Nov. 15, 1949 T. HINDLE 2,488,192

PNEUMATIC SHUTTLE OPERATING MECHANISM

Filed Sept. 28, 1948 4 Sheets-Sheet 1

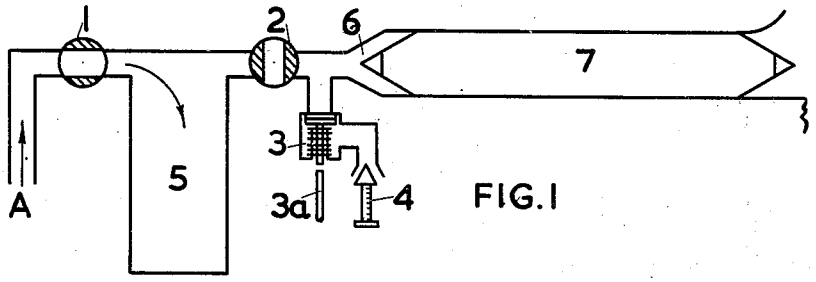


FIG. 1

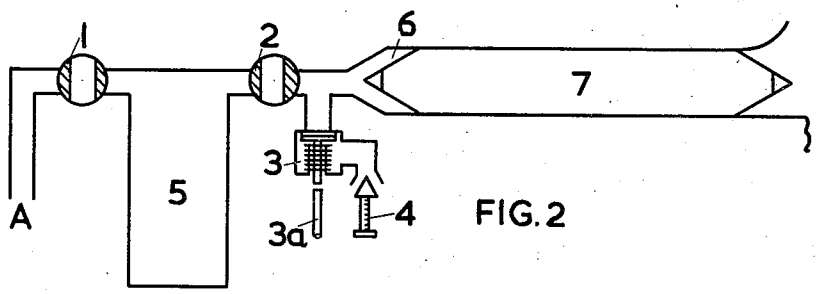


FIG. 2

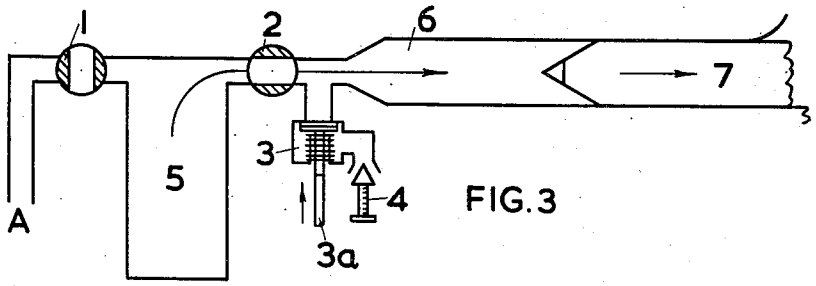


FIG. 3

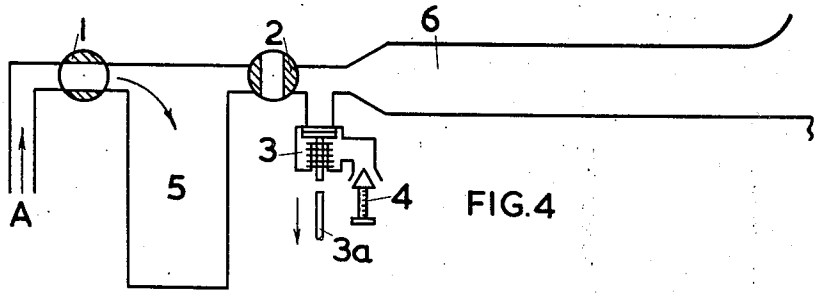


FIG. 4

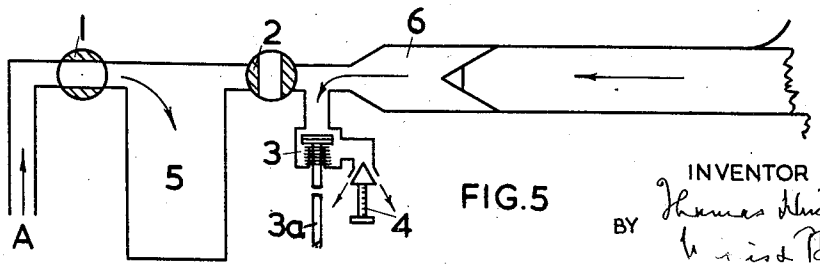


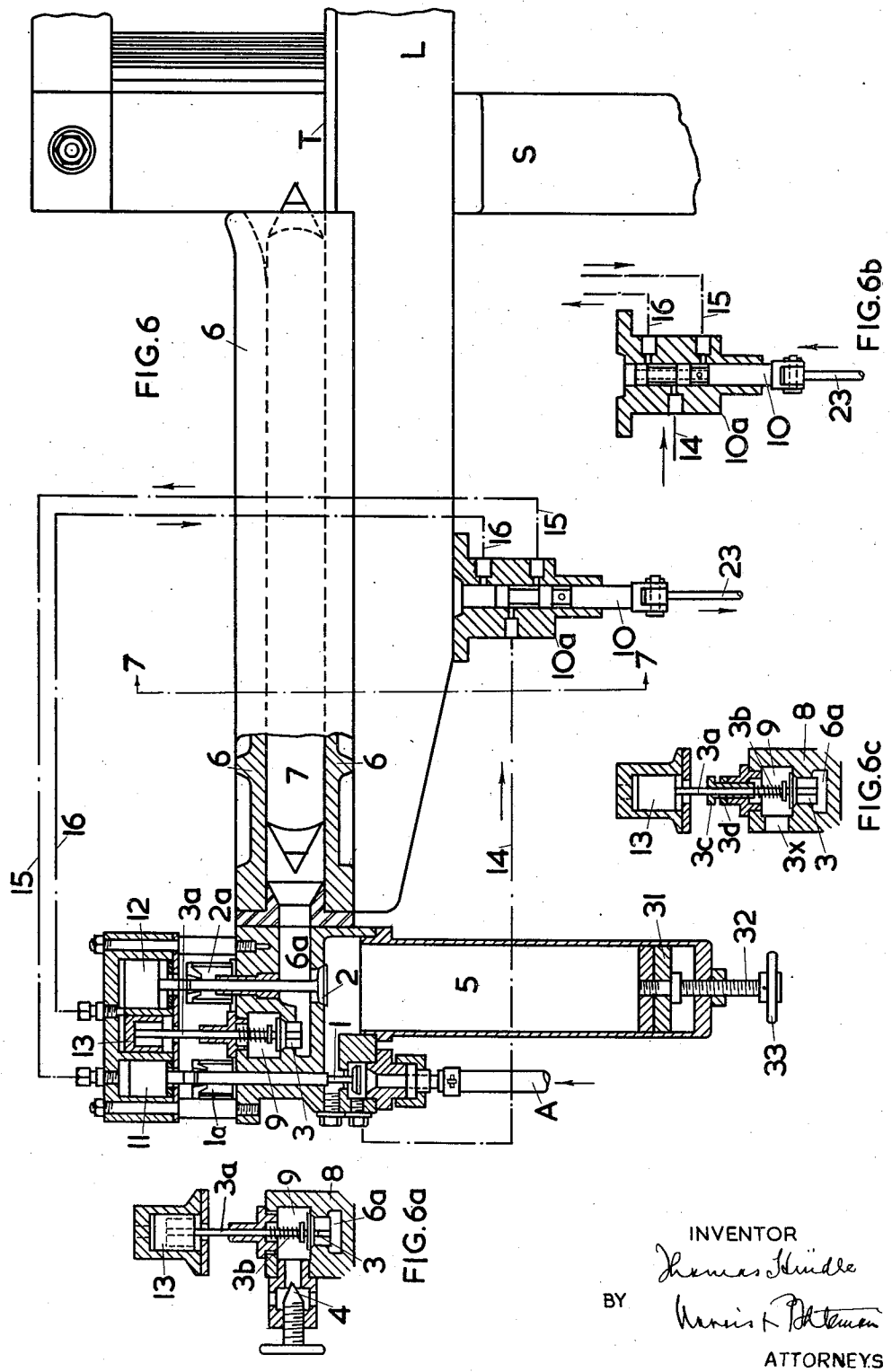
FIG. 5

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PNEUMATIC SHUTTLE OPERATING MECHANISM

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FIG.7

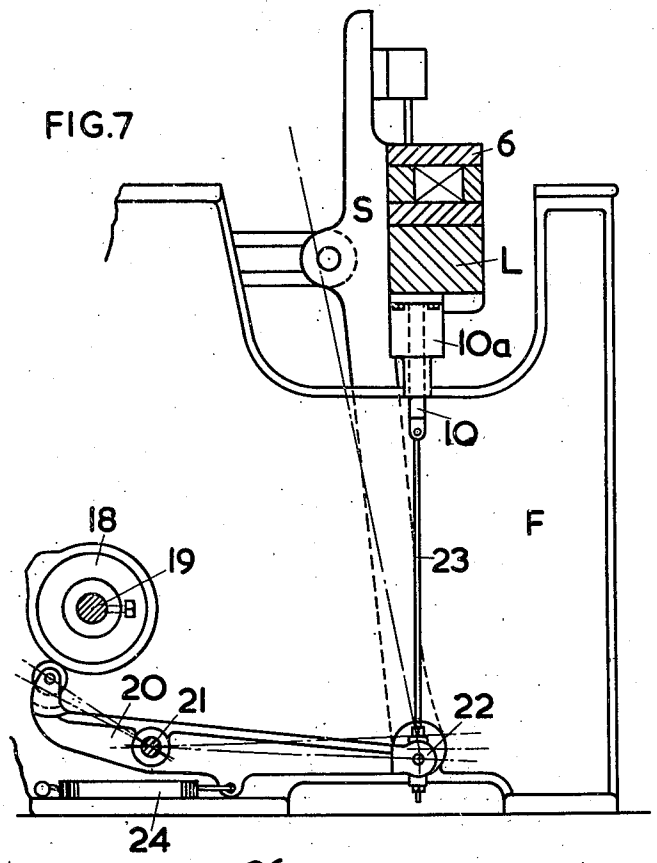
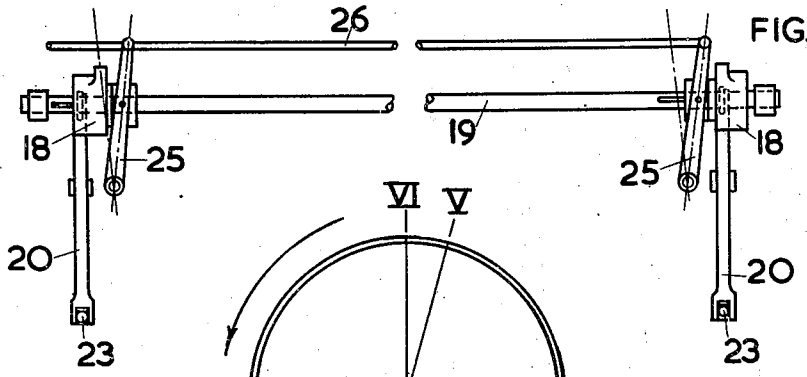


FIG.8



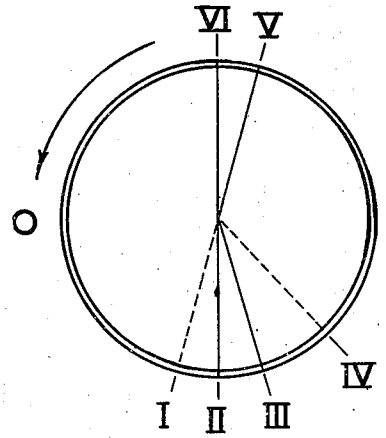


FIG.9

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PNEUMATIC SHUTTLE OPERATING MECHANISM

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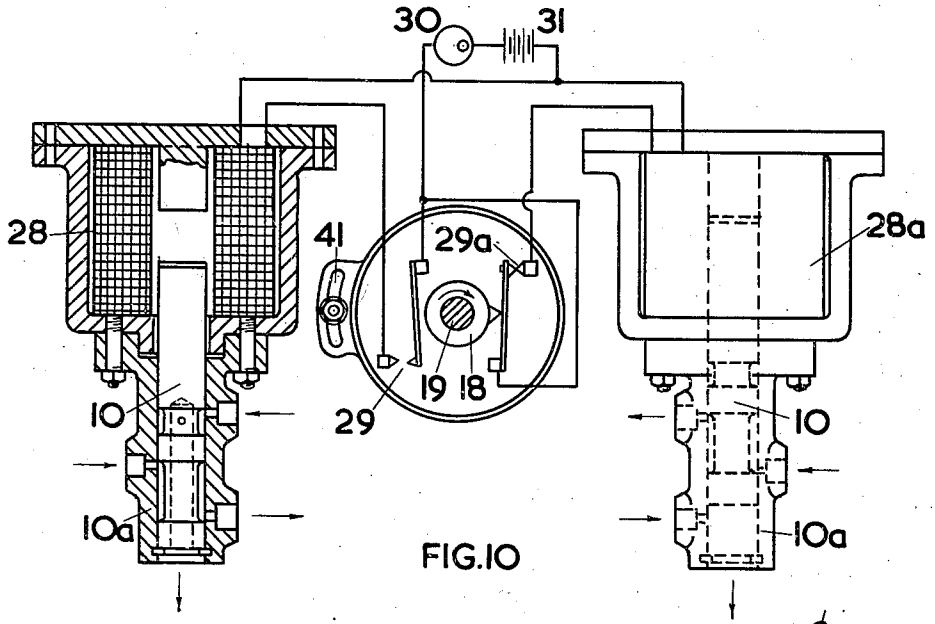


FIG.10

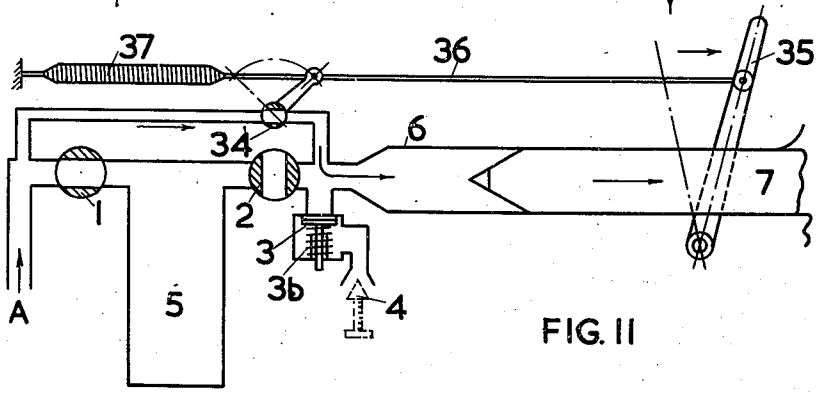


FIG. 11

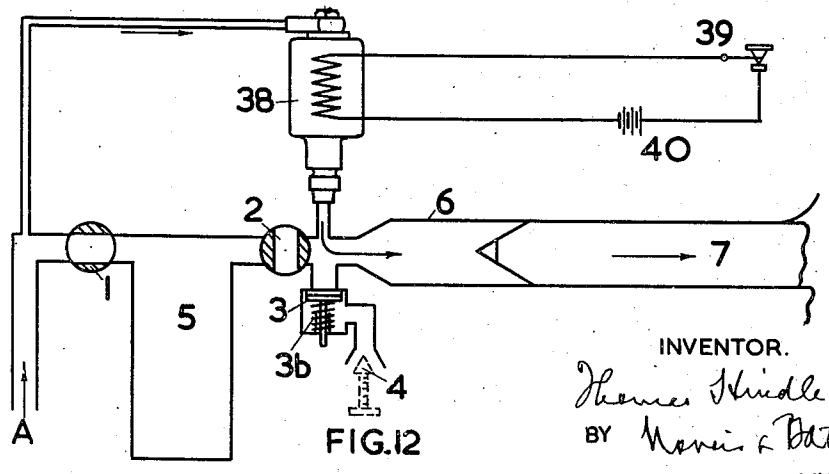


FIG.12

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Patented Nov. 15, 1949

2,488,192

UNITED STATES PATENT OFFICE

2,488,192

PNEUMATIC SHUTTLE OPERATING MECHANISM

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Application September 28, 1948, Serial No. 51,540
In Great Britain October 4, 1947

6 Claims. (Cl. 139—144)

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This invention relates to looms for weaving and in particular to improvements in looms of the type in which the shuttle is expelled from its box and projected across the loom, through the shed and into the opposite box, by the direct action of a blast of compressed air admitted into the outer end of the box behind the shuttle.

One object of the invention is to provide an improved cycle or system of pneumatic picking of the general type above referred to, whereby the pneumatic picking operation is made more reliable, consistent and economical, and also generally more convenient, as the supply of compressed air is preferably derived from a central source, such as a motor-driven air compressor, common to a number of looms.

Another object is to provide apparatus comprising a novel combination of valves which operate in conformity with the requirements of the cycle.

A further object is to provide convenient and simple means whereby the weaver may withdraw a shuttle from a shuttle-box for the purpose of renewing the weft package or for any other purpose.

The improved cycle of operations at each end of the loom according to the invention comprises the following stages in order of sequence:

1. A charging-bottle of suitable and preferably adjustable volumetric capacity is placed in communication with a supply of compressed air maintained at a predetermined pressure, whereby the charging-bottle is charged with a measured volume or charge of air at the said pressure, such measured volume of compressed air being sufficient to effect one pick or discharge of the shuttle.

2. The said charging-bottle is isolated from the supply in immediate anticipation of the pick.

3. At the appropriate time for the picking impulse to commence, (preferably following immediately after stage 2), the said charging-bottle is placed in "full bore" communication with the outer end of the shuttle-box, whereupon the measured charge of compressed air expands into the shuttle-box wherein the pressure of air accelerates the shuttle and discharges it from the box. During the picking impulse any auxiliary outlets, (such as that referred to in stage 4*b*) by which the charged air might escape direct to atmosphere instead of via the shuttle-box, are closed.

4*a*. Shortly after completion of the picking operation as in stage 3, the charging-bottle is first isolated from the shuttle-box, and then re-

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stored to communication with the compressed air supply, from which the bottle thereupon draws a fresh charge of compressed air in readiness for the next picking operation from the same end.

4*b*. Concurrently, the shuttle-box, after disconnection from the charging-bottle as in stage 4*a*, is placed in communication with a cavity or pocket in the valve-box from which air entering the said pocket from the shuttle-box may escape to atmosphere only by passing through an adjustable restriction such as a finely adjustable throttle valve. Thus the incoming shuttle is checked by its compression of the air trapped in the shuttle-box, such air, less that portion which escapes by leakage between the closely fitting shuttle and the shuttle-box walls, being forced out to atmosphere through the said restriction.

The invention is illustrated in and will be described with reference to the accompanying drawings, in which:

Figs. 1, 2, 3, 4 and 5 are diagrammatic views illustrating the cycle of operations for picking;

Fig. 6 is a vertical section of one form of valve gear for carrying out the invention;

Fig. 6*a* is a detail section view at right angles to Fig. 6 of the check valve allowing the escape of air from the shuttle-box as the shuttle enters the box;

Fig. 6*b* is a detail section view of the pilot valve shown in Fig. 6, the valve being in its "off" position in Fig. 6, and in its "pick" position in Fig. 6*b*.

Fig. 6*c* is a detail sectional view of a modified construction of check valve;

Fig. 7 is a partial end elevation of a loom with the slay and shuttle-box shown in section on the line 7—7 of Fig. 6, the pilot valves being mechanically operated;

Fig. 8 is a plan showing further mechanical means for controlling the pilot valves;

Fig. 9 is a timing diagram;

Fig. 10 is a view showing the pilot valve controlled by electro-mechanical means;

Fig. 11 is a diagram showing the use of compressed air controlled by a hand-operated valve for expelling the shuttle from the box at low velocity, and

Fig. 12 is a diagram showing an electro-magnetically actuated valve controlled by a push-button for effecting the same purpose as Fig. 11.

The cycle of operations according to the invention is illustrated diagrammatically in Figs. 1 to 5. In these figures A represents a pipe connected to a source of compressed air maintained at a suitable constant pressure, I the charging-

valve, 2 the pick valve, 3 the spring loaded check valve, 4 an adjustable throttle or choke valve for throttling or choking the air from the check valve to atmosphere, 5 the charging-bottle, 6 the shuttle-box and 7 the shuttle.

In Fig. 1 the charging-valve 1 is open to the compressed air supply A and the charging-bottle 5 is maintained in a fully charged condition. The pick valve 2 is in its closed position, thereby isolating the charging-bottle from the enclosed shuttle-box 6. The check valve 3 is held in its closed position by its spring.

In Fig. 2 the charging valve 1 has been closed to isolate the charging-bottle 5 from the compressed air supply A, in immediate anticipation of the pick.

In Fig. 3 the check valve 3 is forcibly retained in its closed position by the push rod 3*a*, while the pick valve 2 is opened to allow the measured charge of compressed air, previously isolated in the charging-bottle to expand therefrom into the shuttle-box 6. The expanding air exerts pressure on the cross sectional area of the shuttle 7 in sufficient degree to drive the shuttle out of the box at the desired velocity.

In Fig. 4 the check valve 3 is released by retraction of the push rod 3*a*, but the check valve is retained on its seat by its spring. Simultaneously, the pick valve 2 is closed to isolate the charging-bottle from the shuttle-box, after which the charging valve 1 is again opened to admit a fresh charge of compressed air into the charging-bottle. As shown in Fig. 4 the apparatus is ready to receive and to check the shuttle when it returns in due course from the opposite side of the loom.

In Fig. 5 the arriving shuttle traps and compresses the atmospheric air in the shuttle-box 6. A portion of such trapped air escapes directly to atmosphere by way of the small clearance between the shuttle 7 and the closely fitting walls of the box 6, but the major portion is compressed and forced out past the spring loaded check valve 3 and through the adjustable throttle or choke valve 4.

The combined resistance of the check valve 3 and the choke valve 4 checks the incoming shuttle and brings it smoothly to rest in the box, thus completing the cycle of operations.

A practical arrangement of valve gear for implementing the above described cycle of operations as shown in Figs. 6, 6*a*, 6*b* and 6*c*, wherein three poppet or mushroom valves are employed in a valve box 8 provided with the necessary ports and connections. The valve box is bolted to the outer end of the enclosed shuttle-box 6, in the end of which a port 6*a* provides for free passage of air between the valve box and the shuttle-box.

The first of the three valves is the charging valve 1, which opens to admit compressed air from the flexible supply pipe A into the charging-bottle 5, and subsequently closes to isolate the charging-bottle, thereby suspending further withdrawal of air from the supply.

The second valve is the pick valve 2, which opens to admit to the shuttle-box 6, the measured charge of compressed air from the charging-bottle 5, and subsequently closes to seal off the charging-bottle before the charging valve 1 again opens to renew the charge of compressed air in the bottle.

The third valve is the check valve 3, which is forcibly retained in its closed position during the picking impulse (that is, while the pick-valve 2 is open), but otherwise is free to be raised off its seat by air compressed in the shuttle-box by an incoming shuttle. This air then enters the cavity or pocket 9 from which it can escape to atmosphere only by passing through the adjustable throttle or choke valve 4, or equivalent restriction, which, when suitably adjusted, effectively prevents rebound of the shuttle.

The three poppet valves 1, 2 and 3 may be actuated with the described effect by mechanical, electro-magnetic or fluid pressure means, or any combination thereof.

In the form shown in Fig. 6, the charging valve 1 and pick valve 2 are provided with springs 1*a* and 2*a* respectively, which act to close these valves and retain them on their seats. They are opened as required in the sequence hereinbefore specified, also the check valve 3 is forcibly retained on its seat during the picking impulse, by means of compressed air drawn from the supply pipe A and admitted under control of a pilot valve 10 to three relay cylinders, the co-acting pistons 11, 12 and 13 of which are adapted to operate the three valves 1, 2 and 3 either independently or collectively in any desired sequence.

As shown in Fig. 6, the three relay cylinders are mounted on the valve box 8, in axial alignment with the valves. The relay piston 11 actuates the charging valve 1, the relay piston 12 actuates the pick valve 2, and the relay piston 13 acts to hold the check valve 3 forcibly on its seat.

The pilot valve 10 may be of any suitable type such as a piston or slide valve or a combination of seated valves. The preferred form is shown in Figs. 6 and 6*b* and consists of a piston valve of the central admission type with widely spaced ports. The pilot valve 10 may be retained in its "off" position shown in Fig. 6, in which the pick does not occur, by a spring, assisted more or less by gravity or by air pressure, and may be actuated in any convenient manner for the purpose of moving it into its "pick" position shown by Fig. 6*b*.

The pilot valve body 10*a* is connected to the valve box 8 by pipe 14, which conveys compressed air from the supply pipe A for distribution by the pilot valve 10, and by pipes 15 and 16 connected to the relay cylinders containing the relay pistons 11, 12 and 13, the pipe 15 connecting it to the cylinder containing the relay piston 11 and the pipe 16 connecting it to the two cylinders containing the relay pistons 12 and 13.

When the pilot valve 10 is moved into its "off" position (Fig. 6) air pressure is related from the relay pistons 12 and 13, and consequently the pick valve 2 closes under the pressure of its spring 2*a*, while the check valve 3 is left free to open in response to an appreciable increase of air pressure on its underside, such as that caused by an incoming shuttle. The check valve is preferably fitted with a light spring 3*b*, acting to close it and to retain it on its seat. In the "off" position, the pilot valve also admits compressed air from the supply pipe A to the relay piston 11, in consequence of which the charging valve 1 opens and remains open as long as the pilot valve remains in its "off" position.

When the pilot valve is actuated so as to move it into its "pick" position, shown in Fig. 6*b* (with the object of initiating a picking impulse at the corresponding end of the loom) air pressure is first released from the relay piston 11 whereupon the charging valve closes under influence of its spring and air pressure acting directly on the

valve. As the pilot valve completes its movement, air pressure from the supply is admitted simultaneously to the relay pistons 12 and 13, with the result that the check valve 3 is forcibly retained on its seat, and then the pick valve 2 is forced open, so opening up very smartly "full-bore" communication from the charging-bottle 5 to the shuttle-box 6, in which latter the compressed air acts upon the shuttle 7 in known manner.

Shortly after completion of the pick, the pilot valve 10 is caused to return to its "off" position shown in Fig. 6. In the course of this movement, air pressure is first released from the relay pistons 12 and 13, as the port connecting the pipe 16 to the bore of the pilot valve casing 10*a* is opened to the bore above the piston valve, the top of the bore being open to atmosphere, before the port connecting the pipe 15 to the aforesaid bore is in communication with the port connecting the pipe 14 to the bore. Thus, the pick valve 2 closes by reason of its spring before compressed air is admitted to relay piston 11 to re-open the charging valve 1 for the purpose of recharging the charging bottle 5, in preparation for the next picking operation at that end of the loom. The relay pistons 11 and 12, after opening their respective valves abut against resilient washers provided in the bottom ends of the relay cylinders.

In a modification of the valve arrangements so far described, the adjustable choke valve 4 is omitted, in which case the check valve 3 is provided with ready means of adjusting its spring pressure, as shown in Fig. 6*c* in which the spring 3*b* is adjusted by screwed sleeve 3*c* provided with lock nuts 3*d*. The check valve thus adjustably spring loaded, acts as a throttling restriction for the air compressed by an incoming shuttle and escaping to atmosphere by orifice 3*x*.

The pneumatic picking apparatus as shown in Fig. 6 is duplicated at the opposite end of the loom slay L, which is supported in the usual manner on slay swords S and is provided with a shuttle race plate T in alignment with the floors of the shuttle boxes 6.

Alternatively, the valve box 8 may be bolted to or made integral with the front or rear walls of the shuttle box 6, thereby reducing the overall width of the loom.

The two pilot valves may be actuated by cams revolving at half crankshaft speed. Such arrangement is shown by Fig. 7, in which the pilot valve body 10*a* is mounted underneath the slay. The pilot valve 10 at each end of the loom is actuated by a cam 18 secured to a shaft 19 revolving at half crankshaft speed. The cam depresses the rear arm of the lever 20, which is pivoted at 21 on the loom frame F, and causes the front arm of the lever 20 to raise the pilot valve, by means of a vertical link 23, to its "pick" position. The spring 24 acts to assist the gravitational return of the lever and the pilot valve to the "off" position. The bottom end of link 23 is preferably arranged to coincide as closely as possible with the slay sword rocker shaft 22.

The cam at the other end of the loom is displaced by 180 degrees from the position of the cam 18 shown.

Alternatively, the pilot valves may be actuated from a shaft revolving at crankshaft speed as shown in plan view by Fig. 8, wherein cams 18 are adapted to slide longitudinally along the shaft 19, which is provided with feather keys or splines to drive the said cams. Twin levers 25 are pivoted on the loom framework and their free ends connected together by a link 26, which may be actuated by a cam or by a dobby or box motion controlled by a pattern chain in a manner well known. The said twin levers engage the cams 18 and slide them endways, so that when one cam actuates its lever 20 and the pilot valve at that end, the other cam is inoperative.

The pilot valves may also be actuated by electromagnetic means as shown by Fig. 10 in which the pilot valves 10 are alternately lifted into their "pick" positions as their actuating solenoids 28 and 28a are alternately energised by the timing switches 29 and 29*a*. These switches are self-opening, but are closed momentarily and in correct sequence by the cam 18 secured to the shaft 19 revolving at half crankshaft speed. The energising current for this purpose is drawn from a battery 31, or other convenient source of electric power, and the circuit includes a hand-operated master switch 30, by which the picking gear may be put out of action while the loom is being turned over for pick finding purposes.

The timing and the power of the picking impulse provided by the herein described apparatus may be readily and independently adjusted to suit all normal requirements.

Fig. 9 is a timing diagram for a wide loom. The beat-up position is indicated at O, at which time the charging bottle is fully charged. At I the pilot valve at one end is moved into its "pick" position, and the picking impulse occurs at II—III. The cam returns the pilot valve to its "off" position at about IV. The shuttle, after crossing the loom, arrives at the opposite box at V and is checked and brought smoothly to rest at VI.

In the case of the direct cam-actuation of the pilot valves as shown by Figs. 7 and 8, the pick is timed in the usual manner by setting the cam or cams earlier or later on the shaft.

In the case of the electro-magnetically actuated pilot valves as shown by Fig. 10, the timing of the pick is determined by the position of the slay cranks when the timing switch (29 or 29*a*) is closed by the cam. The timing may be adjusted by moving the cam 18 round the shaft 19 in the usual manner, but the preferred method is by rocking the switch or switches as a whole forward or backward around the axis of the cam shaft, which arrangement permits the timing of the pick to be adjusted with great precision while the loom is running. Such rotary adjustment of the timing switches is indicated by providing the casing in which the switches are mounted with an arcuate slot 41 working over a fixed stud provided with a nut by which the casing can be locked in any desired position.

The power of the pick depends upon the volumetric capacity of the charging bottle 5, and the predetermined pressure at which the compressed air supply is maintained. With an air pressure of 60 lbs. p. s. i., the required capacity of the charging bottle is approximately 20 cubic inches per one pound weight of shuttle and cop, so that for a full shuttle weighing 5 lbs., the charging bottle should have a volumetric capacity of about 100 cubic inches, which will provide a shuttle discharge velocity of approximately 45 feet per second.

The power of the pick is increased by an increase of the charging volume of the bottle and also by increasing the maintained pressure of the compressed air supply.

The air supply to each loom or each group of looms may be controlled by an adjustable reducing valve so as to maintain a suitable pressure,

and minor adjustments at individual looms then made by varying the effective volume of each charging bottle. This may be constructed so that it can be screwed in or out of the valve box 8 in order to vary the effective volume of the bottle and, therefore, the volume of one charge of compressed air. Alternatively, the bottle may be provided with a piston 31, the position of which is readily adjustable by means of screw 32 and hand wheel 33 as shown in Fig. 6.

With direct pneumatic picking of the shuttle, the shuttle boxes are necessarily enclosed and consequently the weaver cannot withdraw a shuttle from a box by hand in the accustomed manner. In order to expel the shuttle from the box but at low velocity, a hand operated valve 34 is provided by which compressed air from the supply pipe A may be admitted directly into the outer end of the shuttle box as shown in Fig. 11. Such flow of air is preferably limited by a suitable restriction, or suitably small pipe area, and the valve is of the self-closing type. In Fig. 11, the valve 34 is temporarily opened by hand lever 35 connected to the valve lever by link 36. When the handle is released, the valve is closed by spring 37. These arrangements may be varied in detail.

Alternatively, such temporary flow of air into the shuttle box for gently expelling the shuttle may be controlled, as shown in Fig. 12, by an electro-magnetic valve 38 mounted on the slay and controlled by a push button 39 placed for convenient operation by the weaver, the energising current for this purpose being drawn from battery 40 or other source of electric power.

The pressure of air required for the slow expulsion of the shuttle from the shuttle box is very low and is normally not sufficient to open the check valve 3 against the pressure of its closing spring 3b.

I claim:

1. In a loom for weaving of the type referred to the combination with the shuttle box and the shuttle of a charging bottle connected to a source of compressed air and to the shuttle box, a charging valve arranged between the bottle and the source of compressed air, and a pick valve arranged between the bottle and the shuttle box, the charging valve and the pick valve being controlled from a rotating part of the loom so that they open and close in the desired sequence and the charging valve being always closed when the pick valve is open.

2. In a loom for weaving of the type referred to the combination with the shuttle box and the shuttle of a charging bottle connected to a source of compressed air and to the shuttle box, a charging valve arranged between the bottle and the source of compressed air, a pick valve arranged between the bottle and the shuttle box, and a check valve which operates when a shuttle is entering the shuttle box to allow the escape of air therefrom at a rate which will have a cushioning effect to bring the shuttle to rest at the inner end of the shuttle and means to prevent the opening of the check valve when the pick valve is open, the charging valve, the pick valve and the means preventing the opening of the pick valve so that the charging valve and the pick valve open in the desired sequence, the charging valve being always closed and the check valve always held closed when the pick valve is open.

3. In a loom for weaving as in claim 2 the combination with the charging valve, the pick valve and the means for preventing opening of the check valve of a pilot valve which controls a supply of compressed air to the aforesaid valves in the desired sequence.

4. In a loom for weaving as in claim 2 the combination with the charging valve, the pick valve and the means for preventing opening of the check valve of a pilot valve which controls a supply of compressed air to the aforesaid valves in the desired sequence and a cam rotating at half the speed of the crank shaft of the loom actuating the said pilot valve.

5. In a loom for weaving as in claim 2 the combination with the charging valve, the pick valve and the check valve of a valve box, in which the three valves are located, arranged adjacent to the valve box, three relay pistons each operating in a relay cylinder in the valve and each connected to one of the aforesaid valves, a pilot valve to control a supply of compressed air to said valves, a spring holding the charging valve on its seating but allowing it to be opened when compressed air is supplied to its relay cylinder by the pilot valve, a second spring holding the pick valve on its seating but allowing it to be opened when compressed air is supplied to its relay cylinder by the pilot valve and a third spring holding the check valve on its seating when the compressed air is cut off from its relay cylinder, the said compressed air also holding the valve closed, the said third spring being of such strength that it will allow the escape of air from the shuttle box as a shuttle enters the latter at such a rate as will cushion the shuttle and bring it to rest at the inner end of the box.

6. In a loom for weaving as in claim 2 an auxiliary valve to supply compressed air to the shuttle box to eject a shuttle therefrom at a slow speed.

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