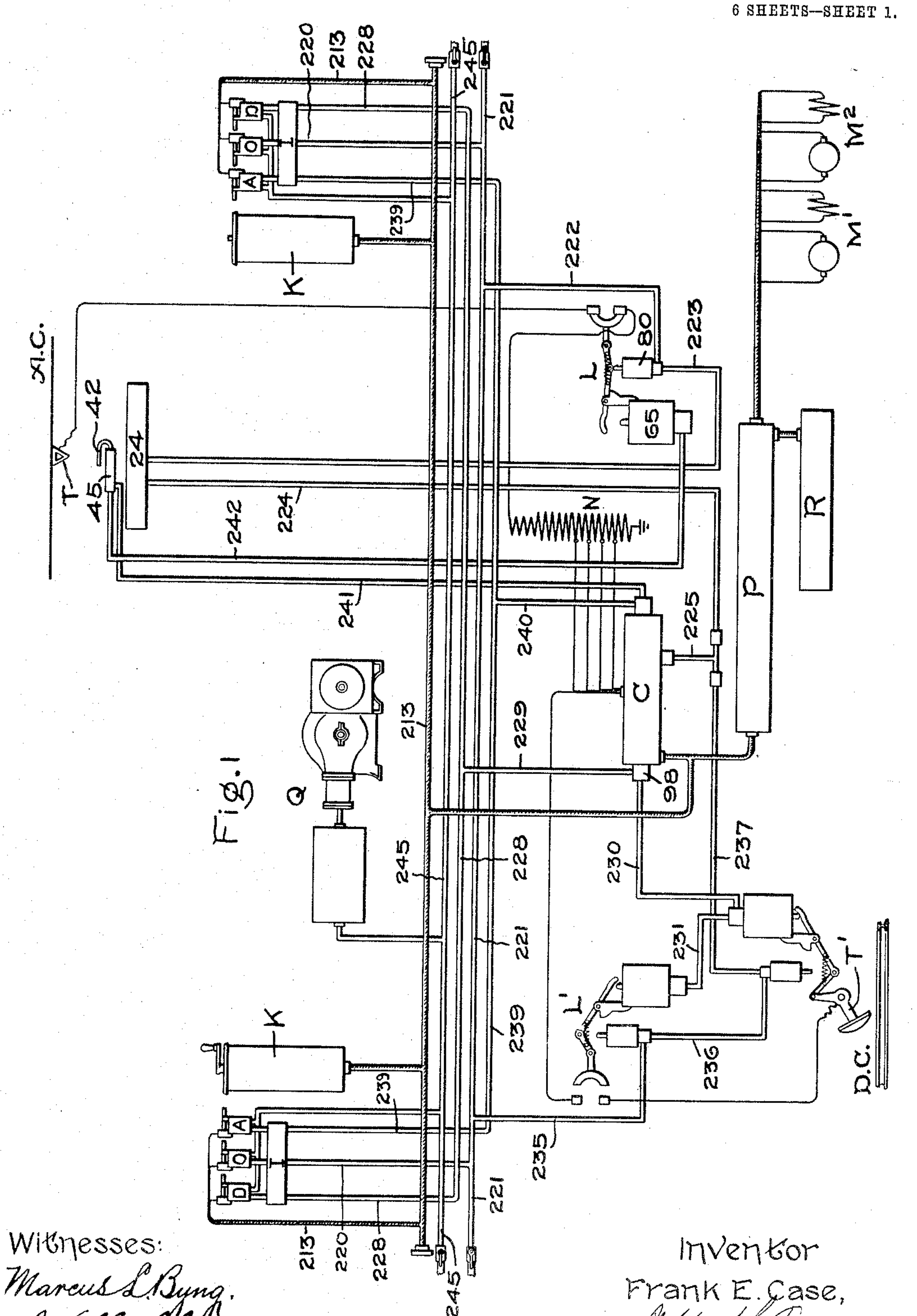
F. E. CASE.

ELECTRIC VEHICLE.

APPLICATION FILED SEPT. 11, 1909.

946,753. **Patented Jan. 18, 1910.**

6 SHEETS—SHEET 1.



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6 SHEETS—SHEET 2.

Fig. 2.

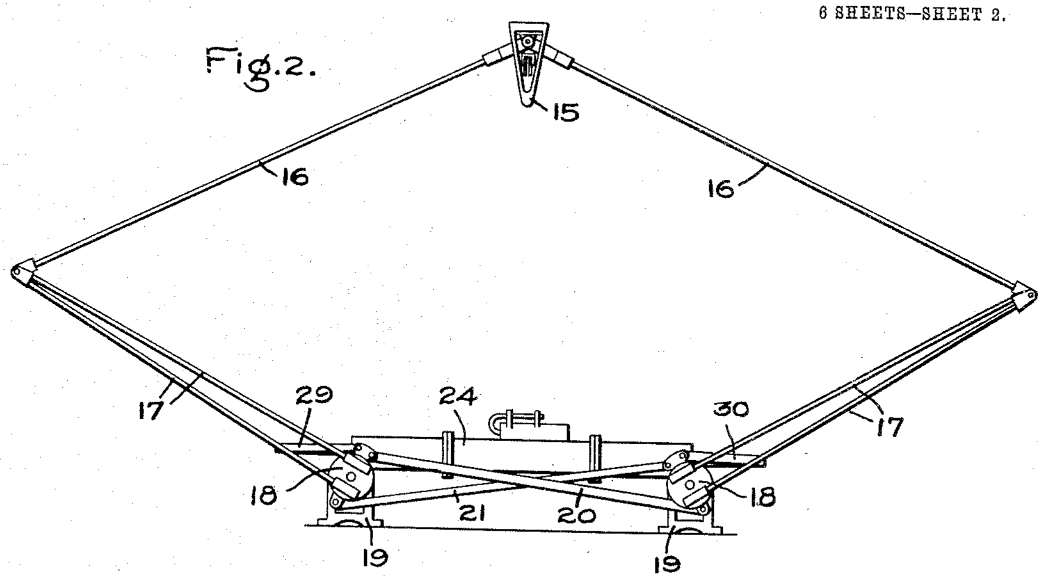


Fig. 3.

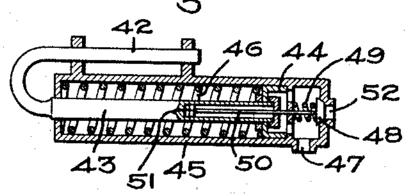


Fig. 4.

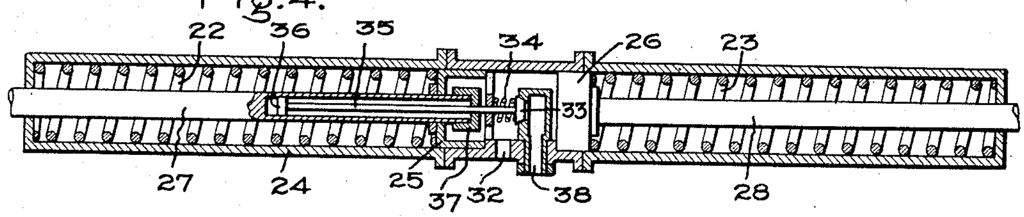
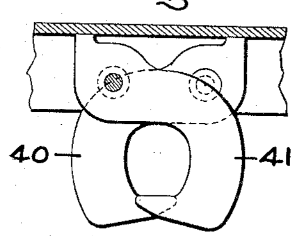


Fig. 5.



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6 SHEETS—SHEET 3.

Fig. 7.

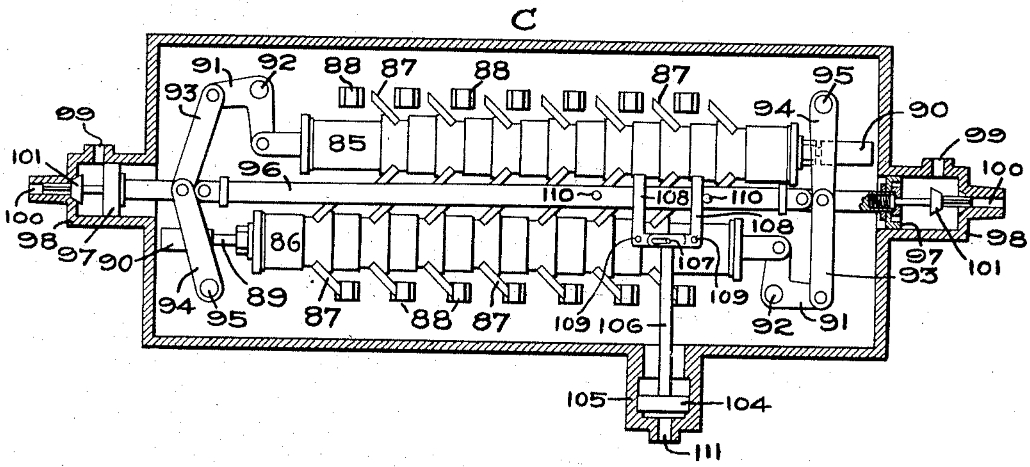
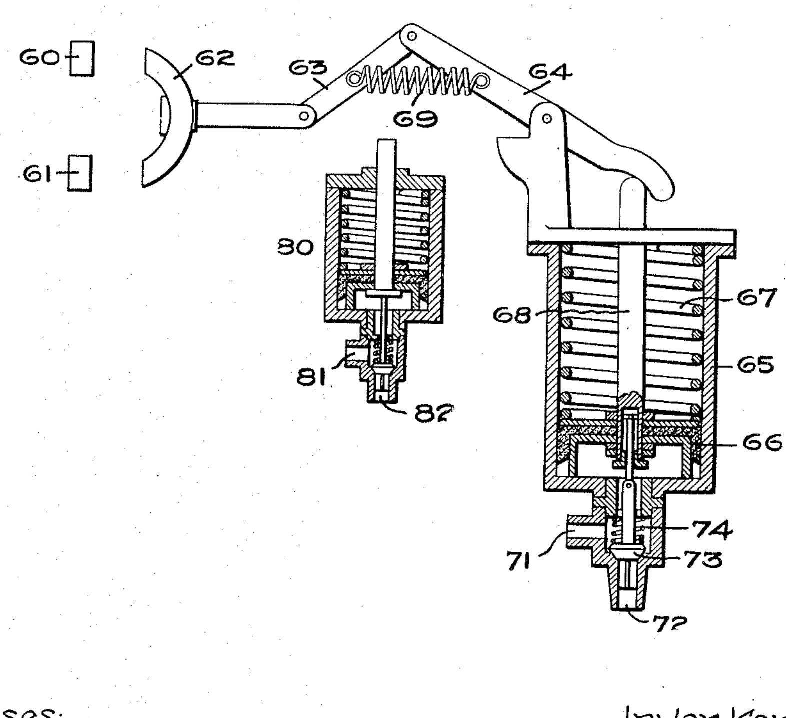


Fig. 6.



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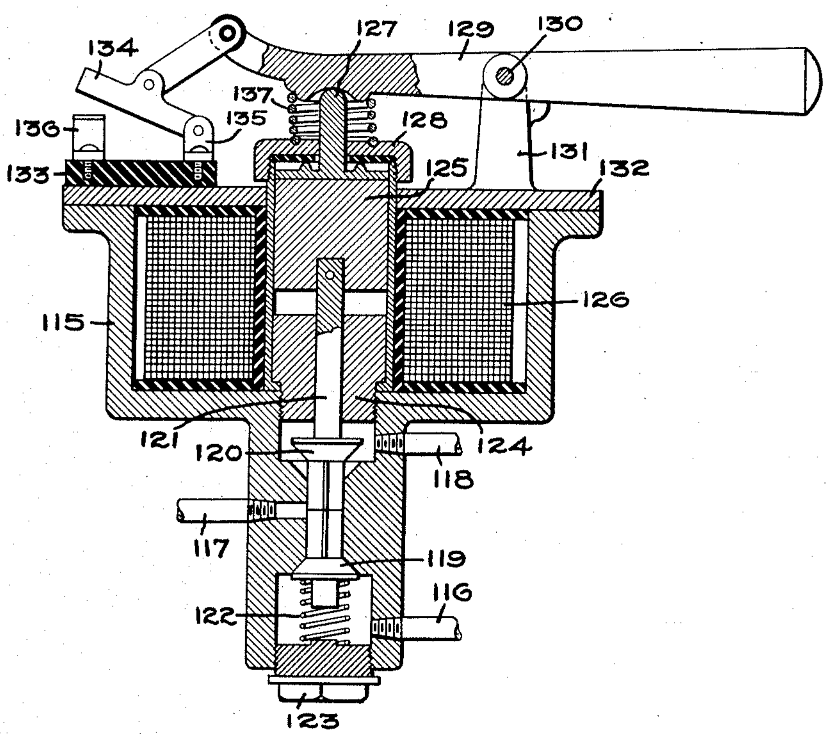
6 SHEETS—SHEET 4.

Fig.8.



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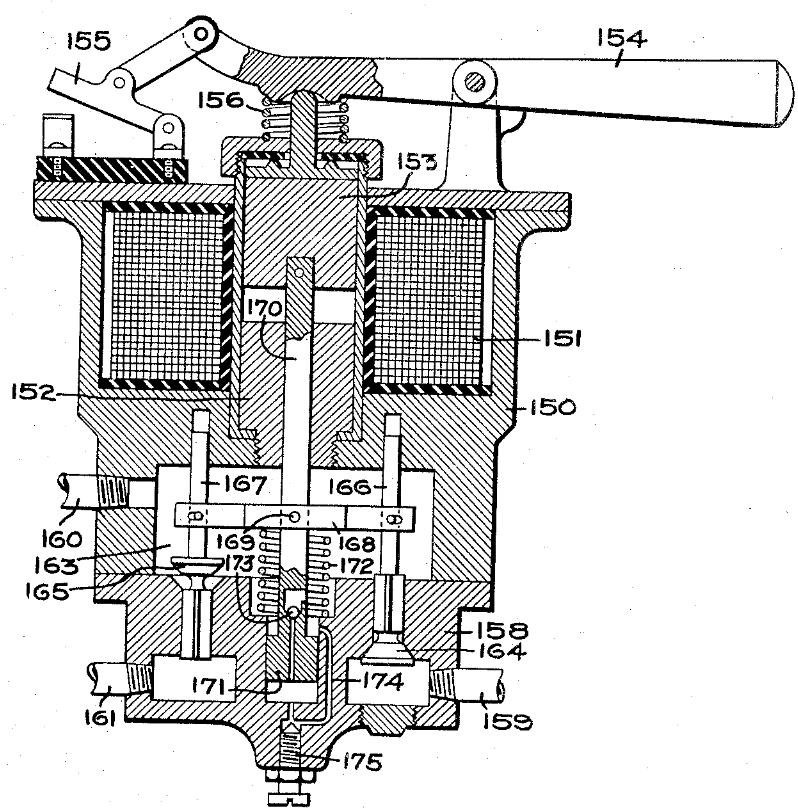
6 SHEETS—SHEET 5.

Fig 9.



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946,753.

Patented Jan. 18, 1910.

6 SHEETS—SHEET 6

Fig. 11.

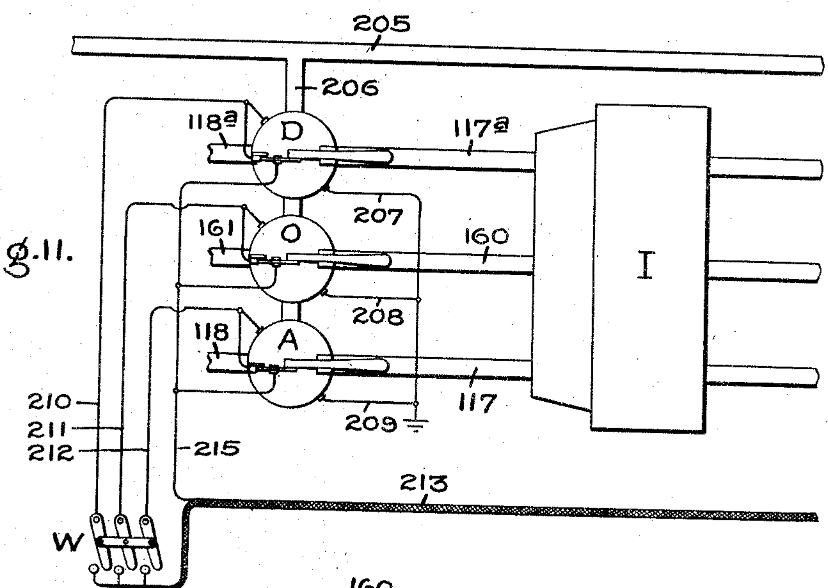
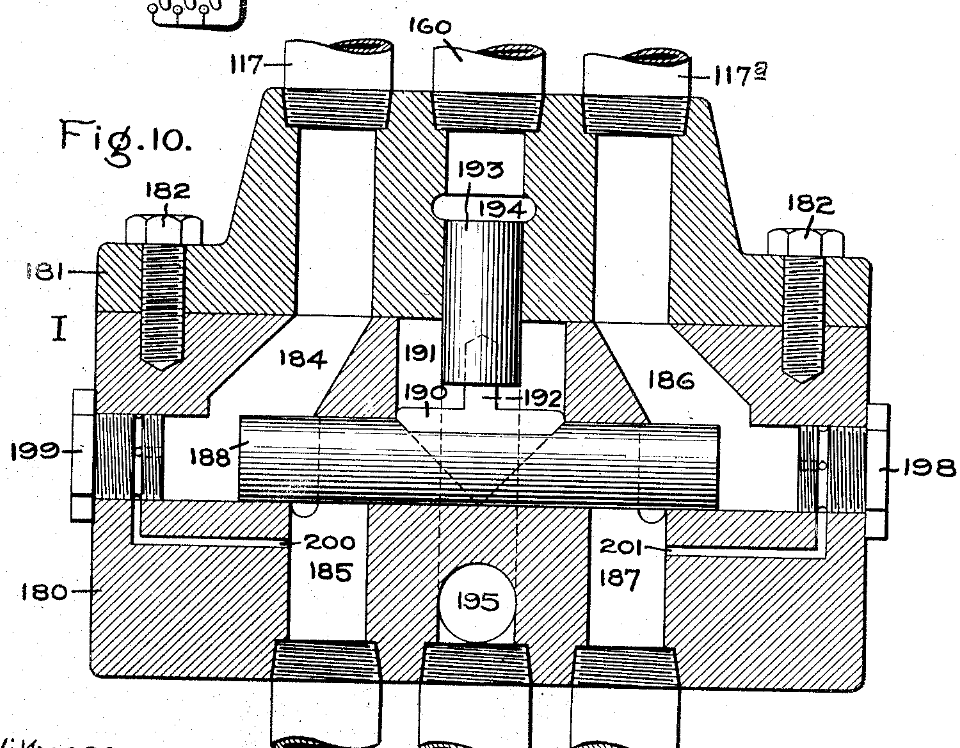


Fig. 10.



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UNITED STATES PATENT OFFICE.

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ELECTRIC VEHICLE.

946,753. Specification of Letters Patent. **Patented Jan. 18, 1910.**

Application filed September 11, 1909. Serial No. 517,304.

To all whom it may concern:

Be it known that I, Frank E. Case, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Vehicles, of which the following is a specification.

My invention relates to improved means for operating certain apparatus used on electrically driven cars or locomotives.

More specifically stated, it relates to the operation of the collecting devices, main switches, and, in some cases, the commutating switch used on electric vehicles, and has for its object to provide means for insuring the operation of these devices into and out of their operative positions in a certain order.

I have hereinafter shown my invention as embodied in a car or locomotive intended for operation both on alternating and direct current and adapted for use in multiple unit operation with other similar cars or locomotives.

My invention will best be understood from the following description of the particular embodiment shown in the drawings, in which—

Figure 1 is a diagrammatic illustration of certain of the apparatus used on a car or locomotive having my invention embodied therein; Fig. 2 is a side elevation of the pantograph trolley which may be used in carrying out my invention; Figs. 3, 4 and 5 are elevations, partly in section, of the latching and operating mechanisms of the pantograph trolley; Fig. 6 is a side elevation, partly in section, illustrating the operating mechanism of the main switches employed in the system; Fig. 7 is an elevation, partly in section, of the commutating switch; Fig. 8 is a side elevation, partly in section, of the valve by which the devices are caused to move to their operative positions, two of these valves being used; Fig. 9 is a side elevation, partly in section, of a valve somewhat similar to that shown in Fig. 8 but adapted for use as the governing means by which the collecting devices and their apparatus are caused to move to their inoperative positions; Fig. 10 is a sectional elevation through the interlocking valve hereinafter described; and Fig. 11 is a diagrammatic illustration of the operating valves showing particularly the arrangement of the electric circuits coöperating therewith.

Referring to Fig. 1, the motors by which the car or locomotive are driven are shown at M^1 and M^2. At K K are indicated the master controllers, located at each end of the car, by which the operator controls the operation of the motors through electromagnetically operated switches or contactors contained in box P. The control resistances are diagrammatically indicated at R. The particular equipment illustrated is intended for operation both on alternating and direct current, the alternating current being supplied from an overhead trolley wire, while the direct current may be taken from a third rail mounted along side the track in the usual manner. The overhead trolley, which may be of the pantograph type, is indicated at T, and the third rail shoe, of any suitable construction, is shown at T′. Although but one trolley and one third rail shoe are shown, a plurality of each may of course be used as is customary on electric cars and locomotives. The main transformer or compensator, used on alternating current operation, is indicated at N and is connected to the trolley T by the main switch L. The third rail shoe T′ is connected through a main switch L′ to the commutating switch C to which, also, go the leads from the taps on the compensator N. This commutating switch C serves in the usual manner to arrange the main circuits and the control circuits for operation of the motors on either alternating or direct current. The trolley T, third rail shoe T′, main switches L and L′ and the commutating switch C are all shown as operated pneumatically by compressed air drawn from a reservoir supplied by a compressor Q.

The operation of the different devices is controlled by three valves A, D and O, located at each end of the car adjacent the master controller. The valve A controls the raising of the pantograph trolley T, closing of the main switch L and throwing of the commutating switch C to its alternating current position. The valve D controls the throwing out into operative position of the shoe T′, closing of the main switch L′ and throwing of the commutating switch C to its direct current position. The valve O controls the lowering of the pantograph trolley T, the drawing in of the shoe T′, the opening of the main switches L and L′ and the movement of the commutating switch C to its mid position. Coöperating with the valves A, D and O is an interlocking valve I which requires the operator to actuate the valve O between operations of the valves A and D, thereby effectually preventing the operator ever throwing out the shoe T′ and closing the switch L′ while the trolley T is up and the switch L is closed, or vice versa. The valves A, D and O are provided with solenoids for operating them electrically, and contacts are provided on each valve which are closed and opened during the operation of the latter and serve to energize train wires extending to the operating coils of the corresponding valves on the other cars, thereby causing the synchronous operation of the corresponding valves on all the cars.

I will now proceed to describe the principal features of the various pieces of apparatus above referred to, and for this purpose shall refer particularly to Figs. 2 to 10, in which the details of construction are illustrated.

In Figs. 2, 3 and 4 is illustrated a pantograph trolley which may be of the well known type in which the collecting element is biased to its raised or operative position by springs and is lowered pneumatically and held in its lowered position by a latch mechanism biased to latched position and released pneumatically. The collecting element 15 of the trolley is supported by rods 16 pivotally secured to frames made up of rods 17 mounted in a well-known manner in disks 18 pivotally arranged in supporting frames 19 secured to the top of the locomotive cab or car body. The disks 18 are connected by rods 20 and 21 pivotally secured to lugs projecting from the disks, these rods serving to cause the disks to rotate in unison. The trolley is biased to its raised position by means of two springs 22 and 23 located within a casing 24, the form of which is best shown in Fig. 4, said springs serving to force the pistons 25 and 26 toward one another, these pistons having rods 27 and 28 which project from the ends of the casing 24 and are connected by connecting rods 29 and 30 to lugs on the disks 18. The trolley is lowered by air pressure which, when admitted through the port 32, forces the pistons 25 and 26 apart, thereby compressing the springs 22 and 23 and forcing the rods 27 and 28 outwardly and, through the medium of the connecting rods 29 and 30, causing rotation of the disks 18 and consequent lowering of the trolley. Located within the chamber in the casing 24 between the pistons 25 and 26, is an exhaust valve 33 biased to its closed position by a spring 34 located between the movable element of the valve and a web extending across the inside of the casing 24, as clearly shown in Fig. 4. To the movable member of the valve 33 is attached a rod 35 having a head 36 thereon which moves in a hole in the piston rod 27. The length of the rod 35 and the length of the hole in the piston 27 is such that, when the piston 25 is forced to the left to the position corresponding to the lowered position of the trolley, the head 36 on the rod 35 will be engaged by the cap 37 on the inner end of the rod 27 and the valve 33 will be opened, thereby allowing the compressed air entering the casing 24 to pass out through the exhaust port 38. The trolley is held in its lowered position by means of latch members 40 and 41, shown in Fig. 5, pivotally secured to the underside of the collecting element proper. These latch members 40 and 41, which may be of the well-known form shown, coöperate with a horizontal rod 42. When the trolley is lowered the latched members 40 and 41 strike the top of the rod 42 and open and close again with their toes below said rod.

As clearly shown in Fig. 3, the rod 42 is carried by a piston rod 43 extending from a piston 44 located within a cylindrical casing 45, said piston 44 being biased in one direction by a spring 46 located between it and the end of the casing 45. The latch is released by the admission, through the port 47, of compressed air which forces the piston 44 to the left and moves the rod 42 longitudinally out of engagement with the latch members 40 and 41, the spring 46 being compressed during this operation. The end of the casing 45 is provided with a valve 48 biased to a closed position by a spring 49, this valve being opened in the same manner as is the valve 33 of Fig. 4; that is, a rod 50 having a head 51 is located within the piston 43 and is moved by it when the piston 44 reaches its extreme left position according to Fig. 3. From the construction shown in Fig. 3, it is evident that when the latching mechanism is released the compressed air entering the casing 45 through the port 47 is allowed to pass on out through the port 52.

Referring to Fig. 6, in which the essential parts of one of the line switches are shown, partly in section, the fixed contact members are indicated at 60 and 61, these being bridged by a movable contact member 62 operated through the medium of toggle levers 63 and 64. The switch is moved to its closed position by the mechanism comprising the cylinder 65 within which moves a piston 66 which is biased to the position in which it is shown by a spring 67 arranged between the top of the piston and the top of the casing 65. The piston 66 is provided with a rod 68, the upper end of which engages one end of the lever 64. As the piston 66 is moved upwardly, the toggle levers 63 and 64 are thrown into line with one another against the tension of a spring 69 and the movable contact member 62 is caused to bridge the fixed contacts 60 and 61 in a manner clear from Fig. 6. The air for operating the piston 66 enters by the port 71 which communicates directly with the space in the cylinder 65 below the piston 66. The exhaust port 72 is controlled by a valve 73 biased to a closed position by a spring 74. The valve stem of the valve 73 is connected with the piston rod 68 by a lost motion connection similar to that employed in the valve mechanisms of the pantograph trolley shown in Figs. 3 and 4 and hereinbefore described. With this arrangement, when the piston 66 has practically reached the upper limit of its travel and the line switch is closed, the valve 73 is opened and the air entering by the port 71 is allowed to pass onward through the port 72. The line switch is tripped pneumatically by means of the pressure operated device 80, shown in Fig. 6, which may be substantially the same as the pressure operated device by which said switch is closed, as will be evident from an inspection of Fig. 6. Air entering by the port 81 will force the piston of the device 80 to its upper position and lift the hinged point of the toggle levers 63 and 64, thereby allowing the spring 69 to become effective to move the contact member 62 away from the fixed contacts 60 and 61. The exhaust port 82 of the tripping device 80 is controlled by a valve in the same manner as is the exhaust port 72 of the switch closing device, this valve being opened by the piston when the latter has moved to nearly the limit of its stroke. It is evident, therefore, that air entering by the port 81, after the tripping device has operated, passes on through the port 82.

The commutating switch C is shown somewhat diagrammatically in Fig. 7 and comprises two movable contact carrying members 85 and 86, the contacts 87 of which bridge fixed contacts 88. The members 85 and 86 are supported, respectively, at one end by rods 89 which project from the ends of said members and slide within fixed journals 90; and at the other end said members 85 and 86 are pivotally supported by bell crank levers 91 pivoted at 92 on some fixed part of the commutating switch frame or casing. The members 85 and 86 are moved through the medium of the bell crank levers 91 by means of toggle levers 93 and 94, the latter being pivotally supported at 95. The toggle levers 93 and 94 at their point of connection are pivotally connected with a rod 96 provided at each end with a piston 97 adapted for movement within a cylinder 98. The admission port of each of the cylinders 98 is shown at 99 and the exhaust port at 100, the latter being controlled by a valve 101 operated from the adjacent piston 97 by a lost motion connection similar to that used in the line switches and the pantograph trolley and hereinbefore described. With this arrangement after the compressed air entering the cylinder 98 by the port 99 has moved the piston 97 almost to the limit of its travel the valve 101 opens and the air is free to pass on through the port 100. The commutating switch C is shown as provided also with means for moving the rod 96 to its mid position, thereby causing both of the members 85 and 86 to move to the position in which the contacts 87 are out of engagement with the fixed contacts 88. This mechanism comprises a piston 104 which moves within a cylinder 105, said piston having a rod 106, the end of which is connected at 107 by a pin and slot connection with two bell crank levers 108 pivoted at 109 and coöperating with pins 110 projecting from the rod 96. If compressed air is allowed to enter the cylinder 105 by the port 111 the piston 104 is moved inwardly and the consequent longitudinal movement of the rod 106 causes the bell crank levers 108 to engage one or the other of the pins 110 and move the rod 96 to its mid position which corresponds to the position in which the contacts 87 and 88 are all out of engagement with one another.

In Fig. 8 is shown one form of motorman's valve, A or D, which may be employed in carrying out my invention. This valve, as explained above, controls the admission of air to the system for the operation of the various devices either to the alternating or direct current positions. Referring to Fig. 8, the body casting 115 may be of the form shown. The valve chamber within the casting 115 is connected to the reservoir by the pipe 116, to the system to be operated by the pipe 117, while the exhaust from the valve chamber is through the pipe 118. The movable valve member 119 controls the opening in the valve chamber between the pipes 116 and 117, and the valve member 120 controls the passage between the pipes 117 and 118, these valve members 119 and 120 being carried by the same valve stem 121 and biased to the position shown by a spring 122 located between the members 119 and a plug 123 screwed into the bottom of the casting 115, as clearly shown in the drawing. The valve stem 121, which may be of brass, passes freely through an iron core 124 arranged as shown, and is connected at its upper end with a movable iron core 125 arranged for sliding movement within the field of the coil 126. The core 125 has a lug 127 projecting upwardly from it through a cap 128 arranged as shown, or in any other suitable manner. This lug 127 is engaged by a handle 129 pivoted at 130 in lugs 131 which extend upwardly from the cap 132 secured to the top of the casting 115. Mounted on the cap 132 on a piece of insulation 133, is a small switch comprising a movable member 134 pivoted in a bracket 135 secured to the insulation 133, said movable member 134 being arranged to engage a fixed contact clip 136. A spring 137 located between the cap 125 and the handle 129 biases the handle and switch member 134 to the position shown in Fig. 8. With this valve, when the operator lifts the outer end of the handle 129 and depresses the lug 127, the core 125 is forced downwardly, thereby through the medium of the valve stem 121 opening the valve 119 and closing the valve 120; the switch member 134 is at the same time forced into engagement with the contact 136 and the electrical circuit passing through this switch is completed. As will be hereinatfer explained, closing of this switch causes the energization of the magnet coil 126, both of the corresponding valve A or D and of the valves A or D on the other cars or locomotives connected together in a train for multiple unit operation. Energization of the magnet coil 126 causes the core 125 to move downwardly in those valves not operated manually by the operator, with the consequent closing of the valve 120 and opening of the valve 119. When the operator releases the lever 129 the spring 137 forces it to the position shown, thereby moving the switch member 134 out of engagement with the fixed member 136 with the consequent interruption of the current in the coil 126 of each of the valves A or D on all of the cars or locomotives of the train. The core 125 and the valves 120 and 119 are then forced to the position shown in Fig. 8 by the spring 122.

The valve O, before referred to, which controls the lowering of the pantograph trolley T, the drawing in of the third rail shoe T', the opening of the main switches L and L' and the movement of the commutating switch C to its mid position is illustrated in Fig. 9. The main casting 150 may be of the form shown. The magnet coil 151, fixed core 152, movable core 153, lever handle 154, switch 155, and spring 156 may be arranged exactly as in the case of the valve previously described and shown in Fig. 8, as will be apparent from an inspection of Fig. 9. The valve seats are located in a casting 158, which may be bolted to the bottom of the casting 150. The pipe leading from the reservoir is shown at 159, that leading to the system to be controlled at 160, and that through which the exhaust escapes at 161. The pipe 160 communicates with a chamber 163 within the casting 150 and this chamber communicates with the reservoir pipe 159 and the exhaust pipe 161, respectively, through valves 164 and 165. The valve 164 is provided with a valve stem 166 and the valve 165 with a valve stem 167, said stems being slidingly arranged in holes in the casting 150, as shown in the drawings. The valve stems 166 and 167 are connected together by a lever 168 pivotally connected at 169 to the rod 170 which is connected to the movable core 153. At its lower end the rod 170 is provided with an enlargement 171 which serves as the plunger of a dash-pot of which the casting 158 is the cylinder member. This dash-pot serves to retard the upward movement only of the rod 170 which is biased in an upward direction by the spring 172 located between the casting 158 and the lever 168, as shown in the drawing. The enlarged head 171 has a passage through it as shown, controlled by a ball valve 173 which may be of well-known form, which allows air to pass freely from below the head 171 to above the same but prevents passage of air in the opposite direction, thereby limiting the retarding effect of the dash-pot to the upward movement of the rod 170. A by-pass 174 around the piston 171 allows air to pass from above the piston to the space below it, the rate at which air is so admitted being controlled by a screw 175 which forms a valve in a well-known manner. When the movable core 153 and its attached rod 170 are forced downwardly, either by the movement of the lever 154 by the hand of the operator, or by the energization of the coil 151, the valve 165 is first closed by the rocking of the lever 168 around the pivotal connection between said lever and the valve stem 166 and after the valve 165 has been seated the valve 164 is opened by the rotation of the lever around the pivotal connection between the lever and the valve stem 167. Air is then free to pass from the reservoir pipe 159 through the valve 164 and the chamber 163 to the train pipe 160. When the magnet coil 151 is deënergized, and the movable core 153 and the rod 170 are free to move under the influence of the spring 172, subject to the retarding effect of the dash-pot, hereinbefore described, the valve 164 is first closed and the valve 165 is then opened by the rocking of the lever 168, first around its pivotal connection with the valve stem 167 and then around the pivotal connection with the valve stem 166. The train pipe 160 is then connected through the chamber 163 and the valve 165 to the exhaust pipe 161.

The interlocking valve I, hereinbefore referred to, is shown in cross-section in Fig. 10. The casing of this valve is shown as comprising a body casting 180 and a cap 181 secured together by bolts 182. The form and arrangement of the passages through the castings 180 and 181 will be evident from the drawing and from the mode of operation of the valve which is hereinafter set forth. The flow of air from the passage 184 to passage 185 and from passage 186 to passage 187 is controlled by a cylinder 188 slidingly arranged in a hole through the casting 180, this cylinder 188 being of such length that in its mid position, as shown, it closes both of the openings between the passages 184 and 185, and between the passages 186 and 187. A V-shaped slot in the middle of the cylinder 188 is engaged by a wedge-shaped member 190 which is capable of vertical sliding movement within a chamber 191. This wedge-shaped member 190 is connected through a lug 192 with the cylinder 193 arranged for vertical sliding movement in a vertical hole in the casting 181, as will be evident from the drawing. This cylinder 193 when in the position shown uncovers a port 194 of the passage 195 through which air is free to pass from the middle pipe 160 to the pipe connected to the middle opening in the bottom of the casting 180. When the cylinder 188 is moved longitudinally in either direction, the wedge-shaped member 190 is forced upwardly and the cylinder 193 is raised, thereby closing the port 194. The cylinder 188 when moved to the right uncovers an opening from the passage 184 to passage 185 and when moved to the left opens a passage 186 to passage 187. The ends of the cylinder 188 move into the cylindrical holes closed by the screw plugs 198 and 199, passages 200 and 201 being provided as shown to allow the air pocketed by the ends of the cylinder 188 to escape into the passages 185 and 187.

The operation of the interlocking valve is as follows: Air being admitted to either the left or right hand pipe 117 and 117ª, respectively, the cylinder 188 is forced in one direction or the other, thereby connecting the passages 184 and 185 or the passages 186 or 187. At the same time, movement of the cylinder 188 causes the cylinder 193 to be forced upwardly in the manner hereinbefore explained, thereby closing the central passage through the interlocking valve. Since, assuming that the cylinder has been moved to the right by admission of air to the left hand pipe 117, the right hand end of the cylinder 188 has entered the hole closed by the plug 198, admission of air to the right hand pipe 117ª will not act to force the cylinder 188 to the left since the air cannot get at the right hand end of the cylinder and become effective upon it. It is, therefore, necessary for the operator after the cylinder 188 has been forced to one side or the other, to admit air to the middle pipe 160 in order to force the cylinder 193 downwardly and by the wedge action of the member 190, thereby to bring the cylinder 188 to its mid position. It is evident that the interlocking valve I, interposed in the three operating pipes of the system, forces the operator to operate his middle valve O between the operation of the other valves A and D. The utility of this arrangement will be hereinafter pointed out.

Fig. 11 shows in a diagrammatic way the electrical connections between the operating valves A, O, D and the train wires which connect the corresponding cars or locomotives of the train. In this figure the pipe leading from the reservoir is shown at 205, this being connected to the valves D, O and A by a branch pipe 206. The interlocking valve I is connected with the valves A, O and D by the pipes 117, 160 and 117ª corresponding to the pipes similarly characterized in Figs. 8 and 9. The exhaust outlets of the valves A, O and D are indicated at 118, 161 and 118ª, respectively, which also correspond to Figs. 8 and 9. One terminal of the coils 115 of the valves A and D and the coil 151 of the valve O are connected to ground by the wires 207, 208 and 209, respectively, and the other terminals are connected through wires 210, 211, 212 and the switch W to three train wires which form part of the cable 213 which extends throughout the train. These train wires are connected, respectively, to the coils of corresponding valves A, O and D on all the cars or locomotives of the train. The switch which is mounted on the top of each valve A, O and D, and is operated by the valve handle, serves to connect the wire 212 or 211 or 210 with the wire 215 which forms part of the cable 213 and leads to the commutating switch where it is furnished with current whether the commutating switch be in its A. C. or its D. C. position. With this arrangement it is evident that operation of either of the valves A or D results in the energization of the corresponding train wire which is connected to the positive side of the coils of all of the corresponding valves on the various cars of the train.

The operation of the system as a whole, best shown in Fig. 1, is as follows: As shown, the apparatus on the car or locomotive is arranged for operation on alternating current, that is, its trolley T is in engagement with the trolley wire, the A. C. line switch L is closed and the commutating switch C is supposed to be in its A. C. position. At this time the third rail shoe T′ is in its inoperative position and the D. C. line switch L′ is open. If the operator desires to arrange the apparatus for D. C. operation it is necessary that he operate the valve O, whereupon the interlocking valve I will be thrown to its mid position, as hereinbefore explained, and air will pass through the pipe 220 to the train pipe 221 which, in the particular arrangement shown, is provided with couplers which enable it to be connected with corresponding pipes on the other cars of the train. From the pipe 221 on each car or locomotive, air passes through the pipe 222 into the tripping cylinder 80 of the A. C. main switch L, thereby causing said switch to open, after which air passes on through the pipe 223 to the casing 24 within which it does work by forcing apart the pistons 25 and 26, thereby lowering the trolley T in a manner which has been explained in connection with Figs. 2 to 5; when the trolley T has been lowered and latched, air passes on through the pipes 224 and 225 to the port 111 (see Fig. 7) of the commutating switch C, thereby throwing this switch to its mid position.

The foregoing operations will take place practically simultaneously on all of the locomotives or cars of the train not only because air will pass from the first locomotive through the pipe 221 to all of the other locomotives, but also because the operation of the valve O on one locomotive will cause simultaneous operation of the valves O on the other locomotives through the electrical connections hereinbefore described. The dash-pot within the valve O renders the latter slow enough in returning to normal position, to give the trolley T time to completely pull down and latch and the commutating switch C time to throw to its mid position after the opening of the A. C. line switch L which, of course, interrupts the current to all of the control circuits of the car including the magnet coils of the valves O. If the operator now operates the valve D the interlocking valve I is thrown to the position in which air is free to pass from the reservoir through the valve D interlocking valve I and the pipe 228 through the pipe 229 into the D. C. operating cylinder 98 of the commutating switch C, thereby throwing said switch to its D. C. position; air then passes on through the pipe 230 to the operating cylinder of the third rail shoe T′, thereby causing the latter to be thrown to its operative position; air then passes on through pipe 231 to operating cylinder of the D. C. main switch L′ which is thereupon closed in a manner hereinbefore explained in connection with Fig. 6. The apparatus is now in its D. C. position and current can be taken from the third rail through the third rail shoe T′, the D. C. main switch L′ and the commutating switch C to the motor and the control circuits of the car. If the operator desires to again arrange the apparatus for A. C. operation, it is necessary that he first operate the valve O, whereupon air admitted to the pipe 221 will pass through the pipe 235 to the tripping cylinder of the D. C. switch L′, thence through pipe 236 to the tripping cylinder of the third rail shoe T′ and then through the pipes 237 and 225 to the commutating switch C which is thereupon thrown to its mid position. Closing of the valve A will then admit air to the pipe 239 from which it will pass through pipe 240 to the A. C. operating cylinder 98 of the commutating switch C, thence on through pipe 241 to the tripping cylinder 45 of the trolley T, and then on through pipe 242 to the operating cylinder 65 of the A. C. main switch L, thereby throwing the commutating switch C to its A. C. position, raising the trolley T and closing the switch L.

From the foregoing, it will be evident that the operator is required to always actuate the valve O in changing the apparatus from the A. C. to the D. C. position or vice versa. It is, therefore, impossible for him to throw both the trolley T and the third rail shoe T′ into their operative positions at the same time. It is also evident that the circuits from the current collectors to the car are always closed and opened by the main switches L and L′, thereby insuring that the arcing all takes place at these switches which can be provided with proper devices for handling the arcs safely. The valve O furthermore serves as an emergency device by which the operator can at any time disconnect the cars from the conductors which normally supply current to them, and it is to be noted that this emergency operation takes place, independently of the fact of whether current is being supplied to the cars or not, as long as compressed air is available in the reservoir of one of the cars or locomotives of the train, the reservoirs being all connected together by a train pipe 245.

I have in this application shown but one embodiment of my invention. I wish it understood, however, that I realize it may be modified in many respects by those skilled in this art without departing from the spirit of the invention. The particular construction and arrangement of apparatus herein shown is intended merely to indicate to one skilled in this art how my invention can be embodied in a practical operative system.

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

1. In an electrically driven car, collecting devices, switches for connecting said collecting devices to the car circuits, means for moving each collecting device into its collecting position and then closing the corresponding switch, means for opening each switch and then moving the corresponding collecting device out of collecting position, and means for insuring the operation of said collecting devices and switches in this order.

2. In an electrically driven car, pneumatically operated collecting devices, pneumatically operated switches for connecting said collecting devices to the car circuits, a valve for controlling the moving of each collecting device into its collecting position and then closing the corresponding switch, a valve for controlling the opening of each switch and then moving the corresponding collecting

device out of collecting position, and means for insuring the operation of said collecting devices and switches in this order.

3. In an electrically driven car, collecting devices, a switch for connecting said collecting devices to the car circuits, pneumatically controlled means for moving said collecting devices into and out of collecting position, pneumatically controlled means for closing and opening said switches, a valve and connections for controlling the successive movement of each collecting device into collecting position and closing the corresponding switch, and another valve and connections for controlling the successive opening of said switches and movement of said collecting devices out of collecting position.

4. In an electrically driven car adapted for operation on currents differing in character, independent collecting devices for the currents of different character, switches for connecting said collecting devices to the car circuits, means for moving each collecting device into its collecting position and then closing the corresponding switch, means for opening each switch and then moving the corresponding collecting device out of collecting position, and means for preventing movement of two collecting devices for currents differing in character into collecting position at the same time.

5. In an electrically driven car adapted for operation on currents differing in character, independent collecting devices for the currents of different character, switches for connecting said collecting devices to the car circuits, pneumatically controlled means for moving said collecting devices into and out of collecting position, pneumatically controlled means for closing and opening said switches, a valve and connections for controlling the successive movement of each collecting device into collecting position and closing the corresponding switch, and another valve and connections controlling the successive opening of all of said switches and movement of all of said collecting devices out of collecting position.

6. In an electrically driven car adapted for operation on currents differing in character, independent collecting devices for the currents of different character, switches for connecting said collecting devices to the car circuits, pneumatically controlled means for moving said collecting devices into and out of collecting position, pneumatically controlled means for closing and opening said switches, a valve and connections for controlling the successive movement of each collecting device into collecting position and closing the corresponding switch, another valve and connections controlling the successive opening of all of said switches and movement of all of said collecting devices out of collecting position, and means coöperating with said valves and connections for rendering each valve which controls the collecting device and switch for currents of one character inoperative after the operation of the valve controlling the collecting device switch for currents of the other character, until the valve has been operated which controls the opening of the switches and the movement of the collecting devices out of operative position.

7. In an electrically driven car adapted for operation on currents differing in character, independent collecting devices for the currents of different character, switches for connecting said collecting devices to the car circuits, a commutating switch for regulating connections on the car according as the latter is to be operated on current of one character or another, means for throwing the commutating switch to one operative position or the other and then moving the corresponding collecting device into its collecting position and closing the corresponding switch, means for opening each switch and then moving the corresponding collecting device out of collecting position, and means for preventing movement of two collecting devices for currents differing in character into collecting position at the same time.

8. In an electrically driven car adapted for operation on currents differing in character, independent collecting devices for the currents of different character, switches for connecting said collecting devices to the car circuits, a commutating switch for regulating connections on the car according as the latter is to be operated upon current of one character or the other, pneumatically controlled means for moving said collecting devices into and out of collecting position, pneumatically controlled means for closing and opening said switches, pneumatically controlled means for throwing said commutating switch to one operative position or the other, valves and connections for controlling the successive movement of the commutating switch to one operative position or the other and the corresponding collecting device into collecting position and closing the corresponding switch, and another valve and connections controlling successive opening of all of said switches and movement of all of said collecting devices out of collecting position and movement of said commutating switch to its mid position.

9. In an electrically driven car, pneumatically operated collecting devices, pneumatically operated switches for connecting said collecting devices to the car circuits, a manually operated valve for controlling the moving of each collecting device into its collecting position and then closing the corresponding switch, a manually operated valve for controlling the opening of each switch and then moving the corresponding

collecting device out of collecting position, a magnet coöperating with each valve and capable of operating the same, train wires arranged to connect the magnets of corresponding valves on all the cars of the train, and a switch coöperating with each valve and arranged to control the energization of the train wire whereby the collecting devices and switches on all the cars of the train may be controlled from one or any car.

In witness whereof, I have hereunto set my hand this 10th day of September, 1909.

FRANK E. CASE.

Witnesses:
BENJAMIN B. HULL,
G. B. CARD.