No. 793,827. PATENTED JULY 4, 1905.

H. M. DAVENPORT.

AUTOMATIC SIGNAL AND TRAIN CONTROL SYSTEM.

APPLICATION FILED SEPT. 3, 1904.

10 SHEETS—SHEET 1.

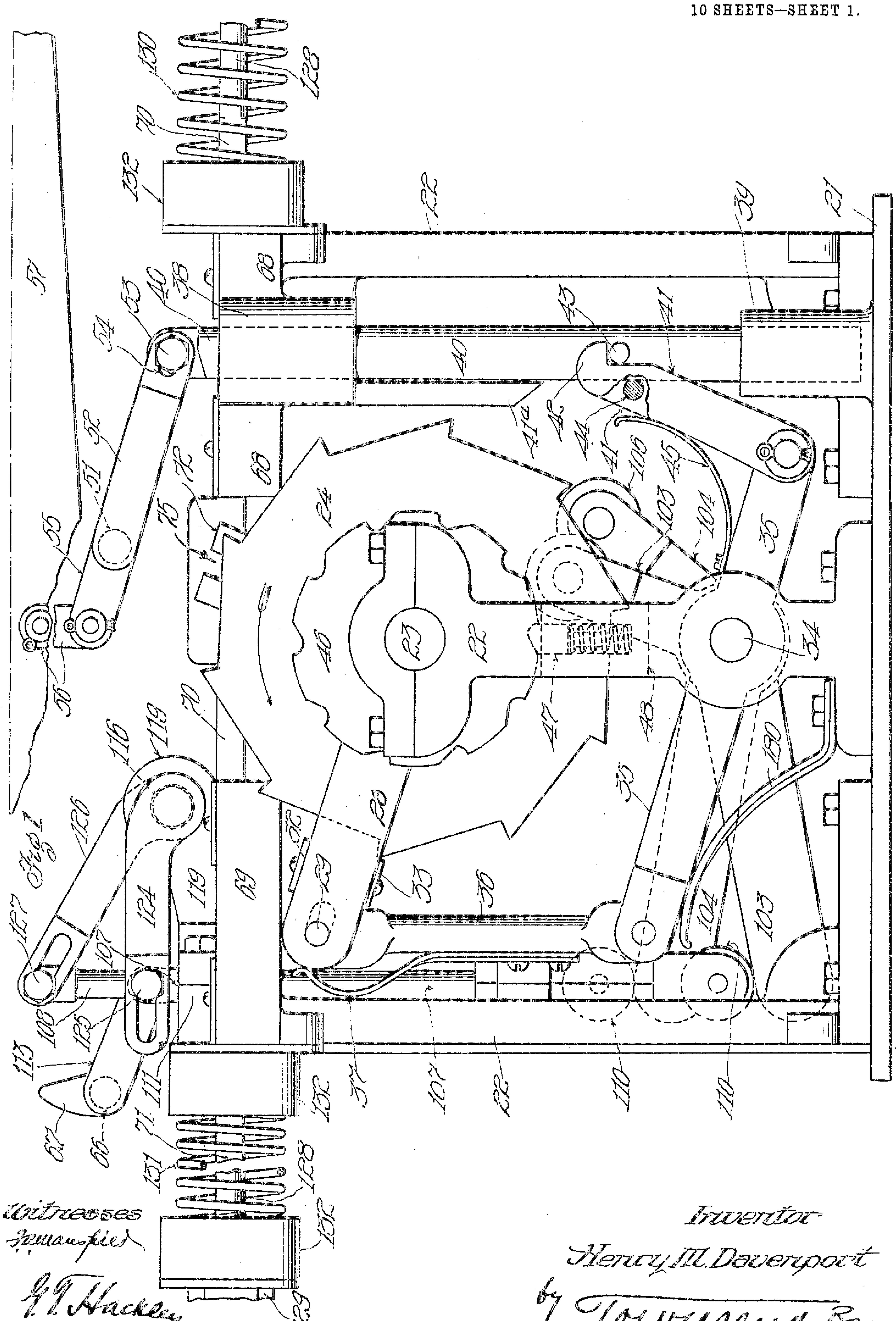

Fig. 1

Witnesses

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10 SHEETS—SHEET 2.

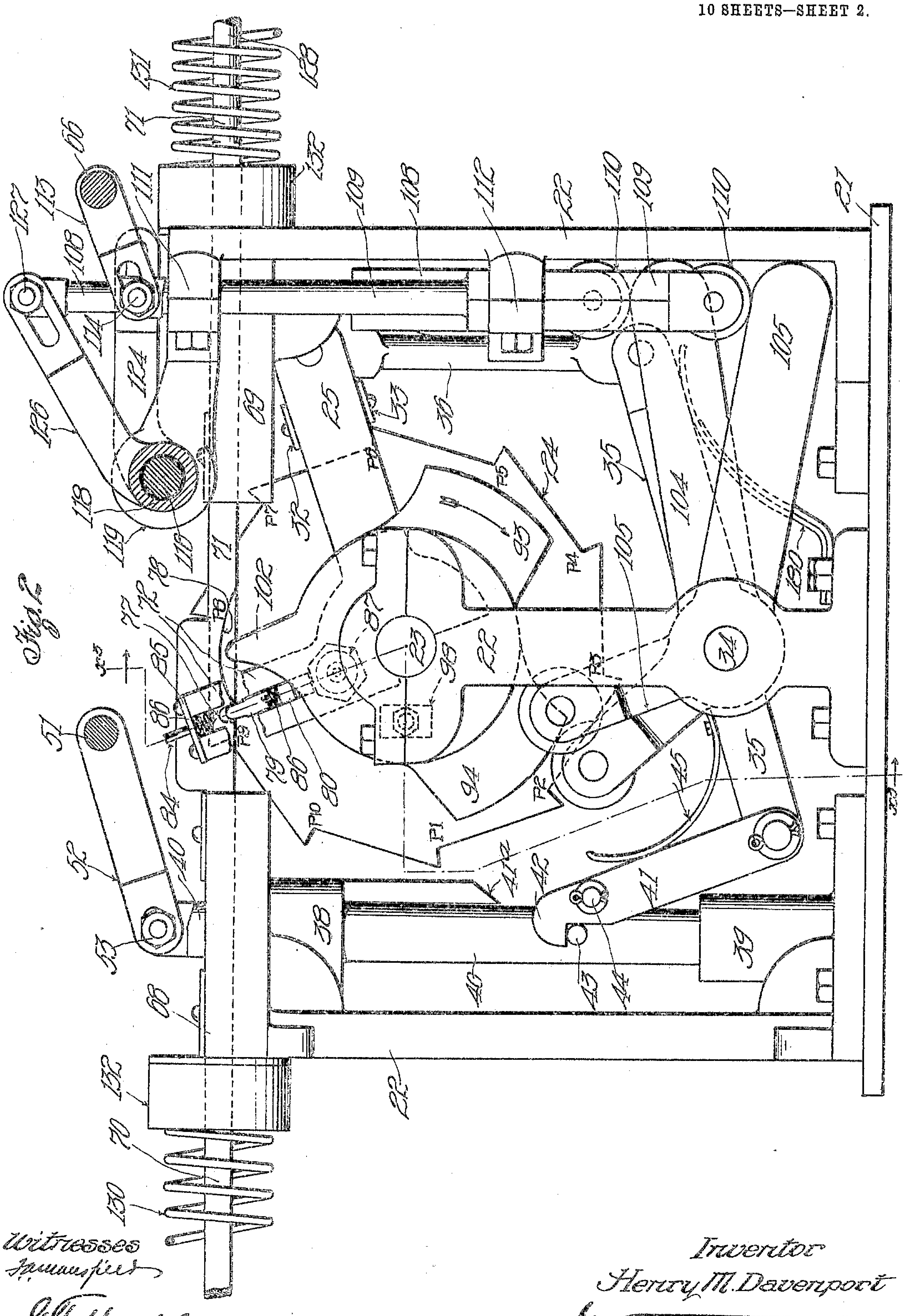

Fig. 2.

Witnesses

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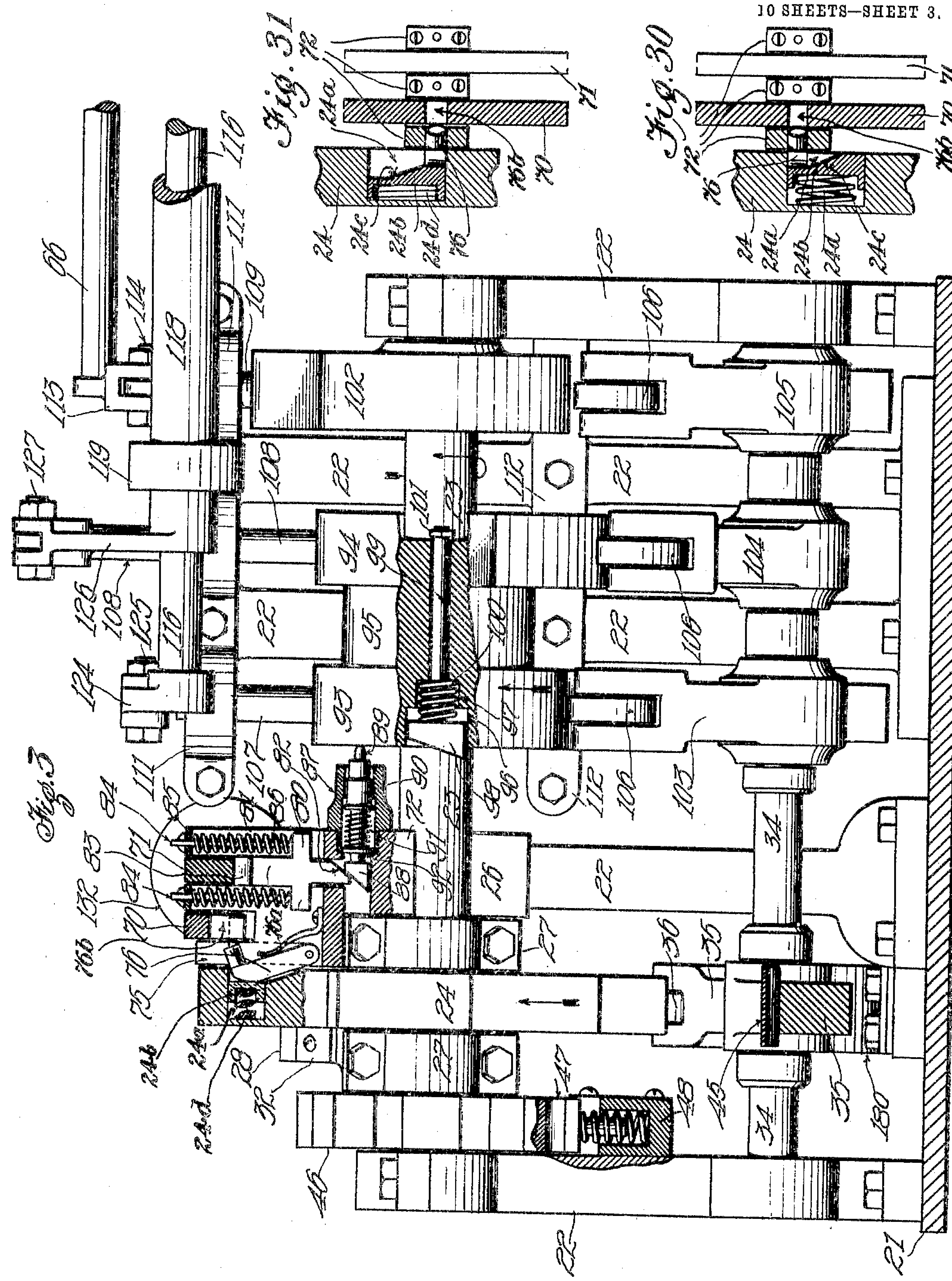
10 SHEETS—SHEET 3.



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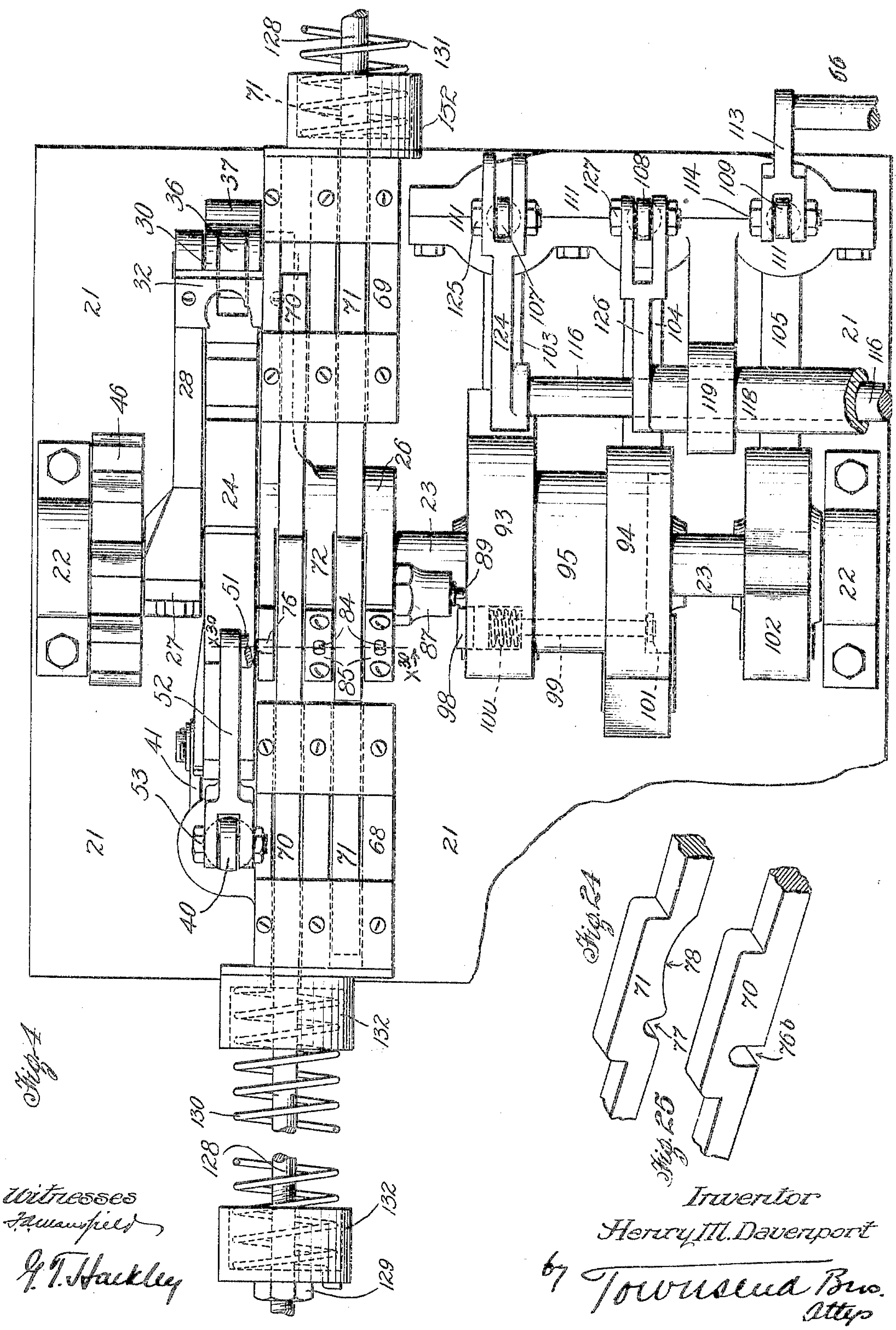

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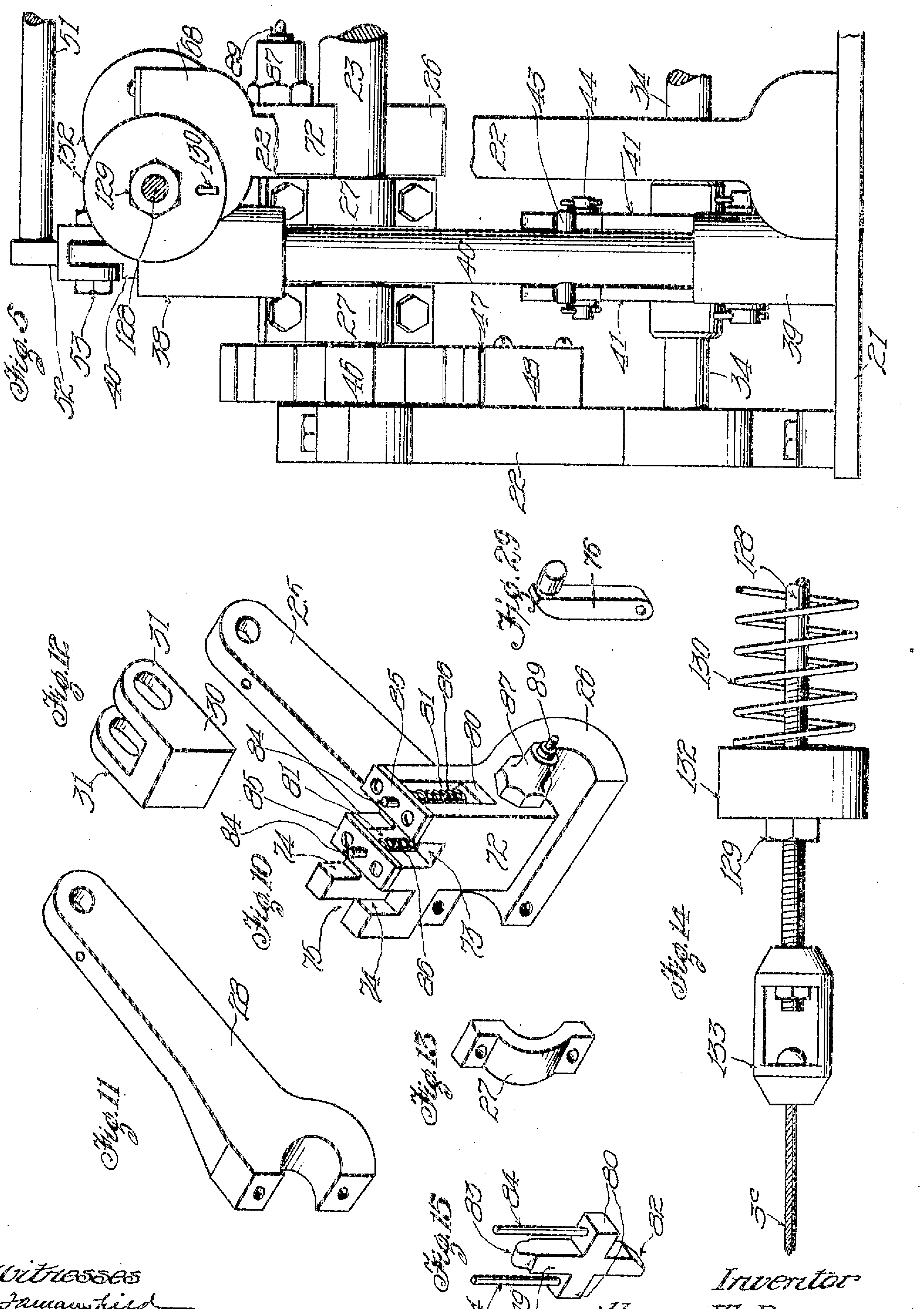

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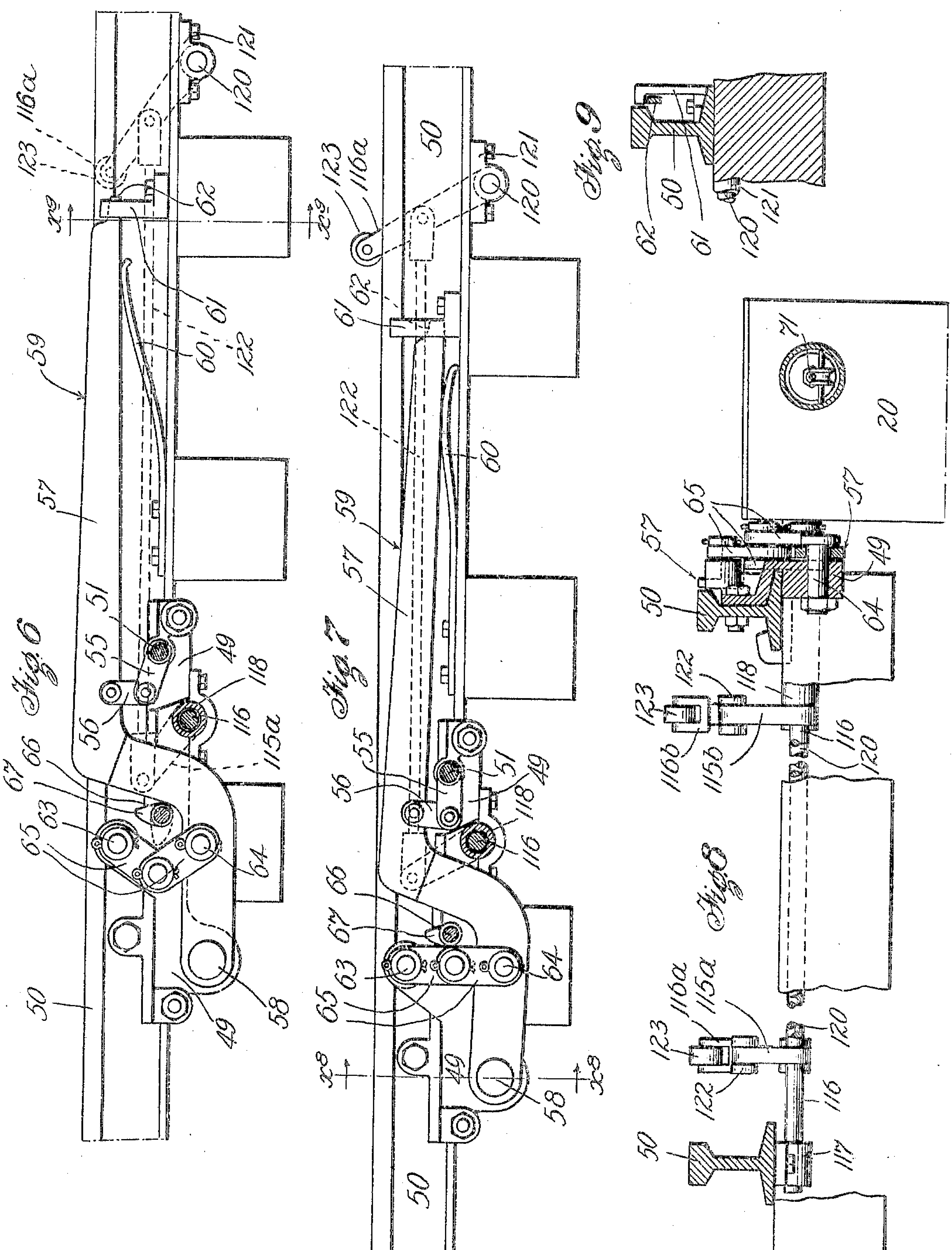
10 SHEETS—SHEET 6.



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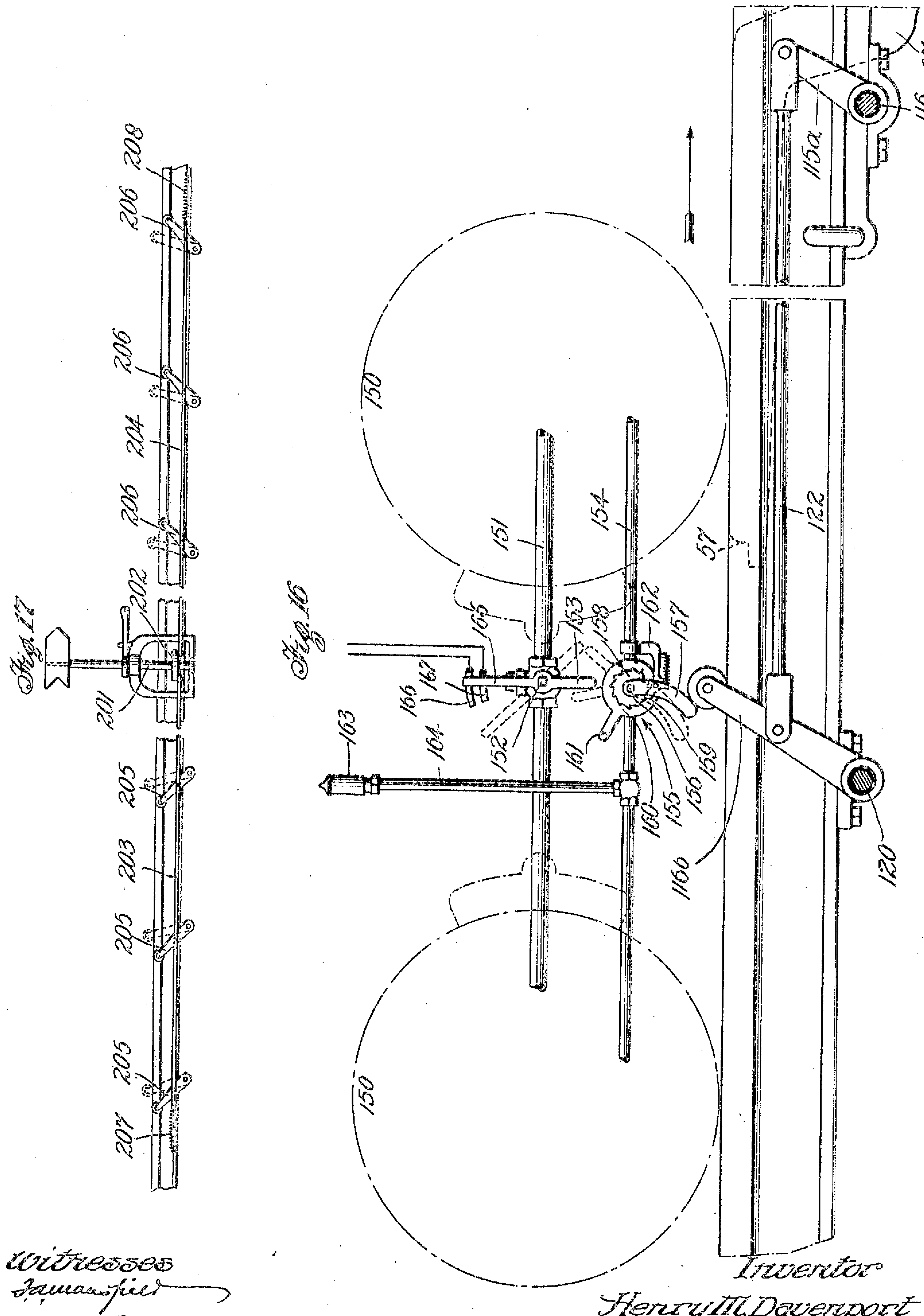
10 SHEETS—SHEET 7.



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10 SHEETS—SHEET 8.

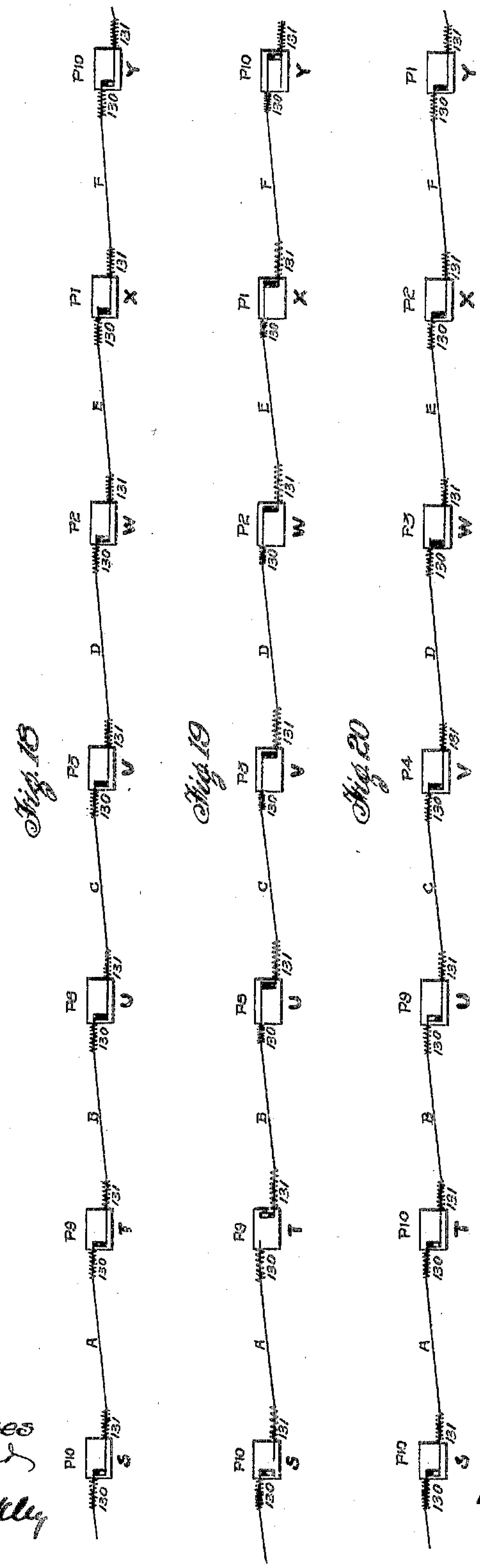

Fig. 18
Fig. 19
Fig. 20

Witnesses
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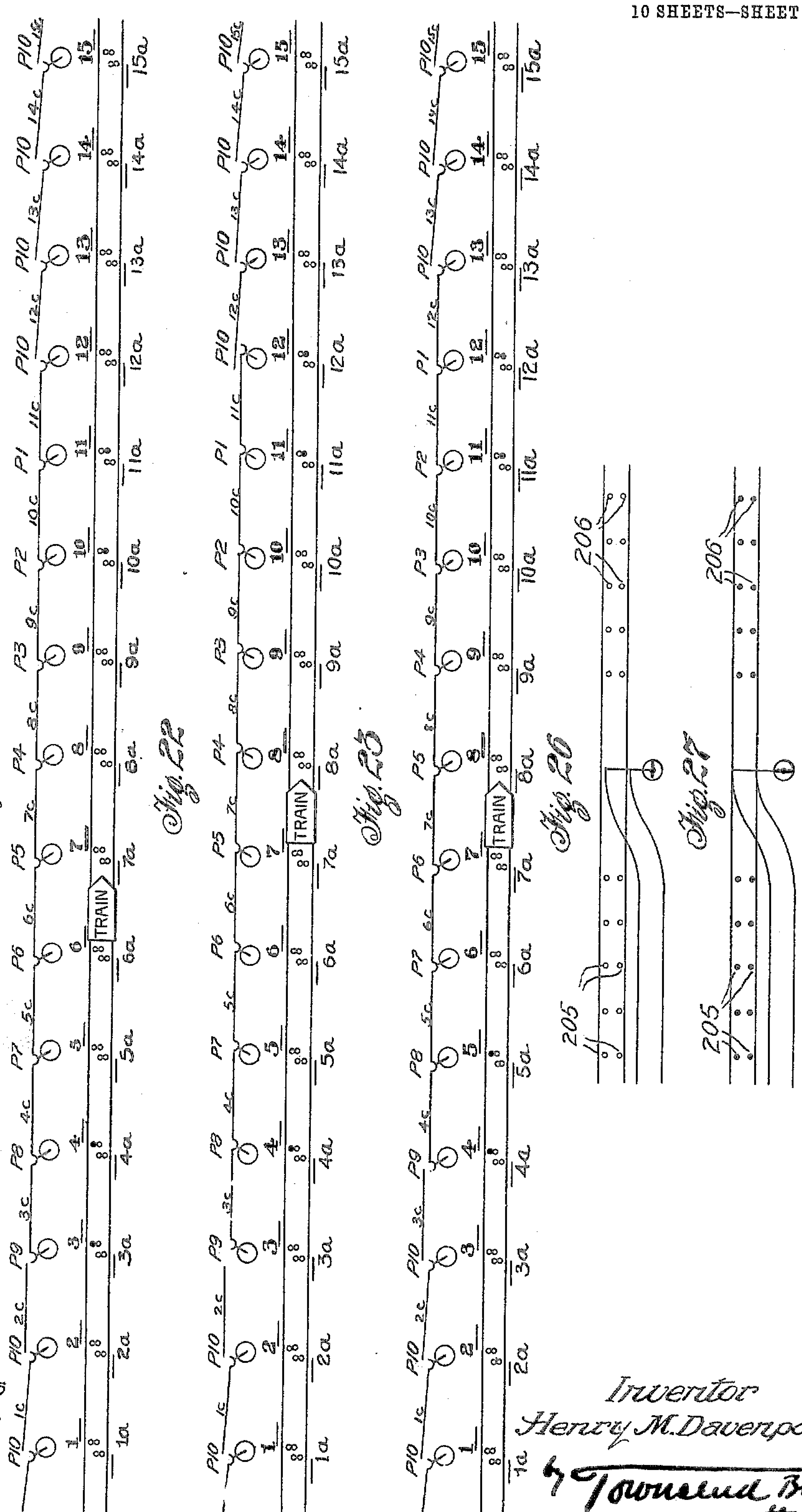
10 SHEETS—SHEET 9.



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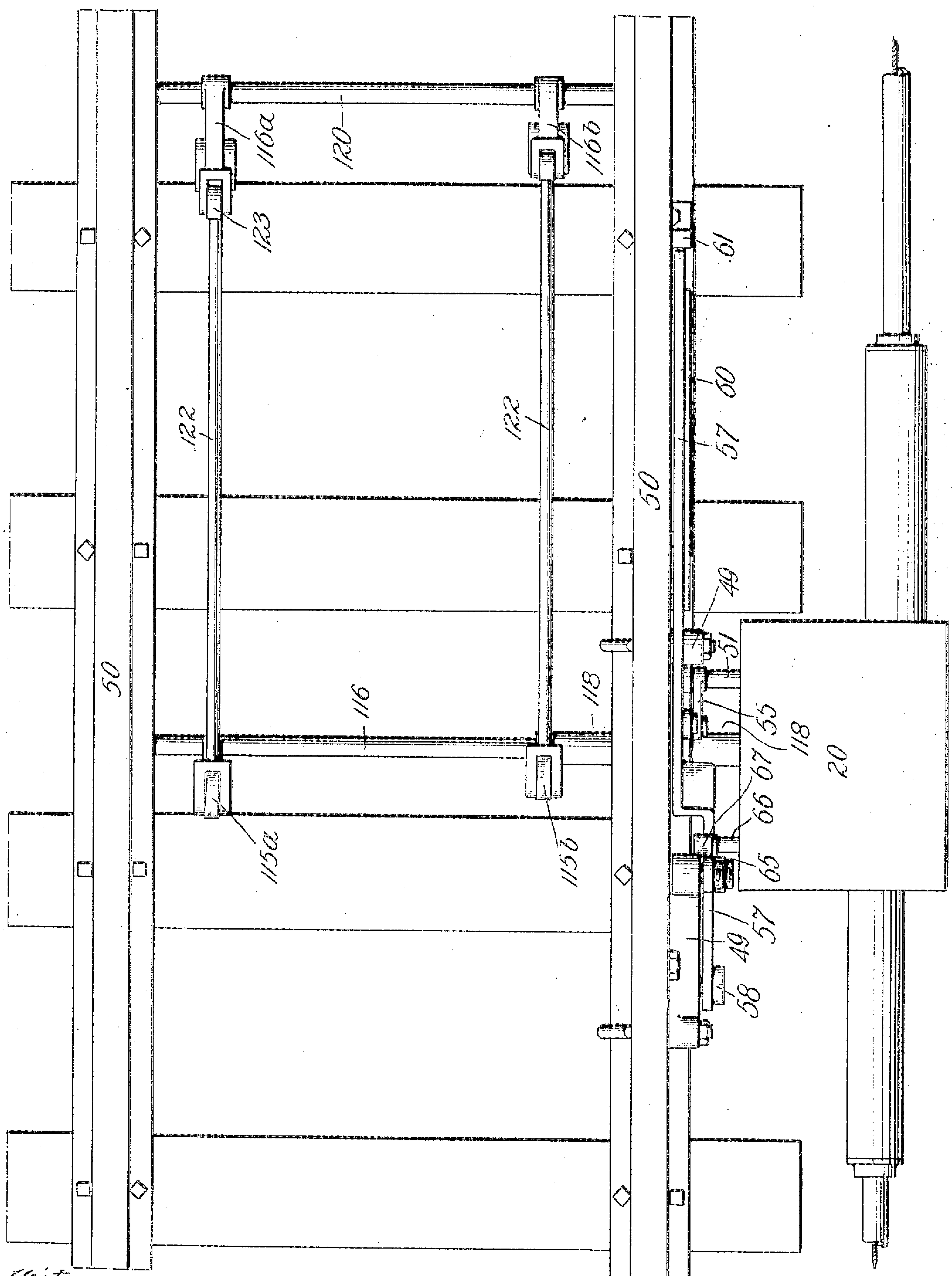
APPLICATION FILED SEPT. 8, 1904.

10 SHEETS—SHEET 10.



Witnesses

Fig. 28.

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No. 793,827. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

HENRY M. DAVENPORT, OF LONGBEACH, CALIFORNIA, ASSIGNOR TO AMERICAN SWITCH AND SIGNAL COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF ARIZONA TERRITORY.

AUTOMATIC SIGNAL AND TRAIN-CONTROL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 793,827, dated July 4, 1905.

Application filed September 8, 1904. Serial No. 223,755.

To all whom it may concern:

Be it known that I, HENRY M. DAVENPORT, a citizen of the United States, residing at Longbeach, in the county of Los Angeles and State of California, have invented a new and useful Automatic Signal and Train-Control System, of which the following is a specification.

This invention relates to a system for automatically operating signals on railways and on trains to avoid accidents and also for automatically controlling trains in such a manner as to absolutely prevent accidents if the signals given by the system are not acted upon by those having the trains in charge.

It relates particularly to a system such as described which operates entirely automatically, not requiring the coöperation of human agency.

It is a block system, but differs from the ordinary block-system type in that the blocks are progressive and travel with the train—that is to say, the railway or that part of it which is embraced by the system is provided with devices arranged at suitable intervals which are brought into action as a train moves along. When a train is at any point, a definite number of these devices forming a chain of units adjacent the train are active. As the train progresses consecutive devices at the front are sequentially brought into the chain of active units and the active devices as they serve their turn are sequentially dropped from the rear of the chain and left in inactive condition. Thus a train at any point of the system lies within a chain of active devices forming a protective zone, and the zone travels with the train. Only those devices embraced in a zone related to a train are active, and every train on the road is hedged by its protective zone of devices, all other devices on the road intermediate of the active train zones being inactive.

The system is such that a train cannot trespass within the protective zone of another train without being automatically signaled. When a train touches the zone of another train, a warning-signal is given to one or both of the trains, which indicates that the trains are as close together as safety will permit. If the trains are both going in the same direction, this signal is given to the rear train only. If the trains are approaching each other, the signal is given to both trains. If this warning-signal is not acted upon and the trains are allowed to draw closer together, one or both trains are automatically brought to a stop. If the trains are both going in the same direction, the rear train is brought to a stop, while if the trains are approaching each other from opposite directions both trains are brought to a stop.

The construction of the system in such that the protective zone for a train may have any suitable limits in front of or behind a train.

The system is applicable to steam-railways, electric railways, and other railways, and in the present embodiment does not depend for its operation upon electric or pneumatic devices. In the present embodiment each unit is a positively-operating mechanism, the units are mechanically connected, and the power for operating a chain of units is derived bodily and positively from the train or car. Certain of the units in the zone when rendered protective are adapted to operate signals of any kind whether mounted locally along the railway or carried on the train—such as whistles, bells, semaphores, or the like—and to operate devices for automatically controlling a train, such as air-brake valves for setting brakes of a train, or electric switches for controlling the circuit through a car of electric systems, or to operate apparatus locally situated along the railway, such as track-switches, crossing-gates, &c.

The object of the invention is to perform these functions and other minor functions by a construction which is simple, positive in action, durable in use, and economical of construction and maintenance.

The accompanying drawings illustrate the invention.

Referring to the drawings, Figure 1 is a side elevation of one of the units, a part of the track-lever being broken away. Fig. 2 is an elevation of the reverse side from that shown in Fig. 1. Fig. 3 is a forward end elevation, parts being in section on line X^3 X^3, Fig. 2. Fig. 4 is a plan view with the track-lever removed. Fig. 5 is part of an end elevation looking at the left end of the machine as shown in Fig. 4. Fig. 6 is a side elevation illustrating the track-lever and adjacent parts, the track-lever being up. Fig. 7 is a view similar to Fig. 6 with the track-lever down. Fig. 8 is a sectional view on line X^8 X^8, Fig. 7. Fig. 9 is a section on line X^9 X^9, Fig. 6. Fig. 10 is a perspective view of the ratchet-lever. Fig. 11 is a perspective view of one of the arms of the ratchet-lever. Fig. 12 is a perspective view of the dog for the operating-ratchet. Fig. 13 is a perspective view of a removable strap for the ratchet-lever. Fig. 14 is a side elevation of a cable-terminal and adjacent connections. Fig. 15 is a perspective of the locking-bolt. Fig. 16 is a side elevation of the signaling and controlling devices of a car about to be operated by passing over a trip-lever. Dotted lines show other positions of the controlling and signaling devices. Fig. 17 is a side elevation of tripping-levers coöperating with a switch. Fig. 18 is a diagrammatical view showing a series of units and illustrates the balancing of the cables. The units are shown in normal position. Four units are removed from the intermediate part of the chain to economize space. Fig. 19 is a view similar to Fig. 18, showing the forward stroke of the coupled cables and connected units. Fig. 20 is a view similar to Fig. 18, showing the chain of coupled cables and connected cables shifted back and illustrates the zone as having progressed one point ahead. Fig. 21 is a diagrammatical view, the upper section representing units and cables in side elevation. The lower section represents the track in plan and the two independent sets of units and represents conditions of tripping-levers and track-levers relative to the position of the train. Fig. 22 is a view similar to Fig. 21, representing the condition of tripping-levers and track-levers in the forward stroke of the chain of cables and units as actuated by the train. Fig. 23 is a view similar to Fig. 21, representing the conditions after the return stroke from the position shown in Fig. 22. Fig. 24 is a perspective view of a portion of the forward coupling-bar. Fig. 25 is a perspective view of a portion of the rear coupling-bar. Fig. 26 is a diagrammatic plan view of a switch-protecting system with the switch represented closed. Fig. 27 is a view similar to Fig. 26 with the switch open. Fig. 28 is a plan view of what is shown in Fig. 7. Fig. 29 is a perspective of the locking-dog for the rear coupling-bar. Fig. 30 is a view, partly in section, on line x^{30} x^{30}, Fig. 4, showing a portion of parts adjacent the locking-dog for the rear coupling-bar and illustrates the dog out of engagement with the rear locking-bar. Fig. 31 is a view similar to Fig. 30, showing the dog about to spring into the notch in the rear coupling-bar.

The system comprises units distributed along the railway, with suitable connections for securing harmonious action of the units. Cars operating over the system are equipped with signaling or controlling apparatus, or both, which are adapted to be operated by the units when brought into contact therewith. Each unit has several primary conditions. It may be considered inactive when out of a chain and active when in a chain. When active, each unit may be considered protective or non-protective, according as it presents or retires a tripping device for signaling or controlling a train. As an active intermediary in a chain a unit operates the chain or series of units when the unit is directly actuated by the train its block is protecting, and a unit connects itself with a series of units to maintain progression of the zone as the train travels, and the unit disconnects or detaches itself from the series after having performed its duty in the chain. In the present embodiment each train-block embraces ten of these units. Each unit when exercising in a block performs a cycle of ten points. The ten respective units of a block are coupled in a series, and although the respective units perform simultaneously each unit performs a different point. Thus while the two extreme units of a block are simultaneously performing points Nos. 1 and 10 the respective intermediate units are performing their relative respective intermediate points according to their relative location.

A clear aspect of the principle of the progressive movement of a block is to consider the present specific embodiment of the chain, which consists of nine coupled cables forming a block. This chain of cables is given a forward and backward shift lengthwise a few inches when the train passes over one of the units connected to the chain. If the units are arranged at intervals of one thousand feet, the actuation of the chain of cables takes place once in every thousand feet of travel of the train. In Fig. 21 the train is shown at a point between units 6 and 7. When the train passes over unit 7, the chain of nine coupled cables 3^c, 4^c, 5^c, 6^c, 7^c, 8^c, 9^c, 10^c, and 11^c is shifted forward and back, coupling with cable 12^c, thus bringing a fresh link into the chain at the front, and the cable 3^c is uncoupled from the rear end of the chain, thus forming a new chain of the same length of nine cables as the old chain, but lying one point farther ahead on the track. The train is now between units 7 and 8. (See Fig. 23.) When the train has traversed the distance between units 7 and 8 and passes over the unit 8, the new chain of cables 4^c, 5^c, 6^c, 7^c, 8^c, 9^c, 10^c, 11^c, and 12^c is shifted forward and back and coupled with cable 13^c, thus bringing a fresh link into the chain, and the cable 4^c is uncoupled and another new chain of nine cables is formed which lies two points ahead of the first-mentioned chain. The train now lies between units 8 and 9. Thus there is a progressive movement of the protective block which accompanies the train.

In the present embodiment each unit at certain points in its cycle projects a tripping device, which will coöperate with train-guarding devices, such as warning and controlling devices, on trains which are encroaching on the block. In this embodiment the two foremost and two rearmost units of a train-block present each a tripping device. Thus while the train is between units 6 and 7 units 3 and 4 at the rear and units 10 and 11 at the front present tripping devices. When the train passes over unit 7 in the formation of the new block, tripping devices of units 5 and 12 are projected and tripping devices of units 3 and 10 are retired, tripping devices of units 4 and 11 being maintained. When the train passes over unit 8 to form the next new block, the tripping devices of units 6 and 13 are projected and the tripping devices of units 4 and 11 are retired, the tripping devices of units 5 and 12 being maintained.

Under the present construction only one unit at a time, and that one being always the unit nearest ahead of the train, is adapted to be operated by the passing over it of the train to actuate the chain of cables in the block. Thus whenever a chain of cables is actuated one unit connected to the chain is operated one point of its cycle by movement imparted to it directly by the train, while all the other units connected with the chain are operated indirectly through the medium of the shifting chain of cables, each operating its respective point in its cycle according to its relative location in the chain.

Each unit has a track-lever which actuates the mechanism of the unit when the lever is depressed by the train. The construction and operation of the cycles of the units in a block are such that the track-lever of the unit just ahead of the train is always up and all other track-levers are down. Thus as the train passes over track-lever of unit 7 that track-lever is depressed and the track-lever of unit 8 is raised. When the train passes over unit 8, its track-lever is thereby depressed and track-lever of unit 9 is raised, and so on.

In the present embodiment a double set of units is employed, each having its cables. The two sets are independent of each other; but the units are preferably arranged in pairs, as indicated in the diagrams of Figs. 21, 22, and 23, one set, as the set having units 1 to 15, being operated by trains going in the direction indicated, the other set having units 1^a to 15^a, being operated by trains running in the opposite direction; but though the sets are independent and are operated independently the tripping devices projected by either set are effective for coöperating with the signaling and controlling devices on trains which are running in either direction. Thus the tripping device of unit 11 as projected in Fig. 21 will warn a train approaching from the opposite direction from that of the moving train shown, and the tripping device of unit 3 will warn a train following the train shown. If in either case the warning is not acted upon, then in the first case the tripping device of unit 10 will stop the train approaching head-on, and in the second case the tripping device of unit 4 will stop the train approaching at the rear. In the former case with both trains approaching head-on not only one train is warned and stopped, but both trains are warned and stopped. Thus referring to Fig. 21, assuming that a train not shown is approaching the one shown and lies between units 12^a and 11^a, this assumed train will have projected tripping devices of units 7^a and 8^a. Now when both trains further approach the train shown will be warned by the tripping device of unit 7^a, while the assumed train will be warned by the tripping device of unit 11. If both trains still proceed regardless of the warnings, then the train shown will be absolutely stopped by the tripping device of unit 8^a and the assumed train will be absolutely stopped by the tripping device of unit 10.

Obviously in the case of the assumed rear train following the train shown only the rear train will be warned and stopped, as the rear train cannot project tripping devices in the block covering the train shown, as the cable 2^c is uncoupled from the cable 3^c, and while the rear train can draw near to the block of the front train the block of the rear train will gradually become shorter, as it cannot couple on cables at its front until the front train leaves units at its rear at the proper cycle-point to permit coupling. Thus there is no interference with the proper working of the system when a rear train approaches close to a train ahead of it nor is there any interference when two trains approach head-on, as in that case the two sets are independently operated.

Having described the general nature of the system and some specific characteristics of the present embodiment by which the system may be carried out, one form in which a unit may be constructed will now be described.

Each unit is preferably incased in an iron box 20, which is preferably sunk in the earth close to the track-rail, as shown in Fig. 8.

21 designates a base having standards 22. A main shaft 23 is mounted in the standards 22, and rigidly mounted on the shaft 23 is a ratchet 24.

25 is a ratchet-lever having a long half-round hub 26 mounted to rock on the shaft 23, being retained thereon by a strap 27. 28

is a rock-lever also loosely mounted on the shaft 23 and lying parallel with the ratchet-lever 25, the two levers being fastened together at their free end by a pin 29, the ratchet 24 being positioned between the two levers 25 and 28. A sliding dog 30 for actuating the ratchet 24 is mounted between the two levers 25 and 28, being provided with slotted wings 31, through which the pin 29 passes, the dog further being held in place by upper and lower plates 32 and 33, fastened to the levers 25 and 28. The two levers 25 and 28 form practically one lever, which will hereinafter be referred to as a "ratchet-lever."

A shaft 34 is mounted on the standards 22, and loosely mounted on the shaft 34 is a rock-lever 35, one end of which is connected by a link 36 with the pin 29. A flat spring 37 is attached to the link 36, the free end of the spring bearing against the slotted wings 31 of the dog 30 and serves to hold the dog yieldingly against the ratchet 24, the slotted wings 31 serving to limit the play of the dog when actuated. One of the standards 22 is provided with a vertical bearing 38, and the base 21 is provided with a socket-bearing 39, while a pull-rod 40 is mounted in bearings 38 and 39, being vertically movable therein. Pivoted to the rock-lever 35 is a double catch-lever 41, comprising two plates having hooked ends 42, and forming a forked hook which straddles the pull-rod 40 and which normally engages studs 43 on the pull-rod. The catch-lever 41 is bridged with a cross-pin 44, which bears against the pull-rod 40 and holds the catch-lever in position, there being a flat spring 45 for normally holding the catch-lever with the pin 44 resting against the pull-rod 40.

A leaf-spring 180 presses against the under side of the rock-lever 35 and serves to normally hold the ratchet-lever and connected elements in the position shown in Figs. 1 and 2. A retaining-ratchet 46 is rigidly mounted on the shaft 23, while a spring-pressed retaining-pawl 47 is slidably mounted in a socket 48 on a standard 22. Referring now to Fig. 6, a track-plate 49, which is outside the box 20, is fastened to the adjacent track-rail 50, and one end of a track-lever rock-shaft 51 is mounted in the track-plate 49. The rock-shaft 51 extends into the box 20 and carries an arm 52, which is forked to receive the upper end of the pull-rod 40, being connected therewith by a bolt 53, having a slot 54 to permit of the necessary swinging movement of the arm. The shaft 51 also has another arm 55, which lies near the track-plate 49 and which is connected by a link 56 with a track-lever 57, the track-lever 57 being pivoted at 58 to the track-plate 49. The track-lever 57 is offset, so as to present its upper inclined bearing edge 59 at the top face of the track-rail 50. The track-lever 57 is adapted to be pressed up into the position shown in Fig. 6 by means of a flat spring 60, there being a slotted bracket 61 for engaging a toe 62 on the track-lever to limit the upward position of the track-lever.

63 is a stud mounted on the track-plate 49, while the track-lever 57 is provided with a stud 64, to which studs a pair of toggle-links 65 are pivoted. A stub-shaft 66 is mounted on the track-plate 49 and carries a cam-finger 67.

When the track-lever 57 is depressed, it rocks the shaft 51 and through the medium of the arm 52 elevates the pull-rod 40, which through the medium of the catch-lever 41, rock-lever 35, and link 36 pulls down the ratchet-lever, thereby advancing the ratchet 24 one tooth, the retaining-pawl 47 clicking into the next notch in the retaining-ratchet 46 and preventing rearward movement of the ratchet 24. As the pull-rod 40 goes up the pin 44 of the catch-lever 41 strikes an inclined abutment 41^a, and the catch-lever is thereby shunted out of engagement with the pull-rod, allowing spring 180 to restore ratchet-lever 25, rock arm 35, and pulling down catch-lever 41, the pin 44 riding down along the side of the pull-rod. The pull-rod is thus left elevated when the track-lever is down, as shown in Fig. 7. The track-lever does not immediately rise, being held down during several steps in the cycle, after which it is released, as will be described later, and when the track-lever is released the pull-rod descends and the studs 43 ride over the rounded nose of the catch-lever 41 and are caught under the hook 42 as the catch-lever snaps back. One side of the retaining-pawl 47 has an easy inclination, and the notches in the ratchet 46 are correspondingly formed, so that no great impedance is given to the ratchet 46 while it is being turned. When the lever 57 is depressed, it straightens the toggle-links 65, as shown in Fig. 7, so that the track-lever 57 is prevented from rising. The track-lever 57 is raised at a certain point in the cycle of the unit by the toggle-links 65 being flexed outwardly by the rocking of the cam-finger 67, as will be hereinafter explained.

Mounted on the standards 22 are ways 68 and 69. (See especially Fig. 4.) The ways 68 and 69 are provided with channels in which coupling-bars 70 and 71 are slidably mounted. The coupling-bar 70 extends rearwardly from the machine, while the coupling-bar 71 extends forwardly from the machine, the two bars overlapping, as shown in Fig. 4. The hub 26 of the ratchet-lever 25 has a block 72, which is provided with notches 73 and 74. The rear coupling-bar 70 passes through the notch 74 and the forward coupling-bar 71 passes through the notch 73. The block 72 is also provided with a slot 75, in which is pivoted a locking-dog 76, adapted to be pressed out by a spring 76^a, and the rear coupling-bar 70 has a notch 76^b, which normally receives the locking-dog 76, Fig. 3. The ratchet 24 has a pocket 24^a, in which is a plunger 24^b, having an inclined face 24^c. A compression-spring 24^d, which is much stronger than the spring 76^a, serves to yieldingly hold the plunger 24^b flush with the side face of the ratchet 24, as shown in Fig. 30. The length of the spring 24^d is not great enough to cause the plunger to protrude from the pocket at any time. The forward coupling-bar 71 is provided on its under side with a notch 77, (see Fig. 24,) and the under face of the forward coupling-bar 71 is slightly concaved, as at 78, adjacent the notch 77. The block 72 is also recessed laterally to form way for a locking-bolt 79, which is slidable therein and which has side lugs 80, slidable in ways 81. (See Figs. 3 and 10.) The lower end of the locking-bolt 79 has an inclined face 82, while the upper end of the locking-bolt 79 has a rounded tip 83. Projecting up from each lug 80 is a pin 84, suitable plates 85 being screwed to the top of the block 72 and perforated to receive the pins 84 to form guides therefor, while compression-springs 86 encircle the pins 84, being interposed between the plates 85 and the lugs 80. Screwed to the side of the block 72 is a thimble 87. Slidably mounted within the thimble 87 is a releasing-bolt 88, having a beveled head, as shown, contacting with the inclined face of the locking-bolt. The other end of the release-bolt has a rounded tip 89, the shank of the release-bolt having a collar 90, which has a sliding fit in the thimble 87, and a compression-spring 91 is interposed between the collar 90 and a stationary washer 92 in the inner end of the thimble, the spring 91 serving to yieldingly press the tip 89 against the side face of a cam 93, which is rigidly mounted on the main shaft 23. Another cam 94 is mounted on the shaft 23 and is preferably formed integral with the cam 93, there being a neck 95 joining the two cams. The cam 93 is provided with a recess 96, having a pocket 97, while a retractor-bolt 98, having a beveled head, is slidably mounted in the recess 96. The stem 99 of the retractor-bolt extends loosely through the neck 95 and cam 94, as shown in Fig. 3, a compression-spring 100, lying within the pocket 97 and bearing against the head 98, serving to press the head outwardly, the outward movement of the retractor-bolt being limited by a nut 101 on the end of the stem 99. Another cam 102 is also mounted on the main shaft 23. Bell-crank levers 103, 104, and 105 lie, respectively, under and in alinement with the cams 93, 94, and 102, each being loosely mounted on the shaft 34, the short arm of each of said levers having an antifriction-roller 106 for riding against its respective cam. Three vertical operating-rods 107, 108, and 109 are respectively mounted over the ends of the long arms of the respective bell-cranks 103, 104, and 105, the lower end of each operating-rod having an antifriction-roller 110, which rests against its respective arm, the operating-rods 107, 108, and 109 being slidably mounted in upper guides 111 and lower guides 112. The lower parts of the operating-rods 107, 108, and 109 are squared, as shown, to slide in the guides 112 and prevent the rods from turning.

The stub-shaft 66, before described, extends into the box 20 and carries a rigid arm 113, having a slotted end, which is connected with the upper end of the operating-rod 109 by a bolt 114.

Referring to Fig. 8, 115^a designates an arm carried by a shaft 116, which in this instance extends across the track underneath the track-rails 50, being journaled at one end in a bearing 117 and at the other end lies within a sleeve 118, which sleeve is mounted to rock in a bearing 119. (See Fig. 3.) The sleeve 118 also carries an arm 115^b, similar to the arm 115^a. A trip-lever shaft 120 is mounted in suitable journals 121 underneath the track-rails 50 at some distance from the arms 115^a and 115^b and near the lower end of the track-lever 57. Trip-levers 116^a and 116^b are loosely mounted on the shaft 120 and are respectively connected with the arms 115^a and 115^b by connecting-rods 122. The two trip-levers are similarly constructed, their upper ends being forked and carrying antifriction-rollers 123. The end of the shaft 116 which lies within the box 20 projects beyond the sleeve 118 and carries a rigid arm 124, having a slotted end and being connected with the upper end of the operating-rod 107 by a bolt 125. The sleeve 118 carries a rigid arm 126, the end of which is forked and slotted and connected to the upper end of the operating-rod 108 by a bolt 127.

Both coupling-bars 70 and 71 have rounded stems 128, which are screw-threaded and carry spring-adjusting nuts 129. (See Fig. 14.)

A coil tension-spring 130 is attached to the adjusting-nut on the stem of the coupling-bar 70 and to the frame of the machine, while a similar tension-spring 131 is attached to the adjusting-nut 129 on the stem of the coupling-bar 71 and to the frame of the machine. Suitable cupped sockets 132 are employed for housing and protecting the ends of the springs and for holding the springs substantially concentric with their respective coupling-bar stems. The end of each stem 128 is connected, by means of a swivel 133, with its cable. The two springs 130 and 131 are both equally stretched and evenly balance each other when the ratchet-lever stands back in its normal position.

One form of signaling and controlling device which may be employed on a car is shown in Fig. 16. This apparatus may be mounted, preferably, on the locomotive. 150 designates the wheels on the locomotive. The train-pipe 151 of the air-brake system is provided with a valve 152, having an arm 153, while the signal-pipe 154 is provided with a valve 155, the valve-stem 156 carrying an arm 157. A ratchet 158 is mounted on the valve-stem 156, and the arm 157 carries a pawl 159 for actuating the ratchet, and thereby the valve-stem. Fixed with the ratchet 158 is a plate 160, having an operating-finger 161. A bracket 162, forming a stop for the ratchet-lever 157, may be attached to the signal-pipe, as shown. When the valve 155 is opened, a signal may be operated thereby—such, for instance, as the whistle 163, which is connected by a pipe 164 with the signal-pipe 154, the whistle being preferably located in the cab of the locomotive. The valve-stem 152 may also have rigidly attached thereto a switch-blade 165, which normally bridges terminals 166 and 167 in an electric circuit. The ratchet-lever 157 has a path of movement which when the train is in motion will bring it against one or the other of the trip-levers 116^a or 116^b, according to the direction of travel of the train, inasmuch as the ratchet-lever 157 is mounted at one side of the train.

In operating the train the two valves 152 and 155 are normally closed, as illustrated in Fig. 16; but if the ratchet-lever 157 should strike a trip-lever it will be moved into the position shown in dotted lines as it is drawn over the roller of the trip-lever, which will open the valve 155 and blow the whistle and move the operating-finger 161 into the position shown in dotted lines, so that it is about in contact with the lever 153, the ratchet-lever 157 being returned by the spring to its normal position resting against the stop 162, but leaving the operating-finger 161 in the position shown. If the signal is not acted upon and the train proceeds and strikes the next trip-lever, the ratchet-lever 157 will again be rocked into the position shown in dotted lines as it rides over the trip-lever roller, which will advance the operating-finger 161 still farther, and as the operating-finger bears against the lever 153 it will open the valve 152 and set the brakes. At the same time the switch-blade 165 will be moved clear of the terminals 166 and 167, thus breaking the circuit. The train is thus automatically brought to a stop. This circuit-closing device may be employed to advantage on electric systems, but may be dispensed with on steam-roads.

The units are distributed along the track and in this embodiment are connected by cables, the coupling-bar 70 of a unit being connected by a cable with the coupling-bar 71 of the unit behind. In order to describe the operation, it is necessary to distinguish the different steps in the operation of each unit. Each unit when exercising in a block performs all of the steps; but the respective units in a block perform different steps at the same time. Each step in the operation of a unit is carried out whenever the ratchet 24 of that unit is advanced one tooth either by direct action of the train or by being actuated through the medium of other units. The position in the cycle which a unit has will be designated as position P', P^2, P^3, P^4, P^5, P^6, P^7, P^8, P^9, and P^{10}, as indicated on the ratchet in Fig. 2. As the ratchet 24 operates the distance of one tooth the coupling-bars 70 and 71 are advanced as one piece and retracted; but while the unit is performing the ninth step the rear coupling-bar 70 does not move, and while the unit is performing the tenth step in its cycle the forward coupling-bar 71 does not move, the two coupling-bars having respectively during the eighth and ninth strokes been uncoupled. P' will be used to designate that position which the unit has after having performed the tenth step, with the two coupling-bars 70 and 71 coupled. The first movement of a unit in its cycle of operation is from position P' to position P^2 and its last movement in the cycle is from position P^{10} to P'.

The operation of a unit in going through its successive steps will first be described without considering its relation with other units.

It will be assumed that the unit stands in position P^3. While in this position its track-lever is down and its trip-levers are down. When the ratchet-lever 25 is rocked forward, it advances the ratchet 24 one tooth and the main shaft, with cams, turns accordingly. During the forward movement of the ratchet-lever the bars 70 and 71 shift forward, thereby stretching the spring 131 and giving it a greater tension and relieving the tension of spring 130. During the return stroke as the coupling-bars 70 and 71 shift back the spring 131 is relieved in tension and the spring 130 is stretched so that both springs are again under equal tension and balance each other. The spring 180, which has been flexed during the forward stroke of the ratchet-lever, reacts and restores the ratchet-lever and connected elements to normal position with the dog 30 in engagement with a new tooth of the ratchet. The unit now stands in position P^4. The ratchet is again advanced and the foregoing action is repeated. As the unit is operated from position P^4 to P^5 during the forward stroke the cam 102 presses down the rock-lever 105, elevating the operating-rod 109, rocking the shaft 66, and thereby turning the cam-finger 67 against the toggle-links 65 (see Fig. 6) and flexing them, thereby allowing the spring 60 to raise the track-lever 57. During this forward stroke the cam 102 only momentarily engages the rock-lever 105 sufficiently to trip the track-lever, and the rock-lever 105 and described connections are restored by gravity to normal position, leaving the track-lever raised. The unit now stands in position P^5. In its next step from position P^5 to P^6 the unit is operated by direct action of the track-lever, the latter being depressed by the train and operating the ratchet-lever, as before described, the track-lever being locked when depressed by the straightening of the toggle-links and remaining so during the remainder of the cycle.

In the previous described steps—namely, the third and fourth steps—the unit was operated by the shifting of the coupling-bars 70 and 71 and not by direct action of its track-lever, as will be later described. As the unit operates from position P^6 to P^7 the ratchet is again advanced one tooth and the main shaft and cams turned accordingly. As the unit is operated from position P^7 to P^8 during the forward stroke the cam 94 presses down the rock-lever 104 and elevates the operating-rod 108, rocking the sleeve 118, tilting the arm 115, and raising the trip-lever 116^b. (See Fig. 7.) The unit now stands in position P^8. As it is operated from position P^8 to P^9 the cam 94 still holds the rock-lever 104 depressed and the trip-lever 116^b up.

During the previous steps the dog 76 has kept in the notch 76^b, being held out by bearing against the side face of the ratchet 24; but during the back stroke of the ratchet-lever the dog 76 springs into the pocket 24^a and rests against the plunger 24^b, Fig. 30, thereby uncoupling the rear coupling-bar 70. The unit is now in position P^9. As the unit operates from position P^9 to P^{10} the cam 94 moves off from the rock-lever 104 and the rock-lever 104 drops, the operating-rod 108 also dropping by gravity, the sleeve 118 turning back accordingly, and the trip-lever 116^b thereby dropped. During the back stroke in moving from P^9 to P^{10} as the ratchet 24 holds still the dog 76^a rides over the inclined face 24^c of the plunger 24^b, and as the dog cannot retract on account of its rubbing along the smooth side face of the coupling-bar 70 it forces in the plunger 24^b, compressing spring 24^d; but as soon as the ratchet-lever is fully retracted the dog 76 registers with the notch 76^b, Fig. 31, and snaps thereinto by the expansion of spring 24^d, thereby coupling the rear coupling-bar 70.

During the back stroke in operating from position P^9 to P^{10} the pin 89 drops into the pocket 96 and strikes against the retractor-bolt 98, the releasing-latch 88 being forced into the pocket by the spring 91. The forward coupling-bar 71 upon thus being released is immediately retracted by spring 131. The rear coupling-bar 70 is also retracted with the ratchet-lever. The reason for the retraction of the rear coupling-bar 70 at this point in the cycle is not apparent until the relation of the unit to other units is considered, and to prevent confusion this will be treated later.

When a unit stands in position P^{10}, the next function arising in it will depend upon whether the unit stands at the rear of the chain of units or at the front of the chain. If it stands at the rear, the next movement in it will be simply an out and back shift of the forward coupling-bar 71 and consequent expansion and reactive contraction of the tension-spring 131. All other parts of the unit are inactive and unaffected; but this function is not here regarded as a step in the cycle and need not be considered further at this point.

The next step in the cycle of the unit is in moving from position P^{10} to P', and while making this step the unit lies at the head of the chain. The rear bar 70 is relieved in tension, as will be treated later, and moves forward with the ratchet-lever. During this forward movement the front coupling-bar remains stationary, being held back by spring 131. As the ratchet-lever moves forward it advances the ratchet one tooth, turning the main shaft and cams accordingly. It will be remembered that the locking-bolt 79 is disengaged from the notch 77 of the forward coupling-bar 71 and that the pin 89 lies in the pocket 96, resting against the bolt-head 98. Thus as the ratchet-lever and cam 93 turn forward together as the unit moves from position P^{10} to P' their relations are unchanged; but at the end of the outward shift the cam is stopped, and as the ratchet-lever rocks back the pin 89 rides over the inclined face of the bolt-head 98 and gradually forces the head back deeper into the pocket as the pin is held out by the locking-bolt 79 riding against face 78; but as soon as the ratchet-lever has rocked back to normal position the pin 89 is pushed back by the outer edge of the bolt 98 and the locking-dog 79 is moved up into the notch 77, the outer end of the pin 89 then lying flush with the side face of the cam 93. During this forward and return stroke of the ratchet-lever the locking-dog is held down, but sweeps back and forth in an arc of a circle, which movement is provided for by the concave undercut face 78 in the coupling-bar 71. As the unit moves from position P^{10} to P' and as the main shaft and cams turn in the forward stroke the cam 93 depresses the rock-lever 103 and pushes up the operating-rod 107, thereby rocking the shaft 116, tilting arm 115^a, and raising trip-lever 116^a. The unit now stands in position P', and as it moves to position P^2 the coupling-bars are shifted forward and back as one piece, as they are coupled, and the ratchet and cams are turned a step ahead accordingly; but the cam 93 still holds the trip-lever 116^a up. The unit now stands in position P^2, and as it moves to position P^3 the coupling-bars are again shifted forward and back, and during the forward stroke the cam 93 moves off from the rock-lever 103, thereby dropping the trip-lever 116^a. The unit now stands in position P^3, thus completing a cycle.

The relation of the units to each other and to the train and the operation of the system will now be described.

Referring to Figs. 21, 22, and 23, in the upper section of each of these figures there are fifteen units represented, the respective units being designated 1 to 15, inclusive. A large circle represents the ratchet-wheel 24, while the respective cables are designated 1^c to 15^c. 25 designates the ratchet-lever of each unit. In Fig. 21 the nine cables 3^c to 11^c, inclusive, are coupled. The units 3, 4, 5, 6, 7, 8, 9, 10, and 11 are shown in their respective positions P^9, P^8, P^7, P^6, P^5, P^4, P^3, P^2, and P'. The units 1, 2, 12, 13, 14, and 15 are respectively in positions P^{10}. The unit in position P^9 has its rear cable uncoupled. Those units which are in position P^{10} have their forward cable uncoupled from their rear cable, as has before been brought out in describing the operation of a single unit. In the lower section of Fig. 21 the small open circles represent trip-levers down, and the black circles represent trip-levers up. The short lines adjacent the circles represent the track-levers. The light lines represent the track-levers which are down and the heavy lines represent the track-levers which are up. As before pointed out, when a unit is in position P^{10}, its forward cable is uncoupled, its trip-levers are down, and its track-lever is down. Hence units 1 and 2 in the diagram which are in position P^{10} have their track-levers and trip-levers down and their forward cables uncoupled at the junction in the units. Units 12, 13, 14, and 15 are likewise in the same condition. Unit 11 being in position P' is protective, has its trip-lever 116^b up, its track-lever down, and the cables 10^c and 11^c coupled in the unit. The unit 10 being in position P^2 is protective, has its trip-lever 116^b up, its track-lever down, and the cables 9^c and 10^c coupled in the unit. Unit 9 being in position P^3 is non-protective, has both its trip-levers down, its track-lever down, and the cables 8^c and 9^c coupled in the unit. Unit 8 being in position P^4 is non-protective, has both trip-levers down, its track-lever down, and the cables 7^c and 8^c coupled in the unit. Unit 7 being in position P^5 is non-protective, has its trip-levers both down, its track-lever up, and the cables 6^c and 7^c coupled in the unit. Unit 6 being in position P^6 is non-protective, has both of its trip-levers down, its track-lever down, and the cables 5^c and 6^c coupled in the unit. Unit 5 being in position P^7 is non-protective, has both of its trip-levers down, its track-levers down, and the cables 4^c and 5^c coupled in the unit. Unit 4 being in position P^8 is protective, has its trip-lever 116^a up, its track-lever down, and the cables 3^c and 4^c coupled in the unit. Unit 3 being in position P^9 is protective, has its trip-lever 116^a up, its track-lever down, and cable 2^c uncoupled in the unit and cable 3^c coupled in the unit. The train is shown in position between units 6 and 7, and as it passes over unit 7 the chain of nine cables 3^c, 4^c, 5^c, 6^c, 7^c, 8^c, 9^c, 10^c, and 11^c shifts forward and operates the ten units 3 to 12, inclusive, each through its respective step in its cycle. Then this chain of cables and these units take the return stroke, at the conclusion of which the units are as represented in Fig. 23, the unit 3 having been uncoupled and dropped from the chain and taking position P^{10}, unit 13 having been brought into the chain by the connection of the cable 12^c with the cable 11^c at the unit 12. The intermediate units 4 to 10, inclusive, remain coupled and each operated its respective step in its cycle. The train now lies between units 7 and 8, and the zone of protection is advanced one point relatively to the track, but is substantially the same with relation to the train, the unit 12 now being an active unit and in protective condition presenting a raised trip-lever 116^b, the unit 11 also being protective, presenting a raised trip-lever 116^b. The unit 10 having lowered its trip-lever is non-protective, the unit 8 presenting a raised track-lever. The unit 3 is inactive, having been dropped from the chain. Its trip-lever is down; but units 4 and 5 are both protective and present raised trip-levers 116^a. In like manner the progression continues according to the speed of the train, so that the train is guarded both front and rear by protective units which present raised trip-levers.

In order to explain the shifting of the chain of cables and consequent action of the units connected therewith, reference is made to Figs. 18, 19, and 20. These figures are designed to embrace a series of eleven units, four units having been removed, thus leaving units S, T, U, V, W, X, and Y. This removal does not alter the action of the chain, as will be seen. When a unit is in normal position with its ratchet-lever standing back, its two springs 130 and 131 are both under an equal tension. In Fig. 18 units U to X are in position P^8 to P', respectively, so that cables entering those units are all coupled. In the two extreme units in this figure, S and Y, both of which stand in position P^{10}, the forward cable of each of these units is uncoupled. Considering the coupled cables B, C, D, E, and F as one continuous cable, which, in fact, they form, there are five tension-springs 131 tending to pull this united cable to the left, and there are five tension-springs 130 tending to pull the cable to the right. Thus the cable is balanced. It is important here to note that the two springs 130 and 131 of unit U balance each other, that the two tension-springs of unit V balance each other, that the tension-springs of unit W balance each other, that the tension-springs of unit X balance each other, and that the tension-spring 130 of the unit Y balances the tension-spring 131 of the unit T. If now the tension-spring 131 of the unit V be slackened, (which happens when the train depresses the track-lever of that unit,) the effect of that spring upon the chain is nullified, and hence there are only four tension-springs 131 tending to pull the chain to the left as against five tension-springs 130 tending to pull the chain to the right. Thus the chain of cables in its entirety shifts to the right. While it may easily be understood that those machines which lie back of unit V may be readily operated forward on account of the direct pull of the cables B C, it should be borne in mind that ahead of the unit V the three springs 130 of units W X Y tend to pull the cables D E F forward, there being only the two springs 131 of units W and X which tend to pull the chain to the left on account of the spring 131 of unit V having been nullified. Hence that part of the chain which lies ahead of the unit V is overbalanced, and the three springs 130 of units W X Y overcome the two springs 131 of units W and X and pull the three cables D, E, and F forward. In this connection it should be noted that the spring 131 of unit Y has no effect upon this action, as it does not enter into the chain at all, the unit Y being in position P^{10} and its forward cable being uncoupled from the cable F. Observing the action of the units at the rear of the unit V it will be noted that as the ratchet-lever of unit V moves forward cables B C are thus necessarily positively drawn forward with it, placing the springs 131 of units T U V under a still greater tension and nullifying the two springs 130 of units U and V. The spring 130 of unit T does not enter into this combination as the ratchet-lever of unit T moves forward free from the cable A, the unit T being in position P^9, with its rear cable uncoupled. While as a matter of fact the foregoing is the action which takes place in the present embodiment of the invention, the rear cables B and C would move forward without the direct tensile strain on those cables. Under this arrangement of springs by reducing the tension of a spring of any unit intermediate the units T and W it will upset the balance of the chain and the chain will move accordingly, owing to the contraction of the majority of springs. It is apparent that as soon as the spring which has been nullified has had its tension restored the opposing strains are again equalized and the chain will naturally shift back again. The springs 180 merely accelerate the return shift and obviously have no effect on the chain when it is in normal position, inasmuch as at that time the springs 130 and 131 both balance each other. The springs 180, while accelerating the return of the cable, are relatively weak and are employed primarily for restoring the intermediate machine elements in each unit and could be dispensed with, as they have no effect upon the balancing action of the cable.

Fig. 17 illustrates trip-lever protection for switches. The vertical switch-shaft 201 when turned opens or closes the switch by the usual mechanism, not necessary to describe, and it carries a disk 202. Pivotally connected to the disk at diametrically opposite points are cables 203 and 204. A series of pivoted trip-levers 205 are arranged at intervals along the track at one side of the switch and connected to the cable 203, while another series of trip-levers 206 are arranged at intervals on the other side of the switch and connected to the cable 204. When the switch is operated, the shaft 201 turns the disk 202, which draws the cables 203 and 204 both toward the switch, thereby elevating the trip-levers 205 and 206, as shown by dotted lines. When the switch is closed, the trip-levers are lowered by the backward shift of the cables, which are restored by springs 207 and 208.

Fig. 26 represents the switch closed with the trip-levers down. Fig. 27 represents the switch open with the trip-levers up. Thus the switch when open is guarded by a series of trip-levers on each side, and trains approaching from either direction will be warned by the signal in the cab caused by the outermost sentinel trip-levers and the trains will be brought to a stop by the next trip-levers if the warning-signal is not heeded. Thus the trains cannot run past an open switch, but are free to run past a switch which is closed. While in this embodiment the unit which operates the chain is intermediate the terminals of the chain of connected units, other units than this could be utilized in this captcity. In fact, any unit in the chain can be so employed by arranging its track-lever to be raised at the requisite cycle-point. This may be done by simply adjusting the cam 102 on shaft 23. If desired, the cam 102 could be set to raise the track-lever when the unit took position P'. In that case there would be no head protection for the train; but such an arrangement might be desirable in certain systems. Obviously the cams which operate the trip-lever may also be set to obtain other timing of the trip-levers than as herein shown, and, vice versa, the track-lever could be in operative condition when the unit was in position P^9. This would give head protection to the train and no rear protection.

The employment of electric means in place of the shifting-cables for securing the harmonious coöperation of the units, which secures progression of the protective zone, would not evade the scope of the claims, as this construction of picking up new units and dropping off old units to cause a progression of the chain is broadly new, and I do not limit myself to the employment of the specific means herein shown for accomplishing the purpose. This progressive chain action requires much less cable-line operating by tension or of wiring when electric means is employed for linking units than is required with independent overlapping blocks, and it enables the concentration in a single unit of mechanism for accomplishing all functions.

More or less units could be employed in the chain by increasing or decreasing the number of teeth in the ratchet 24 accordingly.

It is apparent that the embodiment herein set forth is susceptible of many variations which would lie within the scope of the invention.

In the claims the word "train" is used as including either a regular train of engine and cars, an engine alone, a car alone, or, in fact, any vehicle operating over the line.

What I claim is—

1. A plurality of distributed, normally-inactive units some of which being in a chain are active, one of the active units being in protective condition and others in non-protective condition, and means operated by a train for dropping a unit from the chain and for changing a unit in the chain from non-protective to protective condition.

2. A plurality of distributed, normally-inactive units some of which being in a chain are active, some of the active units being in protective condition and others in non-protective condition, and means operated by a train for linking an inactive unit into the chain and for dropping a unit from the chain and for changing a unit near the rear end of the chain into protective condition and changing a unit near the front end of the chain into non-protective condition.

3. A plurality of distributed, normally-inactive protective units some of which being in a chain are active, and means controlled by a train for linking units into the chain and for dropping units from the chain as the train travels and for maintaining units at both ends of the chain in protective condition and maintaining intermediate units in non-protective condition.

4. A plurality of distributed, normally-inactive units each operative by successive steps through a cycle, mechanism in each unit for rendering the unit protective or non-protective according to its position of its cycle, and means controlled by a train for exercising simultaneously a definite number of units through different cycle-steps.

5. A plurality of distributed, units a number of units adjacent the train being in a chain forming a protective zone and means operated by a train for rendering protective a definite number of the active units in the zone back of the train and for linking other units with the chain and dropping units at the same rate from the chain to maintain the zone of constant length.

6. A plurality of distributed units, a number of said units adjacent a train being in a chain forming a protective zone, and means operated by the train for linking other units with the chain and dropping units from the chain to maintain the zone adjacent the train as it travels.

7. A plurality of distributed units, a number of said units, adjacent a train being in a chain forming a protective zone in which the train is intermediate the limits thereof, and means operated by the train for linking units from without the chain into the chain and retiring units from the chain to maintain the zone in substantially constant position relatively to the train as it travels.

8. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating successively with protective units in the order of their location along the track and signaling the latter train when in conjunction with the first-met protective unit.

9. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating successively with protective units in the order of their location along the track and stopping the latter train when in conjunction with the second-met protective unit.

10. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating successively with protective units in the order of their location along the track and operating a signal on the latter train when in conjunction with the first-met protective unit.

11. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating successively with protective units in the order of their location along the track and setting the brakes on the latter train when in conjunction with the second-met active unit.

12. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating successively with protective units for operating a signal on the latter train when in conjunction with the first-met protective unit, and for setting the brakes on the latter train when in conjunction with the second-met protective unit.

13. A plurality of distributed units, means operated by a train for rendering certain of the units protective, and means carried by a train for coöperating with a protective unit and first operating a signal on the latter train, and for stopping the train when brought into conjunction with another protective unit.

14. A plurality of distributed units, certain of the units being in a chain forming a protective zone, means operated by a train for rendering certain of the units in the zone protective, an electric circuit on a train, and means on the latter train for coöperating with a protective unit controlling the electric circuit and means operated by the former train

for linking units into the chain and retiring units from the chain to cause progression of the zone.

15. A plurality of distributed units, certain of the units being in a chain forming a protective zone, means operated by a train for rendering certain units in the zone protective, an electric circuit on a train, a signaling device on the latter train, means coöperating with protective units for controlling the electric circuit and signaling device on the latter train and means operated by the former train for linking units into the chain and retiring units from the chain to cause progression of the zone.

16. A plurality of distributed units, certain of the units being in a chain forming a protective zone, means operated by a train for rendering certain units in the zone protective, an electric circuit on a train, brakes for the latter train, means coöperating with protective units for controlling the electric circuit and brakes and means operated by the former train for linking units into the chain and retiring units from the chain to cause progression of the zone.

17. A plurality of distributed units, certain of the units being in a chain forming a protective zone, means operated by a train for rendering certain units in the zone protective, an electric circuit on a train, brakes for the latter train, a signaling device on the latter train, and means coöperating with protective units for controlling the electric circuit, brakes and signaling device and means operated by the former train for linking units into the chain and retiring units from the chain to cause progression of the zone.

18. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, means for exerting equal opposing forces on the chain, thereby balancing the chain, and means operated by a train for unbalancing the chain.

19. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, means for exerting equal opposing forces on the chain thereby balancing the chain, and means operated by a train at an intermediate point in the chain for unbalancing the chain.

20. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, means for exerting definite counteracting forces on the chain and means operated by a train for changing the ratio of the counteracting forces.

21. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, means for normally exerting definite counteracting forces on the chain, and means operated by a train for momentarily changing the ratio of the counteracting forces thereby actuating the chain.

22. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections, and means operated by a train for actuating the connections and operating the units coupled therewith.

23. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, counteracting-springs connected with the chain, and means operated by a train for reducing the aggregate power of one set of springs.

24. A plurality of distributed units, connections therefor, certain of the units being coupled with the connections thereby forming a chain, counteracting-springs connected with the chain, and means operated by a train for reducing the aggregate power of one set of springs and for increasing the aggregate power of the other set of springs.

25. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, and means for coupling and uncoupling each connection at definite strokes of its associated shiftable element.

26. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, and means associated with each unit and operable by a train for actuating the shiftable element.

27. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, and means for coupling and uncoupling each connection at definite strokes of its associated shiftable element.

28. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, and means associated with each unit and operable by a train for actuating the shiftable element.

29. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, means for coupling and uncoupling each connection

at definite strokes of its associated shiftable element, a trip device associated with each unit and operated by the shiftable element, and means for coacting with the trip device for operating train-guarding devices on trains.

30. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, a trip device associated with each unit and operated by the shiftable element, means for coacting with the trip device for operating train-guarding devices on trains, and means associated with each unit and operable by a train for actuating the shiftable element.

31. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, means associated with each unit and operable by a train for actuating the shiftable element, and a device associated with each unit for rendering said last means inoperable during certain strokes of the shiftable element.

32. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, means associated with each unit and operable by a train for actuating the shiftable element, and a device associated with each unit for rendering said last means inoperable during certain strokes of the shiftable element.

33. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for exerting opposing forces on each shiftable element, the opposition of said means being broken when the associated connection is uncoupled but the power of said means being maintained, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, a trip device associated with each unit and operated by the shiftable element, means for coacting with the trip device for operating train-guarding devices on trains, means associated with each unit and operable by a train for actuating the shiftable element, and a device associated with each unit for rendering said last means inoperable during certain strokes of the shiftable element.

34. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, and a track-lever associated with each unit adapted to be depressed by a train for actuating the shiftable element.

35. A plurality of distributed units, each unit embracing a shiftable element, connections for the units, means for coupling and uncoupling each connection at definite strokes of its associated shiftable element, a track-lever associated with each unit adapted to be depressed by a train for actuating the shiftable element, and means with each unit for holding said track-lever down after it is depressed by a train during a definite number of strokes of the shiftable element.

36. A plurality of units each operative by successive steps through a cycle, trip devices controlled by the units, mechanism in each unit for setting trip devices at definite cycle positions of the unit and means operated by a train for operating a plurality of units each through a definite cycle-point.

37. A plurality of units each operative by successive steps through a cycle, means embraced by a unit for coöperating with devices on trains, connections for the units, mechanism in each unit for coupling the unit with a connection, and means operated by a train for actuating a plurality of units and thereby controlling the coupling mechanism thereof.

38. A plurality of units each operative by successive steps through a cycle, trip devices for the units, each unit embracing mechanism for operating a trip device at definite points in the cycle of the unit, connections for the units, coupling mechanism associated with each unit for coupling or uncoupling the unit at definite cycle-points and means operated by a train for actuating a series of coupled units substantially simultaneously, each through different cycle-points.

In testimony whereof I have hereunto set my hand, at Los Angeles, California, this 31st day of August, 1904.

HENRY M. DAVENPORT.

In presence of—

GEORGE T. HACKLEY,

M. L. DAVENPORT.