

(No Model.)

2 Sheets—Sheet 1.

J. DENNIS.
PHOTOGRAPHIC APPARATUS.

No. 581,540.

Patented Apr. 27, 1897.

Fig. 1.

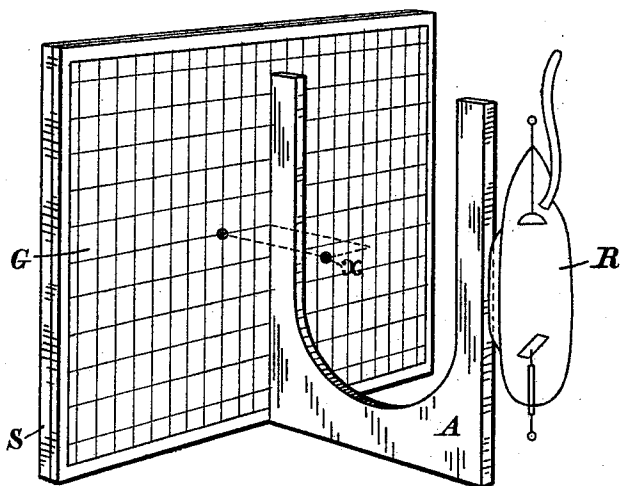
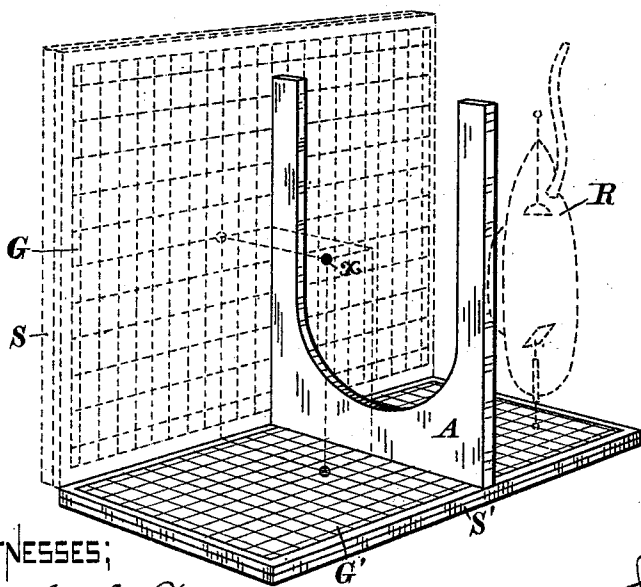
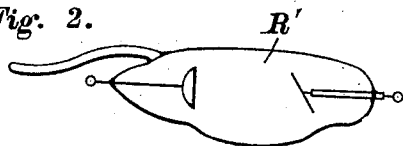


Fig. 2.



WITNESSES;

G. S. Day.

C. E. Bramwell

Fig. 4.

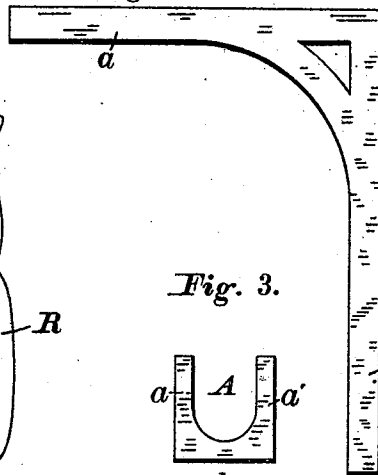
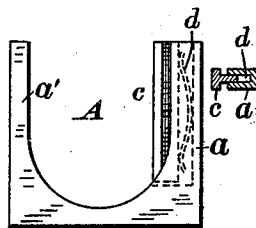
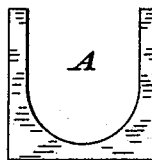
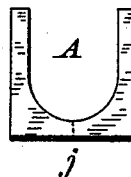
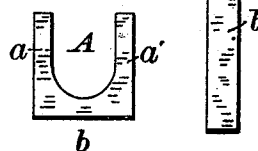


Fig. 3.



INVENTOR;

John Dennis,
By Geo. B. Selden,
att'y

(No Model.)

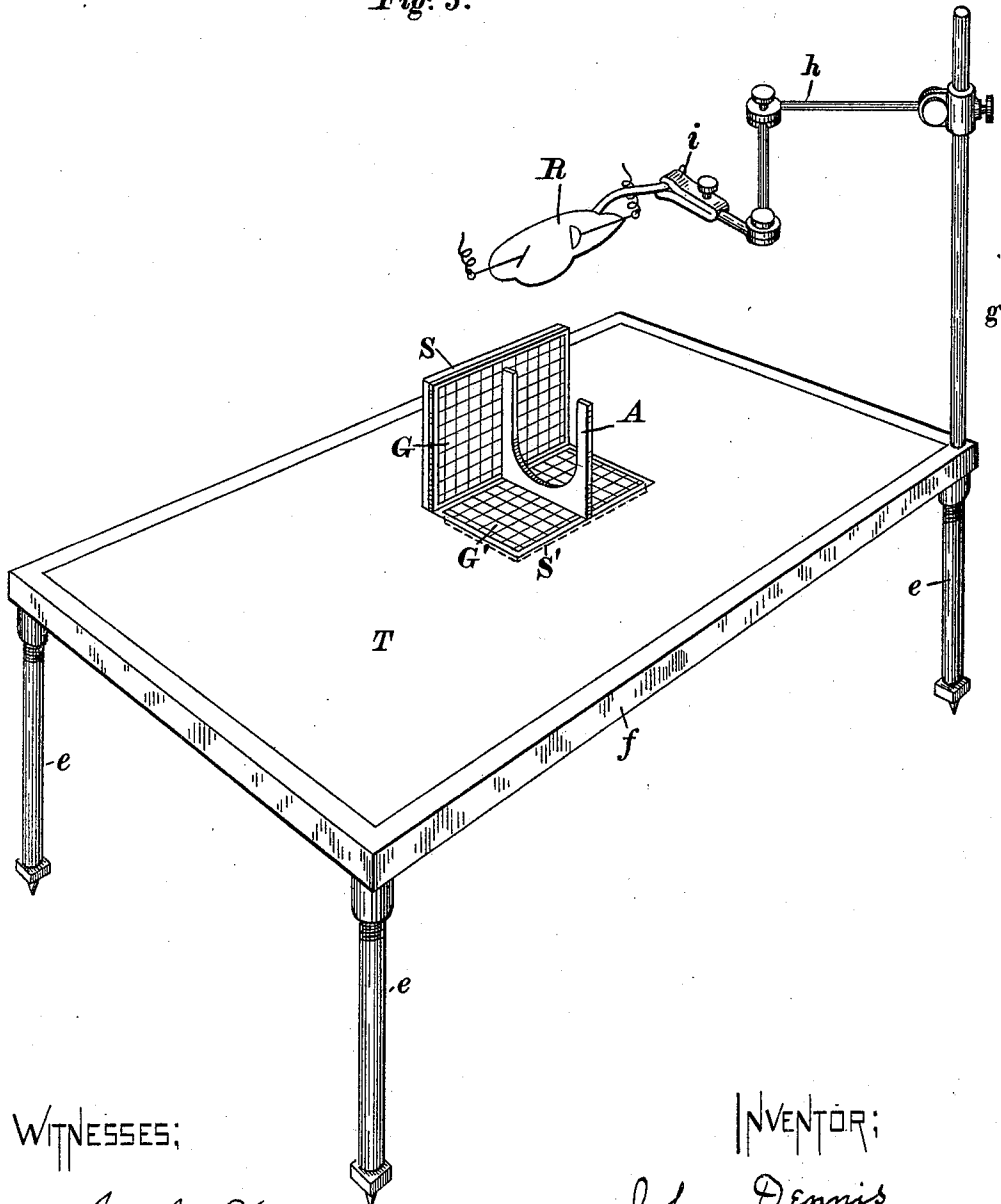
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Fig. 5.



WITNESSES;

L. S. Dey.

C. G. Crannell.

INVENTOR;

John Dennis.
By *Geo. B. Selden.*
Atty.

UNITED STATES PATENT OFFICE.

JOHN DENNIS, OF ROCHESTER, NEW YORK, ASSIGNOR OF ONE-HALF TO
SAMUEL W. PUFFER, OF SAME PLACE.

PHOTOGRAPHIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 581,540, dated April 27, 1897.

Application filed January 16, 1897. Serial No. 619,425. (No model.)

To all whom it may concern:

Be it known that I, JOHN DENNIS, a citizen of the United States, residing at Rochester, in the county of Monroe, in the State of New York, have invented an Improved Radiographic Apparatus, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to an improved radiographic apparatus whereby the exact location of an invisible object, not permeable or difficultly permeable by the so-called "Roentgen" or "X" rays, may be accurately ascertained and measurements made by which operations necessary for the removal of such objects are controlled and guided.

My invention is especially useful for surgeons in locating bullets or other hard or comparatively impermeable bodies or growths in organic substances, but it may also be employed for a variety of other purposes where the object sought is surrounded by more or less permeable material.

My invention is fully described and illustrated in the following specification and the accompanying drawings, the novel features thereof being specified in the claims annexed to the said specification.

In the accompanying drawings, representing my improved radiographic apparatus, Figure 1 is a diagram representing the arrangement of the apparatus when the object can be located from observation in one direction only. Fig. 2 is a diagram representing the arrangement of the apparatus when the object is to be located in two directions. Fig. 3 represents a set of angle-plates. Fig. 4 represents a single angle-plate of larger size. Fig. 5 represents the supporting-table and accessories.

The construction and method of using my improved radiographic apparatus will be understood from the diagrams Figs. 1 and 2, in which x represents the object which it is sought to locate and which is solid or relatively impermeable to the Roentgen or so-called "X" rays and is invisible on account of being surrounded by comparatively permeable organic tissues or other substances; R, a Crookes tube or other source of the X-rays; A, a metallic instrument, which I have

designated as an "angle-plate," which is applied to the permeable substance and insures adjustment in the parallelism of the rays; G, a metallic grating, preferably of crossed wires or bars, and S a sensitive surface on which the image is received and which may be either a fluorescent screen or a photographic plate, either of which may be used in connection with my improved apparatus.

Diagram Fig. 1 represents the arrangement when it is necessary or desired to find the position of object in one direction only, while diagram Fig. 2 represents the operation of locating the object in two directions, preferably at substantially right angles with each other.

Confining our attention first to Fig. 1, it will be understood that the tube R is supported in any suitable manner and furnishes the X-rays of sufficient penetrating-power, that the angle-plate is applied to the permeable substance and may be secured thereto in any suitable way, and that the grating G is interposed between the angle-plate and the sensitive or fluorescent surface S, and that such relative adjustments are made that the angle-plate throws a single definite shadow on the fluorescent or sensitive surface, so that if the object to be located, x , is three inches from the plane of the angle-plate and the grating be made of wires one inch apart the image of the object will be seen on the fluorescent surface to coincide with the third wire from the shadow of the angle-plate. By adjustment of the angle-plate or the tube so that the bars $a a'$ of the plate throw coincident shadows on the fluorescent surface the condition of parallelism of the rays is secured, and then the location of the object sought relatively to the base-line established by the angle-plate may be readily ascertained by means of the grating, the interspaces of which are known. The line where the angle-plate meets the permeable material may be marked, as with iodine or other suitable chemical, and thus a basis is afforded for a measurement which will determine the exact location of the object sought. The arms $a a'$ of the angle-plate, unless in proper alinement or in parallelism with the rays, will throw a double or overlapping shadow on the fluores-

cent surface or fluoroscope, but when alined so as to throw but one shadow thereon the condition of parallelism is attained, and the distance of the object x sought may then be located with reference to the shadows thrown by the angle-plate and by the wires of the grating G. As the X-ray tube usually throws practically parallel rays from a considerable portion of its surface and the object to be located can ordinarily be brought within a reasonably short distance of the base-line established by the angle-plate, there is in my apparatus practically no distortion, which has heretofore generally prevented the obtaining of images sufficiently accurate to guide surgical or other operations. By observation on the fluoroscope the exact location of any given impermeable object relative to the base-line established by the angle-plate may be readily determined by the shadows of the grating of any given dimensions, and any subsequent operations, surgical or otherwise, may be governed by the information thus acquired. For operations which take place on the median plane—as, for instance, the recovery of a coin from the throat of a child—and for many other cases the location of the object in one direction only is sufficient, but where it is necessary to locate the object in two directions I employ the arrangement shown diagrammatically in Fig. 2. In these cases the tube or source of X-rays is changed from position R to R', and a grating G' and fluoroscope S' is employed, so as to locate the position of x in a plane at substantially right angles with that previously observed by following the directions herein set forth with regard to diagram Fig. 1.

From two measurements, one made on fluoroscope S and the other on fluoroscope S', at substantially right angles with each other, and the base-line established by the angle-plate, the exact location of any impermeable object in relatively permeable substances may be determined. Thus in Fig. 2 the location of the object x relatively to the base line or plane being determined with the X-ray tube at R on the fluoroscope S by the aid of the grating G the tube is shifted to R' and the location of the object determined by the grating G' and the fluoroscope S' in a direction substantially at right angles with the former determination. The two determinations, with proper markings indicating the base lines or planes from which such measurements are to be made, will enable the operator to locate any impermeable object inside any permeable substance with the accuracy necessary for any subsequent operations, surgical or otherwise. There is no trouble from distortion, since the condition of parallelism of the rays is secured by the angle-plate.

It will of course be understood that the images of the angle-plate, grating, and object may be observed on any ordinary fluoroscopic surface or that they may be impressed on any

suitable photographic surface, so as to be preserved permanently.

The angle-plate really establishes what may be called an "artificial cross-section" of the permeable body, from which the position of the object is determined in one direction, while in the other direction its position is located with reference to the outside of the body or to one of the edges of the angle-plate.

It will be understood that the angle-plates may be made of different sizes suitable for the particular uses for which they are destined. In fact, a complete set for surgeon's use will include a series of which the smallest will fit the finger, wrist, or arm, while the largest will receive the neck or head. Such a set is indicated in Fig. 3, the arms a a' being connected by the base b . For some purposes the base b may be divided or made separable, as indicated at j , Fig. 3.

It will also be understood that for many purposes the angle-plate may be made with only one arm a , in which case the condition of parallelism with the rays is secured by alining one of the arms lengthwise, so that it throws a single shadow of the same width as the thickness of the arm on the fluoroscope. Such an angle-plate, with one arm a and base b , is represented in Fig. 4. This form of angle-plate is used for establishing a base-line or artificial cross-section in observations on the shoulder or abdomen or larger parts of the human body. It will also be understood that the angle-plate may be used with the base placed toward or against the grating and that it may be bent or shaped in any particular way to conform to the outline of any particular subject submitted to the examination, the essential feature being that the impermeable instruments will throw a shadow on the fluoroscope of its own thickness when properly alined, which serves as a base-line from which the requisite measurements are made in the condition of parallelism of the rays, which measurements are then used on the subject to locate the invisible object.

The angle-plates are made of any suitable material impermeable to the X-rays and preferably, for strength, of metal, such as brass, iron, or steel. In a modified form of the double angle-plate one of the arms may be provided with an elastic or yielding contact-piece c , fitted in a slot in the arm a and provided with a spring d , which presses it inwardly, so as to maintain contact with the permeable substance.

It will also be understood that various changes or alterations may be made in the apparatus already described without departure from the principles involved.

The apparatus may be used in any suitable position with the tube above, at one side of, or below the object under examination. A suitable table or other support T, Fig. 5, is employed, and this table may be made adjustable, so that the subject with the angle-plate in position may be brought into the req-

uisite relation with the tube, grating, and fluorescent surface. The table may be made of wood or any other suitable material which is permeable to the X-rays. For some purposes

5 I employ a table made of glass, which is opaque to the X-rays and which has an aperture to which the grating and sensitive surface are applied. This is particularly useful in cases in which an operation is conducted under the
10 X-rays, the tube being placed above the patient, where an assistant under the table directs the surgeon by the indications which he observes on the fluoroscope, the glass permitting the assistant also to see the position
15 of the patient on the table. My improved apparatus has been used in this way to guide the surgeon in removing a coin from a child's throat, the assistant being able to observe the approach of the forceps to the coin and to instruct the surgeon in grasping and withdrawing it.

The table may be made of any suitable dimensions and the patient, under the influence of anesthetic, if necessary, be strapped
25 or otherwise secured thereto. The impermeable bar or angle-plate is secured in place by strips of adhesive plaster or other suitable means.

The table T is made adjustable in any suitable manner, as by three or more adjusting-screws *e*, Fig. 5, so that the patient placed thereon with the angle bar or plate attached may be adjusted in proper relation with the rays. Suitable supports are provided for the
35 lower ends of the screws, which are fitted into threaded sockets fastened to the lower side of the table, the table being sustained at such an elevation as to permit readily the observation of the fluoroscope by a person below it.

40 When the table is made of glass, it should be strengthened by a suitable frame around its edges, as indicated at *f*, Fig. 5. The grating and fluoroscope may be placed above the opening in the glass table or in or below the same, suitable provision being made for supporting these parts in place, as by clips engaging the edges of the opening.

The grating is provided with bars around its edges to strengthen it and keep it in shape, and the fluoroscope may be made in any ordinary or preferred manner, and it may be either attached to the grating or made removable therefrom, any suitable clips or catches being employed for this purpose.

55 When a photographically-sensitive surface is employed, such as a plate, film, or sensitized paper, such surface may be confined within any suitable holder, which is substituted for the fluoroscope already mentioned, or the fluoroscope may be used in connection with the sensitive photographic surface.

The tube or source of X-rays is arranged in any suitable or preferred way, so that it may be adjusted to secure observations in
65 any two planes at angles with each other, preferably right angles, or so that its position can be varied to suit the requirements of any

given subject in either of the planes. It may be supported directly from the table or independently thereof. In Fig. 5 I have represented a convenient manner of supporting
70 the tube by the rod *g*, attached to the table or its frame, the jointed arms *h*, and the clamp *i*, which permits the location of the tube for any given observation or operation in any
75 suitable relation with the subject, the grating, and the fluoroscope or sensitive surface, even below the patient when it is desired to make the observations from above.

It will also be understood that the operator
80 may avail himself of various devices not herein specifically mentioned, but of ordinary use, to facilitate the measurements and the accurate location of the invisible object sought, such, for instance, as the surface-gage, an
85 instrument which may rest on the table, and carries an adjustable pointer or brush filled with iodine, by which indications may be marked on the permeable substance submitted to examination. Squares or straight
90 bars may also be used, as the occasion may require, to secure accurate measurements, and any ordinary form of calipers may be employed for the same purpose.

Various other mechanical accessories will
95 occur to the skilled operator, which may be used in connection with my new radiographic apparatus.

The angle-plates may, if preferred, be made with the open side closed by any suitable
100 construction.

I claim—

1. The combination with a source of X-rays, of a fluorescent or sensitive surface, and two non-permeable bars arranged in the same
105 plane in the radiographic field between the source and the surface, one between the source and the radiographic object, and the other between such object and the said surface, substantially as described.

2. The combination with a source of X-rays, of a fluorescent or sensitive surface, and two non-permeable bars arranged in the same plane in the radiographic field between the source and the surface, the said source, surface and bars being relatively adjustable,
115 and one of the bars being placed between the source and the radiographic object and the other between the said object and the said surface, substantially as described.

3. The combination of a source of X-rays, a fluorescent or sensitive surface, and an intermediate non-permeable angle-plate, consisting of two parallel bars separated by an interval and arranged in a plane coincident with
125 the direction of the rays, so that the two bars project but a single shadow on the screen, substantially as described.

4. The combination of a source of X-rays, a fluorescent surface, a metallic or non-permeable grating, and an intermediate impermeable angle-plate, having arms arranged at an angle with each other, substantially as described.
130

5. The combination of a source of X-rays, a sensitive surface, an interposed metallic or impermeable grating, an intermediate impermeable bar or plate, and an adjustable table, substantially as described.

6. The combination with a source of X-rays, of an apertured glass table, a metallic or impermeable grating, and a sensitive surface, substantially as described.

7. The combination of an adjustable source of X-rays, a suitable supporting-table, two impermeable gratings arranged at angles with each other, two corresponding sensitive surfaces, and an impermeable bar or plate adapted to establish a base-line, for measurements, substantially as described.

8. The combination of an adjustable source of X-rays, an apertured glass supporting-table, two impermeable gratings arranged at angles with each other, one of said gratings being placed across the aperture in the table, two corresponding sensitive surfaces, and an

impermeable bar or plate adapted to establish a base-line for measurements, substantially as described.

9. The combination of a source of X-rays, a fluorescent or sensitive surface, an interposed metallic or non-permeable grating, and an intermediate non-permeable angle-plate, consisting of two parallel bars separated by an interval and arranged in a plane coincident with the direction of the rays, whereby the two bars project but a single shadow and an undistorted image of the grating is secured on the screen, substantially as described.

10. The combination with a source of X-rays, of an apertured glass table, a metallic or impermeable grating, a sensitive surface, and an interposed impermeable bar or plate, substantially as described.

JOHN DENNIS.

Witnesses:

SAML. W. PUFFER,
W. W. HIBBARD.