted by means of an escapement rod O. The spring I connecting the catches and the bottom box levers keeps the catches clear of the selection lever.

Working

The selection lever is pushed up and down by means of cam T, mounted on the bottom shaft V. The drive to the entire mechanism is obtained from the bottom shaft and hence the selection and movement of boxes are possible only on alternate picks. Thus the weft yarn introduced by any of the shuttles will be only in even numbers. If the selection lever is moved up and if one of the catches is made to engage with it, the catch is also moved up and the corresponding draw hook is pulled down. Being in close contact with a peg of the pegged disc, the draw hook pulls the peg and turns the circular box, thereby imparting one box movement. In this manner, the forward and backward movement of the circular boxes can be obtained by appropriate selection of the catches M. Springs are connected to each of the bottom box levers for their reversing action.

Selection Mechanism

For selection of the appropriate catch, a pattern cylinder and pattern cards are employed in circular-box motion. The pattern cylinder R is mounted at the top. There are two tumbler levers Q, mounted above the cylinder and fulcrummed at their rear ends. The tumbler levers are located in the open grid X, and get up and down movement by means of a separate arrangement, consisting of cam U fixed on the bottom shaft and the connecting rod W. The card cylinder is rotated intermittently so it moves once for every two picks by means of the catch S, which is loosely mounted on the tumbler lever. The movement of the cylinder is to bring the next card into position. The catch gets raised and lowered along with the tumbler lever and tilts the ratchet wheel attached to the card cylinder.

Steel pattern cards are used for selecting the tumbler levers and thereby to give rotation to the multiple boxes in the desired direction. For this purpose the tumbler levers are provided with small studs P. When the tumbler levers are dropped by the action

of the grid, the holes in the pattern cards allow them to move down. This results in the corresponding bell crank levers N, pushing the catch on to the selection lever. As the selection lever goes up it carries the selected catch up and hence the tilting action of the circular-box system takes place as discussed earlier.

Steel pattern cards of three types, as shown in the figure, are used for the selection. The cards are connected together by links and passed over the card cylinder R. The outer holes in the cards fit on pegs cast on the cylinder to hold the cards correctly in position.

Safety device

A safety device is provided at the rear end of the selection lever F to prevent any damage to the boxes, if ever they are locked by any malfunction in the operational sequence. The selection lever is pivoted to the head of the escapement rod O, which works in the sockets of the bracket H. The spring I exerts sufficient pressure on the curved lever G, which under normal conditions prevents the lifting lever from rising when the boxes are being turned. If however there is any obstruction preventing the boxes from rotating and the selection lever from rising with the catches, it would lift at the point J by overcoming the tension of the spring. A spring hammer D, working in contact with the pegged disc B, helps to steady the action of the boxes and minimise vibration when the boxes are moved.

2.2.2 Drop-box Mechanism

The drop-box mechanism, on the other hand, has a fixed number of shuttles arranged one over the other in flat steel shelves. The drop-box can be raised or lowered in a vertical plane and the required shuttle can be set into the right position for picking. Levers controlled by double-disc or compound eccentric arrangements are generally used to activate a drop-box mechanism.

In the ordinary drop-box loom a combination of many boxes is arranged at one end of the sley and a single box is set at the opposite end. In this event, a change in the colour or quality of the weft thread can take place only once for every two picks. In certain special looms, multiple-box arrangements are provided on both sides of the sley. These multiple boxes are capable of introducing any order of weft threads including even single picks of a given colour, count or quality. This type of multiple-box motion is called a `pick-at-will' motion and the loom in which such a system is installed is itself called a `pick-and-pick' loom.

2.3 The Ruti Weft Mixing Motion

The simplest form of drop-box arrangement is the two box motion, which is also called a weft mixer as it permits the mixing of different qualities of weft yarn, e.g. double picks of S and Z twist yarns occurring alternately. This system is used in the production of certain types of weft crepe fabrics. Weft mixers are used even in the

production of certain plain fabrics, especially for masking any irregularity in yarn diameter.

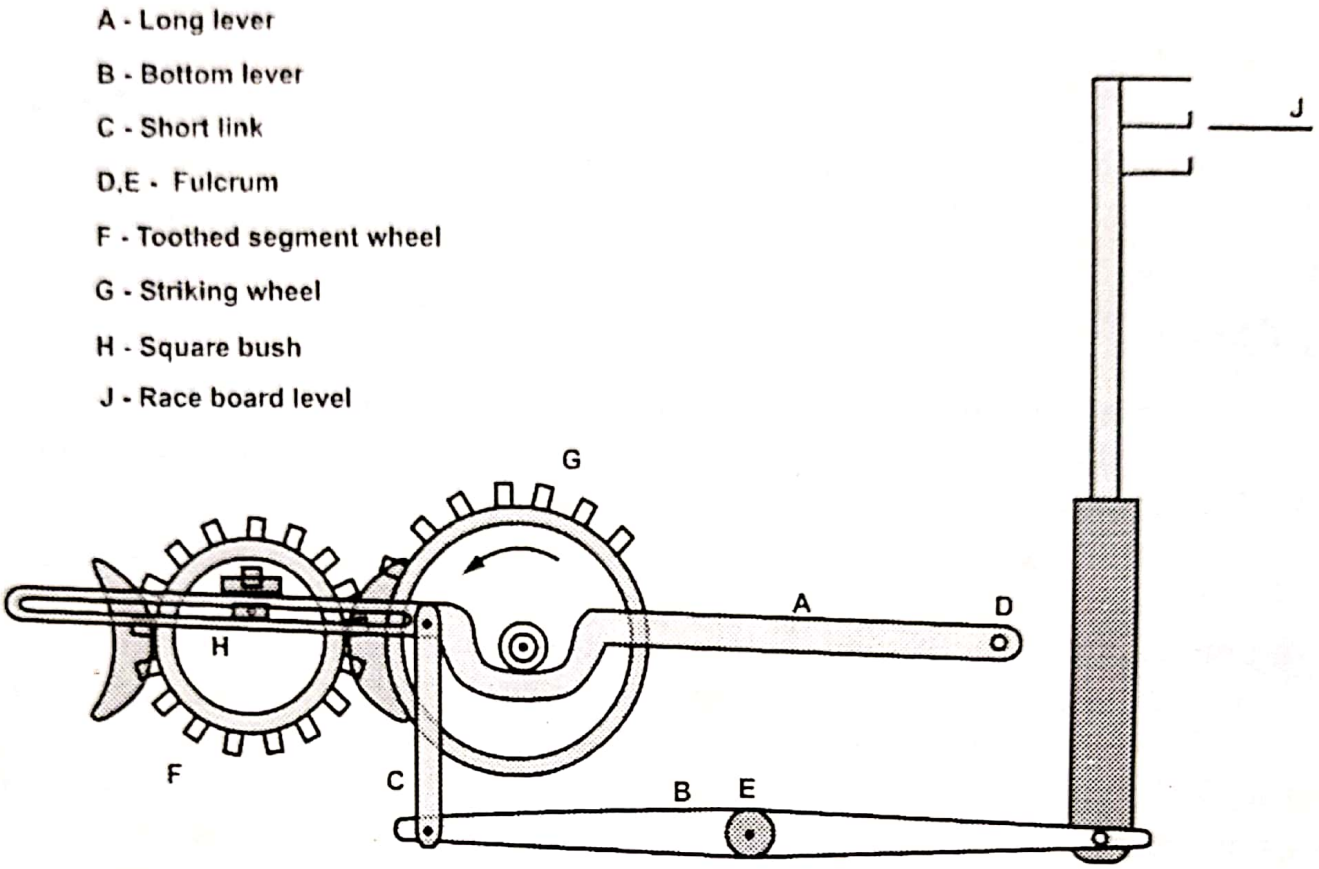

Figure 2.2 Ruti weft mixing motion

A Ruti weft mixer is shown in Figure 2.2. A long lifting lever A, fulcrummed at one of its ends, D, is coupled to one end of the bottom lever B by the short link C. The bottom lever has its fulcrum nearly midway along it, at E, and its other end is connected to the foot of the box rod F. About half the length of the lifting lever A opposite its fulcrummed end is slotted. In the slot is a square bush that is raised and lowered alternately by the toothed segment-wheel G. The segment-wheel meshes with the striking wheel H and rotates half a turn for every two picks inserted. The striking wheel is secured to the bottom shaft of the loom by set-screws. The Ruti weft mixer is thus a simple mechanical system that raises and lowers the boxes every alternate pick.