Feb. 16, 1943. J. O. HUNT 2,311,394

CONTROL MECHANISM

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Fig. 1.

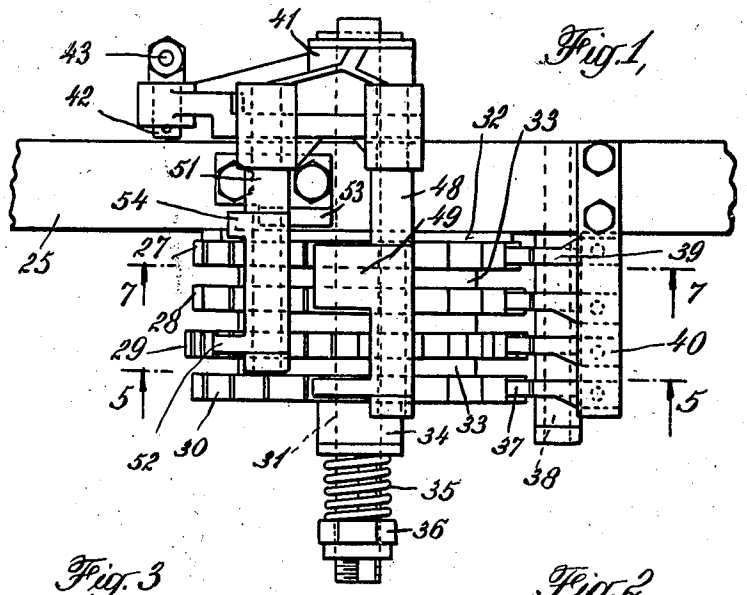


Fig. 3

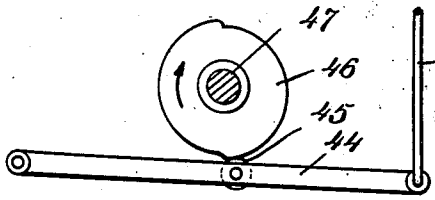
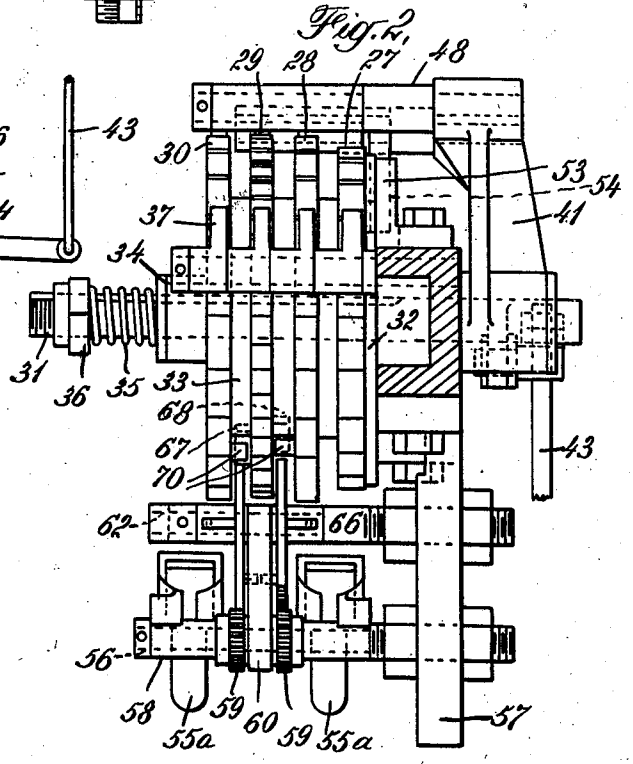


Fig. 2.



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Fig. 4.

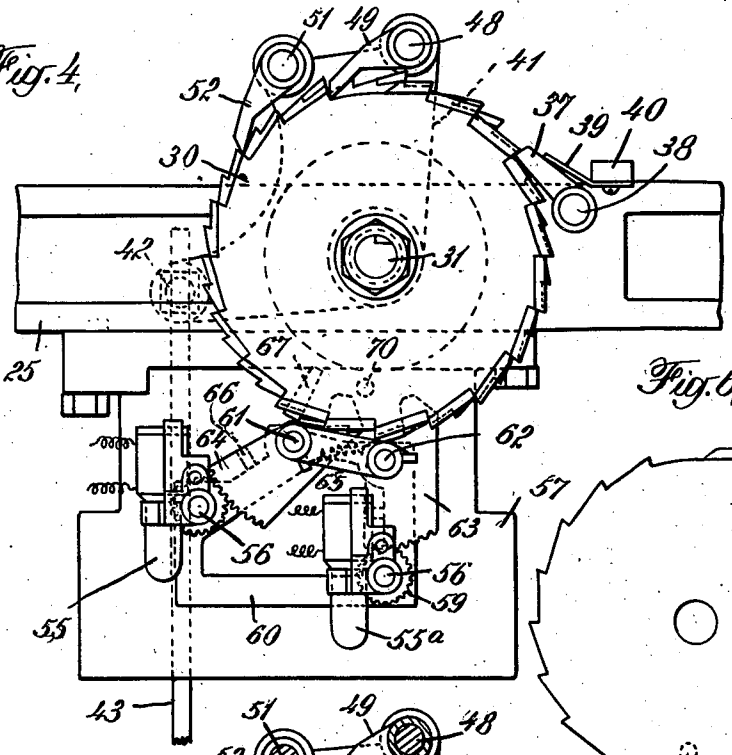
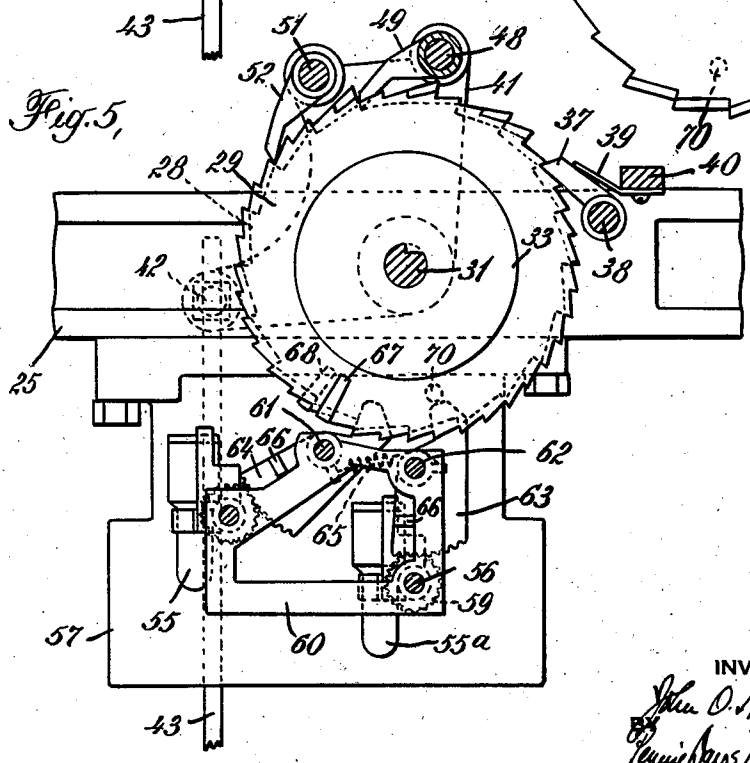


Fig. 6.

Fig. 5.



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Fig. 7,

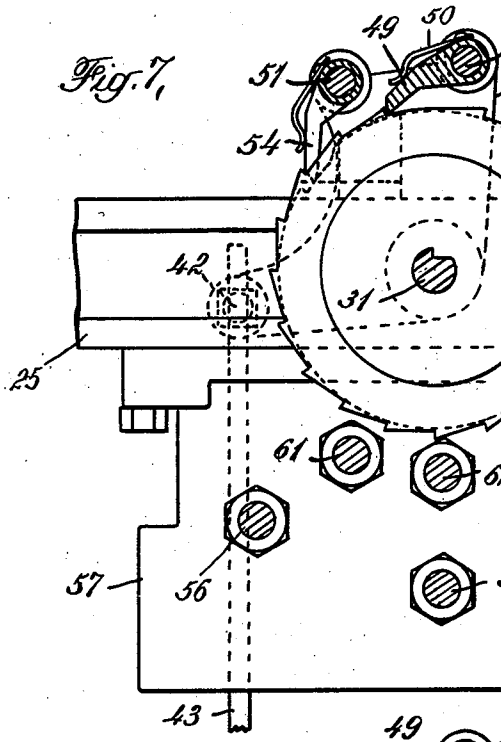


Fig. 9,

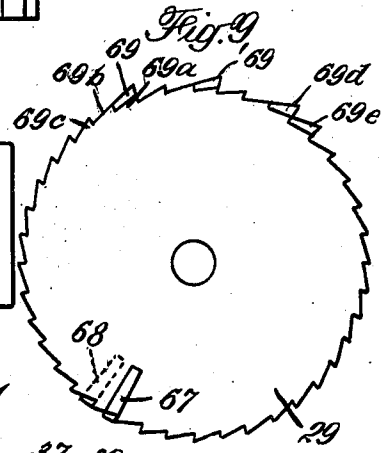
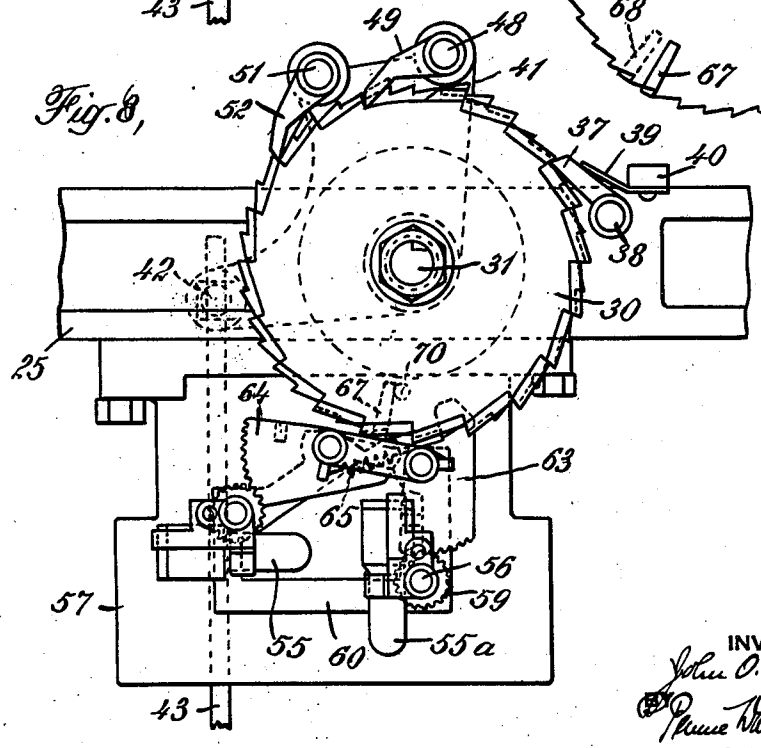


Fig. 8,



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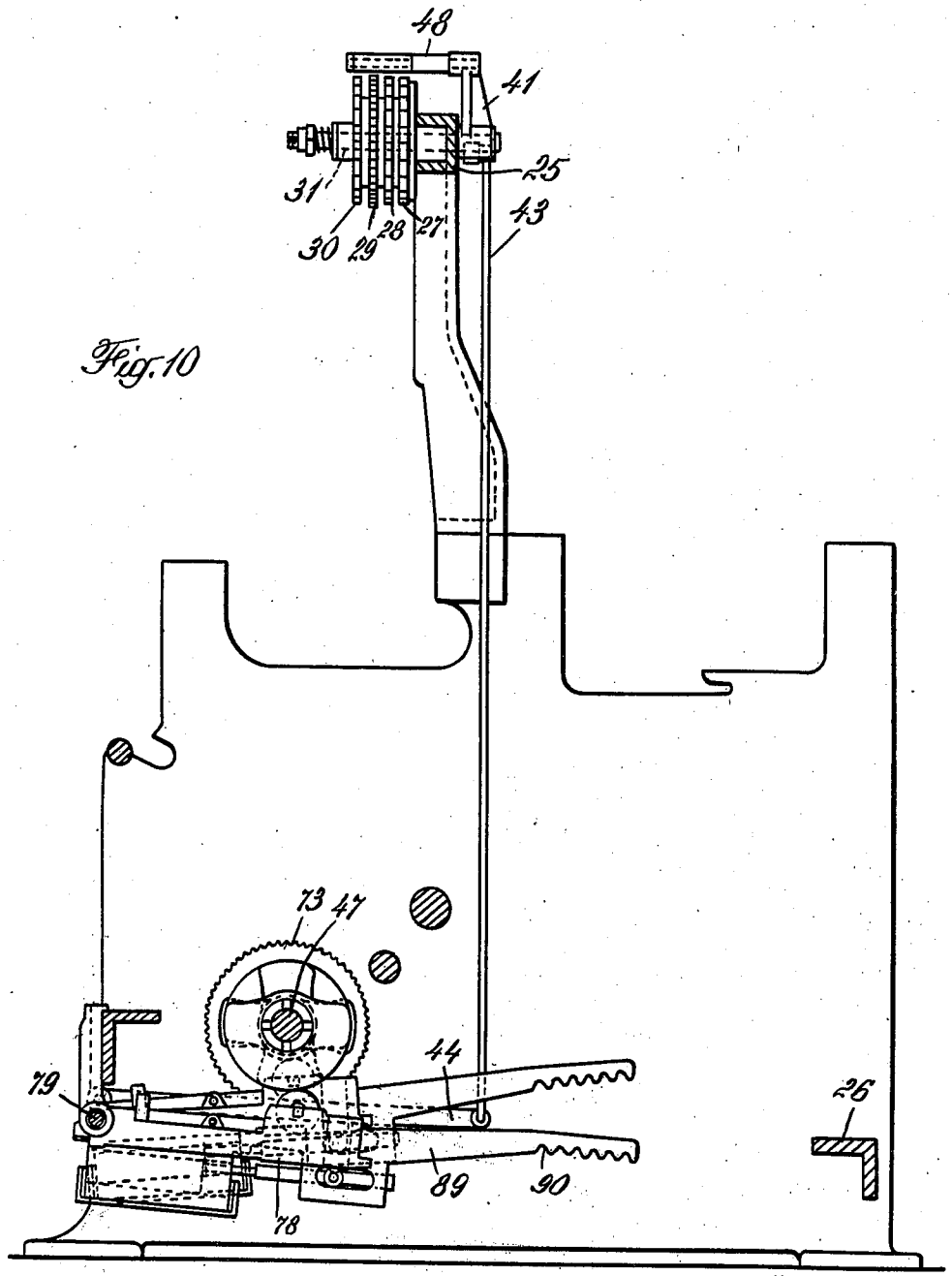


Fig. 10

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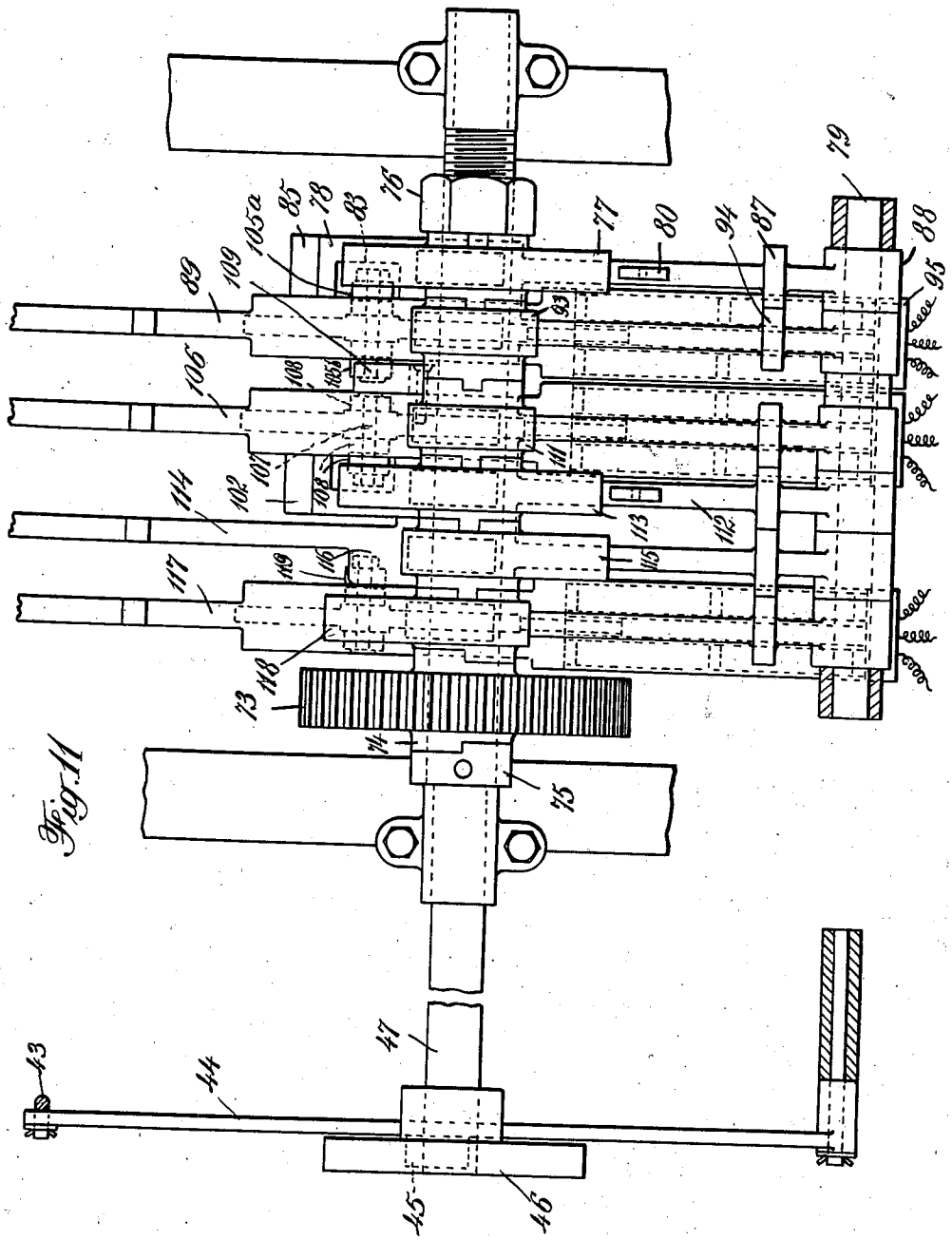


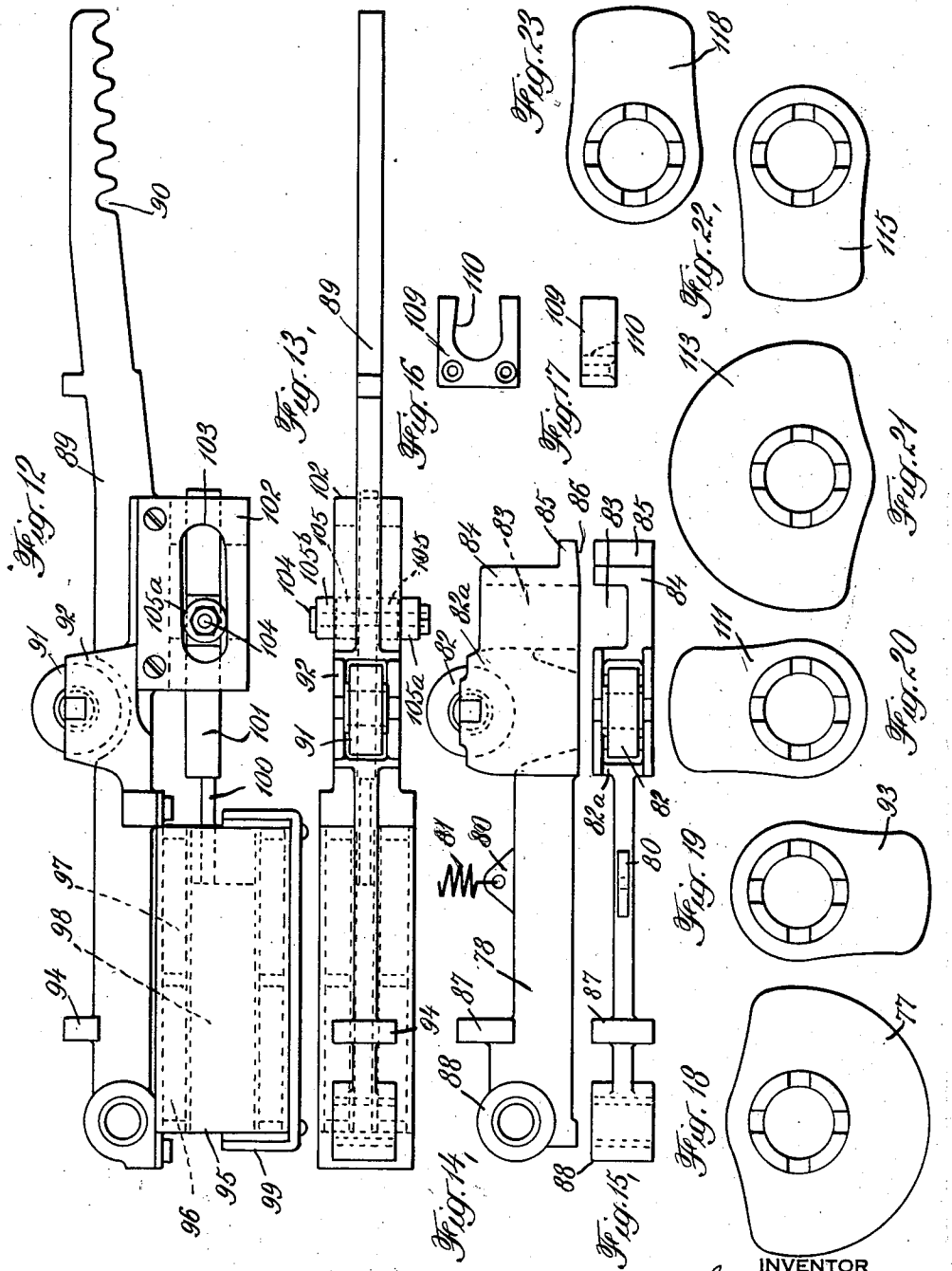
Fig. 11

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CONTROL MECHANISM

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UNITED STATES PATENT OFFICE

2,311,394

CONTROL MECHANISM

John O. Hunt, Ware Shoals, S. C., assignor to Ware Shoals Manufacturing Co., New York, N. Y., a corporation of South Carolina

Original application August 3, 1940, Serial No. 350,679. Divided and this application November 29, 1941, Serial No. 421,006

18 Claims. (Cl. 74—1)

This invention relates to mechanism for controlling the operation of a machine capable of functioning in more than one way, the mechanism causing the changeover in the mode of operation and determining the duration of the period of operation in each way. The novel control mechanism may be used for varying purposes but may be employed to special advantage in controlling the operation of a loom capable of weaving a fabric consisting of alternating lengths of tubular and plain goods. When used in conjunction with such a loom, the control mechanism determines the lengths of the respective sections of tubular and plain goods produced and may be adjusted so that a wide variation in the lengths of these sections is made possible. In order that the construction and operation of the new mechanism may be understood, it will be illustrated and described in a form suitable for use with a loom of the type mentioned, although it is to be understood that its utility is not limited to use with such a loom.

The new control device includes a driver element rotated stepwise in synchronism with the operation of the machine to be controlled and a rotary master element which is advanced under the control of the driver element at a fraction of the speed thereof. During one revolution of the master element, a complete cycle of operations of the machine takes place and, when the control mechanism is used with a loom for making unit lengths of fabric, each containing a plain and a tubular section, the shedding motion of the loom is shifted from one type of operation to the other and back again during one revolution of the master element. The lengths of the sections in a unit length of fabric then depend on the lengths of time required by the master to complete the arcs which it traverses between changes in the operation of the shedding motion.

When it is desired to shorten the length of one of the sections of the fabric being made on the loom, an alteration is made in the master element which causes it to traverse one of its two arcs in a shorter time. This alteration involves the addition of parts, each of which adds an increment of speed, and any desired shortening effect within the capacity of the device may, therefore, be obtained by the addition of more or less parts. Occasionally it is desirable to increase the length of a section of the fabric over that produced by the normal operation of the master and driver elements and, for this purpose, the control device includes a pair of rotary modifier elements, one for each kind of fabric being produced. Each modifier makes one revolution for one of the two arcs of travel of the master element and normally the modifiers perform no functions during their revolution. However, when it is desired to lengthen one of the sections of the fabric, an alteration is made in one of the modifiers, so that it acts thereafter during its rotation to retard the rotation of the driver element by an amount corresponding to the extent of the alteration. With the movement of the driver thus retarded, the time required for the master to traverse that arc of its travel during which the particular fabric section is produced, is increased and, since the loom speed remains constant, a greater length of fabric is thus woven in that section.

The pattern device may exercise its control over the apparatus through various means, but for purposes of explanation, a form of the device will be illustrated and described in which the device operates switches by which current is supplied to means which operate electromagnetically to vary the operation of the shedding motion of the loom.

For a better understanding of the invention, reference may be had to the accompanying drawings in which

Fig. 1 is a top plan view of the new pattern device;

Fig. 2 is a view of the pattern device in side elevation;

Fig. 3 is a view illustrating the drive for the pattern device;

Fig. 4 is a front elevation of the pattern device;

Fig. 5 is a sectional view on the line 5—5 of Fig. 1;

Fig. 6 is an elevational view of one of the modifiers;

Fig. 7 is a sectional view on the line 7—7 of Fig. 1;

Fig. 8 is a view similar to Fig. 4, illustrating the parts in different relative positions;

Fig. 9 is an elevational view of the master element;

Fig. 10 is a sectional view through a portion of a loom on which the new control device is being used;

Fig. 11 is a plan view on an enlarged scale of the treadles and actuating cams of the loom;

Figs. 12 and 13 are views in side elevation and plan, respectively, of one of the treadles of the loom;

Figs. 14 and 15 are views in side elevation and plan, respectively, of one of the treadle actuating levers of the loom;

Figs. 16 and 17 are views in elevation and plan, respectively, of a connecting element which may be carried by one of the loom treadles; and

Figs. 18 to 23 are views in front elevation of the actuating cams of the loom, these cams being illustrated in the relative positions that they occupy as shown in Fig. 11.

The control device of the invention is illustrated in the drawings in a form suitable for controlling the operation of a loom in which there are four heddle frames each connected to a treadle which is actuated by its individual cam. In addition to the treadles, the loom includes a pair of cam actuated levers which are connected to certain of the treadles when the loom is producing one type of fabric. When so connected to a lever, the treadle is actuated by both its own cam and the lever cam and when the levers and treadles are disconnected, the treadles are actuated by their own cams only.

The control mechanism determines the manner in which the treadles will be actuated and the device is mounted on one of the loom girts **25** which connects the side frame members **26** of the loom. The device includes rotary elements **27, 28, 29,** and **30,** which have the form of ratchet wheels and are mounted for free rotation on a stud **31** extending outwardly from the face of the girt. The wheel **27,** which for convenience will be referred to as a driver, has a disc **32** attached to its face opposed to the girt, the disc having a single depression in its surface. Between adjacent wheels are discs **33** of friction material and the wheels are forced together toward the girt to clamp the friction discs between them by a collar **34** on stud **31,** which is pressed against disc **30** by a spring **35** encircling the stud and seated against its outer end against a nut **36.** The stud is formed with a lengthwise channel (Fig. 7) in which portions of the friction discs are seated, so that the discs are held against movement with the ratchet wheels and thus prevent overrunning thereof. Return movement of the wheels is prevented by stop pawls **37** mounted on a rod **38** extending outward from the girt **25,** the pawls being forced against the wheels by individual leaf springs **39** attached to a bar **40** secured to the girt.

A bell crank **41** is mounted for rocking movement on a portion of the stud **31** at the rear side of the girt and one arm of the bell crank is pivotally connected by a pin **42** to a pull rod **43** attached to one end of a lever **44** pivoted on a suitable part of the loom frame. The lever **44** carries a roller **45** held against the surface of a cam **46** on the cam shaft **47** of the loom by means of a spring (not shown) attached at one end to a lever and at the other end to a suitable part of the loom frame. Cam **46** has such a shape that the lever **44** is depressed in two steps and returned to normal position in a single step for each revolution thereof, and the bell crank **41** is correspondingly rocked two short steps in its advance direction and one long step in its return.

The upper arm of the bell crank **41** has two branches and one branch carries a pin **48** which extends over the group of ratchet wheels and carries a multiple pawl **49** having portions engaging the teeth on the driver **27** and on the two wheels **28** and **30,** which may be referred to as modifiers, the pawl being held in contact with the teeth of the several wheels by a spring **50.** Mounted in the other branch of the bell crank is a second rod **51** extending over the group of ratchet wheels and provided with a pawl **52** engaging the teeth on the wheel **29,** which may be referred to as the master wheel. A block **53** is mounted on the girt beneath the rod **51** and close to the surface of disc **32** and the upper surface of the block has the same curvature as the disc **32** and its length is one half the arc of travel of bell crank **41.** The pawl **52** has an extension **54** overlying the edge of the disc **32** and the top of the block and, as the pawl is moved back and forth, the extension bears against the top of the block and the edge of the disc. The block keeps the pawl from engagement with the teeth of the master wheel **29** during the first step of the movement of the pawl and the disc prevents engagement of the teeth of the master wheel by the pawl during the second step of the movement of the pawl, until the depression in the edge of the disc comes beneath the extension. When the disc is in that position, the extension on its next forward movement is kept raised by the edge of the block for the first step and thereafter drops into the depression, and engages a tooth on the master wheel, so that in its second step, the pawl advances the master wheel by one tooth.

The driver and master may have any desired number of teeth, depending on the nature of the fabric to be produced. For one specific fabric, namely, material containing 80 picks to the inch to be used for the manufacture of diapers and made in unit lengths about a yard long, it is desirable to provide the driver with 20 teeth and the master with 40 teeth. A revolution of the master corresponds to the production of a unit length of the fabric, which contains a section of plain weave and another section of tubular weave. Accordingly, during the rotation of the master, the shedding motion of the loom is changed over from one weave to the other and back again under the control of the master.

The changing of the shedding motion of the loom from one weave to the other is effected by proper energization of solenoids associated with the treadles, as will be later described. Current is supplied to the solenoids under the control of four mercury switches **55, 55*a*.** Pairs of these switches are mounted on rods **56** for free swinging movement and the rods are secured to a plate **57** secured to the under surface of the loom girt **25.** Each switch is provided with a sleeve **58** fitting loosely on its rod **56** and attached to the sleeve is a gear **59.** The rods extend through openings in a plate **60** which serves to separate the gears of the two switches on each rod and holds the gears in proper position against movement endwise of the rod.

Extending outwardly from the plate **57** are rods **61, 62** which pass through openings in the plate **60.** Each rod carries a pair of freely movable quadrant members **63, 64** and aligned pairs of quadrant members on the rods **61, 62** are connected together by a spring **65.** Each of the quadrant members **63, 64** is provided with a stop lug **66** and the springs tend to swing the quadrant members to which they are connected to a position in which their stop lugs bear against portions of the plate **60.** Normally, the switches **55, 55*a*** are open and in the upright position illustrated in Fig. 4. When the quadrant member of any switch is swung in a clockwise direction about the rod **61** or **62** on which it is mounted, the switch is moved to a horizontal position (see switch **55,** Fig. 8). This closes a circuit through the switch and permits the flow of current to certain solenoids associated with the loom treadles.

In the construction shown, closing of the switches 55 supplies current to solenoids which operate to place the shedding motion of the loom in condition to weave plain goods, while closing of switches 55a causes energization of other solenoids which change the shedding motion over from plain weave to the production of tubular fabric. The closing of the switches is effected by the swinging of the quadrant plates 63, 64 by means of blocks 67, 68 mounted on opposite faces of the master wheel 29. These blocks are in position to engage the tails of the quadrant plates as the master wheel rotates and the blocks are angularly offset so that the switches of a pair will be closed consecutively. The reason for such successive closing of the switches of a pair is that the changing of the shedding motion can be effected only when the treadles are in specific positions and the blocks are offset by the proper amount to insure that the solenoids will be energized only when the treadles are in the proper positions.

The master wheel 27 ordinarily advances one tooth per revolution of the driver and, consequently, if no provision were made for changing this operation, the one tooth movement of the master wheel would cause block 67 to close one switch 55 and would be followed by a period of rest of the master wheel equal to a complete revolution before closing of the second switch 55. This would prevent the shedding motion from performing its proper functions and to overcome that difficulty, a plate 69 is mounted on the master wheel on top of one of the teeth, the plate having such a shape that its rear surface constitutes a prolongation of the rear surface of the tooth 69a upon which it is mounted and its upper surface constitutes a prolongation of the next preceding tooth 69b. The tooth 69a is two teeth to the rear of tooth 69c, which tooth is engaged by the pawl to advance the master wheel to cause block 67 thereon to swing quadrant 64 and close the first switch 55. On the next advance of the pawl, it engages plate 69 in the first step of its movement and the master wheel is advanced so that block 67 releases the tail of quadrant 64 of the switch 55 that has been closed, permitting that switch to be opened automatically. At the same time, block 68 acts on the quadrant of the other switch 55 and closes that switch. In the second step of the advancing movement of the pawl while it remains in engagement with plate 69, the master wheel is advanced sufficiently to cause block 68 to release the quadrant 64 with which it has been in contact and thus the second switch 55 is allowed to open. The application of the plate 69 to a tooth on the master wheel thus insures that the switches will be operated consecutively and with only a brief duration of closure and it also has the effect of putting out of action the tooth on the master wheel next preceding that on which it is mounted.

After the switches 55 have thus been closed and the loom has begun to produce the section of plain fabric or stripe, the shedding motion remains in condition to produce that weave until it is advanced to the point where, on its next movement, block 67 will engage the quadrant member 63 of each of the switches 55a and effect closing of that switch. The consecutive opening and closing of the switches 55a is effected in the desired short time interval by the application of a second plate 69 to the proper tooth on the master wheel. When switches 55a are thus closed, the solenoids supplied with current through them are energized and the shedding motion is altered, so that the loom produces tubular fabric. This operation continues until the master wheel has been rotated sufficiently to cause blocks 67, 68 to actuate switches 55 a second time.

The control device illustrated is arranged to cause the loom to produce a fabric having relatively long tubular sections and relatively short stripe sections. Accordingly, switches 55 and 55a are so mounted that their quadrant plates lie relatively close together along the path of travel of the blocks 67, 68. The arc through which one of the blocks 67, 68 travels from its point of contact with a quadrant plate 64 to its point of contact with a quadrant plate 63 thus corresponds to the weaving of a stripe and the arc of travel between the point of contact of the block with quadrant plate 63 and the point of contact of the block with quadrant plate 64 corresponds to the weaving of the tubing. In some instances, it may be desirable to produce a fabric in which the sections are of equal length or in which the stripe is longer than the tubing. In those cases, the positions of the switches and quadrant plates are altered to provide arcs of travel of the desired length.

If the master wheel were not equipped with two plates 69, a complete revolution of the driver would be required to advance the master by one tooth and thus, in the given case, with the driver provided with 20 teeth and advanced one tooth per revolution of the loom cam shaft and the master provided with 40 teeth, one revolution of the master would correspond to 800 revolutions of the shaft. In the loom employed, 4 picks are woven in the fabric in each revolution of the cam shaft and in the case assumed, a complete revolution of the master would correspond to the weaving of 3200 picks, that is, to the production of 40 inches of fabric having 80 picks to the inch. However, two plates 69 must be applied to the master to effect closing and opening of the switches of a pair in rapid succession and each plate puts out of action the tooth on the master immediately preceding that on which the plate is mounted, that is, as illustrated, the application of plate 69 to the tooth 69a puts the preceding tooth 69b out of action. Also, when the master pawl has advanced tooth 69c and then moved back behind the plate 69, the pawl in its next forward movement, at once engages the plate and advances the master, instead of remaining ineffective, until the driver has completed a revolution and the depression in plate 32 has moved in front of the nose of the pawl. Accordingly, the presence of a plate 69 speeds up the advance of the master, so that the master advances forward by two teeth on one revolution of the cam shaft, corresponding to 4 picks. With two plates 69 mounted on the master, there are only 36 of the 40 teeth on the master which correspond to the weaving of 80 picks apiece, and while the master is being advanced by engagement of its pawl with those teeth, 2880 picks are being woven. While the master is being advanced by engagement with the pawl with each of the plates 69, the master and driver operate at the same speed and the master performs no accumulating function. Accordingly, a complete revolution of the master, provided with 36 teeth and two plates 69, corresponds to the weaving of a length of fabric containing 2880 picks and thus 36 inches long.

The mounting of a plate 69 on a tooth of the master thus shortens the unit length of fabric and if alternate teeth of the master are provided with such plates, the master will operate as if it were a 20 tooth wheel and will, therefore, rotate at the same speed as the driver so that the unit length of fabric will contain 80 picks. If a single plate 69*d*, additional to those required for switch actuation, is applied to the master, plate 69*d* will put the tooth immediately ahead of it out of action, so that in one stroke of the pawl 52 while it is in engagement with the plate, the master will be advanced by two of its teeth. This advance will occur while 4 picks are being woven in instead of the 160 picks which would normally be woven in during such an advance, if plate 69*d* were omitted. The application of the plate 69*d* thus reduces the unit length of fabric by 156 picks.

If a second additional plate 69*e* is applied to the master immediately behind plate 69*d*, the rear end of plate 69*e* will lie adjacent the forward end of block 53 when the pawl 52 has completed the stroke during which it is in engagement with plate 69*d*. Accordingly, when the pawl makes its next forward movement, it will not engage the plate 69*e* during the first step thereof but only during the second step. The engagement of the pawl with the plate 69*e* will thus cause an advance of the master wheel by only one tooth and during that advance, 4 picks will be woven in the fabric. Accordingly, the application of plate 69*e* to the tooth immediately following that on which plate 69*d* is mounted, shortens the fabric by only 76 picks. From the foregoing, it will be apparent that by the application of plates 69 to the master in varying arrangements, varying reductions of the length of the fabric unit may be obtained.

The relative lengths of the picks in a unit length of fabric depend basically on the length of the arcs through which the master travels between the points of switch actuation, but the mechanism is so constructed that the relative lengths of the sections and also the unit length may be increased, if desired. For this purpose, the modifiers 28 and 30 may be employed.

Each modifier is similar in all respects to the driver 27, except that one tooth has been omitted and each modifier carries a pin 70 which lies in such position as to be engaged by blocks 67, 68 on the master. Normally the modifiers are at rest with the places from which teeth have been omitted lying beneath the ends of extensions on the pawl 49 by which the master is advanced and the modifiers remain in this position until blocks 67, 68 on the master engage the pins 70. One modifier is active during the formation of the stripe and the other during the formation of the tubing.

Assuming that the modifiers are at rest with the pin 70 on modifier 28 just beyond the tail of one of the quadrants 63 (Fig. 5) and the pin on modifier 30 just beyond the tail of one of the quadrants 64 (Fig. 4), the next step in the advance of the master, beyond that which will cause block 67 to rock one of the quadrants 64 and close the associated switch 53, will cause the pin 70 on modifier 30 to be engaged by block 67 and the modifier advanced so that one of its teeth will pass beneath the end of pawl 49. The modifier will then be advanced by one tooth for each action of the pawl until the modifier has completed a revolution and the place from which the tooth is missing again lies beneath the end of the pawl. During this period, the loom will weave the stripe and by the time the modifier has returned to its initial position, the block 67 on the master will have moved past the place then occupied by pin 70 on modifier 30. The modifier will, accordingly, remain at rest until brought into action again by engagement of block 67 with its pin 70.

The modifier 28 is similarly brought into action during the weaving of the tubing by engagement of the block 68 on the master with pin 70 on the modifier. One of the modifiers thus makes a complete revolution during the time in which the loom is weaving the stripe and the other makes a complete revolution while the loom is weaving the tubing.

In order to lengthen a section of the fabric, for example, the tubing, one or more plates 71 are applied to the teeth of the modifier 28 which makes a revolution during the weaving of the tubing. The plates serve to increase the height of the modifier teeth and whenever the pawl 49 rests upon such a plate, the pawl passes over the teeth of the driver in its advancing movement. Accordingly, for every plate thus applied to the modifier, the driver remains at rest for one advancing movement of the pawl, that is, the driver remains at rest for one tooth corresponding to the weaving in of 4 picks. With the driver thus at rest, the time required for the master to move through its arc of travel during which the tubing is being woven is correspondingly increased and, since the loom runs at constant speed, the length of the tube section is similarly increased. As the addition of one plate 71 to the modifier lengthens the tubing section by 4 picks and there are 19 teeth on the modifier, the application of a plate 71 to each tooth thereof will increase the length of the tubing section by 76 picks. A similar lengthening of the stripe section can be obtained by the application of plates 71 to the modifier 30.

By applying to the master only the two plates required for consecutive operation of the switches and applying a plate to each tooth of each modifier, the control mechanism will cause the loom to produce a fabric unit of maximum length containing 2880+76+76=3032 picks or 37.9 inches of 80 pick goods. If every other tooth on the master is equipped with a plate and no plates are applied to the modifiers, the latter will rotate at the same speed as the driver and the unit will be of minimum length and will contain 80 picks. This minimum length can be increased by 4 pick steps to 232 picks by adding plates to one of the modifiers and the increase will appear in the tubing or the stripe, depending on the modifier to which such a plate is applied. Increases beyond a length of 232 picks are effected by removing plates from the master and variations in small steps between the minimum and maximum fabric lengths can be obtained by the use of suitable combinations of plates on the master and the modifiers.

The use of the plates on the master wheel thus permits variations in the length of the fabric unit between 80 and 2880 picks and the use of the plates on the modifier wheels permits the length of the fabric unit, as determined by the master wheel, to be increased in 4 pick steps up to a total of 152 picks. Accordingly, application of plates to all of the teeth of the modifier wheels will increase the length of the fabric to 3031 picks. Variations in the respective lengths of the tubing and stripe sections may be made either by altering the positions of the switches relative to one another or by adding

plates to the modifiers. Also, by employing driven master and modifier wheels having other numbers of teeth than those shown, the control mechanism can be employed in the production of fabric units of greater length than those described and having sections of varying relationship.

The loom in conjunction with which the new pattern device is shown for purposes of explanation includes a cam shaft 47 which carries a gear 73 by which the cam shaft is driven from the main shaft of the loom. The gear has hubs 74 of the clutch type and one of these hubs is engaged with a collar 75 fast on the cam shaft, so that the gear rotates with the shaft. Mounted in a row on the shaft and clutched to the gear and to one another by their hubs are six cams held with their hubs in engagement by a nut 76 threaded on the shaft.

The cams are used for the actuation of treadles and levers, and cam 77, lying next to the nut and having the configuration shown in Fig. 18, actuates a lever 78 pivotally mounted at one end on a rod 79 suitably supported on a fixed part of the loom. The lever is provided with a lug 80 to which is attached one end of a spring 81, the other end of which is secured to a fixed part of the loom. The lever carries a roller 82, the axle of which is journalled in the walls of a box 82a on the lever with a portion of the roller exposed above the box and the roller is held in contact with the surface of cam 77 by spring 81. Beyond the roller the lever is formed with a vertical channel 83 and the outer end wall 84 of the channel is formed at its lower end with a foot 85 having an outwardly and upwardly sloping under surface 86. The lever is also provided with a spacing block 87 on its upper surface near its hub 88.

Pivotally mounted on the rod 79 next to the lever 78 is a treadle 89 which has notches 90 in its under surface near its outer end for reception of the loop of a strap connected to a heddle frame, not shown. In accordance with conventional practice, the frame is acted on by a spring tending to maintain it in its uppermost position and it is moved down by the treadle. For this purpose, the treadle is provided with a roller 91, the axle of which is journalled in the walls of a box 92 forming part of the treadle and the roller runs in contact with a cam 93 next to cam 77 on the cam shaft and having the configuration shown in Fig. 19. The treadle is formed with a spacing block 94 contacting with block 87 on lever 78. During the production of one type of weave on the loom, treadle 89 is connected to lever 78 and moves therewith, so that the treadle may be considered to be actuated at that time by both cams 77 and 93. To effect this connection, the treadle is provided with a housing 95 on its under surface near its hub and within the housing are mounted solenoids 96 and 97 lying in axial alignment. A core 98 lies within the solenoids and is movable from one end of the housing to the other by the action of the solenoids, the movement being limited by the ends 99 of a U-shaped member attached to the bottom of the housing. The core is attached to a rod 100 connected to a bar 101 lying between a pair of plates 102 secured to opposite faces of the treadle. Each plate has a longitudinal slot 103 therein and the bar carries a pin 104 on which are mounted rollers 105.

On the treadle illustrated in Figs. 12 and 13, there are two rollers on the pin on each side of the bar 101 and the two rollers near the bar run in the slots 103 in the plates 102, while the outer rollers on the pin lie outside the plates. When the bar is in its innermost position, illustrated in Figs. 11, 12, and 13, the roller 105a lies in line with the channel 83 on lever 78, so that the lever and the treadle 89 are free to move relatively to one another. When the bar 101 is in its outermost position, the roller 105a lies beneath and in contact with the sloping under surface 86 of the foot 85 on lever 78, and lever 78 and treadle 89 are then connected together and both are actuated by cams 77 and 93.

The movement of the bar 101 between the two positions is effected by the energization of the solenoids 96 and 97 and the supply of current to these solenoids is under the control of the pattern device which causes the solenoids to be energized for brief periods only. When the treadle and lever are connected together with the roller 105a engaging the under surface of foot 85, the roller is prevented from slipping from beneath the foot by the sloping formation of the surface 86, as illustrated in Fig. 14.

Mounted next to the treadle 89 on the rod 79 is a treadle 106, which is similar to treadle 89, except that its pin 107, corresponding to pin 104, carries only three rollers 108, the outer roller having been omitted from the end of the pin lying at the right in Fig. 11. Mounted on the face of treadle 106 is a plate 109 having an opening 110 extending inward from its outer end. This plate is so positioned that when the pin 104 of treadle 89 is in its innermost position, the outer roller 105b of treadle 89 lies within the opening 110 and the two treadles are thereafter connected together. The opening 110 is flared from the outer end surface of the plate and because of that, roller 105b tends to remain within the opening once it has been moved thereinto.

The treadle 106 is actuated by cam 111 on the cam shaft, the configuration of the cam being shown in Fig. 20. When the pin 104 on treadle 89 lies in its innermost position and treadles 89 and 106 are connected together by plate 109 and roller 105b, both treadles are actuated by both cams 93 and 111.

Mounted next to treadle 106 on rod 79 is a lever 112, similar in all respects to lever 78 and actuated by a cam 113 on the cam shaft, this cam having the configuration illustrated in Fig. 21. When the pin 107 on treadle 106 is in its outermost position, the outer roller on the pin lies beneath a foot on lever 112 similar to foot 85 and lever 78, and thereafter the lever 112 and treadle 106 are connected together and both are actuated by cams 111 and 113.

Mounted on the rod 79 next to the lever 112 is a treadle 114 provided with a roller which lies beneath a cam 115 of the configuration shown in Fig. 22. The treadle 115 is not provided with the solenoids, pins, and rollers with which the treadle 89 is equipped but has a laterally projecting portion 116 beyond its cam roller.

A treadle 117, similar to treadle 106, is mounted on the rod 79 next to the treadle 114 and is actuated by a cam 118 of the configuration shown in Fig. 23. When the bar and pin of treadle 117 are in their outermost positions, the outer roller 119 on the pin lies free of the lateral extension 116 on treadle 114 and the treadles are actuated by their respective cams. When the bars are in their innermost positions, roller 119 lies beneath extension 116 on treadle 114 and treadles 114 and 117 are connected together and

both are actuated by their cams 115 and 118.

The loom illustrated is so constructed as to produce alternate sections of plain and tubular fabric and when the tubing is being woven, treadles 89 and 106 are connected, respectively, to levers 78 and 112 and treadles 114 and 117 are disconnected from one another. In that situation, treadle 89 and lever 78 are actuated by both cams 77 and 93 and the treadle has a movement determined by cam 77, which is the larger. Cam 77 has a high point equivalent to ¾ of a revolution of cam shaft 72 and as the cam shaft rotates once while 4 picks are being woven into the fabric, cam 77, accordingly, moves the treadle down for three picks and permits it to be up for one pick of a cycle. At the same time, treadle 106 is given a movement determined by cam 113 acting on lever 112 to which the treadle is connected. Cam 113 has the same configuration as cam 77 but is angularly offset therefrom by 180°. Accordingly, treadle 106 has a movement three picks down and one pick up out of phase by 180° with treadle 44. Treadles 114 and 117, being disconnected, are actuated only by their respective cams 115 and 118, and these cams have such a shape as to cause their treadles to be held down by one pick and up for three picks per cycle, with the treadles out of phase 180°. With the treadles and levers actuated as described, the loom weaves tubular fabric.

When the pins on treadles 89, 106, and 117 are in their innermost positions, treadles 114 and 117 are connected together and none of the treadles is connected to either of the levers. In that situation, treadles 89 and 106 are both actuated by cams 93 and 111, so that in a cycle of four picks, both treadles are alternately up and down twice. Similarly, treadles 114 and 117 are both actuated by cams 115 and 118 and are also alternately up and down twice for four picks during one revolution of the cam shaft. The angular positions of cams 93, 111 and of cams 115, 118 are such that while treadles 89 and 106 are down, treadles 114 and 117 are up, and vice versa.

As previously described, the control mechanism controls the supply of current to the solenoids on the treadles and thus determines how the loom will operate. By making appropriate adjustments in the control mechanism, the loom will weave fabric in different unit lengths, with each length made up of tubing and stripe sections of different lengths, as desired.

In the foregoing, the control mechanism of the invention has been described as applied to a loom to control the shedding motion thereof, so that the loom will weave unit lengths of fabric, each made up of sections of two different weaves. It will be apparent, however, that the utility of the control mechanism is not limited to its use for controlling the operation of a loom and that it may be employed advantageously in controlling the operation of various other kinds of machines which are to operate in different ways. Also, as illustrated, the control mechanism exercises its control to obtain a cycle of operation of the machine controlled in which that machine functions in two different ways. A pair of switches are actuated when each changeover in the operation of the machine is to be effected. By using additional sets of switches, the cycle of operations through which the machine passes may include more than two changes, as will be apparent. Also, it will be clear that the control mechanism, illustrated as exercising its control electrically, may perform its function through mechanical means.

This application is a division of my application Serial No. 350,679, filed August 3, 1940.

I claim:

1. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means operable to rotate the master element stepwise, said means being rendered ineffective by the driver element throughout the greater part of each rotation of the latter, the master element thereby advancing at a slower rate than the driver element, and means actuated by the master element in its advance for altering the operation of the machine to cause it to perform the different operations in the cycle.

2. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means operable to rotate the master element stepwise, said means being rendered ineffective by the driver element throughout the greater part of each rotation of the latter, the master element thereby advancing at a slower rate than the driver element, and a plurality of means actuated by the master element in its advance for altering the operation of the machine to cause it to perform the different operations in the cycle.

3. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means operable to rotate the master element stepwise, said means being rendered ineffective by the driver element throughout the greater part of each rotation of the latter, the master element thereby advancing at a slower rate than the driver element, and a plurality of means, one for each operation in the cycle, actuated successively by the master element in its rotation for altering the operation of the machine to cause it to perform the different operations in the cycle, said means being spaced apart distances corresponding to the desired duration of the respective operations in the cycle.

4. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element, means normally operating to rotate the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a rotary master element, means controlled by the driver element for rotating the master element stepwise at a slower rate than the driver element, and a plurality of means, one for each operation in the cycle, actuated successively by the master element in its rotation for altering the operation of the machine to change it over from one operation to another in the cycle, said

means being spaced apart distances corresponding to the desired duration of the several operations in the cycle.

5. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and means applicable to the master element for increasing its rate of movement through a selected portion of its path.

6. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a rotary modifier actuated by the means for advancing the driver element and operable to vary the effect of said means on the driver element.

7. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a rotary modifier actuated by the means for advancing the driver element and operable to render said means ineffective for a selected period to advance the driver element.

8. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a rotary modifier actuated by the means for advancing the driver element and brought into action by the master element, said modifier being operable to vary the effect of said means on the driver element.

9. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a modifier actuated by the driver advancing means and controlling the advance of the driver element thereby, the modifier being brought into operative relation to said advancing means by the master element once per revolution of the latter.

10. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means normally operating to advance the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a plurality of modifiers, one for each operation in the cycle and brought into action by the master element while its respective operation is being performed, each modifier being actuated by the means for advancing the driver element and being operable to vary the effect of said advancing means on the driver element.

11. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl normally operating to rotate the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise, said means being controlled by the driver element and rotating the master element at a slower speed than the driver element, and means actuated by the master element in its advance for altering the operation of the machine to cause it to perform the different operations in the cycle.

12. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl normally rotating the driver element stepwise in timed relation to the operation of the machine throughout the operation of the latter, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise, said means being controlled by the driver element and rotating the master element at a slower speed than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a rotary modifier operable to render the means for rotating the driver element temporarily ineffective, said modifier being brought into action by the master element once per revolution of the latter.

13. A device for controlling the operation of a machine for the purpose of causing it to perform

different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl for rotating the driver element stepwise in timed relation to the operation of the machine, said means being normally effective throughout the operation of the machine, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise, said means being controlled by the driver element and rotating the master element at a slower speed than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, and a rotary modifier operable to render the means for rotating the driver element temporarily ineffective, said modifier being brought into action by the master element and thereafter being rotated by the means for rotating the driver.

14. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl for rotating the driver element stepwise in timed relation to the operation of the machine, said means being normally effective throughout the operation of the machine, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise, said means being controlled by the driver element and rotating the master element at a slower speed than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, a pair of rotary modifiers, one for each operation in the cycle and brought into action by the master element during the performance of its respective operation by the machine, each modifier when active being actuated by the means for rotating the driver and being operable to render said means temporarily ineffective to rotate the driver.

15. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a driver element, means for advancing the driver element in timed relation to the operation of the machine, said means being normally effective throughout the operation of the machine, a master element, means controlled by the driver element for advancing the master element stepwise at a slower rate than the driver element, a plurality of means, one for each operation in the cycle, actuated successively by the master element in its advance for changing over the operation of the machine from one operation to another, and a plurality of modifiers, one for each operation in the cycle, brought into action during the performance of their respective operations and operable to render the means for advancing the driver temporarily ineffective.

16. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl for rotating the driver element stepwise in timed relation to the operation of the machine, said means being normally effective throughout the operation of the machine, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise, said means being controlled by the driver element and rotating the master element at a slower speed than the driver element, means actuated by the master element in its advance for altering the operation of the machine to change it over from one operation to another in the cycle, a plurality of modifiers, one for each operation in the cycle, provided with ratchet teeth and brought into action during the performance of their respective operations by the master element, said modifiers when active being rotated stepwise by the means for rotating the driver element and being operable to render said means temporarily ineffective to rotate the driver element.

17. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl for rotating the driver element stepwise in timed relation to the operation of the machine, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise at a lower speed than the driver element, at least one plate applied to a tooth of the master element and engageable by the pawl of the means for rotating the master element, said plate causing said means to advance the master element at a faster rate than would be the case if the plate were omitted, and means actuated by the master element for altering the operation of the machine.

18. A device for controlling the operation of a machine for the purpose of causing it to perform different operations in a cycle, which comprises a rotary driver element provided with ratchet teeth, means including a pawl for rotating the driver element stepwise in timed relation to the operation of the machine, a rotary master element provided with ratchet teeth, means including a pawl for rotating the master element stepwise at a lower speed than the driver element, a rotary modifier provided with ratchet teeth and brought into action by the master element once per revolution of the latter, said modifier, when in action, being advanced by the means for rotating the driver element, at least one plate applied to a tooth of the modifier and engageable by the pawl of the means for rotating the driver element, said plate rendering said means ineffective to advance the driver element while said pawl is in engagement with said plate, and means actuated by the master element in its rotation for altering the operation of the machine.

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