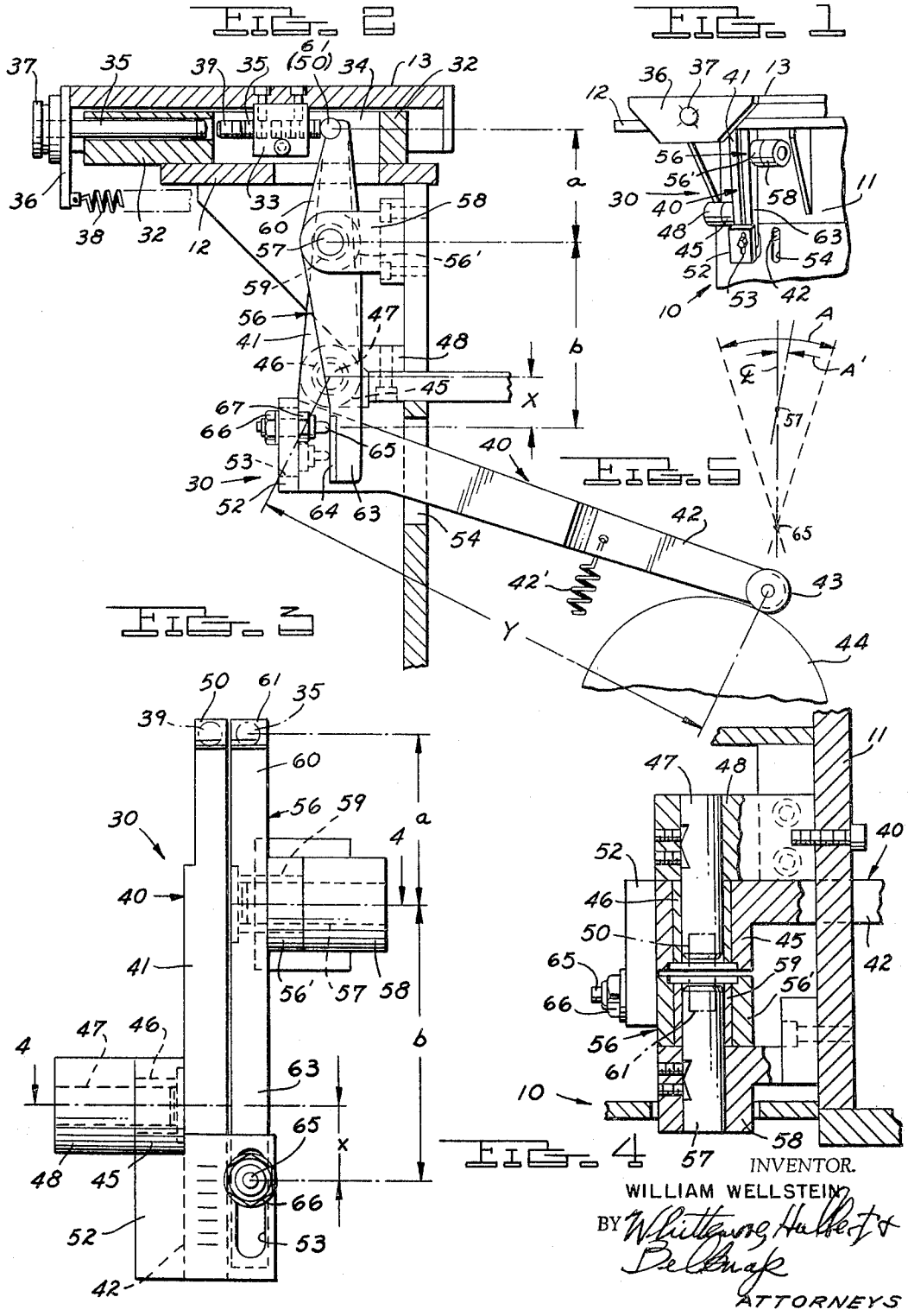
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VARIABLE SPEED LINKAGE

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VARIABLE SPEED LINKAGE

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The present invention relates to improvements in a linkage for the operation of various types of equipment at variable speeds from a single power source. As an example, the improved linkage may be employed to great advantage in controlling the travel of a tool or work carrying slide in reversing strokes under actuation by a single operating cam. More particularly, the control function is performed through the agency of novel dual type bell crank and lever linkage provisions enabling a multiplication of lever arm ratios through such linkage which can produce a vast and widely variable modification of the speed or power of an actuating stroke, applied by the linkage to a tool slide or the like, in relation to the stroke applied to the linkage by a cam or like primary actuator.

In general, it is an object of the invention to provide an improved, variable speed tool slide or equivalent actuating linkage driven from a single master power member, which is capable of providing a wide range of ratios of power cam throw, or stroke or throw of an equivalent operator, to slide stroke distance.

Another object is to provide an improved slide or equivalent unit operated by means of such improved linkage. The unit operated by the linkage might, for example, be a slide mounting a grinding, drilling or like head for variable speed movements, such as approach, working and retract travel components, relative to the work, or mounting a workpiece for variable movement in relation to a tool, or for a more general type of travel for whatever particular purpose may be involved.

More specifically, the improved linkage comprises a primary actuator or medially pivoted bell crank and a coacting secondary actuator lever or arm member. In this arrangement, the bell crank, as directly engaged and operated at one of its arms by a master cam, affords a given ratio of the radial cam throw of that arm to the length of stroke of the slide, as the latter is directly engaged by the other arm of the bell crank. This may be employed, for example, to afford a relatively fast initial advance and final subsequent retraction of a tool on the slide toward and away from a workpiece prior to and following an actual working phase.

The linkage combines with a bell crank having this effect a medially pivoted secondary lever or arm member, one end of which is engaged by an element of the bell crank on the side of the latter's pivot opposite its slide engaging end. Thus the distance of this bell crank element from the bell crank pivot represents a further moment advantage arm of small length through which the medially pivoted lever or arm member is bell-crank actuated.

The product of the combination of crank and lever ratios represents a very high cam throw-slide stroke ratio, indeed, so that with the opposite end of the medially pivoted lever directly engaged with the tool slide, like the bell crank but independently of the latter, there results a slow feed of the tool in the actual working phase of the equipment. In accordance with the invention, the last named product ratio is capable of a wide range of change by an apt selection of bell crank and lever components and an adjustment of their points of engagement with one another.

It is of course to be kept in mind that the improved linkage is well adapted to applications other than tool slide control; however, that application typically illustrates the advantages of the linkage, and will therefore be alone referred to in the following description.

Thus, with the bell crank and medially pivoted arm journaled on independent axes determining the length ratios of their respective arms, and with these members physically acting independently upon the tool slide, but coordinately in at least one of its travel phases, the slide may have a fast initial inward movement from a fully retracted position to the point of engagement of the tool with the work, followed by retarded ensuing movement toward and into the workpiece, then by relatively slow and rapid retractions of the slide after the working phase.

In further accordance with the invention, there is provided an adjustability as to the point of engagement of the bell crank with the medially pivoted, secondary lever or arm, thus permitting a full range of intermediate ultimate ratios of cam throw to slide stroke. Let it be assumed, as herein shown and described, that the bell crank engages the longer of two arm portions of the secondary lever at a relatively short distance from the bell crank pivot, and only a small fraction of the length of the cam-engaging bell crank arm. Then, for example, appropriate selection of the length of bell crank arms and pivoted arm portions will enable a full slide stroke of 0.003 inch when the ultimate ratio is 1:10, a stroke of 0.015 inch at 1:20 ratio, etc.; and an appropriate small adjustment at the point of operating engagement of the bell crank and lever arm will have the effect of selecting an intermediate ratio, such as 1:15.75 or thereabouts. A greater adjustment of the distance from the engagement point to the bell crank axis will result in a greater modification of the ratio, for example, halving or doubling it.

Thus the invention features simple linkage provisions enabling a wide range of control of the stroke of a movable tool slide or other variable stroke member, which were, for instance, heretofore only attained through resort to the use of multiple interchangeable cams or like time-consuming practice, such as is rendered unnecessary by the improved single cam-controlled linkage of the invention.

A general object of the invention is to provide a variable speed operating linkage for a slide or the like, characterized in that the linkage imparts successively to the slide an initial advance stroke in one direction under the sole control of the bell crank of the linkage, a short inward working component under the combined control of the bell crank and lever at a highly increased stroke speed reduction ratio, followed by a retract component in the opposite direction at increased speed, again under the control of the bell crank of the linkage; and in which the transisitions as between these speed components are accomplished smoothly and without any degree of jarring. The invention also contemplates adjustable provisions whereby the point of take-over may be determined as desired for slide strokes of different speed characteristics.

The foregoing as well as other objects will become more apparent as this description proceeds, especially when considered in connection with the accompanying drawings illustrating the invention, wherein:

FIG. 1 is a fragmentary perspective and quite schematic view of a portion of typical tool slide equipment in which the linkage of the invention may be incorporated, other components of this equipment having been omitted as not germane to the invention;

FIG. 2 is a fragmentary view in vertical section through the slide and associated linkage of the machine, showing the dual bell crank and arm of the linkage as operated by a master cam;

FIG. 3 is an end view of components of the linkage alone, as viewed from the left of FIG. 2;

FIG. 4 is a fragmentary view, partially broken away and in horizontal section on line 4—4 of FIG. 3; and

FIG. 5 is a highly schematic diagram illustrating the nature of the advance, working and retract strokes imparted to the slide by the improved linkage.

Referring to FIG. 1, the generally known type of machine **10** shown therein to which the improved linkage is applied may be considered to comprise an appropriate rigid base **11** having a horizontal top **12** upon which a mounting slide **13** is guided for longitudinal reversing movement. Each slide is adapted to have mounted thereon an appropriate tool head (not shown). Further reference to the nature of the slide **13** will be made. The improved linkage of the invention is generally designated by the reference numeral **30**.

Referring now particularly to FIG. 2, the machine top **12** fixedly mounts a guide or way member **32** for the slide **13**, by which the latter is stably guided in its strokes to the right and left as viewed in FIG. 2. A small block **33** is fixed to the bottom of slide **13** to depend within an elongated recess **34** of guide member **32**; and an elongated adjusting stud or stem **35** is threaded through block **33**, extending outwardly through guide member **32** and a depending end cover plate **36** on the slide. Stem **35** has a knurled handpiece **37** secured thereon outwardly of element **36**, and the handpiece may be appropriately calibrated as shown in FIG. 1, to visually indicate the position of threaded adjustment of the stud or stem **35** longitudinally relative to the tool slide **13**. The stem **35** is adapted to be actuated by a part of the linkage **30**, as will be described.

A tension coil spring **38** has one end secured to the end plate element **36** of slide **13** and the other end connected to frame **11**, thus urging the slide to the right, as viewed in FIG. 2, for its in-stroke.

The block **33** also receives another, set screw type adjusting stem **39** shown along with stem or stud **35** in dot-dash line in FIG. 3. The stem **39** serves as an actuator for another component of linkage **30**, as will also appear later.

Now referring to FIGS. 2, 3 and 4, a bell crank member of the linkage **30** is generally designated **40**, comprising an upright slide operating arm **41** and an inclined though generally horizontal operated arm **42**. The arm **42** is provided at its end with a follower roller **43** engageable with a driven faster cam **44**, against which it is urged by an appropriately anchored tension spring **42'**; while the arm **41** is provided with a side boss **45** apertured and receiving a bushing **46**, at which the bell crank is pivoted on a horizontal pin **47** fixedly carried by a bracket **48** on the outer side of the machine frame **11**. It is seen by reference to FIG. 2 that the bell crank **40** is thus pivoted on the frame **11** at a point slightly above the junction of bell crank arms **41** and **42**; and one of the moment arms of the bell crank is established by this positional relationship, as will be described.

At its top end, the bell crank arm **41** is provided with an anti-friction roller **50** adapted for engagement with the adjustable set screw **39** on slide block **33**. Arm **41** also carries, adjacent the pivot bracket **48**, a laterally projecting rectangular pad **52** which is provided with an elongated upright slot **53** for a purpose to be described. The arm **42** of bell crank **40** extends inwardly through an opening **54** of frame **11** for engagement with master cam **44**.

While the cam **44** is shown as the primary power member for the input of energy to linkage **30**, it will be understood that the invention contemplates as an equivalent any other suitable, identically repeating or cycling power unit which is capable of periodically imparting a predetermined throw to the bell crank arm **42**, or equivalent member operated by such power unit, hence is capable of automatically repeating the variable speed operating strokes contemplated by the invention, for a given setting of linkage **30**.

The second component of the linkage **30** is a secondary actuator, arm member or rocker lever, generally designated **56**, which is medially provided with a boss **56'** at which it is pivoted by a pin **57** in a bracket **58** secured to and projecting from the exterior of frame **11**, with a bushing **59** in the arm boss **56'** receiving pin **57**. A slide operating portion **60** of arm **56** above its pivot **57** is provided with an anti-friction roller **61**, which is in side-by-side relation to the roller **50** atop the bell crank arm **41**, as shown in FIGS. 3 and 4. The roller **61** is engageable in operation by the end of adjusting stud or stem **35**.

The lower, operated portion **63** of the medially pivoted arm **56** is provided with a lateral extension piece **64**; and in accordance with the invention, this extension **64** is engageable by an actuator stud **65** which extends through the slot **53** of bell crank pad **52**, being provided with lock nuts **66**, **67** on opposite sides of the pad. This enables the stud **65** to be adjusted as desired up and down in the slot **53**, then clamped to constitute a lever actuating element of the bell crank **40**, the primary actuator of linkage **30**. The position of stud **65** determines its distance from the pivotal axis of bell crank **40** at pin **47**, which distance represents the moment arm (hereinafter referred to) about which the bell crank acts on the lever **56** at the latter's extension **64**.

Thus, reference being had to FIG. 3 of the drawings, it is seen that the distance x of actuator stud **65** from the bell crank pivot at pin **47** represents a very short moment or lever arm of the bell crank **40**, as compared with its long arm distance y from pivot **47** to follower **43**. The ratio $x:y$ of effective lengths may be, for example, 1:10 in a typical installation, and is a multiplier by which the ultimate combined, motion dropping ratio of linkage **30** is determined. The selection of a bell crank having, as between its pivot and its cam and slide ends, a different lever arm or moment ratio will of course vary the combined ratio, enabling it possibly, by choice of bell cranks, to provide an extremely wide range of slide stroke lengths.

The medially pivoted, secondary lever **56** of linkage **30** has a moment arm a from its pivot at **57** to its anti-friction roller **61** and a moment arm b from its pivot to its point of effective engagement by primary bell crank **40** at the actuator stud member **65**. For example, the ratio a/b may be about 1/2 in a typical linkage, so if x/y equals about 1/10, the overall motion conversion ratio of the linkage **30** is about 1:20, i.e., a controlled working motion of the slide **13** where its adjustable stud **35** engages the anti-friction roller **60** of lever **56** amounting to one unit of length for 20 units of radial throw by master cam **44**, the basic driver for the linkage. This affords a slow in and out feed of slide **13** in a working engagement of its tool (not shown) with a workpiece.

On the other hand, there is available a rapid speed advance and retract of slide **13**, as effected only by and at the engagement of set screw stem **39** with the bell crank anti-friction roller **50**, in a much greater ratio of, say, approximately 1:2, for rapid in and out initial and final strokes of a slide cycle, amounting to one length unit of slide travel to only about two radial throw units of cam **44**.

As an instance of the adjustability of the linkage at the actuator stud **65**, let it be assumed that the latter is set on pad **52** at a distance x of 1.3 inches from the bell crank pivot axis at pin **47**, that the effective bell crank arm length from pivot to follower **43** is 13 inches, and that the lever arm lengths a and b are 2.6 inches and 5.2 inches respectively. Then, stated inversely, the combined ratio of linkage **30** is

$$\frac{b}{a}\cdot\frac{y}{x}=\frac{5.2}{2.6}\cdot\frac{13}{1.3}=20:1.$$

However, if actuator stud **65** is adjusted only one inch down on pad **52**, the arm x becomes 2.3", the arm b becomes 6.2", and the combined ratio equals

$$\frac{6.2}{2.6}\,\frac{13}{2.3}$$

or 13.47:1. Thus in the first case there is, in a given range broadly determined by bell crank and lever design, a twenty-fold drop in slide travel, and in the other case a drop of approximately thirteen and a half to one.

A wide selection of slide operating ratios is available, along with a fine control in any general range, as determined by the adjustment of bell crank actuator stud **65**. For instance, the adjustment may result in the multiplying or dividing of the moment arm length *x* to produce different orders of ultimate stroke ratio; and an intermediate fine adjustment may be had in any general order or range of adjustment. It is contemplated that the pad **52** of the bell crank may be calibrated adjacent the stud slot to assist in making the desired setting (FIG. 3). The invention contemplates a selection and adjustment of linkage **30**, in regard to moment arm lengths of bell crank and/or lever, such as will permit combined linkage ratios ranging from 10:1 (representing an overall slide stroke of, say, 0.003 inch) to 40:1 (or a 0.00375 inch stroke).

In operation, assuming that the tool slide **13** is in an extreme withdrawn initial position to the left in FIG. 2, with the follower **43** of bell crank **40** riding a high of master cam **44**, the set screw actuator **39** on the slide's block **33** will then be in engagement with the anti-friction roller **50** of bell crank arm **41**. As follower **43** rides onto a low (not shown) of cam **44**, the bell crank **40** swings clockwise about its pivot pin **47**, enabling bell crank roller **50** to fall inwardly, or to the right in FIG. 2; and the medially pivoted secondary lever **56** follows in the same direction. Thus a rapid instroke of slide **13** and its tool into initial engagement of the latter with a workpiece takes place under the urging of slide spring **38**.

Upon the wheel's assuming such workpiece engagement, with the extension **64** of lever arm **63** engaged by bell crank actuator stud **65**, the motion of slide **13** comes under the control of the combined linkage **30**. The slide continues to be spring-urged inwardly for the working phase of its stroke, as variably controlled by the contour of master cam **44**, but at one of the combined higher ratios discussed above, i.e., at a greatly diminished rate of travel.

As the slide completes this stroke phase, the follower **43** will be actuated by a cam high (not shown) for an outward throw, rocking bell crank **40** counterclockwise about its pivot pin **47**. The resultant initial retraction of the slide and wheel from the work will first be at the slower rate, until the bell crank roller **50** moves to the rear away from lever roller **61**, whereupon the slide **13** will be retracted at the bell crank's 2:1 throw ratio until slide **13** is fully withdrawn outwardly, the secondary lever **56** following at the slower ratio rate.

Schematic FIG. 5 conveniently illustrates the characteristics of the variable speed stroke imparted to slide **13** by the linkage. The bell crank **40** will, at the operating engagement of its roller **50** with the adjustment set screw **39**, describe a stroke arc A extending equidistantly on opposite sides of an upright center line through the roller, the pivot axis at **57** for secondary lever **56** and the point of engagement of actuator stud **65** with the lever extension **64**. However, only the component of the stroke arm A which lies to the left of the center line is directly and alone effective on slide **13**, producing its rapid initial inward component and its rapid final outward component.

As the bell crank arrives at the stroke center line, having effected a coarse slide control movement to approach a tool or the like thereon to close proximity to a workpiece, for example, the fine, high ratio control comes into effect, as exerted by the engagement of the roller **61** on lever **56** with the adjustment stud or stem **35**. The duration of this is only to the slight extent of the stroke arc A′ which lies to the right of the center arm, both on the infeed and outfeed directions of slide movement. In this phase, a tool will be in working engagement with the work.

When the lever **56** is returned to the upright center line, it loses control effect on the slide **13**, which is taken up by the bell crank for the remainder of the retract stroke, on the left of the center line. All of these transitions are effected smoothly and without shock or jarring; and the point of cross-over from one phase to another may be varied by an appropriate adjustment of the adjustment stud **35**.

It is seen that the invention affords a highly versatile slide control mechanism. A single, dual-type bell crank and lever linkage, which is highly compact, simple and inexpensive, and readily adaptable to various sorts of existing machinery, permits changeovers as to slide stroke ratio in a moment's time and without any change whatsoever in the equipment other than in making the adjustment as to bell crank moment arm distance. Such changeovers have heretofore been accomplished only by time-consuming modifications of the equipment. In so far as the matter of stroke accuracy is concerned, the present linkage, as actuated at all times from a single master power input member or cam, is of course at least the equivalent of any heretofore relied on procedure.

As indicated above, the master power source may be a driven cam or any other equivalent agency capable of producing the bell crank throw. Furthermore, while the illustrated embodiment of the invention has its operating slide **13** spring-urged in one direction, and actuated in the other direction by the linkage **30**, it is to be understood that other operating means for the slide, acting in conjunction with the linkage, such as fluid pressure or mechanical operating means, are contemplated.

What I claim as my invention is:

1. In apparatus of the type described, a support, a slide unit mounted for reversing sliding movement on said support, a linkage to operate said slide unit at varying speeds in different phases of said movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis on said support and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion to be operated, a secondary actuator operatively engaging said slide unit and having a pivotal axis on said support in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator also having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to said further portion being substantially different from the distance from said primary actuator axis to its said second operated portion, said actuators thus coacting in operating the slide unit at a different speed in another of said phases, and an automatically cycling drive device engaging said primary actuator at said second operated portion of the latter to provide repeated variable speed movement of the slide unit over the direction of the two phases.

2. A linkage to operate a unit at varying speed in different phases of its movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion adapted to be operated by other means, a secondary actuator operatively engaging said unit and having a pivotal axis in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to

said further portion being substantially different from, and in a predetermined and fixed ratio to, the moment arm distance from said primary actuator axis to its said second operated portion, said actuators thus coacting in operating the unit at a different speed in another of said phases, and means to adjust the ratio of the lengths of said moment arm distances to one another.

3. In apparatus of the type described, a support, a slide unit mounted for reversing sliding movement on said support, and a linkage to operate said slide unit at varying speeds in different phases of said movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis on said support and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion adapted to be operated by other means, a secondary actuator operatively engaging said slide unit and having a pivotal axis on said support in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator also having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to said further portion being substantially different from the distance from said primary actuator axis to its said second operated portion, said secondary actuator providing moment arms from the axis thereof which are of different lengths, respectively, to said further portion and to said first named unit operating portion of the secondary actuator, said actuator thus coacting in operating the slide unit at a different speed in another of said phases, said first actuator being a bell crank medially pivoted between said operating and operated portions thereof, said secondary actuator being a medially pivoted lever.

4. Apparatus in accordance with claim 3, in which said operating connection between said actuators is located on the same side of both of said pivotal axes and closer to the bell crank axis than to the lever axis, and means to adjust the moment arm distance from the axis of said lever to said further portion thereof.

5. A linkage to operate a unit as varying speeds in different phases of its movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion adapted to be operated by other means, a secondary actuator operatively engaging said unit and having a pivotal axis in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to said further portion being substantially, different from, and in a predetermined and fixed ratio to, the distance from said primary actuator axis to its said second operated portion, said secondary actuator providing moment arms from the axis thereof which are of different lengths, respectively, to said further portion and to said first named unit operating portion of the secondary actuator, said actuators thus coacting in operating the unit at a different speed in another of said phases, said first actuator being a bell crank medially pivoted between said operating and operated portions thereof, said secondary actuator being a medially pivoted lever.

6. A linkage in accordance with claim 5, in which the distance from said operated portion to the bell crank axis greatly exceeds the moment arm distance from said bell crank axis to said operating connection, the distance from the medial axis of said pivoted lever to said further portion thereof substantially exceeding the distance from said medial axis to said first named unit operating portion of said lever.

7. A linkage in accordance with claim 5, and further comprising means to adjust said moment arm distance from the axis of said lever to said further portion thereof.

8. A linkage in accordance with claim 6, and further comprising means to adjust said moment arm distance from the axis of said lever to said further portion thereof.

9. A linkage in accordance with claim 8, in which said operating connection between said actuators is located on the same side of both of said pivotal axes.

10. In apparatus of the type described, a support, a slide unit mounted for reversing sliding movement on said support, a linkage to operate said slide unit at varying speeds in different phases of said movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis on said support and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion to be operated, a secondary actuator operatively engaging said slide unit and having a pivotal axis on said support in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator also having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to said further portion being substantially different from the distance from said primary actuator axis to its said second operated portion, said secondary actuator providing moment arms from the axis thereof which are of different lengths, respectively, to said further portion and to said first named unit operating portion of the secondary actuator, said actuators thus coacting in operating the slide unit at a different speed in another of said phases, and an automatically cycling drive device engaging said primary actuator at said second operated portion of the latter to provide repeated variable speed movement of the slide unit over the duration of the two phases.

11. In apparatus of the type described, a support, a slide mounted for reversing movement on said support, and a linkage to operate said slide at widely varying speeds in different phases of said movement, said linkage comprising a primary actuator pivoted on an axis on said support and having operated and operating arms respectively engaging and operated by a driving member and engaging and directly operating said slide in one phase of its movement, a secondary actuator having a pivot axis on said support in parallel but transversely spaced relation to the pivot axis of said primary actuator on the support, said secondary actuator having direct operating engagement with said slide to operate the latter in a different phase of its movement and being provided with means for an operating connection for actuation by said primary actuator at a point transversely spaced from the pivot axis of the latter, the moment arm distance from said primary actuator pivot axis to said operating connection being substantially different from that from said actuator axis to the point of engagement of said operated arm of the primary actuator with said driving member, said secondary actuator providing moment arms which are of different lengths, respectively, to said operating connection and to the point of operating engagement of said secondary actuator with said slide, the slide being thereby operable by the linkage in said different phase of a stroke of said slide at a speed determined by the product of the respective moment arm ratios of said actuators.

12. In apparatus of the type described, a support, a slide mounted for reversing movement on said support, and a linkage to operate said slide at widely varying speeds in different phases of said movement, said linkage

comprising a primary actuator pivoted on an axis on said support and having operated and operating arms respectively engaging and operated by a driving member and engaging and directly operating said slide in one phase of its movement, a secondary actuator having a pivot axis on said support in parallel but transversely spaced relation to the pivot axis of said primary actuator on the support, said secondary actuator having direct operating engagement with said slide to operate the latter in a different phase of its movement and being provided with means for an operating connection for actuation by said primary actuator at a point transversely spaced from the pivot axis of the latter, the moment arm distance from said primary actuator pivot axis to said operating connection being substantially different from that from said actuator axis to the point of engagement of said operated arm of the primary actuator with said driving member, said secondary actuator providing moment arms which are of different lengths, respectively, to said operating connection and to the point of operating engagement of said secondary actuator with said slide, the slide being thereby operable by the linkage in said different phase of a stroke of said slide at a speed determined by the product of the respective moment arm ratios of said actuators, and means to adjust said operating connection toward and away from said pivot axis of said primary actuator.

13. In apparatus of the type described, a support, a slide mounted for reversing movement on said support, and a linkage to operate said slide at widely varying speeds in different phases of said movement, said linkage comprising a bell crank medially pivoted on an axis on said support and having operated and operating arms respectviely engaging and operated by a driving member and engaging and directly operating said slide in one phase of its movement, the length of the operated arm being greater in the degree of a substantial multiple of that of the operating arm, a lever having a pivot axis intermediate its length on said support in parallel but transversely spaced relation to the pivot axis of said bell crank on the support, said lever having direct operating engagement at one end with said slide to operate the latter in a different phase of its movement and being provided adjacent its other end with an operating connection for actuation by said bell crank at a point transversely spaced from the pivot axis of the latter, said other end of said lever being at a side of said bell crank axis remote from the lever axis, the moment arm distance from said bell crank axis to said operating connection being substantially less than that from said bell crank axis to the point of engagement of said operated arm of the bell crank to said driving member, said lever providing moment arms on opposite sides of its pivot axis which are of greater and lesser lengths, respectively, to said operating connection and to the point of lever operating engagement with said slide, the slide being thereby operable by the linkage in said different phase of a stroke of said slide at a speed determined by the product of the respective moment arm ratios of said bell crank and lever.

14. In apparatus of the type described, a support, a slide mounted for reversing movement on said support, and a linkage to operate said slide at widely varying speeds in different phases of said movement, said linkage comprising a bell crank medially pivoted on an axis on said support and having operated and operating arms respectively engaging and operated by a driving member and engaging and directly operating said slide in one phase of its movement, the length of the operated arm being greater in the

degree of a substantial multiple of that of the operating arm, a lever having a pivot axis intermediate its length on said support in paralllel but transversely spaced relation to the pivot axis of said bell crank on the support, said lever having direct operating engagement at one end with said slide to operate the latter in a different phase of its movement and being provided adjacent its other end with an operating connection for actuation by said bell crank at a point transversely spaced from the pivot axis of the latter, said other end of said lever being at a side of said bell crank axis remote from the lever axis, the moment arm distance from said bell crank axis to said operating connection being substantially less than that from said bell crank axis to the point of engagement of said operated arm of the bell crank to said driving member, said lever providing moment arms on opposite sides of its pivot axis which are of greater and lesser lengths, respectively, to said operating connection and to the point of lever operating engagement with said slide, the slide being thereby operable by the linkage in said different phase of a stroke of said slide at a speed determined by the product of the respective moment arm ratios of said bell crank and lever, and means to adjust said operating connection toward and away from the bell crank axis.

15. A linkage to operate a unit at varying speeds in different phases of its movement, said linkage comprising a primary actuator operatively engaging said unit, said actuator having a pivotal axis and having a first portion to engage and operate said unit at a given speed in one of said phases, and a second operated portion adapted to be operated by other means, a secondary actuator operatively engaging said unit and having a pivotal axis in parallel but transversely spaced relation to the pivotal axis of said primary actuator, said secondary actuator having a portion to engage and operate said unit and a further portion providing an operating connection for actuation by said primary actuator, which further portion is transversely spaced from the pivotal axis of the primary actuator, the moment arm distance from said primary actuator axis to said further portion being substantially different from, and in a predetermined and fixed ratio to, the moment arm distance from said primary actuator axis to its said second operated portion, said secondary actuator providing moment arms from the axis thereof which are of different lengths, respectively, to said further portion and to said first named, unit operating portion of the secondary actuator, said actuators thus coacting in operating the unit at a different speed in another of said phases, and means to adjust the ratio of the lengths of said moment arm distances to one another.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,263,511 August 2, 1966

William Wellstein

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, lines 3 and 4, for "assignor, by mesne assignments, to Kerco, Inc., a corporation of Delaware" read -- assignor, by mesne assignments, to Kerr Manufacturing Company, a corporation of Delaware --.

Signed and sealed this 1st day of August 1967.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents