United States Patent

Blatt

[15] **3,665,771**

[45] **May 30, 1972**

[54] STROKE MULTIPLYING RETRACTOR MECHANISM

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[22] Filed: **June 25, 1970**

[21] Appl. No.: **49,862**

[52] **U.S. Cl.** **74/29,** 74/89.12, 74/422

[51] **Int. Cl.** **F16h 19/04**

[58] **Field of Search** 74/29, 30, 422, 89.12

[56] **References Cited**

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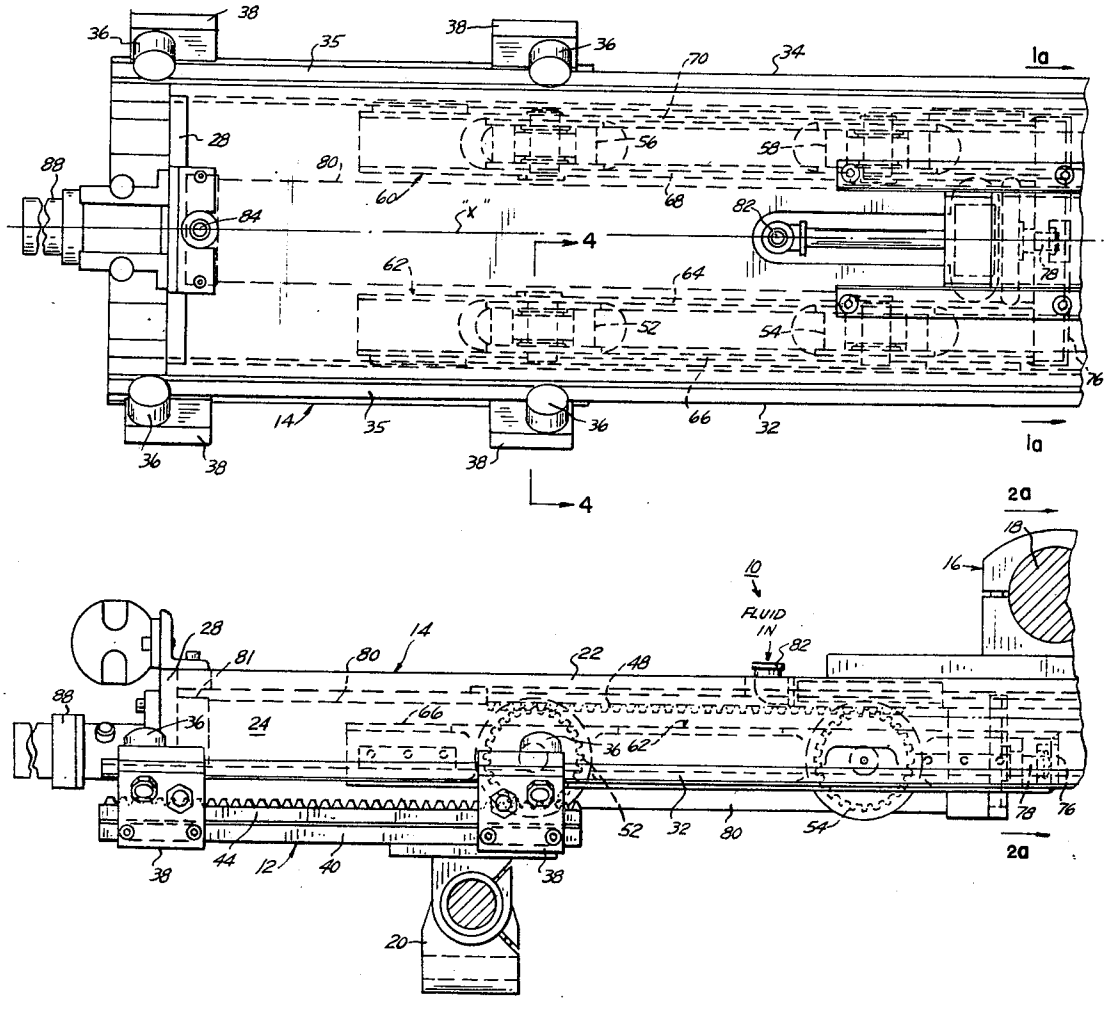
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[57] **ABSTRACT**

A retractor mechanism for an article handling or transfer apparatus is comprised of a stationary, longitudinal frame member, which slidingly supports a longitudinally movable carriage assembly, which normally carries the article handling implement. The carriage assembly is supported on spaced, parallel slideways and is moved by a gear and rack mechanism composed of a fixed rack attached to the stationary frame and a movable rack attached to and moving with the carriage assembly which are interconnected by at least one pinion gear. The pinion gear is supported in a carrier, which is connected to the piston rod of a fluid cylinder which provides a power actuation for longitudinal movement of the pinion carrier to drive the carriage assembly. The carriage driving rack and pinion mechanism, between the carriage and the supporting frame, is such that the piston stroke of the fluid cylinder acting on the pinion carrier to reciprocate the pinion carrier will be multiplied at least two times to move the carriage assembly a distance double the stroke of the fluid cylinder.

5 Claims, 9 Drawing Figures



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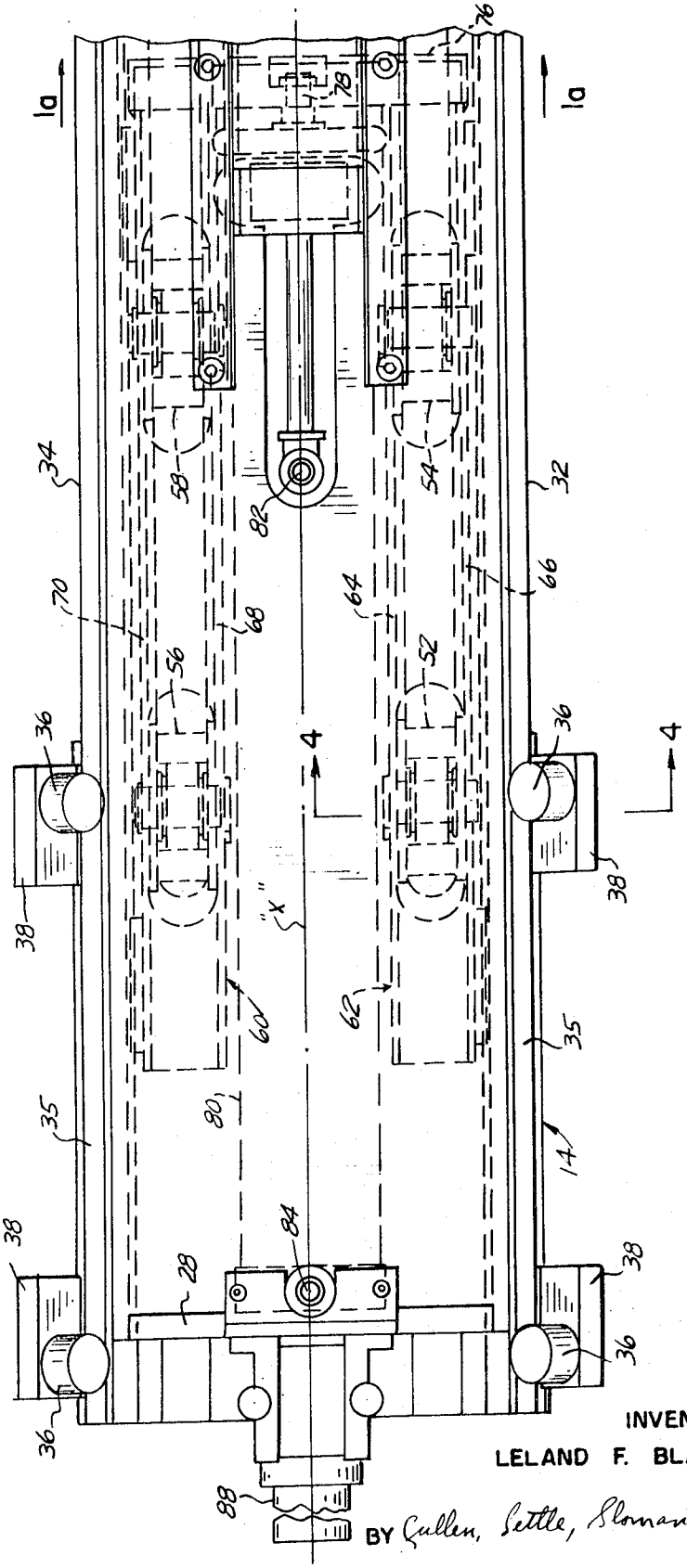


FIG. 1

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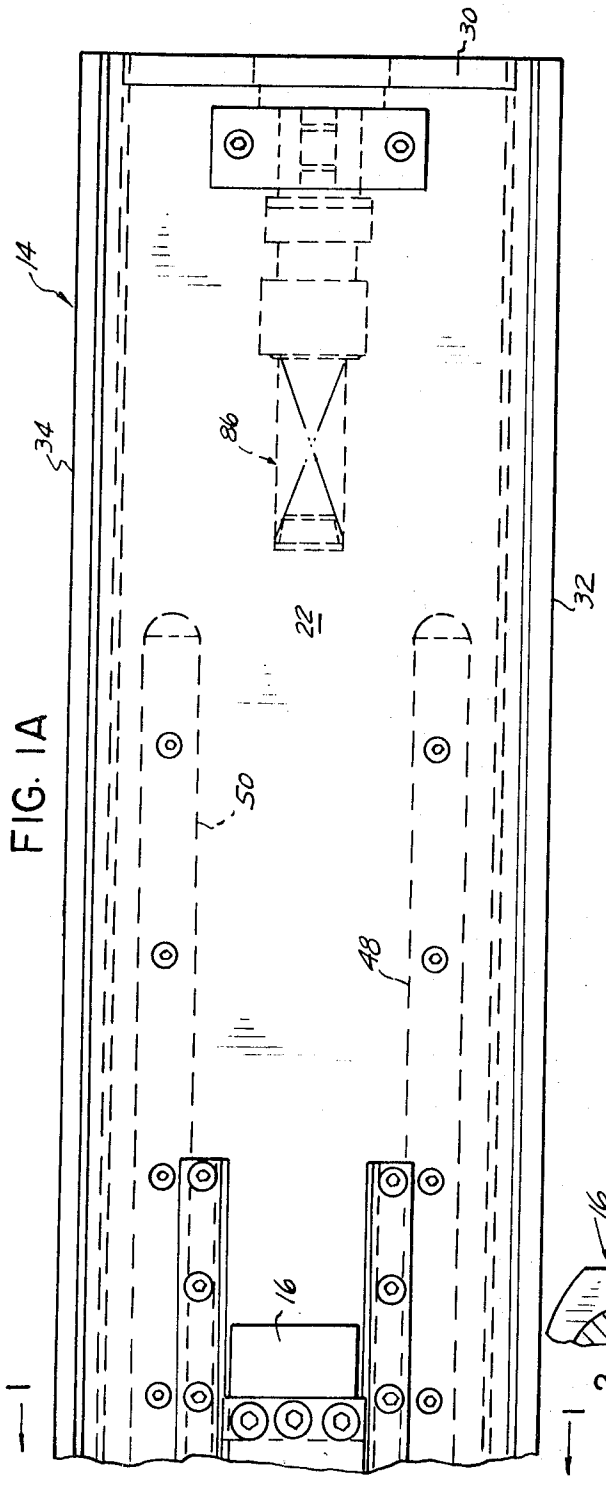


FIG. 1A

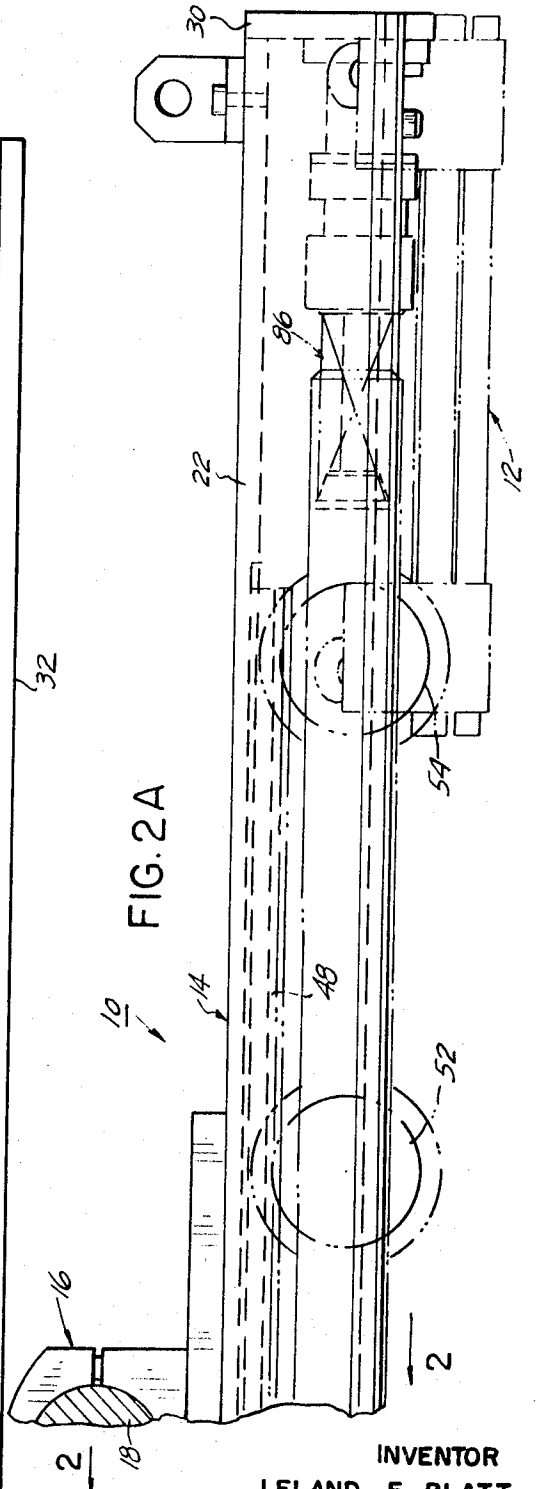


FIG. 2A

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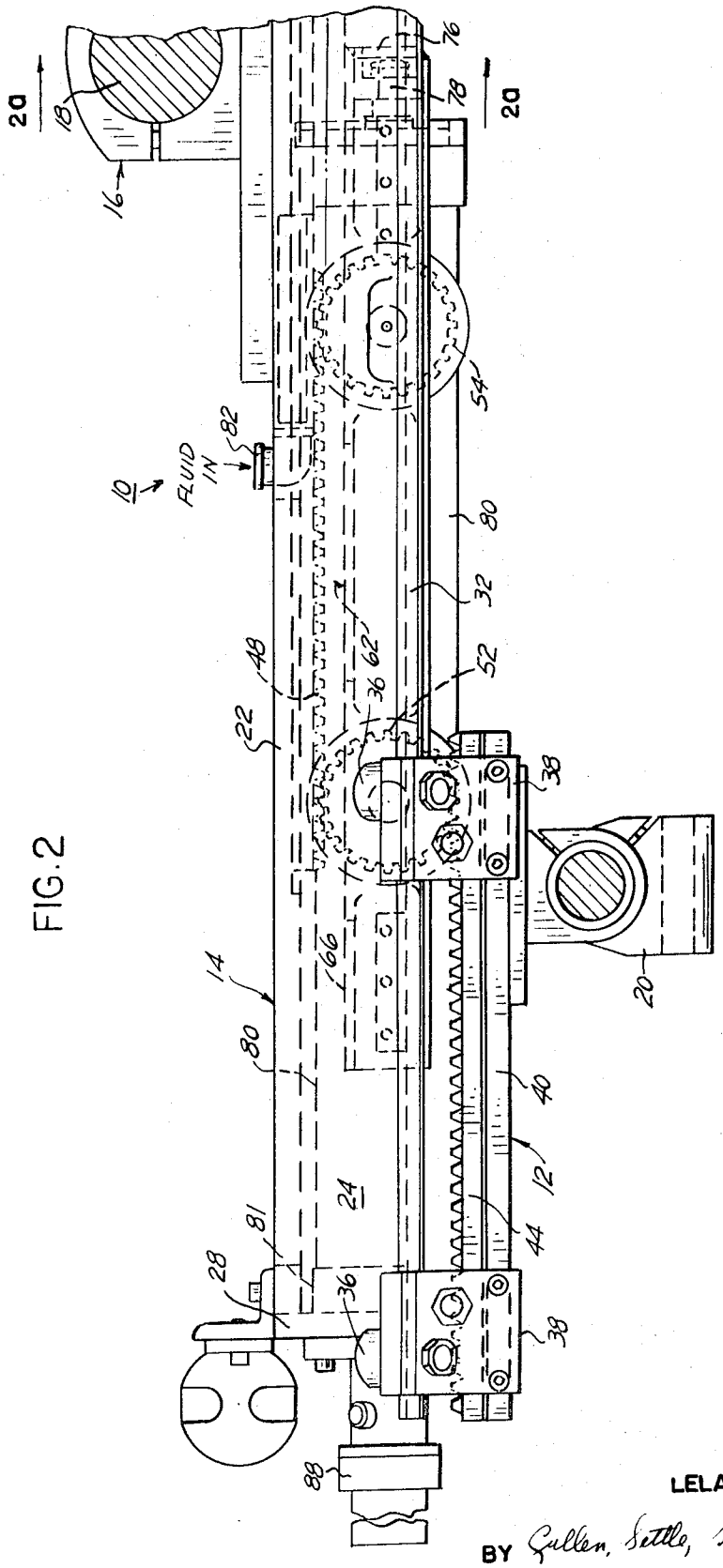


FIG. 2

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FIG. 3

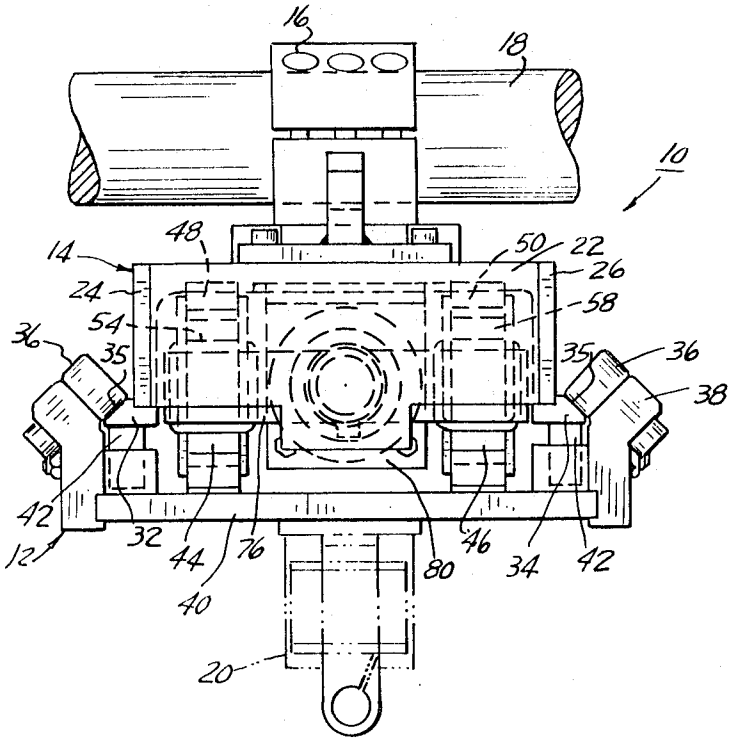
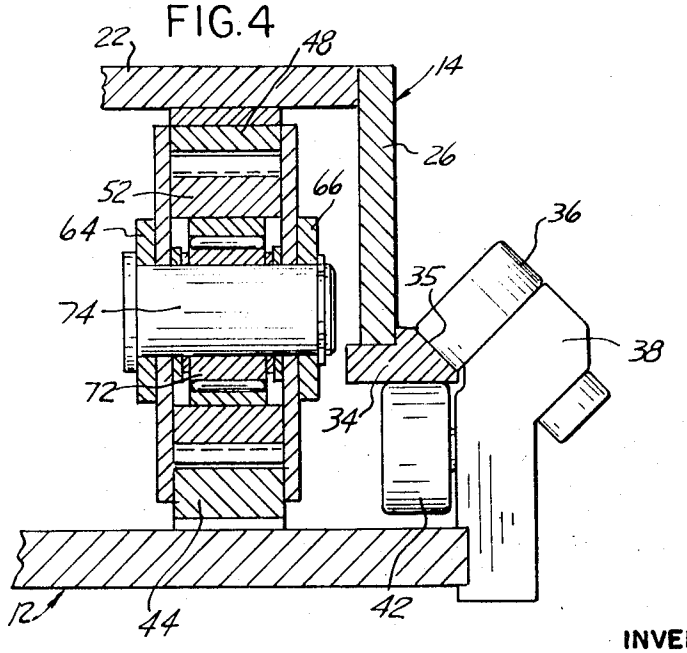


FIG. 4



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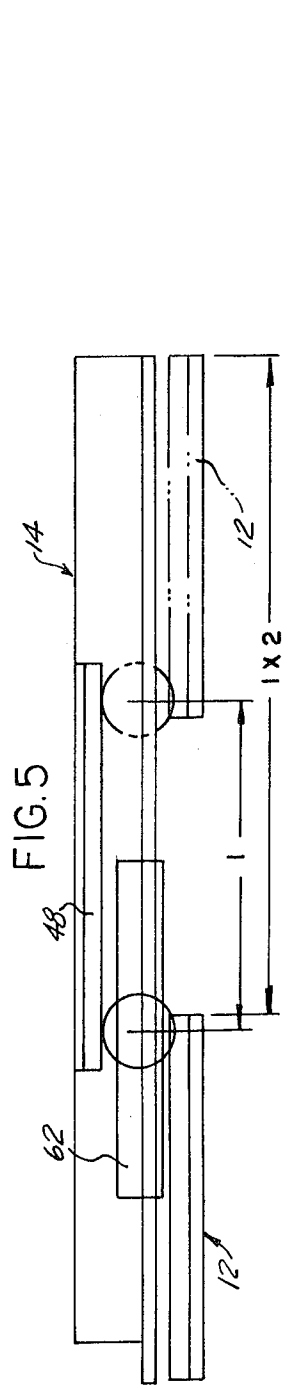


FIG. 5

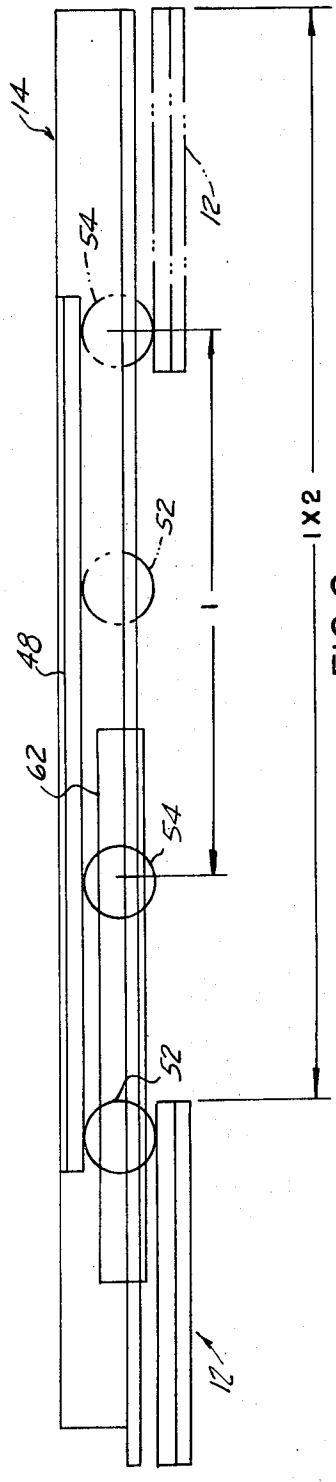


FIG. 6

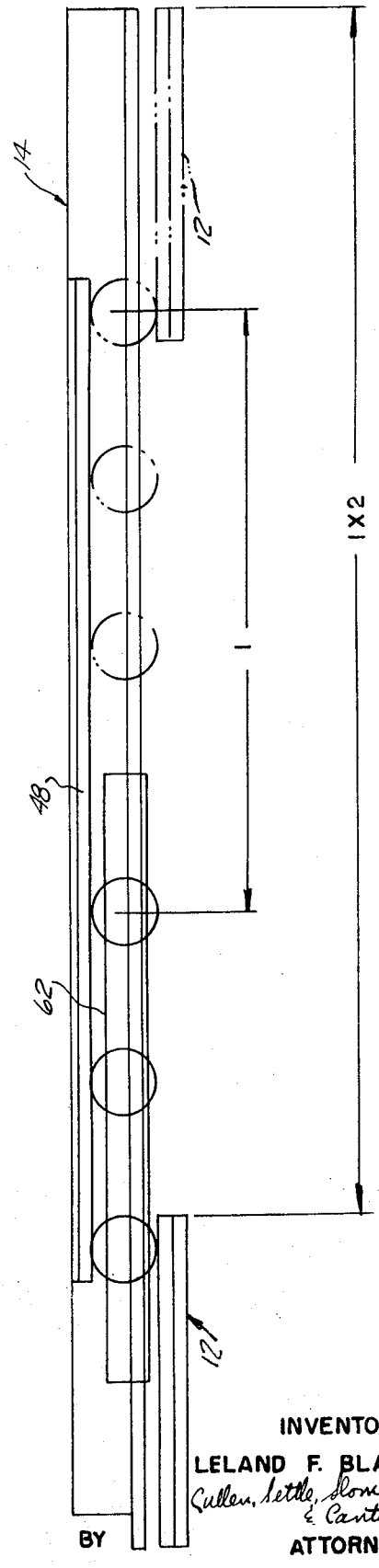


FIG. 7

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STROKE MULTIPLYING RETRACTOR MECHANISM

BACKGROUND OF THE INVENTION

1. Brief Description of the Prior Art

The present invention relates to an improved stroke multiplying retractor mechanism for the handling of work and production equipment.

A typical example of the application of the principle of the invention is in a retractor device by which work is presented for punching or like operations and removed following the operation. This involves gripping and rapid advance of a sheet metal plate, or the like, into a punch press and the withdrawal of the punched sheet and its release and deposit it a stack in a single operating cycle. However, it will appear from the description that follows, that the principles of the present invention are not at all limited in respect to any such special application.

The improved stroke multiplying retractor mechanism is to be broadly considered as one for performing reversing strokes of any desired length with speed and precision and in a smooth, relatively shock free manner.

Reversible stroke retractor mechanisms are known, which, in one particular construction employ a chain and sprocket drive mechanism featuring sets of driving and driven chains trained about sprockets of different diameters. This known chain and sprocket drive mechanism is of rather complex nature and affords a large supporting housing. This structure also requires arrangement for multiple cushioning and floating of some of the chain sprockets to reduce shock loads, particularly during reversing of the mechanism. This structure also requires multiple cushioning for the same reason, which is moved by the sprocket and chain drive mechanism.

The complexity as well as high cost of production of this chain and sprocket drive mechanism has also prevented its universal application.

The present invention provides an improved, considerably simplified reversing and multiplying stroke driving mechanism for the carriage of an article handling apparatus.

SUMMARY OF THE INVENTION

The present invention provides a longitudinally stationary housing or frame member mounted on an overhead cross-bar for transverse positioning movement therealong. The longitudinal stationary frame member has opposite outwardly disposed longitudinal slideways which may be in the form of inclined surfaces, and which are adapted to support roller bearings or the like for rolling engagement therealong.

The roller bearings support a carriage assembly which is adapted for movement along the stationary frame member and which is attached an article gripping device of any known kind. The carriage assembly is actuated for movement by power means, such as a fluid cylinder, and is drivingly connected to the frame member by means of an intermediate gear and rack mechanism, which is composed of a stationary rack member secured to the frame member and an oppositely disposed rack member secured to the carriage assembly. Both rack members are in mesh with intermediate pinions which are supported in a pinion carrier intermediate the frame member and the carriage assembly. The pinion carrier is connected to the fluid power means for reciprocating actuation thereby so that, when the fluid power means it actuated, the pinion carrier will be longitudinally moved causing rotating travel of the pinions along the stationary rack member. Due to the simultaneous engagement with the rack member of the carriage assembly, the carriage assembly is caused to move longitudinally along the stationary frame member. The arrangement of the gear and rack mechanism is such, that the carriage assembly will be moved at least twice the distance of the distance of the stroke effected by the fluid power means.

Thus, the present improved gear and rack mechanism for the retractor assembly of a load handling device, provides an effective mechanical, stroke multiplying means thereby reducing the overall fluid power requirement and requiring considerably less space than the known chain drive stroke multiplying retractor mechanisms.

A further distinct advantage of the present improved stoke multiplying retractor mechanism resides in the arrangement of the fluid power means and opposite cushioning means which are disposed along the central axis of the pinion carrier which provides the reciprocating motion for the carriage assembly. Thus, all forces are taken along the center line of stroke actuation to provide a force balanced actuating mechanism. The present improved gear and rack mechanism, providing a proportional stroke multiplication, permits the carriage to be designed with no gear rack overhang and a low overall silhouette of the apparatus. The cushioning means at opposite ends of the assembly, which are also disposed on the pinion carrier center line of force, are adjustable to cushion the kinetic energy of the moving carriage to bring it to a smooth stop at the respective end of the carriage movement.

Further advantages and novel features of the present improved stroke multiplying retractor mechanism will become apparent by reference to the following detailed description in connection with the appended drawings illustrating a preferred embodiment thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a preferred embodiment of the invention in which:

FIG. **1** and **1***a* is a top plan view of the present improved retractor mechanism;

FIG. **2** and **2***a* is a side elevation of the present improved retractor mechanism of FIG. **1**;

FIG. **3** is a right hand end view of the present improved retractor mechanism of FIG. **1**;

FIG. **4** is an enlarged partial cross-section of the gear and rack drive mechanism and slide bearing arrangement for the carriage as seen along line **4—4** in FIG. **1**;

FIG. **5** is a schematic illustration of the functional characteristic of the present improved retractor mechanism showing a single pinion gear arrangement;

FIG. **6** is a schematic illustration of the functional characteristic of a dual pinion gear arrangement; and

FIG. **7** is a schematic illustration showing the functional characteristic of a triple pinion gear arrangement.

DESCRIPTION OF THE PREFERRED EMBODIMENT

WIth continuous reference to the drawings, the present improved stroke multiplying retractor mechanism **10** is comprised of a longitudinally movable carriage assembly generally indicated at **12** which is supported for movement on an overhead suspended frame member generally indicated at **14**. The frame member **14** is stationary in longitudinal direction of the carriage **12** and is supported by means of a clamp member **16** on a cross-rail **18** or the like for transverse aligning movement along the rail **18**.

The carriage assembly **12** has a mounting portion **20** suspended therefrom, which is adapted to generally support a suitable retractor head (not shown) of a conventional type which may, for instance, be adapted to be operated to seize an article to be handled, present it to a punch press or like operating mechanism and withdraw it after the work operation in a repetition of work cycles. However, the present invention is not concerned particularly with these aspects and it should therefore be considered that the carriage **12** will represent any desired sort of operated unit which is to be moved to and fro in a properly timed cycle at a relatively high speed, but smoothly and without undue shock as the direction of movement is reversed.

The stationary, longitudinal frame member **14** is comprised of a top plate **22** from which depend at both longitudinal sides thereof, side plates **24** and **26**. At both ends of the frame member **14** end plates **28** and **30**, respectively, are provided to provide a substantially rectangular enclosure.

Secured to the lower ends of the side plates **24** and **26** of the frame member **14** are oppositely disposed longitudinal slideways **32** and **34**, respectively, extending outwardly therefrom and each of which is provided with an inclined bearing surface **35**. The inclined bearing surfaces **35** of the opposite longitudinal slideways **32** and **34** of the frame member are adapted to engage oppositely disposed and similarly angularly inclined anti-friction bearing means **36** which are rotatably supported in bracket members **38** attached along opposite sides of a bottom plate member **40** of the carriage assembly **12**. Another group of anti-friction bearing means, such as rollers **42**, is similarly rotatably supported inwardly of the opposite bracket means **38** of the carriage **12** to rotatably engage the bottom surfaces of the opposite slideways **32** and **34** of the frame member **14**, so as to provide a balanced thrust absorbing bearing contact for the carriage assembly **12** along the slideways **32** and **34**.

The bottom plate member **40** of the carriage assembly **12** extends underneath the frame member **14** in longitudinal direction thereof and is provided with a pair of oppositely outwardly disposed gear racks **44** and **46**, respectively, which extend the full length of the bottom plate **40**.

The stationary frame member **14** is likewise provided with a pair of longitudinal gear racks **48** and **50**, respectively, which are disposed in reverse juxtaposed position directly above the respective gear racks **44** and **46** of the carriage assembly **12**. The gear racks **48** and **50** of the stationary frame member **14** are attached to the bottom side of the top plate **22** of the stationary frame member **14**.

It will be noted from the drawings that the top gear racks **48** and **50** of the frame member **14** are considerably longer than the gear racks **44** and **46** of the carriage assembly **12** and are disposed substantially centrally between the ends of the frame support member **14**.

The oppositely disposed gear racks **44** and **48** are adapted to be drivingly connected by the provision of a pair of longitudinally spaced pinion gears **52** and **54**, respectively, and the opposite gear racks **46** and **50** are similarily drivingly connected by a pair of longitudinally spaced pinion gears **56** and **58**, respectively, which are disposed on axially aligned axes with the opposite pinion gears **52** and **54**.

With particular reference to FIG. **4**, each of the pair of gears **52**, **54** and **56** and **58**, respectively, are rotatably supported in opposite carrier assemblies **60** and **62**. Carrier assembly **62** is comprised essentially of longitudinal side plates **64** and **66** supporting the pair of pinion gears **52** and **54** and carrier assembly **60** is comprised of oppositely disposed parallel side plates **68** and **70** supporting the opposite pair of gears **56** and **58**. Each of the pinion gears **52**, **54**, and **56** and **58** is rotatably supported on an anti-friction roller bearing **72** disposed on a shaft **72**, which is stationarily attached to the respective carrier side plates **64**, **66** or **68** and **70**, respectively.

The opposite pinion carrier assemblies **60** and **62** are maintained in parallel opposed alignment on opposite sides of the longitudinal center line "X" of the present stoke multiplying mechanism by mean of a head or cross member **76** disposed transversely relative to the center line "X" and which is connected to the front ends of the pinion carrier side plates **64** to **70**.

The cross head **76**, which connects both opposite pinion carrier assemblies **60** and **62**, is connected along the central axis "X" of the assembly to a piston rod **78** which is reciprocably contained within a fluid cylinder **80**. The fluid cylinder **80** is longitudinally disposed between the pinion carrier assemblies **60** and **62** within the supporting frame member **14** and is suitably attached to the top plate **22** thereof. The fluid cylinder **80** has a front fluid inlet **82** and rear fluid inlet **84** which are suitably connected by conduits (not shown) to a source of fluid under pressure (not shown) of any conventional suitable design. Thus, the fluid cylinder **80** is a double-acting cylinder to provide powered reciprocation of the piston rod **78** in forward and reverse direction along the center line "X."

At the right hand end of the improved retractor mechanism **10**, as shown in FIGS. **1***a* and **2***a*, a resilient cushion assembly **86** is provided disposed along the center line "X" of the assembly which may be a fluid cushion or a mechanical spring bumper of conventional design according to respective installation requirements. Similarly, at the left hand or rear end of the improved retractor mechanism **10** a fluid cushion assembly **88** is provided along the center axis "X" which is integral with the rear end **81** of the fluid cylinder **80**. The fluid cushion **88** at the rear or piston end of the fluid cylinder **80** may be of a design such as for instance illustrated in applicant's co-pending application Ser. No. 49,630, filed June 25, 1970, now abandoned, for "Cushion Seal for a Cylinder" and for a detailed description of the operation of such a fluid cushion, preferably used herein, reference should be had to the above identified application. However, the particular construction and operational characteristics of both front cushion assembly **86** and rear cushion assembly **88** for the improved fluid operated retractor mechanism for no part of the present invention.

In operation of the present improved retractor mechanism, with the carriage **12** being disposed at the left end of the assembly as shown in solid lines, pressurized fluid is being introduced at the piston or head end of the cylinder through the inlet **84** to thereby pressurize the cylinder to move the piston rod **78** forwardly, that is towards the right in the drawings. This actuation causes the dual pinion gear carrier assemblies **60** and **62**, which are connected by the common cross member **76** to the piston rod **78**, to be moved towards the right in the drawings. In the initial position, as seen from FIG. **2**, only the left hand or rear end set of pinions **52** and **56** are in engagement with both the upper stationary racks **48–50** and the lower racks **44–46** of the carriage assembly **12**, which is disposed at the rear end of the stationary frame support member **14**. As seen from FIGS. **1** and **2**, in this position the opposite aligned pinion gears **52** and **56** are disposed between the rear end of the upper stationary racks **48** and **50** and the front end of the carriage racks **40** and **46** whereas the longitudinally forwardly spaced set of pinion gears **54** and **58** are only in meshing engagement with the upper racks **48** and **50**.

As pressurized fluid is introduced through the rear fluid inlet **84** of the fluid cylinder **80**, the piston rod **78** is caused to move the pinion gear carrier **60** and **62** towards the right in the drawing by means of its connection to the cross member **76**, which connects both opposite pinion gear carriers, along the central axis "X" for balanced force application. All of the pinion gears **52** to **58** are thereby caused to rotate simultaneously along the upper stationary racks **48** and **50** of the support frame assembly **14**. Rotation of the opposite set of pinions **52** and **56**, which are in engagement with the carriage racks **44** and **46**, cause longitudinal movement of the carriage assembly **12** along the slideways **32** and **34** of the frame support member **14**. Due to the stationary retainment of the upper racks **48–50** the carriage assembly **12** is moved at a speed twice as fast as the movement of the pinion gear carrier assemblies **60** and **62** caused by movement of the piston rod **78**.

Movement of the carriage assembly **12** twice as fast as the piston stroke exerted by the fluid cylinder **80** causes the carriage assembly **12** to be moved forwardly in advance of the opposite set of pinions **52** and **56** towards the longitudinally forwardly spaced opposite set of pinions **54** and **58** until all of the pinions **52** to **58** are in meshing engagement with both the upper racks **48** and **50** and the lower racks **44** and **46** at an intermediate point in the carriage movement. Continuing stroke movement by the piston rod **78** causes the carriage assembly **12** to still further move ahead of the pinion gears **52–58** reaching a point in the movement where the opposite set of pinions **52** and **56** is disengaged from the carriage racks **44** and **46** so that thereafter only the set of opposite pinions **54** and **58** are in meshing engagement with both the upper racks **48** and **50** of the support frame member and the lower racks **44** and **46** of the carriage assembly **12**. Continuing piston

stroke causes the carriage assembly **12** to still further move ahead of the set of opposite pinions **54** and **58** until, at the end of the stroke, the carriage assembly **12** is disposed at the forward end of the frame support member **14** assuming a position shown in phantom lines in FIG. **2***a*, in which the set of pinions **54** and **58** are now positioned between the forward end of the upper racks **48–50** and the rear end of the carriage racks **44–46**. It will be seen that the carriage assembly **12**, during the actuating stroke of the improved retractor mechanism, has been moved from the rear end of the frame support member **14** from the position shown in FIG. **2** to the front end of the frame support member as shown in FIG. **2***a*, the carriage assembly **12** having changed over from engagement with the set of opposite rear pinions **52–56** into engagement with the set of opposite forward pinions **54** and **58**.

It will be seen from the drawings that, although the carriage assembly **12** has been moved twice the distance than the distance which the pinion gear carriers **60** and **62** have been moved as determined by the stroke of the piston rod **78**, the carriage assembly **12** does not extend at either end beyond the frame support member **14** which is desirable to meet space requirements in actual installations.

According to installation requirements and desired distance of movement of the carriage assembly **12**, the length of the gear racks as well as the pitch and number of the teeth of the racks and pinions can, of course, be varied accordingly to obtain any desired length of carriage movement as well as any desired speed of movement. In addition, as will be described hereafter in connection with FIGS. **5** to **7**, the number of pinion gears which drivingly connect the carriage assembly **12** to the frame support member **14** can, of course, be varied to suit any length of carriage movement according to particular installation requirements.

At the end of the forward stroke as described above, the cross head member **76**, which connects opposite and parallel pinion gear carrier assemblies **60** and **62** and is operably connected to the piston rod **78**, is caused to abut against the front cushion assembly **86** to thereby cushion the end of the stroke movement, which is relatively fast, to prevent shock loads being transferred to the carriage assembly **12**, which supports the load handling implement. Upon reverse movement of the carriage assembly **12** according to a timed work cycle, pressurized fluid is being introduced into the front fluid inlet **82** and exhausted through the rear inlet **84** to thereby reverse the reciprocating movement of the piston rod **78** for retraction into the fluid cylinder **80**. The carriage assembly **12** is then moved, as explained above but in reverse order, from the front end position shown in FIG. **2***a* to the rear end position shown in solid lines in FIG. **2**. The end of the reverse stroke is being cushioned by the fluid cushion assembly **88**, integral with the fluid cylinder **80**, to provide a cushioning stop for the carriage **12** at the end of the reverse stroke.

With reference now to the operation of the schematic embodiments shown in FIGS. **5**, **6** and **7**, it will be noted that the dual pair of pinion arrangement herein before described and shown in FIGS. **1** to **4**, corresponds to the schematic embodiment shown in FIG. **6**.

FIG. **5** schematically illustrates a single pair of pinion arrangement providing a short carriage stroke arrangement and FIG. **7** schematically illustrates a triple pair of pinion arrangement for longer carriage stroke installations. It will be noted that in all of the operations of schematics shown in FIGS. **5**, **6** and **7**, the distance of movement of the pinion carrier assembly (indicated by the numeral **1**), is half that of the movement of the carrier assembly **12** or, in other words, the carriage assembly **12** moves twice the distance of the pinion carrier **62**. Thus, the effective stroke of the fluid cylinder embodied in any particular embodiment employing either single, dual, triple or more pairs of pinions, can be held to a minimum while still obtaining maximum desired carriage movement, thereby considerably reducing the power requirement for operation of the present improved stroke multiplying retractor mechanism.

It will be evident from the foregoing description in connection with the appended drawings, that the present invention provides an improved, simplified and space saving stroke multiplying retractor mechanism, which is rugged and dependable in operation and which lends itself easily to a multitude of installation and stroke length requirements.

It will also be appreciated, that the actuating force as well as the cushioning reaction force are located along the central axis of the retractor mechanism to thereby provide a balanced operation which is supplemented by duplicate gear and rack arrangements located on opposite sides of the central axis of the retractor mechanism to thereby prevent or reduce undue strain and wear on the operating parts of the mechanism.

Although the present invention has been described in connection with a preferred embodiment, it will be obvious that various changes in construction and details may be asserted to by a person skilled in the art to which the invention pertains without departing from the essential characteristic and spirit thereof is indicated by the scope and the appended claims.

What is claimed is:

1. In a retractor mechanism for an article handling apparatus adapted to be longitudinally moved back and forth along a stationary support, the improvement comprising a stationary support including an elongated housing having a longitudinal center axis, a pinion carrier mounted upon and longitudinally movable relative to said housing; a carriage disposed parallel to said pinion carrier guidably mounted upon and depending from said housing; a pair of parallel first rack gears secured within said housing and disposed on opposite sides of said center axis parallel thereto; said carriage being slidably mounted on said housing for movement between a first and a second end position; a second pair of parallel second rack gears secured to said carriage in juxtaposed position to said first pair of rack gears; said pinion carrier being disposed between said first and second pair of rack gears; a pair of axially aligned oppositely disposed pinions rotatably journalled and supported on said carrier in mesh with said first and second pair of rack gears to drivingly connect said carriage to said support, and power means including a cylinder and reciprocal piston rod mounted on said support with said piston rod operably connected to said carrier for reciprocation thereof, so that on actuation of said cylinder, said carrier is moved longitudinally causing rotatable driving engagement of said pinions with said first and second rack gears, to thereby longitudinally move said carriage in the same direction as said carrier but at a different speed; said piston rod being reciprocally disposed along said center axis.

2. In the mechanism as defined in claim **1**, there being a second pair of axially aligned pinions longitudinally spaced along and journalled upon said carrier such that in the first end of travel position of said carriage said first pair of pinions will be in meshing engagement with both said first and second pair of rack gears, and said second pair of pinions will be in meshing engagement with only said first pair of rack gears; in an intermediate position of said carriage said first and second pair of pinions will be both in meshing engagement with said first and second pairs of rack gears, and in a second end of travel position said second pair of pinions will be in meshing engagement with both said first and second pair of rack gears and said first pair of pinions will be in meshing engagement with only said first pair of rack gears.

3. In the mechanism as defined in claim **1**, there being second and third pairs of axially aligned pinions journalled upon and longitudinally equally spaced along said carrier such that in a first end of travel position of said carriage said first pair of pinions will be in meshing engagement with both said first and said second pair of rack gears and said second and third pair of pinions will be in meshing engagement with only said first pair of rack gears; in an intermediate position said first, second and third pair of pinions will be in meshing engagement with both said first and second pair of rack gears, and in a second end of travel position said third pair of pinions will be in meshing engagement with both said first and second

pair of rack gears and said first and second pair of pinions will be in meshing engagement with only said first pair of rack gears.

4. In the mechanism as defined in claim 1, cushioning means mounted on and disposed at opposite ends of said housing alternately engagable with said carrier to prevent shock loads from being transferred to said carriage at respective ends of travel of said carrier.

5. A reciprocating stroke multiplying retractor mechanism comprising in combination: a stationary frame, a carriage movably mounted on said frame for relative sliding movement therealong, at least one upper rack gear fixedly connected to said stationary frame, at least one lower rack gear disposed on said carriage for movement therewith; means drivingly connecting said upper and lower rack gears, said means including a longitudinal support disposed intermediate said upper and lower rack gears, at least one pinion rotatably mounted on said support adapted for coacting meshing engagement with said upper and lower rack gears; a power cylinder and piston rod operably connected to said support for reciprocation of said support; said power means upon actuation causing rotation of said pinion to thereby longitudinally move said carriage relative to said stationary frame by meshing engagement of said pinion with said lower rack gear; said pinion in the first position of said mechanism being disposed between the rear end of said upper rack and the front end of said lower rack gear and in the second position, after actuation of said mechanism by said power means, being disposed between the front end of said upper rack gear and the rear end of said lower rack gears; said lower rack gear and its associated carriage having been moved a distance approximately twice the distance of the longitudinal movement of said pinion along said upper rack gear.

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