(No model.) 4 Sheets—Sheet 1.

W. WHEELER.

APPARATUS FOR LIGHTING DWELLINGS OR OTHER STRUCTURES.

No. 247,229. Patented Sept. 20, 1881.

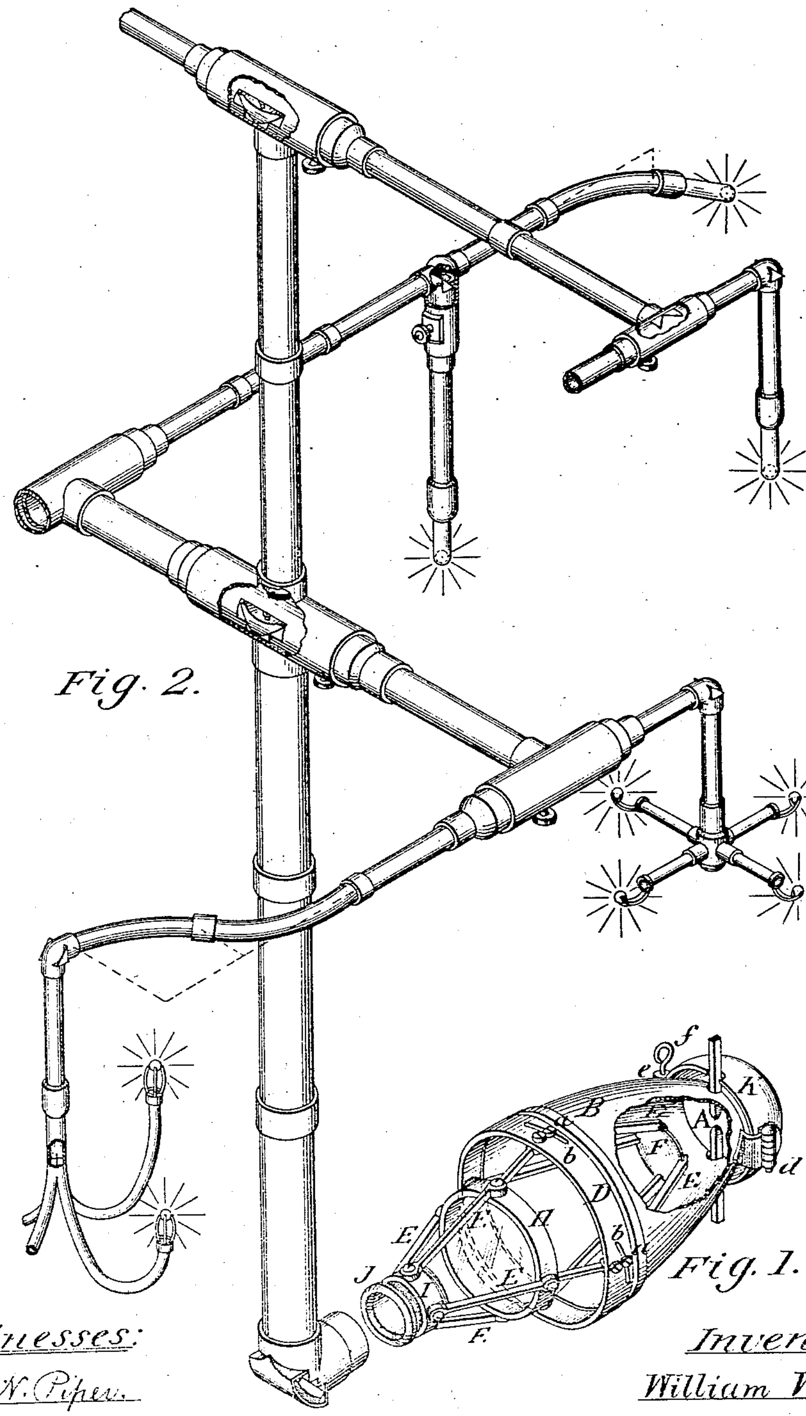

Fig. 2.

Fig. 1.

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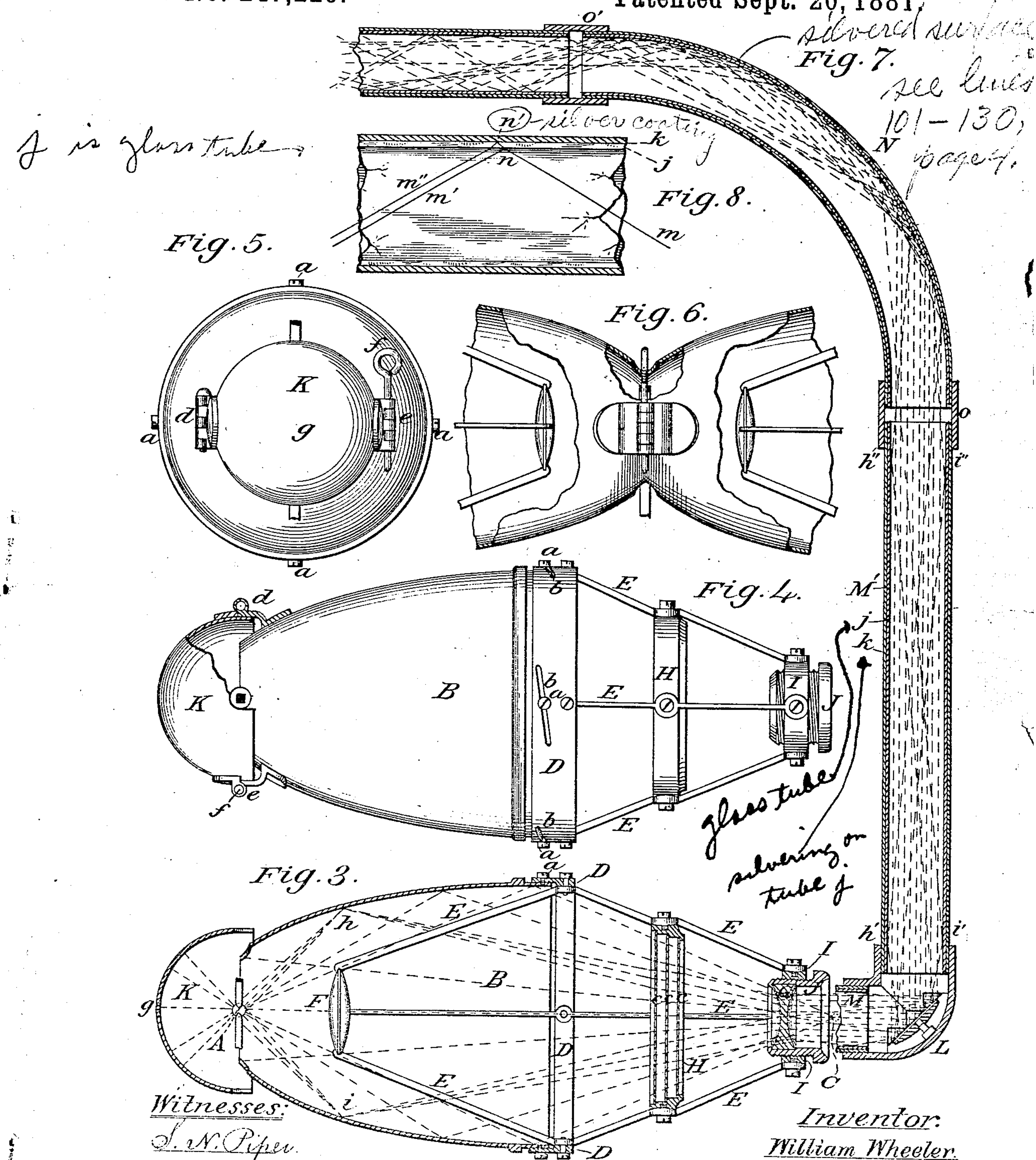

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APPARATUS FOR LIGHTING DWELLINGS OR OTHER STRUCTURES.

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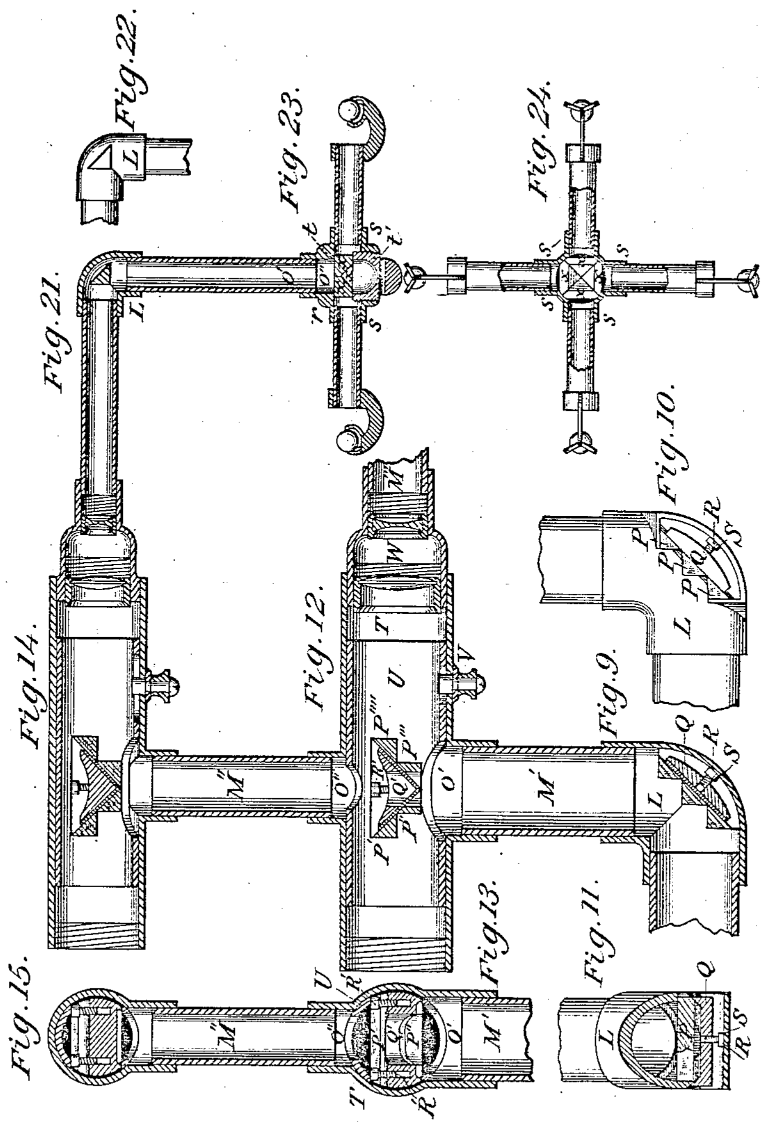

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(No Model.) 4 Sheets—Sheet 4.

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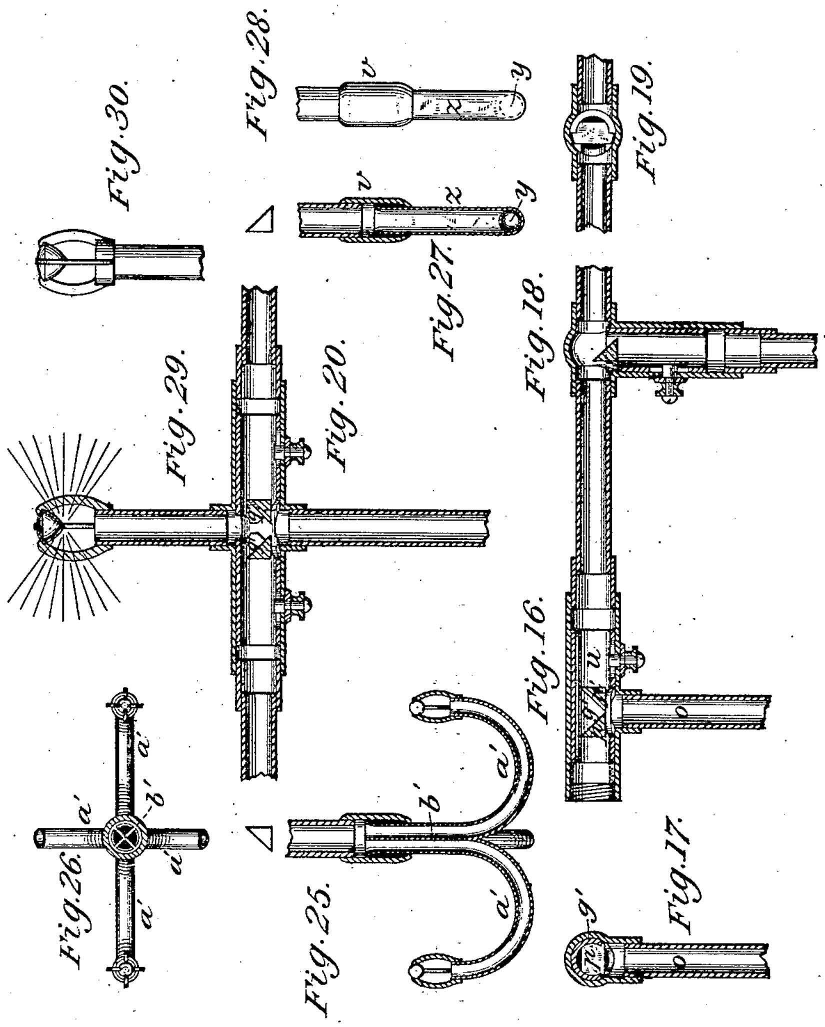

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR LIGHTING DWELLINGS OR OTHER STRUCTURES.

SPECIFICATION forming part of Letters Patent No. 247,229, dated September 20, 1881.

Application filed December 10, 1880. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WHEELER, of Concord, of the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Apparatus for Lighting Dwellings or other Structures; and I do hereby declare the same to be described as follows, reference being had to the accompanying drawings, the figures of which are hereinafter particularly explained.

This invention relates to a system of lighting and to a special apparatus whereby any desired amount of the light-producing energy employed is converted into light-vibrations at a central or single place, from which the light generated is transmitted and distributed to and dispersed at any number of places which it is desired to illuminate by optical conduction, division, and dispersion of light.

This system is adapted to any source of light, but wherever any special modifications of parts are required, or affected by the form or kind of light-source, they are adapted in this invention to the use of the electric arc, and hence to that source this specification may be understood especially to refer.

It is well understood that electric light may be produced through the use of dynamo-electric machines cheaper than light from gas or any known method by combustion. This requires, however, that the light be produced in voltaic arcs of great power and intensity, for if more than one arc is maintained with the same current of electricity the light generated becomes rapidly less, and therefore dearer, as the number of arcs or lights is increased. It is in the nature of the electric current, therefore, that for the economical generation of light it should be used in great intensity in one point, instead of small intensity in many points.

The law may be approximately stated thus: The heating effect of the electric current is proportional to the square of the amount of current multiplied by the resistance, while the lighting effect bears to the heating effect much the same relation as the heating effect does to the amount of current. Hence the light varies by some functions, greatly exceeding the square of the amount of the current times the resistance. Hence with a given amount of current it is evident that its economical division for lighting is very limited and that improvements must be sought by utilizing an arc in which the highest possible temperature is produced within the most limited space practicable. On the other hand, perfection in artificial lighting, optically considered, consists of light of low intensity, radiating from many points in all directions, so that there is an intercrossing of rays, producing a mean amount of light everywhere, and projecting no abrupt or striking contrasts of light and shadow. Such distribution approaches most nearly to the indirect radiation of sunlight from the atmosphere when the direct rays are partially intercepted and disbursed by a summer cloud, and also requires the least amount of light to produce an equal degree of illumination. It has been proved that for lighting large open areas—as in public squares and streets—by increasing the number of lights five times but half as much light was required in the aggregate to produce an equally perfect and satisfactory illumination. The same consideration holds whether the electric current be employed to produce the voltaic arc or to cause incandescence of carbon, platinum, or other refractory solids, although the voltaic arc is far more economical as a producer of light than any devices for incandescence.

Owing to the dazzling brilliancy of the electric arc at short distances and the cost of appliances and their maintenance, the incandescent system is better adapted for house-lighting by direct radiation, while the voltaic arc can compete with gas-light only when it is required to light large spaces without partitions or subdivisions of the space illuminated.

It is the object of this invention to obviate these objections to any of the aforesaid systems of electric lighting, and to provide apparatus whereby is secured that degree of economy attending the generation of light in voltaic arcs of great power and intensity, and the greater optical perfection of artificial lighting due to the radiation of light of low intensity from many different points, together with other important advantages to be specified hereinafter.

The division of the direct light from an artificial source into two or more beams or pencils by means of lenses, prisms, and other reflectors, by which said beams are transmitted through inclosed passages and clear space to dispersing reflectors or refractors, so as to produce two or more secondary lights from one luminary or source for lighting purposes, has been in practical use heretofore, and has been claimed also under a United States patent. In all cases of this kind heretofore known, however, only such rays of light as are parallel, or very nearly so, can be utilized for producing a distant secondary light. The non-parallel rays pass out of the limits of the pencil of useful rays, and are either absorbed by the opaque non-reflecting surfaces which inclose the beam when it is transmitted through an inclosed passage or are lost in space when projected through clear space toward the dispersing object; but it is impossible to devise a beam of parallel, or even mostly parallel, rays of light from an artificial source—such as a flame, an electric arc, or an incandescent or fluorescent substance. Such sources have a certain extent of surface, from every point of which light radiates outward in every direction, so that any point near it receives rays converging from every point of the said surface exposed toward it. Hence the total angular variation from parallelism of reflected or refracted rays emanating from such a source is at least equal to the parallax of the point of incidence at which reflection or refraction first occurs measured from said source of light. From this it is evident that a very large proportion of the whole light thus treated by methods heretofore used or proposed is lost when it is attempted to transmit the pencils or beams through tubes or passages whose lengths are great as compared with their respective diameters. Furthermore, the parallel rays are more or less intercepted by unavoidable deviations and irregularities in the alignment of said tubes or passages, and displaced or deflected out of parallelism with the axis of such tubes and passages by imperfections in the adjustment of lenses, prisms, reflectors, &c.

It is further, therefore, one of the chief objects of my invention to obviate all these objections to other methods or systems for the optical division, transmission, and dispersion of light for lighting purposes, and further to devise and utilize a desirable advantage from the non-parallelism of rays aforesaid.

Referring to the drawings, Figures 1 and 2 comprise a general isometric view of my invention, Fig. 1 representing the holophotal and condensing apparatus; Fig. 2, the conducting, distributing, and dispersing or radiating apparatus. Figs. 3, 4, 5, and 6 represent, in detail, the holophotal apparatus, Fig. 3 showing a vertical longitudinal section, Fig. 4 a plan view as seen from above, Fig. 5 a rear elevation, and Fig. 6 a modified combination for the projection of two primary beams in opposite directions. Figs. 7 and 8 represent longitudinal sections of the pipes or tubes used for the transmission and distribution of the light. Figures 9 to 30, inclusive, represent, in detail, the various parts, in some of their combinations, used for the subdivision, deflection, and dispersion or radiation of beams of light. Of these Figs. 9, 10, and 11 represent a right-angled coupling, in which is mounted a series of right-angled total-reflection prisms, set in echelon, by which a beam of light is deflected at right angles, Fig. 9 showing a longitudinal section, Fig. 10 a side elevation, and Fig. 11 a transverse section, by a plane bisecting the internal angle of the coupling. Fig. 12 represents a vertical longitudinal section of an adjustable four-way branch, with two series of total-reflection prisms set in echelon, by which a single beam, pencil, or tube of light may be divided into three lesser ones. Two of these secondary beams are deflected at right angles to and in opposite directions from the primary pencil or beam of light, and may be varied in the ratio of their intensity to each other, while the third beam is in direct continuation of the primary one, and is invariable in its amount or intensity, except by means hereinafter to be shown. A condenser is shown attached to the right-hand end by which the lateral dimensions of the transmitted beams are reduced. Fig. 13 is a vertical transverse sectional view of the foregoing. Fig. 14 represents a vertical longitudinal section of an adjustable three-way branch, with two series of prisms set in echelon, by which a single beam of light may be divided into two secondary beams or pencils, deflected at right angles to and in opposite directions from the entering beam, and having any desired ratio of intensity or amount of light to each other. A condenser is shown attached to one end. Fig. 15 represents a vertical transverse section of the same. Fig. 16 represents a longitudinal section of an adjustable three-way branch with two single prisms, by which a single beam of light may be deflected, as in the last-preceding instance, without subsequent condensation. A reducer is shown attached. Fig. 17 shows a transverse section of the same. Fig. 18 represents a longitudinal section of an adjustable three-way branch with a single prism, by means of which the whole or any part of the entering pencil or tube of light may be deflected at right angles to the entering beam and the remainder allowed to pass on in continuation. Fig. 19 is a transverse sectional view of the same. Fig. 20 is a longitudinal sectional view of a four-way adjustable branch, with two single prisms set in separate mountings, by means of which the whole light received may be deflected to the right hand or to the left, or allowed to pass between them in continuation, and unaffected or divided between the three outlets, in any desired proportion. This is a double form of that shown in Fig. 18. Figs. 21 and 22 represent a right-angled coupling, in which is mounted or set a single total-reflection prism, by which the entering light is deflected at right angles. Fig. 23 is a vertical sectional view of a five-way non-adjustable branch, with four wedge-shaped total-reflection prisms, by which the light received is deflected equally in four different directions. It is here represented in combination with reflecting-dispensers mounted in the paths of the pencils of light, the whole constituting a four-light chandelier. Fig. 24 represents a horizontal section of the same as viewed from beneath the chandelier. Fig. 25 shows a vertical sectional view of a five-way non-adjustable branch, by means of which the beam of light received is divided and transmitted in any desired direction without the use of prisms or special reflectors. The branch is shown in combination with the reflecting-dispensers, the whole representing a four-light chandelier. Fig. 26 is a plan view of the same, as viewed from above. Figs. 27 and 28 represent a section and an elevation, respectively, of a reflecting-dispenser. Figs. 29 and 30 are views of modified forms of reflecting-dispensers.

In further explanation of the construction and operation of my apparatus, Figs. 1 and 2 may be supposed to represent part of a system adapted for and placed in a dwelling-house of two stories.

The electric light A is maintained in the principal focus of the holophote or reflector B, which is supposed to be placed in the basement. It may be in any convenient place, in or out of the house. Said holophote consists of the following parts, namely:

B is a prolate-ellipsoidal reflector, whose reflecting-surface is such as would be generated by the revolution around its major axis of that part of the elliptic curve included between the latus-rectum and the minor axis. These limits of the curve may, however, vary at either end and in either direction.

C is the position of the other focus of the ellipse, which I shall designate the "secondary focus."

D is an adjustable ring, collar, or sleeve, fitting over and around the front or aperture end of B, and is held by the binding-screws *a a a*, which pass through the oblique or screw-adjusting slots *b b b* in said sleeve and screw into the part B. This construction may be varied by causing the sleeve D to fit inside an enlargement at and of the aperture of B, in which enlarged portion oblique adjusting-slots are cut. The screws *a a a* are then screwed into the ring D.

Secured to the ring D, by screws or otherwise, are the double arms E E E E, &c., extending in both directions, as shown. At their inner ends, held in notches cut in said arms, or by equivalent means, the convex lens F is supported vertically, with its center in the major axis of the ellipse, and at their outer ends they are connected by screws or other equivalent means to the ring or collar I, in which the adjustable mounting J revolves, containing the concave lens G, properly centered, while between the latter and the aperture of the reflector B the ring H is fixed, as represented. The size and position of the lens F are such that its periphery lies in the intersections of straight lines drawn from the foci to the periphery of the opposite ends of the reflecting-surface of B, as represented.

The property of a reflector of the above construction is such that rays of light emanating directly from the focus A and falling on B will be reflected exactly toward the other focus, C. All focal rays radiating toward the open aperture of the reflector are intercepted by the lens F, by which they are refracted, and thereby made also to converge toward the secondary focus, C. The diameter, therefore, of the lens G is made somewhat greater than that of the primary beam or pencil of light to be transmitted through it. Its position is such as to intercept the pencil of rays converging toward C at a point where its diameter is less than that of the lens G, and the curvature of the said lens is such that rays from the exact focus at A are made parallel in their passage through it.

The focal adjustment of F is effected by turning the ring D about the major axis, through the action of the screws *a a a* in the slots *b b b*. The position of G is then corrected and adjusted by screwing its mounting J farther into or out of the ring or collar I, as may be necessary. The lateral movement allowed by the screw-threads on J is about double that by the slots *b b b*, for the reason that the former must be moved both to the extent required for the adjustment of G, and also to counteract the movement to which it is subject in the preceding adjustment of F.

The ring H is provided with three shoulders, turned upon its interior surface, as shown. Against these are hermetically fitted three parallel circular disks of glass, *c c c*. Two thin disks of space are thereby inclosed. They may be filled through cocks set in the side of the ring or otherwise. In one of them is an athermanous liquid or solution interposed in the pencil of light, for the purpose of obstructing heat-rays. In the other a fluorescent liquid or solution is combined, whereby obscure violet or other non-luminous rays than heat-rays are converted into luminous rays. The refractive effect of these disks of glass and liquid changes slightly the focus of the converging pencil, which may be counteracted and corrected at I, as above specified.

At the back of the holophote, when only one beam of direct light or one primary pencil is required, a hemispherical reflector, K, is fixed by means of the pivot-hinge *d* and the separable hinge *e*, the center of K coinciding with the prime focus A. The object of the reflector K is twofold—first, to reflect as much as may be of the direct light which it receives back again through or by the field of the arc to form a part of the pencil of useful rays; and, second, to reflect back again into the field of the arc the heat received, so as to maintain a higher temperature in said arc, and thereby increase its light-power. The reflector K may be swung open on the hinge d (for the removal of carbons in the attached regulator or for other purpose) after withdrawing the eyepin f and separating the hinge e.

At g is shown a small orifice in the exact center of the hemispherical reflector K, used to aid in adjusting the line of collimation of the several parts and to keep the electric arc accurately focused.

When two primary beams or pencils are required the reflector K is to be entirely removed after removing the pins of both hinges, and to the remaining portion of the holophote a second or duplicate holophote, precisely like the first, is to be connected and joined thereto in the place of the removed reflector K, all being as shown in part in Fig. 6, the hinge-sections being so alternated on the opposite sides as to freely admit of such an interchange of parts.

I have already described the course followed in the holophote by rays radiating from the exact focus of the electric arc A, which is also shown in the drawings, Fig. 3, by dotted lines.

At the incident-points h and i rays of light radiating from the outer limits laterally and from opposite sides of the voltaic arc are represented as falling. It will be observed and understood that such rays do not and cannot be reflected toward the same point as focal rays falling upon the same points h and i. Hence such rays will not and cannot be reflected by the lens G so as to become parallel with each other or with the axis of the holophote. On the contrary, such rays meet the surface of the lens G at such points and at such angles of incidence that the error of their direction will be increased by either too great or too little refraction, as is shown in the drawings. The same is true of such rays first incident upon the lens F and then refracted toward G. Now, it is clear that for every ray of light which radiates toward any point of the reflector B or lens F, in an exact line with the prime focus A, there must be an infinite number of rays which radiate to the same point from the rest of the arc, and therefore which are not in line with said focus. None of these will be made parallel with the axis of the holophote on leaving the lens G. It is to be understood that the term "rays," as here applied to the emanations of light, is not used in a technical, but popular sense, in order to give a more concrete form of expression to and a clearer comprehension of my meaning without violating practical truth and accuracy. Hence it appears that there is projecting from the holophote at G a condensed beam or pencil of light, consisting of, necessarily, an infinity of parallel rays, together with an infinitely greater number of rays not parallel to these or to each other. It is therefore evident that an efficient system, method, or apparatus for conducting light in small condensed beams, pencils, or tubes to any considerable distance, as compared with the diameter of said beams, must provide for the transmission and utilization of the rays that are not parallel with the axis of such beams, pencils, or tubes of light. Figs. 7 and 8 show how this is accomplished in my system and by my apparatus.

Fig. 7 represents a longitudinal section of the right-angled coupling L, carrying a series of total-reflection prisms, and connecting the two straight tubes M and M′, to the latter of which curved and straight tubes are joined in succession by the straight couplings o o', &c. The characteristic feature of the tubes, pipes, or passage-ways M and M′, N, &c., used in my invention for the transmission, conduction, and distribution of light is an internal reflecting-surface. The object of said reflecting-surface is to avoid loss of light by absorption by reflecting rays falling thereon, whether by reason of being out of parallel with the axis of the tubes or passages, as shown by h' h'' and i' and i'', or because of inaccuracies or imperfections in the construction or adjustment, or in that of other parts of the apparatus, or for the express purpose of changing the general direction of the pencil or tube of light by the use of the tube only, as shown in N. This last result is also secured by using straight sections of pipes set consecutively at slight angles of deflection with each other. Tubes or passage-ways of any desired form of cross-section, made of any suitable material and provided with any desirable or convenient form of reflecting-surface upon the interior, may be used.

My invention especially refers to the form of tubing shown in the drawings and described below. It consists of an annealed or toughened glass tube, j, of good quality and suitable thickness, upon the outer surface of which is deposited a layer of metallic silver, k, by any suitable silvering process, or an equivalent reflecting body. I produce thereby an intra-cylindrical glass mirror, which gives double reflection. For the temporary protection of the layer of silver or equivalent reflecting body a coating of asphalt in a drying solvent is applied, or an equivalent protection. For the permanent covering of the tube, and to impart adequate strength to the apparatus, an electro-metallurgical deposit of copper, iron, brass, bronze, or other metal or alloy is made upon said asphalt or other covering, or upon the metallic silver direct, the silver being a suitable conductor of the current of electro-deposition, or the asphalted tube may be inserted in a metal tube of suitable size and firmly secured therein. Ornamental finishing by electroplating, polishing, bronzing, or by any process in similar cases used may be performed thereon. In said metal covering screw-threads are cut at the ends of the tube-sections, whereby they are connected by couplings to each other and to the necessary branches, condensers, reducers, dispersers, &c.

Fig. 8 shows, in detail, the manner in which a ray of light in the tube not parallel with its axis is reflected. The ray m, passing from the right toward the left, is incident upon the inner surface of the glass at n. A certain part of the ray is reflected from the first surface in m', the ratio of m' to the whole ray m being dependent on the angle of incidence. The remainder of the ray is refracted through the glass to the silver surface at n', where a small part of it is absorbed and the remainder reflected back into the tube in m'', being refracted into parallelism with m' on leaving the glass. Thus by double reflection the loss of light is much less than by single reflection, and its use admits of dividing and changing the course of beams with the greatest facility and economy of light-power. This invention also allows the tubes or passage-ways to be of very small size, and the light to be carried in them to the greatest possible distance, and is not liable to the production of a dangerous or disagreeable degree of heat through the absorption of any heat-rays which may be present in the beam.

The right-angled coupling L (see Fig. 10) I usually make with an irregular slot or opening in each of its opposite sides, said openings being of such form and situation as to admit into them the prisms P P P, the pressure or holding block Q, and the binding-screw R in such positions that the prisms will receive the whole of a pencil or beam of light entering at one arm and reflect it out at right angles through the other. The prisms P are beveled off across the ends of their reflecting-surfaces, as shown in Fig. 11. The points of the part L which enter the angular spaces between the prisms are beveled in a corresponding manner, as represented in the said Fig. 11. The ends of the compression-block Q are provided with correspondingly-beveled projections, which, bearing upon and projecting over the beveled ends of the prisms and of the pointed parts of the part L, between the prisms, serve to hold all parts in their proper places. The beveled projections of the holding-block Q are a little nearer together than the correspondingly-beveled bearing-surfaces of the prisms, so that the plain intermediate surfaces of the prisms and block may not come into contact with each other to mar the reflecting property of the prisms. By turning the screw outward against the inner cylindrical surface of the coupling L at S the block and prisms are secured in place, and by reversing the screw R the block and prisms will be released to admit of their removal from the coupling. This method of mounting and securing prisms is used where a considerable number are required in one series. It may, however, be used in certain cases, when but one prism is required. In order to equalize the pressure upon a series of prisms, the beveled surfaces of the compression-block Q may be covered with a layer or cushion of yielding compressible material, such as felting, rubber, or cork.

Figs. 21 and 22 represent a simple method of mounting a single prism in a right-angled coupling for ordinary purposes. Openings of the same size and shape as the cross-section of the prism are to be made in opposite sides of the coupling L. Into such opening the prism is snugly and securely set and fitted, as shown. A series of two or more prisms set in echelon may be mounted in like manner.

Figs. 12 and 13 represent a four-way main branch, in which T is a cylindrical case, open at both ends, and connected not only with the receiving branch o', through which the main pencil of light enters, but with an outgoing branch, o'', (having its axis in a straight line with that of the branch o',) through which a part of the main beam passes in continuation.

U is an adjustable sliding tube or cylinder, holding the reflecting-prisms, and which is actuated in a longitudinal direction by a rack in it and by a pinion, V, or equivalent means. An orifice to admit the entering beam is shown in the side of the cylinder U toward the receiving branch, such orifice being of an oblong shape, with semicircular ends. When the cylinder U is in the middle of its allotted range of movement, or as it is represented in the drawings, the middle point of said orifice lies in the common axis of the branch o' and tube M'. The length of said orifice is equal to the diameter of the main tube M plus the range of motion allowed to U, and its breadth is equal to the diameter of M'. Hence, whatever be the position of U within the prescribed limits, the whole beam of light may enter the said receiving-orifice. In the opposite side of the adjustable cylinder U is shown a smaller orifice, whose center is diametrically opposite that of the receiving-aperture.

P', P'', P''', and P'''' are the reflecting-prisms, the ends of which rest and are set in openings in opposite sides of the cylinder U, between the two orifices described above, said prisms extending across at right angles to the axis of both M' and U.

Q' is a pressure-holding block, having a beveled projection or ledge at each end, such projection bearing upon a corresponding bevel on each end of every prism, and also on the angular part of the cylinder U projecting between the faces of said prisms. The block Q' is brought and held to a firm bearing by the action of the binding-screws R' R', which react against the opposing part of the cylinder U, as shown, all in a manner similar to that specified in the case of the coupling L.

The two lower prisms, P'' and P''', are cut away along the middle portion of their length, next the line of their adjoining edges, so as to leave an opening between them, the length of which in the direction of the prism does not exceed the diameter of the upper branch tube, M'', and the breadth of which is not greater than the difference between the diameter of M and the amount of the lateral movement allotted to the adjustable cylinder U. In some cases the desired opening between the prisms

P'' and P''' is obtained, not by cutting them away, as described above, but by simply setting them the required distance apart. The pressure-block Q' is perforated by a corresponding orifice. Hence, whatever the position of U, the whole of the transmitted beam may enter the tube M''—that is to say, through the above-described openings or apertures between the prisms P'' and P''' in the block Q', and through the top of the cylinder U, a certain fixed and invariable part or proportion of the main beam or pencil of light entering at o' passes unchanged directly out of the branch o'' into the tube M'', whatever be the position of the cylinder U within the prescribed range of its motion. Of the remainder of the main beam the prisms P' and P'' reflect a certain variable portion to the left while the prisms P''' and P'''' reflect the balance to the right. The ratio of the parts reflected in such opposite directions is governed by the adjustable cylinder U, and hence may be varied at will within certain limits by operating the pinion V. The cross-section of the deflected beams resembles in form half of a circular ring, whose outer diameter is equal to that of the beam before its division, while its area is only about one-third as great. Hence to reduce the cross-section to such linear dimensions that the beam may enter a tube of which the area of its cross-section is more nearly equal to that of said beam, the condenser W, consisting of a convex and concave lens, both adjustable and mounted as shown, is secured in the end of the cylindrical case T. The reflected beam is thereby reduced in its lateral dimensions so that it may enter the smaller branch tube, M''', which is secured in the smaller end of said condenser, as shown.

It is to be observed here as an important advantage covered by this invention, owing to the large proportion of sensibly non-parallel rays in pencils of artificial light from any source, that, whatever be the form of the cross-section of such pencils on entering a tube of the character described, by the reflection of such non-parallel rays from side to side of the tube in their course through it and at an infinite variety of small angles, the whole bore of said tube in a short distance becomes filled with the rays of light, making a beam or pencil of uniform intensity. To such beams therefore I apply the term "tube of light." Hence, also, a prism which has intercepted and deflected away from a tube of such rays a part thereof only cannot prevent another prism placed at any considerable distance farther along in the course of said tube of light from intercepting a like or due proportion of the remaining rays, even though the latter prism occupy the same field in the cross-section as does the preceding one. Whatever light may be transmitted through the tubes will practically be uniformly distributed throughout their full inclosed space, the shadows projecting behind intercepting prisms and other parts being speedily obliterated by the diffusion and reflection of the remainder of the beam. Thus the non-parallel quality of the greater part of the rays becomes a positive advantage. It also renders unnecessary and inconsequential the exact optical adjustment of the various parts of the apparatus employed.

The four-way branch described above is used in cases where a part of the beam is required to pass on to be used at some point farther along in the line of the main pipes M' and M'', as in the case of a second floor of a house, the two lateral branches supplying light for rooms on the first floor.

Figs. 14 and 15 represent a three-way branch differing from the above-described in that no apertures or orifices are provided for the passage of any part of the beam received in continuation between the prisms and through the pressure-block and adjustable cylinder, as shown; also, in that the field covered by the prisms, and the range of movement allowed to the adjustable cylinder holding them, is equal to two times the diameter of the supply-tube M''. Hence the whole of the beam received may be directed through either arm of the branch, or may be divided between them in any desired proportion. Condensers may be used or not, as desired. This form of branch is used where it is not desired to extend a part of the main beam in continuation, as in the case cited above, in which the branch may be supposed to direct the whole of the light received for lighting the second story, none being required above that floor. Either may be used horizontally, as well as vertically, however.

Figs. 16 and 17 represent a form of branch similar to that last described. It is of smaller size, however, and hence but two prisms are required, one for each of the reflected beams. These prisms are set and secured without the use of a pressure-block and binding-screws. Openings of the same size and shape as the cross-section of the two prisms p and p', when placed in their proper relation to each other, are provided in opposite sides of the adjustable cylinder u, in which the prisms are securely set and fitted. The part g' between the prisms can be sprung so as to admit the prisms, and then made to bear upon the back surface at the ends, and so hold them securely in place. The breadth of the face of each prism is equal to the diameter of the supply-tube o, and the range of motion allowed to the adjustable cylinder u is the same. Hence the whole beam of light admitted may be deflected through either arm of the branch, or may be divided between them in any desired proportion.

It is to be understood that whatever be the number of prisms to be mounted pressure-blocks may be used or dispensed with, as circumstances may require. In general, for large main branches, where a series of prisms in echelon is used, pressure-blocks are used to secure a more equable pressure thereon, while with small-sized branches, requiring a small number of prisms, adequate security may be had without such blocks.

In the carrying out of this invention I prefer to use throughout the parts, where necessary, prisms of a uniform size of cross-section, so that for the smallest size of tubes, couplings, and branches one prism is large enough to reflect the whole beam; for the next size, in which the diameter of the beam is twice that of the smallest, two prisms are used to reflect the whole beam; for the third size, in which the beam is three times as wide, three prisms are used, and so on. Thus greater economy is secured in making and fitting the prisms and other parts.

Figs. 18 and 19 represent a form of three-way branch by which the whole or any desired part of the entering beam may be taken off through the single arm of the branch, leaving the remainder to pass on unchanged in continuation. The prism is mounted the same as in the last-described case, while the carrying-cylinder is terminated by a plane passing through the prism.

Fig. 20 represents a double modification of the branch last described, in which I have a four-way branch with two adjustable prism-supporting cylinders, by means of which the whole or any desired part of the entering beam may be conducted through either of the three distributing branches and the remainder, if any, divided in any desired proportion between the other two. It may be described as being a modification of that shown in Fig. 16, in which case we may suppose the cylinder *u* to be cut by a plane passing between the two prisms and the left-hand portion thereof provided with a rack and pinion of its own. In this double form of branch the two adjacent ends of the adjustable cylinders are projected just far enough to restrain the prisms from a severe or dangerous contact or collision, as shown in the guard-projection *q′* and *q″*, when brought into juxtaposition with each other.

Figs. 23 and 24 represent a five-way non-adjustable branch, by means of which the beam of light received is equally divided into four reflected beams. It consists of the cylindrical boss or hub *r*, into one end of which light is received through the tube *o′* and opening *o″*. Radiating laterally from said hub *r* are four branch openings and connections, *s s s s*. At and below the upper line of said branch openings the diameter of the chamber of the hub *r* is enlarged, forming at the plane of the enlargement the ledge or shoulder *t*. In the enlarged chamber so formed, with the outer part of their receiving sides or faces resting or bearing upward against said ledge or shoulder, are the four prisms *x x x x*. Said prisms have their ends cut or shaped obliquely in vertical planes, and in such manner that their receiving-surfaces converge to a common point in the axis of the chamber, while the outer face of each one is presented outwardly toward its proper branch opening. The back or reflecting surfaces of the prisms combine to form the sides of a regular pyramid. The lower edges of the prisms are cut off by a plane parallel to their receiving-faces to a sufficient extent to furnish a bearing-surface against which the binding core or spigot *t′* presses as it is screwed into the lower end of the hub, thus holding the prisms securely in position. This form of branch may be used in any required position for the general division and distribution of light, and may have any desired number of prisms, with corresponding branch openings and connections. Said prisms may be of equal or unequal size and field, according to the amount of light which it is desired to deflect by each; and the central part of the nest of prisms around the common point of their meeting in the axis of their hub or boss may be cut away so as to allow the passage of a beam of light in continuation.

Figs. 25 and 26 represent a simple form of non-adjustable tubular branch. It consists of a number of curved tubes, *a′*, (four in this instance,) which have each a certain part of one end straight. Said straight portion of each tube is formed so that its cross-section has the shape of a sector of a circle, the annular dimensions of such sectors being such that when their vertices or angular edges are brought into a common line they form together a circular cross-section, as shown in Fig. 26. The tubes may be sealed together, or may be made in the form of one equivalent piece or tube, with cross-partitions, as shown at *b′*, or may be separate and secured only in the mounting. They are mounted in a metal coupling, as shown, the solid black filling representing any suitable sealing compound. It is to be understood that these curved tubes are of the character hereinbefore described as being a part of my invention. In this case the glass tubes which constitute the foundation are first joined together, as described above, and afterward silvered. The metal covering is then deposited by electro-deposition, forming all into one piece. This branch may be used for the general division and distribution of light, and may have any desired number of arms, curved in any desired direction, one (or more) of which may be wholly straight, so as to conduct and transmit a part of the main beam of light in continuation without change of direction.

Figs. 27 and 28 represent a form of dispenser constituting a part of this system of lighting. It consists of the spherical dispenser *y*, held in the bottom of the glass tube *z*, which is mounted in the metal holder and coupling *v*. The spherical dispenser *y* may be polished metal, of hollow glass silvered on the inside, of white chalk or lime, or similar substance, to give a diffused reflection, or of solid glass, to dispense the light by refraction. For brilliant prismatic effects a polyhedron of cut glass may be used. The glass-holder *z* may be clear or ground or opaline, as may be desired. The form of the dispenser *y* may be varied also, according to the manner and direction in which it is desired to distribute the dispersed light.

Figs. 29 and 30 represent a method of mounting such dispensers without the use of glass tubes for holders. Another method of mounting is shown in 23 and 24.

It is to be understood that by the use of suitable apparatus, as set forth, one or more houses may be lighted, or all the houses upon a street may be illuminated, from one electric or other suitable light.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The holophote substantially as described, consisting of the prolate-ellipsoidal reflector B, convex lens F, and concave lens G, arranged and combined essentially in manner and to operate as set forth.

2. The combination of the hemispherical reflector K with the reflector B and the lenses F and G, all being arranged and to operate as set forth.

3. The combination of the ring H, provided with glass disks, the spaces between the said disks being filled with an athermanous liquid, or the latter and a fluorescent liquid, as set forth, with the holophote, substantially as described, consisting of the reflector B and the lenses F and G, all being arranged and to operate essentially as specified.

4. The holophote B and reflector K, provided with the interchangeable connecting-hinges *d e* and pin *f*, substantially as described, for the purpose or purposes set forth, such admitting of the reflector being removed from the holophote in order for the latter to be connected with another holophote, as hereinbefore described.

5. The combination, with the holophote constructed substantially as described, of the reflector B and the lenses F and G, and tubes having inner reflecting-surfaces, as set forth.

6. The combination, with the holophote constructed substantially as described, of the reflector B and the lenses F and G, and one or more tubes having inner light-reflecting surfaces, as set forth, and one or more reflecting-prisms arranged in such tube or tubes, and to reflect light into or through such, as explained.

7. The combination of the hemispherical reflector K, provided with the sight-hole *g*, with the holophote substantially as described, consisting of the reflector B and the lenses F and G, arranged as explained.

8. A light-transmitting tube consisting of a tube of glass, a metallic reflecting-coating encompassing its outer surface, and a circumscribing coating of varnish or asphalt, or varnish and an additional metallic coating surrounding the asphalt or varnish coating, all being essentially as set forth.

9. The combination of the covered tubular coupler L with a series of prisms beveled on their ends as described, and with a compression-block and binding-screw arranged with such couplings and prisms, substantially as set forth.

10. The combination of a covered tube, L, provided with triangular openings on its sides, with one or more reflecting-prisms arranged in such openings, as set forth.

11. Two light-reflecting prisms, or sets of such, arranged and provided with a passage in or between them for the transmission of light, as set forth, such being essential, as shown in Figs. 12 and 13, and as hereinbefore explained.

12. The combination of the adjustable tube U, Fig. 12, provided with one or more lateral openings and means of adjusting it, and with one or more reflectors or prisms, as set forth, with an encompassing-tube, T, and one or two lateral passages or branch tubes, M′ and M″, leading from such tube T, all being essentially as shown and described.

13. The combination of a series of reflecting-prisms arranged about a common axis with a main tube having its axis in prolongation with the axis of the prisms and with a series of branch-tubes extending from the prisms, all being substantially as specified.

14. The combination of a light-dispenser, *y′*, substantially as set forth, with a tube, *z*, for transmitting light in a pencil or beam of rays to such dispenser, as explained.

15. The combination, with a light-transmitting tube, of a series of curved light-reflecting branches, arranged with such light-transmitting-tube, so as to divide and conduct the beam of light passing from it and conduct it off in separate beams or to dispersers, as set forth.

16. The combination of the inclosed sliding tube U with one or more reflectors or reflecting-prisms, designed to reflect variable portions of a beam of light received at right angles to the said tube, all being substantially as set forth.

17. The combination of an adjustable tube or carrier, U, with one or more reflectors or reflecting-prisms, designed to reflect variable portions of a beam of light received at an angle with the said tube and with one or more light conducting and reflecting tubes, substantially as set forth.

18. A light transmitting and conducting tube, of glass externally coated with silver, in combination with and inclosed in a thick tubular covering or electro-deposit of metal, in which screw-threads may be formed or with which other devices may be joined for connecting in a continuous series by suitable couplings two or more of the said glass conducting-tubes thus separately inclosed, all being substantially as set forth.

WM. WHEELER.

Witnesses:
R. H. EDDY,
E. B. PRATT.