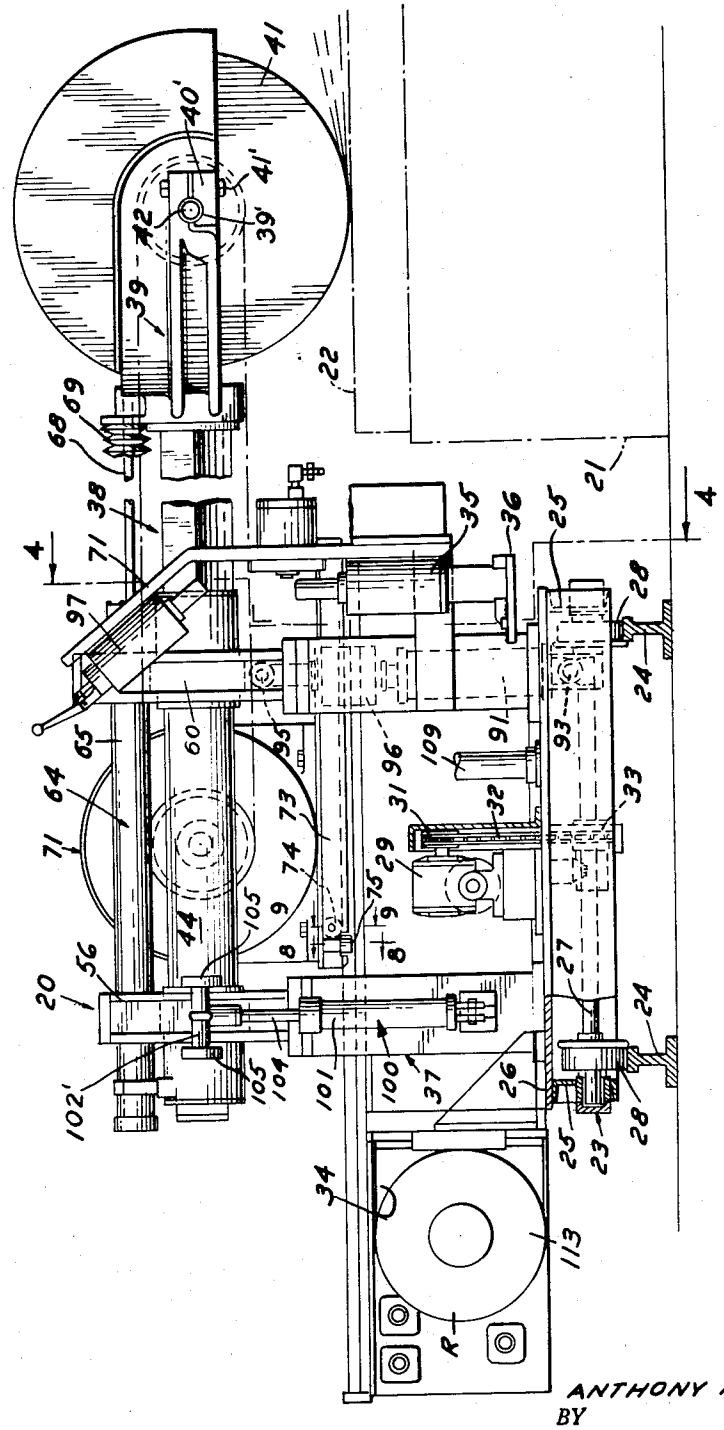
June 19, 1956 A. A. MUEHLING 2,750,714

SWING GRINDER

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FIG. 1



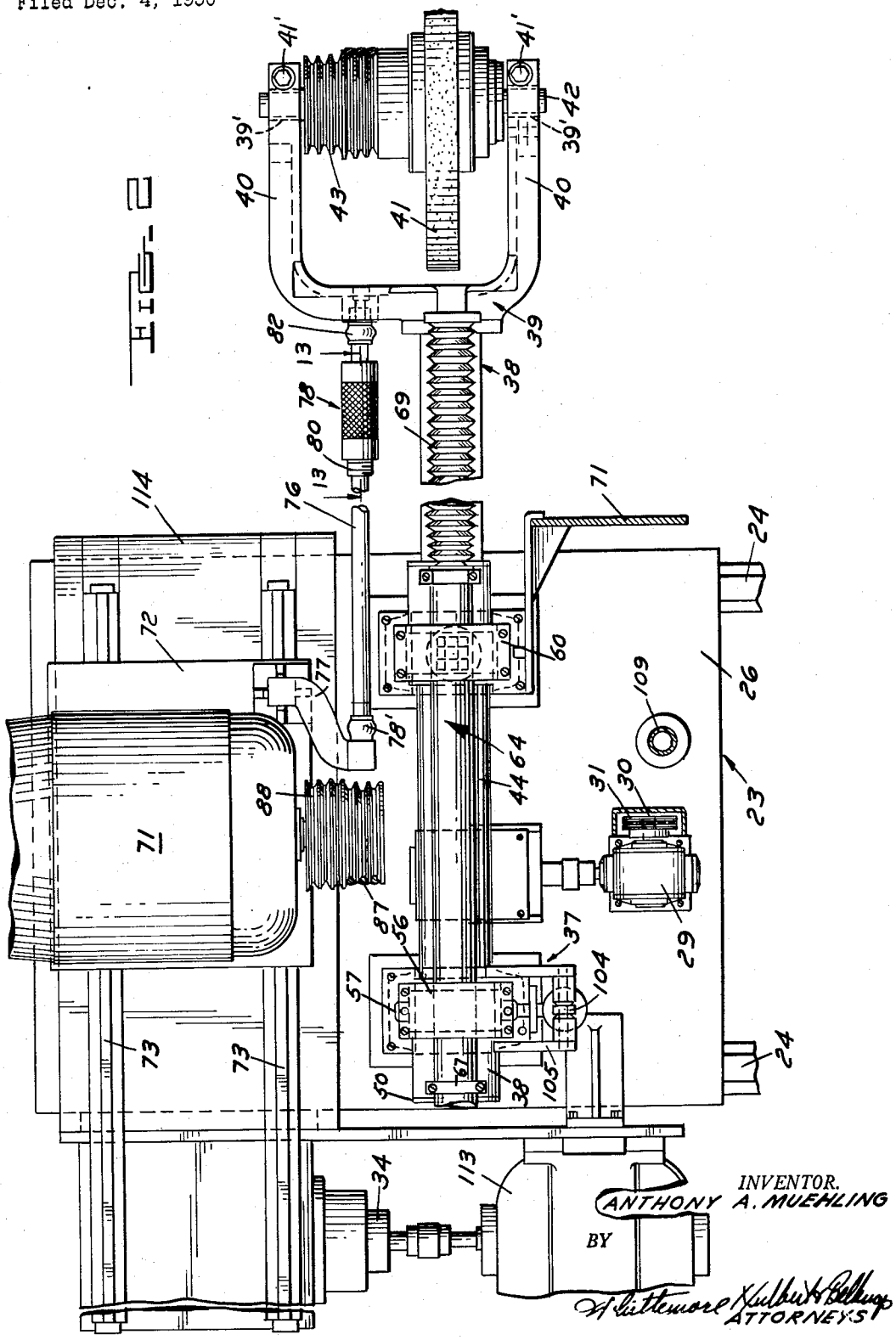
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SWING GRINDER

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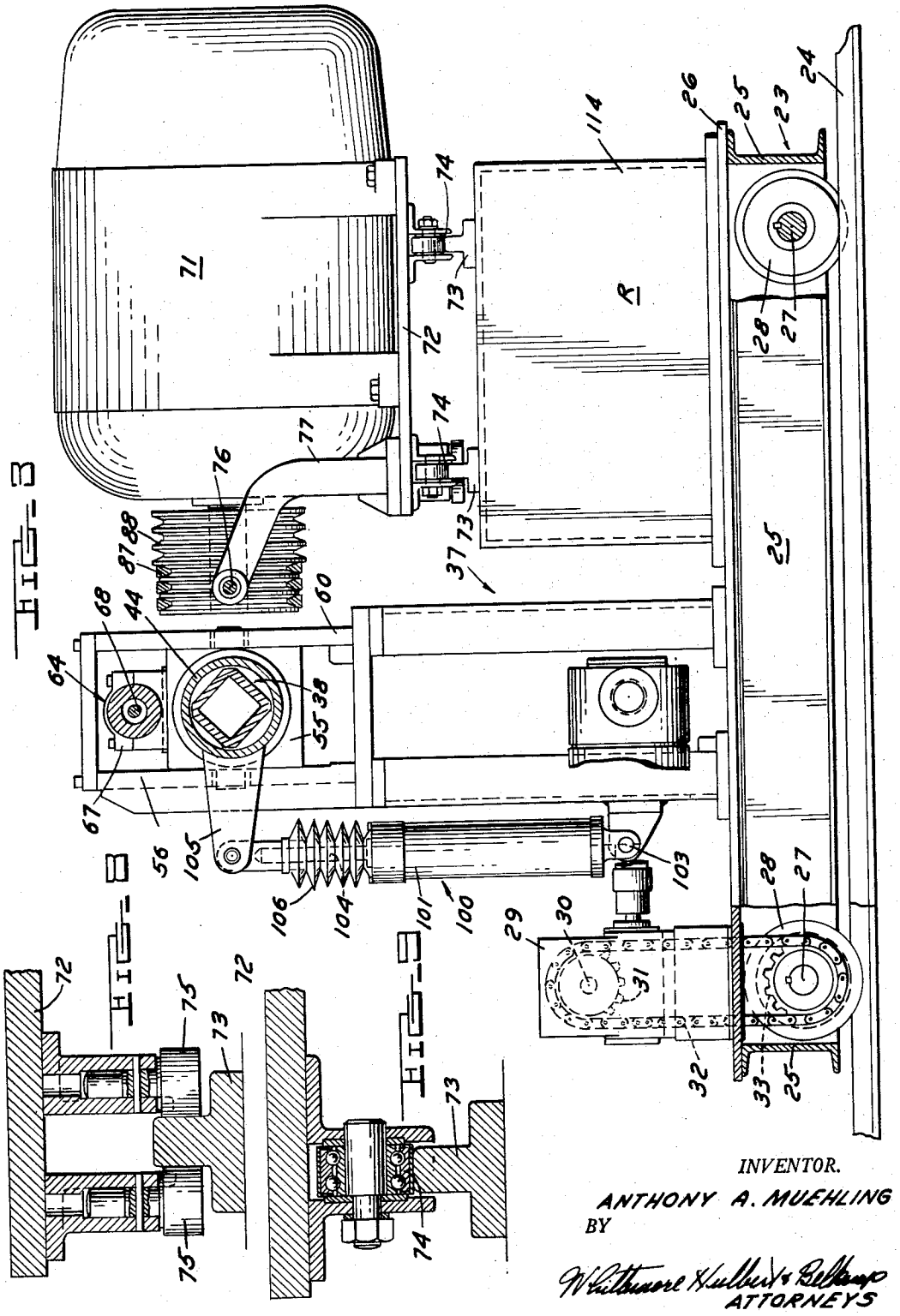
FIG. 2



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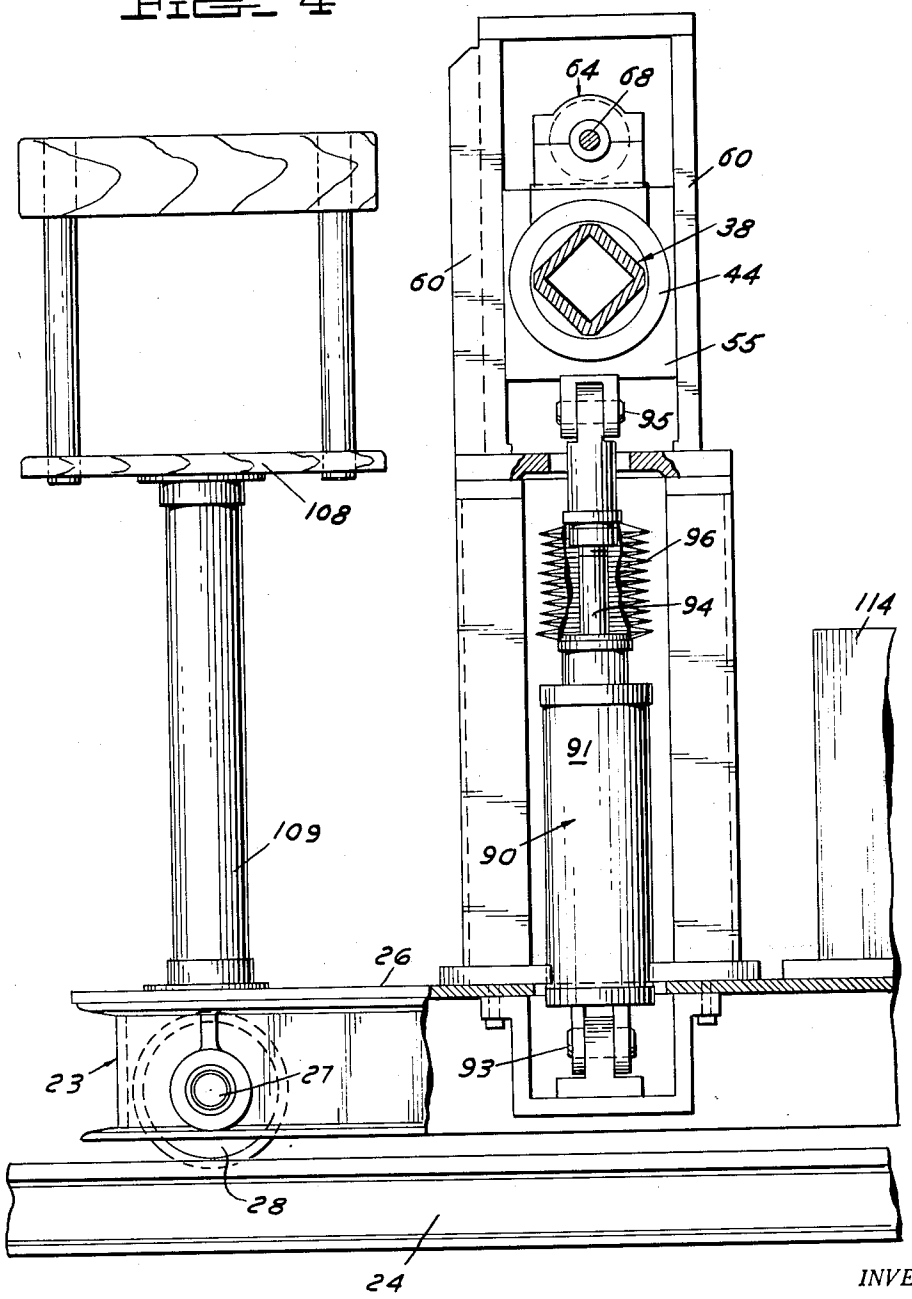
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FIG. 4



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FIG. 5

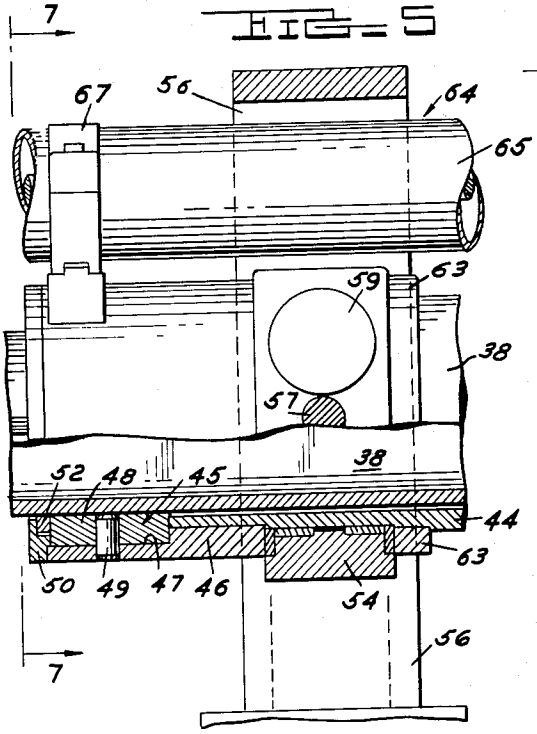


FIG. 7

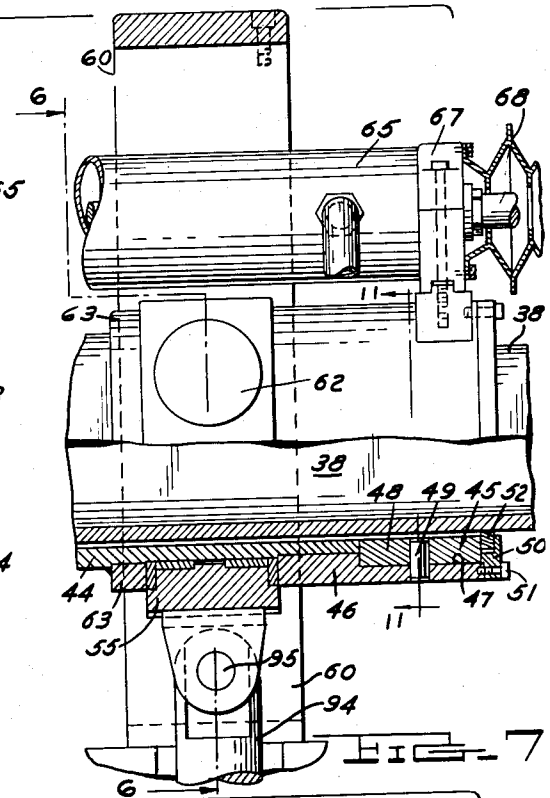
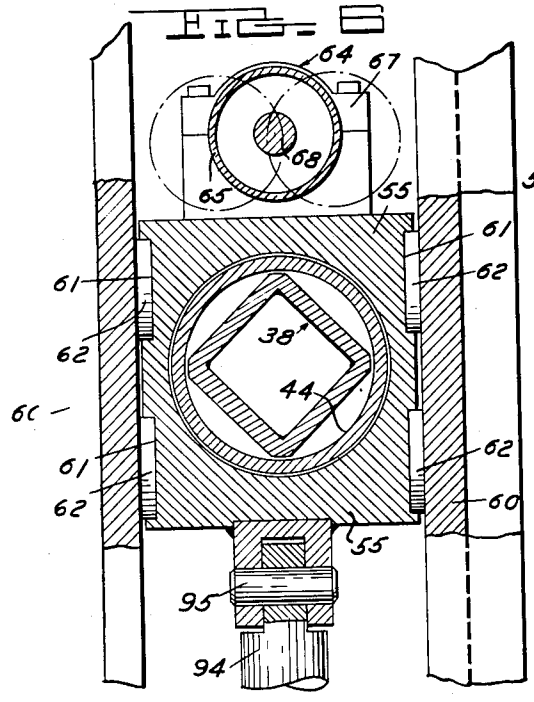
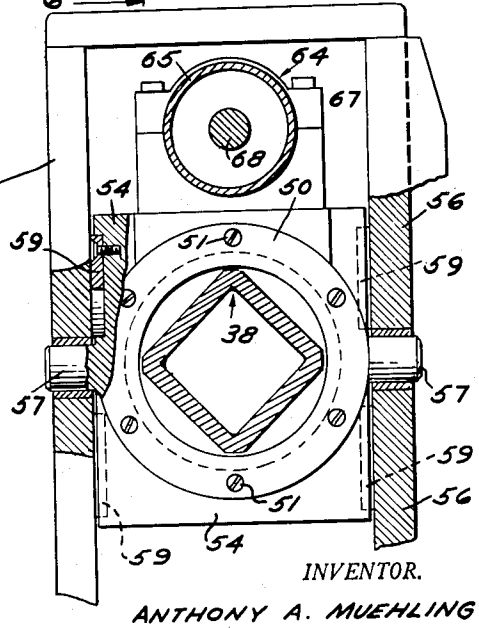


FIG. 6





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FIG. 11

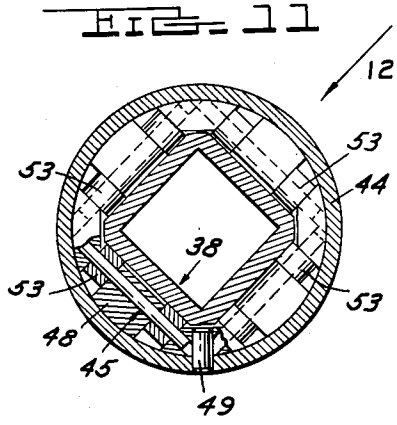


FIG. 12

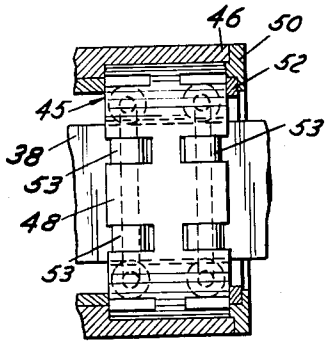


FIG. 10

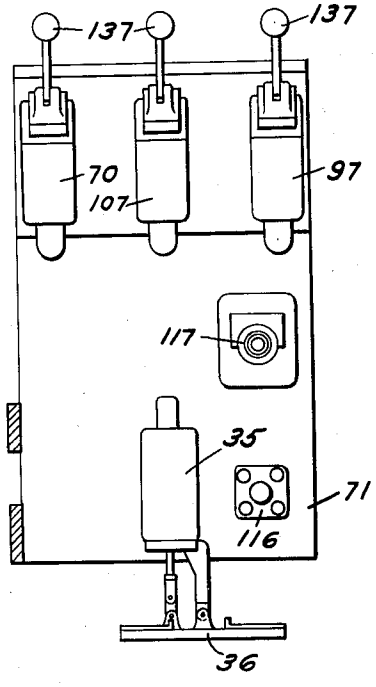
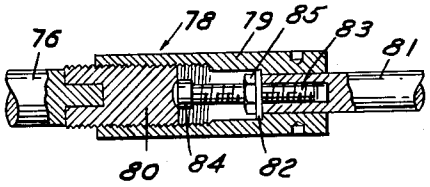


FIG. 13



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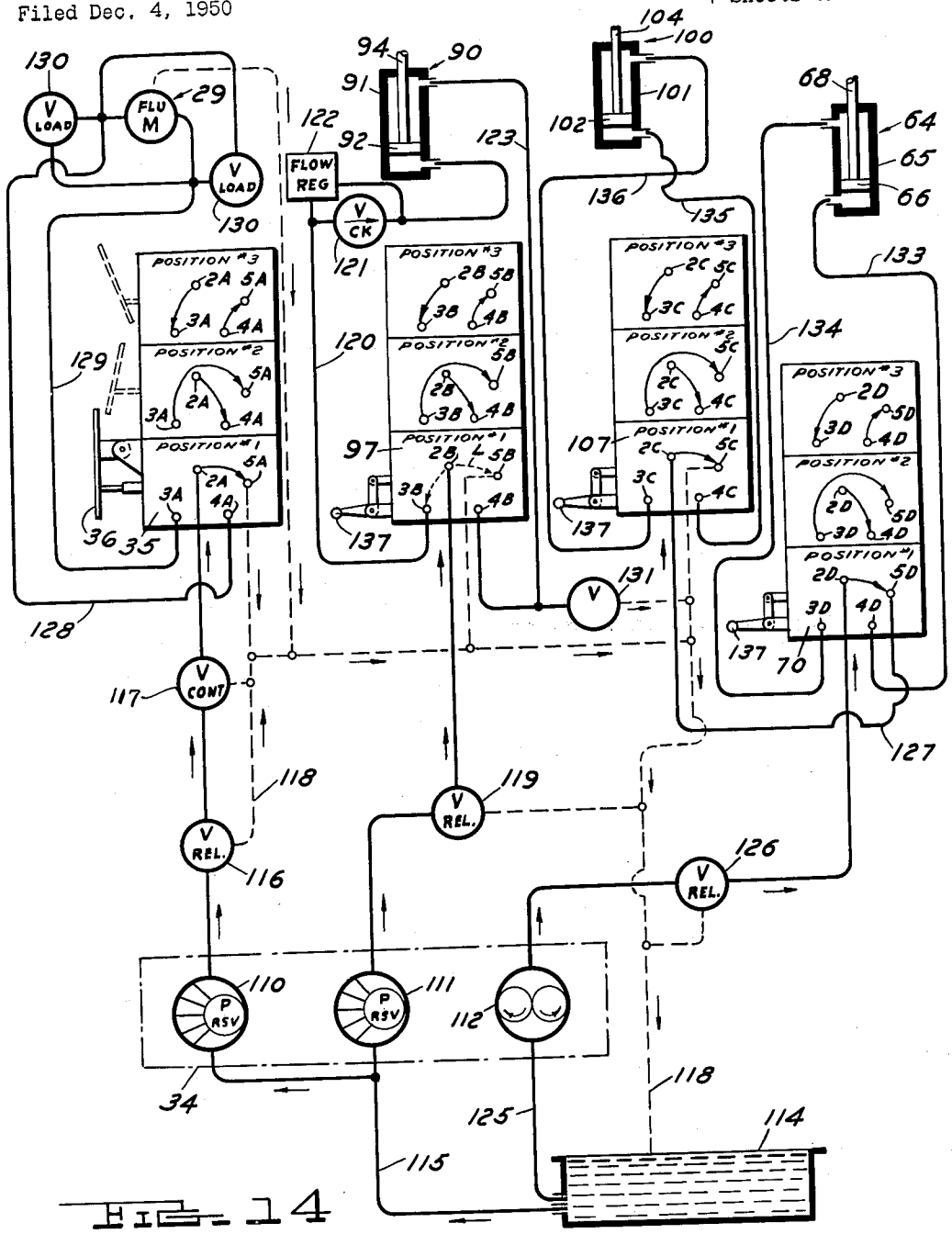


FIG. 14

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United States Patent Office 2,750,714 Patented June 19, 1956

2,750,714

SWING GRINDER

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Application December 4, 1950, Serial No. 198,950

15 Claims. (Cl. 51—32)

This invention relates generally to machines for removing metal from work pieces and refers more particularly to heavy duty grinding machines of the type suitable for grinding metal billets of substantial length.

It is an object of this invention to provide a machine wherein the grinding wheel or other metal removing element is supported by a boom which in turn is supported on suitable frame structure for sliding movement in the direction of length of the boom.

It is another object of this invention to drive the work performing element on the boom with a prime mover supported on the frame structure for sliding movement as a unit with the boom.

It is still another object of this invention to support the boom on the frame structure in a manner to enable rotation of the boom in opposite directions, and to permit swinging movement of the boom in a generally vertical direction.

It is a further object of this invention to mount the supporting frame structure for the boom on a carriage movable along a predetermined path of travel relative to the work to be operated on by the element on the boom.

It is a still further object of this invention to provide power units for selectively sliding the boom together with the element driving means in opposite directions, rotating the boom in opposite directions, swinging the boom in up and down directions, and propelling the carriage in opposite directions along the path of travel thereof.

It is still another object of this invention to provide accommodation on the carriage for an operator, and to also provide controls conveniently located on the carriage for selectively operating the power units noted in the preceding paragraph.

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

Figure 1 is an end elevational view partly in section of a machine embodying the features of this invention;

Figure 2 is a fragmentary plan view of the machine shown in Figure 1;

Figure 3 is a side elevational view of the machine having certain parts broken away for the sake of clearness;

Figure 4 is a sectional view taken on the line 4—4 of Figure 1;

Figure 5 is a fragmentary longitudinal sectional view through the boom of the machine and associated parts;

Figure 6 is a sectional view taken on the line 6—6 of Figure 5;

Figure 7 is a sectional view taken on the line 7—7 of Figure 5;

Figures 8 and 9 are respectively sectional views taken on the lines 8—8 and 9—9 of Figure 1;

Figure 10 is an elevational view of the control panel on the machine;

Figure 11 is a cross sectional view taken on the line 11—11 of Figure 5;

Figure 12 is a fragmentary elevational view of the construction shown in Figure 11 and having certain parts broken away for the sake of clearness;

Figure 13 is a sectional view taken on the line 13—13 of Figure 2; and

Figure 14 is a hydraulic diagram of the fluid pressure operating system embodied in the machine.

The present invention is illustrated in connection with a machine capable of grinding billets of substantial length with a minimum effort on the part of the operator. However, it will be understood from the following description that the invention may be applicable to machines having metal removing elements other than abrasive wheels; and accordingly, reservation is made to make such changes in the specific embodiment selected herein for the purpose of illustration as may come within the purview of the accompanying claims.

With the above in view, reference is made more in detail to the drawings, wherein the numeral **20** indicates the machine generally, and the numeral **21** designates a support for a work piece **22** to be operated upon by the machine **20**. In the present instance the work piece **22** may be considered as a metal billet of substantial length, and it is the purpose of this machine to remove metal from the top surface of the billet.

The machine **20** is shown in Figure 1 of the drawings as having a carriage **23** movable along a predetermined path of travel determined by suitable tracks **24**. In operation the work support is positioned adjacent the tracks **24** in a manner such that movement of the carriage **23** along the tracks feeds the machine **20** lengthwise of the work **22**.

As shown in Figures 2 to 4 inclusive, the carriage **23** has side frame members **25** secured together to provide a rectangular frame and has a platform **26** secured to the top of the frame. A pair of axles **27** are respectively journalled on the carriage frame adjacent opposite ends of the latter, and suitable wheels **28** are respectively keyed or otherwise secured to opposite ends of the axles in positions to engage the tracks **24**.

In the present instance the carriage is driven in opposite directions along the track **24** by a fluid motor **29** of any suitable construction secured to the platform **26** and having a drive shaft **30**. Secured to the drive shaft **30** is a sprocket **31** which is connected by a chain **32** to a sprocket **33** on one of the axles **27** of the carriage.

The fluid motor **29** is driven in a manner to be more fully hereinafter described. Briefly as shown in Figure 14 of the drawings, the motor **29** is connected to fluid under pressure supplied by a duplex pump assembly **34** and is selectively operated by a suitable four-way, three-position valve **35**. The valve **35** is controlled by a foot-operated, double-acting pedal **36** suitably supported on the platform **26** of the carriage **23**.

The carriage **23** also provides a support for suitable frame structure designated generally in the several figures of the drawings by the numeral **37**. The frame structure **37** provides a support for a boom **38** which extends in a direction normal to the path of travel of the carriage **23** and is spaced a substantial distance above the platform **26** of the carriage. As shown in Figures 1 and 2 of the drawings, the outer end of the boom has a yoke **39** secured thereto and the arms **40** of the yoke support a metal removing element such for example as an abrasive wheel **41**. The abrasive wheel **41** is positioned between the arms **40** of the yoke and is secured to a shaft **42** by any suitable type of mounting. The opposite ends of the shaft **42** are respectively journalled in the arms **40** of the yoke, and a pulley **43** is secured to the shaft **42** adjacent the abrasive wheel **41**. In detail, the opposite ends of the shaft are journalled in bearings **39'** which are removably secured to the ends of the yoke arms by the clamping blocks **40'**. The clamping blocks **40'** are re-

movably secured to the ends of the yoke arms by nut and bolt assemblies 41'. The above construction is such as to enable positioning the grinding wheel 41 above the work 22 on the support 21.

In the present instance the boom 38 is mounted on the frame structure 37 for sliding movement in opposite directions lengthwise of the boom to permit movement of the abrasive wheel 41 back and forth across the work 22. The boom 38 is slidably supported by a tubular housing 44 mounted on the frame structure 37 in a position to telescopically receive the inner end portion of the boom 38. Upon reference to Figures 6 and 7 of the drawings, it will be noted that the housing 44 is generally circular in cross section, and that the boom 38 is rectangular in cross section having flat sides free from frictional contact with the interior of the housing 44.

The boom 38 is slidably supported at opposite ends of the tubular housing 44 by anti-friction devices indicated generally by the numeral 45. As shown in Figure 5 of the drawings, sleeves 46 are respectively secured on opposite ends of the tubular housing 44, and the outer ends of the sleeves 46 are counterbored to provide annular recesses 47 for respectively receiving suitable carriers 48. The carriers 48 are secured to the respective sleeves by pins 49, and the outer ends of the recesses 47 are closed by rings 50 secured to the sleeves by studs 51. The rings 50 also serve to secure annular seals 52 in place at the outer sides of the carriers 48. The seals 52 are shaped to frictionally engage the flat sides of the boom, and prevent the entrance of foreign matter into the clearance space provided between the boom and housing 44.

As shown in Figures 11 and 12, each antifriction device 45 includes, in addition, to the carrier 48, four pairs of rollers 53 respectively supported on the carrier in positions to engage the flat sides of the boom 38. It is clear from Figure 11 of the drawings that the openings through the central portions of the carriers 48 correspond generally in shape to the cross sectional area of the boom 38 and are of sufficient size to permit free passage of the boom therethrough. Thus the rollers 53 constitute the sole means for slidably supporting the boom 38 in the tubular housing 44; and as a result, friction is reduced to a minimum.

Referring now to Figures 5 to 7 inclusive, it will be noted that the tubular housing 44 is rotatably supported adjacent opposite ends in a pair of blocks 54 and 55 respectively. The outer block 54 is supported between a pair of upright members 56 and is centrally apertured to provide a bearing for the tubular housing 44. A pair of axially aligned trunnions 57 project outwardly from opposite sides of the block 54, and are respectively journalled in the upright members 56 to enable swinging movement of the housing 44 about the axis of the trunnions 57. If desired opposite sides of the block 54 may be recessed, and hardened wear plates 59 may be secured in the recesses in a manner such that the outer surfaces of the plates 59 respectively slidably engage adjacent sides of the uprights 56 upon swinging movement of the tubular housing 44 about the axis of the trunnions 57.

The inner block 55 is centrally apertured to form a bearing for the tubular housing 44 and is supported between laterally spaced uprights 60. The opposite sides of the block 55 are also formed with recesses 61 for receiving hardened wear plates 62. The wear plates 62 frictionally engage the adjacent inner surfaces of the uprights 60 to guide vertical swinging movement of the housing 44 about the axis of the trunnions 57.

It will also be noted from Figure 5 of the drawings that the blocks 54 and 55 are held against axial outward movement relative to the tubular housing 44 by the inner ends of the sleeves 46. In order to prevent axial displacement of the blocks in an inward direction relative to the housing 44, suitable rings 63 are welded or otherwise secured to the housing 44 in positions to respectively engage the inner sides of the blocks 54 and 55.

The boom 38 is moved in opposite directions axially of the tubular housing 44 by a fluid motor 64. The fluid motor 64 comprises a cylinder 65 and a piston 66 slidably supported in the cylinder. Referring again to Figure 5 of the drawings, it will be noted that the cylinder 65 is supported at opposite ends on the sleeves 46, or in other words, on the tubular housing 44. Suitable clamps 67 are provided for securing opposite ends of the cylinder 65 to the sleeves 46 on the housing 44.

As shown in Figures 1, 5 and 14 of the drawings, a connecting rod 68 is secured at one end to the piston 66 and is secured at the other end to the yoke 39 on the boom 38. A casing 69 of flexible material surrounds the connecting rod 68, and is secured at opposite ends to the cylinder 65 and the yoke. The purpose of the flexible casing 69 is to prevent the entry of abrasive material or foreign matter into the fluid motor 64.

It follows from the above that right hand movement of the piston 66 relative to the cylinder 65 as viewed in Figure 1, slides the boom 38, together with the abrasive wheel 41, in an inward direction across the work 22. On the other hand, left hand movement of the piston 66 in the cylinder 65 slides the boom 38 and abrasive disc 41 in a corresponding direction across the work 22. The piston 66 is moved in opposite directions in the cylinder 65 by fluid under pressure supplied by the duplex pump assembly 34, and operation of the piston is selectively controlled by a manually operable four-way, three-position valve 70 mounted on the control panel 71 of the machine. The specific manner in which the fluid motor 64 is operated to effect sliding movement of the boom 38 and abrasive wheel 41 will be more fully hereinafter described.

As shown in Figures 1 to 3 inclusive, an electric motor 71 is provided for driving the abrasive disc 41. The motor 71 is secured to a plate 72 which in turn is mounted on the frame structure 37 for movement as a unit with the carriage 23. More particularly it will be noted that the plate 72 is mounted upon laterally spaced tracks 73 extending in the direction of sliding movement of the boom 38, and respectively engaged by rollers 74 supported on the plate 72 at the underside of the latter. Lateral shifting movement of the plate 72 relative to the tracks is prevented by providing additional rollers 75 shown in Figure 8 of the drawings as supported on the plate 72 in a position to respectively engage opposite sides of one rail of the tracks 73.

The plate 72 is connected to the yoke 39 for movement by the boom 38 and this is accomplished by a rod 76 having the outer end connected to the upper end of an arm 77 by a universal joint 78'. The lower end of the arm is fixed to the plate 72, and moves as a unit with the latter. The inner end of the rod 76 is connected to the yoke 39 by a coupling 78 shown in detail in Figure 13 of the drawings. The coupling 78 comprises a sleeve 79 and an externally threaded part 80. The part 80 is secured to the inner end of the rod 76 as by welding, for example, and the sleeve 79 is slidably supported on a rod 81 having the inner end connected to the yoke by a universal joint 82. The sleeve 79 abuts a washer 82 secured to the outer end of the rod 81 by a stud 83 and located within the sleeve 79. The outer end of the sleeve is enlarged and is internally threaded for connection to the part 80 in a manner such that rotation of the sleeve in opposite directions relative to the rod 81 increases and decreases the effective length of the connecting rod 76. In the present instance relative positioning of the sleeve 79 and part 80 may be accurately determined by the stud 83 which is threaded into the outer end of the rod 81 and has a head portion 84 at the outer end providing an abutment for the adjacent inner end of the part 80. A nut 85 is provided on the stud for securing the washer 82 in place against the outer end of the rod 81.

The coupling 78 renders it possible to locate the motor 71 in various different positions along the tracks 73, and this is desirable in order to vary the tension of a belt 87 which connects the pulley 43 on the abrasive wheel 41 to a pulley 88 on the drive shaft of the motor 71. Thus the connecting rod 76 not only provides a tie between the motor 71 and boom 38, but in addition, serves as an adjustment for tensioning the driving belt 87 for the abrasive wheel 41.

It has been pointed out above that the housing 44, together with the boom 38, may be swung vertically about the axis of the trunnions 57. This is accomplished by a fluid motor 90 comprising a cylinder 91 and a piston 92 slidably supported in the cylinder. As shown in Figure 4 of the drawings, the fluid motor 90 is supported on the carriage 23 in a vertical position beneath the inner end of the tubular housing 44, and the lower end of the cylinder 91 is pivoted by a pin 93 on the carriage 23 for swinging movement relative to the carriage. The piston 92 has a connecting rod 94 which extends upwardly through the top of the cylinder 91, and is pivoted by a pin 95 to the bottom of the block 55. The upper end of the connecting rod 94 is protected by a flexible casing 96 secured at the lower end to the upper end of the cylinder and secured at the opposite end to the connecting rod 94.

As will be more fully hereinafter described, the piston 92 is moved in opposite directions in the cylinder 91 by fluid under pressure supplied by the duplex pump assembly 34. The flow of fluid under pressure to the cylinder 91 is selectively controlled by a manually operated four-way, three-position valve 97 suitably mounted on the control panel 71.

In some instances it may be desired to tilt the abrasive wheel in opposite directions about the axis of the boom 38. This may be accomplished by rotation of the housing 44 in the bearing blocks 54 and 55. In accordance with this invention the housing 44 is rotated by a fluid motor 100 (Figures 3 and 14) comprising a cylinder 101 and a piston 102 slidably supported in the cylinder 101. The cylinder 101 extends in a generally vertical direction and the lower end is pivoted to the frame structure 37 by a pin 103. The upper end of the cylinder 101 is apertured to slidably support a connecting rod 104 having the lower end secured to the piston 102 and having the upper end pivoted to a cross pin 102' which has the opposite ends secured to the outer ends of arms 105. The inner ends of the arms 105 are secured to one side of the housing 44 in a manner such that reciprocation of the piston 102 in the cylinder 101 rotates the housing 44 and boom 38 in opposite directions. A flexible casing 106 surrounds the upper end of the connecting rod 104 and is secured at opposite ends to the cylinder 101 and rod 104 to prevent the entry of foreign matter into the cylinder 101.

The piston 102 is operated by fluid under pressure supplied by the duplex pump assembly 34, and the manner in which this is accomplished will be presently described more in detail. Briefly the flow of fluid from the pump assembly 34 is selectively controlled by a manually operable four-way, three-position valve 107 mounted on the panel 71.

It follows from the above that the grinding wheel 41 has four distinct movements which are independently controlled by the valves 35, 70, 95 and 107. The valve 35 operates to move the carriage 23 along the track 24 and hence feeds the grinding wheel along the work 22. The valve 70 controls movement of the grinding wheel 41 back and forth across the work 22. The valve 97 controls swinging movement of the grinding wheel 41 toward and away from the work 22. The valve 107, on the other hand, controls tilting of the grinding wheel 41 relative to a vertical plane normal to the work 22. All of these valves are positioned for convenient manipulation by an operator occupying a position on the carriage 23. As shown in Figure 4 a seat 108 is supported by a pedestal 109 on the carriage 23 adjacent the control panel 71.

Hydraulic system

Referring to the diagram, Figure 14, it will be noted that the duplex pump assembly 34 comprises three pumps 110, 111 and 112 driven by an electric motor 113 suitably supported on the carriage 23, as shown in Figure 2 of the drawings. The pumps 110 and 111 are of the rotary blade type and the intake sides thereof are connected by a conduit 115 to a reservoir 114. The reservoir 114 contains a supply of hydraulic fluid and is suitably supported on the carriage 23 beneath the tracks 73, as shown in Figure 3 of the drawings.

The delivery side of the pump 110 is connected through a relief valve 116 and a speed control valve 117 of the bypass type, to the intake port 2A of the valve 35. The intake port 2A in position 1 of the valve 35 is connected to port 5A of the valve 35 and port 5A is connected to the reservoir 114 by a conduit indicated by the broken line 118. The ports 3A and 4A of the valve 35 are closed in position 1 of the valve 35 so that fluid under pressure from the pump 110 is bypassed back to the reservoir 114.

The intake side of the pump 111 is connected to the reservoir 114 by the conduit 115 and the delivery side of the pump 111 is connected through a suitable relief valve 119 to the intake port 2B of the valve 97 in the neutral position 1 of the valve 97. In this neutral position port 2B is connected to port 3B and the latter port is connected to the cylinder 91 below piston 92 by conduit 120 having a suitable check valve 121 and a flow regulator 122 therein. The cylinder 91 above the piston 92 is connected by conduit 123 to port 4B of valve 97 and to the reservoir 114 through a metering valve 131. In the neutral position 1 of the valve 97 and the port 4B is closed so that fluid from the top of the cylinder 91 flows to the reservoir 114 through the metering valve 131. Thus in the neutral position of the valve 97, the boom 38 is swung upwardly, and this is desirable since it reduces the possibility of accidents to a minimum. Upward swinging movement of the boom 38 in position 1 of the valve 97 is effected at a relatively slow rate by adjustment of the metering valve 131 to regulate the return flow of fluid from the top of the cylinder 91. This is accomplished without interfering with the flow of fluid under pressure from the pump 111 to the top of the cylinder 91 through the valve 97. It will also be noted that in position 1 of the valve 97 the pressure inlet port 2B is also connected as at L to the port 5B so that excess fluid under pressure is by-passed back to the reservoir 114.

The intake side of the gear pump 112 is connected to the reservoir tank 114 by a conduit 125, and the delivery side of the pump 112 is connected through a relief valve 126 to the intake port 2D of the valve 70. When the valve 70 is in its neutral position 1, the intake port 2D is connected to port 5D, which in turn, is connected by a conduit 127 to the intake port 2C of the valve 107. In the neutral position 1 of the valve 107, the intake port 2C is connected to the port 5C, and the latter is in turn connected to the reservoir through the conduit indicated by the broken line 118. Thus the pump 112 is connected to both the valves 70 and 107. In the neutral positions indicated by the numeral 1 of both valves 70 and 107, the ports 3C, 4C and 3D, 4D are closed.

Operation

Assuming that it is desired to move the carriage 23 in one direction along the track 24, the operator merely manipulates the foot pedal 36 to move the valve 35 to position 2. In position 2 of the valve, the fluid pressure intake port 2A is connected to port 4A, and the latter port is connected by a conduit 128 to the fluid motor 29. Also in position 2 of the valve 35, the port 3A is connected to the exhaust port 5A. The port 3A is also connected to the exhaust side of the fluid motor 29

by a conduit 129 so that fluid discharged from the fluid motor is returned to the reservoir. In the event the operator wishes to move the carriage 23 in a reverse direction on the track 24, the valve 35 is moved to position 3, wherein the pressure port 2A is connected to the port 3A, and the port 4A is connected to the exhaust port 5A. Thus the fluid motor 29 is operated in the reverse direction. Suitable load valves 130 may be provided in the hydraulic circuit to the motor 29, if desired. Also the speed of rotation and hence the rate of travel of the carriage in either direction may be controlled by the valve 117.

It has been pointed out above that when the valve 97 is in position 1, the boom 38 is swung to its uppermost position. Assuming now that the operator desires to lower the boom and engage the grinding wheel 41 with the work 22, the valve 97 is moved to position 2. In this latter position of the valve 97, the pressure port 2B is connected to port 4B, and the latter is in turn connected by a conduit 123 to the cylinder 91 above the piston 92. As a result the piston 92 and the boom 38 is lowered. Also in position 2 the port 3B is connected to the exhaust port 5B, so that the cylinder 91 below the piston communicates with the reservoir 114.

In the event the operator wishes to raise the boom at a somewhat faster rate than is accomplished in position 1, the valve 97 is moved to position 3 wherein the pressure port 2B is connected to the port 3B, and the port 4B is connected to the exhaust port 5B. As a result fluid under pressure is admitted to the cylinder 91 below the piston 92, and is exhausted from the cylinder 91 above the piston 92.

Assuming now that the operator wishes to slide the boom 38 inwardly, the valve 70 is moved to position 2, wherein the pressure port 2D is connected to the port 4D. The port 4D is in turn connected to the cylinder 65 at the outer side of the piston 66 by a conduit 133 so that fluid under pressure is admitted to the outer end of the cylinder 65. Also in position 2 of the valve 70, the port 3D is connected to the exhaust port 5D, and since the port 3D is connected to the cylinder 65 at the inner side of the piston 66 by a conduit 134, it follows that the inner end of the cylinder is exhausted to the reservoir 114. Thus the piston 66 together with the boom 38 is moved in an inward direction.

In the event the operator wishes to move the boom outwardly, the valve 70 is moved to position 3, wherein the pressure port 2D is connected to the port 3D and the port 4D is connected to the exhaust port 5D. Thus the outer end of the cylinder 65 is connected to the reservoir, and the inner end of the cylinder is connected to the pump 112 and return movement of the piston together with the boom is accomplished.

Under some conditions it may be desirable to rock the boom 38 in opposite directions. The boom may be rocked in one direction by the operator moving the valve 107 to position 2 wherein the pressure port 2C is connected to the port 4C. The port 4C is connected to the bottom of the cylinder 101 by a conduit 135, and the top of the cylinder 111 is connected by a conduit 136 to the port 3C. In position 2 of the valve 107 the port 3C is shown as connected to the exhaust port 5C, so that the piston 102 is moved upwardly in the cylinder 101, and the boom is rocked in one direction.

When the valve 107 is moved to position 3, the pressure port 2C is connected to the port 3C, and the exhaust port 5C is connected to port 4C. Thus the piston 102 is moved downwardly in the cylinder 101, and the boom 38 is rocked in the opposite direction.

It will be noted from the foregoing that each of the four valves 35, 70, 107 and 97 have manually operable controls 137 associated therewith. These controls are conveniently located for manipulation by the operator and are normally urged by suitable spring means to positions wherein the respective valves are in their neutral positions. The controls 137 may be selectively operated by the operator to effect any of the foregoing movements of the boom 38.

What I claim as my invention is:

1. A machine for removing metal from work, comprising frame structure, a tubular housing having one end portion journaled in a bearing pivoted on the frame structure to permit vertical swinging movement of the housing, a bearing for the opposite end of the housing slidably supported on the frame structure, a boom non-rotatably and slidably supported in the housing, and a work performing element mounted on said boom.

2. The machine set forth in claim 1 having a selectively operable power unit connected to the slidable bearing for raising and lowering said housing.

3. The machine set forth in claim 2 having a second selectively operable power unit for rotating the housing in opposite directions.

4. The machine set forth in claim 3 having a selectively operable fluid motor supported on the housing and connected to the boom for sliding the boom relative to the housing.

5. The machine set forth in claim 4 having power means slidable as a unit with the boom and connected to the work performing element for driving the latter.

6. A machine for removing metal from work, comprising frame structure, a boom having a work-performing element at one end portion, means mounting the boom on the frame structure for sliding movement in opposite directions relative to the frame structure and for swinging movement in a generally vertical direction, power units for selectively sliding and swinging said boom, driving means for the work performing element supported on the frame structure for sliding movement relative to the boom in opposite directions extending generally parallel to the path of sliding movement of the boom, and an adjustable connection between the driving means and said boom.

7. The machine set forth in claim 6 in which the boom mounting means further supports the boom on the frame structure for rotation in opposite directions, and in which a power unit is provided for selectively rotating the boom.

8. A machine for removing metal from work comprising a frame structure, a tubular housing having one end portion journalled in a bearing pivoted on the frame structure to permit vertical swinging movement of the housing, a bearing for the opposite end of said housing slidably supported on the frame structure, a boom non-rotatably supported in the housing, and a work-performing element mounted on said boom.

9. A machine for removing metal from work comprising a frame structure, a housing supported on said frame structure for rotation in opposite directions, a boom rotatable as a unit with said housing and supported in said housing for sliding movement relative to said housing along the axis of rotation of said housing, a work-performing element rotatably supported on said boom, driving means for said work-performing element supported directly upon said frame structure for sliding movement relative to said boom in opposite directions extending generally parallel to the path of sliding movement of said boom, and an adjustable connection between said driving means and said boom.

10. A machine for removing metal from a work piece, comprising a carriage movable along a predetermined path of travel, selectively operable power means for driving the carriage, frame structure mounted on the carriage, a boom having its longitudinal axis extending laterally outwardly from the carriage in a direction transverse to the path of travel of the carriage and having an abrasive wheel supported on the outer end thereof for rotation about an axis extending transverse to the longitudinal axis of the boom, said boom having flat sides, a tubular housing supported on the frame structure for rotation about its longitudinal axis and receiving the inner end

of said boom, a carrier supported in the housing and surrounding the boom, anti-friction means mounted on the carrier in positions to engage the flat sides of the boom enabling sliding movement of the boom in the direction of its longitudinal axis relative to the housing and constraining the boom to rotate as a unit with the housing, power means for sliding the boom in the direction of its longitudinal axis relative to the housing, and means for rotating said housing about its longitudinal axis.

11. The structure defined in claim 10 including means pivotally supporting the housing on the frame structure for swinging movement about a horizontal axis, and selectively operable power means for swinging said housing.

12. A machine for removing metal from a work piece, comprising a carriage movable along a predetermined path of travel, selectively operable power means for driving the carriage, frame structure mounted on the carriage, a boom having its longitudinal axis extending laterally outwardly from the carriage in a direction transverse to the path of travel of the carriage and having an abrasive wheel supported on the outer end thereof for rotation about an axis extending transversely of the longitudinal axis of the boom, means supporting the inner end of the boom on the frame structure for rotation in opposite directions about its longitudinal axis and for sliding movement relative to the frame structure in the direction of its longitudinal axis, and means for rotating said boom and abrasive wheel in opposite directions about the longitudinal axis of the boom and having driving means for said abrasive wheel supported on said frame structure for sliding movement in opposite directions extending generally parallel to the path of sliding movement of said boom, and means providing a connection between said driving means and said boom.

13. A machine for removing metal from a work piece comprising a carriage, means supporting said carriage for movement along a predetermined path of travel, selectively operable power means for driving said carriage, frame structure mounted on said carriage, a boom extending in a direction transverse to the path of travel of the carriage, a relatively narrow disc-like abrasive wheel mounted on said boom for rotation about its own axis, said abrasive wheel being positioned on said boom with its axis of rotation extending at right angles to the longitudinal axis of said boom and with its median radial plane located substantially centrally of the boom relative to the longitudinal axis thereof, means for rotating said abrasive wheel, said wheel being adapted to abrade a work piece by contact of its relatively narrow peripheral face with the work piece, means supporting said boom on said frame structure for rotation in opposite directions about the longitudinal axis of said boom, means for moving said abrasive wheel in opposite directions along the longitudinal axis of said boom, and means for rotating said boom in opposite directions about the longitudinal axis of said boom, said wheel being rotatable as a unit with said boom about the longitudinal axis of the latter whereby to engage the work piece with the peripheral face of said abrasive wheel at points located in different radial planes through said wheel.

14. A machine for removing metal from a work piece, comprising a carriage, means supporting said carriage for movement along a predetermined path of travel, selectively operable power means for driving said carriage, frame structure mounted on said carriage, a boom extending laterally outwardly from the carriage in a direction transverse to the path of travel of the carriage, a relatively narrow disc-like abrasive wheel supported on the outer end of said boom for movement as a unit therewith and for rotation about its own axis, said abrasive wheel being positioned on said boom with its axis of rotation extending at right angles to the longitudinal axis of said boom and with its median radial plane located substantially centrally of the boom relative to the longitudinal axis thereof, means for rotating said abrasive wheel, said wheel being adapted to abrade a work piece by contact of its relatively narrow peripheral face with the work piece, means supporting the inner end of said boom on the frame structure for rotation in opposite directions about its longitudinal axis and for sliding movement relative to said frame structure in the direction of its longitudinal axis, and means for rotating said boom in opposite directions about the longitudinal axis of the boom, thereby to engage the work piece with the peripheral base of said wheel at points located in different radial planes through said wheel.

15. A machine as defined in claim 14 in which the inner end of said boom is supported on said frame structure for swinging movement of said boom in a vertical plane.

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