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(54) EXPLOSIVE AUTOLOADING SYSTEM AND EXPLOSIVE AUTOLOADING METHOD

(57) In a tunnel constructed with delay blasting, explosive corresponding to the number of stages of a face plane is loaded automatically into the blasting holes of the face plane. This explosive autoloading system is provided with: a control device that has a storage unit which, for each hole number of multiple blasting holes, stores blasting hole information that associates blasting hole position information, which includes three-dimensional coordinate values of the blasting holes, and blasting hole stage number information, which relates to the number of stages of blasting holes; and an explosive autoloading device which is mounted on an explosive loading boom of a heavy construction machine. The controller controls the explosive loading boom and the explosive autoloading device while referring to the blasting hole position information and the blasting holes stage number information, and performs explosive autoloading control so as to automatically load, in loading blasting holes in which the detonation explosive is to be loaded, a detonation explosive which has a detonation time corresponding to the number of stages of the loading blasting holes.

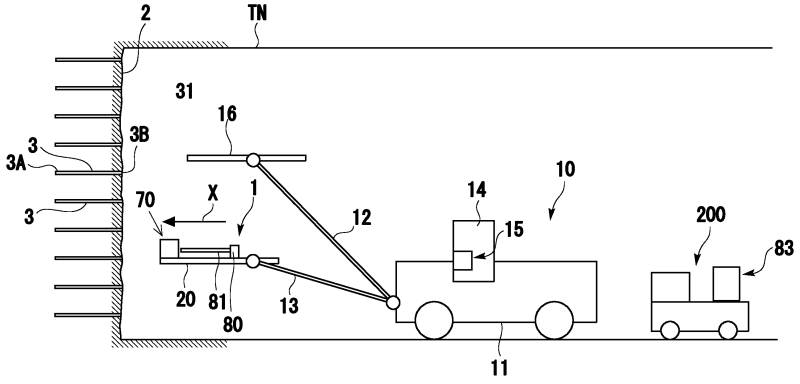

FIG. 1

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Description

Technical Field

[0001] The present invention relates to an explosive autoloading system and an explosive autoloading method for loading explosives into blast holes bored in a tunnel face of a tunnel constructed by a delay blasting method.

Background Art

[0002] A blasting method is known as a tunnel excavation method. When a tunnel is excavated by the blasting method, explosives to which detonators are attached are inserted into a plurality of blast holes (explosive-loading holes) bored in a tunnel face of the tunnel, and the explosives are blasted by detonating the detonators to excavate the tunnel face.

[0003] Conventionally, it has been common for workers to manually load explosives into blast holes at a tunnel site constructed by the blasting method. This loading work involves pushing the explosives into the blast holes sequentially using a long rod, which requires very hard labor.

[0004] Therefore, there has been proposed a technique in which a detonator dynamite for initiation and an additional dynamite (extra dynamite) for increasing blasting power at the time of blasting are loaded into a blast hole from a position apart from the tunnel face using a hose and a pipe (for example, see Patent documents 1 to 3, etc.). This type of explosive loading technique is also called machine loading (remote loading), or the like. In such machine loading, a worker aboard a cage of a drill jumbo inserts a tip of a loading pipe into a blast hole bored in the tunnel face, pressure-feeds compressed air from a loader provided at a proximal end of a hose coupled to the loading pipe toward the tip of the loading pipe, and loads a detonator dynamite and an additional dynamite together with the compressed air into an explosive-loading hole using the loading pipe, for example.

[0005] In the machine loading of the explosives, the worker must perform the work of inserting the loading pipe connected with the hose into the blast hole on a narrow cage, resulting in poor workability, and working efficiency varies depending on the skill and experience of the worker, resulting in a reduction or variation in the working efficiency, thereby leading to increased work cycle time which affects the construction schedule. When the worker aboard the cage performs the work of inserting the loading pipe into the blast hole, the worker may be forced to approach the tunnel face, and therefore improvement in safety is desired.

[0006] On the other hand, there is also proposed an explosive autoloading device that automatically loads explosives into blast holes to improve the safety when the explosives are loaded into the blast holes and to achieve labor saving. For example, Patent document 4 discloses an explosive autoloading apparatus comprising a cage, a loading pipe that is provided on the cage to be movable forward and backward in an explosive loading direction, a detonator dynamite feeding mechanism that is provided on the cage and in front of the loading pipe and is capable of feeding a detonator dynamite coaxially with the loading pipe, a loading hose that is connected in communication with the rear of the loading pipe, and an explosive loading mechanism that is coupled to the loading hose and causes an additional dynamite to pass through interiors of the loading hose and the loading pipe to pressure-feed the additional dynamite, so that the detonator dynamite can be inserted into a tip of the loading pipe. According to the description of Patent document 4, the loading pipe is moved in the loading direction in the state in which the detonator dynamite is fed to the tip of the loading pipe, so that the tip reaches an innermost portion of a blast hole, and then the additional dynamite is fed from the rear of the loading pipe, and at the same time, the loading pipe is drawn from the blast hole, whereby the detonator dynamite and the additional dynamite can be loaded into the blast hole.

[0007] A delay blasting method is known as one of the blasting methods. The delay blasting method is a method of setting a plurality of regions to be blasted in a tunnel face and providing a time lag in initiation timing of a detonator for each of the plurality of set regions to be blasted to perform the blasting. When a delay number in a region to be blasted is increased, the initiation lag time of the delay detonator used for blasting the region to be blasted is normally set to a larger value.

Citation List

Patent document

[0008]

Patent document 1: Japanese Patent No. 2860847
Patent document 2: Japanese Patent No. 5614139
Patent document 3: Japanese Patent No. 5854923
Patent document 4: Japanese Patent Laid-Open No. 2008-25972

Summary of Invention

Technical Problem

[0009] However, Patent document 4 does not presuppose that the explosive autoloading apparatus disclosed in this document is applied to the delay blasting method. In other words, Patent document 4 discloses that the explosive autoloading apparatus includes a detonator dynamite cassette in which a plurality of detonator dynamites can be held, but Patent document 4 does not include a technique of selecting an appropriate detonator dynamite for which the initiation lag time of the detonator is set according to the delay number in the region to be blasted of the tunnel face and loading the appropriate

detonator dynamite into a blast hole, and this suggests that there is still room for more improvement.

[0010] Therefore, the present invention has been made in view of the above-mentioned problems, and therefore has an object to provide a technique that is capable of automatically loading an explosive corresponding to a delay number in a region to be blasted of a tunnel face into a blast hole bored in the tunnel face in a tunnel constructed by a delay blasting method.

Solution to Problem

[0011] To solve the above problem, the present invention employed the following means. That is, the present invention provides an explosive autoloading system that is applied to a delay blasting method of performing blasting with a time lag for each of a plurality of regions to be blasted assigned to a tunnel face of a tunnel and loads explosives into a plurality of blast holes bored in the tunnel face, the explosive autoloading system comprising a control device that includes a memory unit that stores, for each of hole numbers of the plurality of blast holes bored in the tunnel face, blast hole information that associates blast hole position information including three-dimensional coordinate values of the blast hole, with blast hole delay number information about a delay number of the blast hole set corresponding to an initiation lag time of an initiating explosive to be loaded into the blast hole, and an explosive autoloading apparatus that is mounted on an explosive loading boom of a heavy construction machine, wherein the control device controls the explosive loading boom and the explosive autoloading apparatus while referring to the blast hole position information and the blast hole delay number information, and automatically loads, to a loading target blast hole, an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole which is a target into which the initiating explosive is to be loaded.

[0012] Here, the explosive autoloading apparatus may comprise a loading rod that is capable of holding an initiating explosive at a tip, a loading rod feeding mechanism that drives the loading rod, an initiating explosive feeding device that includes an initiating explosive accommodation unit that accommodates a plurality of initiating explosives, and an initiating explosive accommodation unit driving mechanism that drives the initiating explosive accommodation unit.

[0013] The loading rod may be mounted on the explosive loading boom to be movable forward and backward along a preset initiating explosive loading direction, the loading rod feeding mechanism may be configured to be driven forward and backward along the initiating explosive loading direction, and the initiating explosive accommodation unit may be provided in front of the loading rod.

[0014] The control device may be configured to refer to the blast hole position information and control the explosive loading boom, thereby positioning a tip of the loading rod so that the tip of the loading rod coaxially faces the loading target blast hole, refer to the blast hole delay number information and control the initiating explosive accommodation unit driving mechanism, thereby feeding an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole to a predetermined initiating explosive feeding position located coaxially in front of the loading rod, and control the loading rod feeding mechanism to move the loading rod forward along the initiating explosive loading direction, thereby loading the initiating explosive fed to the initiating explosive feeding position into the loading target bore hole while holding the initiating explosive at the tip of the loading rod.

[0015] The loading rod is of a hollow pipe type in which a hollow passage is formed, the hollow passage being connected with a pumping hose that pressure-feeds an additional explosive for increasing blasting power at a time of blasting, an additional explosive feeding apparatus is further provided which has a pumping hose connected to the hollow passage and pressure-feeds an additional explosive for increasing blasting power at a time of blasting to the hollow portion of the loading rod via the pumping hose, and in the explosive autoloading control, after loading an initiating explosive into the loading target blast hole, the control device may load the additional explosive into the loading target blast hole by pressure-feeding the additional explosive from a tip of the hollow passage via the pumping hose while causing the loading rod feeding mechanism to move the loading rod backward along the initiating explosive loading direction.

[0016] The initiating explosive accommodation unit includes a plurality of partitioned accommodation portions which are capable of accommodating initiating explosives sorted to have different initiation lag times from each other, and is provided to be reciprocatingly movable along a loading perpendicular direction perpendicular to an initiating explosive loading direction with respect to the explosive loading boom, the plurality of partitioned accommodation portions are arranged along the loading perpendicular direction, and in the explosive autoloading control, the initiating explosive accommodation unit driving mechanism may move the initiating explosive accommodation unit along the loading perpendicular direction so that a partitioned accommodation portion in which an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole is accommodated is located coaxially with the loading rod.

[0017] The initiating explosive accommodation unit includes an initiating explosive discharge port that is opened on a front surface of each of the partitioned accommodation portions, a rod insertion port that is opened on a rear surface of each of the partitioned accommodation portions and is arranged to face the initiating explosive discharge port along the loading direction, and the loading rod feeding mechanism may discharge an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole from

the initiating explosive discharge port in a state in which the initiating explosive is held in a tip of the loading rod by inserting the loading rod moved forward along the initiating explosive loading direction into the partitioned accommodation portion from the rod insertion port.

[0018] In the initiating explosive accommodation unit, the initiating explosive discharge port and the rod insertion port are formed at positions near a bottom surface of each partitioned accommodation portion, and each of the partitioned accommodation portions may be capable of accommodating initiating explosives of the same initiation lag time and may be provided with a press mechanism that presses, toward the bottom surface, initiating explosives accommodated in each of the partitioned accommodation portion.

[0019] The initiating explosive accommodation unit accommodates a plurality of initiating explosive attachments attached with initiating explosives so that the hollow portion remains on an inner side of a rear end of the cylindrical holding body, and the loading rod may be capable of holding the initiating explosive attachment by inserting the tip of the loading rod into the hollow portion in the inner side of the rear end of the cylindrical holding body.

[0020] The present invention can be identified as an explosive autoloading method executed by the control device in the explosive autoloading system according to any one of the configurations described above.

[0021] The explosive autoloading method according to the present invention comprises a storage step of storing, for each of hole numbers of a plurality of blast holes bored in the tunnel face, blast hole information that associates blast hole position information including three-dimensional coordinate values of the blast hole, with blast hole delay number information about a delay number of the blast hole set corresponding to an initiation lag time of an initiating explosive to be loaded into the blast hole, a rod positioning step of moving a loading rod mounted on an explosive loading boom of a heavy construction machine to be movable forward and backward along a preset initiating explosive loading direction while referring to the blast hole position information and positioning a tip of the loading rod to coaxially face a loading target blast hole into which an explosive is to be loaded, an initiating explosive feeding step of moving an initiating explosive accommodation unit which is provided in front of the loading rod above the loading boom while referring to the blast hole delay number information and feeding an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole to a predetermined initiating explosive feeding portion located coaxially in front of the loading rod, and an initiating explosive loading step of moving the loading rod forward along the initiating explosive loading direction and loading the initiating explosive fed to the initiating explosive feeding position in the initiating explosive feeding step into an innermost portion of the loading target blast hole while holding the initiating explosive in a tip of the loading rod.

Effects of Invention

[0022] According to the present invention, there can be provided a technique that is capable of automatically loading an explosive corresponding to a delay number in a region to be blasted of a tunnel face into a blast hole bored in a tunnel face in a tunnel constructed by a delay blasting method.

Brief Description of Drawings

[0023]

Fig. 1 is a diagram illustrating an overall schematic configuration in which an explosive loading apparatus that loads explosives into a plurality of blast holes for blasting bored in a tunnel face of a tunnel according to Embodiment 1 is mounted on a heavy construction machine.

Fig. 2 is a front view illustrating an arrangement example of the plurality of blast holes formed in the tunnel face.

Fig. 3 is a diagram illustrating a situation after an explosive is loaded into the blast hole bored in the tunnel face.

Fig. 4 is a side view of a detonator dynamite attachment.

Fig. 5 is an exploded view of the detonator dynamite attachment.

Fig. 6 is a schematic side view of the explosive loading apparatus mounted on a guide cell.

Fig. 7 is a schematic front view of the explosive loading apparatus mounted on the guide cell.

Fig. 8 is a diagram illustrating an additional explosive feeding device.

Fig. 9 is a front view of a detonator dynamite accommodation unit.

Fig. 10 is a rear view of the detonator dynamite accommodation unit.

Fig. 11 is a side view of the detonator dynamite accommodation unit.

Fig. 12 is a top view of the detonator dynamite accommodation unit.

Fig. 13 is a diagram illustrating various devices mounted in an operation seat.

Fig. 14 is a diagram illustrating process flow of explosive autoloading control.

Fig. 15 is a diagram illustrating a situation where a rod positioning step has been completed.

Fig. 16 is a diagram illustrating a situation of an initiating explosive loading step.

Fig. 17 is a diagram illustrating a guide function of a conical guide portion in the detonator dynamite attachment.

Fig. 18 is a diagram illustrating a situation where the initiating explosive loading step has been completed.

Fig. 19 is a diagram illustrating a situation where an additional explosive loading step has been completed.

Description of Embodiment

[0024] Hereinafter, embodiments of the present invention will be described with reference to the drawings. Note that the configurations, combinations thereof, and the like in the embodiments are examples, and addition, omission, replacement, and other modifications of the configurations can be made without departing from the spirit of the present invention where appropriate.

<Embodiment 1>

[0025] Fig. 1 is a diagram illustrating an overall schematic configuration in which an explosive loading apparatus 1 that loads explosives into a plurality of blast holes (explosive-loading holes) 3 bored in a tunnel face (rock mass) 2 of a tunnel TN according to Embodiment 1 is mounted on a heavy construction machine. The tunnel TN according to Embodiment 1 is constructed by a blasting method of inserting an explosive to which a detonator is attached into each blast hole 3 bored in the tunnel face 2 and blasting the explosive by initiating the detonator to excavate the tunnel face 2.

[0026] In Fig. 1, the explosive loading apparatus 1 is mounted on a drill jumbo 10. As illustrated in Fig. 1, in the tunnel face 2, the plurality of blast holes 3 are bored at a predetermined boring depth.

[0027] As illustrated in Fig. 1, the drill jumbo 10 includes a self-traveling carriage 11, a boring boom 12 provided on a front side of the carriage 11, an explosive loading boom 13, an operation seat 14, a control device 15, a driving power unit (not illustrated), and the like. The boring boom 12 and the explosive loading boom 13 are pivotably coupled to a front end of the carriage 11, and are movable in an extendable and retractable, tiltable, swingable, or rotatable manner under the operation of a driving mechanism provided to the boring boom 12 and the explosive loading boom 13. In an example illustrated in Fig. 1, a pair of explosive loading booms 13 are provided to the drill jumbo 10, but the number of explosive loading boom 13 is not limited to a particular number.

[0028] A rock mass boring machine 16 is pivotably supported by the boring boom 12. As the rock mass boring machine 16, a known machine is adopted, which bores the blast holes 3 in the tunnel face 2 (rock mass) by the hammering motion and the rotation action of an excavating drill, for example.

[0029] Fig. 2 is a front view illustrating an arrangement example of the plurality of blast holes 3 formed in the tunnel face 2. In the present embodiment, a delay blasting method is used for excavating the tunnel face 2. The delay blasting method is a method of setting a plurality of regions to be blasted in the tunnel face 2 and providing a time lag in initiation timing of a detonator for initiating an explosive for each of the plurality of set regions to be blasted to perform the blasting.

[0030] Reference symbols #1 to #10 illustrated in Fig. 2 each indicate a delay number (corresponding to the blast holes 3) to which the plurality of blast holes 3 belong. In the present embodiment, a plurality of regions to be blasted are set in the tunnel face 2, and delay numbers are assigned (set) to correspond to the respective regions to be blasted. In an example illustrated in Fig. 2, 10 types of regions to be blasted are set in the tunnel face 2, and a first delay interval #1 to tenth delay interval #10 are assigned to the respective regions to be blasted. Note that, in Fig. 2, each blast hole group that includes blast holes 3 belonging to the same delay number is indicated by connecting groups of the blast holes by broken lines, the blast holes 3 being close to each other, in order to make it easy to understand the distribution of delay intervals #1 to #10 in the tunnel face 2. Note that the arrangement pattern and the delay numbers of the blast holes 3 illustrated in Fig. 2, and the number of blast holes 3 belonging to each delay interval are not limited to particular ones.

[0031] Fig. 3 is a diagram illustrating the situation after an explosive is loaded into the blast hole 3 bored in the tunnel face 2. Fig. 3 illustrates a longitudinal sectional view along a boring direction (axial direction) of the blast hole 3. Although details will be described later, in the present embodiment, explosives are loaded into the blast holes 3 not manually but automatically using the explosive loading apparatus 1.

[0032] In Fig. 3, reference symbol 3A denotes an innermost portion of the blast hole 3, and reference symbol 3B denotes an opening of the blast hole 3. Reference symbol 5 denotes a detonator dynamite attachment in which a detonator dynamite with a detonator is attached, the detonator dynamite being an initiating explosive. Reference symbol 6 denotes an additional dynamite which is an additional explosive for increasing blasting power at the time of blasting. The additional dynamite 6 is not limited to a particular type, and, for example, a particulate explosive, or a bulk-type explosive can be suitably used. However, the additional dynamite 6 is not limited to a particulate explosive or a bulk-type explosive, and a cartridge-type explosive may be also employed. In the present embodiment, the particulate explosive is employed by way of example.

[0033] Fig. 4 is a side view of the detonator dynamite attachment 5. FIG. 5 is an exploded view of the detonator dynamite attachment 5. The detonator dynamite attachment 5 has an internally hollow cylindrical (tubular) member 51 and a conical guide portion 52 connected and attached to a front end 51a side of the cylindrical member 51, and the detonator dynamite 4 is accommodated in the cylindrical member 51. In the present embodiment, the cylindrical member 51 of the detonator dynamite attachment 5 is a paper tube having a cylindrical shape, and the conical guide portion 52 of the detonator dynamite attachment 5 is also made of paper. However, the

cylindrical member 51 and the conical guide portion 52 in the detonator dynamite attachment 5 are not limited to paper, and various materials may be used therefor. The conical guide portion 52 has a cone shape, and is attached to the front end 51A of the cylindrical member 51 coaxially with the cylindrical member 51. Note that reference symbol 5A denotes a tip of the detonator dynamite attachment 5. The tip 5A of the detonator dynamite attachment 5 is formed by an apex on the tip side of the conical guide portion 52. Reference symbol 5B denotes a rear end of the detonator dynamite attachment 5, the rear end being formed by a rear end of the cylindrical member 51. The detonator dynamite attachment 5 configured as described above is set so that an outer diameter of the cylindrical member 51 has a smaller dimension than a diameter of the blast hole 3, which makes it possible to load the detonator dynamite attachment 5 into the blast hole 3 as illustrated in Fig. 3.

[0034] The detonator dynamite 4 employs a water containing explosive cartridge, for example, and is formed in the form of a packed explosive (cartridge type) which is packed by paper, plastic film or the like. The detonator dynamite 4 has a delay detonator 41, and a leg wire 42 is connected to the delay detonator 41. The delay detonator 41 in the present embodiment can employ a detonator with a fuse tube (non-electric detonator), for example, to prevent static electricity. However, the delay detonator 41 may be an electric detonator. Note that, when the electric detonator is used for the delay detonator 41, the cylindrical member 51 and the conical guide portion 52 in the detonator dynamite attachment 5 are preferably made of paper to prevent static electricity. In the delay detonator 41, a delay charge is interposed between an ignition charge and an initiating explosive that are accommodated in a case, and the initiation lag time (standard delay time) is set depending on the type of the delay detonator 41 to reach the initiation after a delay of a predetermined time period after a shock wave for actuation (an operating current when the electric detonator is used) is fed via the leg wire 42 (fuse tube). In the delay detonator 41, the initiation lag time may be set to an interval of several tenths of a second, for example. Note that the delay detonator 41 may be, for example, a wireless detonator having an antenna for a wireless initiating detonator (e.g., a receiving coil, etc.) that receives alternating magnetic field energy wirelessly transmitted from an initiation operation device. Such a wireless delay detonator makes it unnecessary to connect the leg wire 42 to the delay detonator 41.

[0035] In the detonator dynamite attachment 5, for example, a hole from which the leg wire 42 is drawn to the outside is provided in the conical guide portion 52 and the leg wire 42 is drawn to the outside from the drawing hole. The length of the cylindrical member 51 is longer than that of the detonator dynamite 4, and the detonator dynamite 4 is attached on the front end 51A side of the cylindrical member 51 as illustrated in Fig. 5. Therefore, a hollow portion 53 is formed inside the cylindrical member 51 on the rear end 51B side. That is, the detonator dynamite attachment 5 is attached with the detonator dynamite 4 so that the hollow portion 53 remains on an inner side of the rear end of the cylindrical member 51. Reference symbol 43 illustrated in Figs. 4 and 5 denotes a binding material that binds the leg wire 42. The binding material 43 binds the leg wire 42 in a midway portion of the leg wire 42 annularly and individually, whereby a ring-shaped portion 42A is formed in the midway portion of the leg wire 42. The binding material 43 is made of paper, for example, and is formed of an easy-to-break material easily breakable by a small external force, and therefore, the binding material 43 is configured to be capable of easily unwinding the bundle of the leg wire 42 by the small external force. Note that as illustrated in Fig. 3, in the state after the detonator dynamite 4 attached to the detonator dynamite attachment 5 and the additional dynamite 6 are loaded into the blast hole 3 in the tunnel face 2, the binding material 43 is broken and a bundle of the leg wire 42 is unwound. As illustrated in Fig. 3, in the state in which the loading of the detonator dynamite attachment 5 into the blast hole 3 has been completed, the tip 5A of the detonator dynamite attachment 5 is located at the innermost portion 3A of the blast hole 3.

[0036] Next, a configuration of the explosive loading apparatus 1 will be described in detail. The explosive loading apparatus 1 is mounted on a guide cell 20 of the explosive loading boom 13, as illustrated in Fig. 1. Fig. 6 is a schematic side view of the explosive loading apparatus 1 mounted on the guide cell 20. Fig. 7 is a schematic front view of the explosive loading apparatus 1 mounted on the guide cell 20. Fig. 6 illustrates a front-rear direction of the guide cell 20. The explosive loading boom 13 is provided with the driving mechanism (not illustrated) that drives the guide cell 20, so that the guide cell 20 is movable swingably in the horizontal direction, swingably in the vertical direction, and forward and backward in the front-rear direction under the operation of the driving mechanism. In the guide cell 20 attached to the explosive loading boom 13, the front portion is located toward the tunnel face 2 side and the rear portion is located toward the carriage 11 side, when the explosives (the detonator dynamite 4 and the additional dynamite 6) are autoloaded into the blast hole 3 in the tunnel face 2 using the explosive loading apparatus 1 mounted on the drill jumbo 10.

[0037] As illustrated in Figs. 6 and 7, the explosive loading apparatus 1 includes a detonator dynamite feeding device 70, a loading rod 81, a loading rod feeding mechanism 80, and the like that are mounted on the guide cell 20. Although details will be described later, the detonator dynamite feeding device 70 (initiating explosive feeding device) includes a detonator dynamite accommodation unit 100 (initiating explosive accommodation unit) that accommodates a plurality of detonator dynamite attachments 5, and a detonator dynamite accommodation unit driving mechanism 90 (initiating explosive accommodation unit driving mechanism) that drives the

detonator dynamite accommodation unit 100.

[0038] The loading rod feeding mechanism 80 is attached with a rear end side of an elongated pipe-shaped loading rod 81 extending in one direction. The loading rod feeding mechanism 80 holds the loading rod 81 in a posture in which the axial direction of the loading rod 81 is parallel to a direction in which the guide cell 20 extends in a state in which a tip 811 of the loading rod 81 is oriented forward of the guide cell 20.

An arrow X illustrated in Fig. 6 indicates a preset initiating explosive loading direction. In the present embodiment, a center axis C1 of the loading rod 81 is parallel to an initiating explosive loading direction X, and the loading rod 81 is held by the loading rod feeding mechanism 80 to be drivable forward and backward along the initiating explosive loading direction X. Note that the outer diameter of the tip 811 of the loading rod 81 has a slightly smaller dimension than an inner diameter of the rear end 5B of the detonator dynamite attachment 5 (cylindrical member 51). Therefore, the tip 811 of the loading rod 81 is inserted into the hollow portion 53 from the rear end 5B side of the detonator dynamite attachment 5 (cylindrical member 51), whereby the detonator dynamite attachment 5 can be held by the tip 811 side of the loading rod 81.

[0039] Note that the material forming the loading rod 81 is not limited to a particular material, but the loading rod 81 is preferably formed of a member such as a synthetic resin having certain degree of rigidity. The guide cell 20 may be provided with a support member 21 that does not inhibit forward and backward movement of the loading rod 81 along the initiating explosive loading direction X and supports the posture of the elongated loading rod 81 in parallel with the initiating explosive loading direction X.

[0040] The loading rod feeding mechanism 80 attached to the guide cell 20 is movable forward and backward along the front-rear direction of the guide cell 20. The loading rod feeding mechanism 80 may be configured by a drifter supported on a top surface of the guide cell 20, for example, and is guided by the guide cell 20, thereby being reciprocatingly movable along the front-rear direction of the guide cell 20. The loading rod feeding mechanism 80 can move forward and backward in the front-rear direction along the extending direction of the guide cell 20 under the operation of a feeder (not illustrated), for example. The feeder that is a driving source of the loading rod feeding mechanism 80 can be configured by a hydraulic cylinder, or the like, for example, but the loading rod feeding mechanism 80 may be driven by an electric driving source.

[0041] As illustrated in Fig. 6, the loading rod 81 is of a hollow pipe type in which a hollow passage 812 is formed.

The rear end side of the loading rod 81 is connected with a pumping hose 82 that pressure-feeds the additional dynamite 6 (additional explosive), so that the pumping hose 82 communicates with the hollow passage 812. The pumping hose 82 may be formed of a synthetic resin hose, a rubber hose, or the like.

[0042] Fig. 8 is a diagram illustrating an additional explosive feeding device 83 that pressure-feeds the additional dynamite 6 to the loading rod 81 via the pumping hose 82. The additional explosive feeding device 83 is mounted on a load bed or the like of a work vehicle 200 (see Fig. 1) arranged with respect to the tunnel face 2, on the rear side of the drill jumbo 10, for example. However, the additional explosive feeding device 83 may be mounted on the drill jumbo 10 or may be arranged at other locations. The additional explosive feeding device 83 includes an air compressor (air pressure-feeding device) 84, a hopper 85 that stores the additional dynamite 6, a chute 86, the pumping hose 82, an air feeding hose 87, a junction pipe 88, and the like. The hopper 85 includes a transfer mechanism 89 that can automatically measure the additional dynamite 6 to be stored to feed a preset amount of additional dynamite 6 to the chute 86, for example. As such a transfer mechanism 89, a rotary valve, or the like may be employed, for example. Furthermore, the junction pipe 88 is connected to a lower end of the chute 86, and the pumping hose 82 is connected to the junction pipe 88. The junction pipe 88 is connected with the air feeding hose 87 extending from the air compressor 84. Therefore, the additional dynamite 6 transferred from the hopper 85 to the chute 86 under the operation of the transfer mechanism 89 combines with the compressed air fed from the air compressor 84 via the air feeding hose 87 at the junction pipe 88, and is pressure-fed together with the compressed air toward the hollow passage 812 in the loading rod 81 via the pumping hose 82.

[0043] Next, returning to Figs. 6 and 7, the detonator dynamite feeding device 70 will be described. As described above, the detonator dynamite feeding device 70 includes the detonator dynamite accommodation unit 100 (initiating explosive accommodation unit), and the detonator dynamite accommodation unit driving mechanism 90 (initiating explosive accommodation unit driving mechanism) for holding and driving the detonator dynamite accommodation unit 100. The detonator dynamite accommodation unit driving mechanism 90 includes a fixing portion 91 that is fixed to the guide cell 20, and a slider 92 provided to be interposed between the fixing portion 91 and the detonator dynamite accommodation unit 100.

[0044] The slider 92 includes a placement portion 93 on which the detonator dynamite accommodation unit 100 can be placed and fixed, and a driving portion 94 interposed between the placement portion 93 and the fixing portion 91. In an example illustrated in Figs. 6 and 7, the detonator dynamite accommodation unit 100 is an accommodation box having a substantially rectangular parallelepiped shape. The placement portion 93 of the slider 92 is formed of a flat steel plate on which a bottom of the detonator dynamite accommodation unit 100 can be placed and fixed, for example, and holds the detonator

dynamite accommodation unit 100 above the guide cell 20 and in a posture parallel to the top surface of the guide cell 20. The slider 92 of the detonator dynamite accommodation unit driving mechanism 90 can cause the detonator dynamite accommodation unit 100 that is held on the placement portion 93 to reciprocatingly move along a predetermined loading perpendicular direction Y. The loading perpendicular direction Y is a direction perpendicular to the above-described initiating explosive loading direction X, and corresponds to a width direction of the guide cell 20 in this example. The driving portion 94 of the slider 92 may be a linear motion mechanism including a linear shaft that is provided on one sides of the placement portion 93 and the fixing portion 91 and extends along the loading perpendicular direction Y, and a linear bush housing unit that is provided on the other sides and accommodates the linear shaft, for example. However, the driving portion 94 of the slider 92 is not limited to the linear motion mechanism having the above-described configuration.

[0045] The detonator dynamite accommodation unit driving mechanism 90 is controlled by the control device 15 to thereby feed, to a predetermined initiating explosive feeding position located coaxially in front of the loading rod 81, the detonator dynamite attachment 5 attached with the detonator dynamite 4 having the initiation lag time corresponding to the delay number of target blast holes which are the blast holes 3 into which the explosives are to be loaded.

[0046] Figs. 9 to 12 each are a diagram illustrating the detonator dynamite accommodation unit 100. Fig. 9 is a front view of the detonator dynamite accommodation unit 100. Fig. 10 is a rear view of the detonator dynamite accommodation unit 100. Fig. 11 is a side view of the detonator dynamite accommodation unit 100. Fig. 12 is a top view of the detonator dynamite accommodation unit 100. The detonator dynamite accommodation unit 100 is a case having a substantially rectangular parallelepiped shape whose contour is defined by a front surface 101, a rear surface 102, a pair of side surfaces 103, a top surface 104, and a bottom surface 105, which accommodates a plurality of detonator dynamite attachments 5. A direction perpendicular to the front-rear direction and the up-down direction of the detonator dynamite accommodation unit 100 is referred to as a width direction. Each direction of the detonator dynamite accommodation unit 100 illustrated in Figs. 9 to 12 represents a relative positional relationship of each element of the detonator dynamite accommodation unit 100.

[0047] The rear surface 102, the pair of side surfaces 103, and the bottom surface 105 of the detonator dynamite accommodation unit 100 are provided with a rear wall 110, side walls 120, and a bottom wall 130, respectively. The top surface 104 of the detonator dynamite accommodation unit 100 is opened.

[0048] The interior of the detonator dynamite accommodation unit 100 is divided into a plurality of partitioned accommodation portions 150 by partition walls 140. In the present embodiment, nine partition walls 140 are arranged at intervals in the width direction of the detonator dynamite accommodation unit 100, and the interior of the detonator dynamite accommodation unit 100 is divided into a first partitioned accommodation portion 150 (#1) to a tenth partitioned accommodation portion 150 (#10). Each partition wall 140 is arranged in parallel to the side surfaces 103 (side walls 120) and extends from the front surface 101 to the rear surface 102. Each partition wall 140 is arranged at constant intervals in the width direction of the detonator dynamite accommodation unit 100. As a result, the width dimensions of the partitioned accommodation portions 150 are equal to each other. As illustrated in Figs. 6 and 7, the detonator dynamite accommodation unit 100 is installed on the placement portion 93 of the slider 92 in a posture in which the front-rear direction thereof is parallel to the initiating explosive loading direction X and the width dimension is parallel to the loading perpendicular direction Y. As described above, each partitioned accommodation portion 150 in the detonator dynamite accommodation unit 100 is arranged side by side along the loading perpendicular direction Y. That is, the front-rear direction of each partitioned accommodation portion 150 in the detonator dynamite accommodation unit 100 is parallel to the loading perpendicular direction Y and the center axis C1 of the loading rod 81.

[0049] The plurality of partitioned accommodation portions 150 (#1 to #10) in the detonator dynamite accommodation unit 100 are configured to be capable of accommodating the detonator dynamite attachments 5 attached with the detonator dynamites 4 sorted so that the respective delay detonators 41 have different initiation lag times from each other. Each of the partitioned accommodation portions 150 is configured to be capable of accommodating a plurality of initiating explosives having the same initiation lag time. In the delay blasting method according to the present embodiment, the first delay interval #1 to the tenth delay interval #10 are assigned to the respective regions to be blasted set in the tunnel face 2, as illustrated in Fig. 2. Here, when the blast holes 3 belonging to (corresponding to) the first delay interval #1 to the tenth delay interval #10 are defined as first delay blast holes 3 (#1) to tenth delay blast holes 3 (#10), respectively, first detonator dynamite attachments 5 (#1) to tenth detonator dynamite attachments 5 (#10) attached with the detonator dynamites 4 having the initiation lag times corresponding to the delay number #1 to #10 are loaded into the first delay blast holes 3 (#1) to the tenth delay blast holes 3 (#10). In the detonator dynamite accommodation unit 100, the first detonator dynamite attachments 5 (#1) to the tenth detonator dynamite attachments 5 (#10) into which the detonator dynamite attachments 5 are sorted are accommodated in the first partitioned accommodation portion 150 (#1) to the tenth partitioned accommodation portion 150 (#10), respectively. The number of detonator dynamite attachments 5 capable of being accommodated in each parti-

tioned accommodation portion 150 is not limited to a particular number, but, for example, about five detonator dynamite attachments 5 can be accommodated in each partitioned accommodation portion 150. As a matter of course, the capacity of each partitioned accommodation portion 150 in which the detonator dynamite attachments 5 can be accommodated may be increased or decreased depending on the number of blast hole groups belonging to each delay interval set to the tunnel face 2. As apparent from Figs. 11 and 12, the detonator dynamite attachment 5 in each partitioned accommodation portion 150 is accommodated in a state in which the tip 5A side is located on the front surface 101 side and the rear end 5B side is located on the rear surface 102 side.

[0050] Here, the width dimension of each partitioned accommodation portion 150 is set to a dimension corresponding approximately to the outer diameter of the cylindrical member 51 in the detonator dynamite attachment 5 (or may be a slightly larger dimension than the outer diameter of the cylindrical member 51). Therefore, in each partitioned accommodation portion 150, the plurality of detonator dynamite attachments 5 are accommodated in a state of being aligned in multiple stages in the up-down direction. Hereinafter, the plurality of detonator dynamite attachments 5 accommodated in each partitioned accommodation portion 150 are referred to as the lowermost stage (first stage) of detonator dynamite attachment 5, the second stage of detonator dynamite attachment 5, ..., and the uppermost stage of detonator dynamite attachment 5, respectively, in this order from a position closer to the bottom surface 105 (bottom wall 130).

[0051] The rear wall 110 of the detonator dynamite accommodation unit 100 covers the rear surface 102 while retaining a lower region in the rear surface 102 as an opening. Therefore, in the lower region of the rear surface 102 in each partitioned accommodation portion 150, a "rod insertion port 106" is formed as an opening. The rod insertion port 106 is an opening for inserting, into the partitioned accommodation portion 150, the loading rod 8 that is driven forward along the initiating explosive loading direction X by the loading rod feeding mechanism 80 illustrated in Fig. 6. The height dimension of the rod insertion port 106 has a dimension larger than the outer diameter of the cylindrical member 51 and smaller than twice the outer diameter of the cylindrical member 51 in the detonator dynamite attachment 5.

[0052] A stopper plate 160 that partially covers the front surface 101 is provided in the front surface 101 of the detonator dynamite accommodation unit 100. As illustrated in Figs. 9 and 12, the stopper plate 160 is attached to the front end of the partition wall 140 of each of the plurality of partitioned accommodation portions 150. The partition wall 140 in each partitioned accommodation portion 150 is arranged so that a discharge port 107 is formed in a lower region of the front surface 101 in each partitioned accommodation portion 150. The discharge port 107 is an opening for discharging to outside the lowermost stage (first stage) of detonator dynamite attachment 5 that is accommodated in each partitioned accommodation portion 150, and corresponds to an initiating explosive discharge port. The discharge port 107 formed on the front surface 101 side of each partitioned accommodation portion 150 is arranged to face the rod insertion port 106 formed on the rear surface 102 side. Similar to the rod insertion port 106, the height dimension of the discharge port 107 in each partitioned accommodation portion 150 also has a dimension larger than the outer diameter of the cylindrical member 51 and smaller than twice the outer diameter of the cylindrical member 51 in the detonator dynamite attachment 5. Therefore, each partitioned accommodation portion 150 can discharge only the lowermost stage (first stage) of detonator dynamite attachment 5 to the outside via the discharge port 107.

[0053] The detonator dynamite attachments 5 located in the second stage to the uppermost stage in each partitioned accommodation portion 150 are prevented by the stopper plate 160 from being discharged to the outside from the front surface 101. Here, the lateral width dimension of the stopper plate 160 has a smaller dimension than the lateral width dimension of each partitioned accommodation portion 150. Therefore, a leg wire drawing opening 108 is formed on the side portion of (beside) the stopper plate 160 in each partitioned accommodation portion 150, and the leg wire 42 of the detonator dynamite attachment 5 can be drawn to the outside via the leg wire drawing opening 108. Note that Fig. 9 illustrates the leg wires 42 of only some of the detonator dynamite attachments 5 accommodated in the detonator dynamite accommodation unit 100 for convenience of drawing.

[0054] Furthermore, in each partitioned accommodation portion 150 of the detonator dynamite accommodation unit 100, a press mechanism 170 is installed, which presses the detonator dynamite attachments 5 accommodated in each partitioned accommodation portion 150 toward the lower side (bottom surface 105). A specific configuration of the press mechanism 170 is not limited to a particular configuration, but for example, the press mechanism 170 may include a pressing plate 171 having an oblong shape, and a torsion spring 172 interposed between the pressing plate 171 and the rear wall 110. Reference symbol 171A illustrated in Fig. 11 denotes a rotary shaft portion provided on the proximal end side of the pressing plate 171. The rotary shaft portion 171A of each pressing plate 171 may be supported on the partition wall 140 or the side wall 120. The pressing plate 171 is urged in a direction A illustrated in Fig. 11 by an elastic force of the torsion spring 172. Therefore, the detonator dynamite attachments 5 accommodated in each partitioned accommodation portion 150 can be always pressed toward the lower side (bottom surface 105) by the pressing plate 171 of the press mechanism 170. This enables the lowermost stage (first stage) of detonator dynamite attachment 5 to be always pressed toward the bottom surface 105 (bottom wall 130) even when the pos-

ture of the detonator dynamite accommodation unit 100 is tilted when the explosive loading boom 13 and the guide cell 20 are driven.

[0055] An explosive loading system S including the explosive loading apparatus 1 configured as described above is applied to the delay blasting method of performing the blasting with a time lag for each of a plurality of regions to be blasted assigned to the tunnel face 2 of the tunnel TN, and the explosive loading apparatus 1 is used to perform the explosive autoloading control of automatically loading explosives into the plurality of blast holes 3 bored in the tunnel face 2. The explosive loading system S in the present embodiment includes the above-described drill jumbo 10, the additional explosive feeding device 83, and the control device 15, and the control device 15 controls the explosive loading apparatus 1 and the additional explosive feeding device 83 to thereby perform the explosive autoloading control.

[0056] Hereinafter, the detail of the explosive autoloading control executed by the control device 15 will be described.

Fig. 13 is a diagram illustrating various devices mounted in the operation seat 14. The operation seat 14 is provided with a monitor (display device) 210, the control device 15, and an input device (a remote switch 231 for loading, a control panel 232, a keyboard 233, a pointing device 234, etc.) to the control device 15. In the drill jumbo 10, the worker can manually operate the boring boom 12, the explosive loading boom 13, the guide cell 20, the explosive loading apparatus 1, the additional explosive feeding device 83, etc. in the drill jumbo 10 using various devices of the input device. In the explosive autoloading control, the control device 15 controls the explosive loading boom 13, the guide cell 20, the explosive loading apparatus 1, and the like to thereby enable automatic or semi-automatic loading of the detonator dynamite 4 and the additional dynamite 6 into the blast holes 3 bored in the tunnel face 2. The control device 15 is, but is not limited to, for example, a computer provided with an input unit, a processing unit, and an output unit, and the like. The processing unit of the control device 15 can be configured to include a processor for executing various programs, various programs necessary for the operation of the processor, a main memory (memory unit) that stores various information, and the like.

[0057] Hereinafter, the work procedure of the explosive autoloading control executed by the control device 15 of the explosive autoloading system S will be described. Fig. 14 is a diagram illustrating a procedure flow of the explosive autoloading control executed by the control device 15 of the explosive autoloading system S. First, as illustrated in Fig. 1, the carriage 11 of the drill jumbo 10 travels and moves to near the tunnel face 2 planned to be blasted, and a plurality of blast holes 3, 3, ... each having a predetermined length are bored sequentially by driving the boring boom 12 and the rock mass boring machine 16 at boring planned positions in the tunnel face 2 according to the blasting pattern (step S1). When the blast holes 3 are bored by the rock mass boring machine 16 of the drill jumbo 10, the control device 15 associates hole numbers with all the blast holes 3. Then, the control device 15 causes the main memory to store, for each of the hole numbers of the blast holes 3, blast hole information that associates blast hole position information including three-dimensional coordinate values of a first coordinate P1 (X1, Y1, Z1) of an opening 3B corresponding to the hole number and a second coordinate P2 (X2, Y2, Z2) of an innermost portion 3A corresponding to the hole number, with blast hole delay number information about a delay number for the blast hole 3 corresponding to the hole number (storage step). Note that the drill jumbo 10 may be a full auto drill jumbo (also referred to as a "computer drill jumbo"), and the blast holes 3 may be bored at the boring planned positions in the tunnel face 2 sequentially by automatically controlling the boring boom 12 and the rock mass boring machine 16 on the basis of boring planned position information of the blast holes 3 stored in the main memory of the control device 10. In the example illustrated in Fig. 2, in the tunnel face 2, the first delay interval #1 to the tenth delay interval #10 are assigned to the respective regions to be blasted, and in step S1, the first delay blast holes 3 (#1) to the tenth delay blast holes (#10) each including one or a plurality of blast hole group is bored with respect to the first delay interval #1 to the tenth delay interval #10 in the tunnel face 2. The detonator dynamites 4 for which the initiation lag times are set in association with the respective delay numbers are inserted into the first delay blast holes 3 (#1) to the tenth delay blast holes 3 (#10).

[0058] Next, the explosive loading boom 13 is arranged near the tunnel face 2 in which the blast holes 3 are bored, under the operation via the input device (e.g., the control panel 232). As illustrated in Fig. 1, the work vehicle 200 is arranged behind the drill jumbo 10, and a predetermined amount of additional dynamite 6 is loaded into the hopper 85 in the additional explosive feeding device 83.

[0059] Next, in step S2, by computer control of the control device 15, with reference to the blast hole position information including the three-dimensional coordinate values of a first coordinate P1 (X1, Y1, Z1) and a second coordinate P2 (X2, Y2, Z2) of the blast hole 3 corresponding to the preset hole number, the explosive loading boom 13 and the guide cell 20 of the drill jumbo 10 are automatically driven, and the loading rod 81 is positioned so that the tip of the loading rod coaxially faces a loading target blast hole 3_{TGT} into which explosives (the detonator dynamite 4, the additional dynamite 6) are to be loaded this time among the blast holes 3 bored at a plurality of positions in the tunnel face 2 (rod positioning step) . As described above, when the blast holes 3 are bored in the tunnel face 2 by the rock mass boring machine 16 of the drill jumbo 10, the control device 15 causes the main memory to store, for each of the hole numbers of the blast holes 3, the blast hole position information that associates a first coordinate P1 (X1, Y1, Z1) of an opening

3B and a second coordinate P2 (X2, Y2, Z2) of an innermost portion 3A in the blast hole 3, with the hole number, and the blast hole delay number information about the delay number of the blast hole 3 corresponding to the hole number, the blast hole position information being associated with the blast hole delay number information. Therefore, the control device 15 refers to the blast hole position information, and reads the first coordinate P1 (X1, Y1, Z1) and the second coordinate P2 (X2, Y2, Z2) corresponding to the loading target blast hole 3_{TGT}, whereby the loading rod 81 can be positioned so that the tip 811 of the loading rod 81 faces the loading target blast hole 3_{TGT}. Fig. 15 is a diagram illustrating a situation where the rod positioning step has been completed. Hereinafter, the position of the loading rod 81 in a state in which the rod positioning step has been completed is referred to as a "rod positioning completed position". In Fig. 15, the center axis C1 of the loading rod 81 in the state of being arranged at the rod positioning completed position is positioned coaxially with respect to a center axis C2 of the loading target blast hole 3_{TGT}, and the tip 811 of the loading rod 81 is arranged at position separated from the opening 3B of the loading target blast hole 3_{TGT} by a predetermined dimension. In the state in which the loading rod 81 is arranged at the rod positioning completed position, a distance of the tip 811 of the loading rod 81 from the opening 3B (hereinafter, referred to as an "initial rod-to-opening distance") is not limited to a particular dimension.

[0060] Next, the control device 15 refers to the blast hole delay number information and controls the detonator dynamite accommodation unit driving mechanism 90, thereby moving the detonator dynamite accommodation unit 100 (initiating explosive accommodation unit) provided in front of the loading rod 81 above the explosive loading boom 13 (guide cell 20) along the loading perpendicular direction Y and feeding the detonator dynamite 4 (initiating explosive) having the initiation lag time corresponding to the delay number of the loading target blast hole 3_{TGT} to the initiating explosive feeding position located coaxially in front of the loading rod 81 (initiating explosive feeding step). In the above-described configuration example, the interior of the detonator dynamite accommodation unit 100 is divided into the first partitioned accommodation portion 150 (#1) to the tenth partitioned accommodation portion 150 (#10). Accordingly, the control device 15 feeds, to the above-described initiating explosive feeding position, the detonator dynamite attachment 5 attached with the detonator dynamite 4 for which the initiation lag time corresponding to the delay number of the loading target blast hole 3_{TGT} is set.

[0061] As described above, the detonator dynamite accommodation unit 100 includes a plurality of partitioned accommodation portions 150 which can accommodate the detonator dynamite attachments 5 attached with the detonator dynamites 4 (initiating explosives) sorted to have different initiation lag times from each other, and is provided to be reciprocatingly movable along the loading perpendicular direction Y with respect to the explosive loading boom 13 (guide cell 20). Each partitioned accommodation portion 150 is arranged in the loading perpendicular direction Y and is provided to be reciprocatingly movable along the loading perpendicular direction perpendicular to the loading direction. Therefore, in the initiating explosive feeding step, the control device 15 causes the detonator dynamite accommodation unit 100 to be moved along the loading perpendicular direction Y by automatic control of the detonator dynamite accommodation unit driving mechanism 90, whereby the partitioned accommodation portion 150 (hereinafter, referred to as a "loading target partitioned accommodation portion 150_{TGT} ") in which the detonator dynamite attachment 5 (hereinafter, referred to as a "loading target detonator dynamite attachment 5_{TGT}) is accommodated, the detonator dynamite attachment 5 being attached with the detonator dynamite 4 for which the initiation lag time corresponding to the delay number of the loading target blast hole 3_{TGT} is set, can be arranged at the initiating explosive feeding position located coaxially in front of the loading rod 81.

[0062] Furthermore, in the present embodiment, the installation relationship between the detonator dynamite accommodation unit 100 installed on the placement portion 93 of the slider 92 and the loading rod 81 held by the loading rod feeding mechanism 80 is defined so that the height of the center axis of the detonator dynamite attachment 5 accommodated in the lowermost stage (first stage) in each partitioned accommodation portion 150 of the detonator dynamite accommodation unit 100 is substantially equal to the height of the center axis C1 of the loading rod 81 above the explosive loading boom 13 (guide cell 20). The width dimension of each partitioned accommodation portion 150 in the detonator dynamite accommodation unit 100 is set to a dimension corresponding approximately to the outer diameter of the cylindrical member 51 in the detonator dynamite attachment 5 as described above. Therefore, the detonator dynamite attachment 5 is accommodated in each partitioned accommodation portion 150 in the state in which the center axis position of the detonator dynamite attachment 5 (cylindrical member 51) is aligned with the center position in the width direction in each partitioned accommodation portion 150. In the above-described initiating explosive feeding step, the control device 15 causes the detonator dynamite accommodation unit 100 to be moved so that the center position in the width direction in the loading target partitioned accommodation portion 150_{TGT} is arranged coaxially with the loading rod 81 (on an extension line of the center axis C1). Thus, the center axis of the loading target detonator dynamite attachment 5_{TGT} accommodated in the lowermost stage (first stage) in the loading target partitioned accommodation portion 150_{TGT} can be arranged coaxially with the center axis C1 of the loading rod 81.

[0063] Here, for example, when the delay number of the loading target blast hole 3_{TGT} is the eighth delay in-

terval #8 (i.e., when the loading target blast hole 3_{TGT} is the eighth delay blast hole (#8), the control device 15 activates the slider 92 so that the center position in the width direction of the eighth partitioned accommodation portion 150 (#8) in which the eighth detonator dynamite attachment 5 (#8) as the loading target detonator dynamite attachment 5_{TGT} is accommodated is arranged coaxially in front of the loading rod 81 (on the extension line of the center axis C1). As a result, the center axis of the eighth detonator dynamite attachment 5 (#8) accommodated in the lowermost stage (first stage) in the eighth partitioned accommodation portion 150 (#8) as the loading target partitioned accommodation portion 150_{TGT} can be arranged coaxially with the center axis C1 of the loading rod 81. As a result, the eighth detonator dynamite attachment 5 (#8) as the loading target partitioned accommodation portion 150_{TGT} can be arranged at the initiating explosive feeding position located coaxially in front of the loading rod 81.

[0064] Next, in step S3, the control device 15 automatically controls the loading rod feeding mechanism 80, moves the loading rod 81 forward along the initiating explosive loading direction X, and loads the loading target detonator dynamite attachment 5_{TGT} into the innermost portion 3A of the loading target blast hole 3_{TGT} while holding the loading target detonator dynamite attachment 5_{TGT} fed to the initiating explosive feeding position in the tip 811 of the loading rod 81.

[0065] As described above, in each partitioned accommodation portion 150 of the detonator dynamite accommodation unit 100, the discharge port 107 is formed in the lower region of the front surface 101. Therefore, when the loading rod 81 is moved forward along the initiating explosive loading direction X by the loading rod feeding mechanism 80, the tip 811 of the loading rod 81 can be inserted from the rod insertion port 106 corresponding to the loading target partitioned accommodation portion 150_{TGT} in the detonator dynamite accommodation unit 100.

[0066] The detonator dynamite attachment 5 is attached with the detonator dynamite 4 so that the hollow portion 53 remains on an inner side of the rear end of the cylindrical member 51. Therefore, in the initiating explosive loading step, the tip 811 of the loading rod 81 inserted into the loading target partitioned accommodation portion 150_{TGT} from the rod insertion port 106 is inserted into the hollow portion 53 of the loading target detonator dynamite attachment 5_{TGT} located at the lowermost stage in the loading target partitioned accommodation portion 150_{TGT}, whereby the loading target detonator dynamite attachment 5_{TGT} can be held in the tip 811 of the loading rod 81. This enables the loading target detonator dynamite attachment 5_{TGT} held in the tip 811 of the loading rod 81 to be easily moved forward by the loading rod 81, the tip 811 of the loading rod 81 being inserted into the loading target partitioned accommodation portion 150_{TGT} from the rod insertion port 106. Note that the loading target detonator dynamite attachment 5_{TGT} is held coaxially by the loading rod 81.

[0067] Fig. 16 is a diagram illustrating a situation of the initiating explosive loading step. In the present embodiment, the discharge port 107 formed in the lower region in the front surface 101 side of each partitioned accommodation portion 150 is formed to face the rod insertion port 106 formed in the lower region on the rear surface 102 side. Therefore, in the initiating explosive loading step, the loading rod 81 in the state in which the loading target detonator dynamite attachment 5_{TGT} is held is moved further forward along the initiating explosive loading direction X, whereby the loading target detonator dynamite attachment 5_{TGT} in the lowermost stage (first stage) in the loading target partitioned accommodation portion 150_{TGT} can be discharged from the discharge port 107. The extending direction in the front-rear direction of each partitioned accommodation portion 150 of the detonator dynamite accommodation unit 100 is parallel to the initiating explosive loading direction X and the center axis C1 direction of the loading rod 81. Therefore, the loading target detonator dynamite attachment 5_{TGT} held in the loading rod 81 is moved along the front-rear direction of each partitioned accommodation portion 150 by moving the loading rod 81 forward along the initiating explosive loading direction X, whereby the loading target detonator dynamite attachment 5_{TGT} can be smoothly discharged from the discharge port 107. Since the stopper plate 160 is provided in the front surface 101 of each partitioned accommodation portion 150 to prevent the detonator dynamite attachments 5 located in the second stage to the uppermost stage in each partitioned accommodation portion 150 from being discharged from the front surface 101 side, the detonator dynamite attachments 5 located in the second stage and subsequent stages can be prevented by the friction with the loading target detonator dynamite attachment 5_{TGT} from being discharged from the front surface 101 side when the loading target detonator dynamite attachment 5_{TGT} in the lowermost stage is moved forward by the loading rod 81.

[0068] In the above-described rod positioning step, the loading rod 81 is positioned so that the center axis C1 of the loading rod 81 is arranged coaxially relative to the center axis C2 of the loading target blast hole 3_{TGT}. Therefore, in the initiating explosive loading step, the loading rod 81 in the state in which the loading target detonator dynamite attachment 5_{TGT} is held is moved further forward along the initiating explosive loading direction X, whereby the loading target detonator dynamite attachment 5_{TGT} can be smoothly inserted into the loading target blast hole 3_{TGT} from the tip 5A side.

[0069] Incidentally, in the above-described rod positioning step, the center axis C1 of the loading rod 81 is positioned to be arranged coaxially relative to the center axis C2 of the loading target blast hole 3_{TGT}, but the case is assumed that the positioning error in several centimeters level is caused actually. Fig. 17 is a diagram illustrating a guide function of the conical guide portion 52 in the detonator dynamite attachment 5. Fig. 17 illustrates

a situation where the initiating explosive loading step is performed under the circumstance where the center axis C1 of the loading rod 81 is eccentric relative to the center axis C2 of the loading target blast hole 3_{TGT}.

Note that in Fig. 17, the loading rod feeding mechanism 80 and the detonator dynamite accommodation unit 100 are not illustrated.

[0070] In the detonator dynamite attachment 5 in the present embodiment, the conical guide portion 52 is provided at the front end 51A of the cylindrical holding body 51, and the conical guide portion 52 has a cone shape as described above. Therefore, even when the loading rod 81 is moved forward in the state in which the loading rod 81 is eccentric relative to the loading target blast hole 3_{TGT}, the detonator dynamite attachment 5 can be moved to the inside of the loading target blast hole 3_{TGT} while bringing the side surface of the conical guide portion 52 having collided with an edge (edge 2A in the tunnel face) in the opening 3B of the loading target blast hole 3_{TGT} during the initiating explosive loading step into sliding contact with the opening 3B (edge 2A). That is, the detonator dynamite attachment 5 can be smoothly inserted into the inside of the loading target blast hole 3_{TGT} while reducing an amount of eccentricity of the center axis C1 of the loading rod 81 which is eccentric relative to the center axis C2 of the loading target blast hole 3_{TGT} at the time of the rod positioning completed position. Even when an obstacle 3C such as a falling rock caused by the hole damage or the like exists in the loading target blast hole 3_{TGT} in the course of moving the loading target detonator dynamite attachment 5_{TGT} forward to the innermost portion 3A of the loading target blast hole 3_{TGT}, the detonator dynamite attachment 5 can be moved forward toward the innermost portion 3A while bringing the side surface of the conical guide portion 52 into sliding contact with the obstacle 3C.

[0071] As illustrated in Fig. 16, in the initiating explosive loading step in the present embodiment, the leg wire 42 connected to the delay detonator 41 in the loading target detonator dynamite attachment 5_{TGT} (detonator dynamite attachment 5) may be inserted into the loading target blast hole 3_{TGT} (blast hole 3) in the state of being bundled by the binding material 43. In this case, the diameter of the ring-shaped portion 42A formed by bundling the leg wire 42 in a ring shape by the binding material 43 is set to have a larger dimension than the diameter of the opening 3B of the blast hole 3. Then, the ring-shaped portion 42A for bundling the leg wire 42 is caught in the edge 2A located around of the opening 3B in the course of inserting the loading target detonator dynamite attachment 5_{TGT} (detonator dynamite attachment 5) into the loading target blast hole 3_{TGT} (blast hole 3), and the resulting resistance causes the breakage of the binding material 43. As a result, the bundle of the leg wire 42 by the binding material 43 can be automatically unwound. Here, the binding material 43 is formed of an easy-to-break material such as paper, and therefore, the binding material 43 can be easily broken by the small force. Therefore, in the course of unwinding the bundle of the leg wire 42 during the initiating explosive loading step, a large load can be prevented from being applied to the leg wire 42.

[0072] The following another embodiment may be employed as a method of automatically unwinding the bundle of the leg wire 42 in the loading target detonator dynamite attachment 5_{TGT} (detonator dynamite attachment 5) during the initiating explosive loading step. For example, one or a plurality of leg wire holding rod members for hanging and holding the ring-shaped portion 42a of the leg wire 42 in each detonator dynamite attachment 5 may be provided at an appropriate position in the outer surface of the detonator dynamite accommodation unit 100 in the present embodiment. Such a leg wire holding rod member may be provided on the side surface 103 (outer surface of the side wall 120) of the detonator dynamite accommodation unit 100, for example. From the viewpoint of orderly holding the ring-shaped portion 42A of the leg wire 42 in each detonator dynamite attachment 5 in the leg wire holding rod member, the detonator dynamite accommodation unit 100 preferably includes a plurality of holding rod members 42A.

[0073] For example, the detonator dynamite accommodation unit 100 preferably includes one or a plurality of leg wire rod members for each of left and right side surfaces 103. When the loading target detonator dynamite attachment 5_{TGT} held in the loading rod 81 is moved forward in the initiating explosive loading step, the stress is applied to the binding material 43 bundling the ring-shaped portion 42A held in the leg wire holding rod member during this step, whereby the binding material 43 can be broken by the stress. Of course, the binding material 43 is formed of an easy-to-break material such as paper, and therefore, the stress is not applied to the wire 42 before the binding material 43 is broken. Also in such an embodiment, the ring-shaped portion 42A is held in the leg wire holding rod member in advance, the bundle of the leg wire 42 by the binding material 43 can be automatically unwound during the initiating explosive loading step. Note that after the bundle of the leg wire 42 by the binding material 43 is unwound, the leg wire 42 can be fed continuously from the leg wire holding rod member when the loading rod 81 is moved forward.

[0074] Note that when the leg wire holding rod member is provided in the side surface 103 in the detonator dynamite accommodation unit 100, the leg wire holding rod member may be provided to protrude laterally from the side surface 103. When a plurality of leg wire holding rod members are provided in the side surface 103 in the detonator dynamite accommodation unit 100, the plurality of leg wire holding rod members may be provided on different levels in the up-down direction of the detonator dynamite accommodation unit 100. When the plurality of leg wire holding rod members are provided on different levels, the leg wires 42 held in each leg wire holding rod member are unlikely to be entangled with each other.

[0075] In the above-described initiating explosive loading step, the control device 15 calculates a forward move-

ment amount of the loading rod 81 and drives the loading rod feeding mechanism 80 on the basis of the calculated forward movement amount of the loading rod 81. The forward movement amount of the loading rod 81 can be calculated on the basis of the design lengths of the initial rod-to-hole distance and the loading target blast hole 3_{TGT} in the state in which the loading rod 81 is arranged at the rod positioning completed position, for example. The control device 15 may calculate the forward movement amount of the loading rod 81 required to position the tip 5A of the loading target detonator dynamite attachment 5_{TGT} at the innermost portion 3A of the loading target blast hole 3_{TGT} on the basis of the loading target blast hole 3_{TGT} and the initial rod-to-hole distance, the loading target blast hole 3_{TGT} being calculated on the basis of the first coordinate P1 (X1, Y1, Z1) of the opening 3B and the second coordinate P2 (X2, Y2, Z2) of the innermost portion 3A in the loading target blast hole 3_{TGT} that are stored in the blast hole position information. In this way, when the control device 15 automatically controls the loading rod feeding mechanism 80, the loading of the loading target detonator dynamite attachment 5_{TGT} is completed in the state in which the tip 5A of the mounting target detonator dynamite attachment 5_{TGT} is positioned at the innermost portion 3A of the mounting target blast hole 3_{TGT}, as illustrated in Fig. 18.

[0076] Then, after the initiating explosive loading step, in step S4, the control device 15 controls the loading rod feeding mechanism 80 to activate the additional explosive feeding device 83 while moving the loading rod 81 backward, and pressure-feed the additional dynamite 6 (additional explosive) to the hollow passage 812 of the loading rod 81 via the pumping hose 82 (additional explosive loading step). The additional dynamite 6 press-fed to the hollow passage 812 of the loading rod 81 is loaded into the inside of the loading target blast hole 3_{TGT} from the tip 811 of the loading rod 81 (hollow passage 812). Fig. 19 is a diagram illustrating a situation where the additional explosive loading step has been completed. When the additional explosive loading step is completed, the loading of the detonator dynamite 4 (detonator dynamite attachment 5) and the additional dynamite 6 into the inside of the loading target blast hole 3_{TGT} is completed. As illustrated in Fig. 19, in the state in which the loading rod 81 is withdrawn from the loading target blast hole 3_{TGT}, the control device 15 controls to automatically load explosives (the detonator dynamite 4, the additional dynamite 6) into next loading target blast hole 3_{TGT}. That is, each step of the above-described steps S2 to S4 is sequentially repeated, and therefore the work of loading explosives (the detonator dynamite 4, the additional dynamite 6) into all the blast holes 3 can be automatically performed.

[0077] As described above, according to the explosive loading system S including the explosive loading apparatus 1 and the control device 15, the explosives corresponding to the delay numbers of the regions to be blasted assigned to the tunnel face 2 of the tunnel TN can be automatically loaded to the blast holes 3.

Reference Signs List

[0078]

1	Explosive loading apparatus
2	Tunnel face
3	Blast hole
4	Detonator dynamite
5	Detonator dynamite attachment
6	Additional dynamite
10	Drill jumbo
13	Explosive loading boom
20	Guide cell
70	Detonator dynamite feeding device
80	Loading rod feeding mechanism
81	Loading rod
83	Additional explosive feeding device
90	Detonator dynamite accommodation unit driving mechanism
100	Detonator dynamite accommodation unit
140	Partition wall
150	Partitioned accommodation portion

Claims

1. An explosive autoloading system that is applied to a delay blasting method of performing blasting with a time lag for each of a plurality of regions to be blasted assigned to a tunnel face of a tunnel and loads explosives into a plurality of blast holes bored in the tunnel face, the explosive autoloading system comprising:

a control device that includes a memory unit that stores, for each of hole numbers of the plurality of blast holes bored in the tunnel face, blast hole information that associates blast hole position information including three-dimensional coordinate values of the blast hole, with blast hole delay number information about a delay number of the blast hole set corresponding to an initiation lag time of an initiating explosive to be loaded into the blast hole; and

an explosive autoloading apparatus that is mounted on an explosive loading boom of a heavy construction machine,

wherein the control device controls the explosive loading boom and the explosive autoloading apparatus while referring to the blast hole position information and the blast hole delay number information, and automatically loads, to a loading target blast hole, an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole which is a target into which the initiating explo-

sive is to be loaded.

2. The explosive autoloading system according to claim 1, wherein
the explosive autoloading apparatus comprises:

a loading rod that is capable of holding an initiating explosive at a tip;
a loading rod feeding mechanism that drives the loading rod; and
an initiating explosive feeding device that includes:

an initiating explosive accommodation unit that accommodates a plurality of initiating explosives; and
an initiating explosive accommodation unit driving mechanism that drives the initiating explosive accommodation unit.

3. The explosive autoloading system according to claim 2, wherein

the loading rod is mounted on the explosive loading boom to be movable forward and backward along a preset initiating explosive loading direction,
the loading rod feeding mechanism is configured to be driven forward and backward along the initiating explosive loading direction, and
the initiating explosive accommodation unit is provided in front of the loading rod.

4. The explosive autoloading system according to claim 3, wherein

the control device is configured to
refer to the blast hole position information and control the explosive loading boom, thereby positioning a tip of the loading rod so that the tip of the loading rod coaxially faces the loading target blast hole,
refer to the blast hole delay number information and control the initiating explosive accommodation unit driving mechanism, thereby feeding an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole to a predetermined initiating explosive feeding position located coaxially in front of the loading rod, and
control the loading rod feeding mechanism to move the loading rod forward along the initiating explosive loading direction, thereby loading the initiating explosive fed to the initiating explosive feeding position into the loading target bore hole while holding the initiating explosive at the tip of the loading rod.

5. The explosive autoloading system according to claim 4, wherein

the loading rod is of a hollow pipe type in which a hollow passage is formed, the hollow passage being connected with a pumping hose that pressure-feeds an additional explosive for increasing blasting power at a time of blasting,
an additional explosive feeding apparatus is further provided which has a pumping hose connected to the hollow passage and pressure-feeds an additional explosive for increasing blasting power via the pumping hose at a time of blasting to the hollow passage of the loading rod, and
in the explosive autoloading control, after loading an initiating explosive into the loading target blast hole, the control device loads the additional explosive into the loading target blast hole by pressure-feeding the additional explosive from a tip of the hollow passage via the pumping hose while causing the loading rod feeding mechanism to move the loading rod backward along the initiating explosive loading direction.

6. The explosive autoloading system according to any one of claims 3 to 5, wherein

the initiating explosive accommodation unit includes a plurality of partitioned accommodation portions which are capable of accommodating initiating explosives sorted to have different initiation lag times from each other, and is provided to be reciprocatingly movable along a loading perpendicular direction perpendicular to an initiating explosive loading direction with respect to the explosive loading boom,
the plurality of partitioned accommodation portions are arranged along the loading perpendicular direction, and
in the explosive autoloading control, the initiating explosive accommodation unit driving mechanism moves the initiating explosive accommodation unit along the loading perpendicular direction so that a partitioned accommodation portion in which an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole is accommodated is located coaxially with the loading rod.

7. The explosive autoloading system according to claim 6, wherein

the initiating explosive accommodation unit includes an initiating explosive discharge port that is opened on a front surface of each of the partitioned accommodation portions, a rod insertion

port that is opened on a rear surface of each of the partitioned accommodation portions and is arranged to face the initiating explosive discharge port along the loading direction, and
the loading rod feeding mechanism discharges an initiating explosive having an initiation lag time corresponding to a delay number of the loading target blast hole from the initiating explosive discharge port in a state in which the initiating explosive is held in a tip of the loading rod by inserting the loading rod moved forward along the initiating explosive loading direction into the partitioned accommodation portion from the rod insertion port.

8. The explosive autoloading system according to claim 7, wherein

the initiating explosive discharge port and the rod insertion port are formed at positions near a bottom surface of each partitioned accommodation portion, and
each of the partitioned accommodation portions is capable of accommodating initiating explosives having the same initiation lag time and is provided with a press mechanism that presses, toward the bottom surface, initiating explosives accommodated in each of the partitioned accommodation portions.

9. The explosive autoloading system according to any one of claims 2 to 8, wherein

the initiating explosive accommodation unit accommodates a plurality of initiating explosive attachments attached with initiating explosives so that the hollow portion remains on an inner side of a rear end of the cylindrical holding body, and the loading rod is capable of holding the initiating explosive attachment by inserting the tip of the loading rod into the hollow portion in the inner side of the rear end of the cylindrical holding body.

10. An explosive autoloading method executed by the explosive autoloading system according to any one of claims 1 to 9, wherein
the control device controls the explosive loading boom and the explosive autoloading apparatus while referring to the blast hole position information and the blast hole delay number information, and performs an explosive autoloading control of automatically loading, into the loading target blast hole, an initiating explosive having an initiation lag time corresponding to a delay number of a loading target blast hole into which the initiating explosive is to be loaded.

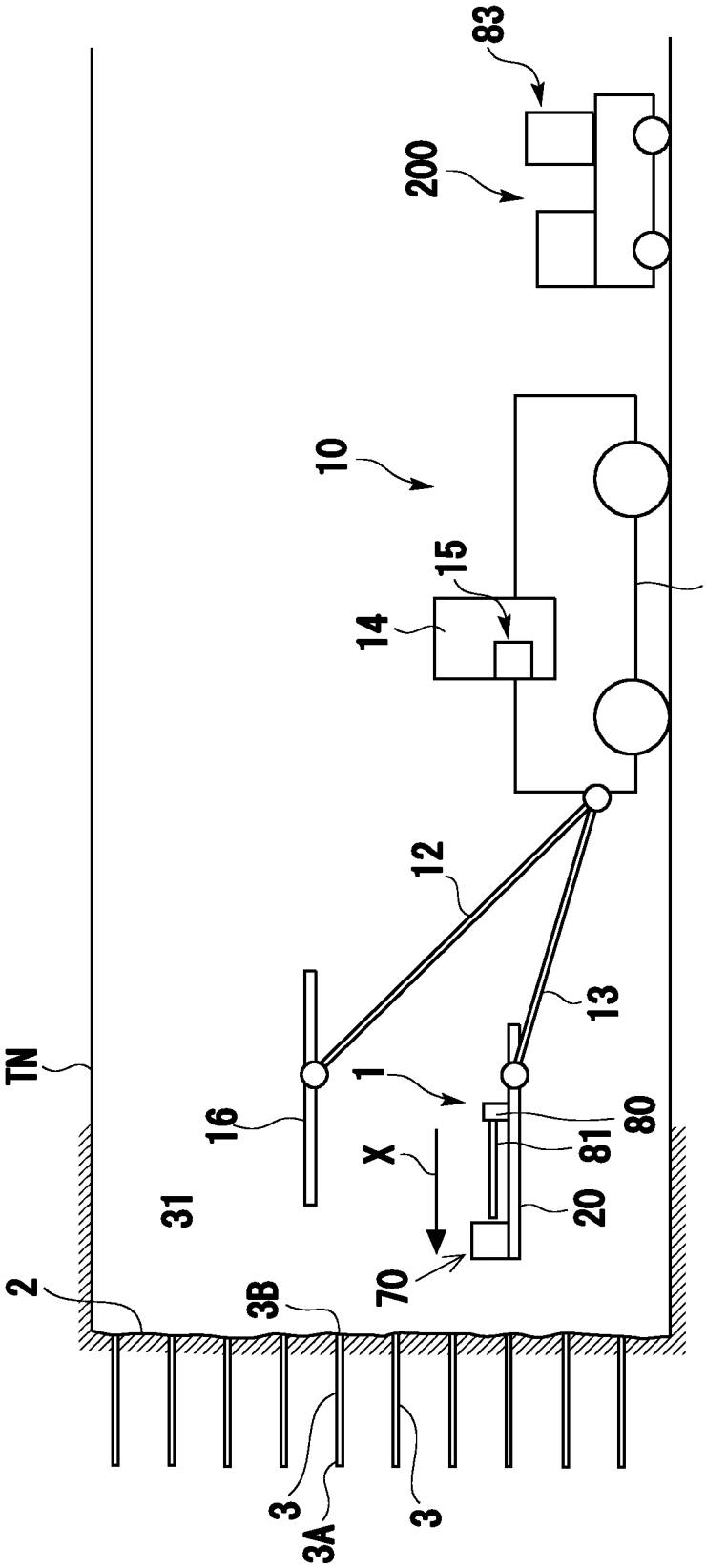

FIG. 1

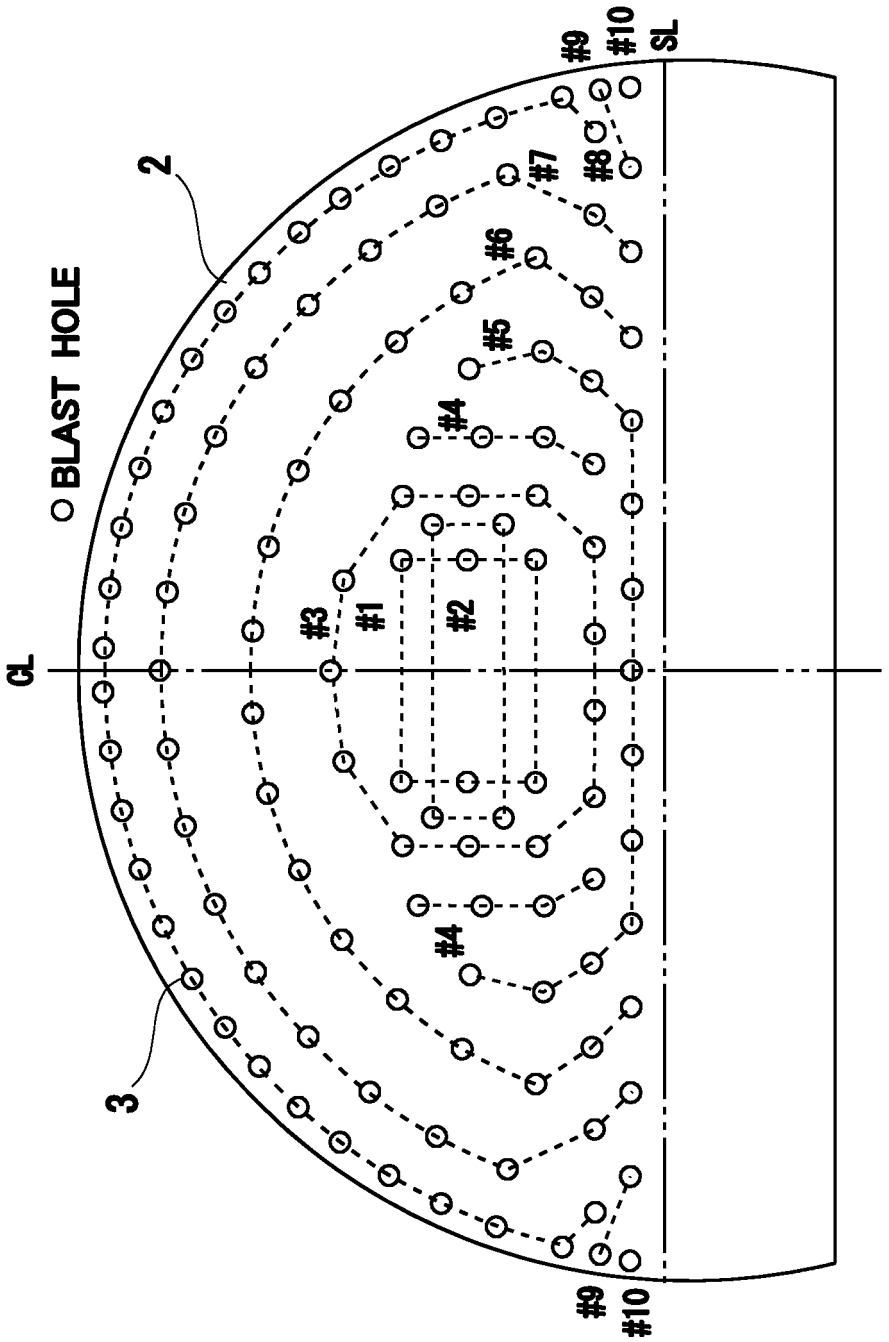

FIG. 2

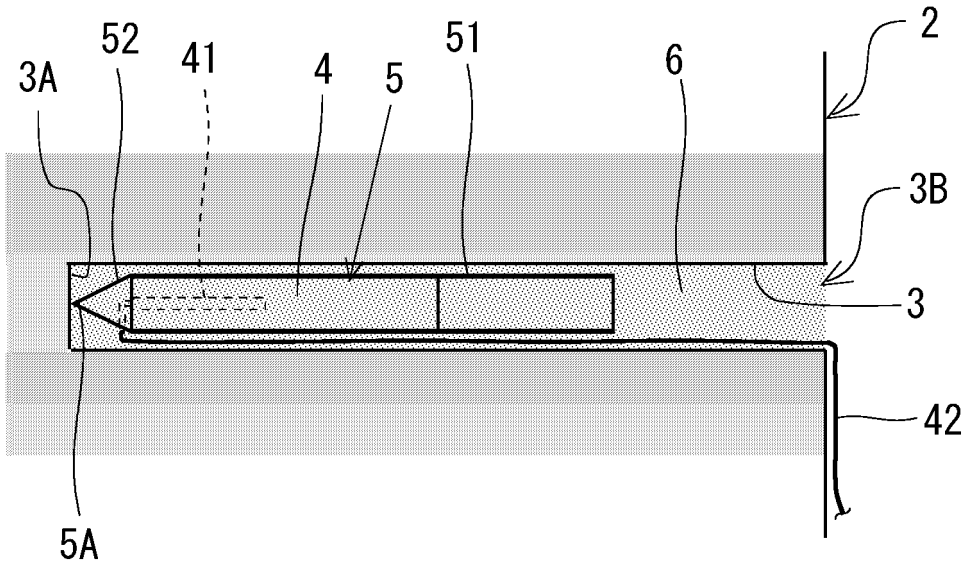

FIG. 3

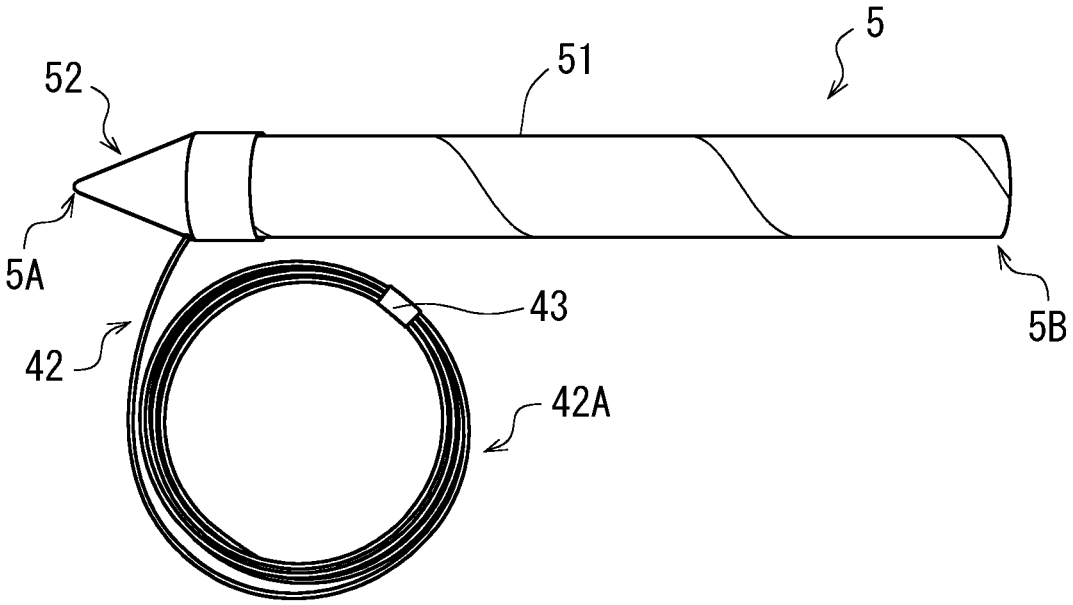

FIG. 4

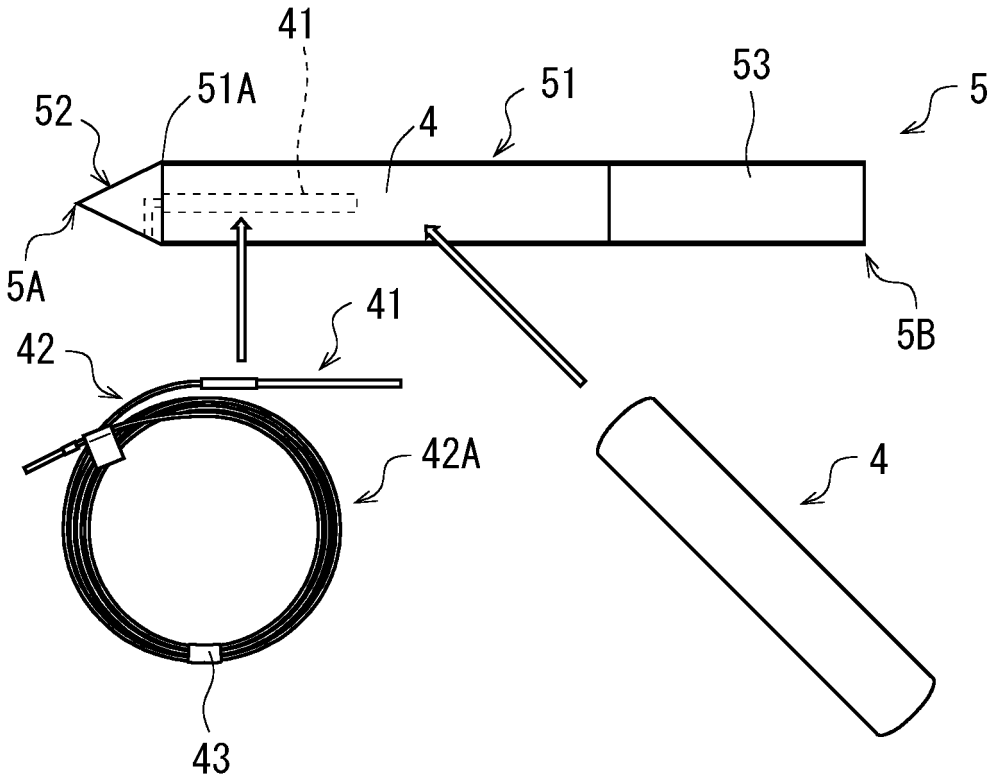

FIG. 5

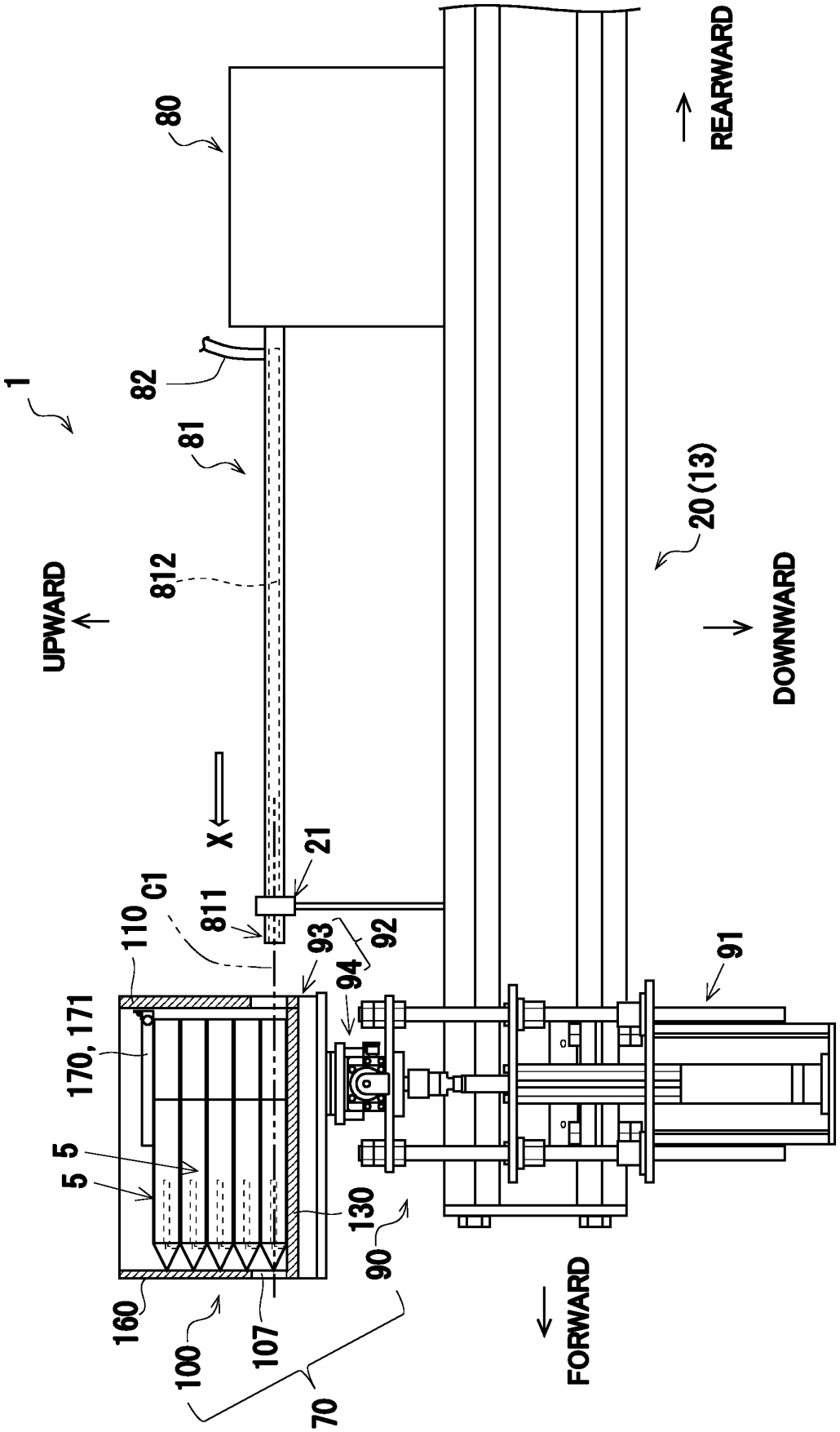
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FIG. 6

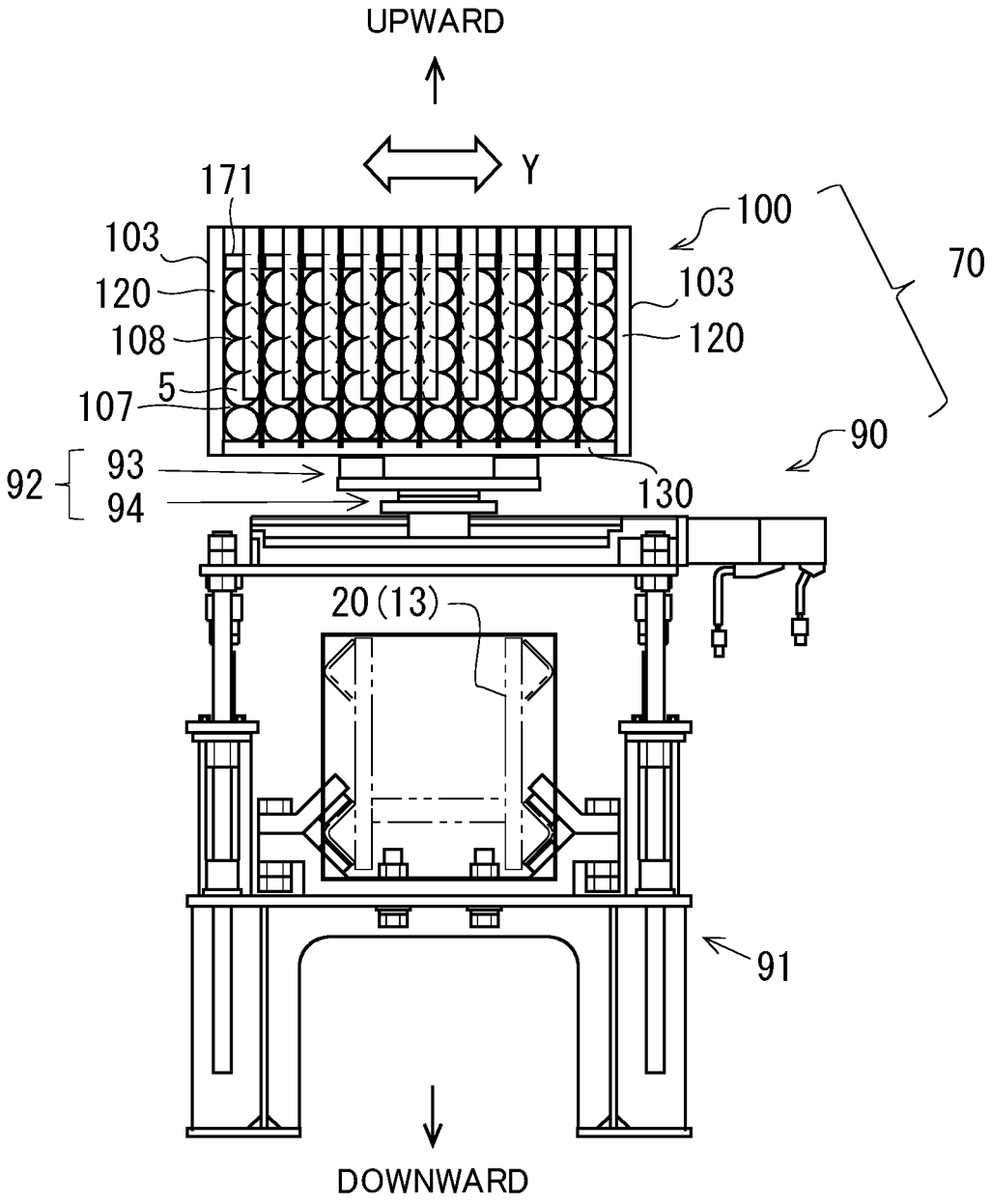
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FIG. 7

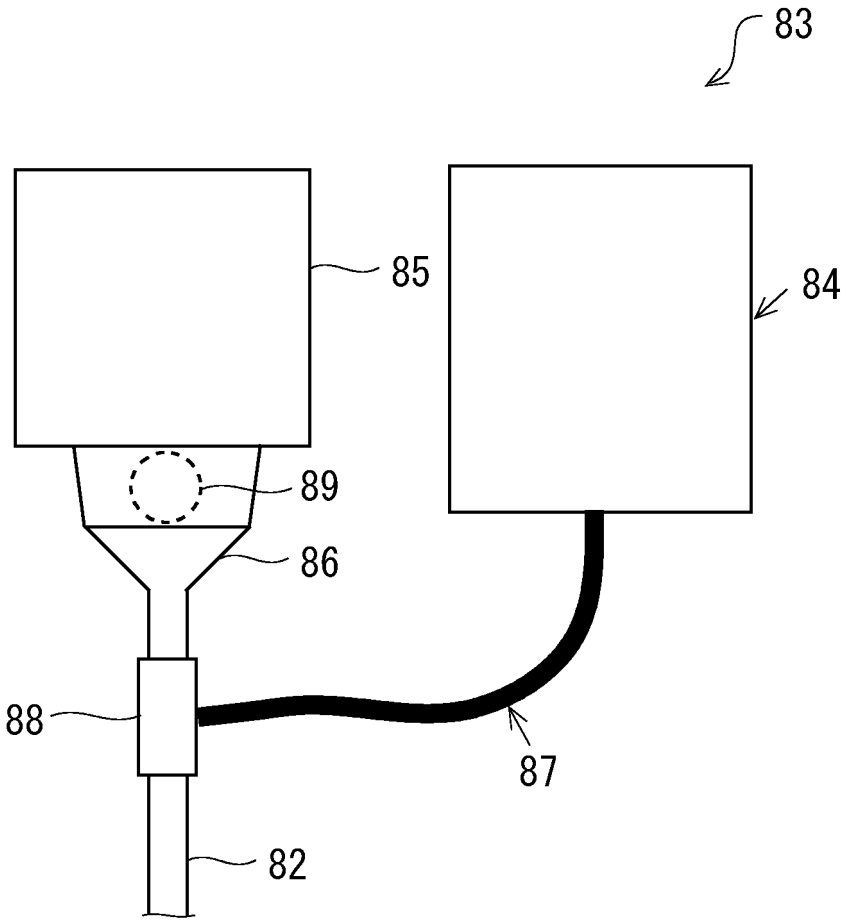

FIG. 8

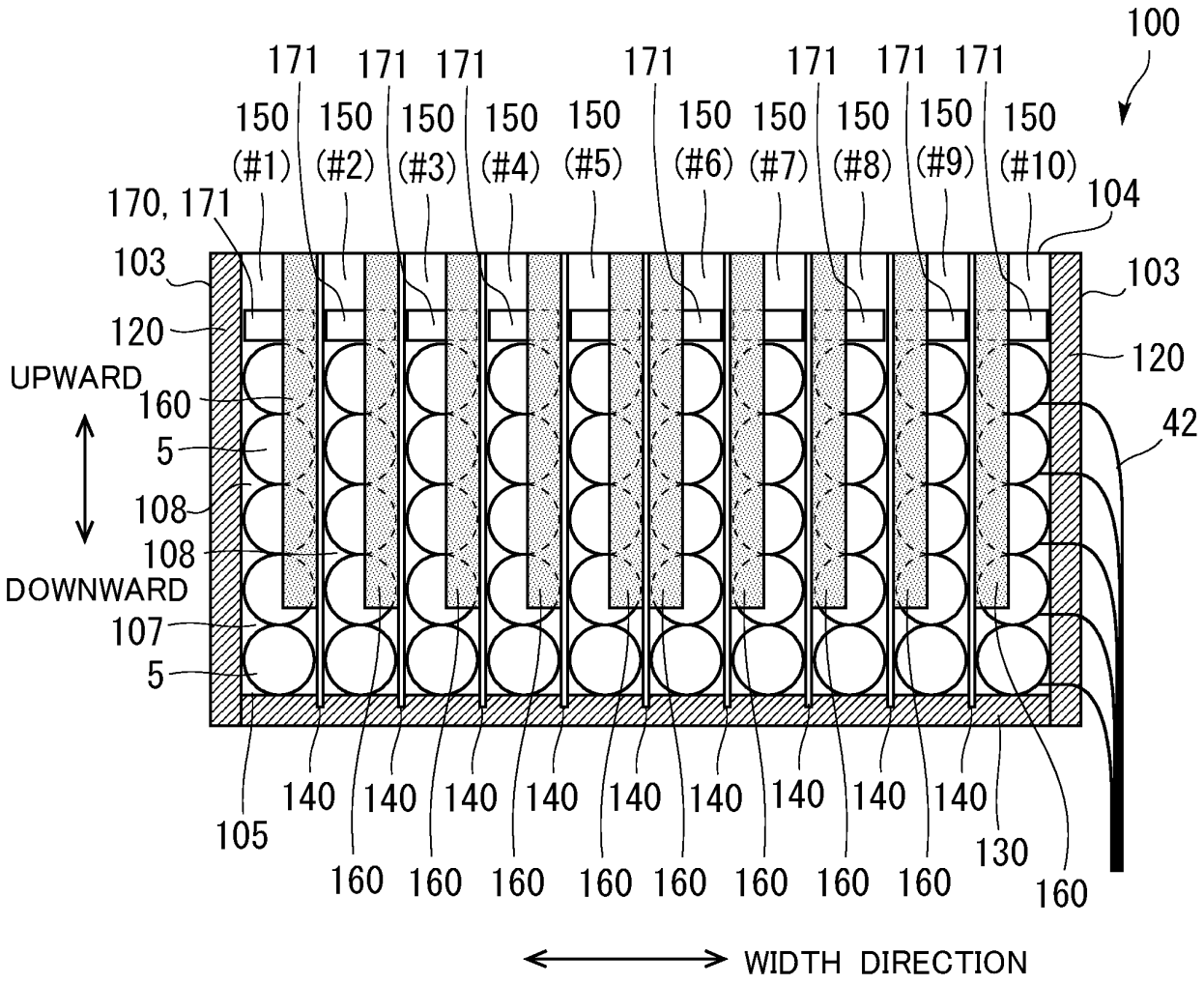
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FIG. 9

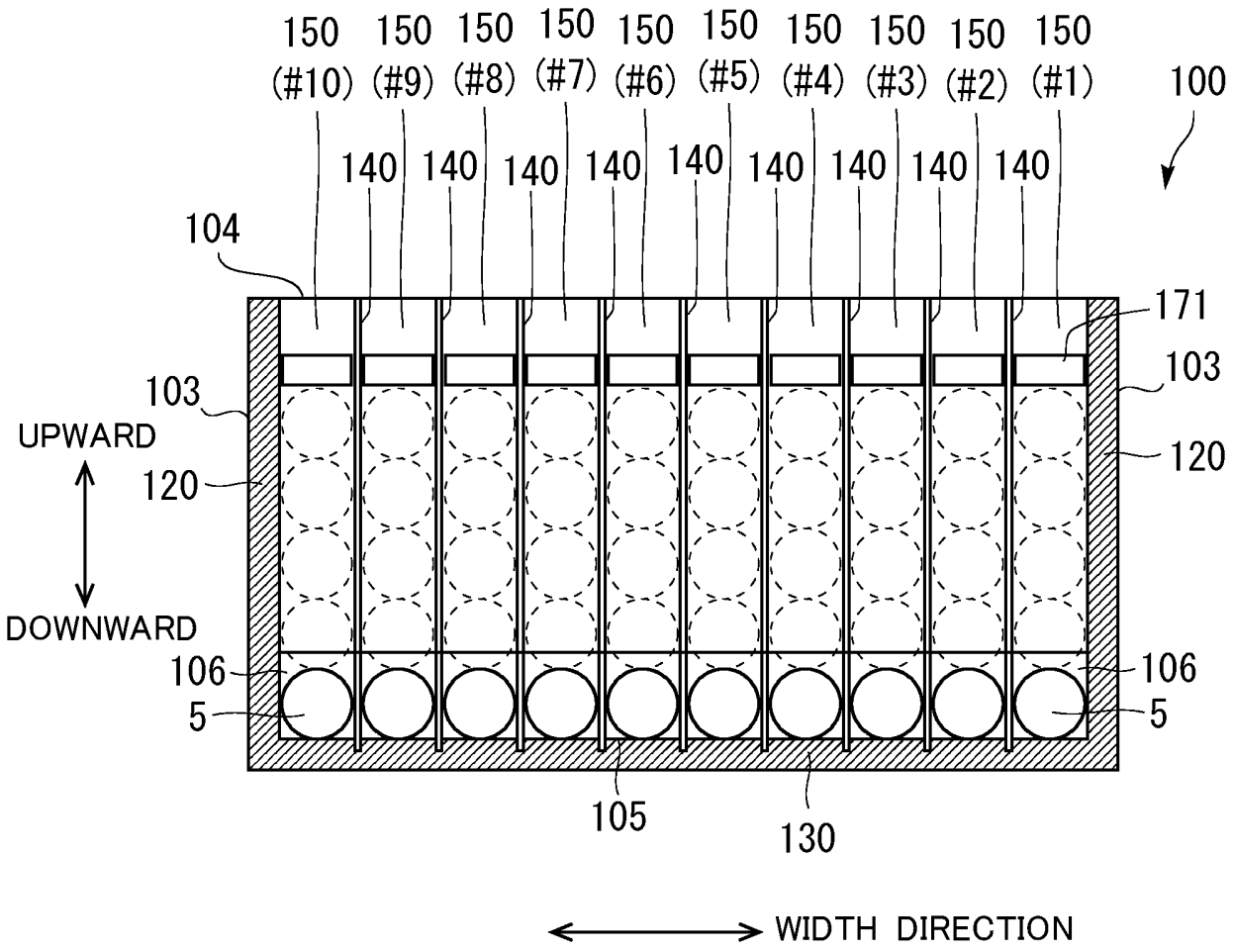
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FIG. 10

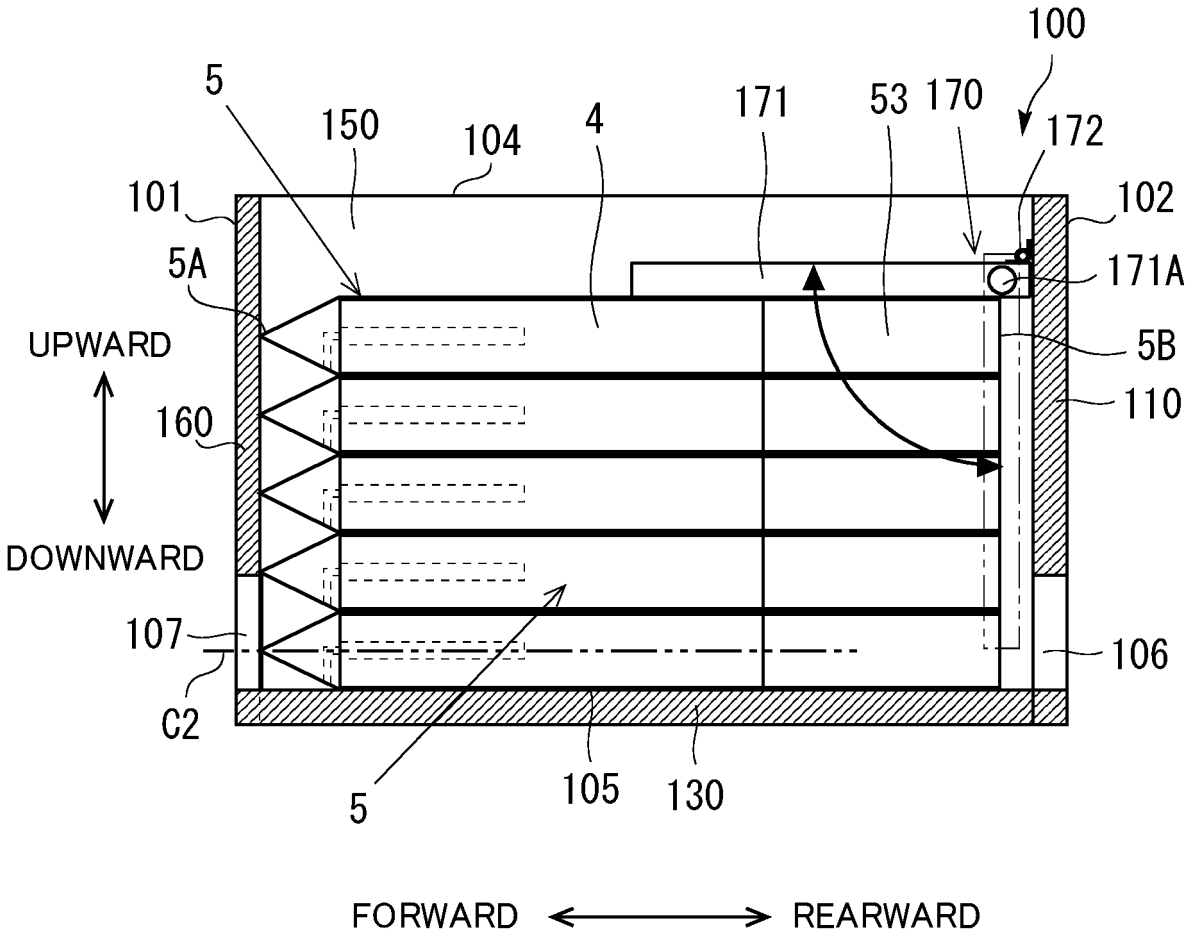
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FIG. 11

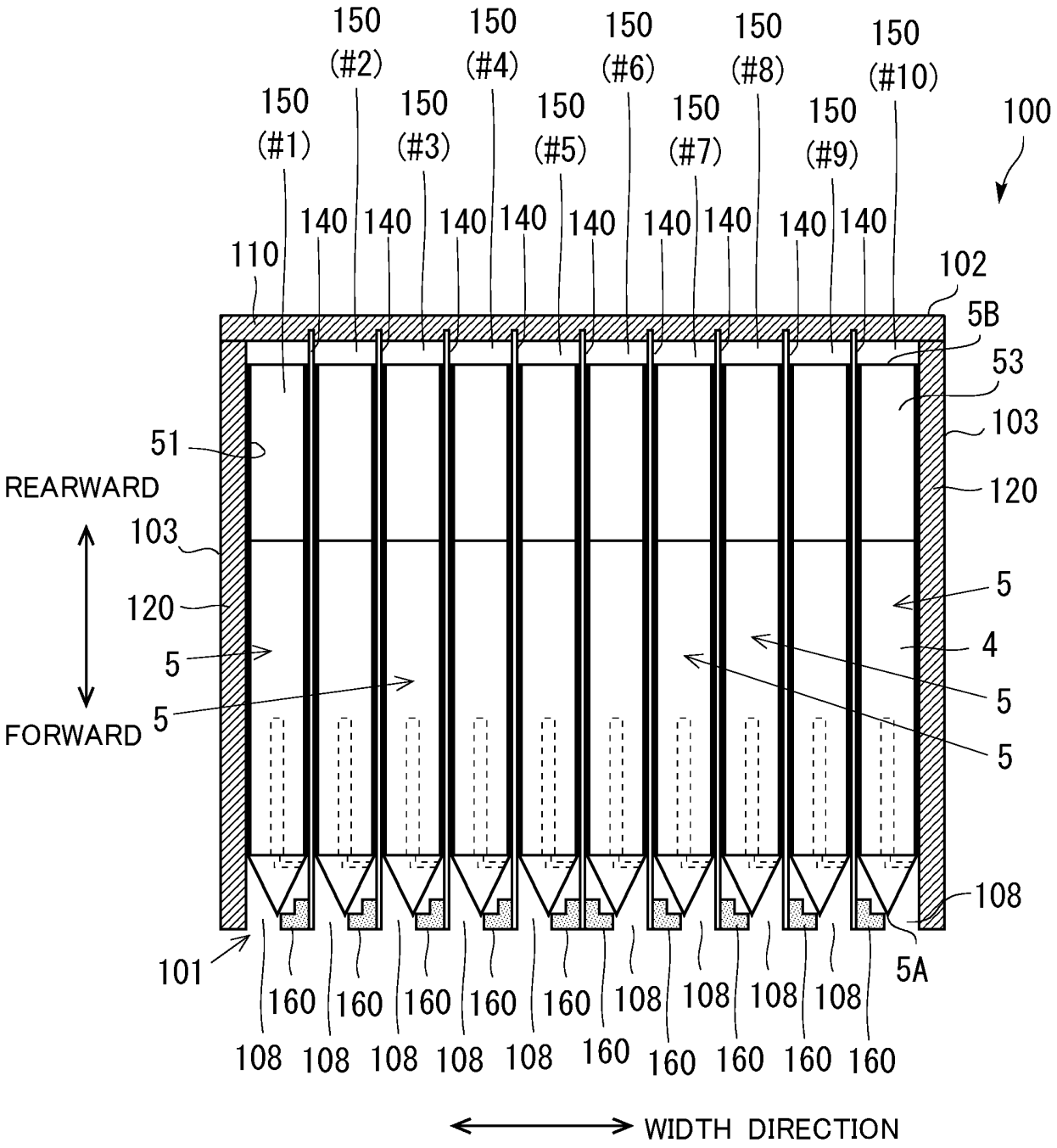
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FIG. 12

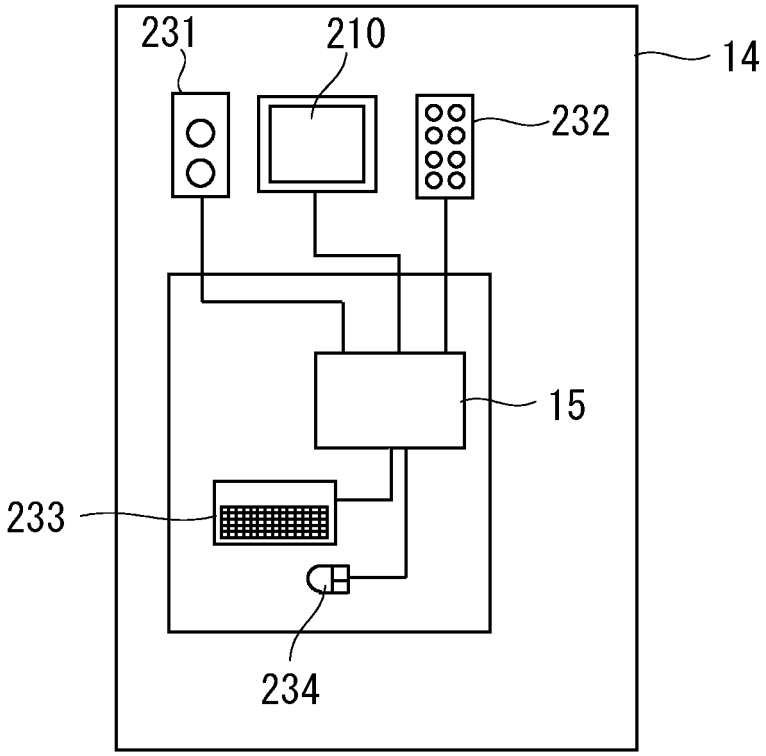

FIG. 13

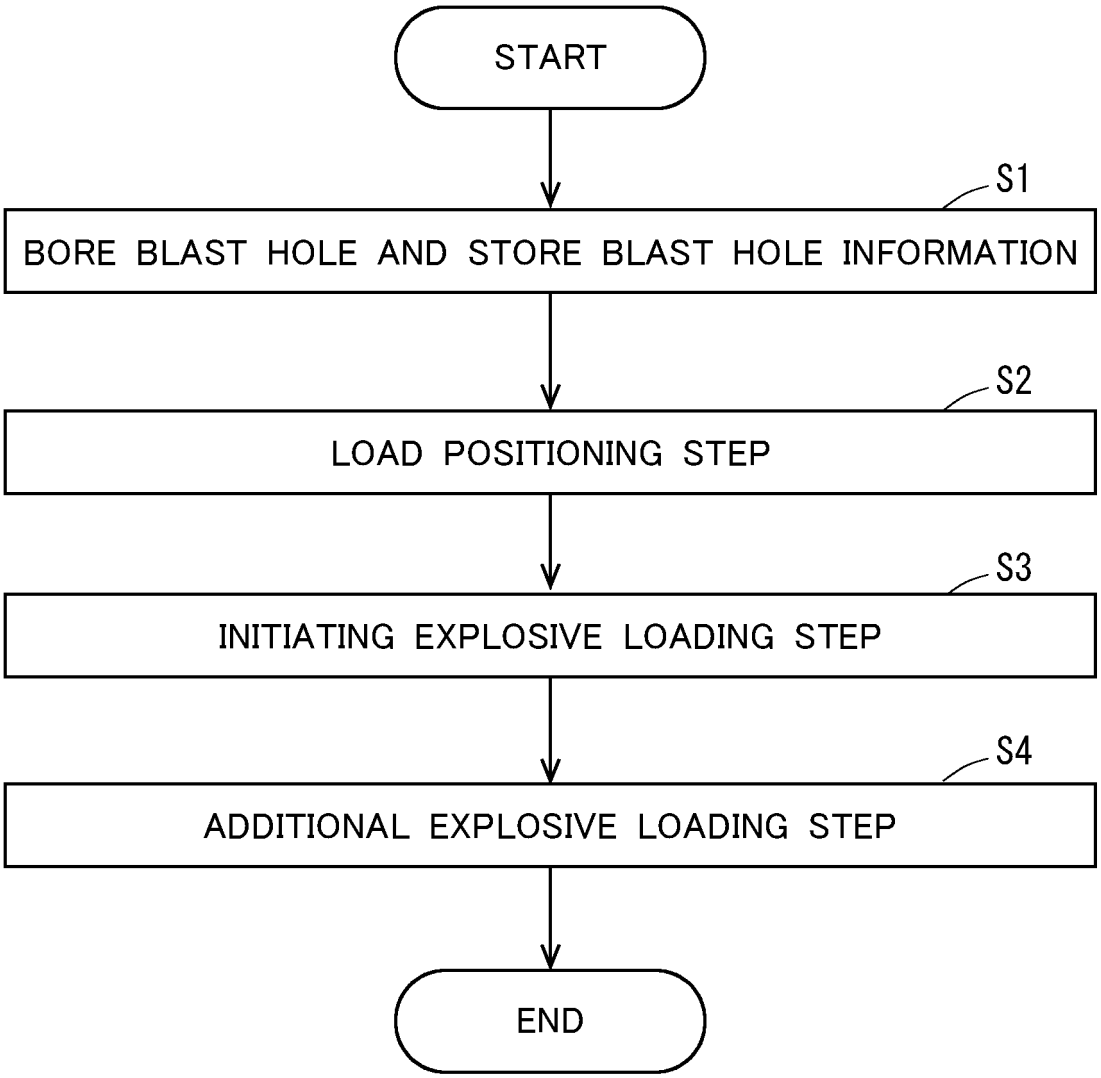
START
S1
BORE BLAST HOLE AND STORE BLAST HOLE INFORMATION
S2
LOAD POSITIONING STEP
S3
INITIATING EXPLOSIVE LOADING STEP
S4
ADDITIONAL EXPLOSIVE LOADING STEP
END

FIG. 14

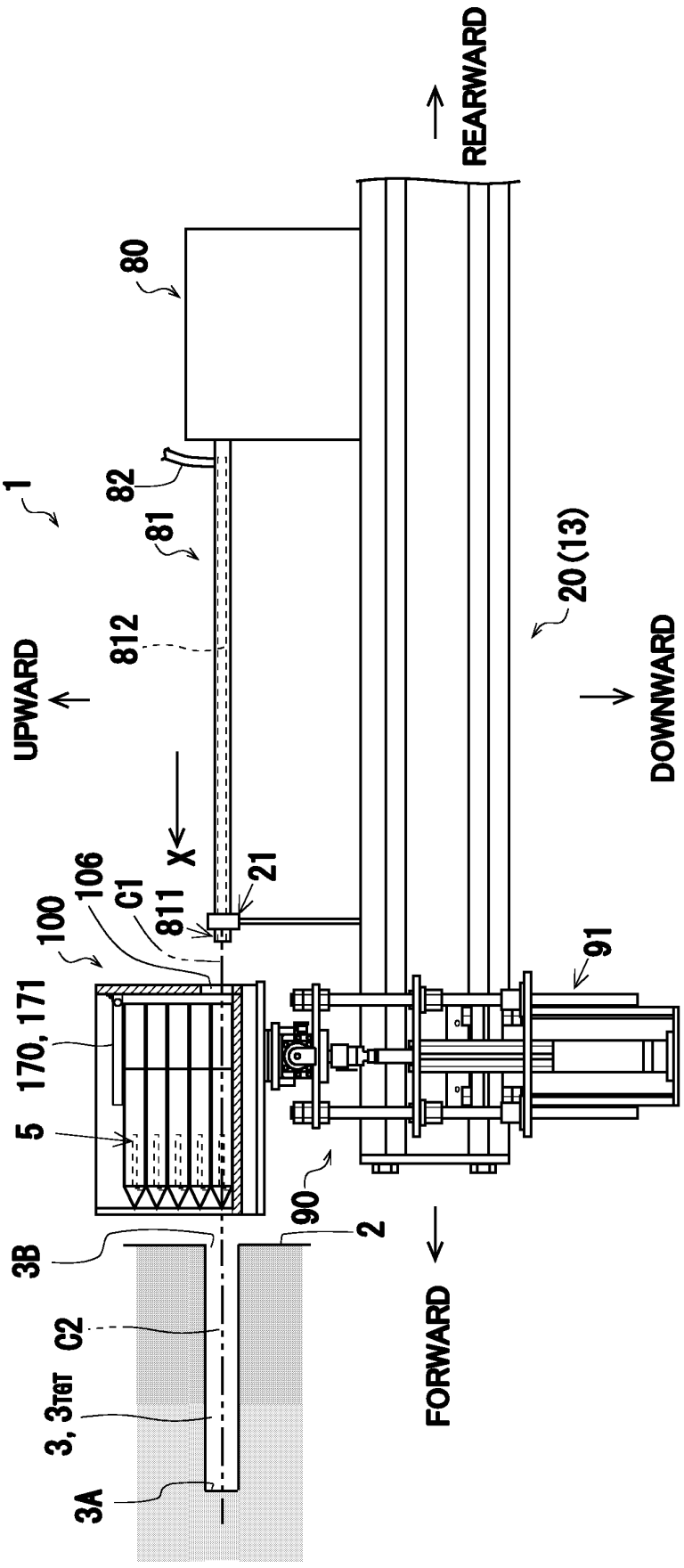
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FIG. 15

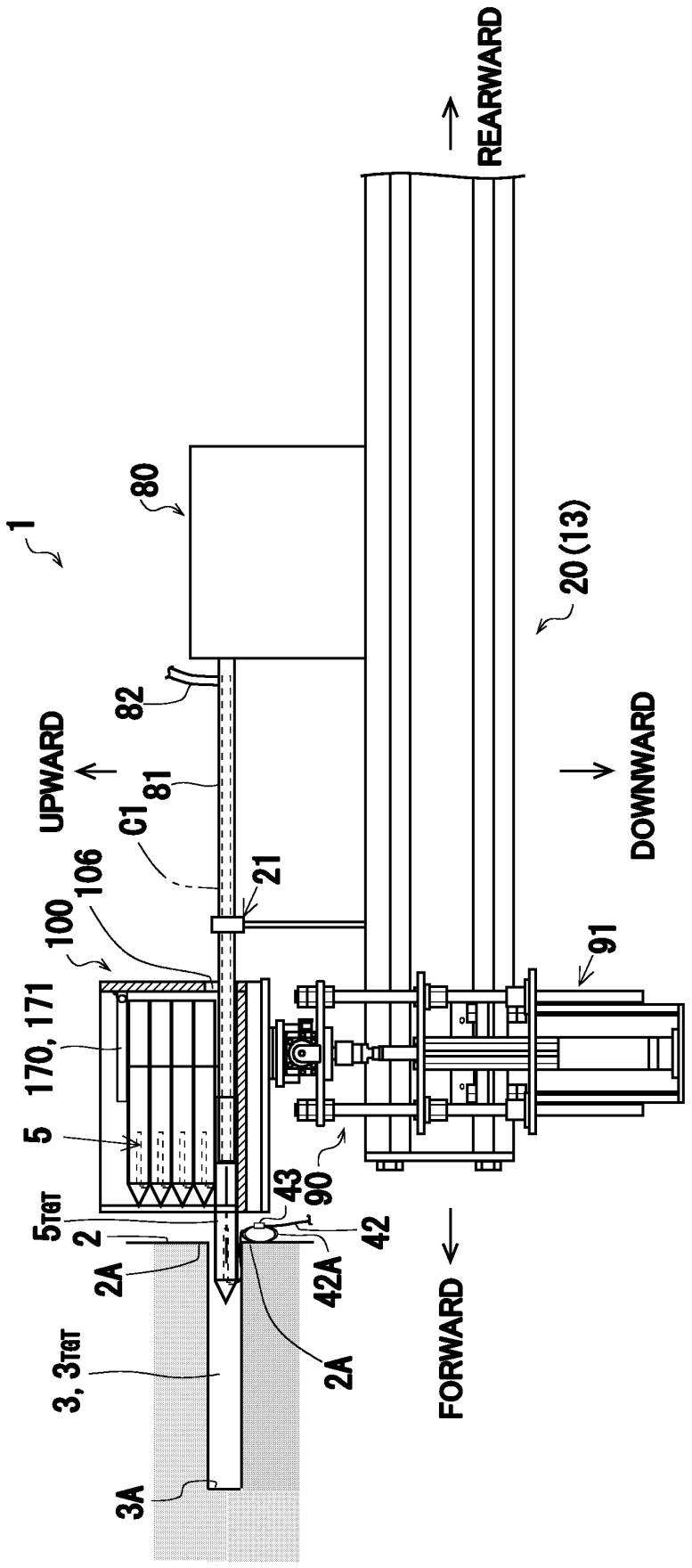
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FIG. 16

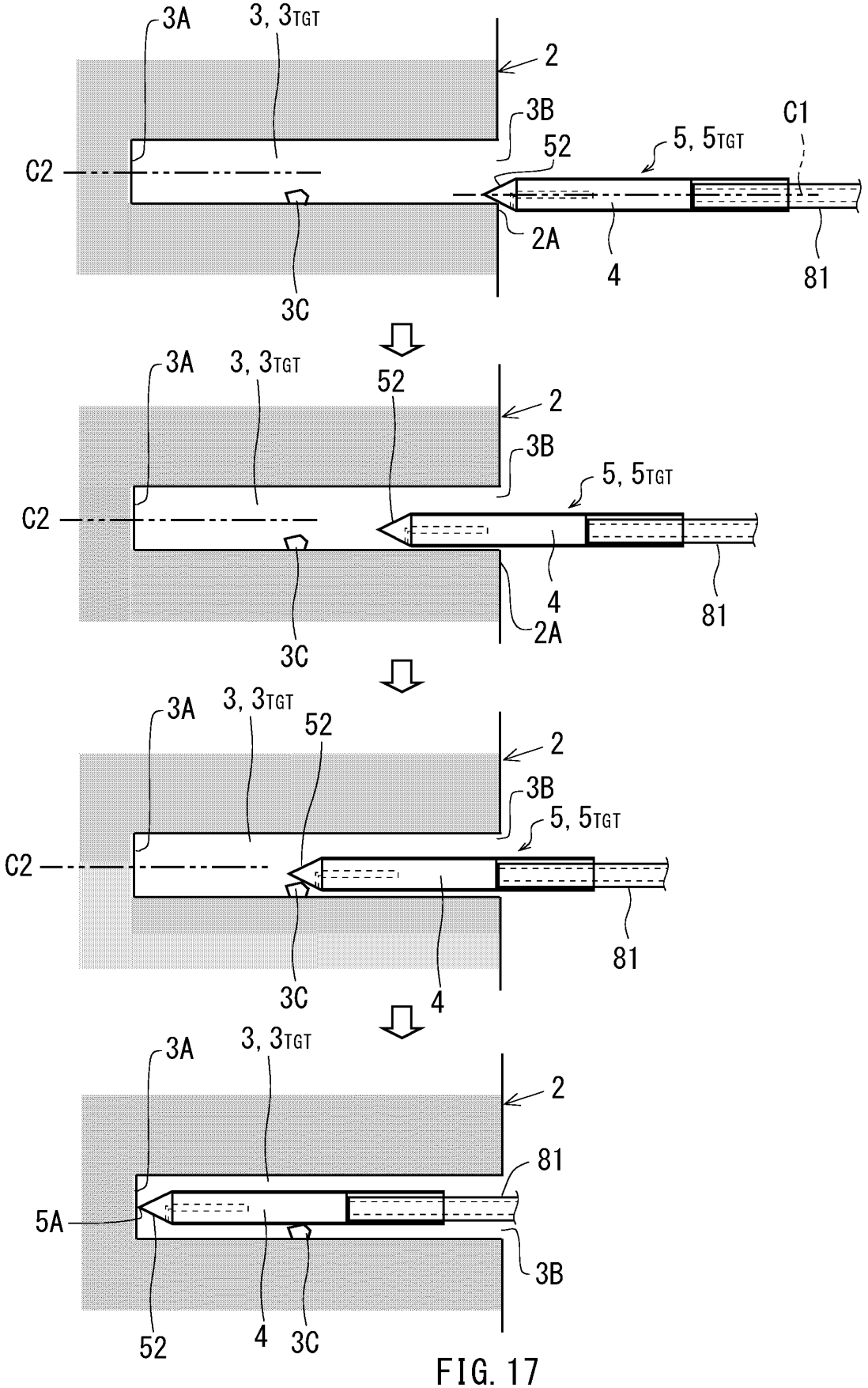
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FIG. 17

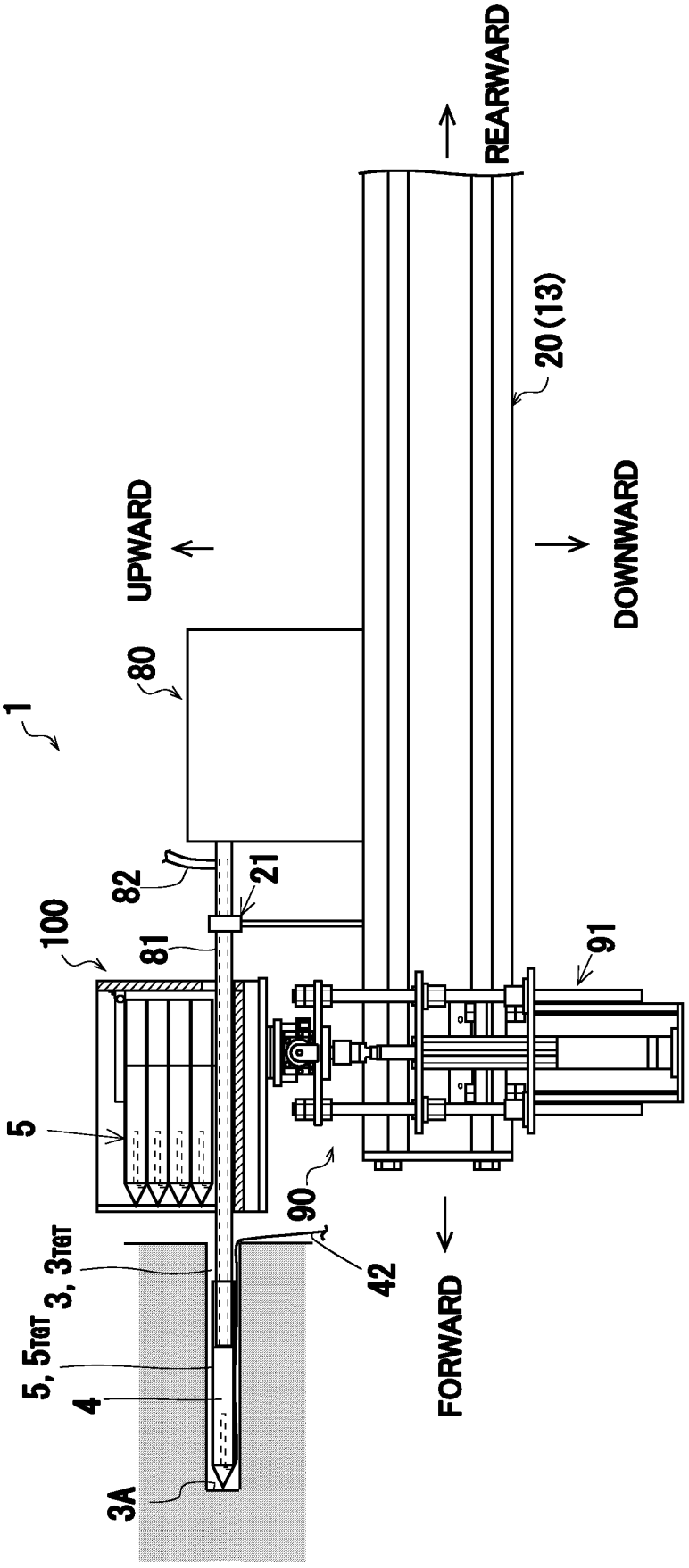
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FIG. 18

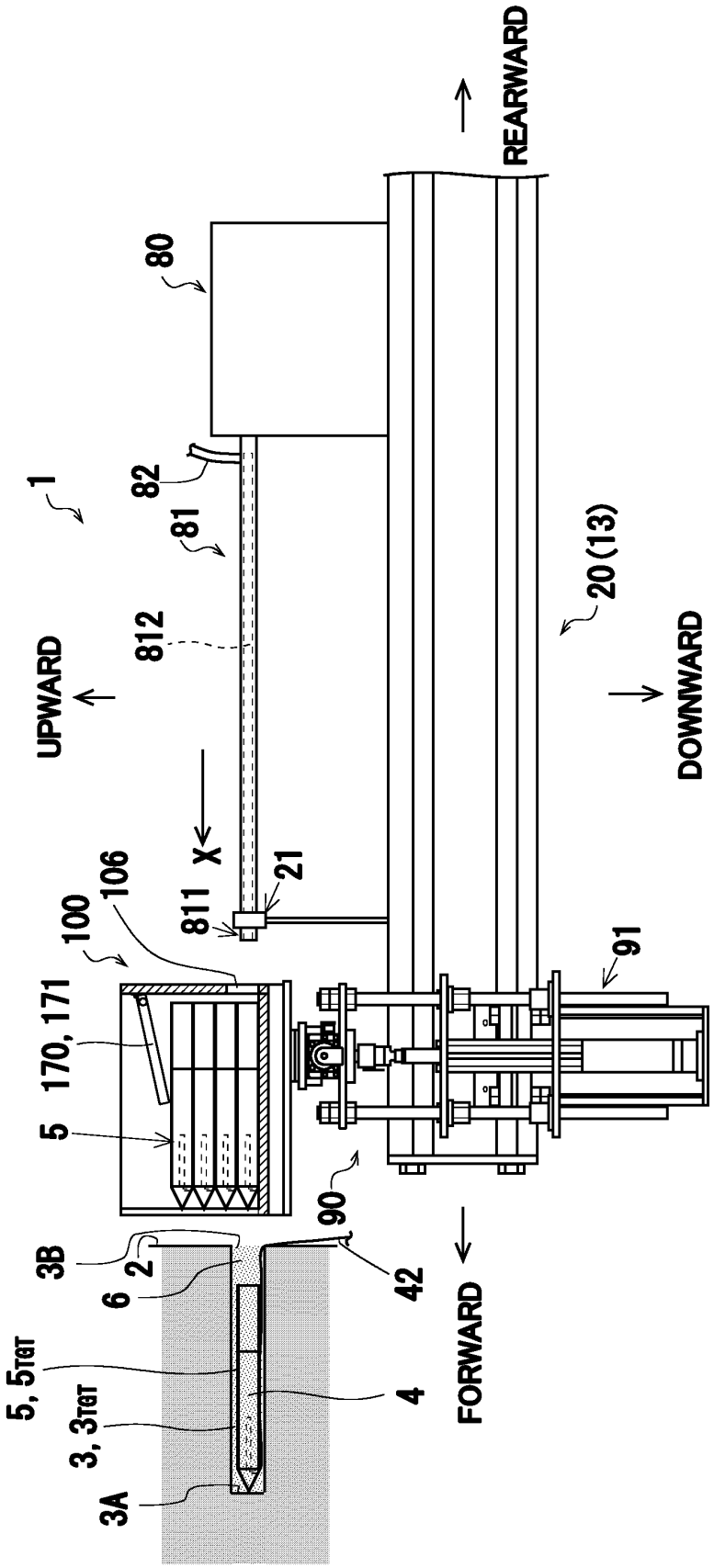
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FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/011030

A. CLASSIFICATION OF SUBJECT MATTER

F42D 1/08(2006.01)i; ***E21D 9/00***(2006.01)i
FI: F42D1/08; E21D9/00 C

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F42D1/08; E21D9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2008-25972 A (SHIMIZU CONSTRUCTION CO LTD) 07 February 2008 (2008-02-07) paragraphs [0001], [0010]-[0017], [0028]-[0034], fig. 1-10	1-5, 9-10
A		6-8
Y	JP 2016-176621 A (FUJITA CORP) 06 October 2016 (2016-10-06) paragraphs [0021]-[0023], fig. 1-2, 8	1-5, 9-10
A		6-8
Y	US 2005/0217525 A1 (ADVANCED INITIATION SYSTEMS, INC.) 06 October 2005 (2005-10-06) paragraphs [0051]-[0058], fig. 1-4	1-5, 9-10
A		6-8
A	JP 6-323795 A (ASAHI CHEM IND CO LTD) 25 November 1994 (1994-11-25)	6-8

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 May 2022	**31 May 2022**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/011030

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2008-25972 A	07 February 2008	(Family: none)	
JP 2016-176621 A	06 October 2016	JP 2019-113309 A	
US 2005/0217525 A1	06 October 2005	US 2005/0103219 A1	
		WO 2005/047812 A1	
JP 6-323795 A	25 November 1994	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2860847 B **[0008]**
- JP 5614139 B **[0008]**
- JP 5854923 B **[0008]**
- JP 2008025972 A **[0008]**