May 4, 1965 H. STUTZ 3,181,573

SHUTTLE CONTROL FOR LOOMS

Filed July 6, 1962 2 Sheets-Sheet 1

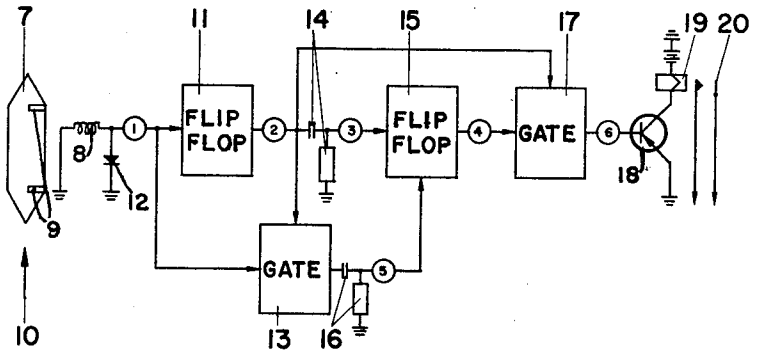


FIG. 1

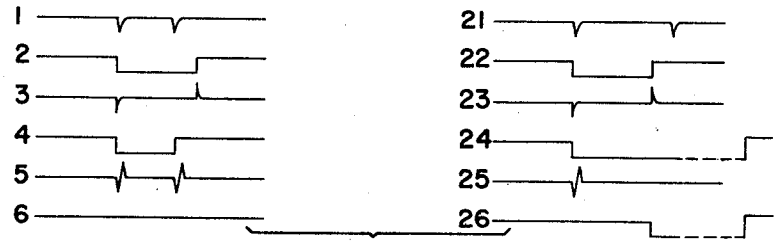


FIG.2

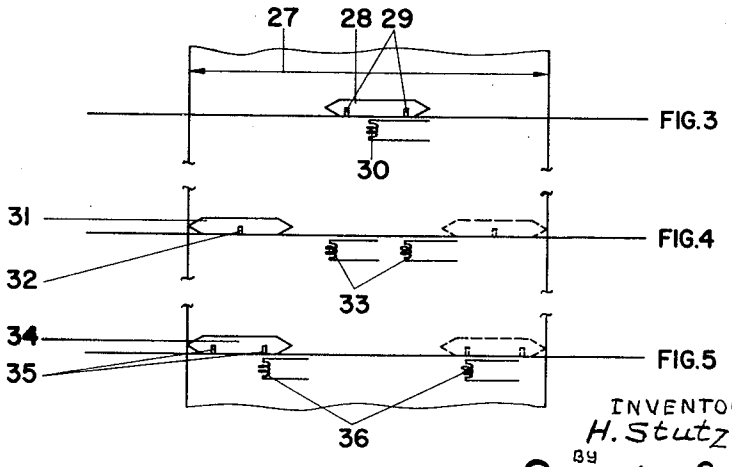


FIG.3

FIG.4

FIG.5

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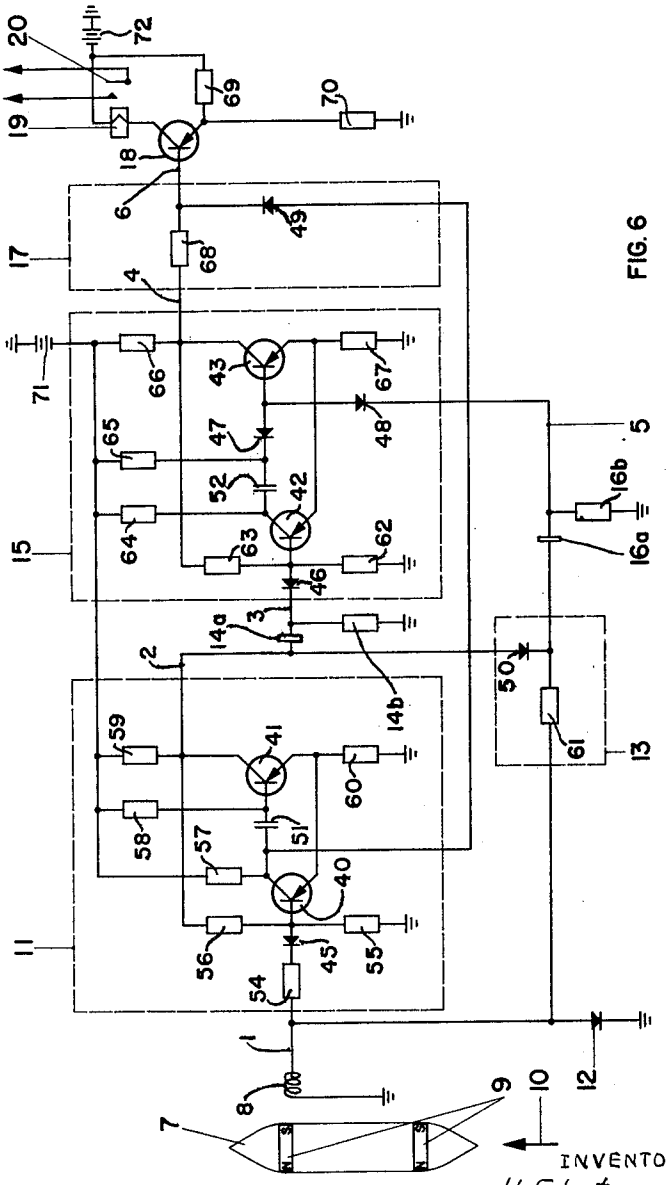


FIG. 6

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SHUTTLE CONTROL FOR LOOMS

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4 Claims. (Cl. 139—341)

This invention relates to shuttle control for looms and refers more particularly to an electromagnetic shuttle control device in looms, which operates without physical contact with the shuttle and which actuates a releasing device to stop the loom when the movement of the shuttle becomes irregular.

Shuttle control devices in looms have the purpose of immediately stopping the loom when movement of the shuttle becomes irregular. Improper movement of a shuttle can result from the following causes:

(*a*) The lay or lathe drive of the loom is worn out or has shifted.

(*b*) A part of the lay or lathe drive is broken.

(*c*) The coupling is worn out and shifts or the driving motor is defective and runs, for example, only on two phases; in both cases the shuttles would be insufficiently accelerated.

(*d*) The shed or parts thereof are not completely open and brake the movement of the shuttle.

(*e*) A single warp thread hangs through and brakes the movement of the shuttle.

In all these instances, if the shuttle control is ineffective, the shuttle would be located in the shed during the beating up of the reed and would tear a substantial number of warp threads or damage the reed.

In prior art mechanical shuttle control systems the shuttle upon reaching the shuttle box raises a resilient shuttle tongue and a pin connected therewith. If due to the above-described circumstances the energy of the shuttle is insufficient to raise the pin, the batten during the next beating up movement, will cause the pin to strike a stop member, so that the batten is prevented from reaching its front end position for the beating up of the reed. Since this control takes place only during the last phase of the shuttle movement, namely, when it penetrates the box, and since, on the other hand, the loom must be stopped before the next beating up of the reed, there is extremely little time available for loom stoppage. Therefore, the operation is limited to a direct blow braking of the batten, and in the case of high speeds this may easily result in breakage.

For these reasons it is desirable to provide means for detecting an irregularly moving shuttle at an earlier time, namely, at a time when the shuttle is still in the shed and not when it passes into the shuttle box; such arrangement would make available more time for the stoppage of the loom, so that a normal brake could be used for that purpose. It has been suggested to mount a coil in the path of the shuttle in which the shuttle induces a voltage impulse during each passage. If this voltage impulse takes place later than at an instant which is set by a cam mounted upon the batten shaft or the crankshaft, a stopping device is actuated. According to another suggestion, which is based on the same fundamental idea, the movement of the shuttle past a predetermined location of its path is registered by optical means.

The main drawback of both of these proposed solutions is based on the following consideration:

After the shuttle has been thrust, it moves in the loom as an independent kinematic system and is no longer connected with the actual producers of the weaving cycle, such as the crankshaft, batten shaft etc. If the movement of the shuttle past a predetermined section of its path in relation to a time period determined by the position of the cam be taken as the criterion of the correct flight of the shuttle, then this is equal to the determining of the time period from the moment the shuttle is ejected by the beating up device to the moment when it reaches said predetermined location upon its path. However, since the shuttle moves during this time period from its end position to the location at which the release may be actuated, i.e., since it moves through a definitely determined portion of its flight path, the above-mentioned determining of the time period means a rough determination of the speed of the shuttle. The speed is only approximate since the shuttle, during its passage through the stretch being determined, moves partly with an accelerated speed and partly with a decelerated speed, so that only an average speed can be determined in this excessively long stretch. It can happen that, for example, the shuttle is excessively accelerated due to an excessive blow and after being projected is excessively retarded due to insufficient shed opening; these two errors may compensate each other, so that the shuttle will pass through the designated location at the right moment and the control will not be actuated, and yet the shuttle will not reach the box due to increased friction produced by the insufficiently opened shed and the corresponding loss in energy.

An object of the present invention is to eliminate the drawbacks of prior art constructions.

Other objects will become apparent in the course of the following specification.

The present invention is characterized by the feature that instantaneous speed of the shuttle is determined at one or more locations upon the path of the shuttle and is compared with a set value. The scale for this speed comparison is supplied by an electronic time keeper which is independent from the cycle of the loom.

Consequently, the present invention provides for determining the instantaneous speed of the shuttle over a short passage at the location of the releasing means, and not the determining of an average speed over a long path which includes the stretch during which the shuttle is accelerated.

According to one embodiment of the present invention, two permanent magnets are built into the shuttle, which release two voltage impulses when the shuttle flies past a coil mounted in the path of the lathe.

According to another embodiment of the present invention, only one permanent magnet is built into the shuttle which induces a voltage impulse in each of two coils mounted close to and behind one another in the path of the lathe.

In both embodiments the time period between the two impulses which follow each other is compared with an impulse of constant duration. As soon as the time between the impulses exceeds a permissible limit, i.e., when the shuttle moves too slowly, a relay is actuated through an electronic system, said relay being connected to the release magnet of the loom for stopping the loom.

A further feature of the present invention consists in that solely diodes and/or transistors are used for the electronic impulse receiving and transforming purposes as non-linear or active switching elements, and that in these elements only the completely closed and the completely conducting conditions are utilized. This arrangement takes into consideration the requirement for absolute lengthy time stability, since the electronic device operates independently from the characteristic lines of the construction elements used therein. The requirement concerning the highest possible lengthy time stability is of utmost importance for shuttle control in looms, since it must be always taken in consideration that the loom is a producing machine which is usually operated in three shifts and which produces from 200,000 to 300,000 shuttle-inserted wefts in a single day, whereby in large weaving establishments several hundred machines are located in the same room. Therefore, unless the shuttle control operates with the greatest reliability, unpredictable difficulties will arise due to this exceptionally high number of inserted wefts. To these difficulties resulting from large amounts of wefts, there are added the exceptionally high shock and vibration conditions in the loom; for example, during the ejection and the braking of the shuttle accelerations can occur during normal operation which amount to 110 times that of the earth.

In accordance with the present invention, the electronic impulse converting device operates with monostable multivibrators or flip-flop devices and actual time measuring takes place by means of gate connections.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings showing, by way of example, preferred embodiments of the inventive idea.

In the drawings:

FIGURE 1 shows diagrammatically a shuttle control device of the present invention.

FIGURE 2 consists of twelve diagrams representing voltages as a function of time at different locations of the device indicated in FIG. 1, during normal operation of the loom and also when the shuttle moves at an improperly slow speed.

FIGURE 3 illustrates diagrammatically the shuttle and the control coil in their relation to the fabric.

FIGURE 4 is similar to FIG. 3 but illustrates a different construction wherein two control coils are used, while the shuttle has one magnet.

FIGURE 5 is similar to FIG. 3 and illustrates yet another construction wherein the shuttle has two magnets, while two control coils are used.

FIGURE 6 illustrates the shuttle control device of FIG. 1 in greater detail, particularly as far as the various electrical connections are concerned.

The general operation mode of an embodiment of the shuttle control device will be first explained in connection with FIGS. 1 and 2.

In FIGURE 1, the shuttle **7** which moves forth and back in the shed contains two permanent magnets **9**. For explanation purposes, it is assumed that during this reciprocatory movement the shuttle will move in the direction indicated by the arrow **10** past a control coil **8**. A single signal wave form consisting of a positive and a negative signal impulse is induced in the coil **8** by each permanent magnet **9**. The signal impulses are fed to a control circuitry which consists of the circuit elements **11–17**. The operation of the control circuitry is such that no output control impulse is generated when the two input signal waves from the coil **8** have a time spacing which is smaller than a predetermined time interval, e.g. 20 milliseconds. This case is represented at the left side of FIG. 2, curves **1–6**, where **6** is the output control signal. On the other hand, an output control impulse is generated when the time spacing of said input signal waves is greater than said predetermined time interval. This case is represented at the right hand side of FIG. 2, curves **21–26**, where **26** is an output control impulse.

The circuit elements **11–17** have the following functions:

The clipping diode **12** short-circuits the positive impulses of the input signal wave from the coil **8** so that, at point **1** in FIG. 1, at each passage of the shuttle **7**, two negative signal impulses appear as indicated by curve **1** in FIG. 2.

Circuit element **11** is a time pulse generator, or flip-flop circuit which when triggered by the first of said negative signal impulses of the curve **1** generates a rectangular time impulse as represented by the curves **2** and **22** in FIG. 2. This time impulse has a predetermined duration, e.g. of 20 milliseconds. The second of said negative signal impulses has no influence on that time impulse.

The differentiating capacitor-resistor element **14** derives from said rectangular time impulse a sharp negative and a sharp positive time impulse, as represented by the curves **3** and **23** in FIG. 2, which time impulses have a time spacing equal to the duration of the rectangular time impulse, e.g. 20 milliseconds.

The gate element **13** together with the differentiating element **16** forms a time discriminator circuit. The gate element **13** has a signal input to which the signal impulses (curve **1**) from point **1** are fed, and a control input to which the rectangular time impulse (curve **2**) from point **2** is supplied. The gate element **13** passes the first of the input signal impulses to point **5**. However, the second of the input signal impulses (curve **1**) is transmitted through gate **13** only if it arrives within the predetermined time interval which is defined by the duration of the rectangular time impulse (curve **2**). This case which indicates a proper shuttle flight is represented by the curve **5** in FIG. 2. In case the shuttle is too slow and the second input signal impulse is late (curve **21**), this impulse cannot pass the gate **13** so that, at point **5** of FIG. 1, a curve represented by **25** in FIG. 2 will be produced.

The circuit elements **15** and **17** together form a signal transforming circuit which in the case of two impulses at point **5** (see curve **5** in FIG. 2), delivers no output signal as is represented by curve **6** in FIG. 2, but which in the faulty case according to curve **25** generates a rectangular output impulse (see curve **26**), serving to stop the loom mechanism. Circuit element **15** is a controllable rectangular impulse generator or flip-flop having a first input to which the sharp time impulses (curve **3** or **23**, FIG. 2) are fed and a second input to which the discriminated signal impulses (curve **5** or **25**, FIG. 2) from point **5** are supplied. This flip-flop generates, on triggering it with a single negative impulse, i.e. the first negative impulse in curve **3** or **23**, a rectangular impulse of a relatively long predetermined duration, as represented by the curve **24** in FIG. 2. The duration of this rectangular impulse must be long enough, e.g., 300 milliseconds, to secure the actuation of the loom stopping mechanism which occurs if there appears no second negative impulse at the second input of flip-flop **15** (see curve **25** representing the faulty case). However, when in the case of proper shuttle flight a second negative impulse (curve **5**) is fed to the second input of controllable flip-flop **15**, the latter impulse causes resetting of this flip-flop to its normal, or non-conducting state, so that a shortened rectangular impulse as represented by the curve **4** is generated at the output, or point **4** of flip-flop **15**.

The end gate element **17** has a first input to which the output signals of the controllable flip-flop **15** (curve **4** or **24**) are fed, and a second input to which the rectangular time impulse (curves **2**, **22**) from the time impulse generator **11** is supplied.

The end gate 17 is blocked by the negative rectangular time impulse so that in case the impulse at point 4 is shorter than the rectangular time impulse as in the case of proper shuttle flight (see curve 4), no output signal occurs at point 6, FIG. 1. However, when as in the faulty case the rectangular impulse (curve 24) lasts longer than the rectangular time impulse from point 2, there will be produced a rectangular stop impulse as represented by the curve 26 in FIG. 2, the end of which impulse is defined by the end of the rectangular output impulse of the controllable flip-flop 15, at point 4 (curve 24).

As shown in FIG. 6, the flip-flop 11 which is actuated by the first signal impulse from the coil 8, includes two transistors 40, 41 of the OC70 type interconnected by a condenser 51 of 0.5 microfarad and grounded through a resistor 60 of 220 ohms. One of these transistors 40 is connected with the point 1 through a diode 45 of the OA70 type. At the output terminal of the second transistor 41, namely, at the point 2, there will appear a rectangular impulse of 20 milliseconds duration, as represented by the curve 2 in FIG. 2. This rectangular impulse is transmitted to a R-C, i.e. resistor-capacitor element 14 which includes a condenser of 0.25 microfarad and which has a differentiating effect. Therefore, at the point 3 there will be produced a short negative impulse at the beginning and a short positive impulse at the end of the 20 milliseconds rectangle (numeral 3 of FIG. 2). These short impulses are transmitted to a second flip-flop 15 the conducting time of which amounts to approximately 300 milliseconds. The flip-flop 15 includes two transistors of the OC70 and OC75 types which are interconnected by a condenser of 9 microfarads and a diode of the OA70 type; they are both grounded. The OC75 transistor is connected to a resistance of 220 ohm and to a battery of 12 volts. At the outlet of this flip-flop 15, i.e. at the point 4, will be thus produced a rectangular impulse having the duration of 300 milliseconds. The two impulses of the control coil 8 are transmitted at the same time to a gate element 13 which is operated by means of the flip-flop 11 and which includes a diode of the OA70 type. This device permits the passage of impulses coming from the control coil 8 only when the flip-flop 11 is in the conducting position. At the outlet of this device again a differentiation takes place through the R-C (resistor-capacitor) element 16 having a condenser of 0.1 microfarad; the impulses thus obtained are transmitted to the flip-flop 15. The last-mentioned actuation serves the purpose of switching off the flip-flop 15, so that as soon as an impulse is received from the point 5. The flip-flop 15 is brought back to its position of rest. The outlet voltage of the flip-flop 11 actuates at the same time a further gate element 17 which operates upon the outgoing impulse of the flip-flop 15 and which includes a diode of the OA70 type. Consequently, voltage is present at the point 6 only when the flip-flop 15 is still switched on, the flip-flop 11 being in its switched off position. In that case the relay 19 is excited by the transistor 18 and will actuate by means of its contact 20 the magnet which stops the loom. The transistor 18 is grounded through a resistance of 220 ohm. The relay 19 is connected to a battery of 48 volts.

Obviously, all these indications appearing in FIG. 6 have been given by way of example only.

FIGURE 2 shows the curves of voltages as they appear at the points 1 to 6 of the devices illustrated in FIGS. 1 and 6. At point 1 appear two negative impulses transmitted from the control coil, which are spaced by a time interval of less than 20 milliseconds. Point 2 at at the outlet of the flip-flop 11 has an impulse of a precise duration of 20 milliseconds. Point 3 has a short positive impulse at the beginning of the 20 milliseconds rectangle and a negative impulse at the end thereof produced by the element 14. Point 4 at the outlet of the flip-flop 15 has a rectangular impulse which begins at the first coil impulse and which ends at the second coil impulse, since the flip-flop 15 is brought into its position of rest by the second coil impulse. At point 5 there are two short impulses which come from the coil impulses and which have passed through the gate device 13. Point 6 has always zero voltage since the gate devide 17 stops the short impulse of point 4.

When the speed of the shuttle become smaller, there is a greater distance between the two impulses, as indicated, by way of example, at 21. As before, in point 2 there will be produced a precisely 20 milliseconds long rectangular impulse 22 which is supplied by the flip-flop 11.

Point 3 has a negative and a positive impulse 23 at the beginning and at the end of the 20 milliseconds rectangle. Point 4 has an impulse 24 which is 300 milliseconds long. Point 5 has only the first spool impulse 25; the second spool impulse was suppressed by the gate device 13. As the result, the flip-flop 15 is not switched off any more and, therefore, at the point 4 there appears a 300 milliseconds rectangle 24. The gate device 17 permits the passage of this 300 milliseconds impulse 24 as soon as the 20 milliseconds impulse 22 is terminated. Consequently at point 6 there is a voltage 26 which remains for 280 milliseconds and which actuates the relay 19 for 280 milliseconds through the transistor 18. The switching off magnet is actuated by the contact 20 and the loom stops.

The shuttle control device of the present invention can be used in a loom in a number of different ways:

FIGURE 3 shows an embodiment wherein a control coil 30 is located in the middle of the lay and wherein the shuttle 28 has two permanent magnets 29. As soon as the shuttle 28 has passed with its second magnet the control coil 30, the decision can be made as to whether its speed is adequate or not. Therefore, it is possible to brake the loom from this moment on, if the speed of the shuttle is insufficient. It is obviously apparent that in this construction a substantially greater time is available for the braking of the loom than in prior art constructions which examine the presence of the shuttle at the end of the fabric in the shuttle box.

According to the embodiment of FIGURE 4 the control is carried out by providing two control coils 33 which operate parallel to the flip-flop connections. In that case only one permanent magnet 32 is located in the shuttle 31, which induces an impulse first in one control coil and then in the other control coil.

FIGURE 5 shows a further embodiment of the control device. In this device there are two control coils 36 which again operate parallel to the flip-flop connections. The shuttle 34 contains two permanent magnets 35 and induces two impulses in each coil 36. Thus the flight of the shuttle is always measured at the beginning of the fabric, as well as at the end of the fabric.

As already stated, the detailed switching connections are shown, by way of example, in FIG. 6 in which the flip-flops 11, 15 are provided with transistors as switching elements, whereas the gate elements 13, 17 each are formed by a diode and a resistor.

The whole circuitry is constructed so that the transistors have to provide solely a definite minimum amplification factor. Above this minimum the amplification factor may have any value without affecting the electrical circuit.

This results in a very securely functioning device, since the diodes and the transistors at any time are either in a completely switched off position or in a completely conducting position.

The following table indicates the various electrical components shown in FIG. 6, and their types or values unless already mentioned in the description to FIG. 1.

Table

Reference Number	Component	Value	Type
18	Transistor		OC77
40	do		OC70
41	do		OC70
42	do		OC70
43	do		OC75
12	Diode		OA70
45	do		OA70
46	do		OA70
47	do		OA70
48	do		
49	do		OA70
50	do		OA70
14a	Capacitor	0.25 microfarad	
16a	do	0.1 microfarad	
51	do	0.5 microfarad	
52	do	8 microfarads	
14b	Resistor	27 kilohms	
16b	do	10 kilohms	
54	do	27 kilohms	
55	do	10 kilohms	
56	do	27 kilohms	
57	do	3.3 kilohms	
58	do	47 kilohms	
59	do	3.3 kilohms	
60	do	0.22 kilohm	
61	do	10 kilohms	
62	do	10 kilohms	
63	do	27 kilohms	
64	do	3.3 kilohms	
65	do	47 kilohms	
66	do	3.3 kilohms	
67	do	0.22 kilohm	
68	do	4.7 kilohms	
69	do	4.7 kilohms	
70	do	0.22 kilohm	
71	DC source	12 volts	
72	do	48 volts	

As already stated, the detailed switching connections which are shown, by way of example, in FIG. 6, comprise gate elements which are formed by means of diodes, while the flip-flop elements are formed by transistors. The switching connections are so arranged that the transistors require the last possible strengthening. Above this minimum the additional strength can vary at will without affecting the function of the electrical circuit. This results in a very securely functioning device, since the diodes and the transistors at any time are either in a completely switched off position or in a completely conducting position.

The shuttle control device of the present invention operates with an exceptionally high safety. The basic criterion of the instantaneous speed for determining an improper flight of the shuttle is better suited for solving this problem than was the case with prior art constructions; in particular, the braking of the shuttle by warp threads is properly taken into consideration and compensation by counter-acting processes, such as excessive acceleration during projection and excessive braking in the guide, is completely eliminated. Furthermore, the wiring is very simple, since all parts of the control device are located closely to each other in space; it is not necessary to mount one part of the device in the batten, and the other in the shuttle drive, as is the case in prior art constructions.

The device operates substantially without inertia, due to the elements used in accordance with the present invention, namely, inductive emitters and electronic impulse-varying means, thus further stressing the feature that a greater amount of time is available for the braking of the loom. The device of the present invention, as compared with mechanical devices, has the substantial advantage that it has no mechanically movable parts which are subjected to wear and tear, so that for all practical purposes it has an indefinite life expectancy.

It is apparent that the examples described above have been given solely by way of illustration and not by way of limitation and that they are subject to many variations and modifications within the scope of the present invention. All such variations and modifications are to be included within the scope of the present invention.

What is claimed is:

1. In a loom having a lathe, a shuttle which reciprocates along a predetermined path, and loom stopping means; a shuttle control comprising, in combination with a permanent magnet carried by the shuttle, a pair of fixed coils located in the path of the lathe close to the path of the shuttle and receiving magnetic impulses from said permanent magnet while the shuttle moves past said coils, electronic time-comparing means connected with said coils and actuated by said impulses, and means operatively connected with said electronic time-comparing means and said loom stopping means and actuating said loom stopping means when the time difference determined by said electronic time-comparing means deviates from a predetermined time period.

2. In a loom having a lathe, a shuttle which reciprocates along a predetermined path, and loom stopping means; a shuttle control comprising, in combination with a pair of permanent magnets carried by the shuttle, a fixed coil located in the path of the lathe close to the path of the shuttle and receiving magnetic impulses from said permanent magnets while the shuttle moves past said coil, electronic time-comparing means connected with said coil and actuated by said impulses, and means operatively connected with said electronic time-comparing means and said loom stopping means and actuating said loom stopping means when the time difference determined by said electronic time-comparing means deviates from a predetermined time period.

3. In a loom having a lathe, a shuttle which reciprocates along a predetermined path, and loom stopping means; a shuttle control comprising, in combination with a permanent magnet carried by the shuttle, a pair of fixed coils located in the path of the lathe close to the path of the shuttle and receiving magnetic impulses from said permanent magnet while the shuttle moves past said coils, a flip-flop connected with said coils and actuated by one of said impulses to produce an impulse of predetermined duration, a gate element operatively connected with said loom stopping means, and means connected with said flip-flop and said gate element and actuating said gate element to transmit an impulse to said loom stopping means when a second impulse from said permanent magnet is received by said flip-flop after the termination of the impulse of predetermined duration.

4. In a loom having a lathe, a shuttle which reciprocates along a predetermined path, and loom stopping means; a shuttle control comprising, in combination with a pair of permanent magnets carried by the shuttle, a fixed coil located in the path of the lathe close to the path of the shuttle and receiving magnetic impulses from said permanent magnets while the shuttle moves past said coil, a flip-flop connected with said coil and actuated by one of said impulses to produce an impulse of predetermined duration, a gate element operatively connected with said loom stopping means, and means connected with said flip-flop and said gate element and actuating said gate element to transmit an impulse to said loom stopping means when a second impulse from said permanent magnets is received by said flip-flop after the termination of the impulse of predetermined duration.

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