United States Patent

Isvetkov et al.

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[54] AUTOMATIC PROGRAMMING DEVICE FOR LOOMS

[72] Inventors: **Krum Kostov Isvetkov; Ezekiya Gueorguiev Ezekiev,** both of Sofia; **Petko Petrov Nikolov; Vassil Christov Otsetov,** both of Samokov, all of Bulgaria

[73] Assignee: **DSO Avtomatizatsia I Priborostroene,** Sofia, Bulgaria

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[52] **U.S. Cl.** .....**235/92 PD,** 139/171, 139/317, 235/92 R, 235/92 CC, 235/92 PE

[51] **Int. Cl.** **G07c 3/10**

[58] **Field of Search** .....139/171, 179, 317, 319; 235/92 DD, 92 CA, 92 CT, 92 CC, 92 PE

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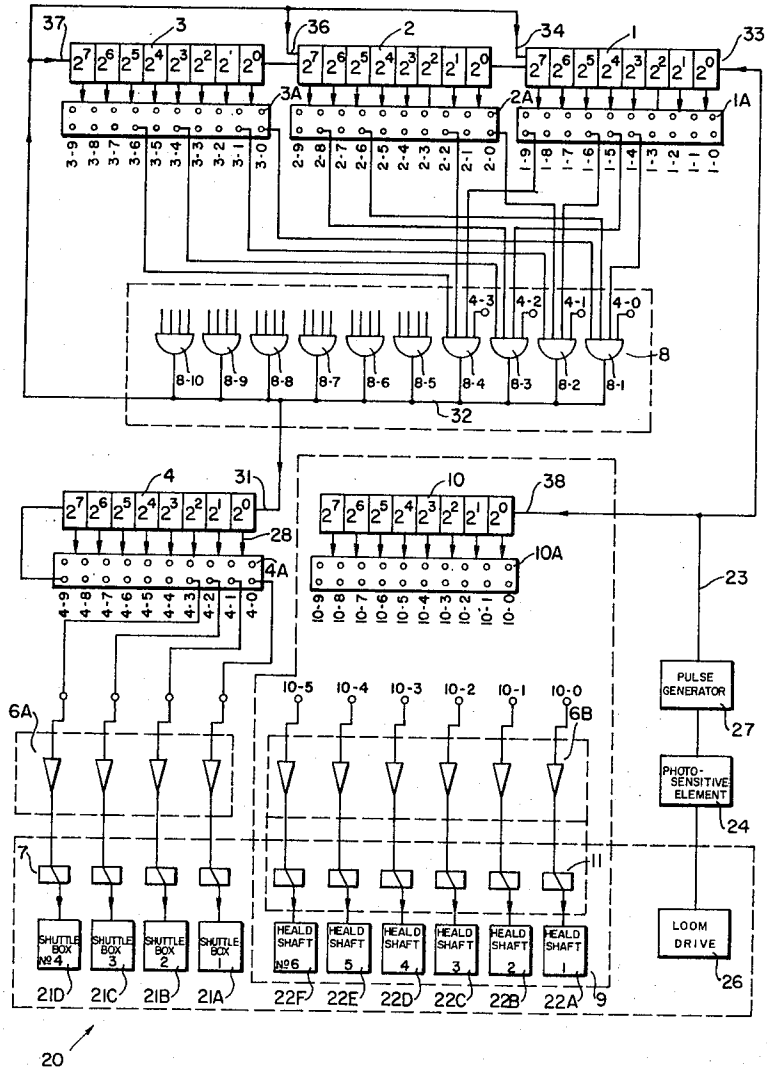
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Primary Examiner—Maynard R. Wilbur
Assistant Examiner—Joseph M. Thesz, Jr.
Attorney—Arthur O. Klein

[57] **ABSTRACT**

A prescribed program of weft color repeats for a loom is represented by stored counts in a plurality of binary counters. During each of a succession of operating cycles of the loom in which wefts of the same color are to be repeated, the loom shuttle box assigned to that color is actuated by a corresponding output of a first one of the counters, whose counting input is driven by a coincidence circuit associated with a second counter. The second counter is pre-set for the prescribed number of weft color repeats and is stepped at the rate of operation of the loom. When the last weft of that color repeat is inserted, the second counter excites the coincidence circuit to step the first counter. This action excites the shuttle box associated with the next weft color. A third counter stepped in synchronism with the stepping of the second counter selectively activates the loom heald shafts in preparation for insertion of the appropriate wefts.

5 Claims, 2 Drawing Figures



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SHEET 1 OF 2

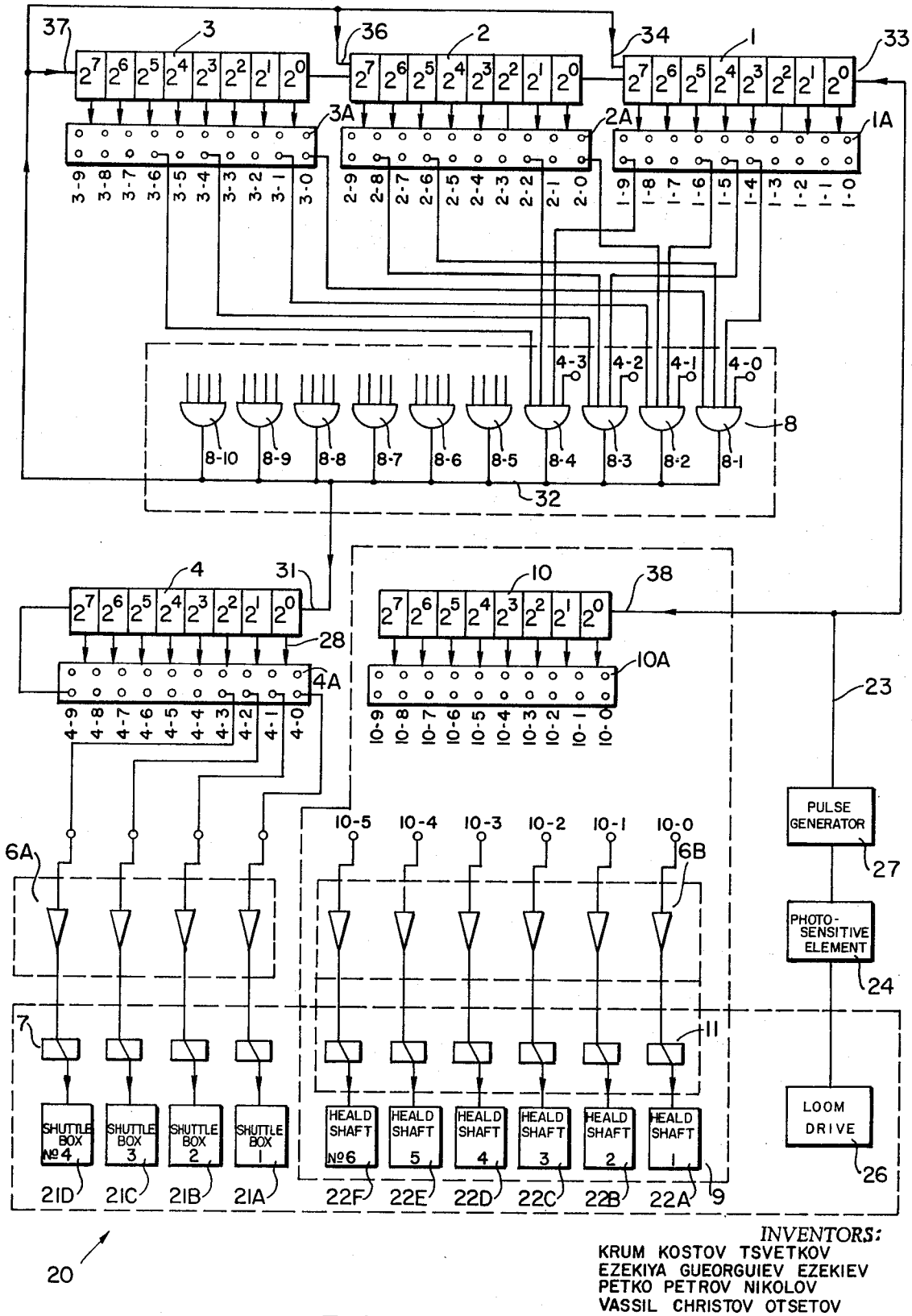


FIG. 1

INVENTORS:
KRUM KOSTOV TSVETKOV
EZEKIYA GUEORGUIEV EZEKIEV
PETKO PETROV NIKOLOV
VASSIL CHRISTOV OTSETOV

BY: Arthur O. Klein

Attorney

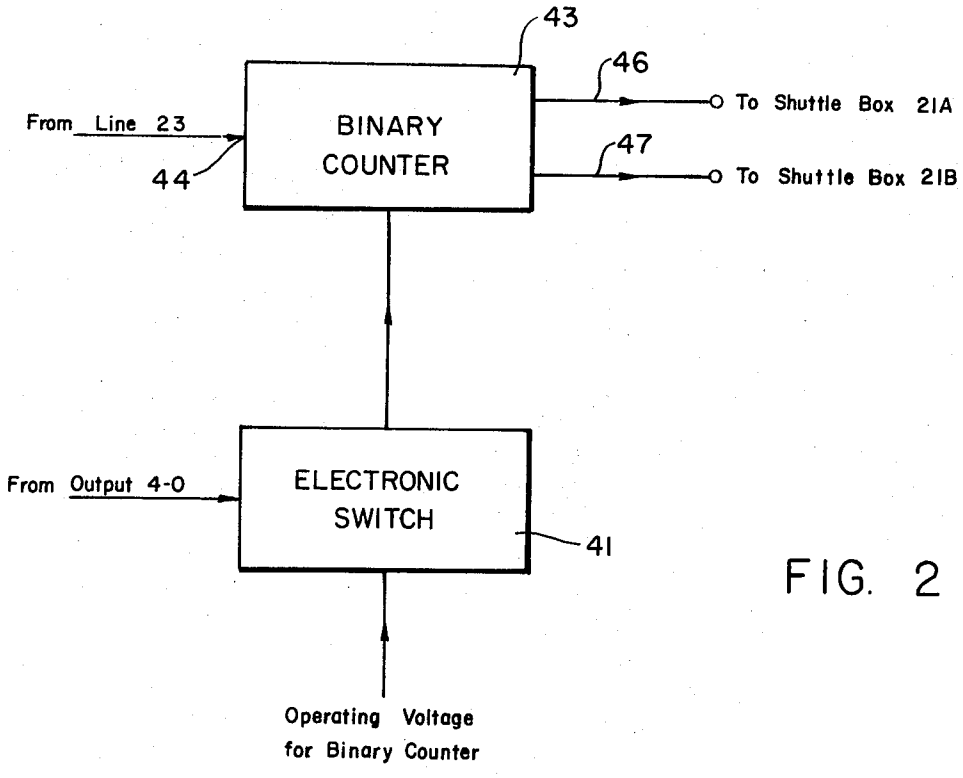


FIG. 2

INVENTORS:
KRUM KOSTOV TSVETKOV
EZEKIYA GUEORGUIEV EZEKIEV
PETKO PETROV NIKOLOV
VASSIL CHRISTOV OTSETOV

BY: Arthur O. Klein
Attorney

AUTOMATIC PROGRAMMING DEVICE FOR LOOMS

BACKGROUND OF THE INVENTION

One common way to program the operation of a loom for complex repeats of a plurality of weft colors is to arrange rollers on axles in a definite sequence. A plurality of levers, whose sequence of operations depends on the relative positions of the rollers on the axles, are employed to actuate the shuttle boxes associated with the different weft colors and with heald shafts used to form a shed in the warp to facilitate weft insertion.

Another common way to control the operating sequence of the shuttle boxes and heald shafts is to employ perforated cards.

The roller-axle arrangement is disadvantageous in that it generally requires chain drives to couple the rollers and levers for operation. Not only does the required frequent lubrication of the chain drive tend to soil the fabric being manufactured, but the arrangement is also subject to rapid mechanical wear and is bulky and complicated when large numbers of wefts in a repeat are contemplated. Program cards are also disadvantageous in that they are time-consuming to prepare and easily torn; moreover, the springs and contact pins on the machine parts with which they are associated are subject to frequent breakage.

SUMMARY OF THE INVENTION

An improved manner of programming a loom for operation to avoid those disadvantages employs the arrangement of the present invention. In an illustrative embodiment suitable for color repeats of up to 10^4 wefts each, each shuttle box is made actuable by a separate decimal output of a first, suitably converted multi-stage binary counter. A common output of a plurality of coincidence circuits is connected to the counting input of the first counter. Each coincidence circuit has (A+1) inputs, A of which are coupled to the individual digits of a unique A-digit number. The latter is represented by corresponding decimal outputs of a tandem arrangement of N second, suitably converted multi-stage binary counters. The remaining inputs of the coincidence circuits are individually connected to the separate decimal outputs of the first binary counter. The counting input of the lowest order second counter is stepped at the rate of operation of the loom.

Each heald shaft is also made actuable, in a similar manner, in response to a selected decimal output of a third, suitably converted multi-stage binary counter. For this purpose, the third counter is stepped in synchronism with the lowest order second counter so that, during each cycle of the loom, a selected warp is lifted in preparation for the corresponding weft insertion.

Means may also be provided for actuating a pair of the shuttle boxes alternately in response to a single selected output of the first counter so that two-faced fabrics may be woven.

BRIEF DESCRIPTION OF THE DRAWING

The nature of the invention and its advantages will appear more fully from the following detailed description taken in conjunction with the appended drawing, in which:

FIG. **1** is a diagrammatic representation of programmed circuitry for selectively actuating the shuttle boxes and heald shafts of a loom in accordance with the invention; and

FIG. **2** is a diagrammatic representation of a modification of a portion of FIG. **1**, wherein a single control output of the programmed circuitry may be employed to control a pair of shuttle boxes of the loom.

DETAILED DESCRIPTION

Referring now to the drawing, FIG. **1** represents an arrangement for automatically sequencing weft color repeats of a conventional multicolor weaving loom **20**. The loom includes a plurality (illustratively four) shuttle boxes **21A–21D** and a further plurality (illustratively six) heald shafts **22A–22F**.

While not specifically illustrated in the drawing, it will be understood that the shuttle boxes **21** may be associated with different color wefts which are to be selectively inserted during each operating cycle of the loom **20** through a shed formed by lifting selected warps. (Illustratively, the boxes **21A–21D** are respectively associated with red, green, blue, and brown wefts.) The warps in turn are separately associated with the heald shafts **22A–22F**.

Each of the shuttle boxes and heald shafts may be brought into operation by suitably exciting an associated one of normally unoperated electromagnetic actuators **7—7** and **11—11**, respectively. The actuators are programmed for excitation in the manner indicated below.

During each cycle of the loom, the required timed operation of the then-actuated heald shaft and shuttle box is synchronized as indicated below by means of a timing pulse generated, during each operating cycle of the loom, on a line **23**. Each such pulse may be derived in a conventional manner by a photosensitive element **24**, which senses the occurrence, at the conclusion of each cycle of operation of the loom, of the sudden making or breaking of a light path in the loom drive mechanism, represented by the block **26**. The excitation of the photosensitive element **24** triggers the operation of a conventional one-shot pulse generator **27**, whose output is coupled to the line **23**.

In accordance with the invention, the individual actuators **7—7** and **11—11** for the various shuttle boxes and heald shafts of the loom **20** may be programmed for a desired sequence of operation by means of a network of multi-stage binary counters. In particular, a first binary counter **4** has a plurality of parallel outputs **28—28** coupled to the inputs of a first binary to decimal converter **4A**. Selected individual decimal outputs **4-0, 4-1. . .4-9** of the converter **4A** are coupled to selected ones of the actuators **7—7** for the shuttle boxes **21** through individual DC amplifiers **6A—6A**. (Illustratively, the first four outputs **4-0, 4-1, 4-2** and **4-3** are coupled to the actuators for the shuttle boxes **21A, 21B, 21C** and **21D**, respectively).

The decimal outputs **4-0, 4-1. . .4-9** may be stepped in sequence to operate successive shuttle boxes **21** by means of stepping pulses applied to a counting input **31** of the counter **4**. Such pulses are produced on a common output **32** of a network of coincidence gates **8-1, 8-2. . .8-10**.

Illustratively, each of the gates **8** has four inputs. Corresponding first inputs of each gate are individually connected to the decimal outputs **4-0, 4-1. . .** of the converter **4A**. The remaining three inputs of each gate **8** are individually coupled in a selected manner to successively higher order decimal outputs of three second binary to decimal converters **1A, 2A**, and **3A**. The particular decimal outputs connected to each gate **8** represent the number of selected repeats for a given weft color as indicated below. (For simplicity, only the gates **8-1, 8-2, 8-3**, and **8-4** are shown with such input connections.)

The converters **1A, 2A**, and **3A** are respectively associated with the parallel outputs of three second multi-stage binary counters **1, 2**, and **3**, which are connected in tandem as shown so that the associated decimal outputs of the converters **1A, 2A**, and **3A** are of successively higher order as required above. As a result, the gate **8-1**, for example, is connected to converter outputs representing the decimal number **064**; the gate **8-2** is connected to the number **106**; the gate **8-3** to the number **485**; and the gate **8-4** to the number **629**.

A counting input **33** of the lowest order second counter **1** is coupled to the line **23** for receiving stepping pulses once during each cycle of operation of the loom **20**. The common output **32** of the coincidence circuits **8** is connected to each of reset inputs **34, 36**, and **37** of the counters **1, 2**, and **3**.

An additional multi-stage binary counter **10** is provided for programming the operation of the actuators **11** for the heald shafts **22**. The counter **10** has a plurality of parallel outputs coupled to the inputs of a binary to decimal converter **10A**. Selected outputs **10-0, 10-1 . . . 10-9** of the converter may be coupled as shown to selected ones of the actuators **11** via DC amplifiers **6B-6B**. (Illustratively, the six outputs **10-0, 10-1. .**

.10-5 are coupled individually to the actuators for the heald shafts 22A, 22B. . .22F.) The counter 10 is connected as shown to automatically reset after the six outputs 10-0, 10-1. . .10-5 have been stepped in sequence. (Illustratively, the counter 4 controlling the shuttle boxes 21 is also connected as shown to automatically reset after the six outputs 4-0, 4-1. . .4-5 have been stepped in sequence.)

A counting input 38 of the counter 10 is coupled to the line 23 for receiving stepping pulses once during each cycle of operation of the loom 20 in synchronism with the stepping of the counter 1.

The manner in which the arrangement of FIG. 1 may be employed will now be described. Assume that a fabric is to be woven with a sequence of weft color repeats (i.e., successive insertions of wefts of the same color during successive cycles of the loom) in accordance with the following table:

Sequence	Color	Number of Repeats
1	red	64
2	green	106
3	blue	485
4	brown	629

In order to execute this program, it is assumed that (1) the loom has just been started, so that no stepping pulses have yet appeared on the line 23 and (2) the counters 1, 2, 3, 4, and 10 have been reset to zero. Accordingly, the decimal "0" outputs 1-0, 2-0, 3-0, 4-0, and 10-0 are excited.

Because of the presence of an output on the line 4-0, the gate 8-1 is conditioned for operation; however, since such gate is pre-set as shown for the count 064, and since the initial count is 000, no output will appear on common line 32.

The excited decimal outputs 4-0 and 10-0 excite the actuators 7 and 11 associated respectively with the "red" shuttle box 21A and the rightmost heald shaft 22A. During the first cycle of the loom, therefore, the selected shuttle box 21A may insert a red weft through the shed formed by actuating the heald shaft 22A. This, of course, is the first weft of the repeat called for in sequence No. 1 of the aforerecited table.

At the conclusion of the first cycle of the loom, the photosensitive element 24 is excited to trigger a pulse from the generator 27. This pulse, appearing on the line 23, steps the counting inputs 33 and 38 in synchronism so that the outputs 1-1 and 10-1 of the converters 1A and 10A are now excited. The count applied to the still-conditioned gate 8-1 is now 001, and the output 32 will remain unexcited. The next heald shaft 22B will be actuated, however, by the excited output 10-1 for forming the shed for the second cycle of the loom.

Since the counter 4 has not been stepped by a pulse on the line 32, the "red" shuttle box 21A is again operated during this second cycle of the loom to repeat the insertion of a red weft.

This sequence of red wefts will continue until 64 red wefts have been inserted. At the end of the 64th cycle of the loom, the stepping pulse on the line 23 will cause the count of the counters 1, 2, and 3 to equal the count 064 pre-set for the gate 8-1. Hence, the gate 8-1 will be opened to excite the output 32. This, in turn, will reset the counters 1, 2, and 3 to zero, and step the counter 4. The output 4-1 will therefore be excited to condition the gate 8-2 for operation and to simultaneously actuate the "green" shuttle box 21B.

Since the gate 8-2 is pre-set for a count of 106, the shuttle box 21B will insert green wefts during the next 106 cycles of the loom in a manner identical to that just described. Further, since the gates 8-3 and 8-4 associated with the outputs 4-2 and 4-3 are pre-set for counts 485 and 629 respectively, and since such outputs 4-2 and 4-3 are individually set to actuate the "-blue" and "brown" shuttle boxes 21C and 21D, it follows that sequences 3 and 4 called for in the aforementioned table will be executed in turn after the green weft insertion. The heald shafts 22A–22F, of course, are operated in sequence during each succession of six cycles of the loom 20 during the execution of the program of the table.

Preferably, each of the second counters 1, 2, 3, 4, and 10 are reversible so that the scheme shown in FIG. 1 may also be employed to control the unweaving of the wefts of an already woven multi-color fabric. In such a case, the counters may be stepped backwards in synchronism with successive pulses on the line 23, thereby to respond to a detected sequence of weft color repeats of a fabric to be unwoven in a manner analagous to the weaving operation described above.

A modification of the arrangement of FIG. 1 is shown in FIG. 2, wherein a pair of the shuttle boxes e.g., 21A and 21B may be actuated alternately by the excitation of a single output, e.g. 4-0 , of the converted counter 4. In this scheme, which is useful, e.g., for interweaving wefts of two different colors, the output 4-0 is applied to the trigger input of a normally closed electronic switch 41. The switch 41 selectively couples operating voltage from a source not shown to a conventional binary counter 43. The counter 43 has a counting input 44 and a pair of outputs 46 and 47. In the absence of operating voltage applied to the binary counter, both outputs 46 and 47 thereof remain unexcited irrespective of the state of the input 44. In the presence of such operating voltage, however, the outputs 46 and 47 are alternately excited by successive pulses applied to the input 44.

The stepping pulses on line 23 are applied to the input 44 of the binary counter 43. The outputs 46 and 47 are respectively coupled to the shuttle boxes 21A and 22A.

With this arrangement, so long (and only so long) as the output 4-0 is excited (i.e., during the 64 pre-set counts handled by the gate 8-1 of FIG. 1 in the example indicated above), operating voltage will be coupled through the switch 41 to the binary counter 43. Hence, the corresponding 64 successive pulses coupled from the line 23 during this interval to the counter input 44 will be effective to alternately excite the shuttle boxes 21A and 21B, thereby interweaving 32 red and 32 green wefts.

In the foregoing, the invention has been described in connection with preferred embodiments thereof. However, since many other variations and modifications will now be obvious to those skilled in the art, it is accordingly desired that the breadth of the claims now be limited to the specific disclosure herein contained.

WHAT IS CLAIMED IS:

1. For use with a loom having a plurality of shuttle boxes associated with separate wefts and operable at a first rate, apparatus for programming the shuttle boxes for operation in a prescribed sequence with weft repeats of up to 10^4 wefts each, which comprises:

a plurality of normally unoperated first means for individually actuating the shuttle boxes when operated;

a first multi-stage binary counter having a counting input and a plurality of parallel outputs individually associated with each stage;

a first binary to decimal converter associated with the parallel outputs of the first binary counter for producing decimal outputs corresponding to the count of the first counter;

means for connecting selected decimal outputs of the first converter to selected ones of the first actuating means for operating the latter when the associated decimal outputs are excited;

a plurality of first coincidence circuits each having A + 1 inputs and a common output;

A second multi-stage binary counters connected in cascade, each second counter having a counting input, a reset input, and a plurality of parallel outputs individually associated with each stage;

A second binary to decimal converters individually associated with the parallel outputs of the A second counters for producing decimal outputs corresponding to the count in the associated first counters to define an A-digit decimal quantity;

means for connecting to A inputs of each first coincidence circuit, decimal outputs from the A second converters representing selected A-digit decimal quantities;

means for individually connecting to the remaining inputs of the first coincidence circuits, the selected outputs of the first converter;

means for coupling the common output of the first coincidence circuits to the counting input of the first counter and the reset inputs of each of the second counters; and

first means for stepping the counting input of the lowest order second counter at the first rate.

2. Apparatus as defined in claim 1, in which the loom further comprises T heald shafts, and in which the apparatus further comprises, in combination, a plurality of normally unoperated second means for individually actuating the heald shafts when operated; a third multi-stage binary counter having a counting input and a plurality of parallel outputs individually associated with each stage; a third binary to decimal converter associated with the parallel outputs of the third binary counter for producing decimal outputs corresponding to the count of the third counter; means for connecting selected decimal outputs of the third converter to selected ones of the second actuating means for operating the latter when the associated decimal outputs are excited; and means synchronized with the first stepping means for stepping the counting input of the third counter at the first rate.

3. Apparatus as defined in claim 1, in which the first stepping means comprises in combination, means for generating a pulse at a selected point in each operating cycle of the loom, and means for coupling the output of the generating means to the counting input of the lowest order second counter.

4. Apparatus as defined in claim 3, in which the apparatus further comprises, in combination, a normally disabled binary counter having an input and first and second outputs, the binary counter being operative when enabled to alternately excite the first and second outputs thereof in response to successive pulses applied to the input; means for coupling the output of the pulse generating means to the input of the binary counter; normally disabled electronic switch means for selectively coupling operating voltage to the binary counter to enable the counter, the switch means having a trigger input operative when excited to enable the switch means; means for coupling a selected decimal output of the first converter to the trigger input of the switch means; and means for individually coupling the first and second outputs of the binary counter to a selected pair of the first actuating means.

5. Apparatus as defined in claim 3, in which, each of the first, second, and third binary counters is reversible.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,674,991 Dated July 4, 1972

Inventor(s) Krum Kostov Tsvetkov et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet [72] the inventor's name "Krum Kostov Isvetkov" should read -- Krum Kostov Tsvetkov --.

Signed and sealed this 7th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.