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A new Technique for Determination the Machine Timing, Shuttle Location and Shuttle Speed by Using Electronic Triggers

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ABSTRACT

It is necessary to determine the start and the end of the machine cycle of the loom, because it will facilitate the investigation of the behavior of the loom during the machine cycle. An instrument was developed to determine the machine cycle electronically. This instrument consisted of a light switch which could be made of different shapes to fit the different parts of the loom where needed. Two types of the light switch were made and used in this work, type (E) and type (F). Both types were used in this work. Type (E) was used to determine the start and the end of two machines cycled. Type (F) was used to determine the shuttle locations during its flight through the warp shed and the shuttle speed inside the shuttle box. The results obtained gave accurate and valuable knowledge about machine timing and shuttle locations at any milli second through the machine cycle.

INTRODUCTION:

To assess the effects of any textile and mechanical parameters on a weaving loom, a method to determine the timing of the machine cycle should be introduced. Due to the high speed of the loom and the moving parts of all the mechanisms of the loom, a new technique for measuring the timing of the loom and the locations of the shuttle during its flight through the shed and inside the shuttle boxes became essential (Holocombe,1974). To determine the exact speed of the shuttle inside the shuttle box was impossible (Lord and Mohammed, 1975) before introducing this technique. Because of the fast speed of the shuttle, an electronic trigger was developed in this work. Two types of the electronic triggers were made in this work, type (E) and type (F) and both are described below.

MATERIALS AND METHODS:

Electronic trigger type (E):

Figure (1) shows the light switch type E. The plate (D) was firmly fixed to the bottom shaft of the picanol loom and so rotated with it. A slot (C) was made on the plate (D) just wide enough to let the light pass through. The bracket containing (A) and (B) was fixed to the frame of the loom. (A) was a light source and (B) a photoelectric cell. When the light passed from (A) to (B) through the slot (C), a switch activated by the photoelectric cell was closed, triggering a signal to a channel (Nicolet Digital Oscilloscope's 3091) of an oscilloscope (channel B). The plate was fixed in such a position that the trigger was activated when the machine was at front dead centre. Because plate (D) was mounted on the bottom shaft, the switch operated only once each two machine cycles. The other channel of the oscilloscope (channel A) could display any other measurement of a textile parameter. When both channels were on both measurements would be displayed on the screen.

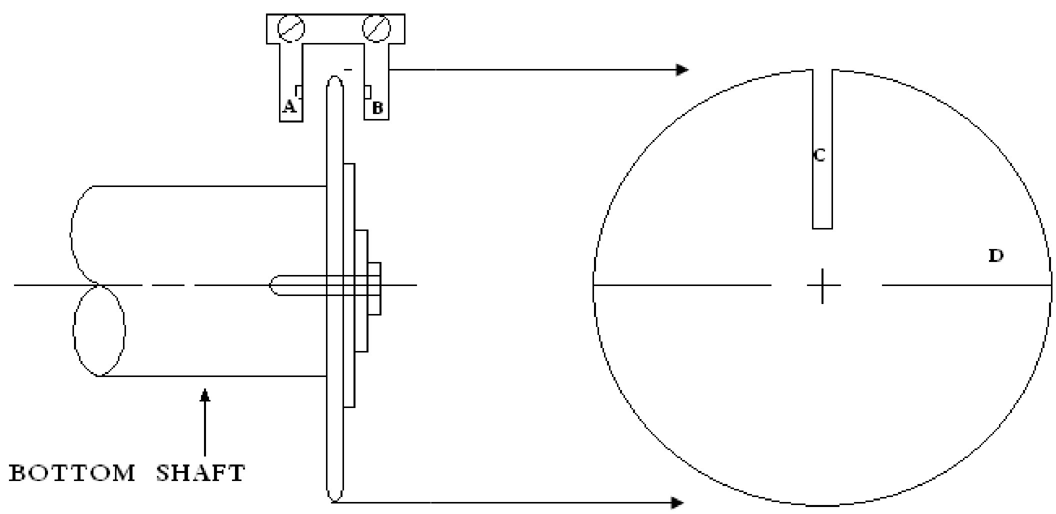

Figure 1: light switch type (E)

Electronic trigger, type (F):

This configuration of the light switch is shown in figure (2). It works on the principle of reflecting the light back to the switch to close the circuit. The source of light came from the groove (A) and was detected at (B) after being reflected via a reflective material mounted on a moving part. The best distance between the switch and the reflecting material was found to be (10) millimeters. If the light from (A) was reflected to (B), the circuit of the switch would be closed (Fitzgerald and Higginbotham, 1957) triggering a signal to the oscilloscope (channel B). This type (F) was used as well to determine the machine cycle of the loom. The switch containing (A and B) was mounted to the frame of the loom and the reflecting material was placed on the rim of the wheel of the crank shaft, so that when the light was reflected by the reflecting material, the machine was at the front dead centre.

This type (F) proved very useful, because it was small in size and it could be fitted easily into confined spaces on the loom. It was used to trigger the shuttle when entering and leaving, the shed and shuttle boxes on both sides of the picanol loom (Picanol "President"). It was used also to determine the exact angle of the start of picking.

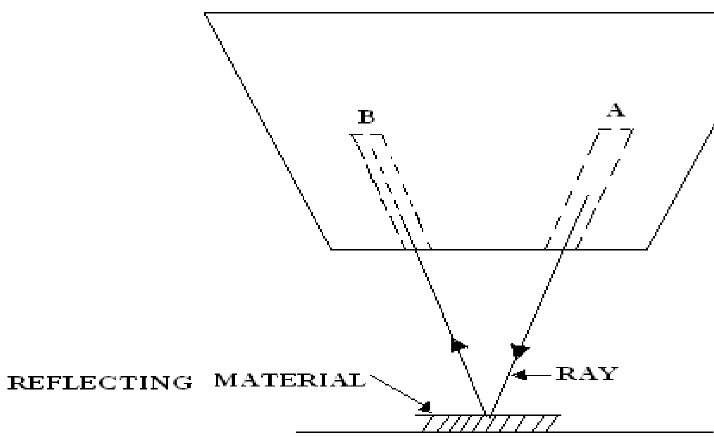

Figure 2: light switch type (F)

RESULTS AND DISCUSSION:

Applications of using the electronic trigger:

The shuttle flight through the shed from the feeler side (F.S):

The light switch type (F) was mounted on the sley coinciding with the last warp end at the left side of the loom (F.S). The reflective material was placed (across) the top of the shuttle on the leading end with respect to picking from the feeler side. When the loom was running, with the light switch connected to the oscilloscope, two timing marks (N) and (R) were obtained each two picks as shown in figure (2.1). Mark (N), occurring nearer to the end of the cycle, coincides with the timing of the exit of the trailing end of the shuttle at the feeler side when picked from the battery side of the loom (right hand side). This can be seen from the figure occurring at 270° after the front dead centre.

KEY

N : THE SHUTTLE EMERGED OUT OF THE SHED TOWARDS THE (FS) SHUTTLE BOX AT 270 DEGREES OF THE CRANK SHAFT ANGLE

R : THE SHUTTLE ENTERED THE SHED FROM THE (FS) SHUTTLE BOX AT 110 DEGREES OF THE CRANK SHAFT

FS : FEELER SIDE (LEFT)

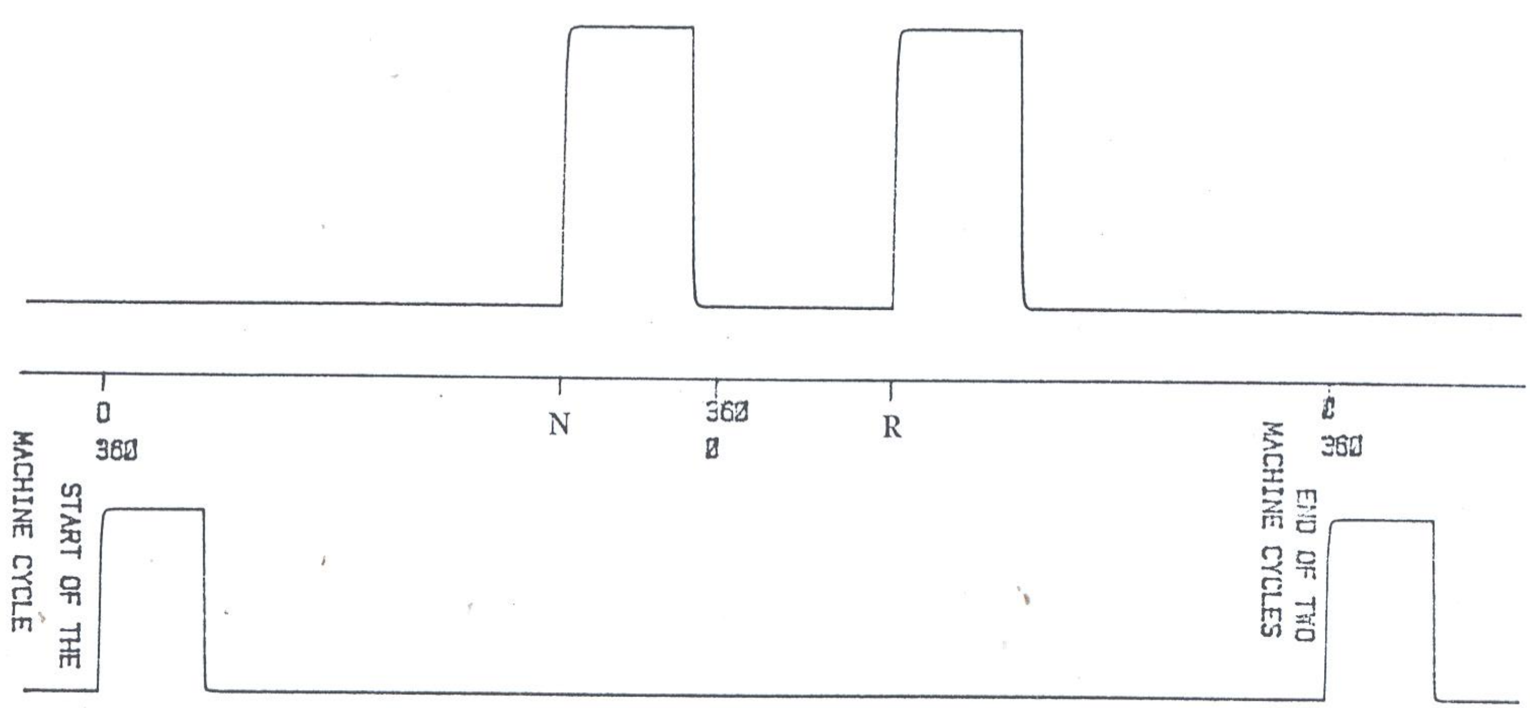

Fig. 2.1 Timing diagram of the shuttle flight through the shed from the feeler side shuttle box

The mark (R) occurring nearer to the commencement of a cycle, indicates the time at which the shuttle enters the shed when picked from the feeler side. This can be seen to occur at 110° of crank shaft rotation from front dead centre. Clearly, by considering the time of entry of the shuttle into the shed from one side of the loom and the time of its exit from the shed at the same pick, the duration of the shuttle flight (Vincent, 1939) in the shed could be determined. The duration of the shuttle inside the shed for this loom is 160° of crank rotation (270° - 110°).

The shuttle flight through the shed from the battery side (B.S):

Figure (2.2) shows the timing diagram of the shuttle flight through the shed when picked from the battery side (right hand side). To achieve this diagram, the light switch (type F) was mounted on the sley to coincide with the last warp end towards the battery side of the loom. A 3mm wide strip of reflective material was placed across the top of the shuttle on the leading end with respect to picking from the battery side. The light switch was connected to channel (A) of the oscilloscope. When the loom was running, two timing marks (K and M) were obtained for each two picks. Mark (K), occurring nearer to the commencement of a cycle, indicates the time at which the shuttle enters the shed when picked from the battery side. This can be seen occurring at 110° of crank shaft rotation. Mark (M) coincides with the timing of exit of the trailing end of the shuttle after being picked from the feeler side. This can be seen to occur at 270° after front dead centre.

The entry of the shuttle into the battery side shuttle box:

Figure (2.3) shows the timing diagram of the shuttle when it enters and leaves the battery side shuttle box. To obtain this diagram, the light switch was mounted on top of the battery side shuttle box and the reflecting material on top of the shuttle. The position of the switch was carefully selected in relation to the shuttle, to ensure that the trigger signal was given at the instant that the shuttle came to rest. Again the signals were sent to the oscilloscope. Mark (A) of figure (3.1) occurring near the start of the cycle clearly indicates the time at which the shuttle leaves the battery side shuttle box. It can be seen that this occurred at 86° of crank shaft rotation after front dead centre. Mark (C), occurring near the end of the pick cycle indicates the timing of the final rest of the shuttle when travelling to the battery side box. This occurs at 300° of crank shaft rotation.

The entry of the shuttle into the feeler side shuttle box:

Figure (3.2) shows the timing diagram of the shuttle when it enters and leaves the feeler side shuttle box. To obtain this diagram, the light switch was mounted on top of the feeler side shuttle box and the reflecting material on top of the shuttle. Again, the position of the switch was selected to ensure that the trigger signal was given at the instant that the shuttle came to rest. Mark (Q) of figure (3.2), occurring near the end of the pick cycle indicates the timing of the final rest of the shuttle when travelling to the feeler side box. This occurs at 300° of the crank shaft rotation. The mark (R), occurring near the start of the cycle, indicates the time at which the shuttle

KEY

K : THE SHUTTLE ENTERED THE SHED FROM THE (BS) SHUTTLE BOX AT 110 DEGREES OF THE CRANK SHAFT

M : THE SHUTTLE EMERGED OUT OF THE SHED TOWARDS THE (BS) SHUTTLE BOX AT 270 DEGREES OF THE CRANK SHAFT

BS : BATTERY SIDE

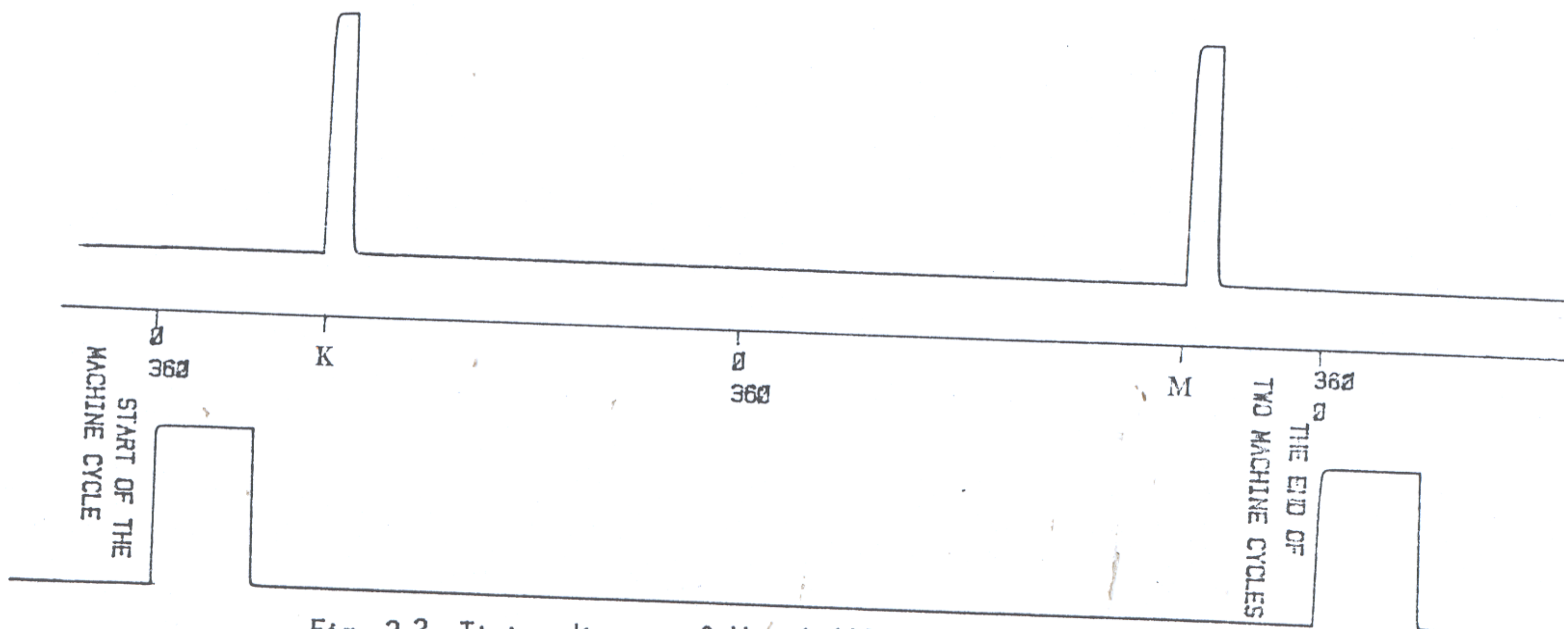

Fig. 2.2 Timing diagram of the shuttle flight through the shed from the battery side shuttle box

KEY

A : THE STARTING OF THE (BS) PICKING MECHANISM OCCURS AT 86 DEGREES OF THE CRANK SHAFT ANGLE

C : THE SHUTTLE ENTERED COMPLETELY THE (BS) SHUTTLE BOX AT 300 DEGREES OF THE CRANK SHAFT ANGLE

BS : BATTERY SIDE (RIGHT)

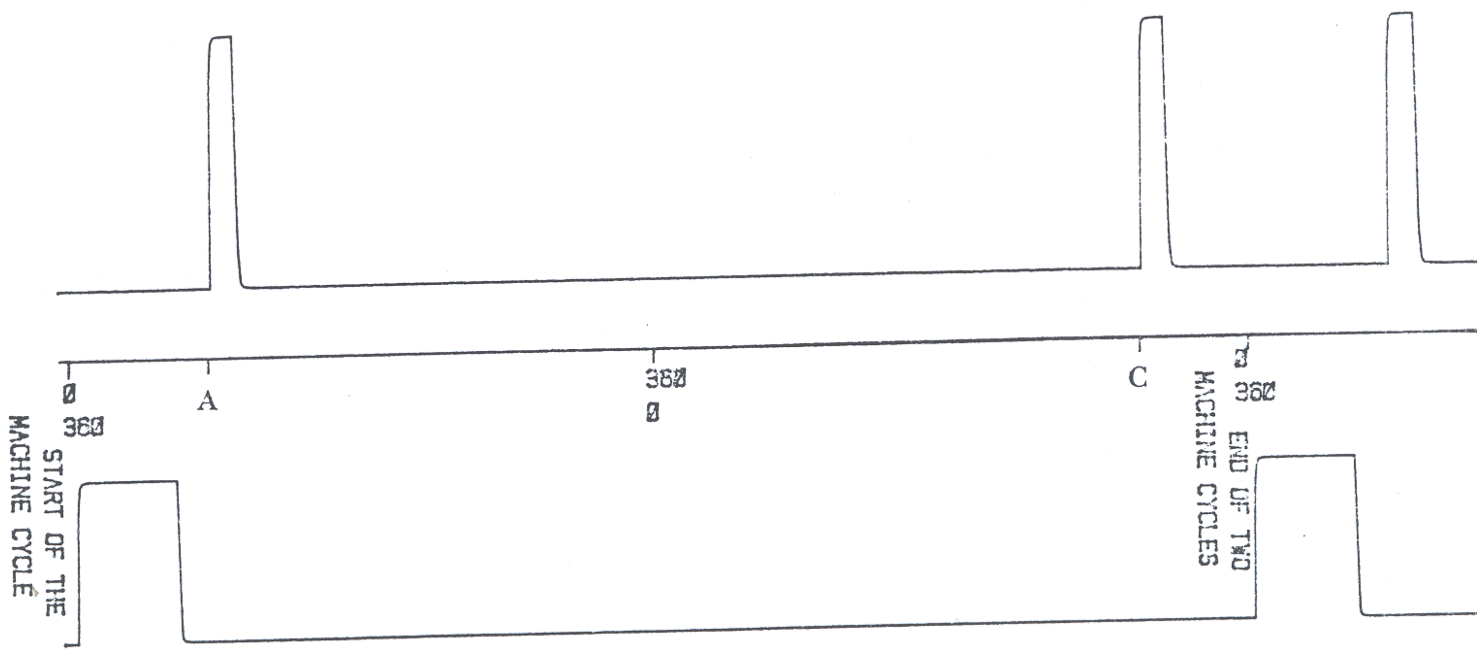

Fig. 3.1 Timing diagram of the shuttle entering and leaving the battery side shuttle box

KEY

Q : THE SHUTTLE ENTERED COMPLETELY THE (FS) SHUTTLE BOX AT 300 DEGREES OF THE CRANK SHAFT ANGLE

R : THE STARTING OF THE (FS) PICKING MECHANISM IS AT 75 DEGREES OF THE CRANK SHAFT ANGLE

FS : FEELER SIDE

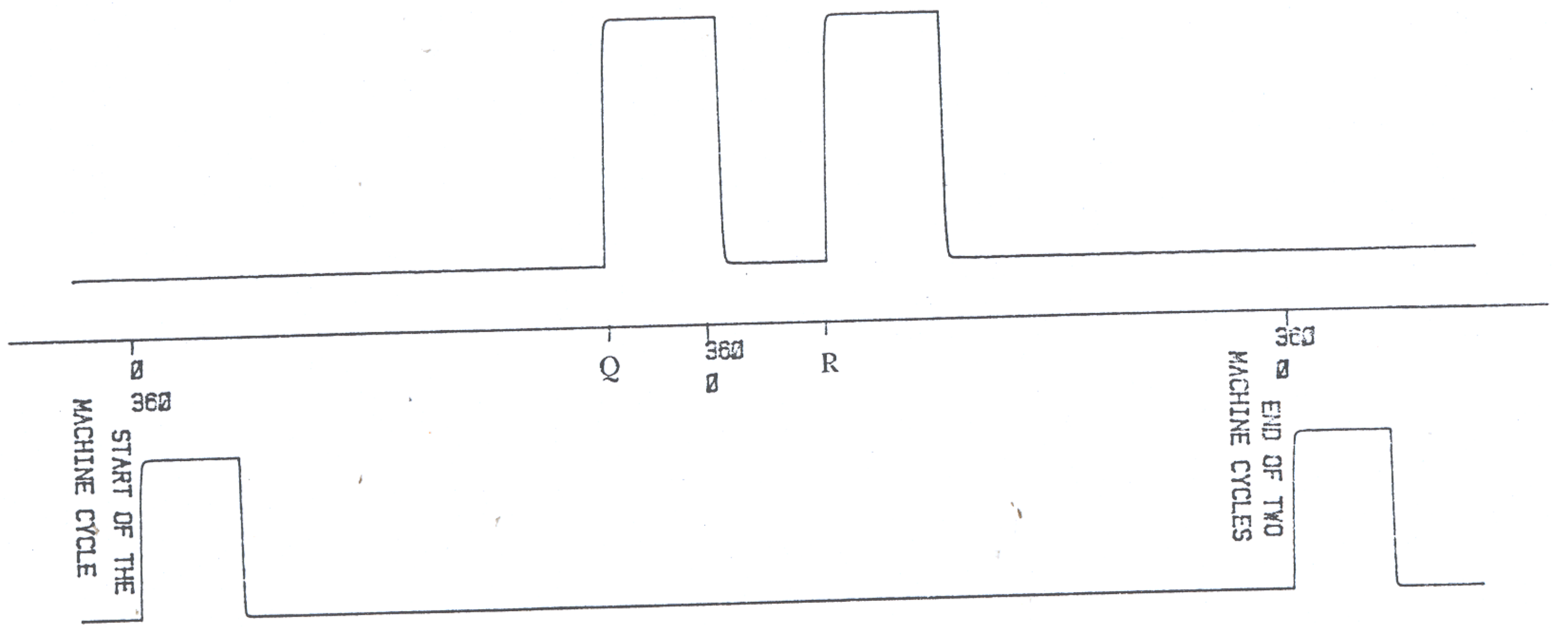

Fig. 3.2 Timing diagram of the shuttle entering and leaving the feeler side shuttle box

Leaves the feeler side shuttle box. It can be seen that this occurred at 75° of crank shaft rotation after front dead centre.

Determination of the velocity of the shuttle inside the shuttle box:

It is a very hard task to determine the velocity of the shuttle inside the shuttle box. The front and back walls of the shuttle box as well as the top cover obstructed any trial for measuring the velocity of the shuttle inside the shuttle box (Gorshkov, 1956).

The new technique in this study by using the light switch made the determination of the velocity of the shuttle inside the shuttle box possible. The light switch was mounted and fixed on top of the shuttle box. Eleven marks were made on top of the shuttle by using the reflecting material. The space between each two marks all through the length of the shuttle was 3 centimeters. The time in milliseconds at the marks was recorded.

The velocity of the shuttle was calculated (Thomas Bevan 1964) using the recorded displacements and times at the marks. Two speeds of the loom were used, namely 161 and 170 revs/min. The data obtained when using the speed of 161 revs/min of the loom was recorded on table (1.A) and plotted in figure (4.1). The data obtained when using the speed of 170 revs/min of the loom was recorded on table (1.B) and plotted in figure (4.2).

Table 1.A: Velocity of the shuttle inside the shuttle box at the loom speed of 161 revs/min

Index (marks)	Time (M.S) (t)	Displacement (CM) (s)	Velocity(M/S) (v)
1	0	0	0.00
2	4.2	3	7.14
3	7.6	6	7.89
4	10.2	9	8.82
5	12.4	12	9.68
6	14.8	15	10.14
7	17	18	10.59
8	19	21	11.0
9	21.4	24	11.20
10	23.6	27	11.44
11	25.8	30	11.63

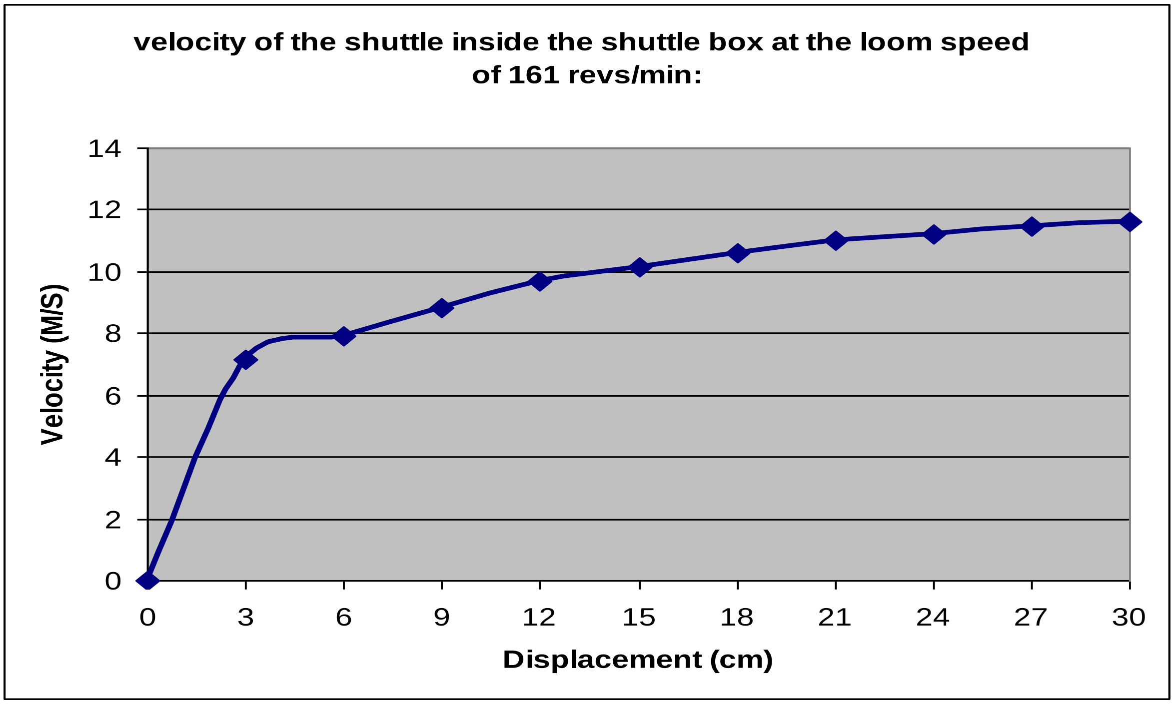

Figure 4.1: Velocity of the shuttle inside the shuttle box at the loom speed of 161 revs/min

Table 1.B: velocity of the shuttle inside the shuttle box at the loom speed of 170 revs/min

Index (marks)	Time (M.S) (t)	Displacement (CM) (s)	Velocity(M/S) (v)
1	0	0	0.00
2	4.2	3	7.14
3	7.4	6	8.11
4	10.0	9	9.00
5	12.2	12	9.84
6	14.4	15	10.42
7	16.6	18	10.84
8	18.7	21	11.29
9	20.8	24	11.54
10	23.0	27	11.74
11	25.0	30	12.00

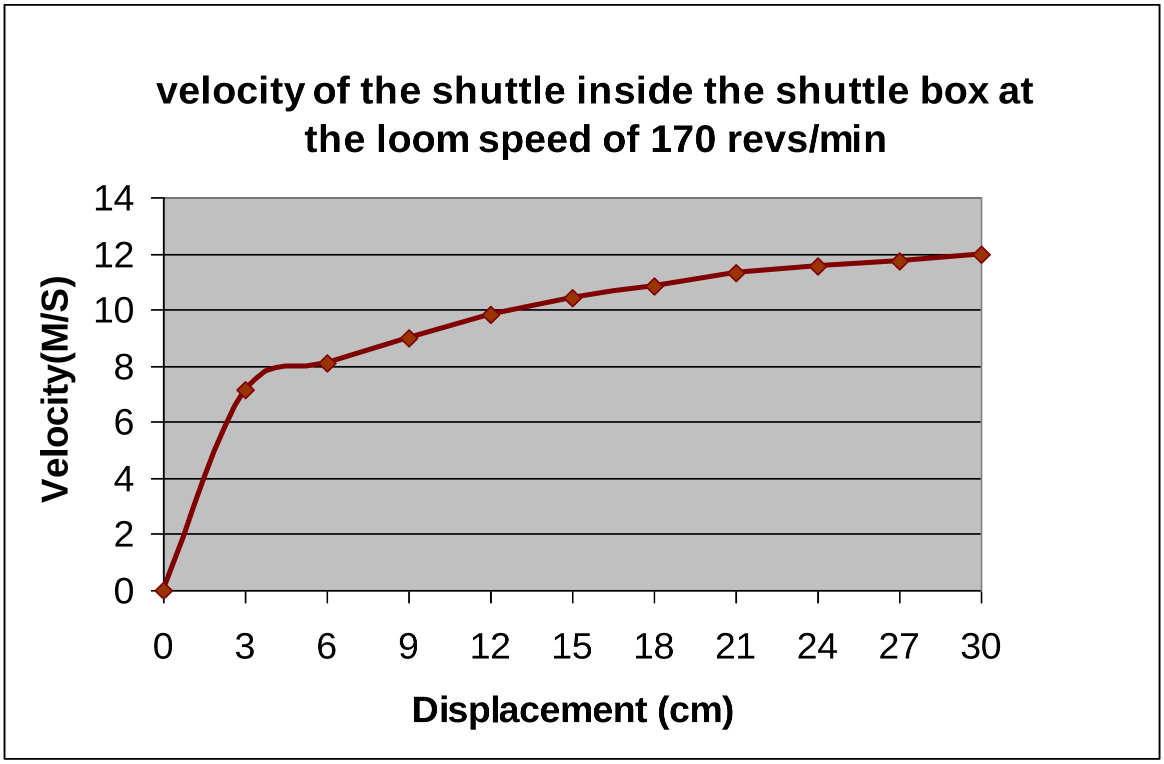

Figure 4.2: velocity of the shuttle inside the shuttle box at the loom speed of 170 revs/min

CONCLUSIONS:

A new technique has been developed in this work by using electronic triggers for the determination of the timing of the weaving machine introduced in this work. Two types of triggers (type (E) and type (F)) were both applied to the weaving machine. The exact angles of the shuttle locations during its flight inside the warp shed were determined. The angles of entering and of leaving both shuttle boxes were determined precisely. This technique made it possible to determine the velocity of the shuttle inside the shuttle box, in a very simple and an accurate way. This light switch could be made in various and small shapes to fit any confined space in the loom.

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