No. 742,221. PATENTED OCT. 27, 1903.

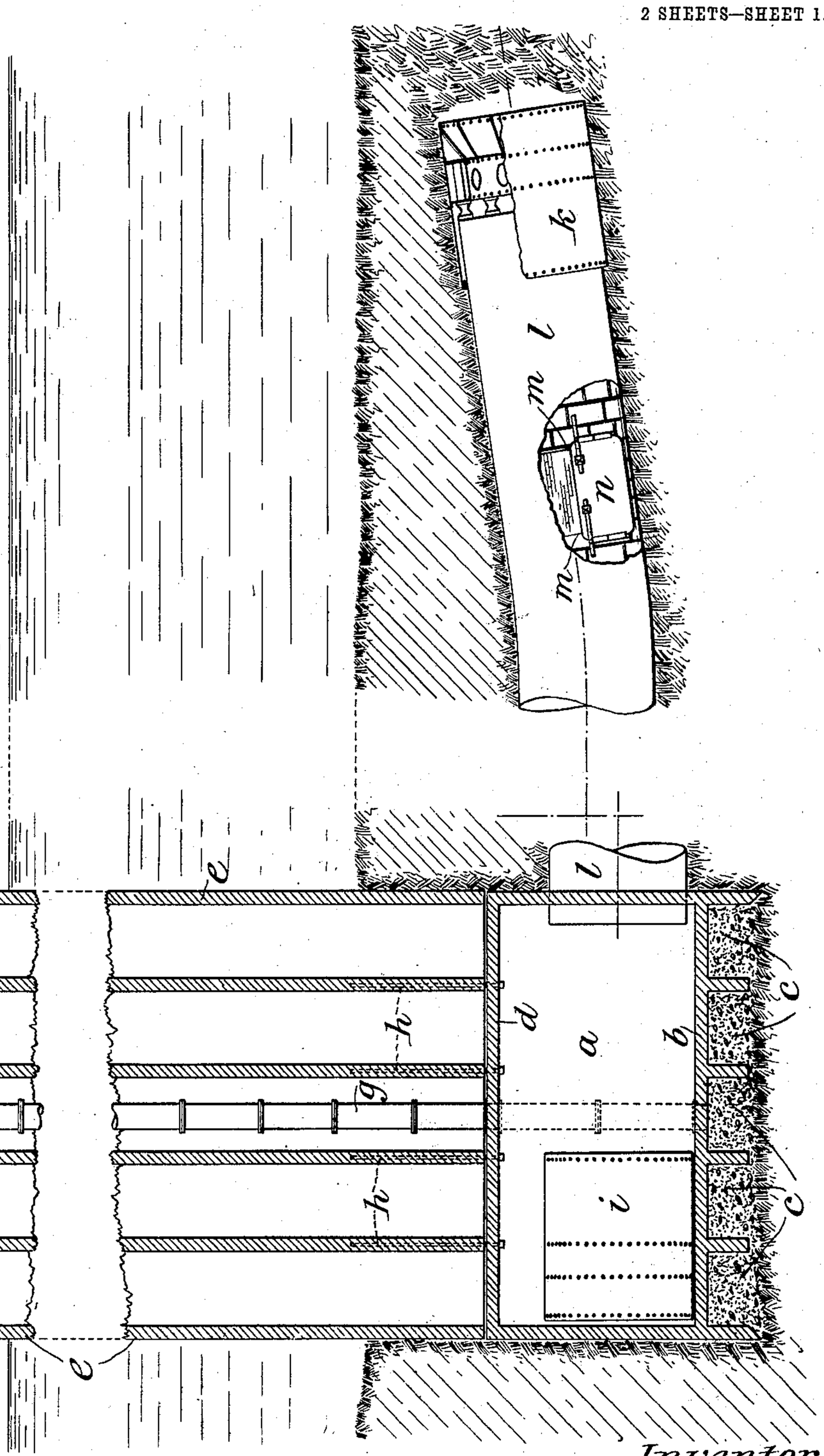
J. F. O'ROURKE.

TUNNEL CONSTRUCTION.

APPLICATION FILED JAN. 19, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



Attest:
A. N. Jesbera
E. W. Taylor.

Inventor:
John F. O'Rourke
by Redding, Kiddle & Peeler
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 742,221. PATENTED OCT. 27, 1903.

J. F. O'ROURKE.

TUNNEL CONSTRUCTION.

APPLICATION FILED JAN. 19, 1903.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

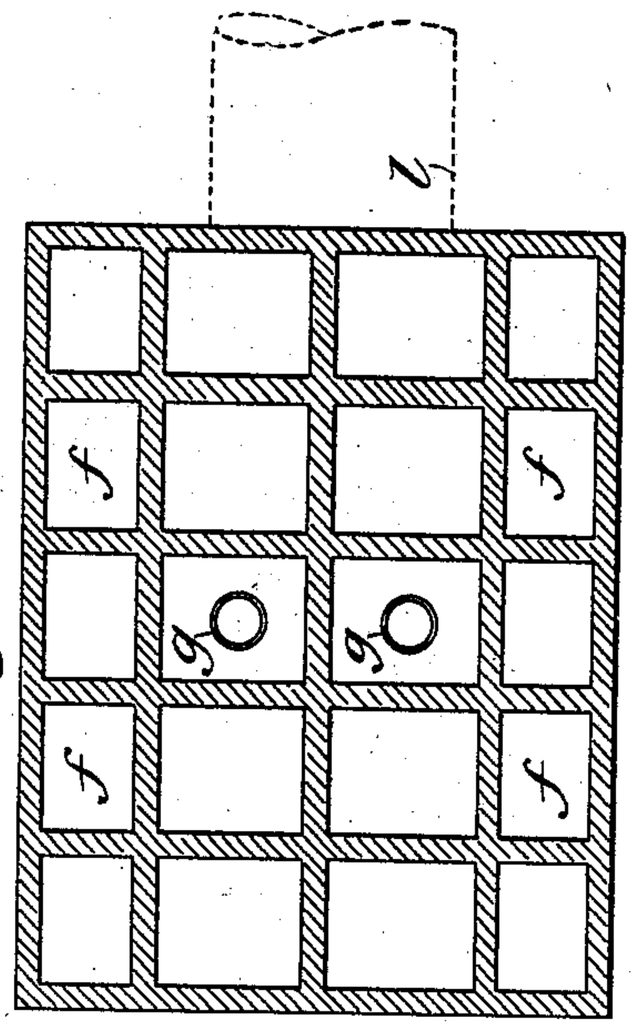


Fig. 4.

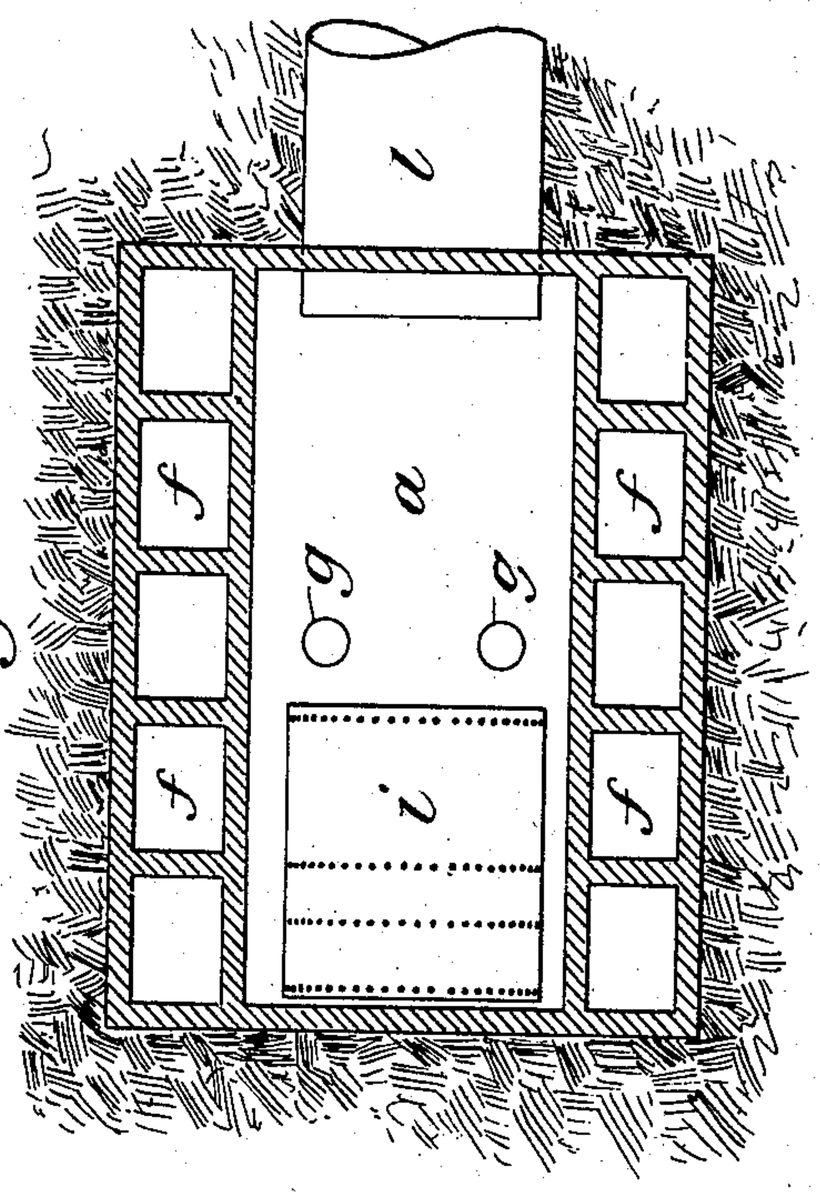


Fig. 2.

Attest:
A. N. Jesbera.
E. W. Taylor.

Inventor:
John F. O'Rourke
by Redding, Kiddle & Greeley
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 742,221. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

JOHN F. O'ROURKE, OF NEW YORK, N. Y.

TUNNEL CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 742,221, dated October 27, 1903.

Application filed January 19, 1903. Serial No. 139,561. (No model.)

To all whom it may concern:

Be it known that I, JOHN F. O'ROURKE, a citizen of the United States, residing in the borough of Manhattan, in the city of New York, in the State of New York, have invented certain new and useful Improvements in Tunnel Construction, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

Heretofore when a tunnel was to be constructed beneath the bed of a body of water it was usual to excavate the tunnel from the shore ends toward the middle, the work frequently being carried on from shafts sunk at some distance back from the edge of the water, so that it was unnecessary to work under air-pressure above atmospheric until the tunnel was carried well toward the edge of the water. Under some conditions, particularly where the extent of the tunnel is not very great and where the character of the material to be excavated is favorable, this old method is satisfactory. It will be obvious, however, that when the tunnel is very long the time consumed in the work will necessarily be considerable, since it can be carried on at only two headings. Furthermore, when the tunnel, as is usually the case, dips toward the middle it is a matter of considerable trouble and expense to keep the headings, where the work is carried on, free from water, it being necessary to pump the water constantly from the heading back to the shaft, where it can be raised and discharged. It is proposed by the present invention to overcome these difficulties and objections and to carry on the work from the middle or lowest point of the tunnel, while it may also be carried on, if desired, from the shore ends, as heretofore. It is impracticable in ordinary cases to begin the work at the middle or lowest point from an ordinary open shaft, and to make it possible to begin the work at this point an air-pressure chamber, in which the pressure above atmospheric necessary to prevent the entrance of water can be maintained, is formed or placed at the lowest point or other point at which the work is to be commenced and from this auxiliary air-pressure chamber the work is carried forward in both directions, if desired, until it has progressed far enough to permit the air-pressure to be maintained within the tunnel itself as far as constructed and the pressure within the auxiliary chamber to be relieved. It thus becomes possible to carry on the work from four headings instead of two, reducing proportionately the time necessary for the completion of the work. A further advantage lies in the fact that through the upward inclination of the tunnel from the point of starting the water which finds its way in will immediately leave the heading at which the work is being carried on and will pass without the necessity of pumping to the auxiliary chamber, from which it can be raised and discharged.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a view in longitudinal vertical section, showing the auxiliary chamber, the caisson above it, and the tunnel carried out beneath the bed of the body of water in one direction, a shield being shown in readiness to be carried through the wall of the chamber in the opposite direction. Fig. 2 is a transverse section on the plane indicated by the line 2 2 of Fig. 1. Fig. 3 is a horizontal section on the plane indicated by the line 3 3 of Fig. 1. Fig. 4 is a horizontal section on the plane indicated by the line 4 4 of Fig. 1.

The auxiliary air-chamber *a* of suitable dimensions may be formed ashore of any suitable material which will permit the desired pressure to be maintained within and will also resist the pressure from without. It is tightly closed on all sides and is so constructed as to form, at least temporarily, a portion or section of the tunnel structure. Its diameters, however, are preferably somewhat greater than the diameters of the tunnel structure, so that the tunnel from the air-chamber can be accurately placed without requiring the chamber itself to be placed in exact position.

The air-chamber *a* may be placed by any convenient method. Thus beneath its floor *b* may be formed working chambers *c*, while above its roof *d* may be erected a crib or caisson *e*, which is sunk by being filled in whole or in part with pig-iron or other material. The excavation of material beneath the air-chamber may be carried on through the shafts *f* of the caisson and at the sides of the auxil-

iary chamber, or if air-pressure is necessary the air-shafts *g* may be carried through the chamber *a* into the working chamber beneath the same, as indicated by dotted lines in Figs. 1 and 2, and the work of excavating be carried on in the working chamber under air-pressure, as usual. The working chamber is eventually filled in with concrete or other suitable material, and the portions of the air-shafts *g* within the chamber *a* are removed to permit the operations within the air-chamber to be carried on. The roof *d* of the air-chamber is preferably stayed to resist pressure from above by long bolts or stay-rods carried up into the crib or caisson above, as indicated at *h* in Fig. 1. When the chamber *a* has been placed, the exact position of the tunnel-walls is determined and the end walls, either one or both, of the chamber are broken through, the necessary air-pressure being first established within the chamber. If the character of the material through which the tunnel is to be driven is such as to require it, shields are formed within the air-chamber, as shown at *i* in Fig. 1, are placed in position against the end walls, respectively, and are projected through the end walls and are carried forward in the usual manner as the excavation of the tunnel progresses, as shown at *k* at the right of Fig. 1. The lining *l*, which follows the shield, is also carried through the wall of the air-chamber, the joint between the lining and the wall being made tight in any suitable manner. It will be understood that the tunnel is usually carried upward at a slight inclination, so that water at the heading drains back toward the air-chamber. When the tunnel has been carried forward a suitable distance, bulkheads *m m* may be erected in the tunnel and an air-lock *n* provided, so that the air-pressure above atmospheric need be maintained only between the heading and the air-lock, while the pressure in the chamber *a* is relieved.

It will be understood that the improvements in tunnel construction herein described may be practiced in structures differing more or less in detail from what is shown and described herein and that the invention is not to be restricted to any particular structure.

I claim as my invention—

1. The method of constructing tunnels, which consists in forming a structure adapted to serve as a portion or section of the tunnel, sinking said structure bodily to permanent position and carrying forward the work of excavation laterally from said structure; substantially as described.

2. The method of constructing tunnels, which consists in forming a structure adapted to serve as a portion or section of the tunnel, sinking said structure bodily to permanent position, maintaining air-pressure in said structure and carrying forward the work of excavation laterally from said structure; substantially as described.

3. The method of constructing tunnels, which consists in forming a structure adapted to serve as a portion or section of the tunnel, having its ends closed, sinking said structure bodily to permanent position, maintaining air-pressure in said structure, driving a shield through the closed end of said structure and carrying forward the shield and the excavation of the tunnel laterally from said structure; substantially as described.

4. The method of constructing tunnels, which consists in forming a structure adapted to serve as a portion or section of the tunnel, sinking said structure bodily to permanent position, maintaining air-pressure in said structure, carrying forward the excavation of the tunnel from said structure under the pressure maintained therein, constructing bulkheads in the tunnel so excavated, producing air-pressure between the bulkheads and the heading and relieving the air-pressure in the structure; substantially as described.

5. The method of constructing tunnels which consists in forming an air-chamber at a low point of the tunnel and carrying forward the work of excavation through the wall of said chamber under air-pressure at an upward inclination; substantially as described.

6. The method of constructing tunnels which consists in forming a structure adapted to serve as a portion or section of the tunnel, sinking said structure bodily to place at a low point of the tunnel, maintaining air-pressure in said structure and carrying forward the work of excavation therefrom at an upward inclination; substantially as described.

This specification signed and witnessed this 9th day of January, A. D. 1903.

JOHN F. O'ROURKE.

In presence of—

ANTHONY N. JESBERA,

W. B. GREELEY.