C. O. BURTON.

AUTOMATIC BRIDGE CONTROL.

APPLICATION FILED DEC. 7, 1918.

1,383,286.

Patented July 5, 1921.

4 SHEETS—SHEET 1.

Fig 3.

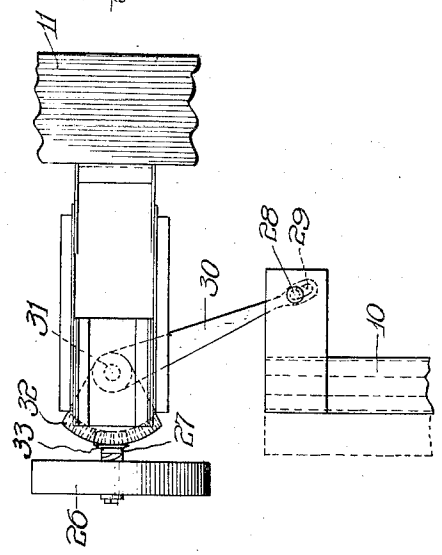


Fig 1.

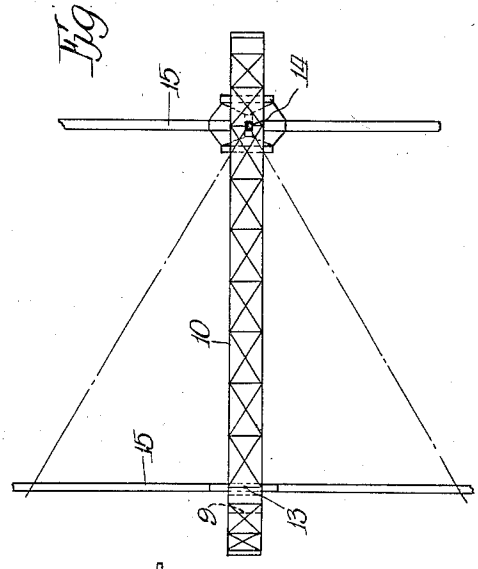


Fig 2.

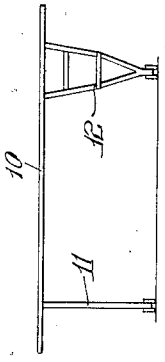


Fig 4.

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4 SHEETS—SHEET 2.

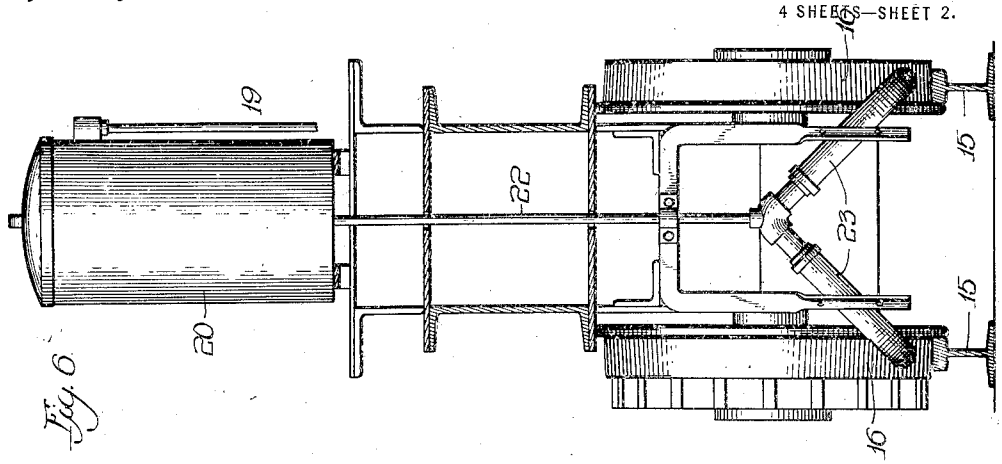


Fig. 6

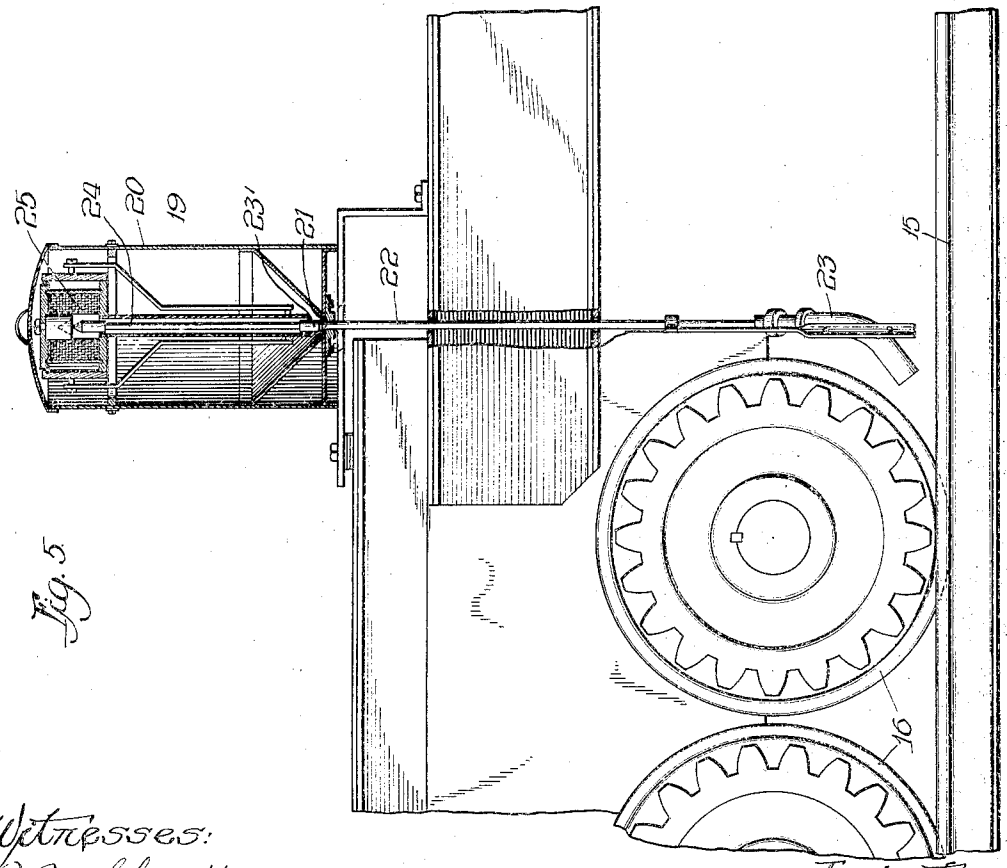


Fig. 5

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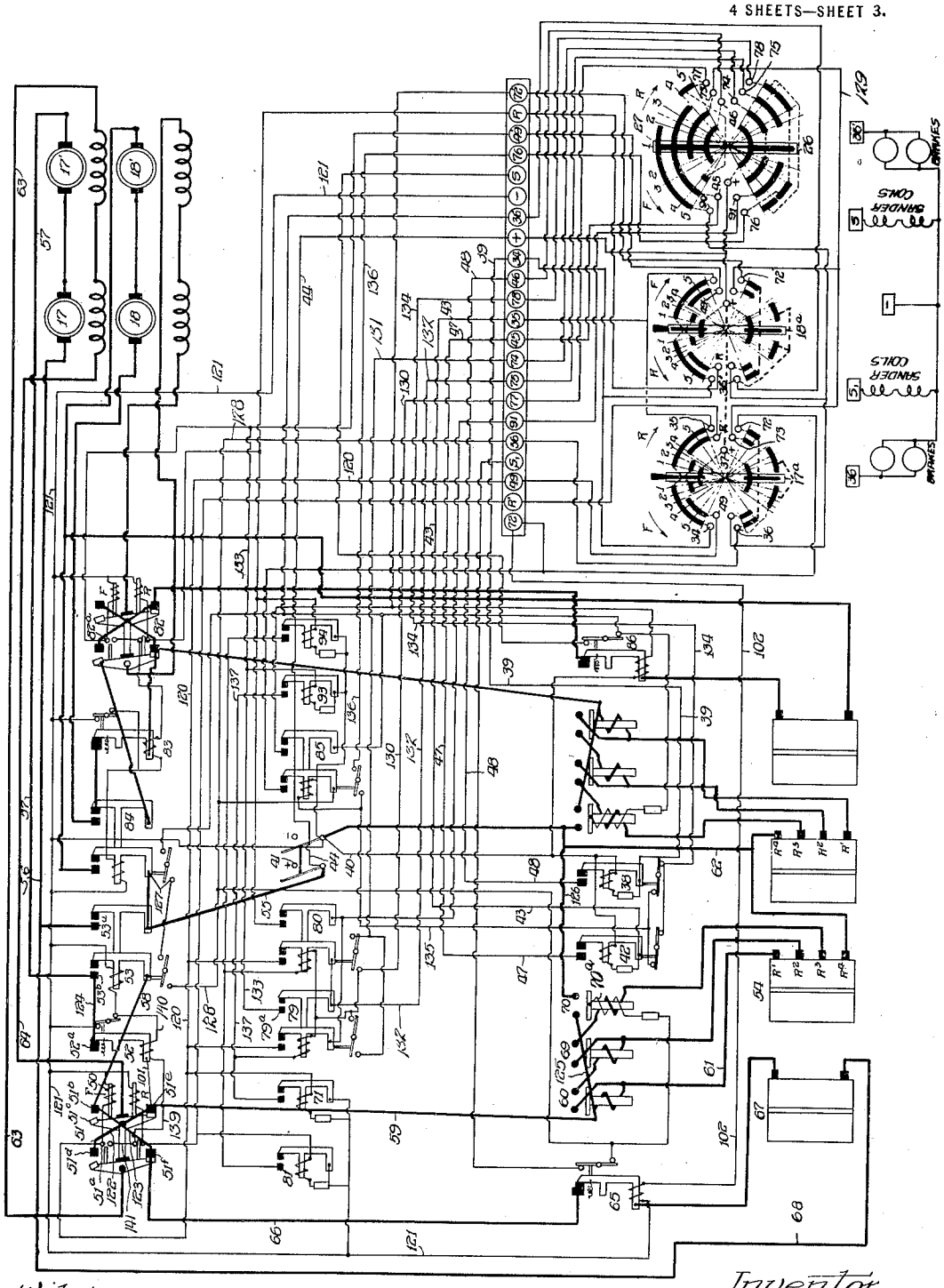
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4 SHEETS—SHEET 3.



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Fig. 7

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AUTOMATIC BRIDGE CONTROL.

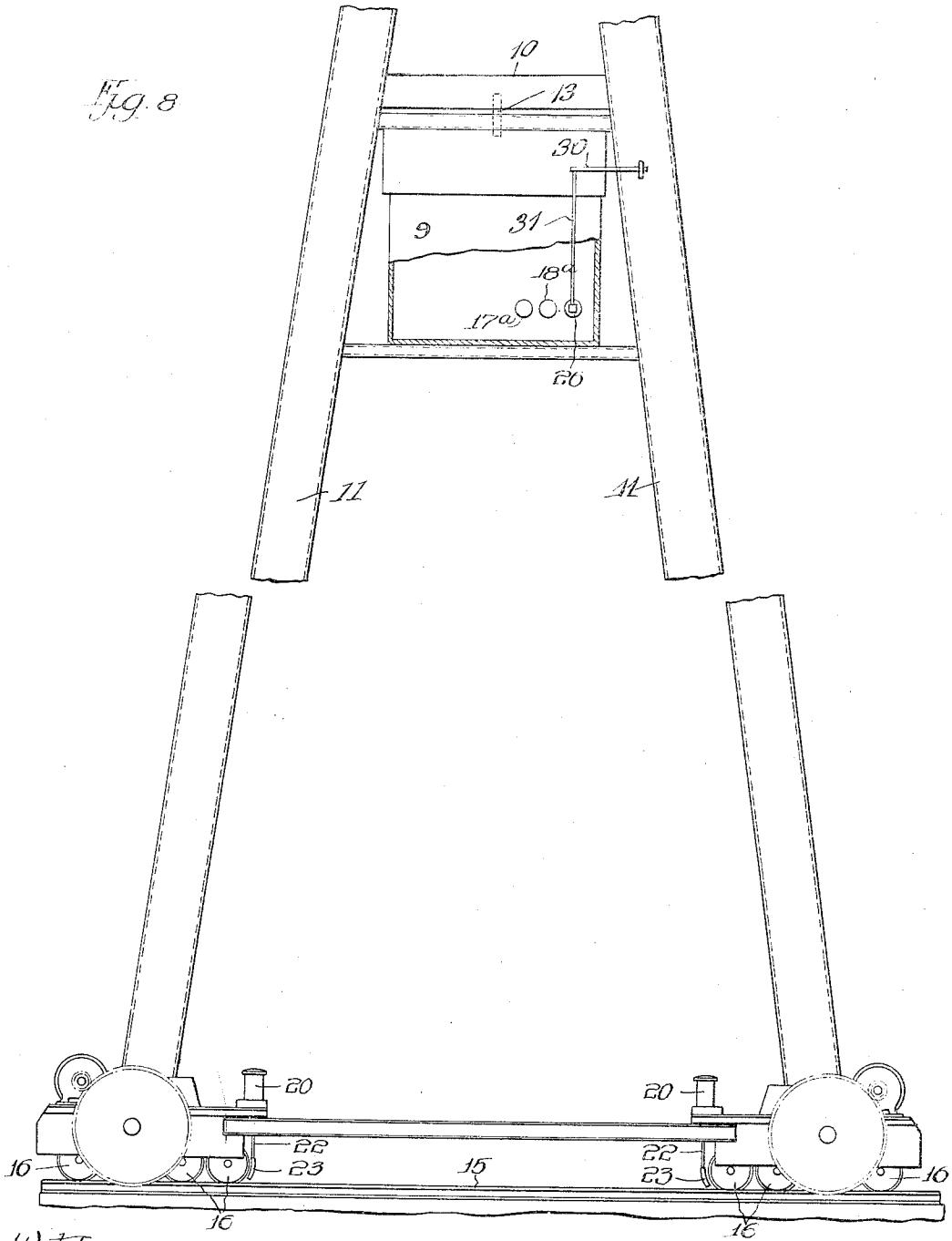
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4 SHEETS—SHEET 4.

Fig. 8



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UNITED STATES PATENT OFFICE.

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AUTOMATIC BRIDGE CONTROL.

1,383,286. Specification of Letters Patent. Patented July 5, 1921.

Application filed December 7, 1918. Serial No. 265,753.

To all whom it may concern:

Be it known that I, CARL O. BURTON, a citizen of the United States, residing at Duluth, in the county of St. Louis and State of Minnesota, have invented certain new and useful Improvements in Automatic Bridge Control, of which the following is a specification.

In a certain type of overhead traveling crane, ordinarily known as ore or coal bridges, the overhead structure or transverse girders are supported on legs which are provided at their lower ends with wheels which travel on suitable rails mounted on the ground. One of these legs is known as the shear leg, and the other as the pier leg. The bridge or transverse girder is not securely riveted to the legs, but is flexibly secured thereto by means of a king bolt at either end, so that the bridge can assume an angle other than 90° with respect to the rails. In practice it is customary to move one end of the bridge forward and bring it to a stop when a predetermined angle has been reached. Then the other end of the bridge is moved in the same direction until it reaches a predetermined point, it being understood that suitable members are mounted on the different legs for propelling the bridge. If desired, however, the motors may be driven to actuate the entire structure in one direction or the other. It is obvious that if one end of the bridge is stationary there is but a limited distance which the other end can be moved without derailment or destruction of the bridge. It frequently has happened in practice that one end of the bridge has moved faster than the other, owing to wind pressure, or unskilled handling of the bridge. This has resulted seriously in connection with many bridges.

One object, therefore, of my invention is to prevent the bridge from skewing beyond a predetermined angle and to prevent derailment and possible destruction of the bridge as a result thereof.

Another object is to automatically control the bridge in a manner to prevent disastrous movements thereof.

Another object is to provide a system of control on ore bridges of the type mentioned adapted to meet the various requirements for successful use thereof.

These and other objects are accomplished by means of the mechanism disclosed on the accompanying sheets of drawings, in which—

Figure 1 is a schematic and somewhat diagrammatic plan view of a coal or ore bridge in connection with which my invention is particularly applicable;

Fig. 2 is a side elevation of the same bridge shown somewhat schematically;

Fig. 3 is a detail view showing a control connection between relatively movable parts of the bridge;

Fig. 4 is a fragmentary side elevation of the same;

Fig. 5 is a detail side elevation of one of the trucks forming a part of one of the legs and showing in section an automatically controlled sander connected therewith;

Fig. 6 is a fragmentary end view of the same arrangement, parts being shown in section;

Fig. 7 is a wiring diagram showing the system of control; and,

Fig. 8 is a view showing somewhat diagrammatically one of the legs and associated parts, including trucks with motors and sanders, and also cage with electric control parts.

The various novel features of my invention will be apparent from the following description and drawings and will be particularly pointed out in the appended claims.

Referring first to Figs. 1 and 2 of the drawings, it will be noted that I have shown a coal or ore bridge 10 supported at one end by a shear leg 11, and at the other end by a pier leg 12, the bridge being pivotally connected to each of said legs by king pins 13 and 14. As a result of this pivotal connection, it is readily apparent that the bridge 10 may skew, the ends thereof change their relative positions, or the bridge change its angularity with respect to the rails 15 upon which the legs are mounted. The lower ends of these legs 11 and 12 are provided with trucks, including wheels 16, which travel on the rails 15.

Preferably, the bridge is driven by four

electric motors 17, 17′, 18 and 18′, two being mounted upon the shear leg structure, and the other two upon the pier leg structure. Each leg has two trucks, associated with each of which is an electrically operated sander 19 (see Figs. 5 and 6), including a hopper 20 for holding the sand, in the lower end of which hopper is an opening 21 through which passes a pipe 22 branching near its lower end into two pipes 23 for directing sand upon the associated rails 15. The opening 21 is controlled by a valve 23′ mounted upon one end of a stem 24, the upper end of which is located within a solenoid or coil 25, which when energized draws the valve 23′ upwardly to permit sand to flow upon the tracks. At this point it may be stated that sand is permitted to flow to the tracks upon starting and stopping actions. It will be understood that any suitable sander may be provided for assisting in starting and braking operations of the bridge.

The opposite ends of the bridge are independently driven and movable, and, therefore, may assume different relative positions. Assuming that one end of the bridge is moving while the other is stationary, the moving end is permitted to travel only to a certain predetermined limit before it is stopped, the stationary end remaining stationary, or under certain control conditions said end may be started in the same direction. Whether or not one end is stationary, or both ends are traveling in the same or different directions, the bridge will be permitted to skew only a certain predetermined amount before driving conditions are changed to stop the bridge or rectify its position.

The motors 17 and 17′ at one end of the bridge are controlled by a master controller 17ª, and the motors 18 and 18′ at the other end of the bridge are controlled by another master controller 18ª. These preferably are operated manually by an operator for normally controlling the movements of the bridge. However, it is desired to automatically control the bridge, especially in connection with limiting the skewing action thereof, and to rectify the position of the bridge when the latter has become skewed a certain predetermined amount. To this end I have provided a limit switch 26 which is operatively connected with both of the master controllers 17ª and 18ª, and which is controlled by relative movements of the bridge and one of the legs; or, in other words, the movable member 27 of the limit switch is actuated in accordance with the degree of skew of the bridge.

By referring to Figs. 3 and 4, it will be noted that a portion of the bridge 10 is provided with a pin 28, which is received by a slot 29 in one end of a radius arm 30, which is secured to the upper end of a shaft 31 carried by the shear leg. Fixed to the lower end of the shaft 31 is a toothed sector 32 meshing with a gear 33 connected to the movable member 27 of the limit switch 26. From this arrangement it is apparent that if there is a relative movement between the bridge 10 and the shear leg 11, and, therefore, between the bridge and the pier leg, or, in other words, a skewing action between the bridge and either of its supporting legs, a corresponding movement will be transmitted to the movable member 27 of the limit switch 26 to automatically control the movements of the bridge and rectify the position thereof in the event that the bridge assumes a certain predetermined skewing angle.

The limit switch automatically operates under various conditions when the bridge is skewed; for example, when one end of the bridge is stationary and the other end is moving in either direction; when both ends of the bridge are moving in the same direction at different speeds; and when both ends of the bridge are moving in opposite directions. The master controllers 17ª and 18ª and the limit switch 26 are mounted in the operator's cage 9.

Referring to the wiring diagram shown by Fig. 7 of the drawings, the operation and control of the bridge will be considered under various conditions. Consideration first will be given operation of the bridge with one controller only, master controller 17ª and the limit switch. When the control handle is moved forward into position 1, segments 34, 35, 36 and + segment 37 are covered. Under such conditions the coil on switch 38 is energized, the current passing from the + segment 37 through the segment 34, conductor 39, through coil on switch 38 and conductor 40 connected to the negative side of the main switch 41. The switch 38 thereupon is closed. At the same time the switch 42 is closed as a result of its coil being energized, the current passing from the + segment 37 through segment 35, conductor 43, coil on switch 42, conductor 40, to the negative side of the line, it being understood that both master controllers 17ª and 18ª and limit switch 26 are fed from the positive side of the line through conductor 44. Through segment 36 the brakes on the end of the bridge operated by master controller 17ª are released. With the movable element of master controller 17ª in the second position, a positive feed or energizing current for holding switches 38 and 42 in a closed position is cut off from the master controller because control handle of controller 17ª is moved out of electrical connection with + segment 37 and maintained by the limit switch 26 through segments 45 and 46, respectively, segment 45 being connected to the

coil of switch 42 by the conductor 47 and segment 46 connected to the coil of switch 38 by conductor 48, it being understood that segments 45 and 46 are electrically connected to the + segment of the limit switch 26 through the handle of the latter. With the handle of controller 17ª in position 3, circuit conditions are the same as shown in position 2, with the exception that contacts 34 and 35 are no longer electrically connected. With the controller handle in fourth position, segments 34 and 49 are covered and segments 36 and + segment 37 are uncovered. As a result thereof the forward coil 50 on switch 51 is energized, causing switch 51 to close in the proper direction. The circuit includes + segment on limit switch 26, through limit switch handle, segment 46, conductor 48, switch 38, conductor 39, segment 34 of controller 17ª, controller handle, segment 49, conductor 120, switch auxiliary contact 51ª and coil 50 to the negative conductor 121. Auxiliary contacts on switch 51 are mechanically operated, causing a closing of a parallel circuit from contact 51ª through conductor 139, coil on switch 52, conductor 140, auxiliary contact on switch 52 to negative conductor 121, whereupon said coil on switch 52 is energized for opening switch 52 and the auxiliary switch carried thereby. The auxiliary, or butterfly switch, on switch 52 when closed shunts the coil on switch 53. Accordingly, after switch 52 is opened, switch 53 is closed, throwing the motors 17 and 17′ in series with the starting resistance 54, the circuit including conductor 55 leading from the main switch 41, the right-hand member of switch 53, conductor 56, armatures of motors 17 and 17′, conductor 57, through the left-hand member of switch 53, conductor 58, contact 51ᵇ, movable contact 51ᶜ through upper half of right arm of switch 51, conductor 64, series fields of motors 17 and 17′, conductor 63 through upper half of left arm of switch 51, contact 51ᵈ, conductor 122, contact 51ᵉ, conductor 59, coil of relay, switch 60, conductor 61, through resistance 54, conductor 62, to the negative side of the switch 41. Switch 65 at this time is in closed position, connecting a shunt across the armatures of the motors, including switch contact 51ᵇ, conductor 123, switch contact 51ᶠ, conductors 66, switch 65, resistance 67 and conductor 68, running into conductor 56, completing the shunt circuit at contact 53ª of switch 53. The current flow caused by this shunt prevents current limiting resistance relays 60, 69 and 70 from closing. It will be understood that these relays are responsive to a limited maximum current, a larger current having no responsive action in so far as closing said relays is concerned. This shunt around the armature 17 and 17′ through switch 65 causes the excessive current flow which prevents the relays 60, 69 and 70 from closing. Later, with the controller 17ª in fifth position, the switch 65 will be opened, removing armature shunt and permitting motors 17 and 17′ to accelerate to full speed. When switch 65 is opened, the current flow through the motor fields will be decreased, causing motors to increase in speed. This reduced current permits relays 60, 69 and 70 to close in turn, cutting out sections of starting resistance 54, whereupon the motors accelerate to maximum speed. Switch 53 cannot close until switch 52 and its butterfly switch are open, thereby preventing a short circuit across the line through the motor armatures, shunting the fields. This short circuit would begin at contact 53ᵇ of switch 53 and include conductor 124, switch 52, contact 51ᵉ, conductors 59 and 125, relay 70 and conductor 126 to the negative side of main switch 41. Closing of the butterfly switch on switch 53 holds the brakes released, shunting the circuit originally maintained through + segment 37 and segment 36 on the master controller. The connection goes from + segment on left-hand side of switch 84 through conductor 127, butterfly on 53, conductor 128 to brake segment 36. The coil of switch 71 is in parallel with the forward coil of switch 51 and closes simultaneously therewith. With the movable switch member of the master controller 17ª in the fifth position, the connections are the same as in position 4, with the exception that the coil on switch 65 is energized through covering segments 72 and 73 on the master controller, causing the opening of switch 65 for permitting the motors to accelerate as explained hereinabove. This circuit includes + segment on limit switch 26, through switch handle, segment 73 on limit switch, conductor 129, segment 73 on master controller 17ª, switch handle, segment 72, conductor 102, and coil of switch 65 to the negative side of the line.

If the movable member of master controller 17ª is moved slightly in its fifth position to the extent that contact segments 72 and 73 are uncovered, the coil on switch 65 is deënergized, allowing this spring closing switch to close, shunting the armature. The starting resistance in this case, however, is not in series with the motor across the line, for the reason that relay 70 is held in closed position by its holding coil 70ª. Upon a further movement to position 3 the coils on switches 51, 52, 53 and 71 are deenergized, allowing switch 53 and switch 71 to open and spring closing switch 52 to close, completing the dynamic braking circuit. Starting with armatures 17 and 17′, the dynamic braking circuit includes conductor 57, switch contact 53ᵇ, conductor 124, switch contact 52ª, switch 52, conductor 101, switch contact 51ᵉ, conductor 122, contact

51[d], upper half or left switch arm 51, conductor 63, field coils, conductor 64, upper half of right arm of switch 51, contacts 51[c] and 51[d], conductor 123, contact 51[f], conductor 66, switch 65, shunting resistance 67, conductor 68 and back to armature 17. The brakes are held released at this time by the master controller 17[a] through segment 36, allowing the bridge to coast along without power on dynamic braking. In moving back through positions 2 and 1, the conditions are the same as in position 3, no switches being operative. When neutral position is reached all segments on the master controller 17[a] are uncovered with exception of the + segment, brakes are set, and the bridge brought to a stop. Switches 38 and 42 remain closed. The holding coil on switch 70 is deënergized, allowing relay to open.

The operation of the bridge through the use of the master controller 18[a] is the same as for master controller 17[a], except that it is for the opposite end of the bridge. The sequence of the operation of the switches is the same for either direction. The sanders are operated in either direction and cause a flow of sand both on starting and stopping. They are operated through the butterfly on switch 65. They also operate when the segments 36 and 36′ are covered on the master controllers.

The operation of the system with one master controller 17[a] in its last or full speed position, together with the operation of the limit switch, will now be considered.

Let it be assumed that the movable element 27 of the limit switch 26 is in its central position with the bridge 10 square. With the master controller 17[a] as mentioned, switch 51 is closed in the forward direction, switches 52 and 65 are opened, switches 53 and 71 are closed, relay 70 also is closed, cutting out all of the starting resistance, and switches 42 and 38 are closed, it being understood that one end of the bridge is moving at full speed, while the other end is stationary. The movable element 27 of the limit switch 26 moves in a forward direction to the second position in which the segment 73 is uncovered, removing the positive feed from the coil of switch 65, thereby shunting the armature. Segments 74 and 75 are covered, but have no effect in this position. The sanders are also simultaneously operated with the shunting of the armature. This is effected through the butterfly on switch 65. When the movable element of the limit switch reaches the third position, segment 76 is covered, but without effect at this time, the bridge meanwhile skewing with the armature shunted and traveling at a reduced speed. When the movable element of the limit switch reaches its fourth position, the segments 46 and 76 are uncovered. Segments 77 and 78 are covered. Uncovering segment 46 on switch 26 removes the positive feed from segment 46, through conductor 48, switch 38 and finally to the coil on switch 38, allowing this switch to open. This causes feed from switch 38, through conductor 39, segment 34 on master switch 17[a], switch handle, segment 49, conductor 120, contact 51[a], conductor 141, and conductor 139, to be removed from coil of switch 52, through conductor 140 and coil on switch 53, allowing spring closing switch 52 to close and switch 53 to open. When switch 53 is open the current supplied to the motors is shut off and the brakes are set on the moving end of the bridge. Segment 77 is covered just shortly before segment 46 is uncovered, thereby allowing all switch action to take place before segment 46 is uncovered. From the above circuit it will be seen that when segment 46 is uncovered, feed is removed from conductor 120 and coil of switch 71, allowing switch 71 to open. Current is fed from segment 77 through conductor 130 to one side of the coils on switches 79 and 80. The other side is fed through switches 71 and 81, respectively. Switch 71 being closed causes switch 79, and not switch 80, to be closed. Switch 79 being closed remains closed by a circuit including conductor 131 through segment 74 on the limit switch. The main feed of switch 79 comes from segment 75 and passes through conductor 132, right arm of switch 79, contact 79[a], conductor 133, auxiliary contact 82[a] to the forward coil of switch 82 to the negative side of the line, energizing the coil and actuating the switch, and in turn causing the actuation of switch 83 and switch 84, placing the motors 18 and 18′ on the lagging end of the bridge in circuit for starting said end of the bridge in motion in same direction as first end was proceeding before stopped. Current also leaves conductor 133 passing through coil of switch 93 to the negative side of the line, closing switch but without additional effect. With switch 38 open, the butterfly thereon is closed, completing circuit from segment 78 on the limit switch through conductor 134, through butterfly on switch 38, conductor 135 to the coil on switch 85 to negative side of switch 41, causing switch 85 to close. Closing of switch 85 energizes the coils on both switches 86 and 65, removing shunts from the armatures on both sets of motors. This allows the lagging end of the bridge to come up to full speed. Power has been removed from the head end of the bridge, hence the opening of the shunt at this end has no effect. The limit switch is now in its extreme position, position 5, with segments 46 and 76 uncovered, and segments 77, 74 and 75 covered. When the movable element of the limit switch reaches this position, it starts back in a reverse direction.

It will be understood that the contact finger on the movable element of the limit switch is wide enough to span the space between the interrupted segment 78 electrically connecting the segments 76 and 78. Accordingly, switch 85 is kept closed through its butterfly, conductor 136 and segment 76; switch 79 is kept closed through conductor 137, switch 93, and the butterfly on switch 79, butterfly receiving its positive feed through conductor 131 from segment 74. The bridge continues with its lagging end moving at full speed and the head end stationary until the limit switch on its return movement passes position 3, where segment 76 is uncovered, opening switch 85, and switches 86 and 65 are closed, replacing armature shunt and decreasing the speed of the lagging end of the bridge. The bridge now moves along with the armature shunted until segments 74 and 75 are uncovered, opening switch 79, thereby deënergizing the forward coil on switch 82, and operating coil on each of the switches 83 and 84. The brakes are set on this end of the bridge as switch 84 opens, and the bridge comes to a complete stop. Operation may be resumed by centering the involved master controller and resetting the switch 38 as in the position which it takes when the movable member of the master controller 17^a is moved into its first position.

Operation of the system will now be considered with both master controllers on "full" and the limit switch in actual operation.

Let it be assumed that the bridge is operating under normal conditions with both ends traveling at the same rate of speed in the same direction. Assume, further, that some exterior force, such as the unbalancing effect of the wind, irregularity of the rails, dragging of the rail grips, etc., now causes one end of the bridge to travel faster than the other. Under these conditions, let it be assumed that the end of the bridge controlled by the master controller 17^a travels faster than the end controlled by the other master controller 18^a. The movable element of the limit switch in this case moves in a forward direction. It is assumed also that both master controllers are operating in a forward position. The limit switch uncovers segment 73 first, deënergizes the coil of switch 65 through conductor 129, segment 73 on master controller 17^a, movable handle, segment 72, conductor 102, to coil on switch 65 to the negative side of the line, thereby shunting the armatures of motors 17 and 17', causing same to slow down. Normal operation under this condition will tend to square the bridge, or at least sufficiently so to cover segment 73 of limit switch 26, before repeating the cycle. But let it be assumed that conditions are extreme, and the bridge continues to skew as first assumed. The movable element of the limit switch continues to move in the forward direction, whereupon segment 46 is finally uncovered, deënergizing the coil on switches 51, 52 and 53, stopping the leading end of the bridge while the opposite end continues to travel at full speed until the reverse skewing limit to position 2 in the reverse direction is reached. With the movable element of the limit switch in position 2 on the reverse side, segment 90 is uncovered, thereby deënergizing the coil on switch 86 and shunting the armatures of motors 18 and 18'. Covering of segments 74 and 91 at this time has no effect. With the movable element of the limit switch in reverse position 3, the connections are the same as in reverse position 2, with the exception that segment 76 is covered without effect. In reverse position 4 segments 45 and 76 are uncovered and 77 and 78 are covered. Current is fed through segment 77 to the positive side of switch 79. Return feed is furnished through switch 93 which is closed at this time. Current is fed through segment 91 to the left side of switch 79, which, being closed, energizes the forward coil of switch 51, switch 52, switch 53 and switch 71. Parallel circuits from switch 79 include segment 49 on master controller 17^a and segment 34, and reenergize coil on switch 38, closing same, which is held closed through segment 46 on the limit switch. Uncovering segment 45 opens switch 42, closing the butterfly thereon and allowing switch 85 to close, being energized through limit switch segment 78 and butterfly on switch 42. Switch 85 closing, completes circuit through conductor 102, coil of switch 65, to negative conductor 121, opening spring closing switch 65 and allows the end of the bridge on which motor 17 and 17' are located to obtain full speed, tending to swing the movable element of the limit switch back past the reverse position 3, wherein segment 76 is uncovered, opening switch 85. Switch 65, however, is held opened through the master controller 17^a. Therefore, opening switch 85 has no effect. When the movable element of the limit switch moves back into second reverse position the bridge is skewed back to a position wherein segment 90 is covered, thereby causing switch 86 to open and bringing the other end of the bridge on which motors 18 and 18' are located up to full speed. Both ends of the bridge are now traveling at full speed and the cycle may be repeated. Segments 74 and 91 are uncovered, opening switch 79 without effect. The limit switch is now in its central position with both controllers on "full" and all switches in their original position.

The same sequence of the operation holds true in case the controllers are thrown on "full" in the opposite direction, except the

corresponding switches are actuated instead of those named. In all of the above operations the accelerating relays are actuated only through reduced currents. Their operation is entirely automatic, having no connection with the manual part of the control. Stopping of the bridge is controlled through the master controllers, as described in an earlier operation when the limit switch is in central position.

Consideration will now be given to the bridge with both controllers on "full," but in opposite directions with the limit switch in operation. When position 1 is reached, let it be assumed that master controller 17ª is moved in a forward direction, and master controller 18ª being in the reverse direction, the movable element of the limit switch swinging in a forward direction, the coil of switch 51, together with the coil of switches 52, 53, 65 and 71, are energized from the master controller 17ª. The reverse coil on switch 82, together with coils on switches 83, 84, 86 and 94, are energized from master controller 18ª. Switches 42 and 38 are closed and all resistance cut out from the motor circuit.

When position 2 is reached segment 73 is uncovered, deënergizing the coils on switches 65 and 86, thereby closing said switches and shunting the armatures of the motors at both ends of the bridge. Segments 74 and 75 are covered, but without effect.

When position 3 is reached the connections are the same as in position 2, with the exception that segment 76 is covered without effect.

When position 4 is reached segments 77 and 78 are covered, and segments 46 and 76 are uncovered. When segment 77 is covered, current is fed therethrough to one side of switches 79 and 80. The other side of the switches are fed through switches 71 and 94, both being closed. Accordingly, switches 79 and 80 are closed, energizing reverse coil on switch 51 for the side controlled by master controller 17ª, and the forward coil of switch 82 for the side controlled by master controller 18ª. Segment 46 uncovered, deenergizes the forward coil of switch 51 and reverse coil of switch 82. Switches 52, 53, 83 and 84 are in open position until switches 51 and 82 have been reversed, whereupon they immediately close again, starting the motors in the opposite direction. Switches 71 and 94 open, and switches 81 and 93 close. Segment 46 being uncovered, causes switch 38 to open, closing the butterfly thereon, closing switch 85, which is held closed through segment 76. The contact on the movable element of the limit switch spans the space between the broken segment 78 for connecting segments 78 and 76. Switch 85 upon closing, opens switches 65 and 86, removing the shunt from the armatures from both sets of motors. The bridge now starts to square itself, and the movable element of the limit switch moves in the reverse direction past forward position No. 3, in which position segment 76 is uncovered, causing the opening of switch 85 and the closing of switches 65 and 86, thereby shunting the armatures of both sets of motors and reducing the speed of the bridge until forward position No. 2 is past, in which case segments 74 and 75 are uncovered, causing switches 79 and 80 to be opened, deënergizing the coils on switches 51, 52, 53, 84, 83, 82, 81 and 94 stopping the bridge. The limit switch is now in its normal position, both controllers are on "full." Switch 42 is closed and switch 38 is open, all of the other switches being in their normal off position.

The bridge may be moved in either direction after centering controllers and resetting switch 38.

It will be appreciated that opposite ends of the bridge should not be operated simultaneously in opposite directions from the standpoint of safety of operation. However, provision is made for controlling the bridge under such conditions, in the event that the same is carelessly operated. In case of failure of coils for either end of the bridge, the bridge will skew only to the limit and come to a stop without starting up the lagging end. Stopping of one end of the bridge through the limit switch with both controllers on "full" is accomplished by setting of the brakes and sanding of the tracks. Therefore, the chance of skidding on the rails and excessive skewing is reduced to a minimum.

In case the current is turned off for a short period of time, the bridge comes to a stop without attention, opening switches 42 and 38, and will not start again without the operator first centering the controllers and resetting the switches.

Briefly considered, the operation of the bridge is as follows: Assuming manual operation of one of the master controllers, one end of the bridge being stationary and the second end moving, the second end at first moves slowly as a result of its armatures being shunted. The second end of the bridge then increases in speed as a result of the shunt being removed, said end of the bridge then moving at full speed until the limit switch causes it to slow down as a result of its motor armatures again being shunted. When the bridge has skewed the maximum amount, there is an automatic dynamic braking effect and then the mechanical brakes are set bringing the bridge to rest.

Next, considering the first end of the bridge stationary and the second end of the bridge traveling at full speed, as the skewing limit is approached the armatures of the

motors on that end of the bridge are shunted to slow down that end of the bridge. The sanders also simultaneously are operated. When the bridge has skewed to its limit at reduced speed, the current is shut off and the brakes applied. The lagging, or first end of the bridge, is then started slowly with the armatures of the motors at that end being shunted. Later, shunt is removed, whereupon the first end of the bridge travels at an increased rate of speed. When the first end passes beyond the second end of the bridge, it slows down as a result of its armatures being shunted and finally the power is shut off and the bridge is stopped.

Consider both the master controllers in operation with both ends of the bridge traveling in the same direction at the same rate of speed. Assume, now, however, that one end is caused to travel faster than the other as a result of wind pressure, etc. The first end which is traveling at an increased rate of speed has its motor armatures shunted until the bridge becomes squared, but if the conditions are so adverse as not to permit the bridge to become squared in this manner, the motors on the first end of the bridge are stopped, it being understood that the second end of the bridge is traveling at full speed. When the second end of the bridge passes beyond a squared position to a reverse skewing limit, the second end slows down as a result of its motor armatures being shunted, whereupon the first end of the bridge is started in motion and later assumes full speed, whereupon the second end is raised to full speed, both ends then traveling at full speed. This will continue until one end skews beyond the other.

Considering both controllers in operation both ends of the bridge traveling, but in opposite directions, let it be assumed that opposite ends of the bridge are traveling in opposite directions at full speed. Shortly the motor armatures on both ends of the bridge are shunted for reducing the speed. Later the current supply is shut off entirely. Later the motors are driven in opposite directions with their armatures shunted, opposite ends of the bridge traveling at slow speed. The shunts are removed to increase the rate of travel of the opposite ends, and as the bridge approaches a square position, the ends thereof travel more slowly as a result of armature shunting, and when the bridge reaches a square position it is stopped.

The switches are shown only diagrammatically in Fig. 7, but it will be understood to those who are skilled in the art that switches of any desirable type may be employed. In an actual construction of the switches shown in this diagram as now in use, only switches 65, 86, 52 and 83 are spring closing switches, all other switches being magnetically closed. The arms of switch 51 are both rigidly secured to a common shaft, pivoting in bearings at each of its ends. Both arms operate in the same direction simultaneously either up or down as the operation demands. Magnetic solenoids acting on steel plungers, hinged to these arms actuate the switch. The two arms of switches 53 and 84 each operate in unison with a right and left motion. They are mechanically rigid acting as a single unit. Switches 60, 69 and 70 operate as a plunger and solenoid. The coil being energized with current at a certain value magnetizes and lifts the plunger to complete circuit on the two upper contacts shown on each. The small rectangles in circuit with coils on switches 38, 42 and 70 represent resistance units used only to safeguard said coils from overheating due to excessive current values. It will be understood that any other switch constructions and arrangements may be used, the essential features being that the contacts on the switches are placed together and moved apart during operation as may be necessary under the conditions imposed.

There may be various modifications of my invention as herein particularly shown and described, and it is my intention to cover all such modifications which do not involve a departure from the spirit and scope of the invention as set forth in the following claims.

I claim:

1. In combination, a bridge of the class described, and means for automatically righting the position thereof when the opposite ends of the bridge have moved in opposite directions a given amount.

2. In combination, a bridge of the class described, and means for automatically changing the position thereof when the opposite ends of the bridge have moved in different directions a predetermined amount.

3. In combination, a bridge of the class described, and electrical control means whereby the bridge is given a rectifying movement after it has assumed a predetermined position by its ends moving relatively in opposite directions.

4. In combination, a traveling bridge, the opposite ends of which may move in different directions, and means for changing the relative positions of said ends when they have moved in different directions a given amount.

5. In combination, a bridge, the opposite ends of which may move relatively with respect to each other, and control means for automatically limiting the relative movements of said ends in opposite directions within certain predetermined limits and for rectifying the position of the bridge.

6. In combination, a bridge, the opposite ends of which may move relatively with respect to each other, and control means for

automatically returning the ends of said bridge to certain relative positions after they have moved in opposite directions a given amount.

7. In combination, a bridge, the opposite ends of which may move independently of each other, driving means for the ends of said bridge, and means for automatically controlling the driving action of said driving means whereby the ends of the bridge may be given a certain relative position after they have moved in different directions.

8. In combination, a bridge, the opposite ends of which may assume different relative positions, means for driving the ends of said bridge, and limit means for automatically changing the driving conditions when the ends of said bridge have moved a given amount in opposite directions.

9. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors responsive to skewing of the bridge whereby a stationary end of the bridge automatically may be set in motion, when only the other end was in motion, independent of any previous manual operation to give motion to the stationary end.

10. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors responsive to skewing of the bridge whereby a stationary end of the bridge automatically may be set in motion, when only the other end was in motion, independent of any previous control operation to give motion to the stationary end.

11. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors responsive to skewing of the bridge whereby a stationary end of the bridge automatically may be set in motion to aline with the other end of the bridge, when only said other end was in motion, independent of any previous control operation to give motion to the stationary end.

12. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors whereby when the bridge is skewed by opposite ends of the bridge moving in opposite directions, the motion of the opposite ends of the bridge is reversed.

13. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors whereby when the bridge is skewed by opposite ends of the bridge moving in opposite directions, the motion of the opposite ends of the bridge is automatically changed.

14. In control mechanism for the propulsion of an ore bridge or the like, control means for the motors whereby when the bridge is skewed by opposite ends of the bridge moving in opposite directions, the relative movements of the ends of said bridge are changed.

15. In combination, a bridge of the class described, means for automatically righting the position thereof when one end is moved in advance of the other a predetermined amount, and means for automatically righting the position of the bridge when opposite ends thereof have moved in opposite directions a given amount.

16. In combination, a bridge of the class described, the ends of which may assume different relative positions, means for driving the bridge, means for automatically changing the driving action of said driving means when the ends of the bridge have assumed a certain predetermined relative position, and means whereby the motion of the bridge is retarded by dynamic braking.

17. In combination, a bridge of the class described, the ends of which may assume different relative positions, means for actuating one end of the bridge, and means whereby when said end of the bridge assumes a certain predetermined relative position with respect to the other end of the bridge the driving action of said driving means is changed and a dynamic braking action takes place.

18. In combination, a bridge of the class described, one end of which travels on rails, and means whereby the rails are automatically sanded when the end of the bridge is starting and stopping.

19. In combination, a bridge of the class described, one end of which travels on rails, and electrically operated means whereby the rails are automatically sanded when the bridge is given a retarding action.

20. In combination, a bridge of the class described, the opposite ends of which may assume different relative positions, one end of said bridge traveling on rails, power means for driving said end of the bridge, and means whereby when power is shut off a dynamic braking action takes effect and the rails are sanded.

21. In combination, a traveling bridge, the opposite ends of which may travel simultaneously and oppositely of each other, and means whereby when the ends of the bridge travel oppositely a given amount a rectifying action automatically will take place.

22. In combination, a bridge, one end of which may remain stationary while the other end travels, means for stopping the traveling end of the bridge after it has assumed a certain predetermined position with respect to the other end of the bridge, means for stopping opposite ends of the bridge after said opposite ends have moved in opposite directions a predetermined amount, and means for rectifying the position of said bridge.

23. In combination, a bridge, one end of which may remain stationary while the other end travels, means for stopping the traveling end of the bridge after it has assumed a certain predetermined position with respect to the other end of the bridge, means for stopping opposite ends of the bridge after said opposite ends have moved in opposite directions a predetermined amount, and means for driving opposite ends of said bridge in opposite directions to square the bridge.

Signed at Duluth, Minnesota, this 22 day of November, 1918.

CARL O. BURTON.