July 5, 1932. A. T. CROCKER 1,866,347

CONTROL DEVICE

Filed Dec. 15, 1928

Fig. 1.

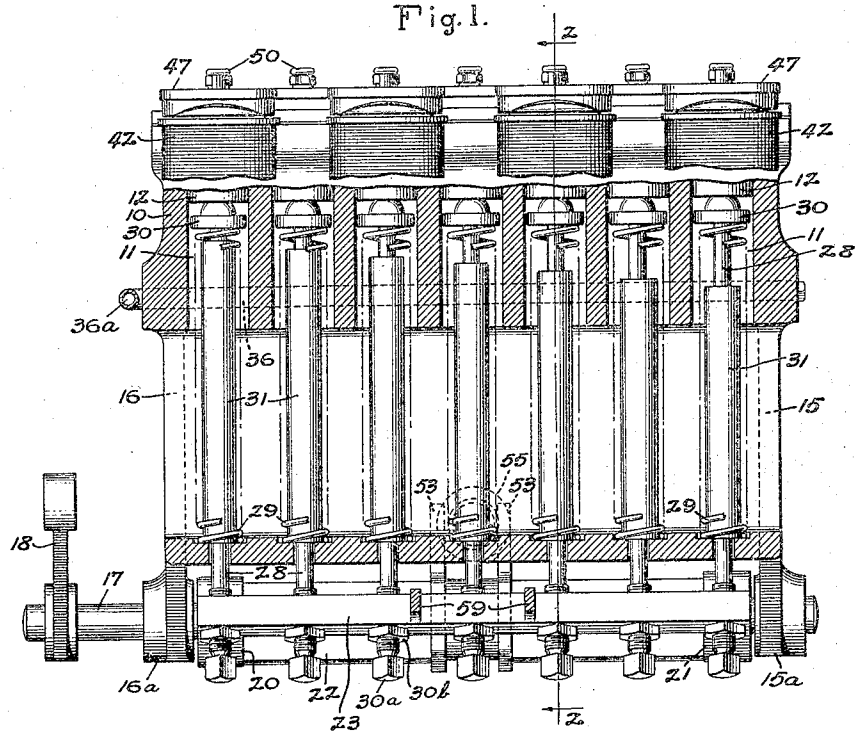


Fig. 2.

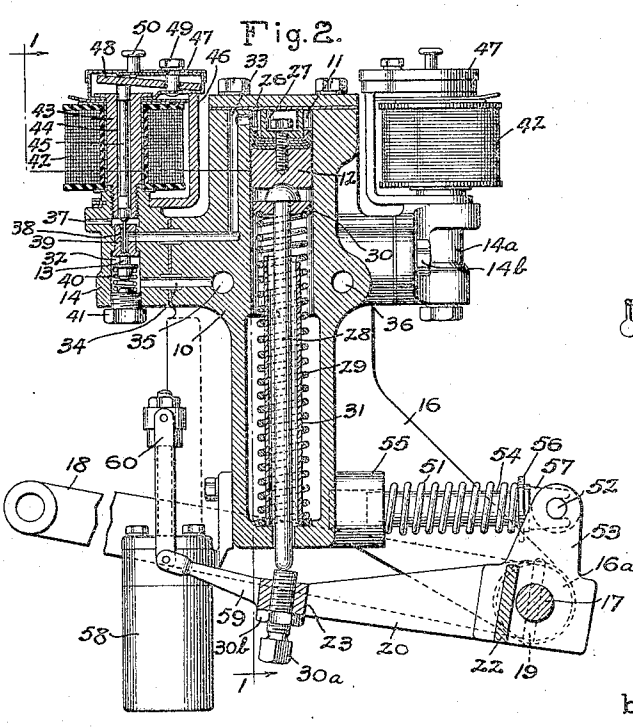


Fig. 3.

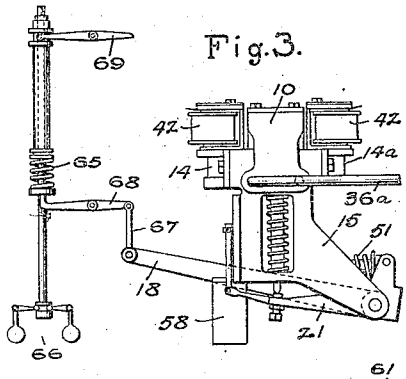
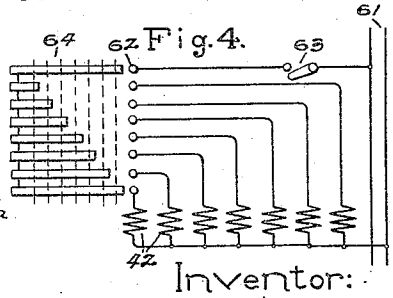


Fig. 4.



Inventor:
Arthur T. Crocker,
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Patented July 5, 1932

1,866,347

UNITED STATES PATENT OFFICE

ARTHUR T. CROCKER, OF ERIE, PENNSYLVANIA, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

CONTROL DEVICE

Application filed December 15, 1928. Serial No. 326,399.

My invention relates to control devices, more particularly to fluid pressure actuated control devices such as may be used in the step by step regulation of a movable member such as a throttle valve or the like from a remote point, and has for its object the provision of an improved device of this character.

In the operation of railroad trains, it is often desirable to connect together two or more locomotives of the gas-electric type or of the Diesel type, so that all of the locomotives may be simultaneously controlled by one operator who may be located on the train at a point remote from one or more of the locomotives. One of the features of my invention is the provision of a pressure actuated throttle controlled device for each locomotive, these devices being simultaneously electrically controlled by an operator at a relatively distant point.

In accordance with my invention I have provided a device in which a plurality of electromagnets are adapted to be energized from a remote point, these electromagnets serving to govern the admission of a fluid under pressure to a plurality of pressure responsive devices, the pressure responsive devices in turn actuating a controlled member in a series of progressive steps. The controlled member may be connected to a device to be regulated, for instance, directly to a throttle valve of a locomotive or to a spring which may serve as a bias for an engine governor.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 is a front elevation partly in section of a control device embodying one form of my invention, this section being taken on line 1—1 of Fig. 2; Fig. 2 is a side elevation partly in section taken on line 2—2 of Fig. 1; Fig. 3 is an assembly view showing an application of my control device, while Fig. 4 is a diagrammatic representation of an electrical system used in the actuation of my control device.

Referring to the drawing, in carrying out my invention in one form, I have provided a casing or cylinder-block 10 having formed therein a plurality of cylinders 11 of equal length, these cylinders containing pistons 12 actuated in a progressive sequence by a pressure fluid controlled by magnetically operated valves 13. The pistons 12 have strokes of equal lengths but stops are provided so that when the pistons are successively actuated, a member co-operating with the pistons will be moved to each of a series of definite positions. The cylinders 11 are preferably arranged in alignment with each other in a substantially vertical plane, and while I have shown my control device as having seven cylinders, it is to be understood that the number of cylinders is not limited since any other desirable number may be used.

Attached to the sides of the cylinder-block or casing 10, are a pair of valve casings 14, 14*a*, these casings being secured to the cylinder-block 10 by suitable bolts 14*b*. At one side of the cylinder-block 10 I have provided a pair of supporting arms 15, 16, the extremities of these arms serving as bearings 15*a*, 16*a*, respectively, for a transverse rock shaft 17. Attached to one end of the rock shaft is a controlled member or arm 18, and also rigidly secured to the shaft 17 by means of keys or pins 19 are a pair of arms 20, 21. A transverse strip 22 is secured to and connects the arms 20, 21 and extends in parallel with and relatively close to the rock shaft 17. A bar 23 is supported by the arms 20 and 21, and while I have shown this bar as being integral with the arms 20 and 21, it is to be understood that it may be a separate member attached to the arms by any suitable means. It will be seen that I have provided a rigid frame comprising members 18, 20, 21, 22, 23 pivotally mounted upon the rock shaft 17 and arranged so that should the bar 23 be moved upwardly or downwardly about the rock shaft 17, the control member or arm 18 will be angularly moved in a similar direction.

The pistons 12 provided within the cylinders 11 are preferably of the floating type, each piston comprising a piston head and a plurality of packing rings 26 secured to the upper end of each piston head. A metallic,

cup-shaped member 27 is secured to each piston head by means of a suitable machine screw or bolt, each member 27 serving to hold the packing washers against the upper side of the piston head, and also serving as a stop to prevent the piston from coming into engagement with the top of the casing 10. In order to transmit motion from the pistons 12 to the bar 23, and thus to the control arm 18, I have provided a plurality of push-rods 28, these push rods being of substantially equal length and biased to an upward position by means of cylindrical compression springs 29. The compression springs 29 abut at their lower ends against the casing 10 and at their upper ends against washers 30, these washers in turn adjoining heads formed on the upper ends of the push rods 28. The heads of the push rods abut against the under sides of the pistons 12.

In order that the bar 23 may be adjusted toward or away from the push rods 28 I have provided adjusting means comprising screws 30*a* threaded through the bar 23 in registering relation with the ends of the push rods 28 and adapted to be maintained in position by lock nuts 30*b*. By adjusting the positions of the screws 30*a* the bar 23 may be moved relatively to the lower ends of the push rods 28.

In order that the bar 23, and consequently, the controlled arm 18 may be given a definite amount of movement when a predetermined piston 12 is forced downwardly due to the pressure of a fluid above the piston, I have provided a series of stop members 31 for limiting the piston movement. Each stop member 31 is in the form of a hollow cylinder of a slightly smaller diameter than the compression springs 29, but greater in diameter than the push rods 28. The stop members 31 are graduated in length as will be noted with reference to Fig. 1, the shortest stop member being mounted in the cylinder at the right in viewing Fig 1 while the longest stop member is mounted in the cylinder at the left.

The valve casings 14 and 14*a* containing the valves 13 are each provided with a plurality of valve chambers 32, these valve chambers being located in conduits 33 and 34, the conduit 33 leading from the upper end of the cylinder to the valve casing and the conduit 34 leading from the valve casing to one of a pair of transverse conduits 35 or 36, depending on whether the valve is mounted in the valve casing 14 or in the valve casing 14*a*. The conduits 35 and 36 are connected to a source of fluid under pressure by means of a conduit 36*a*. A plurality of exhaust ports 37 are provided in the valve casings 14, 14*a*, each exhaust port leading from the upper portion of a valve chamber 32 outwardly to the atmosphere. The valves 13 are double-acting and are longitudinally mounted in each valve chamber, the opposite ends of each valve being adapted to close at different times, a central aperture 38 in a valve seat 39. In order to bias the valve 13 in an upward direction I have provided a compression spring 40 abutting at its lower end against an adjustable screw 41 and at its upper end against a shoulder affixed to the lower end of the valve 13.

It will be observed that when the conduit 36*a* is attached to the source of fluid under pressure, assuming that a predetermined valve 13 is in its lower extreme position, the fluid will pass from conduits 35 or 36, as the case may be, through the conduit 34, valve chamber 32, aperture 38 in the valve seat 39 and through the conduit 33 into the top of the cylinder above the piston 12 and the piston will be forced downwardly against the action of the compression spring 29 until the washer 30 engages the upper end of its stop or limiting member 31. Assuming that the valve 13 is raised to its upper position, as shown in Fig. 2, the fluid will pass from above the piston 12 through the conduit 33 to the central aperture 38 in the valve seat 39 and thence to the atmosphere through the exhaust port 37, thus allowing the piston 12 to be moved upwardly due to the action of the spring 29.

In order to control the actuation of valves 13 from a relatively distant point, I have provided a plurality of electromagnets 42 corresponding in number to the number of cylinders 11 and valves 13, each electromagnet being secured to the upper side of a valve casing 14 or 14*a* directly above and concentric with a valve 13. Each of the electromagnets 42 comprises a core 43 secured at one end in a valve casing 14 or 14*a* and provided with a central aperture 44 in which is slidably mounted a rod 45, preferably of non-magnetic material, and connected to a valve 13 so as to form an extension thereof. The winding of each magnet 42 is secured in a suitable drum and surrounds the core 43 in the usual manner. A plurality of brackets 46 are attached to the upper sides of the valve casings 14, 14*a* and extend upwardly at the side of the magnets 42, each bracket 46 serving to support a housing 47 mounted above one of the magnets 42. Within each of the housings 47 and directly above the upper end of the core 44 is mounted a vertically movable armature 48 of a suitable magnetic material. A guide member 49 is secured in the housing 47, this member extending through an aperture in armature 48 so as to guide the armature in its upward and downward movement. A plurality of plungers 50 normally biased to an upward position are mounted in the housings 47 directly above the armatures 48.

In case it is desired to operate my device by hand, by pressing upon one of the plung-

ers 50, its respective armature 48 may be forced downwardly, thus moving the valve 13 to the lower extreme position and allowing compressed fluid to pass into the cylinder to force the piston 12 downwardly. It will be observed that in normal operation, when one of the magnets 42 is energized, the armature 48 mounted above that magnet will be drawn downwardly, thus forcing its valve 13 into the lower position and allowing compressed fluid to pass into the cylinder above one of the pistons 13 whereby the piston and its push-rod 28 is moved downwardly against the action of the compression spring 29 until the washer 30 engages the upper end of the stop member 31. The bar 23 and consequently the controlled arm 18 will thus be forced downwardly a predetermined distance, depending on which one of the magnets 42 was energized. When this same magnet 42 is deenergized the compression spring 40 will force the valve 13 upwardly, thus allowing the fluid above the piston 12 to be exhausted to the atmosphere through the conduit 33 and the exhaust port 37.

In order to bias the bar 23 upwardly to hold it against the lower ends of the push rods 28, I have provided resilient means comprising a compression spring 51 supported between the casing 10 and a rod 52 secured between the ends of a pair of short arms 53 rigidly attached to the rock-shaft 17. The spring 51 surrounds a rod or plunger 54 slidably mounted at one end in a small cylindrical guide 55 integral with the lower portion of the casing 10 and bears at one end against the guide 55 and at the other end against a shoulder 56 secured to the outer end of the plunger 54. The outer end of the plunger 54 is also provided with a bifurcated portion 57 engaging the rod 52, and it will thus be seen that the spring 51 normally forces the arms 53 in a clockwise direction, as in viewing Fig. 2, thus biasing the bar 23 upwardly against the push-rods 28.

In order to delay the movement of the control arm 18 I have provided retarding means comprising a dash-pot 58 secured to a side of a casing 10 opposite to the cylinder 55. The arms 20 and 21 are provided with extensions 59, these extensions being connected through links 60 with a piston in the dash-pot 58.

In Fig. 4 I have shown diagrammatically one form of switching means for actuating my control device. One terminal of each of the magnets 42 is connected to one side of a supply line 61 while the other side of the supply line 61 and the other terminals of the magnets 42 are connected to a series of contacts 62 adapted to be engaged by metallic contacting strips or bands on a drum controller 64. It will be seen that when the switch 63 is closed and the drum controller rotated, the magnets 42 will be energized in progressive sequence. As has been explained hereinbefore, when a magnet 42 is energized the valve 13 controlled by that magnet is caused to move downwardly admitting pressure fluid to its respective piston 12 and downward movement of the piston causes the bar 23 and the control member or arm 18 to be moved correspondingly. By rotating the drum controller 64 so that more and more of the magnets 42 are energized, the bar 23 and controlled arm 18 will be moved downwardly greater and greater distances due to the fact that the strokes of the pistons 12 increase as additional pistons are actuated, assuming of course, that the piston at the extreme left in viewing Fig. 1 is the first to be actuated. While I have shown a form of switching means embodying a drum controller, I do not wish to be limited to this particular form since my device may be actuated in other ways. For example, switching means may be provided so that any one of the magnets 42 may be energized alone to give the control arm 18 a predetermined movement.

In Fig. 3 I have illustrated an application of my control device in which the device is connected so as to modify a governor spring 65 which in turn regulates the action of a centrifugal governor 66. The control arm 18 is connected through a link 67 and a pivotally mounted lever 68 to a collar attached to the lower end of the spring 65. A pivotally mounted lever 69 connected at one end to the governor rod may be connected at its other end to a throttle or fuel injection valve or to any other desired regulating device. While I have illustrated my control device as being used to modify a governor spring, it is to be understood that many other uses for my device are available, and I do not wish to be limited to the particular application illustrated.

While I have described my invention as embodied in concrete form and operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electro-magnetically controlled pressure operated mechanism arranged for step-by-step operation of a throttle control including a cylinder block provided with a plurality of cylinders, pistons movable in said cylinders, a movable control member, operating connections between said pistons and movable member, a source of fluid pressure, conduits connecting said source of fluid pressure to said cylinders, valves in said con-

duits for controlling the admission of fluid under pressure to said pistons, stop members in said cylinders of graduated lengths cooperating with said pistons and electro-magnets for controlling successive operation of said valves to obtain a step-by-step movement of said movable control member.

2. An electro-magnetically controlled pressure operated mechanism arranged for step-by-step operation including a cylinder block provided with a plurality of cylinders, pistons movable in said cylinders, a movable control member, piston rods operatively connecting said pistons and movable member, a source of fluid pressure, conduits connecting said source of fluid pressure to said cylinders, valves in said conduits for controlling the admission of fluid under pressure to said cylinders, stop members in said cylinders of graduated lengths cooperating with said pistons, and electro-magnets for selectively controlling operation of said valves to obtain a step-by-step movement of said movable control member, said pistons being biased away from said control member and said control member being biased toward said pistons.

3. An electro-magnetically controlled pressure operated mechanism arranged for step-by-step operation including a cylinder block provided with a plurality of cylinders, pistons movable in said cylinders, a movable control member, piston rods operatively connecting said pistons and movable member, a source of fluid pressure, conduits connecting said source of fluid pressure to said cylinders, valves in said conduits for controlling the admission of fluid under pressure to said cylinders, stop members in said cylinders of graduated lengths cooperating with said pistons, electro-magnets for selectively controlling operation of said valves to obtain a step-by-step movement of said movable control member, said pistons being biased away from said control member and said control member being biased toward said pistons, and a time delay means operatively connected with said movable control member.

4. An electro-magnetically controlled pressure operated mechanism arranged for step-by-step operation, including a cylinder block provided with a plurality of cylinders, pistons movable in said cylinders, a movable control member, operating connections between said pistons and movable member, a source of fluid pressure, conduits connecting said source of fluid pressure to said cylinders, electro-magnetic means controlling the admission of fluid under pressure to said pistons for selectively operating the same, substantially cylindrical stop members mounted in each of said cylinders in the path of one of said pistons and concentric with the piston rods, said stop members being of graduated lengths and cooperating with said pistons whereby upon selective operation of said pistons said movable member has a step-by-step movement.

5. An electro-magnetically controlled pressure operated mechanism arranged for step-by-step operation, including a cylinder block provided with a plurality of cylinders, pistons movable in said cylinders, a movable control member, operating connections between said pistons and said movable control member, stops associated with said pistons of graduated lengths to stop movement of said movable control member at different positions, electro-magnetic means for selectively controlling operation of said pistons, said electro-magnetic means comprising electro-magnets mounted alternately on opposite sides of said cylinder block, valves controlling the admission of fluid under pressure to said pistons, said valves being controlled by said electro-magnets, and conduits connecting said cylinders to the source of fluid pressure and to the atmosphere, said conduits being opened and closed by said valves for causing operation of said pistons to give said movable control member a step-by-step movement.

6. In combination with a source of fluid pressure, a cylinder block provided with a series of cylinders, pistons mounted in said cylinders, said cylinder block being provided with conduits connecting said cylinders with said source of pressure and with the atmosphere, valves in said conduits, a control member, means normally connecting said pistons with said control member, a series of stop members mounted in said cylinders in the paths of said pistons, said stop members being graduated in length so as to allow said pistons to travel progressively greater distances, and a plurality of electromagnets arranged to actuate said valves in succession.

7. In combination with a source of fluid pressure, a casing provided with a series of substantially parallel cylinders, pistons slidably mounted in said cylinders, said casing being provided with conduits connecting one end of each cylinder with said source of pressure and with the atmosphere, a valve in each of said conduits, an electromagnet for actuating each of said valves, said electromagnets being mounted on said casing alternately on opposite sides thereof, a control member, rods connecting said pistons with said control member, and a series of graduated stop members, one of said stop members being mounted in each of said cylinders in the path of one of said pistons.

8. In combination with a source of fluid pressure, a cylinder block having a plurality of cylinders, pistons in said cylinders, conduits connecting one end of each of said cylinders with said source of fluid pressure, valves mounted in said conduits, a plurality

of electromagnets arranged to actuate said valves, a rock shaft, a control arm secured to said rock shaft, a bar secured to said rock shaft in substantially parallel relation therewith and arranged for movement angularly with respect to said rock shaft, a plurality of push rods between said pistons and said bar, means for normally biasing said pistons away from said bar, and a plurality of stop members of graduated lengths mounted in said cylinders in the path of said pistons.

9. A control device comprising, in combination with a source of fluid pressure, a cylinder block provided with cylinders, pistons in said cylinders, said cylinder block being provided with conduits connecting said cylinders with said source of fluid pressure, valves in said conduits, a laterally movable bar, a pivotally mounted arm arranged to move with said bar, a push rod between each of said pistons and said bar, means for biasing said piston away from said bar, means for biasing said bar toward said push rods, a plurality of graduated stop members mounted in said cylinders to limit the movement of said push rods, and electromagnet means for controlling said valves in succession so as to progressively actuate said pistons to move said bar in a series of successive steps.

10. A control device comprising, in combination with a source of fluid pressure, a casing provided with cylinders, pistons in said cylinders, said casing being provided with conduits connecting said cylinders with said source of fluid pressure, valves in said conduits, a laterally movable bar, a pivotally mounted arm arranged to move with said bar, a push rod between each of said pistons and said bar, means for biasing said pistons away from said bar, means for biasing said bar toward said push rods, a plurality of graduated stop members mounted in said cylinders to limit the movement of said push rods, electromagnetic means for controlling said valves in succession so as to progressively actuate said pistons to move said bar in a series of successive stops, means cooperating with said bar for adjusting the effective length of said push rods, and time delay means for retarding the movement of said bar.

11. In combination with a source of fluid pressure, a casing provided with a series of cylinders, pistons mounted in said cylinders, said casing being provided with conduits connecting said cylinders with said source of pressure and with the atmosphere, valves in said conduits, a control member, rods normally connecting said pistons with said control members, a series of stop members mounted in said cylinders in the paths of said pistons, said stop members being graduated in length so as to allow said pistons to travel progressively greater distances, a plurality of electromagnets arranged to actuate said valves in succession, means cooperating with said control member for adjusting the effective length of said rods, and means for retarding the movement of said control member.

12. A step-by-step control device including a casing having a series of reciprocating fluid pressure operated motors having cylinders of equal length mounted in parallel alignment, electro-magnetic means for automatically controlling the admission of fluid under pressure to said motors to effect operation of any portion thereof, a control member and means connecting said motors and control member, a stop member within each of said cylinders for limiting movement of said motors, said stop members being graduated in length whereby said control member will be moved to different positions upon operation of each of said motors.

13. In combination with a source of fluid pressure, a casing provided with a series of cylinders, pistons mounted in said cylinders, said casing being provided with conduits connecting said cylinders with said source of pressure and with the atmosphere, valves in said conduits, a control member, rods normally connecting said pistons with said control member, a series of stop members mounted in said cylinders in the paths of said pistons, said stop members being graduated in length so as to allow said pistons to travel progressively greater distances, a plurality of electromagnets arranged to actuate said valves in succession, resilient means for biasing said pistons away from said control member, resilient means for biasing said control member toward said rods, and means cooperating with said control member for adjusting the effective lengths of said rods.

14. In combination with a source of fluid pressure, a casing provided with a series of cylinders, pistons mounted in said cylinders, said casing being provided with conduits connecting said cylinders with said source of pressure and with the atmosphere, valves in said conduits, a control member, rods normally connecting said pistons with said control member, a substantially cylindrical stop member mounted in each of said cylinders in the path of one of said pistons and concentric with one of said rods, said stop members being graduated in length so as to allow said pistons to travel progressively greater distances, and a plurality of electromagnets arranged to actuate said valves in succession.

15. A control member secured to said shaft, a bar secured to and arranged for angular movement around said rock shaft, a casing having a plurality of fluid operated motors for moving said bar angularly around said rock shaft, electromagnetic means for con-

trolling operation of said fluid operated motors, and graduated stop means associated with said motors whereby movement of said rock shaft is accomplished in a series of progressive steps.

In witness whereof, I have hereunto set my hand this 13th day of December, 1928.

ARTHUR T. CROCKER.