

N^o 16,181



A.D. 1901

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COMPLETE SPECIFICATION.

“Improved Apparatus for Making Industrial Use of the Heat of the Sun and Obtaining High Temperatures.

I, MANUEL ANTONIO GOMES HIMALAYA, of 13 rue de Buzenval, Boulogne-sur-Seine, Department of Seine, in the Republic of France, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to an apparatus for making industrial use of solar heat, particularly in the metallurgical and chemical arts which necessitate the use of temperatures higher than those of ordinary furnaces, including the electrical furnace.

10 The apparatus comprises a reflecting surface arranged to cause the solar rays to converge upon a confined focus placed in the centre of a furnace, crucible or other receiver, this furnace or other receptacle being if desired placed completely outside the reflecting system; it comprises besides means for adjusting or setting the apparatus so as to maintain the convergence of the rays upon the focus
15 selected whatever be the height of the sun above the horizon; it comprises also a kind of furnace or heat receiver specially constructed for the purpose of making industrial use of the solar heat according to my invention.

I now proceed to describe my arrangement, reference being made to the accompanying drawings, upon which:—

20 Figure 1 is a section through the axis of a paraboloid of revolution A B C of which the part near the vertex is cut along X Y perpendicularly to the axis and in which a truncated sector *a b c d* forming an essential part of the apparatus is cut out.

25 Figure 2 shows in plan and upon a reduced scale the same truncated paraboloid A B X Y of Figure 1, divided into eight sectors S¹ to S⁸ mounted upon a horizontal axis D D arranged perpendicularly to the axis of the paraboloid of revolution at the level of the focus Z and supported by means of two columns 1, 1 movable upon the circular track 2.

30 Figure 3 shows in plan and in the working position the truncated paraboloidal sector *a b c d* of Figures 1 and 2, directing the solar rays within a crucible E, the sun being vertical.

Figure 4 is a vertical section upon line M—N of Figure 3.

Figure 5 is a modified form of the arrangement shewn in Figure 4.

35 Figure 6 is a front view of the reflecting system of Figure 5 and in section upon line P—Q of Figure 1.

Figure 7 shows, in part vertical section two reflecting systems placed back to back in such a manner as to form two foci in two furnaces symmetrically opposite.

40 Figure 8 is a plan view on a reduced scale of Figure 7. Figures 9 to 13 relate to modifications in the construction of and means for manipulating the reflecting surface.

The essential feature of the invention consists in the use of a reflecting surface

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formed by a sector of a paraboloid of revolution $a b c d$ (Figure 1) capable of reflecting a conical pencil of solar rays $a b Z$ (Figures 2 to 13) having an angle at the vertex sufficiently acute for the focus Z to be formed at the centre of the furnace or other receiver E and to produce a very high temperature.

In point of fact the paraboloid of revolution and similar surfaces, although being the ideal form of optical apparatus for concentrating the solar rays upon a physically perfect focus, cannot form a focus capable of industrial use, because the rays reflected reaching the focus from all sides of the figure, cannot be concentrated upon the centre of a furnace or receiver for heating; they can heat only around and outside a crucible or a boiler. In this manner, the temperatures developed are relatively small and the losses of heat through radiation and reflection are very important.

My invention is based upon the principle of the resolving of the paraboloid of revolution into as many parts as may be necessary for obtaining a portion of a paraboloid capable of producing a focus practically and easily useable in metallurgy and in all branches of industry.

This result is attained by cutting at the vertex a paraboloid of revolution upon line $X Y$ (Figure 1) and by dividing the paraboloidal frustrum so obtained into, for example eight parts or sectors S^1 to S^8 (Figure 2) and by suitable adjusting or setting one of these sectors as will be hereafter seen.

The aperture of this paraboloidal sector $a b c d$ (which for greater simplicity I term the "reflector"), Figures 1, 2 and 3, is preferably about 45 degrees but may be larger or smaller according to circumstances. This sector may be cut off at one or more sides or upon all sides in such case assuming the form of either a frustrum of a paraboloidal sector which is that shown upon the drawings or a circle, an ellipse, a polygon or other shape. This reflector may be formed of one or more parts or elements of a paraboloid the shape of which may be varied; that is to say each of the elements forming the reflector may have the shape of a trapezoid K which is that illustrated in Figures 1 to 13, or that of a circle (Figures 1^a and 1^b) or a hexagon (Figure 1^c) a triangle, a square &c.

In case the reflector is composed of a number of small elementary reflectors which will in fact be the usual case, the section and the surface of each of them may be plane or curved, spherical, parabolic, polyhedral, *etc* according to the dimensions of the apparatus.

These small elementary reflectors $k k$ (Figures 1, 2 and 3) forming the reflector are arranged in regular manner upon a support or framework 3, 3 (Figures 3 to 13) so that each pencil of solar rays reflected by each one of the small elementary reflectors is directed towards the same igneous zone or focus Z (Figures 2 to 13) in which the temperature is proportionately higher as the surface of the reflector is greater and the area of the igneous zone or focus Z is more confined. The general shape of this framework 3, 3 upon which are placed the small elementary reflectors $k k$ (Figures 1, 2 and 3) is that of a section or sector of a paraboloid of revolution (Figures 1 to 13) or of a paraboloidal polygon, an ellipsoid, an hyperboloid, or the like.

The elementary reflectors $k k$ (Figures 1, 2 and 3) are made of silvered glass, polished metals or any other suitable reflecting material and they are mounted either fixedly, or movably upon the framework 3, 3 (Figures 4 to 13) according to whether or not it is wished to vary the focal length.

The whole combination forming the reflector is usually provided with two adjustments so as to maintain the convergence of the rays at the focus Z .

Such adjustments for setting the apparatus are shown in Figures 4 to 11. The first motion is that of rotation around a horizontal axis D ; the second is a rotation around a vertical axis O . These two movements, suitably controlled and combined ensure the convergence of the rays at the focus Z whatever be the altitude of the sun, according to the hour of day and the time of year in all latitudes.

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From the constructional point of view, the direction of these movements relatively to the axis of the sun or solar pencil and to the radius of the earth at the point in question, varies according to the different methods of carrying out the invention and, consequently, the position of the axes D and O, especially D, can be equally varied.

Further, as will be presently seen, more than two movements may be imparted to the reflector *a b c d*. As a general rule whatever be the method of setting the apparatus, the mean inclination of the reflector to the sun is preferably 45 degrees, but it may be greater or less according to circumstances.

By way of example, I will describe some arrangements by means of which the reflector can be adjusted in various ways

To explain the differences between and the object of these various arrangements, I now refer to Figure 2 of the drawings showing the frustrum of a paraboloid of revolution mounted upon a horizontal axis D passing through the focus Z perpendicularly to the axis of revolution and supported by two vertical columns or frames 1, 1 movable upon the circular rails 2 placed centrally around the apparatus.

By causing this paraboloidal frustrum to revolve about the horizontal axis D and this latter to travel upon the track 2 around the centre, so that the axis of the solar pencil remains a prolongation of the axis of the paraboloid, it will be seen that each of the sectors S^1 to S^8 produces a cone of reflected rays having different movements and, consequently, foci in Z, capable of always being located at the centre of a furnace E or any other suitable device affording a concavity.

The arrangement shown in Figure 2 having these two movements of rotation each cone of rays reflected by each of the sectors S^1 to S^8 must also have two movements of rotation.

But since the axis D passes through the focus Z perpendicularly to the axis of rotation, the cone of rays reflected by the two sectors S^1 and S^2 revolves because its axis is the same as the axis D. The focus produced by these sectors S^1 and S^2 thus remains in the prolongation of the always horizontal axis whatever be the position of the sun, having when the sun is oblique, scarcely a movement of rotation which remains parallel to the horizon.

The arrangement of reflector shown in plan, Figure 3, and in vertical section Figures 4 and 5, corresponds with the frustrum of the paraboloidal sector S^1 of Figure 2 and as in that case produces a focus Z which always remains in the prolongation of the horizontal axis D D^1 , having like it a single movement of translation upon the track 2 central about the vertical axis O which renders this applicable by preference to metallurgy and the chemical arts which necessitate the use of high temperatures and heavy and awkward furnaces, crucibles or other apparatus.

As will be seen from Figures 2 and 4, the horizontal axis D always maintains its relative position; it is inclined about 45 degrees to the normal at the centre of the reflector *a b c d* and the focus Z is in the plane and on a prolongation of this same axis D describing each day when the sun is oblique, scarcely an arc of a circle upon the track 2 from the centre formed by the vertical axis O. The movement of rotation of the reflector *a b c d* around the horizontal axis D is guided or obtained (Figure 4) by means of pinions 4, 4 travelling upon two racks 5, 5 arranged as the arcs of a circle struck from the horizontal axis D.

These two racks 5, 5 (Figure 4) rest upon a suitable framework 6 movable upon the track 2 arranged centrally around the vertical pivot O.

A portion 7 of the framework serves as a counterbalance maintaining the equilibrium of the apparatus.

The rotatory movement of the reflecting surface around the vertical axis O is effected by means of rollers 8 upon the rails 2. This movement takes place only when the axis of the solar pencil is oblique relatively to the radius of the earth.

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When the axis of the solar pencil is in line with the earth's radius, *i.e.*, vertical, only a movement of rotation around its horizontal axis D is imparted to it and the focus Z remains fixed during the whole of the day.

The two adjustments of this apparatus as also that of the truck *e* carrying the crucible E are obtained by means of suitable gear-wheels or the like, the arrangement of which may be varied according to the motive power, whether human, animal or mechanical. These gear wheels are suitably connected with the wheel 9 and rollers 4 and 8 or with other parts of the apparatus.

The minerals or other materials to be melted or treated in the furnace E are inserted preferably through a door or an opening 10 in such a manner as to form a tubular wall or casing, resting upon the bed 11 of the furnace which forms a cavity within which the converging rays form a focus whilst acting directly upon the substance to be treated.

The materials fall into a receiver 12 whence they are run off into a pocket or pot 13. The truck carrying the crucible E can be wheeled around a track *e*² concentric with the axis O.

Figure 5 relates to an arrangement similar to Figure 4 but having some modifications facilitating the two rotary movements of the reflector.

For this purpose the arrangement for rotating the apparatus around the vertical axis O is supported solely by this latter. The two racks 5 5 arranged centrally from the axis D are mounted upon frames 14 integral with the skeleton of the reflecting surface (Figures 5 and 6) and upon the part 7 acting as a counter-balance, as before stated. These racks 5 5 are supported upon toothed pinions 4 fixed to two frames 6 integral with the pillar 1 turning around the vertical axis O. The reflector may be further supported by means of rollers 15 upon rails 16 mounted upon the same framework 6.

In order to effect the rotatory movement around the horizontal shaft D it is sufficient to turn the pinions 4 by means of a crank handle 17. The rotary movement around the vertical axis O is obtained by means of a worm 18 engaging a worm wheel 19 secured upon the pillar 1.

In this apparatus the centre of gravity is brought back to the intersection of the two planes of the axes O and D by means of suitable counterbalances 7 and 20.

Figures 7 and 8 show in vertical section and in plan, an arrangement composed of two reflectors *a b c d* supported upon the same vertical axis O, resting upon the same horizontal axis D in such a manner that all the movements of the two reflectors and of the two cars carrying the crucibles are symmetrical.

This form of carrying out the invention is a combination of two apparatus of the kind shown in Figures 4 and 5 so as to obtain a combined apparatus better balanced as to its movements and more symmetrical in shape than the form shown in Figures 4 and 5, without the addition of the counterbalances 7 and 20, the two reflectors balancing one another.

The rotation of this apparatus around the vertical axis O is guided by rollers 8 upon rails 2 central with the axis O. This movement can be effected by means of pinions, crank-handles or other suitable operating mechanism engaging either the rollers 8 or the wheel 9 placed above or below the horizontal axis D.

The rotation around the horizontal shaft D is guided by the racks 5 placed below the axis D, and rack 21 placed above this axis these various racks being shaped to the arcs of a circle struck from axis D and supported by the framework 6. This movement may be controlled by acting through the intermediary of suitable gearing or convenient mechanism, upon the pinions 4 or upon the pinion 22 of rack 21 or at any other suitable part of the apparatus.

This form of the invention affords two foci Z and Z (Figures 7 and 8) placed symmetrically in an extension of the horizontal axis D within two crucibles E E and having only a single movement of horizontal rotation upon the track *e*² central with the vertical shaft O.

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Figures 9 and 10 show in vertical section and elevation respectively, an arrangement permitting as for the sector S^3 of Figure 2, a different adjustment of the reflector and affording a focus having certain special movements. The shaft D instead of being placed in the plane of the normal at the centre of the reflector in such a manner as to form with this normal an angle of about 45 degrees as for the sectors S^1 and S^2 and in the preceding figures, is situated in a plane parallel to the respective chord or tangent of each normal arc of the reflecting surface. The point at which this shaft is fixed to the reflector $a b c d$ (Figures 9 and 10) is optional; it may be in $a b$, or in the middle, or in $c d$.

So as not to multiply the figures of the drawings, I have shown an example of only this last (Figures 9 and 10). The shaft D is replaced by a shaft P at the lower part of the reflecting surface and parallel to the chord or to the tangent to the normal arc of this surface, at the level of $c d$; rotation around the horizontal axis P still takes place in a plane parallel to the axis of the solar pencil. In this manner the focus Z and the crucible E in which it is formed must have a parallactic movement when the sun is oblique and a semi-circular movement around the horizontal axis P and according to the plane of the terrestrial parallel, when the sun is vertical.

In this last case and to avoid the upsetting of the materials placed in the furnace E or if it be a boiler the entrance of water into the steam chamber, at midday when the sun is at the zenith, I may cause the apparatus to turn a half circumference around the vertical axis O and afterwards adjust it only by the movement of vertical rotation around the axis P. This movement is guided by the pillar 1 by means of two guides supporting the two racks 5, 5 and it is controlled by means of the pinion 4.

The counterbalances 7 and 20 maintain the equilibrium of the apparatus. The crucible or other device E is supported by means of two frames or girders 23. The horizontal rotation around the vertical shaft O is obtained in the same way as in the case of Figure 5. In this form of carrying out the invention I have shown a boiler as the apparatus to be heated.

Figure 11 shows in vertical section the frustrum of the paraboloidal sector S^4 of Figure 2, mounted and in position for working when the sun is parallel to the horizon.

The horizontal axis P is as in Figures 9 and 10, parallel to the chord or to the tangent of the normal arc of the reflecting surface, but it is placed in the middle of this same surface.

The two rotary movements around the horizontal axis P and around the vertical axis O are obtained by the same mechanism as that of Figures 9 and 10.

The focus Z of this arrangement is not easily applicable to metallurgical purposes because the melted materials would fall upon the reflecting surface, but it is applicable to the heating of a boiler such as the arrangement shown in Figures 9 and 10 and can be applied to the production of nitrous acid and other compounds derived from nitrogen which can be obtained by the direct combustion of the nitrogen in the atmosphere by means of the very high temperatures existing in the vicinity of the focus Z.

The nitrous vapours and other compounds of nitrogen resulting from this combustion pass into the chamber e^1 whence they may be drawn off.

The focus Z is situated in a vertical line when the sun is parallel to the horizon and is horizontal when the sun is in line with the radius of the earth at the point in question.

Figures 12 and 13 show respectively in vertical section on line M—N and horizontal section on line P—Q (Figure 1) each one of the four paraboloid of revolution frustra $S^5 S^6 S^7 S^8$ of Figure 2, mounted and in the working position, Figure 12 assuming the sun to be vertical and Figure 13 assuming the sun to be parallel with the horizon.

This arrangement of my invention permits of at least two methods of setting or adjusting the apparatus. In the first method, not separately illustrated, the

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apparatus has only two rotary movements, the one around the vertical shaft O and the other oblique (relatively to the radius of the earth at the point in question) around the oblique axis D guided by the collar 24 and operated by means of the circular wheel 25 driven by means of a worm 26.

The focus Z afforded in this example of the apparatus which is hardly or only approximately adjusted by means of these two movements, would not be applicable with facility to purposes other than the heating of a boiler or the combustion of atmospheric nitrogen, like the form of apparatus shown in Figure 11.

But by imparting to it a third movement, the focus Z afforded by this arrangement can be applied to metallurgical and to industrial purposes generally. This third movement is a vertical rotation of the shaft D around the horizontal axis P directed by means of the racks 5.

The rotary movement of the apparatus around the shaft D is obtained by means of a worm 26 engaging the toothed wheel 25. The two other movements are obtained as in the arrangement shewn in Figures 9 and 10.

In order to set the apparatus, see Figures 11 and 12 the reflecting surface is turned (1) around the axis D, (2) around the axis O, and (3) around the horizontal axis P, in such a manner that the convergence of the solar rays is ensured at the point Z situated within the crucible E which may remain horizontal, having scarcely a semi-circular rotary movement upon the rails e^2 arranged centrally about the vertical axis O, whatever be the altitude of the sun above the horizon and in all latitudes.

The crucible E may be furnished with special and corresponding movements upon the truck or car e according to requirements necessitated by the various applications of the invention.

It is to be understood that I may make various modifications in my reflecting system and construction alterations without changing the general idea of my invention and such as are necessitated by its application to the various branches of industry. I do not, moreover, limit myself beyond the essentials cited to any strict form of the whole forming the reflecting concavity and its components, nor to any fixed type of framework or girders, supports and other similar parts nor to any exclusive method of adjusting the reflecting system, nor to the geometrically perfect curve of a paraboloid of revolution; I may indeed make use of reflectors formed by cutting out one or more sectors in a figure of revolution consisting of a paraboloid or an approximation to a paraboloid.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An apparatus for obtaining high temperatures by means of the convergence of the solar rays upon a restricted focus which may be formed in the centre of a furnace, crucible, boiler, or the like by means of one or more reflecting surfaces, having the general shape of sectors (preferably truncated) of a paraboloid of revolution or of a similar geometrical figure, these reflecting surfaces being formed of a variable number of small reflectors or elementary reflecting surfaces, substantially as above described.

2. The various forms and constructional arrangements of the apparatus for obtaining high temperatures by means of the convergence of solar rays upon a restricted focus, all substantially as described and set forth with regard to the annexed drawings, namely

(a) The forms of carrying out the invention shown in Figures 3, 4, 5 and 6 fitted with a single reflector having two adjustments.

(b) The form, Figures 7 and 8, fitted with two reflectors mounted symmetrically upon the same axes.

(c) The form, Figures 9 and 10, specially applicable to the heating of a steam boiler.

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- (d) The form, Figure 11, applicable to the production of nitrous acid by the combustion of the nitrogen in the air.
- (e) The form of the invention shown in Figures 12 and 13 fitted with three adjustments.

5 Dated this 12th day of August, 1901.

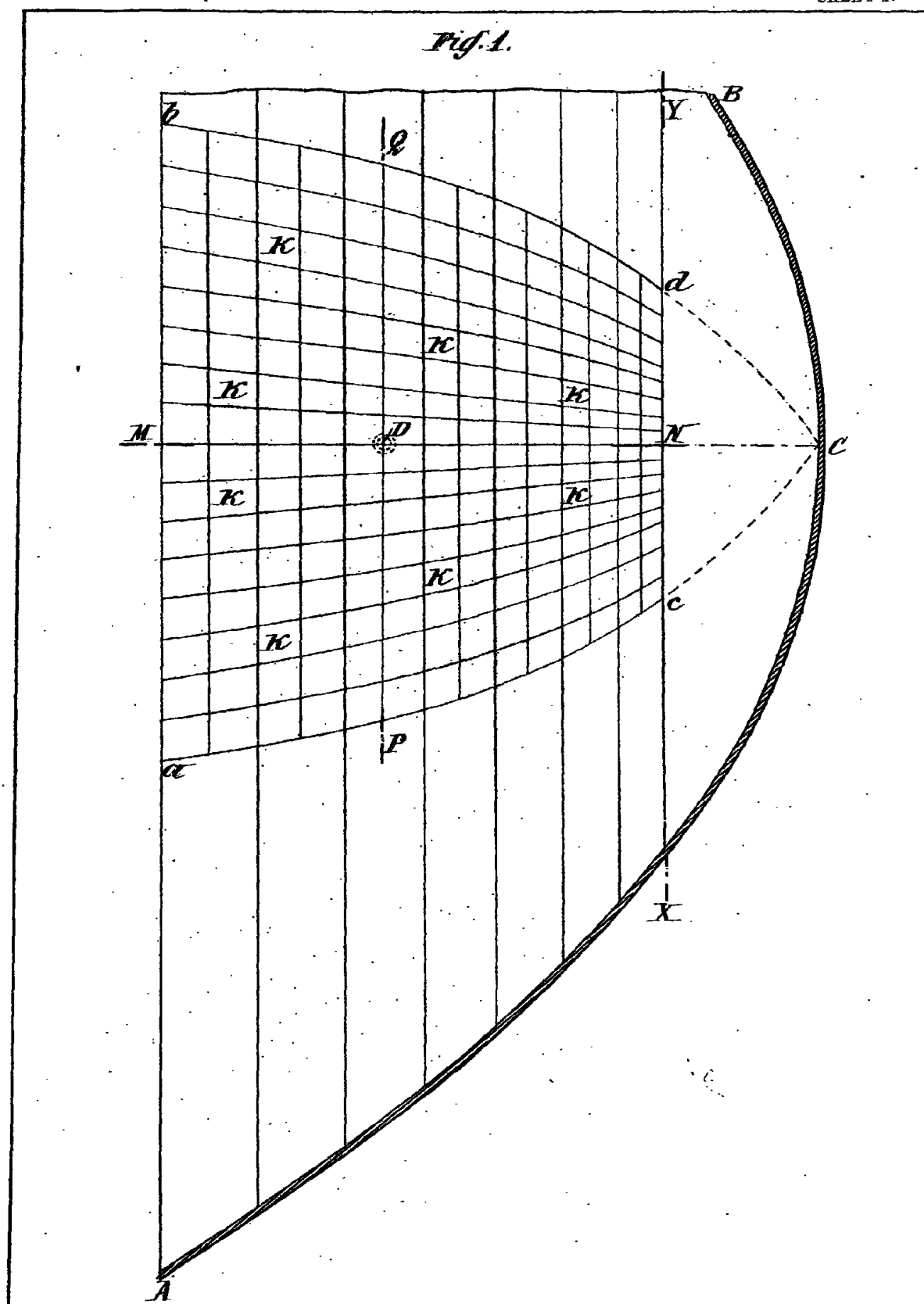
For the Applicant,

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HIMALAYA'S COMPLETE SPECIFICATION.

(5 SHEETS)
SHEET 1.



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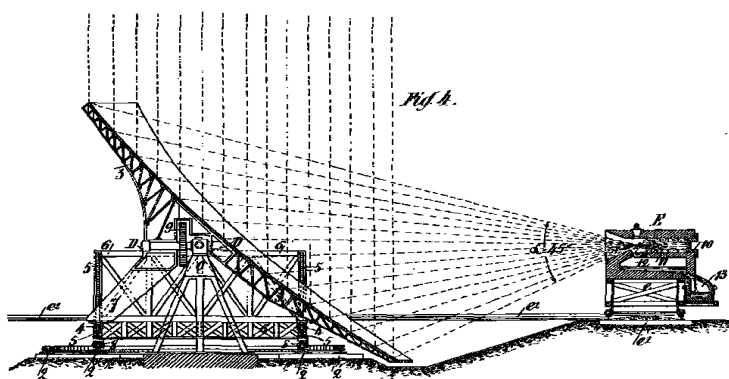
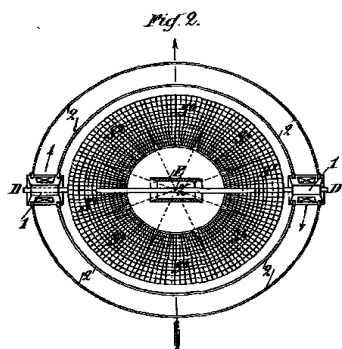


Fig. 1^a

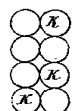
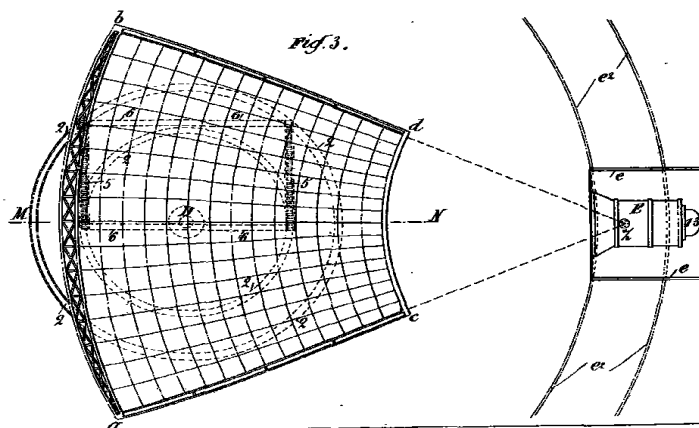


Fig. 1^b



Fig. 1^c



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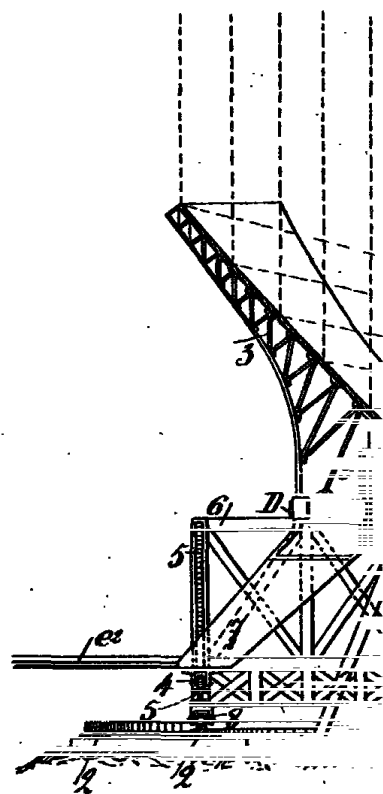
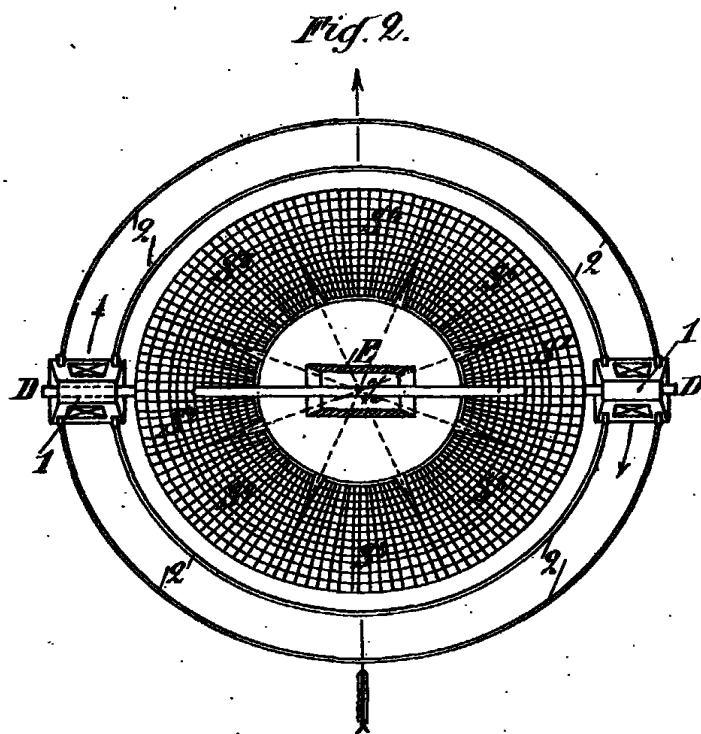


Fig. 1^a

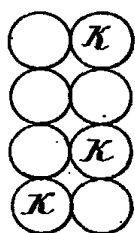


Fig. 1^b

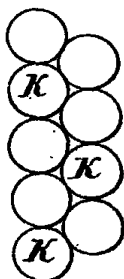


Fig. 1^c

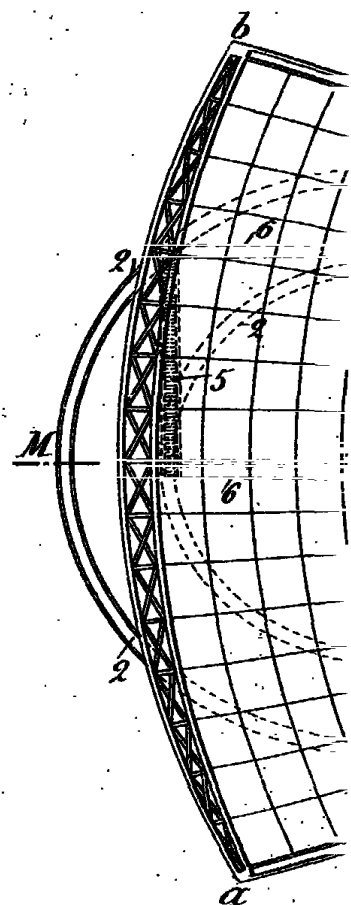


Fig. 4.

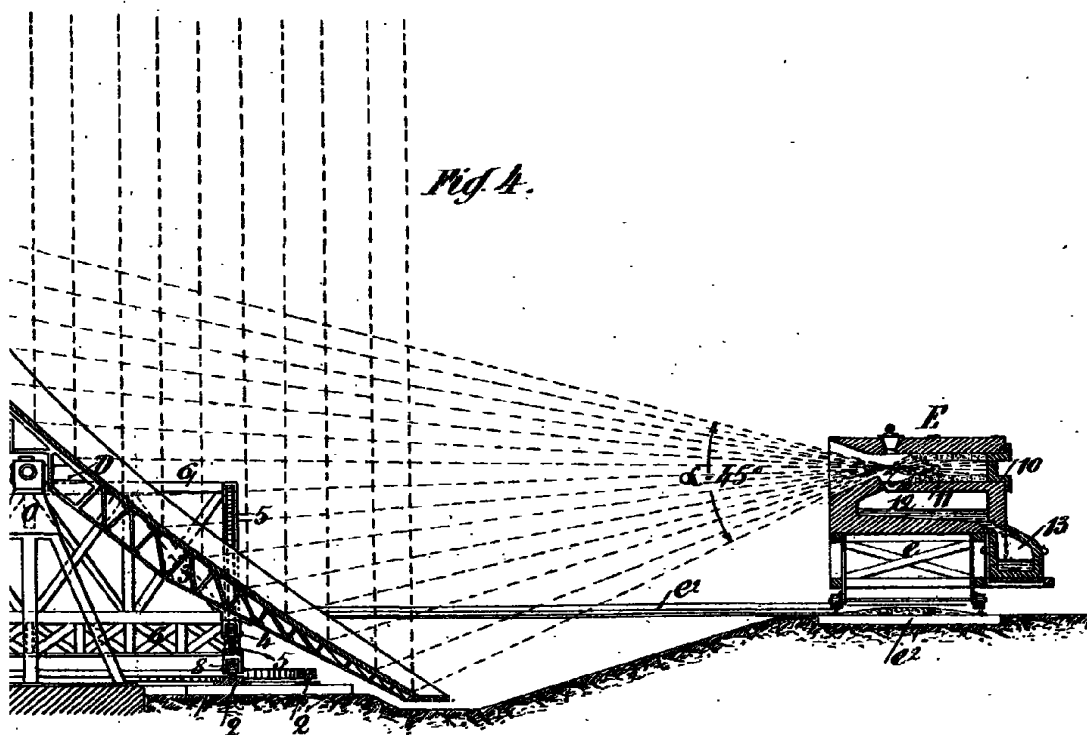
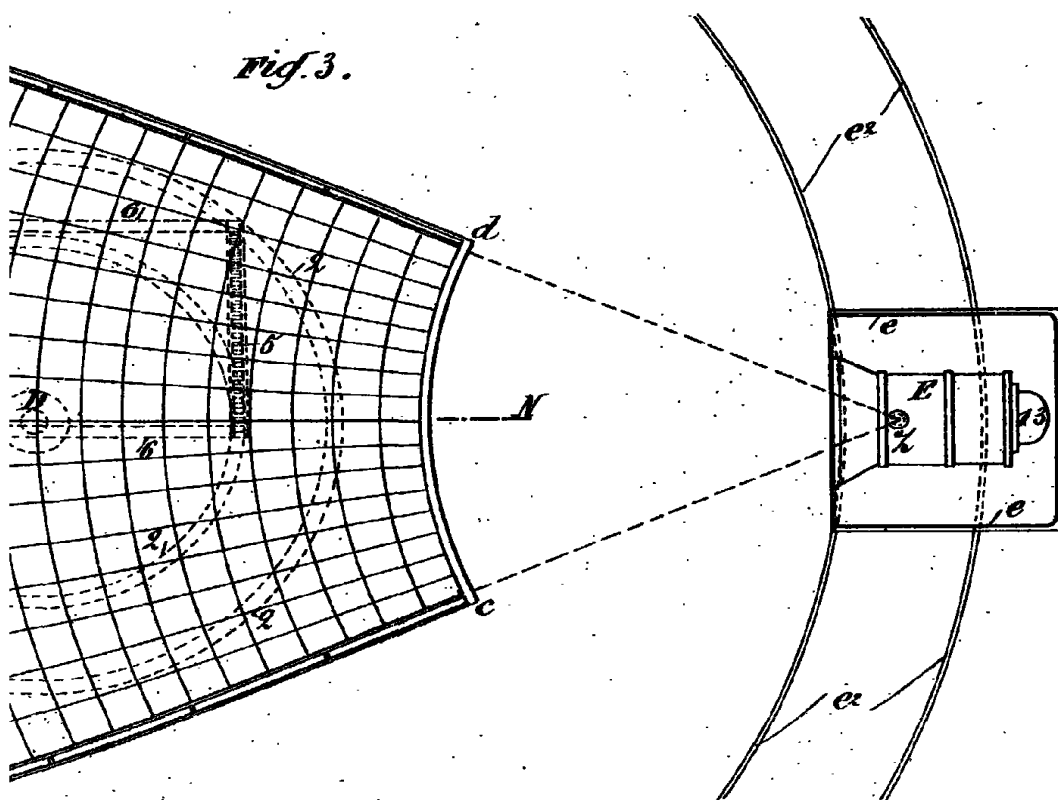
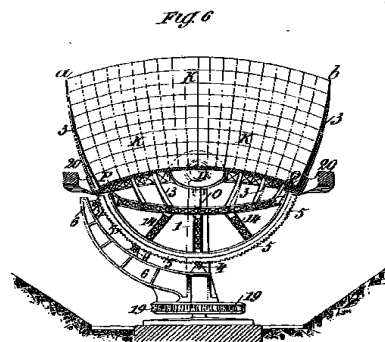
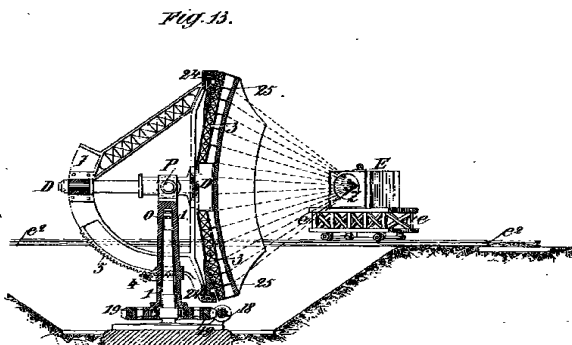
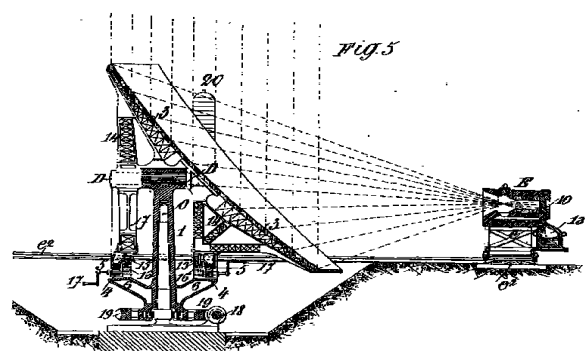
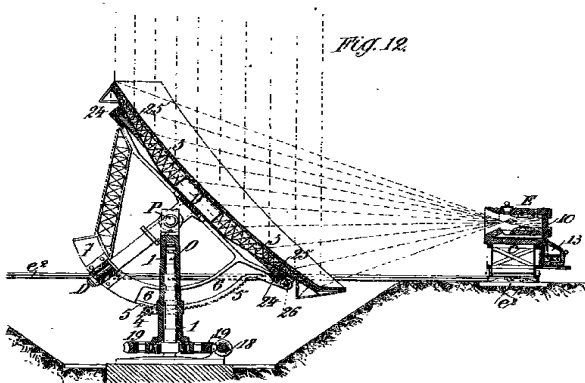


Fig. 3.



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Fig. 12.

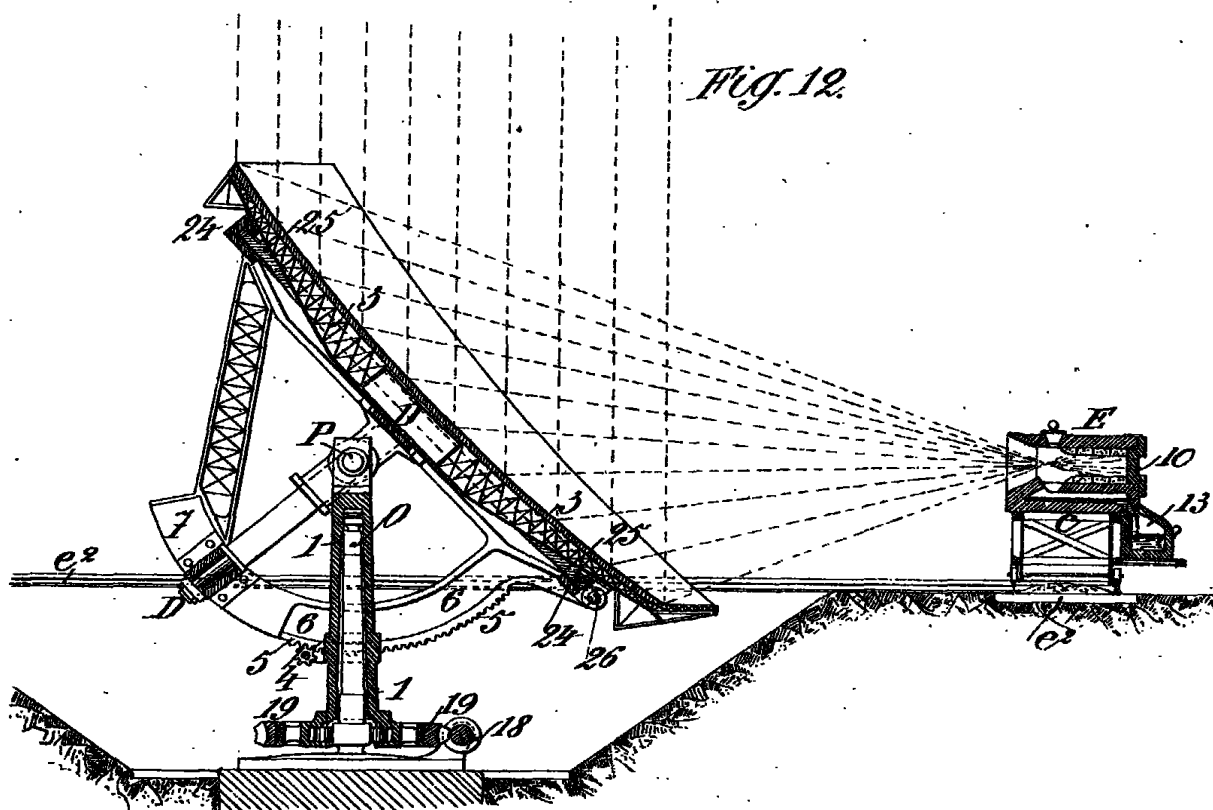


Fig. 13.

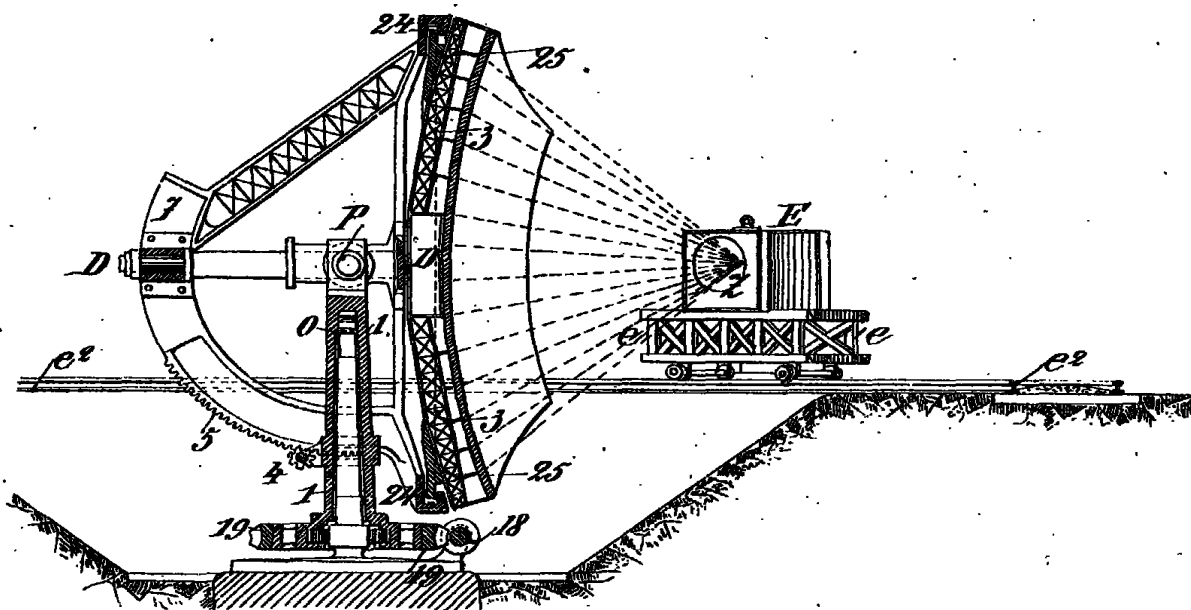


Fig. 5

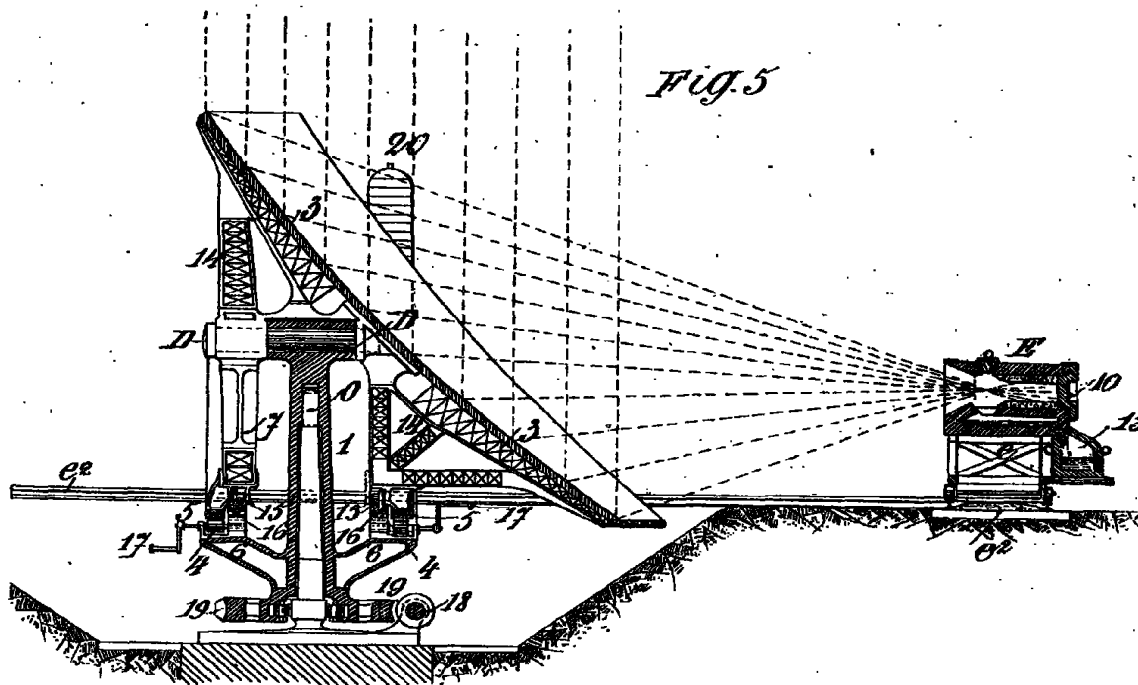
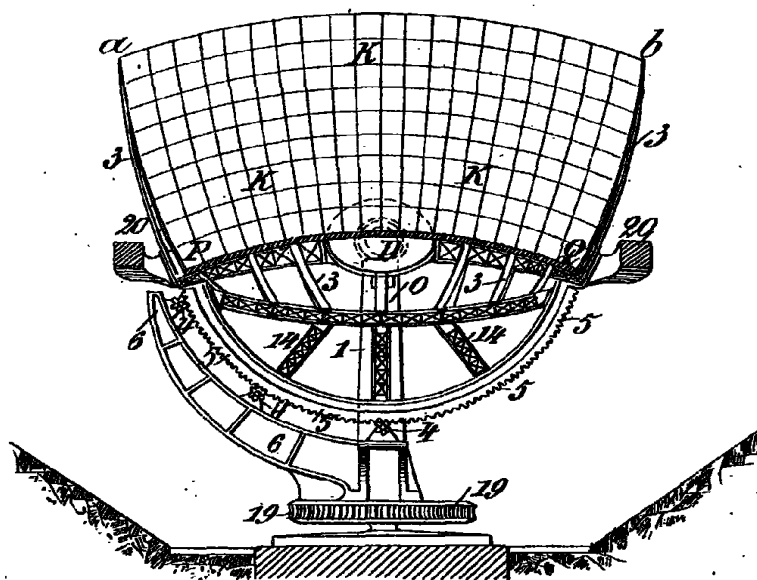
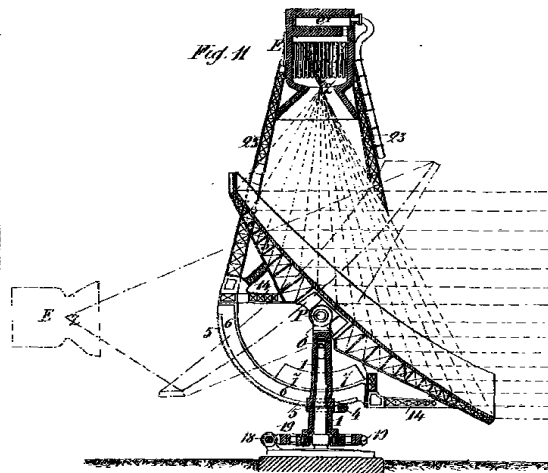
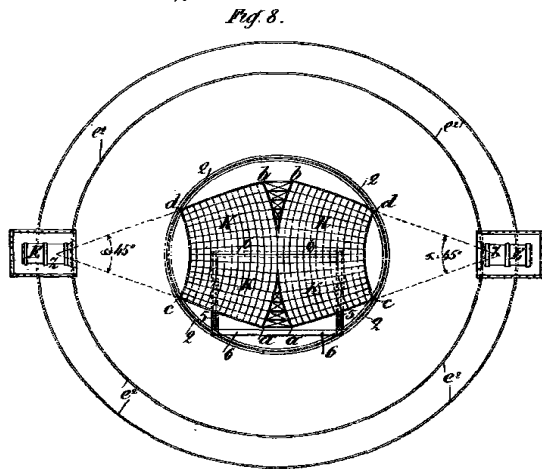
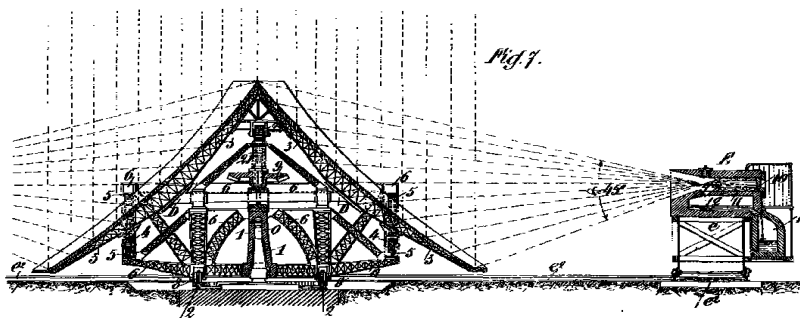


Fig. 6



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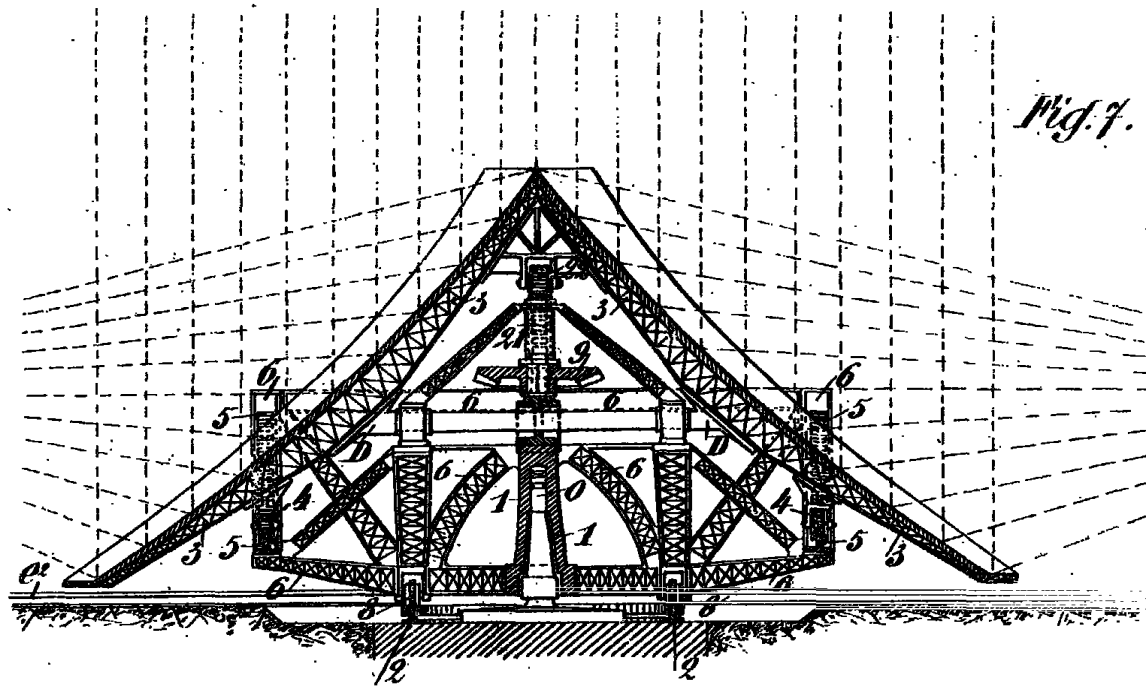
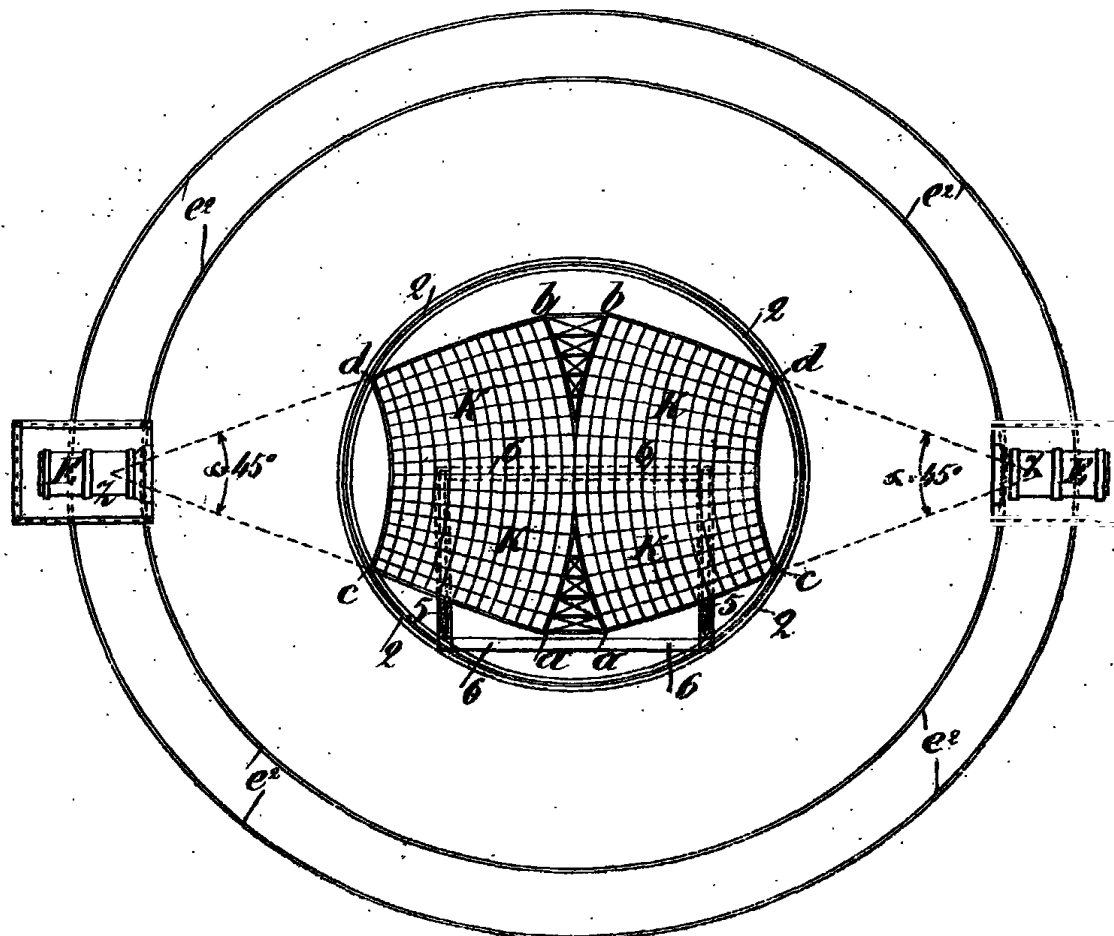


Fig. 8.



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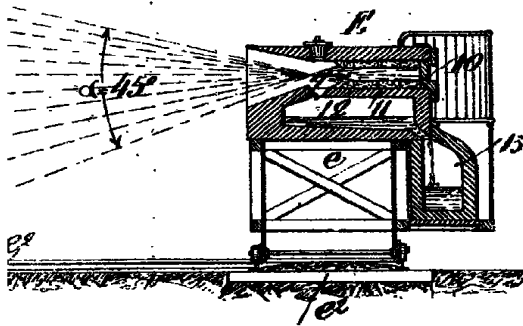
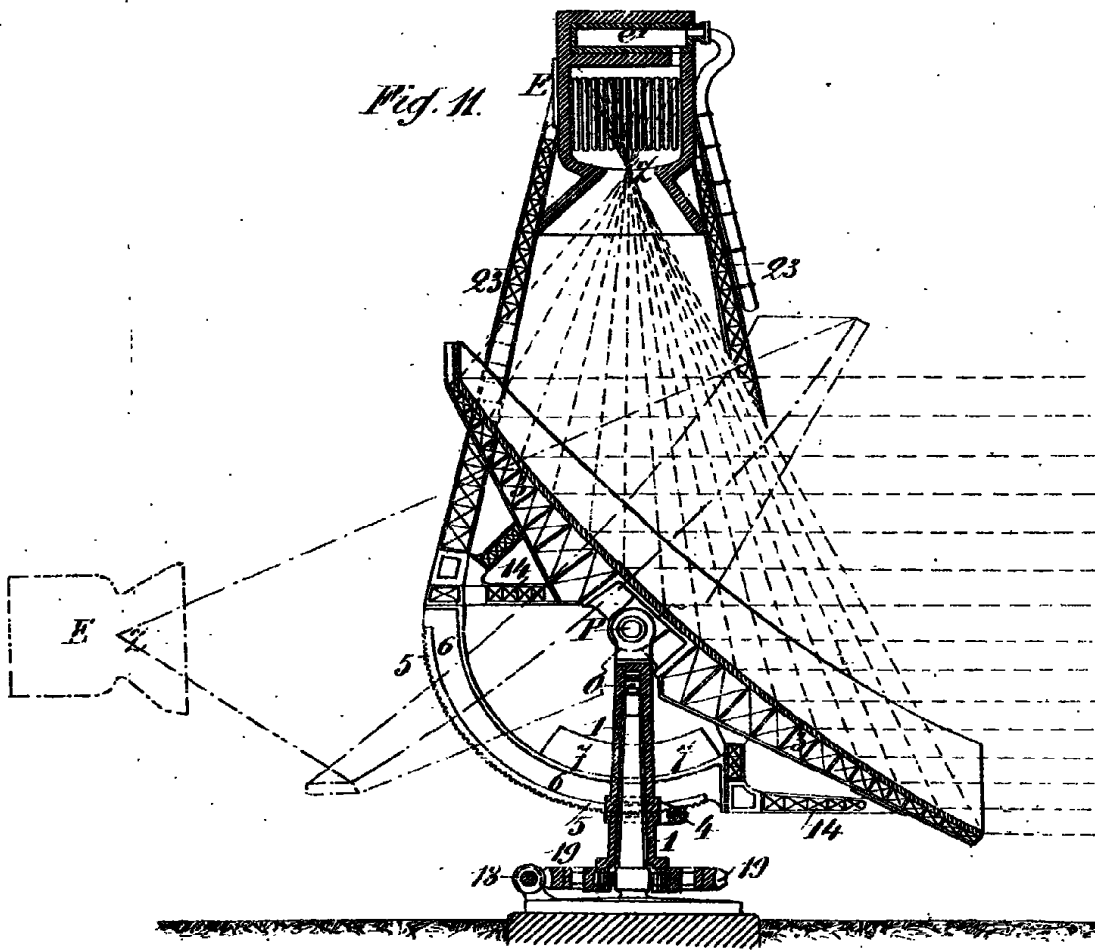
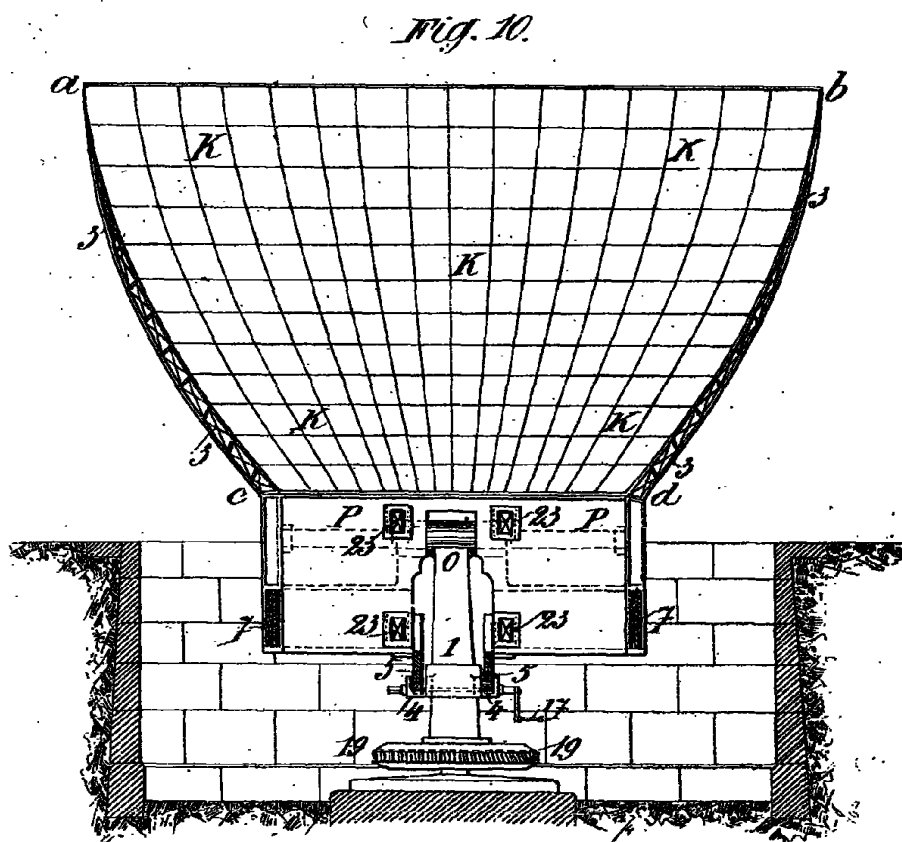
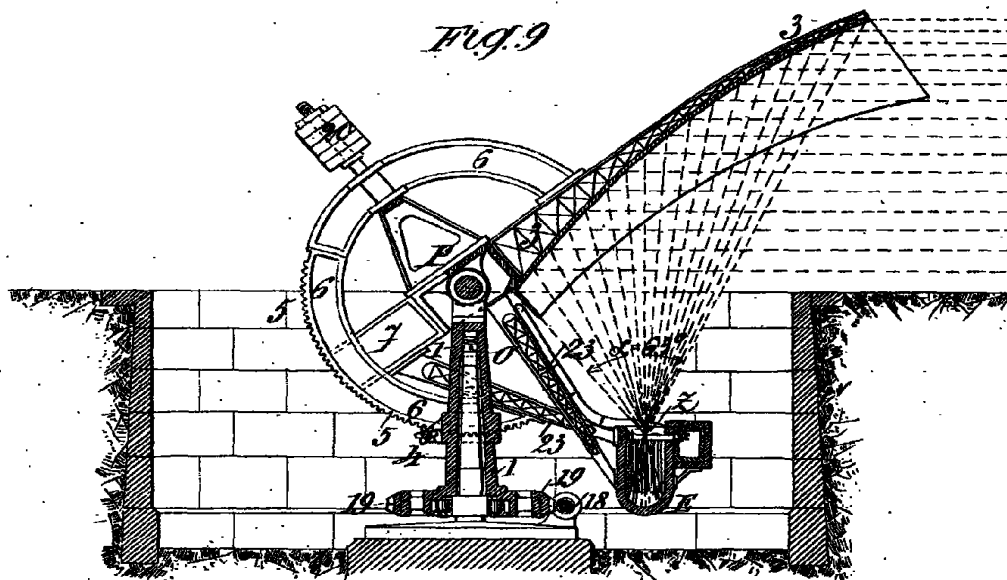


Fig. 11.





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