G. W. JACKSON.

ART OF CONSTRUCTING CONCRETE WALLS, SUBWAYS, &c., IN THE EARTH.

APPLICATION FILED FEB. 18, 1910.

1,007,287.

Patented Oct. 31, 1911.

3 SHEETS—SHEET 1.

Fig. 1

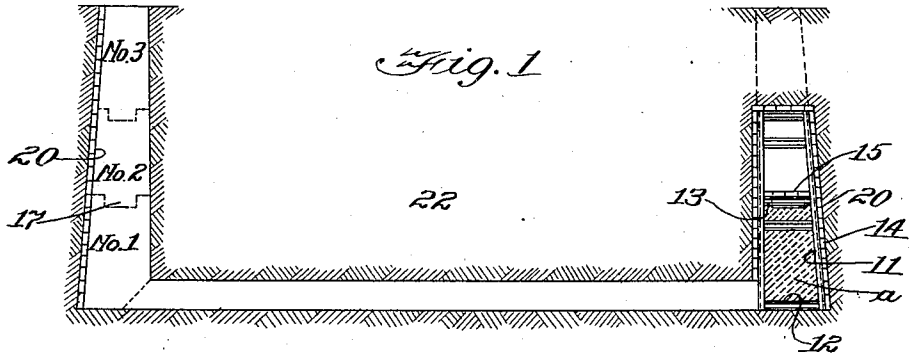
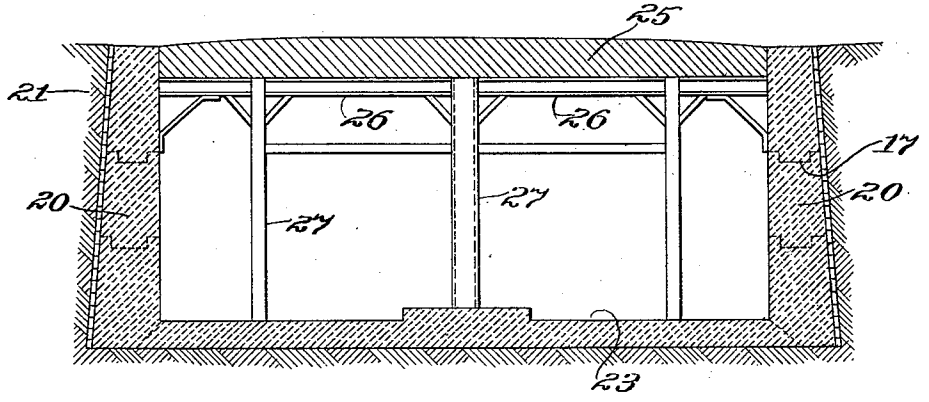


Fig. 2



WITNESSES:

Wm. H. Yagle.

W. Goldberger.

INVENTOR

George W. Jackson.

BY William H. Hall

ATTORNEY

G. W. JACKSON.

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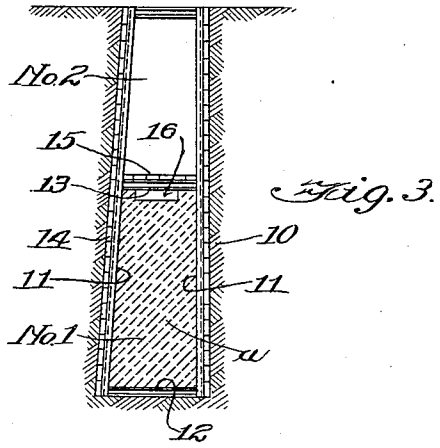
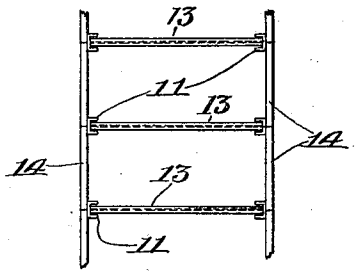


Fig. 3.

Fig. 5



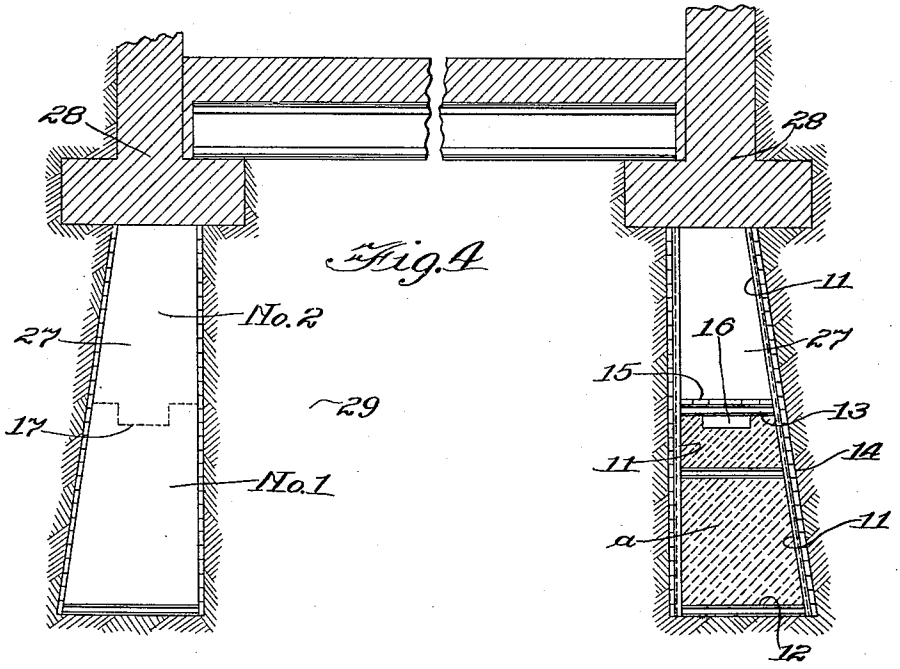


Fig. 4

WITNESSES:

Wm. H. Yagle

W. Goldberger.

INVENTOR

George W. Jackson.

BY William b. Hall

ATTORNEY

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

G. W. JACKSON.

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3 SHEETS—SHEET 3.

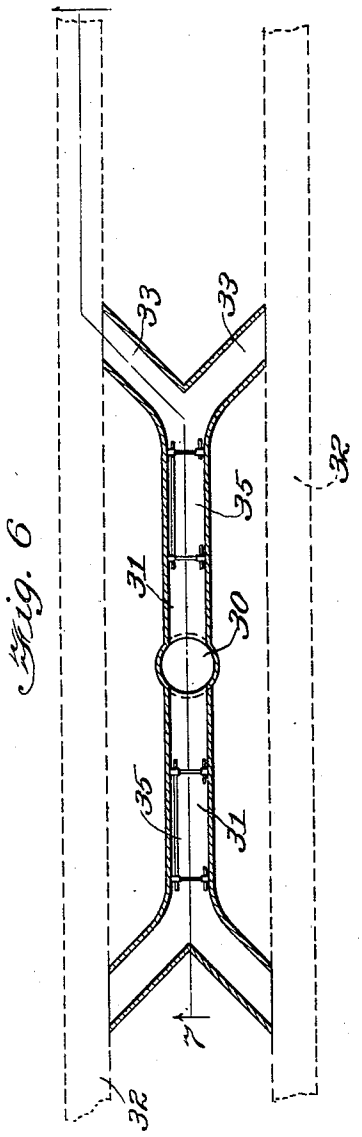

Fig. 6

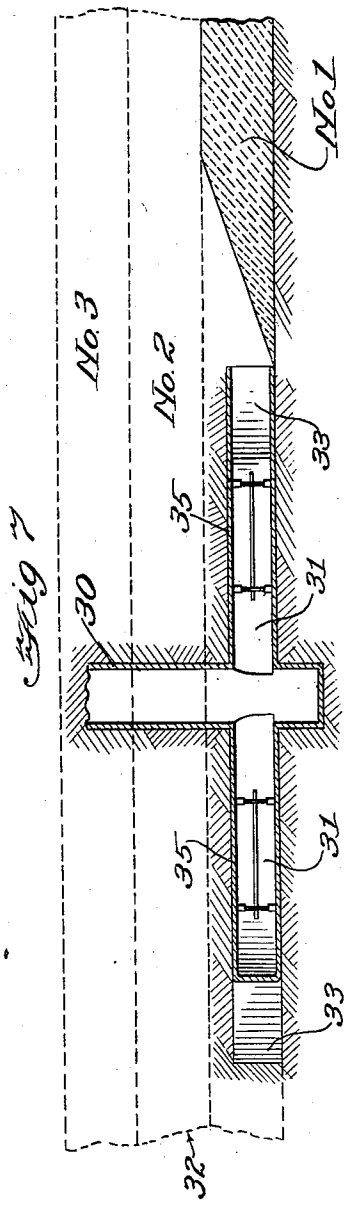

Fig. 7

WITNESSES:

W. Goldberger.

Harry S. Gaither

INVENTOR

George W. Jackson.

BY Williamson & Hall

ATTORNEY

UNITED STATES PATENT OFFICE.

GEORGE W. JACKSON, OF CHICAGO, ILLINOIS.

ART OF CONSTRUCTING CONCRETE WALLS, SUBWAYS, &c., IN THE EARTH.

1,007,287. Specification of Letters Patent. **Patented Oct. 31, 1911.**

Application filed February 18, 1910. Serial No. 544,527.

To all whom it may concern:

Be it known that I, GEORGE W. JACKSON, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in the Art of Constructing Concrete Walls, Subways, &c., in the Earth; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the art of constructing concrete or masonry walls or piers in the earth for various purposes, and refers more specifically to an improved method designed to facilitate the building of such walls, and the building of under-ground structures embodying such walls, in relatively soft or unstable earth where extraordinary provisions are required to avoid injury to building foundations along the line of the wall, due to lateral shifting of the earth toward the excavation formed to receive the wall.

My improved method may be employed for constructing retaining walls for general or specific uses, for constructing open cut subways and general open cut work, for constructing supporting piers, or piers or walls for underpinning foundations of buildings or other superstructures preparatory to excavating the earth beneath the same for building a sub-basement, a subway or other reconstruction work beneath the underpinned structure.

Among the objects of the invention is to provide a simple and safe mode of constructing retaining walls, supporting piers or open cut work in the earth embodying such retaining walls, which will greatly lessen the liability of injuring adjacent building foundations or the like, and to provide a method or plan which is relatively inexpensive as compared to present methods of construction.

In constructing a retaining wall, a pier, or a wall for a subway or the like in accordance with my improved method, I build the wall in sectional courses, beginning at the lowermost course of the wall and constructing each superjacent course or section upon a subjacent course or section previously laid. I first excavate a small wall section tunnel along the line of the proposed wall and at the level of the lower course thereof of the width approximately that of the lower course of the proposed wall. This small wall section tunnel is excavated for a considerable distance, depending upon the general character of the earth in which the work is being done. The tunnel is braced and lagged as the work of excavation progresses and after the predetermined length of tunnel has been excavated it is filled with a body of concrete or other suitable wall forming substance. In filling the excavation, the filling may begin at the far or blind end of the tunnel, working back to the beginning point. The body of filling material thus placed constitutes the lower course of the wall. The wall is completed by constructing above the lower course one or more superposed course or courses which will be constructed in the earth in the same manner as the lower course. In case the top course of the wall shall reach the surface of the earth it may be filled with the concrete or wall forming substance through the open wall section tunnel cut. The bottom of the excavation of each upper course opens upon the already placed concrete or filling material of the lower course so that the superposed courses will be placed one directly on the other to constitute a transversely continuous solid wall. The height of each excavation or tunnel for each wall course will depend somewhat on the character of the earth in which the work is being done, it being apparent that when working in firm or solid earth the cut may be made higher than in less stable earth, with less liability of shifting of the earth laterally at the side of the line of the wall, or of the tunnel bore caving in.

As a means of gaining access to the level of the lower course of a proposed wall, I may sink a vertical shaft alongside the line of the proposed wall to or below the level of the lower course, and extend from this shaft a small tunnel or bore to connect with the excavation for the lower wall course. It is through this shaft and connecting tunnel that the operatives and material may be passed into and from the wall section excavation or tunnel. When two parallel walls are constructed to constitute the two side walls of an open cut subway or tunnel or the like, I may employ a single shaft for both walls by sinking the shaft between the walls and branching the connecting tunnels

leading therefrom to constitute twin tunnels that open oppositely and laterally into the lines of the two opposite walls. Said connecting tunnels may extend in opposite directions from the shaft, along the line of the walls, to enter the wall section tunnels at a plurality of points and thereby provide means for simultaneously working a plurality of cuts from one shaft.

As shown in the drawings, Figure 1 is a cross section showing two parallel walls which are built and constructed in the earth in accordance with my invention, and arranged to constitute the side walls of an open cut subway. Fig. 2 illustrates a type of subway which may be constructed in accordance with my improved method. Fig. 3 is a cross section of a retaining wall shown as constructed in accordance with my improved method. Fig. 4 illustrates a mode of underpinning a superposed structure, such as the foundation of a building, for the purpose of constructing a sub-basement beneath the same, or other reconstructing work. Fig. 5 is a detail of the lagging and bracing for the excavation walls. Fig. 6 is a diagrammatic plan view illustrating an arrangement of the shaft and connecting tunnels through which access is had to the wall section tunnels or excavations. Fig. 7 is a diagrammatic elevation illustrating the manner of raising said shaft from the level of one wall course to a next higher course.

The construction in Fig. 3 is a simple form of wall construction to which my invention is shown as applied. This may be either an elongated supporting pier or a retaining wall, or it may constitute one of the side walls of an open cut to be built in the earth. As shown it is made in two vertically separate sections or courses, but the wall may embody three or more courses.

In forming the wall shown in Fig. 3, and other like walls, the earth is excavated at the level of the foot of the wall, to form a tunnel of the width of the foot of the wall to receive the material, as concrete, to constitute the lower course of the proposed wall. The said excavation or tunnel to receive the wall material will be made of considerable length from the starting point or shaft, depending upon the local conditions, the character of the earth, etc. As the excavation proceeds it is braced and lagged. The lagging braces are open frames of the same cross section and dimensions as the wall section tunnel or excavation, and comprise uprights 11, 11 and cross pieces 12, 13. It is behind the uprights that the lagging 14 to support the side walls of the tunnel is placed. The lagging 15 to support the roof of the tunnel is placed on the upper cross pieces 13. After the excavation is completed, braced and lagged it is filled with the wall material *a*, shown in Fig. 3, which constitutes the lower course of the wall 10. The filling material is placed in the excavation by beginning at the far or blind end thereof and working toward the point of commencement of the excavation. Thereafter the next upper course of the wall is placed by first excavating the wall section tunnel No. 2 immediately above the course No. 1 already laid, bracing and lagging the same and finally filling it with concrete or other wall forming material. Before the filling of an upper course is placed the lagging 15 of the next lower course is removed so that the superposed courses are laid as one solid wall. Preferably also the upper side of a lower course will be formed with a recess 16, or otherwise made roughened or irregular, to receive a key 17 by which the upper and lower course are bonded or united. The lagging braces or frames and outer courses of lagging may be left in place to constitute reinforcing media for the walls. The level of the lower course may be reached through a vertical starting shaft which is sunk to or slightly below the level of the first or lower course and connected therewith by relatively small lateral bores or tunnels. Through said shaft and connecting tunnel ingress to and egress from the wall tunnel sections may be had for the operatives and material. The particular arrangement of this shaft and of the connecting tunnels in the relation thereof to parallel walls is shown in Fig. 6, and will be described in connection therewith. When the cut for the upper course of the wall intersects the surface of the earth, said cut or excavation need be braced and lagged at the sides only and the filling material may be placed therein through the top of the open cut.

In Fig. 1 are shown two parallel walls 20 which are constructed in the earth in the same manner as the wall 10, shown in Fig. 3, to constitute the side walls of the open cut subway 21 that is shown in Fig. 2. After the side walls 20 have been completed the middle section 22 is removed in short lengths, and the invert or floor 23 placed in position in any approved manner. The roof 25 of the subway is supported between the upper sides of the top walls upon said walls, horizontal girders 26, and posts 27, and said roof constitutes a support for the street pavement above.

In Fig. 4 is shown an arrangement whereby walls 27, constructed of successively higher, separately formed courses, like the walls 10 and 20 before described, are built beneath the foundations 28 of a building or other superstructure for the purpose of underpinning or supporting the superstructure in order to excavate the earth between the said supporting walls to form a sub-basement or the like beneath the building or

superstructure, or for other like purpose. After the walls 27 have been completed to underpin or uphold the foundations, the central section or area 29 is excavatel or mined away and the sides and bottom of the excavation treated in accordance with the general design of the proposed reconstruction or extension work.

In order to reach the level of the lower courses of the walls, I may provide a vertical shaft 30, as indicated in Fig. 6, which shaft is arranged to be connected by small horizontal tunnels or bores 31 with the tunnels or excavations for the proposed walls 32. When said shaft and connecting tunnels are employed in the building of the parallel walls of the subway or the like, they will usually be located midway between the walls. As shown in Fig. 6 the horizontal tunnel 31 connected directly with the shaft 30 extends in opposite directions from the shaft, and both ends thereof are formed to provide branch or twin tunnels 33, 33 which extend laterally in opposite directions for intersection with the lines of the two side walls 32 at the level of the lower courses thereof. With this arrangement it is practicable to have access to four separate cuts from a single vertical shaft 30. This shaft and the horizontal tunnels therefrom afford access for the operatives and material to the wall section tunnels and egress therefrom.

When working in earth which requires to be supported by air pressure, in addition to the bracing and lagging referred to, the horizontal tunnels 31 may be equipped with suitable air locks, designated as a whole in Fig. 6 by 35, and made of any usual or preferred construction which will permit the passage of the material and operatives therethrough while maintaining the working pressure in the excavations beyond the air locks.

In order to reach successively higher wall tunnel levels from the shaft tunnel 31 after a lower section or course of the wall has been completed, I may provide the arrangement shown in Fig. 7. As therein shown the concrete body of a wall course is not fully completed to the opening of the tunnel 33 into the wall section tunnel, but the end of the wall course is formed with a slope that inclines gradually from the bottom of said course to form an inclined passage 37 over which the material and operatives may pass from the level of the tunnel 33 to the level of the wall section tunnel for wall course No. 2. Similarly the tunnel for the wall course No. 3 may be reached from the wall section tunnel No. 2. When building single retaining walls, such as is shown in Fig. 3, the shaft 30 and connecting tunnel 31 will be arranged at the side of the line of the wall and connected or made to intersect the line of the wall by being turned laterally.

By following the method herein outlined of constructing walls in the earth and of constructing subways or tunnels having such walls, the excavation for the walls is attended with little or no liability of injury to building foundations located alongside the line of the walls. This is because of the fact that the mining or excavation of the earth is effected in small sections, as compared to the full cross section of the wall or walls, so that there is less liability of the earth at the sides of the excavations shifting toward the bores of the excavations or tunnels than in cases where the wall tunnels are mined or excavated throughout the full cross section thereof as open cut work. Moreover the method here outlined may be conducted with greater safety to the operatives, and also at considerable less expense of bracing. For this reason the cost of building retaining walls in the earth or of constructing a subway having such walls is materially lessened as compared to the construction of walls by the open cut method. The method of constructing the walls here outlined may also be employed in the construction of tunnels located wholly beneath the surface of the earth, such for instance as illustrated in my companion application filed of even date herewith, Serial Number 544,528. In the construction of tunnels as therein shown the side walls of the tunnel are constructed in the same manner as above described, and thereafter the roof section and the section between the walls are excavated in short lengths and the material of the arch or roof and the invert placed as the excavation proceeds.

I claim as my invention:

1. The improvement in the art of constructing concrete or like walls in the earth, which consists in sinking a shaft to or below the level of the foot of the proposed wall, extending a tunnel from said shaft to the line of the proposed wall, excavating successively higher wall section tunnels along said line, beginning at the level of the shaft tunnel, placing an air lock in said shaft tunnel between said shaft and the wall section tunnels and separately filling the wall section tunnels as they are excavated.

2. The improvement in the art of constructing concrete or like walls in the earth, which consists in sinking a shaft to or below the level of the foot of the proposed wall, extending a tunnel from said shaft to the line of the proposed wall, excavating successively higher wall section tunnels along said line, beginning at the level of the shaft tunnel, separately filling the wall section tunnels as they are excavated, and arranging inclined passages from the level of the shaft tunnel to the successively higher wall

section tunnels to afford access to all the wall section tunnels from the shaft tunnel.

3. The improvement in the art of constructing open cut subways and the like, which consists in forming the side walls therefor of separately constructed, successively higher courses of wall forming material and thereafter excavating the middle section between the walls and placing the floor or invert as the excavation proceeds.

4. The improvement in the art of constructing open cut subways and the like, which consists in forming the side walls thereof by excavating successively higher wall section tunnels or excavations along the lines of the proposed walls, beginning at the lower level of the walls, separately filling each tunnel as it is excavated with wall forming material and thereafter excavating the middle section and placing the floor or invert as the excavation proceeds.

5. The improvement in the art of constructing open cut subways and the like, which consists in forming the side walls thereof by excavating wall section tunnels of less height than the proposed wall along the lines of said proposed walls at the lowermost level thereof, bracing and lagging said tunnels, filling the tunnels with wall forming material, thereafter similarly excavating, bracing and lagging and filling higher wall section tunnels to complete the walls, and finally excavating the earth between the finished side walls.

6. The improvement in the art of constructing open cut subways and the like, which consists in sinking a shaft between the lines of the proposed walls, extending tunnels in opposite directions from said shaft, branching said tunnels at their outer ends to connect with the lines of said walls, excavating successively higher wall section tunnels, beginning at the level of and communicating with said branched tunnels, separately filling each wall section tunnel before the next higher tunnel is excavated and excavating the middle section between said walls.

7. The improvement in the art of constructing open cut subways and the like, which consists in sinking a shaft between the lines of the proposed walls, extending tunnels in opposite directions from said shaft, branching said tunnels at their outer ends to connect with the lines of said walls, excavating successively higher wall section tunnels, beginning at the level of and communicating with said branched tunnels, placing air locks in the ends of the shaft connecting tunnels, one between said shaft and the outer end of each tunnel, separately filling each wall section tunnel before the next higher tunnel is excavated and excavating the middle section between said walls.

8. The improvement in the art of constructing open cut subways and the like, which consists in sinking a shaft between the lines of the proposed wall, extending tunnels in opposite directions from said shaft, branching said tunnels at their outer ends to connect with the lines of said walls, excavating successively higher wall section tunnels, beginning at the level of and communicating with said branched tunnels, and forming inclined passages for connecting the outer ends of the shaft tunnels with the levels of the successively higher wall section tunnels.

9. The improvement in the art of constructing open cut subways and the like, which consists in forming the side walls thereof by excavating successively higher wall section tunnels or excavations along the lines of the proposed walls, beginning at the lower level of the walls, separately filling each tunnel as it is excavated with wall forming material, thereafter excavating the middle section and placing the floor or invert as the excavation proceeds, and finally erecting a roof over the tunnel between the side walls.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of witnesses, this 8th day of February A. D. 1910.

GEORGE W. JACKSON.

Witnesses:

GEORGE R. BENNETT,

J. M. SINGLETON,

L. WEBSTER STACKPOLE.