F. B. FLINN.

APPARATUS FOR SEPARATING ORE MATERIALS FROM EACH OTHER.

APPLICATION FILED MAR. 19, 1915.

1,314,316.

Patented Aug. 26, 1919.

2 SHEETS—SHEET 1.

Fig. 1.

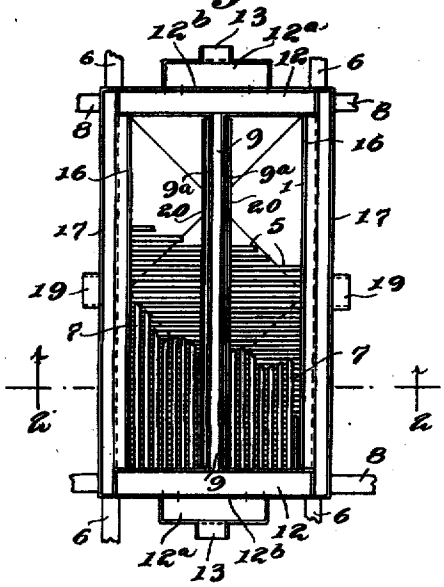


Fig. 6.

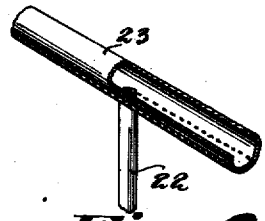


Fig. 5.

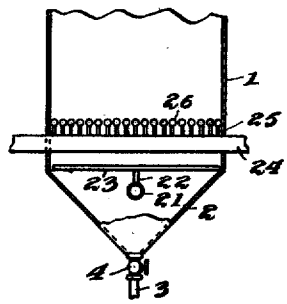


Fig. 7.

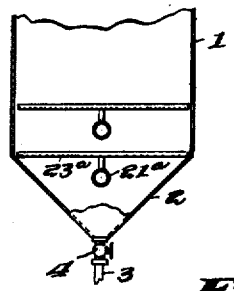


Fig. 2.

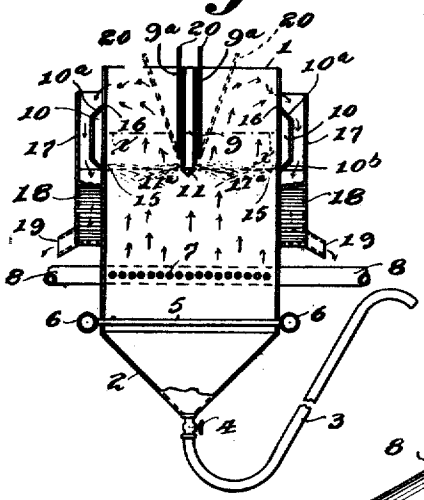
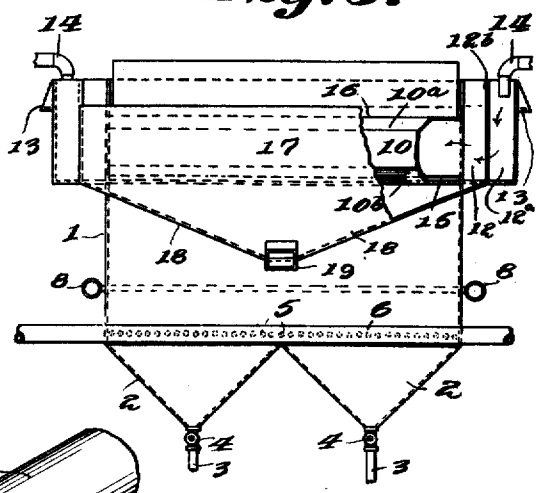


Fig. 3.



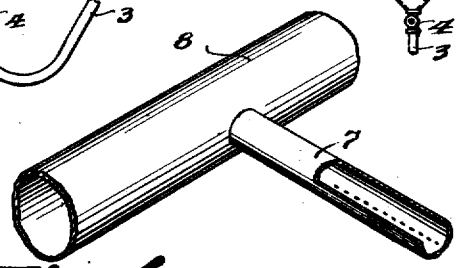


Fig. 4.

Witnesses

A. N. Lybrand

S. Jay Teller

Inventor

Frederick B. Flinn

By H. H. Bliss

Attorney

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

F. B. FLINN.

APPARATUS FOR SEPARATING ORE MATERIALS FROM EACH OTHER.

APPLICATION FILED MAR. 19, 1915.

1,314,316.

Patented Aug. 26, 1919.

2 SHEETS—SHEET 2.

Fig. 8.

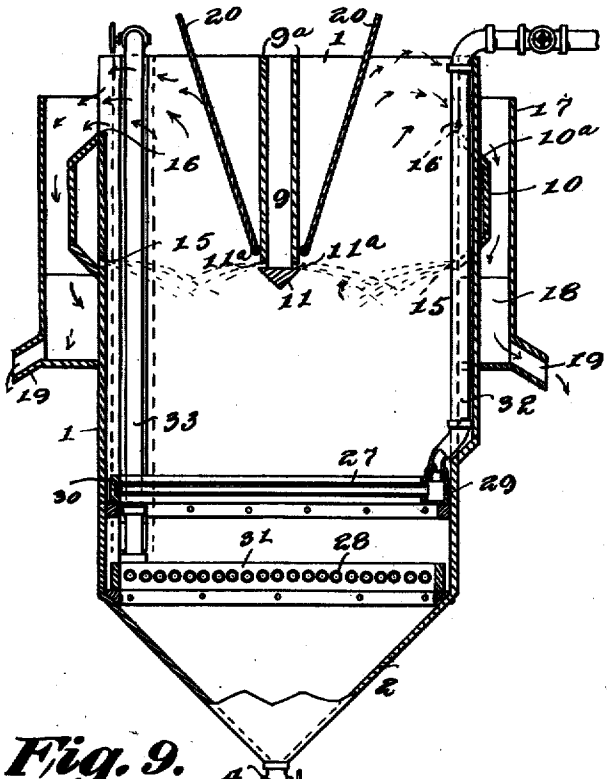
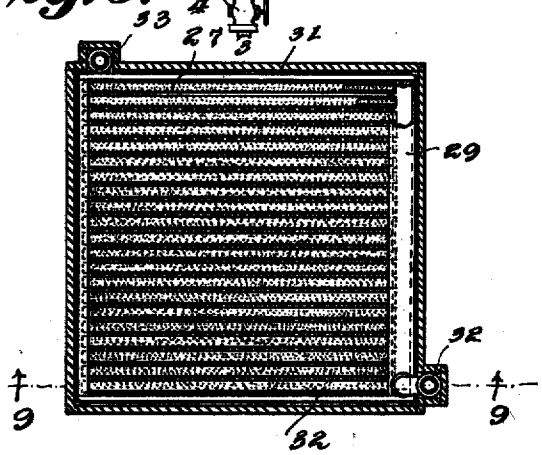


Fig. 9.



Witnesses

W. H. Lybrand

S. Jay Teller

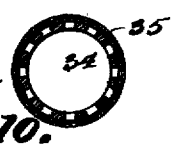


Fig. 10.

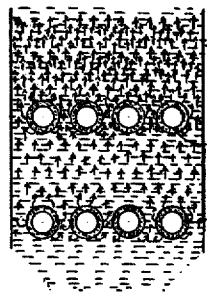


Fig. 13.

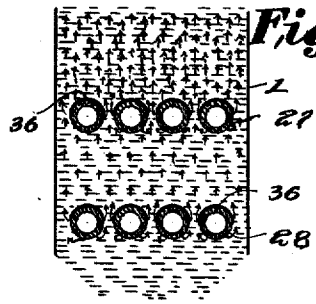


Fig. 12.

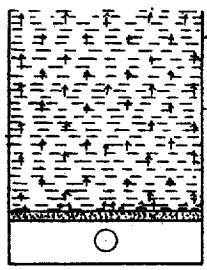


Fig. 11.

Inventor

Frederick B. Flinn

By H. H. Bliss

Attorney

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

FREDERICK B. FLINN, OF ORANGE, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO PNEUMATIC PROCESS FLOTATION COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

APPARATUS FOR SEPARATING ORE MATERIALS FROM EACH OTHER.

1,314,316. Specification of Letters Patent. Patented Aug. 26, 1919.

Application filed March 19, 1915. Serial No. 15,550.

To all whom it may concern:

Be it known that I, FREDERICK B. FLINN, a citizen of the United States, residing at Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Separating Ore Materials from Each Other, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to an apparatus for separating the metalliferous particles from the non-metalliferous particles of an ore mass. The apparatus is of the general class by means of which air is introduced into a fluid pulp mass in the form of relatively large bubbles which are caused to rise through the mass and to separate the metalliferous particles therefrom. A number of forms of apparatus have already been proposed. One proposal was to introduce the air into the bottom of the tank in which the separation takes place by means of a plurality of perforated pipes arranged parallel to each other in a horizontal plane. I have found, however, that under some circumstances it is difficult to secure a sufficient volume of air and to properly distribute it by means of a single series of pipes such as has been heretofore proposed. One of the objects of my present invention is to provide means whereby the volume of air can be increased without changing the size of the bubbles and without detrimentally affecting their distribution.

A further object of the invention is to provide means whereby, for a given number of pipes, air can be more evenly distributed and supplied in smaller streams.

Mechanisms constructed in accordance with earlier proposals have been limited in capacity because of the necessarily limited horizontal cross area of the tank resulting from the feed devices which were used. Most of the tanks were cylindrical and the ore was fed radially inward from the periphery, or radially outward from the center, or both inward and outward. But it will be clear that with a cylindrical tank the diameter is necessarily limited, even when the feed is both inward and outward to four times the distance through which the pulp can be horizontally projected. By my present invention I provide a rectangular tank and with it provide means for feeding the material horizontally inward from two opposite sides and also for feeding it horizontally outward from the central longitudinal plane. With this construction the width of the tank (like the diameter of the cylindrical tank mentioned above) is limited to four times the horizontal distance through which the pulp can be projected. But the length of the tank can be increased indefinitely, and thus a unit of any desired capacity can be constructed.

In the accompanying drawings I have shown several constructions embodying the invention, but it will be understood that other embodiments of the invention can be used without departing from its spirit.

Of the drawings—

Figure 1 is a plan view.

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a side view with a part broken away.

Fig. 4 is a detailed view showing one of the air feed pipes.

Fig. 5 is a fragmentary vertical sectional view showing a modified form of construction.

Fig. 6 is another illustration of part of an air pipe.

Fig. 7 illustrates a part of another modified apparatus.

Fig. 8 is a vertical sectional view on a larger scale showing a modified construction of tank and adjuncts.

Fig. 9 is a horizontal section through Fig. 8.

Fig. 10 is an enlarged sectional view of a pipe.

Figs. 11 to 13 are diagrammatic views illustrating the manner in which the air is introduced.

Referring to the drawings, 1 represents, as a whole, the main tank within which the ore pulp to be treated is contained. This tank is rectangular and its width is determined by the distance through which the inflowing pulp can be projected, as will be more fully explained below. The tank can have any length that may be necessary to give the capacity that is desired for any given unit. It can be extended indefinitely.

The tank 1 is provided with a bottom all of the parts of which are inclined. This inclination can be secured in any of several ways, but for purposes of illustration I have shown the tank as formed with a series of inverted pyramidal sections 2, 2 adjoining each other. At the apexes of the pyramids there are provided discharge apertures with which are connected the discharge pipes 3, 3 having valves 4, 4. The pipes 3 are preferably flexible, or at least adjustable so that their outer ends can be raised or lowered to regulate the discharge.

For supplying air to the tank in finely divided condition a plurality of sets of pipes are provided one above the other, two such sets being shown for purposes of illustration. As shown, the pipes of the lower set marked 5 extend transversely of the tank and through the walls thereof. They are arranged parallel to each other and close together. The pipes 5 extend through the walls of the tank and at the outside communicate with longitudinal headers or manifolds 6, 6 which are connected with a suitable source of air supply. The pipes of the upper set marked 7 extend longitudinally at right angles to the pipes 5 and are similarly arranged parallel to each other and close together. At the ends of the tank they extend through the walls and are connected with headers or manifolds 8, 8, which, like the manifolds 6, 6, are connected with a suitable source of air supply. The pipes 5 and 7 are provided with series of small perforations extending from end to end, these being preferably arranged at the lower sides of the pipes. It will be seen that when air is supplied through the manifolds 6, 6 and 8, 8 it will flow into and through the pipes 5 and 7 and will emerge through the apertures therein in the form of very fine streams. When liquid is present in the tank this finely divided air will form bubbles which will rise. It is obvious that the amount of air which can be introduced through one set of pipes is limited, especially when sufficient space is left between the pipes to permit the free vertical movement of liquid. And it has been found that, under many circumstances, more air must be provided than it is practicable to supply through one set of pipes. For this reason the plurality of sets of pipes have been provided at angles to each other, thus multiplying the air supply for the given total cross area which is left free for the vertical movement of liquid.

For feeding the ore pulp to the receptacle 1, devices are provided which extend longitudinally of the tank. There is provided a central feed device 9 and, under some circumstances, this single device may be sufficient, but usually the tank is of such a width that the pulp cannot be distributed over its horizontal cross area from the center. When such a wide tank is used, supplemental side feeding devices 10, 10 are provided. The central feed device 9 is in the form of a trough extending from end to end of the tank and having vertical side walls 9^a, 9^a. The trough is open at the bottom and to provide for the horizontal distribution of the pulp, the distributer 11 is provided which is preferably triangular in vertical section. It is mounted immediately beneath the trough so as to provide narrow slots 11^a, 11^a through which the pulp is forced out horizontally.

The inclined bottom surfaces of the distributer 11 serve to deflect upwardly moving bubbles laterally without breaking them. At the end of the tank are feed reservoirs 12, 12 with which the trough 9 communicates at its ends. Preferably each reservoir 12 is provided with an extension 12^a separated from the main part by the slotted partition 12^b. At 13, 13 the feed reservoirs are provided with overflow spouts. The pulp can be fed to the reservoirs 12, 12 (preferably the sections 12^a, 12^a thereof) by means of pipes 14, 14.

When supplemental side feed devices are necessary they are preferably constructed as indicated by 10, 10 being in the form of horizontal ducts extending longitudinally of the tank and communicating at their ends with the aforesaid reservoirs 12, 12. Preferably each duct 10 has its upper wall inclined downward and outward, as indicated at 10^a, and its bottom wall inclined downward and inward as indicated at 10^b. At the bottom of the duct 10 and adjacent the lower edge of the wall 10^b is a feed slot 15, preferably in the same horizontal plane as the aforesaid feed slots 11^a, 11^a. Through these slots 15, 15, the pulp is forced horizontally outward in the opposite directions to the pulp which passes out through the slots 11^a, 11^a.

When the apparatus is in operation the pulp is allowed to accumulate to a depth approximating that indicated by the line x—x of Fig. 2, a continual discharge taking place through the pipes 3, 3, and a continual horizontal inflow taking place through the slots 11^a, 11^a and 15, 15. The air introduced through the pipes 5, 5 and 7, 7 forms relatively large bubbles horizontally distributed over the entire cross area of the tank and these rise relatively rapidly through the pulp selecting metalliferous particles and lifting them to the exclusion of the non-metalliferous particles, in the way now well known. The bubbles as they reach the line x—x emerge from the fluid column of pulp and continue upward in the form of a bubble column. The side walls of the tank are cut away at 16, 16 to form horizontal ledges over which the bubbles constituting the bubble column and carrying the metalliferous

particles, can flow horizontally by gravity. For receiving and collecting these bubbles which flow horizontally out of the tank, there are provided at the sides of the tank the collectors 17, 17, each having a bottom made in oppositely inclined sections 18, 18 and leading to a discharge spout 19. From the spouts 19 the bubbles (now largely broken down) can be conveyed to any other suitable apparatus for subsequent treatment.

Preferably deflecting boards 20, 20 are provided adjacent the central feed trough 9. These boards extend longitudinally of the tank from end to end and can be inclined as indicated by dotted lines in Fig. 2. Preferably the boards are pivoted at their lower edges so as to permit them to assume vertical positions, or any desired angular positions. When adjusted to angular positions, as shown in Fig. 2, they serve to deflect the upwardly moving bubbles outward and to assist them in reaching the overflow lines at 16, 16.

It will be understood that the fresh pulp can be projected horizontally through only a short distance from feed devices such as those here shown. When the circumstances are such that only a relatively narrow tank is desired it may be possible to effect the feeding entirely from the central feed device 9, that is, it may be possible to project the pulp horizontally outward from the feed device 9 to cause it to reach the parts of the tank adjacent the side walls. But when a wider tank is desired the central feed device has to be supplemented by side feed devices such as those shown. With both central and side feed devices the incoming pulp can be projected horizontally both outward and inward, thus making it possible for the tank to be twice as wide as is possible with only the central feed device. In other words, the maximum width of the tank is four times the maximum distance through which the incoming pulp can be projected horizontally through the pulp column. It will be seen that while the width of the tank is limited for the reasons stated the length can be increased indefinitely when the feed devices are constructed as shown and described. The engineer, upon being given the required capacity of a unit, and knowing the cross area of tank necessary for each unit of capacity, can readily calculate the length which the tank must have to give the desired capacity. I believe myself to have been the first to provide an apparatus of this character in which the maximum width is attained and in which the length can be indefinitely increased.

In Figs. 5 and 6 I have shown a construction which is modified as concerns the means for introducing the air, it being similar otherwise to the construction fully described. As shown, a plurality of manifolds are provided inside of the tank 1, two being shown for purposes of illustration. As shown, the lower one of these, marked 21, extends longitudinally of the tank and can be connected to a suitable source of air supply. Tapped into the pipe 21 at equal distances therealong are vertical nipples 22 at the ends of which are mounted horizontal cross pipes 23 closed at their ends and having perforations therein distributed from end to end. One of these pipes 23, with its supporting nipple 22, is shown in detail in Fig. 6. The upper pipe 24 extends transversely of the tank and is connected to a suitable source of air supply. It will be understood that more than one of these pipes 24 can be provided if the tank is long enough to make them necessary. The pipe 24 carries nipples 25 and horizontally perforated pipes 26 similar to the nipples and pipes 22 and 23 already described.

It will be understood that the construction shown in Figs. 5 and 6 has certain features of advantage for some classes of work, as the air supply system is entirely self-contained and can be easily removed for repair or cleaning. It is necessary to provide but one (or possibly two) apertures for each set of pipes as contrasted with thirty or more for the construction shown in Figs. 1 to 3.

The air supply pipes of the two sets, while preferably arranged at right angles to each other, need not necessarily be so arranged and can, if desired, be arranged parallel to each other. Such an arrangement is shown in Fig. 7. In Fig. 7 I have shown inside headers 21^a, 21^a for the supply pipes 23^a, 23^a, but it will be understood that either of the means already described for mounting and connecting the supply pipes can be used.

In Figs. 8, 9 and 10 there is shown a modified means for supplying air, this consisting of a plurality of sets of pipes which are porous instead of perforated, as are those already described. As shown, there are two sets of pipes 27—27 and 28—28 one above the other, the pipes of each set being parallel to each other and close together, and the pipes of the two sets being at right angles to each other. Each of the pipes 27—27 is connected at one end into a header 29 and is closed at the other end. Preferably the closed ends of the pipe fit in sockets in a bar 30, this bar serving to support the pipes and hold them equally spaced. The pipes 28—28 are connected with a header 31 arranged at right angles to the header 29 and for the opposite closed ends of the pipes 28—28 there is provided a bar 32 similar to the bar 30 above referred to. The two headers 29 and 31 are suitably connected with a source of air supply.

Preferably each of the headers 29 and 31

is connected with the air supply by means of vertical pipes 32 and 33, which can be located in a groove or housing at the sides of the tank, as shown.

Each of the pipes 27—27 and 28—28 is porous, it preferably being formed of some homogeneous porous material, such as porcelain or carborundum. As shown in Fig. 10, however, a pipe which is in effect porous can be constructed by providing a metallic pipe 34 with numerous relatively large perforations and winding upon it layers of canvas 35.

Figs. 11, 12 and 13 are diagrams illustrating the amount of porous surface which is exposed with different constructions. Fig. 11 shows a simple horizontal porous plate such as has heretofore been used, the porous area of this plate being the same as the horizontal cross area of the receptacle. Fig. 12 shows a porous pipe construction such as that shown in Figs. 8 and 9, with the exception that the upper halves of the pipes are enameled, as indicated at 36, or otherwise made impervious. With some kinds of ore difficulty is sometimes experienced because of the settling of the ore upon the porous air supply surfaces, causing them to become clogged. With the upper surfaces of the pipes made impervious, as described, a smooth surface is provided upon which the ore does not readily stick and which cannot be detrimentally affected even if the ore does collect upon it.

And it will be noted that with the construction shown in Fig. 12, even with the upper surfaces of the pipes made ineffective, the total porous surface is considerably greater than with a simple plate, as shown in Fig. 11. The total surface will be from one to one and a half times the horizontal area for each set of pipes, thus making from two to three times the horizontal cross area for the two sets of pipes as shown.

Fig. 13 shows pipes porous on the tops and bottoms, this being the construction illustrated in Figs. 8 and 9. Here the porous surface is twice as great as in the construction shown in Fig. 12 and is from four to six times as great as the surface of the simple plate shown in Fig. 11.

What I claim is:

1. The combination of a pulp receptacle, and two stationary air delivering and bubble forming devices respectively positioned in a plurality of vertically separated horizontal planes and each arranged transversely across the pulp receptacle, to deliver a stratum of bubbles over substantially the entire cross area of the pulp and each comprising a plurality of parallel pipes and means for supplying air thereto, each pipe being adapted to deliver fine streams of air uniformly distributed throughout its length and the pipes of the two devices being positioned at right angles to each other and the pipes of each upper bubble forming device being arranged to permit the bubbles from each lower device to freely pass upward between them and to permit the solid particles to freely pass downward between them.

2. The combination of a rectangular pulp receptacle, means for supplying air to the receptacle near the bottom thereof to form bubbles uniformly distributed over the horizontal cross area, means at the bottom of the receptacle for the discharge of barren pulp, means at the top of the receptacle for the reception of metal-carrying bubbles, and a pulp feed trough extending through the center of the receptacle extending from end to end thereof and having outward opening horizontal feed slots in its sides and arranged to form rectangular sheets of pulp extending toward the sides of the rectangular receptacle.

3. The combination of a pulp receptacle, means for supplying air to the receptacle near the bottom thereof to form bubbles uniformly distributed over the horizontal cross area, means at the bottom of the receptacle for the discharge of barren pulp, means at the top of the receptacle for the reception of metal-carrying bubbles, a pulp feed trough extending through the center of the receptacle adapted to supply pulp to the receptacle, pulp supply reservoirs at the ends of the receptacle and communicating with the feed trough, and deflectors positioned at the sides of the feed trough for deflecting the bubbles outward toward the sides of the tank, the said deflectors being adjustable to vary the angles of outward inclination thereof.

4. The combination of a rectangular pulp receptacle, means for supplying air to the receptacle near the bottom thereof to form bubbles uniformly distributed over the horizontal cross area, means at the bottom of the receptacle for the discharge of barren pulp, means at the top of the receptacle for the reception of metal-carrying bubbles, a pulp feed trough extending through the center of the receptacle and having outwardly opening horizontal feed slots in its sides, and feed ducts at the sides of the receptacle parallel to the said feed trough and having inwardly opening horizontal feed slots in their inner sides.

5. The combination of a rectangular pulp receptacle, means for supplying air to the receptacle near the bottom thereof to form bubbles uniformly distributed over the horizontal cross area, means at the bottom of the receptacle for the discharge of barren pulp, means at the top of the receptacle for the reception of metal-carrying bubbles, a pulp feed trough extending through the center of the receptacle and having outwardly opening horizontal feed slots in its sides, feed

ducts at the sides of the receptacle parallel to the said feed trough and having inwardly opening horizontal feed slots in their inner sides, and pulp supply reservoirs at the ends of the receptacle and communicating with the central feed trough and the side feed ducts.

In testimony whereof, I affix my signature, in presence of two witnesses.

FREDERICK B. FLINN.

Witnesses:
ROBT. A. TOWNS,
CHARLES SMITH.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."