May 31, 1966 R. R. STRATTON 3,253,716

CRANE HAVING ARTICULATED BOOM

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Fig. 1

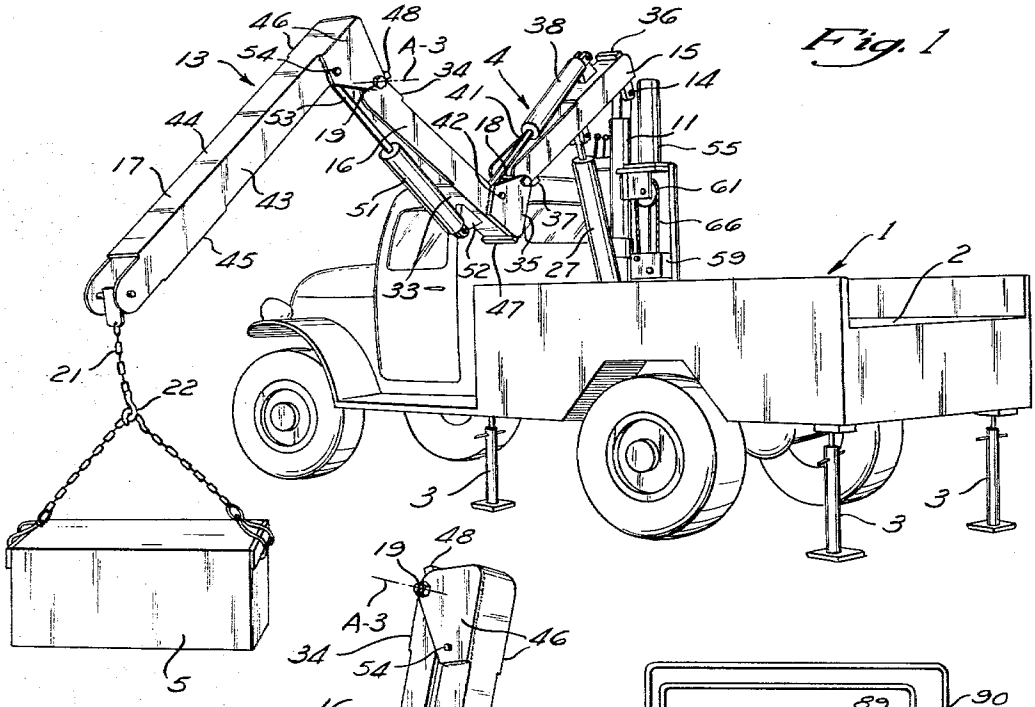


Fig. 2

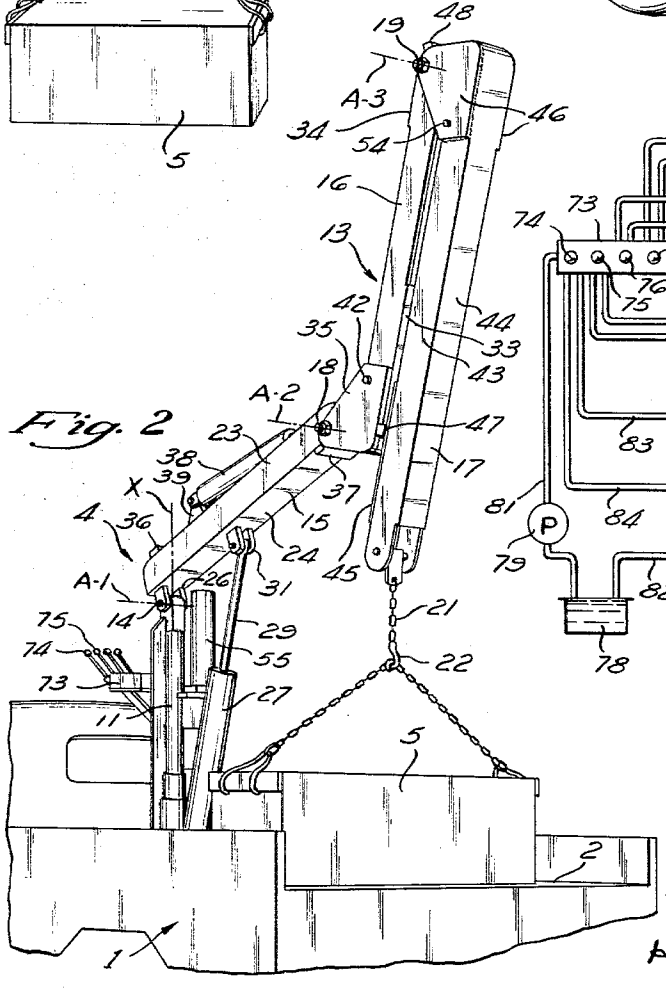
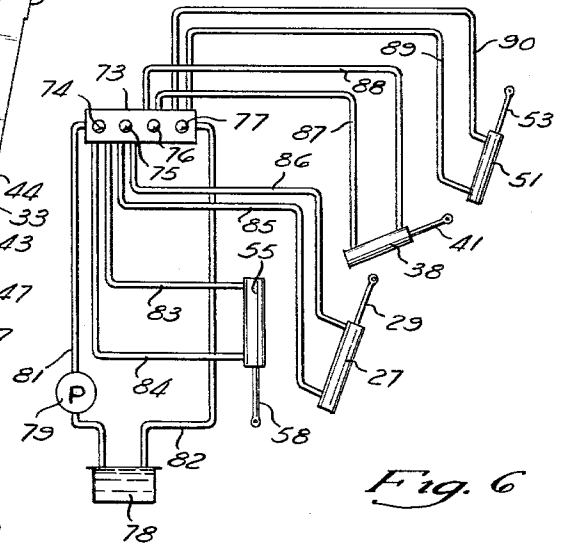


Fig. 6



INVENTOR.
RONALD R. STRATTON
BY
Bosworth, Sessions
Herrstrom & Knowles
ATTORNEYS

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Fig. 3

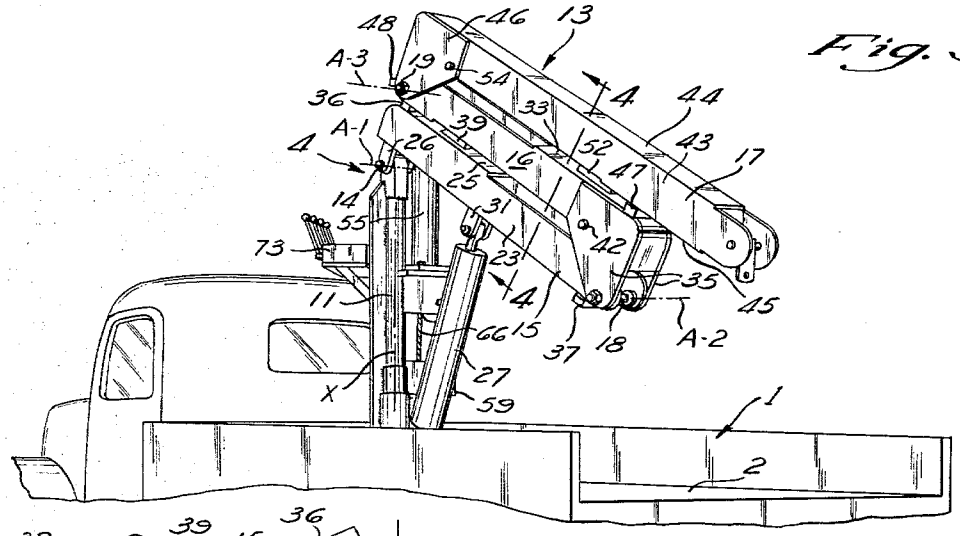


Fig. 4

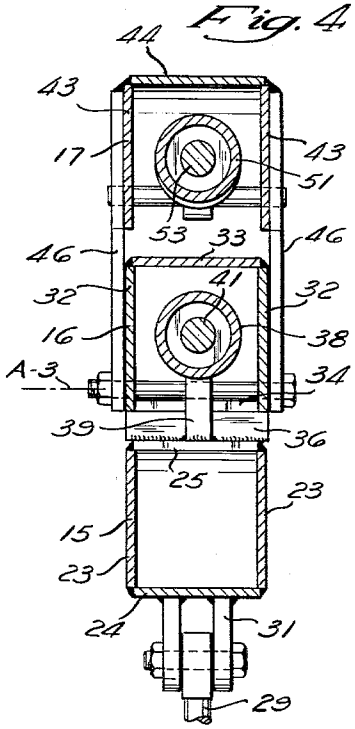
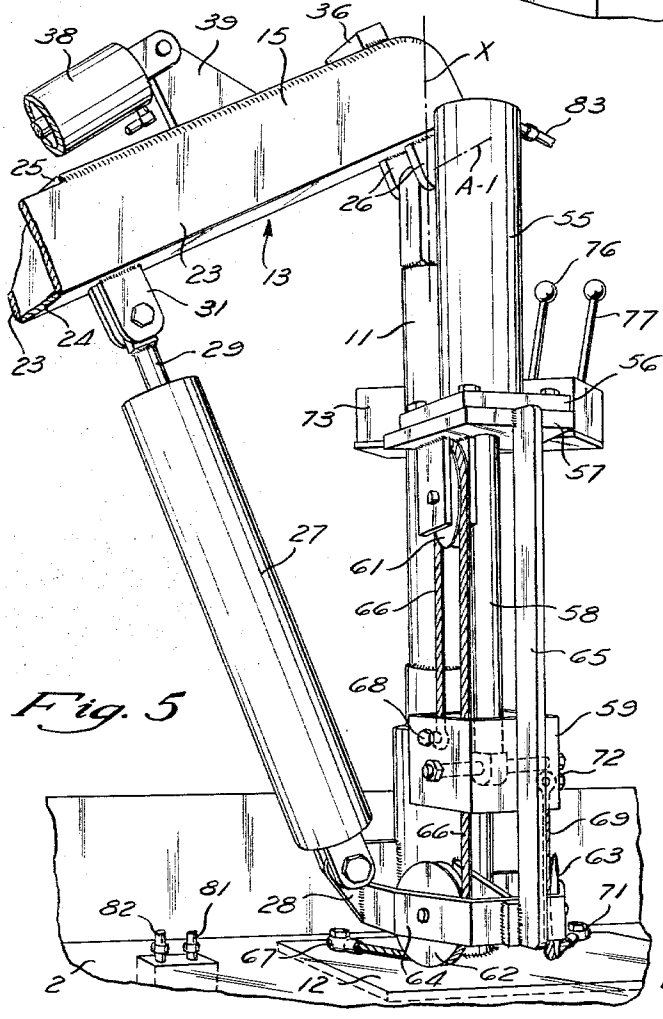


Fig. 5



INVENTOR.
RONALD R. STRATTON
BY
Bosworth, Sessions
Herrstrom & Knowles
ATTORNEYS

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3,253,716

CRANE HAVING ARTICULATED BOOM

Ronald R. Stratton, East Cleveland, Ohio, assignor to Stratton Equipment Company, Solon, Ohio, a corporation of Ohio

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8 Claims. (Cl. 212—35)

This invention relates to cranes, and more particularly to a crane having an articulated boom.

While the invention may be used advantageously in cranes for various purposes, it will be described hereinafter as employed in a mobile crane mounted on the bed of an automotive truck, since it provides noteworthy advantages when so used.

In such a crane, it is desirable that the boom of the crane be retractable into a small space contained within the width and length of the truck bed and extending only a short distance above the truck bed. The boom of the crane, moreover, preferably should be extendable so that it can reach a considerable distance away from the truck on at least sides and rear of the truck and be capable of manipulation so it can pick up and deposit loads on or close to the truck. It is also desired that the boom be capable of being extended to reach considerable heights above the truck to permit lifting of loads to or from elevated positions. The crane preferably should be capable of supporting substantial loads, even those weighing several thousand pounds. The crane should be easy to operate and should be capable of ready retraction. When retracted into the compact space described above, it is desirable that the crane should not swing or be subject to damage from impacts during over the road travel. The crane should be of sturd construction, require little maintenance, and be capable of being manufactured economically.

An object of the invention is the provision of cranes, having articulated booms, which will provide as many of the above indicated advantages as may be desired.

This and other objects of the invention will become apparent from the following description of a preferred embodiment of the invention, in connection with the accompanying drawings in which:

FIGURE 1 is a perspective of an automotive truck having mounted thereon a crane embodying the invention, the crane being shown as having its boom extended to support a load a considerable distance away from the truck;

FIGURE 2 is a perspective of a portion of the truck, showing the position of parts of the crane when the crane is in position to deposit a load on or pick it up from the rear of the truck bed;

FIGURE 3 is a perspective of a portion of the truck, showing the illustrated embodiment of the crane in which the articulated boom is in collapsed condition, ready for traveling over the road;

FIGURE 4 is a section of the collapsed boom along line 4—4 of FIGURE 3;

FIGURE 5 is a perspective of the upright supporting member rotatable about a generally vertical axis, showing in particular the means for rotating the support about its axis; and

FIGURE 6 illustrates diagrammatically the hydraulic fluid power system that energizes the boom and the means for turning the crane about the upright axis.

As apparent from FIGURE 1, the illustrated embodiment comprises a standard automobile truck 1 having a bed 2 that is braced by jacks 3 temporarily positioned to resist overturning forces. The truck carries a crane 4, embodying the invention, shown as supporting a load 5.

Crane 4 comprises a supporting post 11 that is supported from base member 12 fixed to the truck bed (FIGURE 5). Post 11 is rotatable about an essentially vertical axis that is perpendicular to base member 12. Post 11 pivotally supports boom 13 of the crane about an axis A–1 passing through pivot pin 14 on the upper end of the post. This axis is perpendicular to axis X of the post, and hence is essentially horizontal.

Boom 13 comprises three arms 15, 16 and 17, which are pivotally connected end to end. The first arm 15 of the boom is that which is connected at its rear end to post 11 by first pivot pin 14 to pivot about first axis A–1; at its unsupported front end it pivotally supports the second arm 16 by one end thereof by second pivot pin 18 to pivot about second pivot axis A–2. The unsupported end of second arm 16 pivotally supports the third arm 17 by third pivot pin 18 to pivot about third pivot axis A–3. The unsupported end of the third arm 17 carries the load-carrying means, which in the illustrated embodiment is the chain 21 and hook 22. The pivot axes A–1, A–2 and A–3 are parallel in the illustrated embodiment.

More specifically, the major portion of the first arm 15 is of channel cross section formed of sidewalls 23 and a bottom wall 24 extending substantially throughout the length of the arm. Its rear portion also has a top wall 25 that causes the arm to be of box section for added strength and support of parts to be described. Downwardly extending lugs 26 on the bottom wall receive therebetween the upper end of the post 11, the pivotal connection being made by the bolt-type pivot pin 14. Arm 15 is supported by hydraulic cylinder 27 so the outer end of the arm can move in an arc about pin 14 between positions in which it is substantially lower than axis A–1 (as shown in FIGURE 1) and substantially higher than such axis (as shown in FIGURE 2). The closed end of the cylinder is pivotally connected to a bracket 28 fixed to the lower end of supporting post 11, and the piston rod 29 of the cylinder is pivotally connected to a bracket 31 fixed to the bottom wall 24 of arm 15 at a suitable substantial distance from the pivot axis A–1, as shown in FIGURES 2 and 5.

The second arm 16 has generally channel-shaped cross sections throughout a major portion of its length. It comprises sidewalls 32, a bottom wall 33 that extends for a substantial portion of the length of the arm from its supported end, and a top wall 34 extending rearwardly from the supported end of the arm. The supported end portion of the second arm 16 carries two gussets 35 that engage the bolt-type second pivot pin 18 through the unsupported end of the first arm 15, gussets 35 being shaped so that axis A–2 of pivot pin 18 is offset from the main portion of second arm 16 to permit this arm to be folded back over the first arm 15 so that the second arm overlaps and is essentially parallel to the first arm, as shown in FIGURE 3; a spacing block 36 is provided for this purpose at the top of the supported end of arm 15. Gussets 35 are also shaped so that when the second arm is swung to form the maximum angle between the first and second arms, which is substantially larger than a right angle, as shown in FIGURES 1 and 2, the edges of the gussets 35 bear against a cross member 37 fixed to the bottom of the outer end of the first arm 15, thus providing a stop limiting outward swinging movement of the second arm 16 relative to the first arm 15.

Second arm 16 is positively moved from the folded position shown in FIGURE 3 to the extended position shown in FIGURE 2, and supported in each of these positions and in intermediate positions by a hydraulic cylinder 38. The closed end of this cylinder is pivot-

ally connected to a bracket **39** rigidly fixed to the top wall **25** of first arm **15** at a location spaced substantially from its unsupported end, and its piston rod **41** (FIGURE 1) is pivotally connected to a pivot pin **42** fixed in the gussets **35** of the second arm at a location spaced a substantial distance from the pivot axis A–**2** around which the second arm pivots relative the first arm.

The third arm **17** also is of partial channel-shaped and partial box-shaped cross section. It comprises two longitudinally extending sidewalls **43** that extend throughout the length of the arm, a topwall **44** fixed to the sidewalls and extending substantially throughout the length of the arm, and a bottom wall **45** extending for a portion of the length of the arm at its unsupported end (FIGURE 2) to define the box section for added strength and resistance against twisting. The third arm is longer than the first and second arms so that it overlaps the second arm when folded as in FIGURES 2 and 3. Gussets **46** are fixed to the rear or supported end of the third arm. These gussets engage the bolt-type third pivot pin **19** mounted to the unsupported end of second arm **16**, being so shaped that the axis A–**3** of pivot pin **19** is offset from the main portion of the third arm **17**, permitting the third arm to be folded against the second arm in essentially parallel relation, as is shown in FIGURES 2 and 3. Second arm **16** carries a spacer block **47** at the top of its supported end portion to facilitate this. The gussets **46** for the third arm have welded to them a heavy crossbar **48** that serves to reinforce the gussets laterally and also to act as a stop to limit movement of the third arm away from the second arm **16** by bearing against the second arm as shown in FIGURE 1. The third arm is capable of pivotal movement relative to the second arm from the position in which it is folded against the second arm as is shown in FIGURES 2 and 3 to an extended position in which it forms an angle greater than a right angle, as in FIGURE 1.

The third arm is moved relatively to the second arm into either of these positions as well as intermediate positions, and is supported in any such position, by a third hydraulic cylinder **51**. At its closed end the cylinder is pivotally connected to a bracket **52** fixed to the top plate **33** of the second arm at a location spaced substantially from the unsupported end of the arm; the piston rod **53** of the cylinder is pivotally connected by a pivot pin **54** fixed in the gussets **46** of the third arm at a location spaced a substantial distance from the axis A–**3** of the pivot pin **19** connecting the second and third arms.

The three arms **15**, **16** and **17** are so arranged that when they are completely retracted or folded as shown in FIGURE 3, all arms are essentially parallel to each other and the second arm is folded between the first and third arms. Furthermore, as shown in FIGURE 4, the actuating cylinder **38** that moves the second arm relatively to the first arm is nested between the sidewalls of the second arm, as is its piston rod **41** and its supporting bracket **39**; the actuating cylinder **51** that moves the third arm on the second arm is also nested between the sidewalls **43** of the third arm, together with the bracket **52** that supports the cylinder piston rod **53**.

The first arm **15** has actuating cylinders **27** and **38** on opposite sides of the arm, and the second arm **16** has actuating cylinders **38** and **51** on opposite sides of that arm. These cylinders are arranged to permit a desirable distribution of forces on the arms and also facilitate the nesting of cylinders **38** and **51** when the arms to which they are connected are in folded relation. The three arms, as is apparent, are in generally Z-shaped relationship regardless of their relative positions.

The means by which this articulated boom **13** can be swung to a large range of angular positions about the upright axis X of the post **11** is apparent from FIGURES 1, 3 and 5. A hydraulic cylinder **55** is rigidly mounted on the post **11** by its flange **56** bolted to bracket **57** fixed to the post. This cylinder has a downwardly projecting piston rod **58** that is fixed to a terminal member **59** that is moved upwardly and downwardly relative to the cylinder **55** as its piston rod is retracted and extended. The post **11** also rotatably carries an upper sheave **61** that is rotatably mounted about a horizontal axis fixed relative to the post and two lower sheaves **62** and **63** that are rotatably mounted in a bracket **64** that is reinforced by bar **65** for rotation about axes fixed relative to the post and angularly disposed relative to each other in the same horizontal plane. A steel cable **66**, one end of which is secured at **67** to the base member **12** on which the post **11** is mounted for rotatable movement passes under lower sheave **62**, through terminal member **59**, over upper sheave **61** and down to terminal member **59** to which it is fixed at **68**. Another steel cable **69** is fixed at **71** on the other side of post **11** to the base member **12** and passes under sheave **63** upwardly to the terminal member **59** to which it is fixed at **72**.

It is apparent, then, that when the piston rod **58** is downwardly extended by cylinder **55**, the length of cable **66** between fastening **67** and the sheave **62** is shortened, since the cable is drawn over upper sheave **61** and downwardly by terminal member **59**, while the length of cable **69** between fastening **71** and sheave **63** is correspondingly increased. The post **11** therefore turns angularly toward fastening **67**, carrying the boom **13**, to the position shown in FIGURES 1 and 5.

Conversely, when the piston rod **58** is retracted upwardly by the cylinder **55**, the length of cable **69** between lower sheave **63** and fastening **71** is shortened and the corresponding length of the other cable **66** is lengthened, so that post **11** turns angularly in the other direction on its axis, carrying the boom with it.

FIGURE 6 diagrammatically illustrates the hydraulic power system for actuating and controlling the various hydraulic cylinders so that the boom **13** as a whole swings in various angular positions relative to the axis X of the post **11** and so that the various arms **15**, **16** and **17** forming the boom move relatively to each other as desired. The control valve **73**, shown as mounted on the post **11** of the crane in FIGURES 2, 3 and 5, has four control levers **74**, **75**, **76** and **77**, each of which may be moved to various positions to control one of the cylinders for extension of its piston rod, retraction of its piston rod, locking of the piston rod in the desired extended or retracted position, and freeing the piston rod for movement in either direction in the cylinder. Such a control valve is of conventional construction and requires no further description.

In the system of FIGURE 6, **78** indicates a hydraulic fluid sump, from which liquid is pumped by pump **79** to maintain a suitable pressure in pipe **81** that supplies liquid to the valve **73**. A return line **82** returns liquid from the valve to the sump. The cylinder **55** that operates to turn the post **11** about its axis X is connected by conduits **83** and **84** to the valve **73** and is controlled by lever **74**. The first cylinder **27** that moves first arm **15** is actuated by hydraulic fluid supplied through conduits **85** and **86** and controlled by lever **75**. The second cylinder **38** that moves the second arm **16** relative to the first arm is actuated by hydraulic liquid in conduits **87** and **88** and controlled by lever **76**. The third cylinder **51** that moves third arm **17** relative to the second arm is actuated by hydraulic liquid in conduits **89** and **90** and controlled by lever **77**.

It is apparent that each of the arms can be controlled independently of each of the other arms and also of the means for turning the post and swinging the boom as a whole angularly about the axis of the post. It is also apparent that the boom can be swung about the axis of post independently of all of the other arms.

In the illustrated crane, the arms can be folded compactly, as is shown in FIGURE 3, and held in this position by proper manipulation of their control levers, so that they do not move relatively to each other or to the

post. When folded, the arms do not extend greatly above the truck bed and lie within the lateral boundaries of the truck bed so that there are no clearance problems arising during over the road movement of the truck carrying the crane.

At the worksite, the crane can be easily controlled by an operator to pick up loads from the truck or in close proximity to the rear or sides of the truck, and to transport them a considerable distance away from the truck or to heights a considerable distance above the truck. The crane is simple in construction and operation, strong and durable in construction, and may be manufactured and installed at reasonable cost.

Those skilled in the art will appreciate that various changes and modifications can be made in the preferred form of the apparatus described herein without departing from the spirit and scope of the invention.

I claim:

1. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm having an unsupported end, pivotally mounted on said support about a first generally horizontal axis that is spaced from the unsupported end of said first arm, for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis essentially parallel to said first axis so that said second arm may be located relative to said first arm in a position in which it is folded back adjacent said first arm as well as in a position in which said second arm extends away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second axis, means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a position in which it is folded back adjacent said second arm at its side that is opposite the side thereof that is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in a position in which said third arm is away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, and means operable between said second and third arms for moving said third arm about said third axis to said positions.

2. A crane comprising a support rotatable about an upright axis; and an articulated boom comprising a first arm having an unsupported end, pivotally mounted on said support about a first generally horizontal arm axis that is spaced from the unsupported end of said first arm, for movement essentially in a plane containing said support axis so that the unsupported end of said first arm may be positioned at different elevations relative to said first arm axis, means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second arm axis essentially parallel to said first arm axis so that said second arm may be located relative to said first arm in a position in which it is folded back adjacent said first arm as well as in a position in which said second arm extends away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second arm axis, means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a position in which it is folded back adjacent said second arm at its side that is opposite the side thereof that is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in a position in which said third arm is away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, and means operable between said second and third arms for moving said third arm about said third axis to said positions.

3. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm having an unsupported end, pivotally mounted on said support about a first generally horizontal axis that is spaced from the unsupported end of said first arm, for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, fluid cylinder means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis essentially parallel to said first axis, so that said second arm may be located relative to said first arm in a position in which it is folded back adjacent said first arm as well as in a position in which said second arm is away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second axis, fluid cylinder means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a position in which it is folded back adjacent said second arm at its side that is opposite the side thereof that is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in a position in which said third arm is away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, fluid cylinder operable between said second and third arms for moving said third arm about said third axis to said positions, and means for individually controlling each of said cylinders.

4. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm, having an unsupported end, pivotally mounted on said support about a first generally horizontal axis that is spaced from the unsupported end of said first arm, for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, force-exerting means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis essentially parallel to said first axis, so that said second arm may be located relative to said first arm in a retracted position in which it is folded back adjacent said first arm as well as in an extended position in which said second arm extends away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second axis, force-exerting means operable between said first and second arms for pivotally moving said second arm to and between said posiitons relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a retracted position in which it is folded back adjacent said second arm at its side that is opposite the side thereof that

is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in an extended position in which said third arm extends away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, and force-exerting means operable between said second and third arms for moving said third arm about said third axis to said positions, said first, second and third arms being shaped and the force-exerting means between said first and second arms and between said second and third arms being such that when either of said second arm or third arm is in its retracted position said arm is closely adjacent the arm adjacent to which it is folded with the force-exerting means operable between said arms nested between said arms.

5. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm, having an unsupported end pivotally mounted upon said support about a first generally horizontal axis that is spaced from the unsupported end of said first arm for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis essentially parallel to said first axis, so that said second arm may be located relative to said first arm in a retracted position in which it is folded back on said first arm and essentially parallel thereto as well as in a position in which said second arm extends away from said first arm at an angle thereto greater than a right angle, said second arm having an unsupported end spaced from said second axis, means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a retracted position in which it is folded back on said second arm and essentially parallel thereto at the side of said second arm that is opposite the side that is adjacent said first arm when said second arm is folded back on said first arm, as well as in an extended position in which said third arm extends away from said second arm at an angle thereto greater than a right angle, said third arm having an unsupported end spaced from said third axis, and means operable between said second and third arms for moving said third arm about said third axis to said positions.

6. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm having an unsupported end, pivotally mounted on said support about a first generally horizontal axis that is spaced from the unsupported end of said first arm, for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis essentially parallel to said first axis, so that said second arm may be located relative to said first arm in a retracted position in which it is folded back adjacent said first arm as well as in a position in which said second arm extends away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second axis, means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, means operable between said first and second arms for limiting the maximum amount of said second arm may be extended relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis essentially parallel to said first and second axes so that said third arm may be located relative to said second arm in a position in which it is folded back adjacent said second arm at its side that is opposite the side thereof that is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in a position in which said third arm is away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, means operable between said second and third arms for moving said third arm about said third axis to said positions, and means operable between said second and third arms for limiting the maximum amount said third arm may be extended relative to said second arm.

7. A crane comprising a support; and an articulated boom carried by said support, said boom comprising a first arm having an unsupported end, pivotally mounted on said support about a first axis that is located in an essentially horizontal plane and is spaced from the unsupported end of said first arm, for movement so that the unsupported end of said first arm may be positioned at different elevations relative to said first axis, means operable between said support and said first arm for pivotally moving said first arm to and between such positions, a second arm pivotally mounted on said first arm at its unsupported end for pivotal movement about a second axis in a plane essentially parallel to a plane containing said first axis, so that said second arm may be located relative to said first arm in a position in which it is folded back adjacent said first arm as well as in a position in which said second arm is away from said first arm at a substantial angle thereto, said second arm having an unsupported end spaced from said second axis, means operable between said first and second arms for pivotally moving said second arm to and between said positions relative to said first arm, a third arm pivotally mounted on said second arm for pivotal movement about a third axis in a plane essentially parallel to a plane containing said second axis so that said third arm may be located relative to said second arm in a position in which it is folded back adjacent said second arm at the side of said second arm that is opposite the side thereof that is adjacent said first arm when said second arm is folded back adjacent said first arm, as well as in a position in which said third arm is away from said second arm at a substantial angle thereto, said third arm having an unsupported end spaced from said third axis, and means operable between said second and third arms for moving said third arm about said third axis to said positions.

8. A crane comprising a support; and an articulated boom carried by said support, said boom comprising first, second and third arms, the first of said arms being pivotally connected to said support, the second arm being pivotally connected to said first arm, and the third arm being pivotally connected to said second arm, said first, second and third arms being disposed in generally Z-shape relationship, first force-exerting means disposed between said support and first arm to move said arm pivotally relatively to said support, second force-exerting means disposed between said first and second arms to move said second arm pivotally relatively to said first arm, and third force-exerting means disposed between said second and third arms to move said third arm pivotally relatively to said second arm, said first and second force-exerting means being on opposite sides of said first arm, and said second and third force-exerting means being on opposite sides of said second arm.

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GERALD M. FORLENZA, *Primary Examiner.*