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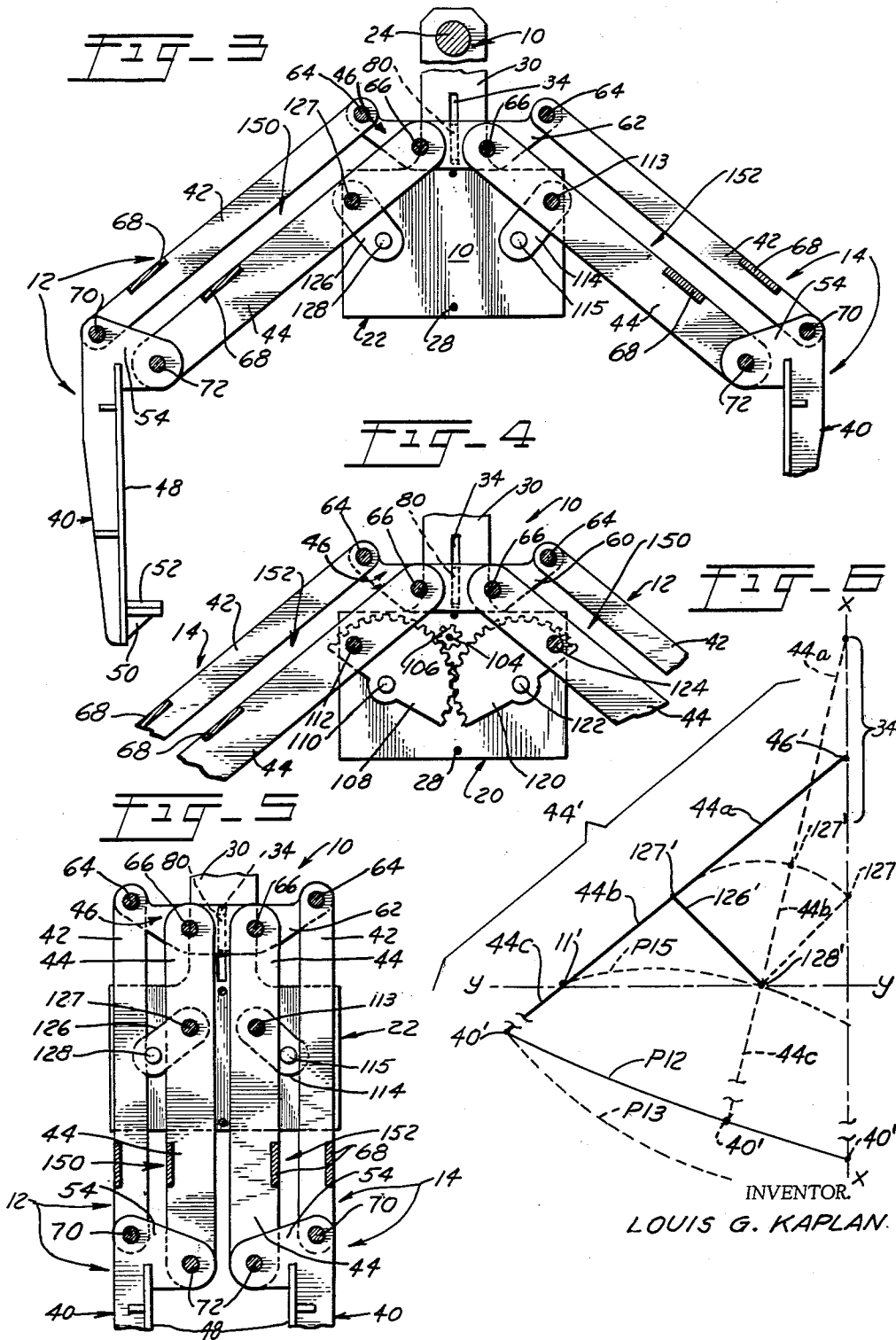
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ARTICULATED LIFTER WITH SUBSTANTIALLY
CONSTANT JAW GRIPPING FACTOR

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ARTICULATED LIFTER WITH SUBSTANTIALLY CONSTANT JAW GRIPPING FACTOR

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5 Claims. (Cl. 294-88)

The present invention relates to industrial lifters of the opposed jaw type such as are primarily employed for lifting, moving, transporting or otherwise handling relatively heavy and usually massive objects such as coils, billets, stacks of flat sheet metal stock, castings, ingots and the like. Such lifters are commonly employed at the steel mill or foundry for loading purposes, and at consumer locations where such objects are distributed throughout the plant for fabrication purposes. Insofar as their jaw action is concerned, such lifters are of two types. Either the opposed jaws are provided with projecting fingers or flanges at their lower ends, these fingers or flanges being adapted to be projected beneath the object to be lifted when the jaws are closed upon each other so that when the lifter is raised bodily by an overhead hoist, the object is supported upon the fingers or flanges, or the opposed jaws are of the gripping type wherein they engage the opposite vertical side surfaces of the object with sufficient gripping force to make certain that the object is seized between the jaws for lifting purposes. In the former instance, the jaw-actuating power source, which usually is an electric motor operating through a gear reduction device, is relied upon for the gripping action of the jaws. In the latter instance, the power supplied by the motor is augmented by a tongs action whereby the lifting force of the overhead hoist is converted into lateral inward pressure of the jaws so that a powerful gripping force which is substantially independent of the jaw control motor is exerted upon the object to be lifted. It is to the former type of lifter that the present invention specifically relates.

Conventional lifters of the character with which the present invention is concerned are comprised of two series of jointed leg assemblies which are hinged at their upper ends to the opposite sides of a supporting structure. In the case of a sheet lifter, the lower ends of the legs carry angle irons which have opposed inwardly projecting flanges adapted to engage under a stack of sheets for supporting it. In the case of a coil lifter, the lower ends of the legs carry opposed inwardly projecting fingers adapted to enter the central bore of the involutely wound spool like structure. The supporting structure carries means, which may be either manual or motorized, for closing and opening the jaws afforded by the relatively movable leg structures to thus thrust the inwardly projecting flanges or fingers beneath the load. The gripping force exerted by such lifters is purely secondary and the force which is required for a safe lift need be no greater than that which is required to maintain the load-supporting flanges or fingers beneath the load so that when the lifter is raised bodily by the overhead crane or hoist associated therewith, substantially the entire weight of the load will be supported upon the load-supporting flanges or fingers. With this type of lifter, the compressional force exerted by the power train alone is relied upon to maintain the load captured between the lifter jaws. The gripping action which takes place against the sides of the load has little or no effect upon the lifting function, this latter function being substantially entirely a function of the load-supporting flanges or fingers.

Lifters of the character briefly outlined above are possessed of at least one serious limitation, namely that the gripping force exerted by the jaws is variable and, at times, it is insufficient to maintain the jaws closed upon

the load against accidental dislodgment. Small as this load-gripping force need be in the free state of a lifter when carrying a load, it must at least be sufficient at all times to prevent jaw spreading movements under accidental conditions, as for example when the travelling lifter or the load carried thereby inadvertently strikes another object. In such swinging jaw type lifters, the jaws are carried at the lower ends of pivoted links the upper ends of which are pivotally connected directly to the lifter framework. Thus the jaws follow curved paths during jaw-closing movements. The curve involved is a function of jaw spread and, when the jaws are wide open, the increments of motion of the jaws are vertically downward rather than horizontally inward whereas, when the jaws are nearly closed, the increments of motion of the jaws are horizontally inward rather than vertically downward. Theoretically, when the jaws are fully spread apart, initial closing movement of the jaws results in an initial vertical increment of motion of the jaws with no inward motion thereof. Continued closing movements of the jaws will gradually supply increasing horizontal inward components of motion to the jaws until such time as the jaws are fully closed, at which time the motion thereof will be entirely horizontal. Due to the principle of tongs action involved, the force applied by the jaws against the work is inversely affected by the directional component of motion of the jaws. Thus, when a relatively narrow load is being carried and the jaws are close together, the pressure exerted upon the load is relatively small and a blow struck upon the load or upon one of the lifter jaws in a direction counter to jaw-closing movement may, if of sufficient magnitude, displace the jaw outwardly a sufficient distance to withdraw the associated load-supporting finger from beneath the load so that the latter will fall to the ground. Where a relatively wide load is concerned, this danger is not prevalent but, on the other hand, if the load is in the form of an involute coil of sheet metal, the pressure brought to bear upon the regions of jaw-contact therewith may be so great as to damage the coil laminations. Also, if the load is comprised of a relatively few superimposed sheets of flat sheet metal stock insufficient to produce a stack of high proportions, the pressure of the jaws on the load may be sufficiently great as to bend the load in the middle and cause load slippage against the sides of the jaws. In short, with conventional lifters of the swinging jaw type, there is danger of both insufficient jaw pressure and of excess jaw pressure, each leading to a special type of hazard.

The present invention is designed to overcome the above noted limitations that are attendant upon the construction and use of conventional swinging jaw type lifters and, toward this end, the invention contemplates the provision of a lifter wherein a uniform and safe inward jaw pressure is at all times exerted upon the load regardless of load width, this pressure being somewhat less than the full gripping action of which the power train which drives the jaws is capable of exerting, yet being at all times sufficiently great that accidental blows or other forces which may be applied to the lifter jaws in any positions thereof, will not, in the course of normal use of the lifter, be of sufficient magnitude as to effect outward jaw displacement.

In carrying out the invention it is contemplated that the swinging arms which support the jaws, instead of being pivoted at their upper ends directly to fixed points on the lifter framework, have their upper ends pivoted to a vertically shiftable head on the framework. The head is constrained to move vertically under the influence of a toggle mechanism including toggle links which are connected to the swinging arms in such a manner that the upper portions of the arms constitute counterpart toggle links of the toggle mechanism. The remaining lower por-

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tions of the swinging arms constitute toggle link extensions which carry the jaws at their lower ends. The lengths of the toggle links and of the toggle link extensions are calculated according to engineering expediences to the end that as the lower end of the toggle link extensions swing downwardly at the commencement of jaw closing operations, the toggle action forces the head upwardly while at the same time a relatively large component of inward motion is applied to the lower ends of the toggle link extensions. This vertical upward movement of the head is a simple harmonic motion, as also is the inward motion of the lower ends of the toggle link extensions. The vertical upward movement of the head in effect draws the swinging arms bodily upwardly to lessen the normal rapid downward motion of the jaws which ordinarily takes place at the commencement of jaw closing operations. Since this upward movement is a decelerating movement, the gradually decreasing increments of vertical downward movement of the jaws which ordinarily take place when the jaws are mounted on swinging arms having fixed pivots are translated into horizontal increments of inward motion of the jaws, the rate of such translation being inversely proportional to the normal incremental increase in inward movement of the jaws as heretofore outlined. The net result is that the jaws follow a substantially straight linear path of movement having appreciable increments of inward movement which remain substantially constant during the initial portions of the closing movements of the jaws. These inward components of motion are not so great as to result in undue pressure upon the sides of the load nor are they so insignificant that they will permit inadvertent spreading of the jaws under the influence of accidental contingencies as outlined above.

According to the present invention, due to the decelerating simple harmonic motion which is imparted to the vertically shiftable head by the toggle action, the vertical upward displacement of the head rapidly decreases and terminates as the toggle action approaches and arrives at its dead center position when the toggle links are in alignment. This condition takes place approximately at the time that the jaws are in their mid position or, in other words, are half closed upon each other. Thereafter, as the swinging arms continue their inward motion, the toggle action serves to lower the head with a now accelerating simple harmonic motion. This lowering action takes place at a time when the jaws normally would move inwardly toward each other with large increments of inward motion and small increments of downward motion. This lowering of the head under the influence of the toggle action imparts to the jaws the necessary downward motion to preserve the desired straight line movement thereof and to lessen the high degree of pressure ordinarily applied by the jaws against the sides of the load as heretofore explained. Again the inward component of motion imparted to the jaws during their final closing movements is not so great as to exert undue pressure upon the sides of the load, nor are they so small as to allow inadvertent jaw spreading action under the influence of accidental blows or the like.

To summarize the action of the vertically shiftable jaw-supporting head of the present invention, the initial upward decelerating simple harmonic motion imparted thereto at the commencement of jaw closing operations lessens the large component of downward motion ordinarily applied to the jaws and translates a portion of such downward motion into inward motion of the jaws during initial jaw closing operations. Similarly, the terminal downward accelerating simple harmonic motion imparted to the head at the completion of jaw closing operations lessens the large component of inward motion of the jaws and translates a portion of such motion into downward motion thereof. The normal arcuate path of movement of which conventional swinging jaws are capable is thus, in effect, straightened out into substantial linear propor-

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tions so that constant pressure on the load by the jaws is exerted regardless of load width.

The provision of a lifter of the character briefly outlined above and one possessing the stated advantages being the principal object of the invention, numerous other objects and advantages will become readily apparent as the following description ensues.

In the accompanying two sheets of drawings forming a part of this specification one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is an end elevational view of a lifter constructed according to the principles of the present invention;

FIG. 2 is a side elevational view of the structure shown in FIG. 1 with certain parts broken away to more clearly reveal the nature of the invention;

FIG. 3 is a fragmentary sectional view taken substantially along the line 3—3 of FIG. 2 in the direction indicated by the arrows;

FIG. 4 is a fragmentary sectional view taken substantially along the line 4—4 of FIG. 2 in the direction indicated by the arrows;

FIG. 5 is a fragmentary sectional view similar to FIG. 3 but with the lifted jaw structure in its fully closed condition; and

FIG. 6 is a diagrammatic view illustrating certain geometrical principles which obtain in connection with the jaw movements of the present lifter.

The invention has been illustrated in the accompanying drawings and described in this specification in connection with a motorized coil lifter designed for use specifically in handling relatively heavy involutely wound sheet metal coils. It is to be distinctly understood, however, that the principles of the invention are equally well applicable to other types of lifters, for example lifters which are provided with lifting flanges or multiple lifting fingers at the lower regions of the opposed jaws for engagement beneath the side edges of a stack of metal sheets or lifters which are not motorized but which rely for their jaw-opening and jaw-closing movements upon hand power which may be transmitted through a power train from a crank, hand wheel or the like. Irrespective however of the particular type of lifter to which the present invention may be applied, the essential features of the invention are at all times preserved.

Referring now to the drawings in detail and in particular to FIGS. 1 and 2, the lifter selected for illustration herein involves in its general organization a supporting framework 10, a pair of jaw assemblies 12 and 14, a reversible electric motor 16, and a power train 18 extending between the motor and jaw assemblies for conjointly shifting the latter toward and away from each other in response to the operation of the motor.

The supporting framework 10 includes a pair of spaced apart plates 20 and 22 which are maintained in their spaced relationship by means of various cross members including an upper bail 24, an intermediate horizontal plate 26, and a lower cross pin 28. For convenience of description, the plate 20 will be regarded herein and referred to as a front plate, while the plate 22 will be considered to be a rear plate, the motor 16 thus being disposed at the rear of the lifter. The two plates 20 and 22 are substantially identical and each is generally of inverted T-shape design and includes an upper stem portion 30 and a lower rectangular body portion 32. The stem portion 30 of each plate is provided near the base thereof with an elongated vertical slot 34, the function of which will be made clear presently. The bail 24 is designed for cooperation with the lifting hook 36 of an overhead hoist or crane (not shown) by means of which the lifter as a whole may be raised bodily and transported from place to place as is customary in connection with lifters of the type with which the present invention is concerned.

The jaw assemblies 12 and 14 are of the articulated

parallelogram linkage type commonly employed in connection with tongs type lifters and wherein the jaws proper are carried at the outer or distal ends of respective pairs of parallel swinging links so that as the links swing toward and away from each other, the jaws proper maintain positions of parallelism or, at least, do not change their orientation. Each jaw assembly includes a jaw proper 40, the upper end of which is pivoted at spaced points to a pair of parallel swinging links including an outer link 42 and an inner link 44. The links are pivoted to the jaw 40 at their distal ends and the proximate ends of the links are pivoted at spaced points to a vertically shiftable free floating jaw-supporting head 46 which is common to both jaw assemblies 12 and 14.

The two jaws 40 are substantially identical and each is comprised of an elongated vertical member which is generally T-shape in transverse cross section and presents an inwardly facing flat coil-engaging surface 43. The lower end of the member is provided with an inwardly directed coil-supporting finger 50 adapted to be projected into the open ended bore of an involutely wound coil to be lifted and having a curved upper surface 52 shaped conformably to the inner surface of the bore. The coil, when fully engaged for lifting purposes, has its opposite ends supported upon the surfaces 52 of the two jaws 40 while the flat vertical surfaces 43 of the jaws bear against the opposite end faces of the coil. The upper end of the T-shaped jaws 40 are provided with enlargements in the form of inwardly directed short extensions 54 which, in effect, constitute link elements of the parallelogram linkage arrangement associated with the jaw assemblies. The portions of the vertically shiftable head 46 between the points of pivotal connection for the links 42 and 44 also, in effect, constitute link elements of the parallelogram linkage arrangement so that as the pairs of links 42 and 44 are swung toward and away from each other to effect jaw-closing and jaw-opening movements respectively, the members 40 which constitute the jaws will maintain their vertical positions of parallelism.

Referring now additionally to FIGS. 3, 4 and 5, the vertically shiftable jaw-supporting head 46 is of a composite nature and is comprised of two spaced apart parallel plates 60 and 62 of generally wide angle V-shape configuration and rigidly connected together by transversely extending cross pins including upper pins 64 which constitute the pivotal connections for the links 42 and lower pins 66 which constitute the pivotal connections for the links 44. The various links 42 and 44 likewise are of a composite nature in that they are each of a dual nature and include parallel link elements suitably connected together in their medial regions by spacer bars 63. The upper ends of the dual links associated with each composite link 42 are pivoted on one of the upper pins 64 while, similarly, the upper ends of the dual links associated with each composite link 44 are pivoted on one of the lower pins 66. The lower ends of the dual links 42 and 44 are pivoted on outer and inner pins 70 and 72 respectively carried on the jaw enlargements 54.

The head 46 is free floating and vertically slidable between the two framework plates 20 and 22 and is guided in its vertical movement by means of guide shoes 80 provided on the head plates 60 and 62 and which project into the elongated vertical slots 34 formed in the framework plates 20 and 22. The free vertical movements of the head 46 take place as a consequence of the swinging movements which are imparted to the pairs of links 42 and 44 during jaw-opening and jaw-closing operations under the control of the motor 16 operating through the power train 18 as will be described presently.

The electric motor 16 by means of which the jaw assemblies 12 and 14 are actuated is preferably of the reversible series wound direct current type and the power train 18 which extends between the motor and jaw assemblies includes a torque-limiting slip clutch 82, a gear reduction device 84, and a train of gearing 86, the motor

16 being carried on a supporting bracket 83 and the gear reduction device 84 being carried on a supporting bracket 90. The motor 16, clutch 82 and gear reduction device 84, as well as the supporting brackets 83 and 90, are supported from the rear framework plate 22 and are enclosed in a suitable housing 92 as best seen in FIG. 2. The torque-limiting clutch 82 may be of any suitable type but preferably it is of the type shown and described in my United States Patent No. 2,920,465, granted on January 12, 1960, and entitled "Torque Limiting Clutch Assembly With Heat Dissipating and Lubricating Means." Such a clutch is interposed between the output shaft 94 of the motor 16 and the input shaft 96 of the gear reduction device 84.

The train of gearing 86 includes a drive pinion 100 (FIG. 2) mounted on the output shaft 101 of the gear reduction device 84. The pinion 100 meshes with a gear 102 carried on a shaft 104 which extends between and is rotatably journaled in the plates 20 and 22 and this latter shaft carries a small pinion 106 which meshes with a gear segment 108 mounted on a post 110 fixedly carried by the plate 20. The segment 108 is rotatable on the post 110 and an eccentric pin 112 on the segment near the periphery thereof is pivotally connected to one of the link elements of the composite dual link 44 of the jaw assembly 14. The other link element of the dual link 44 is connected by a pin 113 (FIGS. 3 and 5) to one end of a short link 114. The other end of the link 114 is connected to a post 115 mounted on the rear plate 22, the effective length of the link 114 being equal to the extent of eccentricity of the pin 112 on the segment 108.

The gear segment 108 meshes with a similar and counterpart gear segment 120 which is rotatable on a post 122 carried on the front framework plate 20. An eccentric pin 124 on the segment 120 is pivotally connected to the inner composite link 44 of the jaw assembly 12, the connection being similar to the connection for the segment 108. Likewise, a short link 126 corresponding to the link 114, has one end connected to the inner link element of the composite link 44 associated with the jaw assembly 12 by means of a pin 127. The other end of the link 126 is connected to a post 128 on the rear plate 22.

In order to counterbalance the weight of the various instrumentalities within the housing 92 at the rear side of the lifter, a counterweight 130 (FIGS. 1 and 2) is secured to the front face of the front plate 20 and extends thereacross.

In the following description of the operation of the lifter, it may be assumed for purposes of discussion that the parallelogram type linkage associated with each jaw assembly, and including the outer and inner composite swinging links 42 and 44, and the connecting portions of the head 46 and jaw proper 40 constitutes in effect a jaw-supporting arm. Collectively, the two jaw-supporting arms associated with the jaw assemblies 12 and 14 have been designated at 150 and 152 respectively. These arms may be considered as being pivoted at their upper ends to the vertically shiftable head 46 with the jaws proper 40 being carried at the lower or distal ends of the arms. Thus, as the arms are swung downwardly and inwardly toward each other from the positions in which they are shown in FIG. 3 to the positions in which they are shown in FIG. 5, the jaws proper 40 will move toward each other and assume their fully closed positions. It also may be assumed for purposes of discussion that when the jaws are fully open the jaw-supporting swinging arms 150 and 152 will assume positions wherein the longitudinal axes thereof extend at an angle of 90° from each other or at a 45° angle from a vertical plane.

When it is desired to engage and lift a coil of appreciable axial extent, as for example the coil shown at C in dotted lines in FIG. 1, the operator of the overhead hoist who has at his disposal not only the controls for the overhead hoist but also the controls for the electric

motor 16 of the lifter, will energize the motor 16 in a direction to effect opening of the lifter jaws to an extent sufficient that they may straddle the coil, after which the lifter will be brought over the coil and lowered to a position wherein the coil-supporting fingers 50 are at least approximately in horizontal register with the opposite open ends of the bore 156 which extends axially through the coil. Such a position of the jaw assemblies 12 and 14 has been shown in broken lines in FIG. 1. The motor 16 is then energized to close the jaws proper 40 upon the end faces 158 of the coil C as shown in dotted lines in this view, the jaws moving inwardly and downwardly toward each other as indicated by the two substantially straight linear paths of movement designated at P12 and P14 respectively. Motion to the jaws 40 is transmitted from the motor 16, through the torque-limiting clutch 82, gear reduction device 84 and power train 86 to the shaft 104 and from thence through the pinion 106 to the gear segment 108 which rotates in a clockwise direction as seen in FIG. 4 (or a counterclockwise direction as seen in FIG. 1) so as to draw the attached link element of the composite link 44 of the jaw assembly 14 inwardly, while at the same time forcing the link element upwardly and to the right as viewed in FIG. 4 so that a component of upward thrust is applied to the vertically shiftable head 46 which moves vertically upwardly under the guiding influence of the guide shoes 80 and the associated slots 34. At the same time, the short link 126 rotates in unison with the gear segment 108. Upward motion is also transmitted to the head 46 through the gear segment 120 which meshes with the segment 108 and thus rotates in a counterclockwise direction as seen in FIG. 4 so as to force the link element of the composite link 44 of the jaw assembly 12 upwardly and to the left. As will be set forth in greater detail in connection with the diagrammatic view of FIG. 6, the upward movement of the head 46, and consequently of the upper ends of the jaw-supporting arms 150 and 152, when coupled with the normally inward and downward swinging movements of the lower ends of the jaw-supporting arms, results in a straightening out, so to speak, of the paths of movement of the lower ends of these arms and of the jaws 40 carried thereby so that the jaws are constrained to travel in substantially straight linear paths throughout their entire range of movements as indicated by the dotted line paths of motion P12 and P14 respectively in FIG. 1.

After the jaws 40 have been closed upon the end faces 158 of the coil as shown in dotted lines in FIG. 1 and as described above, the two coil-supporting fingers 50 will be projected into the bore 156 of the coil C and thereafter the operator of the overhead hoist may operate the hoist so as to raise the hook 36 to pick up the lifter bodily for coil-elevating purposes. As the lifter moves vertically upwardly, the weight of the coil will maintain the coil on the floor or other supporting surface until such time as the fingers 50 engage the inner wall of the bore 156, at which time the fingers will bear the entire weight of the coil and cause the same to be lifted from the supporting surface.

It is to be noted at this point that the directions of the two linear paths P12 and P14 are such that, regardless of the positions of the jaws 40, an appreciable inward component of motion, substantially greater than the vertical component of downward motion, is applied to each jaw as the jaws are moved inwardly from any point along their path of travel. By reason of this fact, an inward thrust of constant proportions is at all times applied to the end faces of the coil undergoing lifting regardless of the axial extent of the coil. Thus, when lifting any coil having an axial extent which is relatively great, when the jaws 40 are closed upon the end faces of the coil the tendency for the eccentric pins 112 and 124 is to force the head 46 upwardly and alleviate some of the relatively great inward tongs-initiated pressure which ordinarily would be exerted by the jaws 40 against the end faces of

the coil laminations. Ordinarily, in connection with conventional lifters having jaw arms which are pivoted directly to the framework of the lifter, the forces applied to the jaws when the arms are at a wide angle to each other is extremely large in a horizontal inward direction but is small in a vertical downward direction. Thus, when lifting and transporting coils of large axial extent, the danger of crushing of the coil laminations is ever present.

Conversely, when the lifter is employed for lifting a coil of small axial extent such as the coil C2 shown in broken lines in FIG. 1, the jaw-supporting arms 150 and 152 will extend substantially vertically and the two jaws 40 will assume positions of relatively close proximity to each other. At this time a relatively small component of inward force of the jaws will result from the tongs action of the arms 150 and 152. As shown in FIG. 5, the position of the short links 114 and 126 will be such that they will tend to pull the head 46 downwardly and at the same time force the arms 150 and 152 inwardly to increase the pressure of the jaws 40 against the end faces of the coil C2. Because of this phenomena, the relatively small inward pressure against the end faces of the coil which would be exerted by the jaws of conventional lifters having jaw arms which are directly pivoted to the framework is appreciably increased so that the jaws will present sufficient inward pressure to resist becoming dislodged from the coil when accidentally struck by an object in passing.

The geometrical considerations associated with the lifter of the present invention have been diagrammatically portrayed in FIG. 6 wherein the articulation of the interconnected head 46, link 44 of the jaw assembly 12 and short link 126 has been represented by similarly interconnected and pivoted straight lines which are graphically illustrated. The purpose of the diagram or chart is to illustrate the derivation of the substantially straight linear path of movement P12 (see also FIG. 1) of one of the lifter jaws 40. In this diagram the point 46' represents the vertically shiftable head 46; the link 44 is represented by three link section line representations 44a, 44b and 44c; the short link 126 is represented by the line 126'; one of the lifter jaws 40 is represented by the point 40'; the pivot pin 127 is represented by the point 127'; and the pivot pin 128 is represented by the point 128'. Discussion of the diagram will be made in connection with reference to FIG. 3 since the diagram is representative of the structure shown in this view.

Considering the structure of FIG. 3 in connection with the diagram of FIG. 6, the vertical axis X—X is coincident with the vertical path of movement of the head 46. The horizontal axis Y—Y passes through the pin 128 which establishes the fixed point of pivotal connection for the short link 126 on the lifter framework. The link 44 has been divided into a sectional representation 44a in FIG. 6 of the fixed distance between the head 46 and the pin 127; a sectional representation 44b of the distance between the pin 127 and the intersection between the link 44 and the axis Y—Y when the jaws are fully open; and a sectional representation 44c of the extension of the link 44 downwardly beyond the axis Y—Y when the jaws are fully open. One of the guide slots 34 for the head 46 has been represented in FIG. 6 by the bracket 34'.

It is to be noted that the link 44, in moving from its 45° full line position to its 0° or vertical position during jaw closing movements passes across the pivot pin 128. This, of course, is because the pin 66 which establishes the pivotal connection between the upper end of the link 44 and the head 46 lies inwardly of the lifter, i.e. to the right as seen in FIG. 3, from the vertical plane of the pivot pin 128 for the link 126. It is also to be noted that as the link 44 swings downwardly in a counterclockwise direction during jaw-closing movements, the link 126 swings in a clockwise direction about the pin 128 and the head 46 slides vertically upwardly along the axis X—X, thus drawing the jaw 40 inwardly or to the right and out of the normal arcuate path P13 of movement which it ordinarily

would follow if the upper end of the link 44 were pivoted directly to the framework of the lifter as is the case with conventional parallelogram type lifters. By properly selecting predetermined lengths for the sections of the link 44 represented at 44a, 44b and 44c in FIG. 6, and for the link 126, and by placing the pivot pin 123 a predetermined distance to the outside, i.e. to the left, of the axis X—X, it is possible to produce a path of movement P12 for the jaw 40 which is substantially linear, yet which at the same time has the necessary downward slope that a constant pressure will be applied to the end faces of a coil regardless of the extent of jaw spread at the time of coil engagement. This path P12 should have a component of inward movement to insure against accidental jaw dislodgement where a narrow spread is concerned, as previously explained, and a component of downward movement so that there will not be too great a degree of inward pressure on the coil where a wide jaw spread is concerned as also previously explained.

It is obvious that the greater the length of the link 44 from the pin 127 to the jaw 40, the more nearly arcuate will be the path P12. If this length is exorbitantly great, the effect of vertical shifting of the head 46 will be lost and there will be an appreciable component of downward movement at the commencement of jaw-closing operations and an appreciable component of horizontal inward movement at the termination of jaw-closing operations. The shorter the link 44, the greater will be the initial inward component of motion of the jaw 40 and the greater will be the terminal downward component of motion. For example, considering the link 44 to have an extent only as great as the distance represented in FIG. 6 between the points 46' and 11', as the jaws close upon each other, the point 11' will follow the curved path P15. This path P15 has an upward and inward component of motion at the outset since the short line 126', while swinging in a clockwise direction, carries the lower end 11' upwardly above the axis Y—Y as the point 46 slides upwardly along the axis X—X. The line 126' and section 44a constitute a toggle joint and, at such time as this toggle joint reaches a dead center position as shown in broken lines in FIG. 6 and with the line 126' and section 44a in alignment, the point 66' reaches its highest point in the bracketed area 34'. The point 11 has by this time commenced to descend and has reached its original level on the axis Y—Y. Thereafter, as the line 44' swings inwardly, the short line 126' pulls the point 46' downwardly and the descent of the point 11' is more rapid. At the time that the line 44' assumes a vertical position as shown in dotted lines, the point 11' lies appreciably below the level of the axis Y—Y. In general, the shorter the length of the line 44', the steeper will be the initial rise in the curve and the longer will be the duration of such rise. At the same time, the steeper will be the terminal decline in the curve and the shorter will be the duration of this decline.

The nature of the path P12 will be some function of the two paths P13 and P15. In general, and by computations which may be either mathematical or graphical, and which involve a subtraction of abscissae, the rise in the curve P15 occasioned by upward sliding of the head 46 is subtracted from the relatively sharp initial decline in the curve P13 at the commencement of jaw-closing operations. Similarly, the normal tendency for an almost horizontal inward motion of the point 40' with little or no downward vertical motion near the end of jaw-closing operations is compensated for by the addition to the horizontal portion of the curve P13 of the declining portion of the curve P15 occasioned by downward motion of the point 46'.

Reference to FIG. 6 will reveal the fact that as the link 44 (FIG. 3) swings inwardly from its full line representation in FIG. 6 to its dotted line representation, the head 46 represented by the point 46' is pushed upwardly and the link 126 represented by the line 126' approaches and arrives at a dead center position. In moving from the

dotted line position to the broken line position, the head is pulled downwardly and the line 126' recedes from its dead center position. Any attempt to actuate the lifter jaws by applying power to the head 46 instead of to the link 44 would be impractical and would cause jamming of the lifter at the dead center position of the link 126. For this reason it is necessary to actuate the jaws by applying power to the links 44. Partial operation of the lifter on either side of the dead center position of the thrust link 126 would permit power to be applied to the head 46 and, in either event, the portion of the jaw path represented by the line P12 in FIG. 6 would be effective, the path being substantially straight. By applying power to the links 126, they may be carried over their dead center positions with little difficulty and the full effective length of the path P12 utilized. Obviously, unless the pivot pins 66 are spaced apart on opposite sides of the central vertical plane of the head 46, and unless the pins 115 and 123 (FIG. 3) are similarly spaced apart, no dead center position can be had and the final downward movement of the head 46 cannot take place. As a consequence, no straight linear path of movement of the jaws, as represented by the line or path P12 in FIG. 6 can be attained.

The invention is not to be limited to the arrangement of parts specifically illustrated in the accompanying drawings or described in this specification since various changes in the details of construction may be resorted to without departing from the spirit of the invention. For example, although in the illustrated form of lifter the maximum jaw spread is such that the lifter arms 150 and 152 assume 45° angles with respect to a vertical plane, the lifter may be designed for greater or lesser maximum angles of inclusion between the arms. As a matter of fact, the greater the included angle involved, the more significant will be the straight line path of movement of the jaws since, with extremely wide included angles, initial jaw-closing movements associated with conventional lifters having frame-pivoted jaw-supporting arms are accompanied by very great inward jaw pressure. Additionally, while the invention has been illustrated in connection with a lifter employing a parallelogram type linkage mechanism for supporting the jaws proper, the same is applicable to lifters employing integral or one-piece jaw-supporting arms. Still further, the power train by means of which the lifter is operated may vary in its construction and it may be either motorized as shown or manually operated. If desired, the use of intermeshing gear segments such as the segments 103 and 120 may be dispensed with and suitable thrust links or cam mechanism may be employed for changing the angularity of the jaw-supporting arms 150 and 152 during jaw movements. Various other modifications, substitutions and alterations may be resorted to within the scope of the appended claims.

Having thus described the invention, what I claim and desire to secure by Letters Patent is:

1. In a lifter of the character described, a lifter framework, a jaw-supporting head mounted for free floating vertical shifting movements on the framework, a pair of jaw-supporting arms pivotally connected at their proximate ends to said head at points spaced apart thereon for swinging movements toward and away from each other, one of the points being located on one side and the other point being located on the opposite side of the central vertical axis of the head, a pair of opposed object-engaging jaws carried at the distal ends of said arms, said arms being movable in unison between a position of wide angularity therebetween wherein the jaws carried thereby are widely separated and are fully open, and a position of small angularity wherein the jaws are in close proximity to each other and are fully closed, a pair of thrust links, one for each arm, each having one end thereof pivoted to its respective arm medially thereof and the other end thereof pivoted to the framework, the point of pivotal connection between each thrust link

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and the framework being offset laterally outwardly from the vertical plane passing through the point of pivotal connection between the respective arm and the head and normal to the plane of swinging movement of the arms, whereby said jaw-supporting arms, in moving from their positions of wide angularity to their positions of small angularity, will move initially toward positions of alignment with the respective thrust links to which they are pivoted and effect raising movements of the head, and thereafter will move away from such positions of alignment and effect lowering of the head, the length of said arms being such, and the points of pivotal connection between the arms and their respective thrust links being so located, that during movement of the arms between their positions of wide and small angularity the jaws carried thereby will travel in substantially straight downwardly and inwardly inclined linear paths, and means constraining said arms to move toward and away from each other in unison.

2. In a lifter of the character described, in combination, a lifter framework including front and rear frame plates, a jaw-supporting head vertically slidable between said plates, interengaging guide means on said plates and head constraining the latter to follow a vertical path of movement, a pair of jaw-supporting arms pivotally connected to said head at spaced points thereon, one of the points being located on each side of the central vertical axis of movement of the head, for swinging movements toward and away from each other, a pair of object-engaging jaws carried at the distal ends of said arms, said arms being movable in unison between a position of wide angularity therebetween wherein the jaws carried thereby are widely separated and fully open, and a position of small angularity wherein they are substantially vertical and wherein the jaws are in close proximity to each other and are fully closed, a pair of thrust links, one for each arm, each having one end thereof pivoted to its respective arm medially thereof and the other end pivoted to said front plate, an additional pair of thrust links, one for each arm, each having one end thereof pivoted to its respective arm medially thereof and the other end pivoted to said rear plate, the point of pivotal connection between each thrust link and the respective plate to which it is pivoted being offset laterally outwardly from a vertical plane passing through the point of pivotal connection between its respective arm and the head and normal to the plane of swinging movement of the arm, and means constraining said arms to swing toward and away from each other in opposite directions in unison.

3. In a lifter of the character described, the combination set forth in claim 2, wherein said constraining means

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comprises interengaging gear teeth on the thrust links of one pair of thrust links.

4. In a lifter of the character described, the combination set forth in claim 2, including additionally power actuated means for effecting rotation of one of said thrust links in opposite directions about its point of pivotal connection to its respective plate.

5. In a lifter of the character described, a lifter framework, a jaw-supporting head mounted for free floating vertical shifting movements on the framework, a pair of jaw-supporting arms pivotally connected at their proximate ends to said head at points spaced apart thereon for swinging movement downwardly and inwardly toward each other, one of the points being located on one side of and the other point being located on the other side of the central vertical axis of the head and being equally spaced therefrom, a pair of opposed object-engaging jaws carried at the distal ends of said arms, said arms being movable in unison between a position of wide angularity therebetween wherein the jaws carried thereby are widely separated and are fully open, and a position of small angularity wherein the jaws are fully closed, a pair of thrust links, one for each arm, each having one end thereof pivoted to its respective arm medially thereof and the other end thereof pivoted to the framework, the point of pivotal connection between each thrust link and the framework being offset laterally outwardly from the vertical plane passing through the point of pivotal connection between its respective arm and the head and normal to the plane of swinging movement of the arm, and the length of said jaw-supporting arms and of said thrust links being such that in all positions of the arm the distal ends of the arms are disposed appreciably below the horizontal plane passing through the points of pivotal connection between the thrust links and the framework whereby during movement of the arms between their positions of wide and small angularity the thrust links will move toward dead center positions wherein the free floating head is at a position of maximum height and the jaws will travel in substantially straight downwardly and inwardly inclined linear paths, and means constraining said arms to swing toward and away from each other in unison in opposite directions.

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