PREVENTION OF SET MARKS IN WEAVING

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The search for a suitable method of preventing set marks has long been a matter of research. Such a method should be conducive in generating normal beat-up intensity during a loom start-up stage. This article reviews available methods and introduces an effective method for doing this.

1. INTRODUCTION

Set marks are a type of fabric fault that tends to arise when a loom is restarted after a stoppage [Islam 98a, Wulfhorst *et al* 90, 93]. These show up as a sudden variation of pickspacing from its normal value which gradually diminishes over a number of picks. The variation could be either an increase or a decrease of pickspacing, which takes the appearance of a thick or thin place respectively [Islam *et al* 95, Islam 96e]. A model of a typical set mark is shown in Fig. 1. Such faults become prominent when the variation exceeds a certain threshold. Generally spun yarns, due to their inherent hairiness, mask the fault to some extent, whilst the fault is more apparent when continuous filament yarns are used.

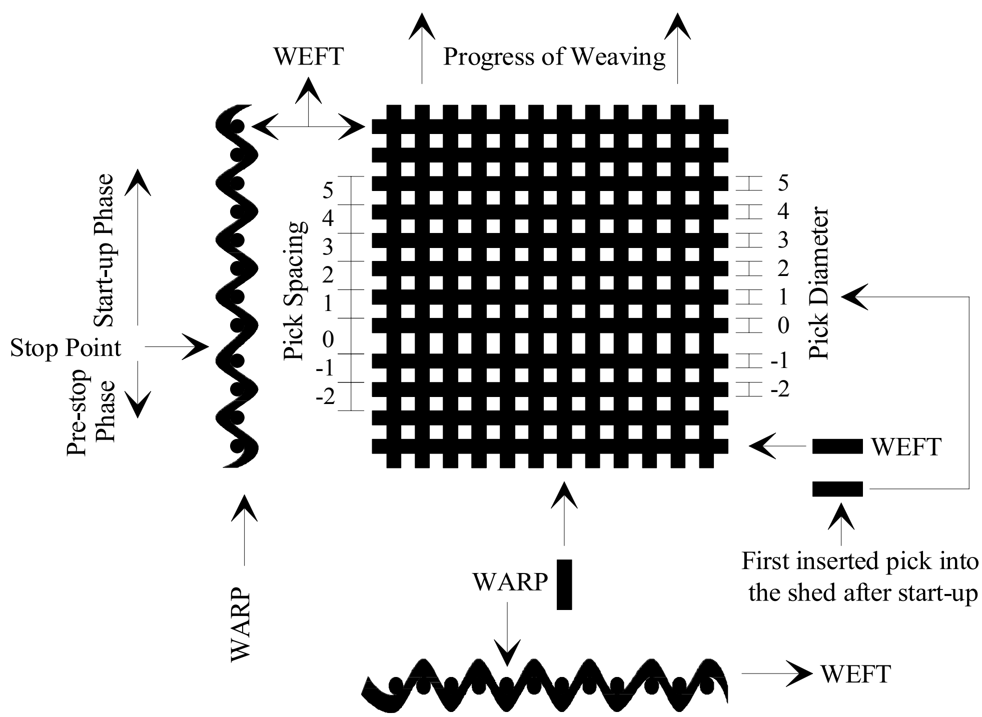


Fig. 1 Features identification of a typical set mark, open space [Islam 96e]

One of the well known causes of set marks is the creep of the cloth fell position during a loom stoppage due to the visco-elastic properties of the warp and fabric [Greenwood 57, 75; Tsien 61]. The amount of drift depends on the duration of the stoppage, as well as such factors as the warp tension, loom stopping position, and the previous stressing undergone by the warp.

The initial loom start-up speed also has a significant influence on the formation of set marks. This is because the reed does not reach its full working speed over the first one or two picks and causes an insufficient beat-up during that period. However this problem has been effectively overcome by the use of rush motor drives [Dornier 89] or by not inserting picks till the loom speed has built up [Picanol 93].

Modern weaving machines incorporate many refinements to produce a high quality fabric. However, set marks are still likely to be produced as the amount of cloth fell drift during a loom stoppage may vary from stoppage to stoppage and cannot be determined accurately except by some direct measurement. Should this fell displacement be measured, and corrected immediately before resuming weaving, then it is logical that any pickspacing variation likely to take place at start-up can be minimised.

Although different preventive measures are in use, yet an effective method has to be designed that considers direct compensation for actual amount of fell drift. This paper presents a review of existing methods and introduces a computer linked laser based system for compensating cloth fell creep seems to be effective in eliminating set marks in weaving.

2. BACKGROUND AND DEVELOPMENTS

Greenwood *et al* [56a, 56b] studied the most fundamental theoretical and practical aspect of the cloth fell on power looms. Vangheluwe [95] and Waesterberg [56] used Instron models to explain the visco-elastic nature of fell displacement during a loom stoppage due to creep of the warp and fabric. However, set marks seem to be more pronounced particularly in high speed weaving [Mohamed 92], and weaving machine manufacturers offer a variety of measures in attempts to avoid this. These include:

- high speed start-up by changing the mode of the motor drive for an initial few picks and then back to normality as shown in Fig. 2 (a) [Dornier 89, 92b],
- shed levelling [Dornier 92a] at stop phase to reduce creep of the warp and fabric,
- reduce tension at stop and restore it before start-up [Benelli 92] in order to minimise resultant creep of the warp and fabric when the loom is stand still,
- late start of let-off with a time delay initially to resume weaving following a stoppage, Fig. 2 (b) [NuovoPignone 93],
- zero crossings at start-up phase i.e., healds crossing without insertion of weft by incorporating slow reverse and full speed forward motion (Fig. 3) [Picanol 93],

❍ starting the loom by applying excessive tension on the warp depending upon the loom starting state: close or open shed start (Fig. 4) [Nissan 83],

❍ shifting cloth fell in an interactive mode based on weaver's experience before starting a loom following a prolong stoppage [Dornier 94],

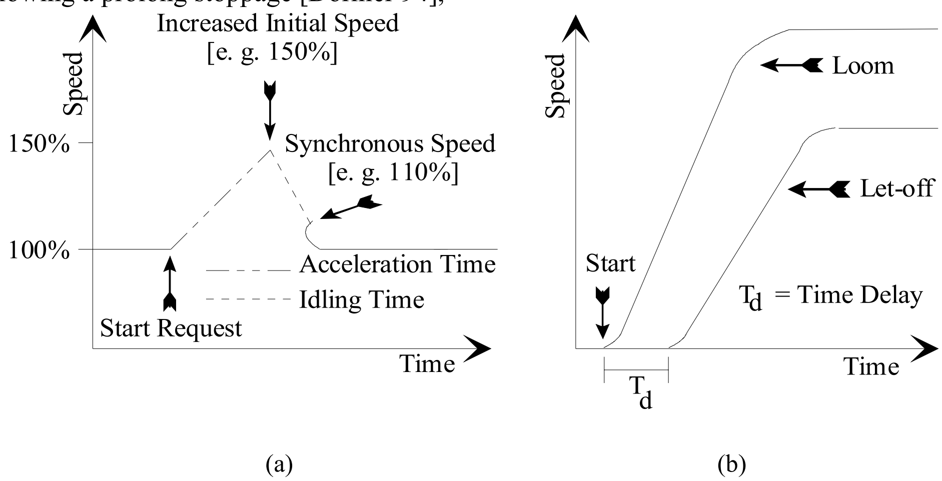


Fig. 2 Loom start-up: (a) rush motor drive, and (b) late let-off start

❍ controlling shed vertex following a stop signal to prevent faulty pick being beaten-up and resumption of weaving without fabric marking [NuovoPignone 94; Sulzer 94a, 94b],

❍ cloth fell control prior to loom star-up in order to eliminate set marks [Islam 96e, Sulzer 95].

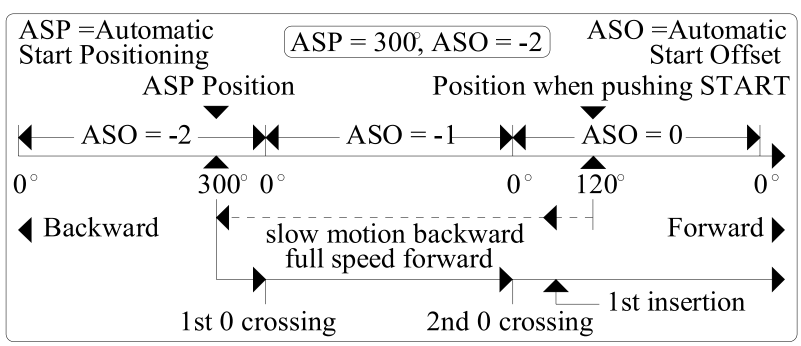


Fig. 3 Zero crossings principle at start-up

To prevent set marks Inui [70] devised a device which restrained warp tension roller only when the loom was started or stopped. This device should be associated with another device manually operated during the loom start, to compensate for reed bending which is more dominant on a water jet loom. In addition, the sley should be brought to the front centre position to operate the 'special pedal'.

Nissan [83] introduced a system, which consists of an optical sensor for detecting loom starting angle, a counter for determining at least one initial cycle during which warp tension is controlled, a tension selector for selecting one of the warp tension signals and a pneumatic actuator to push the easing lever to increase warp tension (Fig. 4). Since the warp and fabric on a loom remain under tension, the cloth fell shifts from its correct position depending on the collective creep of the warp and fabric.

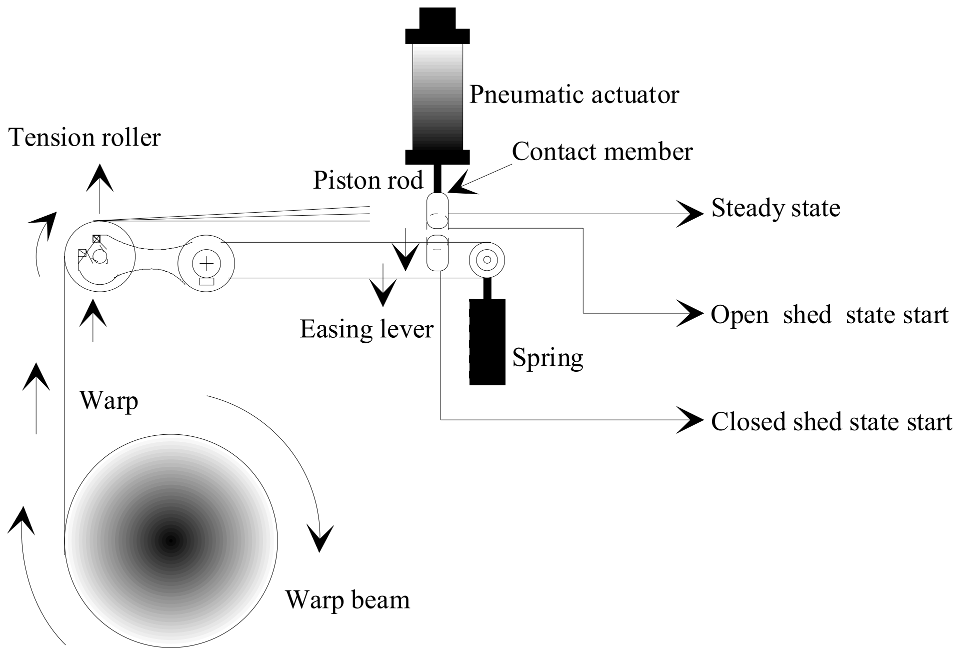


Fig. 4 Extra tension at the resumption of weaving

Depending upon a starting stage - open or closed shed state, by controlling the pneumatic pressure a moderate or high pressure is exerted respectively on the easing lever. This is usually applicable for one or two cycles until the main motor speed becomes stable. Closed shed and open shed state are crucially significant to repair warp and weft breaks respectively. In Fig. 4, a contact member connected with a piston rod of a pneumatic cylinder linked to a three-way electromagnetic valve has three distinct operating states. In the steady state, the cylinder releases its air pressure to keep away the contact member from the spring loaded easing lever.

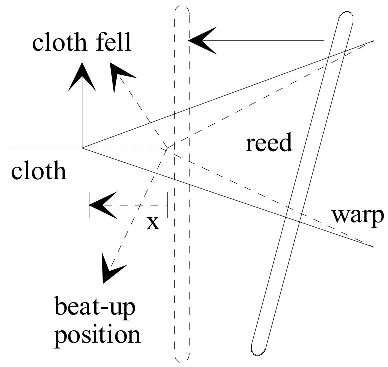


Fig. 5 Cloth fell shifting and repositioning for fault correction

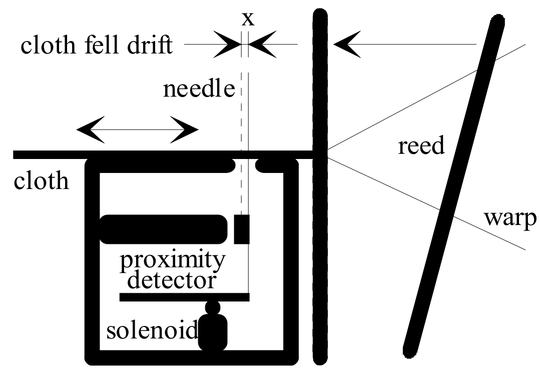
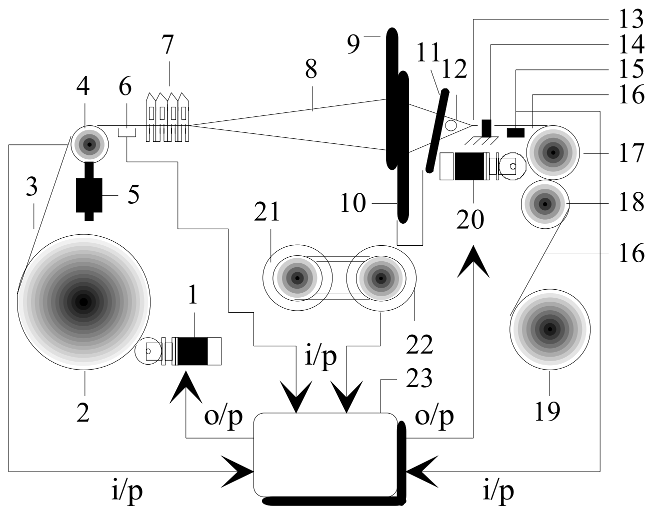


Fig. 6 Cloth fell control to prevent start-up mark formation using proximity sensor

Fig. 5 shows the cross sectional view of the shed vertex movement [Sulzer 94a, 94b; NuovoPignone 94]. As claimed, the mechanism gives an effective start-up after a stoppage, especially for looms with a high insertion rate, without leaving a mark in the fabric. Following a fault signal the control system stops the loom and simultaneously shifts the cloth fell to an offset setting so that the faulty weft is not being beaten by the reed.

In a recent patent [Sulzer 95], Sulzer uses a direct cloth fell control technique. During a loom stoppage, the mechanism (Fig. 6) achieves monitoring the fabric near the fell by inserting a needle, the time dependent displacement x of which is measured by using a proximity detector. Finally, a control function is initiated to reposition the fabric edge prior to loom start-up to prevent creation of set marks.

Islam [96e] introduced a laser based system (Fig. 7) to measure the cloth fell deviation during a loom stoppage and correct it accordingly under computer control before resuming actual weaving. When the loom was stopped, a light weight target plate was provided in the close vicinity of the cloth fell to enable the laser sensor to measure the time dependent fell drift in effect the drift of the target plate. Consequently the cloth fell displacement provided a proportional change in the laser sensor output voltage and this was measured with a sensitivity of 1 μm [Laser 92].



1 let-off motor, 2 warp beam, 3 warp yarn, 4 spring loaded back rail, 5 LVDT: detects the back rail position, 6 warp tension gauge, 7 drop wires, 8 open shed, 9 back heald shaft, 10 front heald shaft, 11 reed, 12 new pick, 13 cloth fell, 14 target plate, 15 laser sensor, 16 fabric, 17 take-up roller, 18 pressure roller, 19 cloth roller, 20 take-up motor, 21 main motor, 22 crank shaft, 23 computer controller, i/p: signal input, o/p: signal output.

Fig. 7 Cloth fell control to eliminate set mark by using a laser sensor [Islam *et al* 96 a]

Prior to loom start-up, the target plate was withdrawn; and cloth fell was corrected for the actual amount of deviation and the normal weaving parameters were restored by means of electronically controlled let-off and take-up mechanisms. In doing so, when the loom was started from a stoppage there was no set marks appeared in the fabric being woven[Islam *et al* 96a, 98b, Islam 96b, 96e, 98a].

3. DISCUSSION

The methods of preventing set marks could be classified as either direct or indirect systems. Indirect systems are used to minimise the size of set marks on the basis of arbitrary assumption based on one's weaving skills. The corrections are not made according to the actual measurement. A direct system is important as it accounts correction of a real-time cloth fell drift measurement; therefore, such a system is likely to be more reliable and effective.

Normal proximity sensors, whose operating distance is limited to only a few millimetres, are not best suited for time dependent cloth fell drift measurement. One of the important advantage of using the laser sensor as described is that it allows to measure the cloth fell from a reasonable distance, as the cloth fell zone is highly critical and significantly interfered with the beat-up action of the reed, and by the nature of pick slipping back when the reed recedes away from the contact of the cloth fell. The laser based method on a loom has been found to be effective in eliminating set marks. The effectiveness of the method is due to the fact that the fell correction provided will be in keeping with the actual drift that takes place during each stoppage.

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