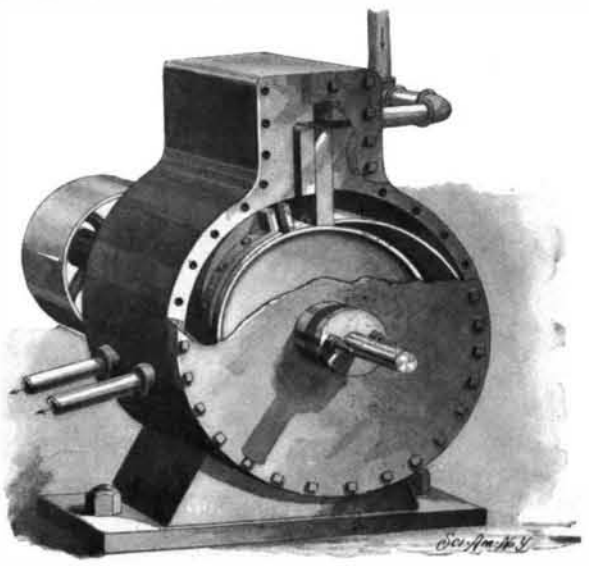
AN IMPROVED ROTARY ENGINE.

The engine shown in the illustration is designed to work with a minimum of friction, has but few parts, and is not liable to get out of order. It has been patented by Gutie H. Tuttle, of Montgomery, Ala., and William W. Buford, of Donaldsonville, La. The engine comprises two cylinders in one casing, the cylinders being separated by a central web, and the shaft carrying two wheels or disks, each occupying one of the cylinders. To opposite sides of each wheel or disk are attached two abutments, each having in its face a packing strip to make steam-tight contact with the periphery of the cylinder, and each abutment has on

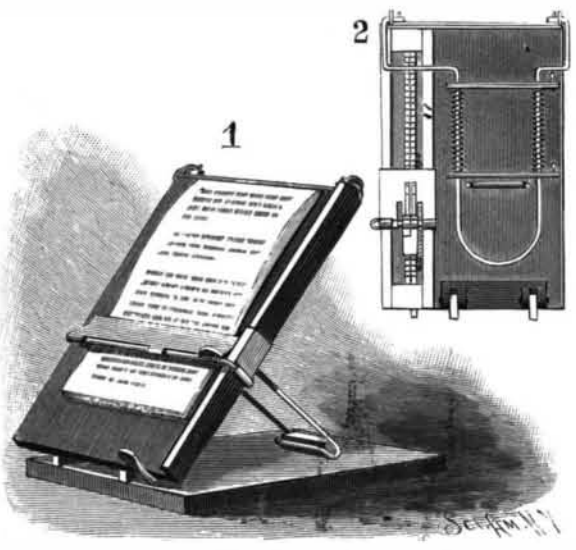


TUTTLE AND BUFORD'S ROTARY ENGINE.

one side a cam or incline adapted to engage and move a sliding abutment or plate, the opposite end of which has movement across the supply port. One end of a flat spring is secured to the lower end of the sliding abutment by means of dovetail tongues, the spring being adapted to lie in a recess in the periphery of the cylinder, and its opposite end being secured in position by screws. The spring extends from the sliding abutment in a direction opposite the direction of rotation of the wheel or disk on the shaft, the cam or incline on the wheel pressing the spring into the recess as the abutment or sliding plate is moved across the supply port, and the spring moving the sliding plate down to admit steam behind the piston head as soon as the latter has passed. The steam pipe delivering steam to the engine is forked into two branches, so as to deliver steam to each side of the engine. The exhaust port is placed at an angle of about ninety degrees from the steam port, and the two piston heads of each wheel being attached at an angle of about ninety degrees on opposite sides, alternate with each other to bring one of the piston heads into use at all times. The spring plate is so proportioned that the pressure of the movable abutment on the wheel will be very slight, thus avoiding undue friction.

A MANUSCRIPT HOLDER AND SPACER.

A device more especially designed for the use of typewriters, to securely hold the manuscript in place and permit of readily turning its pages, while properly indicating the lines of writing as the copying proceeds, is shown in the accompanying illustration, and has been patented by Albert N. Woodruff, of the United States



WOODRUFF'S MANUSCRIPT HOLDER.

Engineer Corps, Willets Point, New York Harbor. Fig. 1 represents the device in use, Fig. 2 being a back plan view partly in section. The manuscript support is hinged at its lower end to a suitable base, and is held in inclined position by a brace, which may be disconnected to fold the support down upon the base. The manuscript is held at its upper end by a clamping bar extending along the top edge of the support, this bar being hung in the ends of a frame which slides in bearings on the back of the support, the frame being pressed on by springs to hold the clamping bar down on manuscript or a book. The lower end of the frame has a handle, by taking hold of which the clamping bar is lifted to permit the removal of the book or manuscript, or, when a page of manuscript has been copied, it may be swung to the rear over the clamping bar. The spacing or line plate is mounted on a rod secured to a slide movable in a guideway at one side of the manuscript support, a spring pressing on the plate to hold it in firm contact with the outer page of the manuscript. The slide extends to the rear of the support, where it carries spring-pressed pawls in mesh with two rack bars, one fixed to the back of the support, while the other slides in bearings, and has at its lower end a finger piece projecting to the front lower edge of the table. By pressing upon this finger piece, when the device is in use, the sliding rear rack bar with its pawl is carried downward, together with the slide and the spacing or line plate, the entire downward movement being the distance between two lines on the manuscript or copy. It only requires a slight pressure on the finger piece to enable the operator to shift the spacing plate as desired.

THE AVEN ARMAND, LOZERE, FRANCE.

BY HORACE C. HOVEY.

In southern France is a region, once an unbroken plain, but now cut by erosion into a number of dry, barren, treeless uplands by deep and picturesque canyons. This is known as the Land of the Causses, a word derived from the Latin calx, through the Provençal caous. These independent plateaus rise to a height of from 1,000 to 4,000 feet above the level of the sea, and the gorges between them are correspondingly deep. There are few running streams along their surfaces; but the rainfall is swallowed by "avens," or pits, like the sink holes of Kentucky, to reappear in gushing springs, that are gathered into rivers clear as crystal, whose cliffs tower to a tremendous height, and display as rich a variety of colors as may be seen in the Grand Canyon of the Colorado.

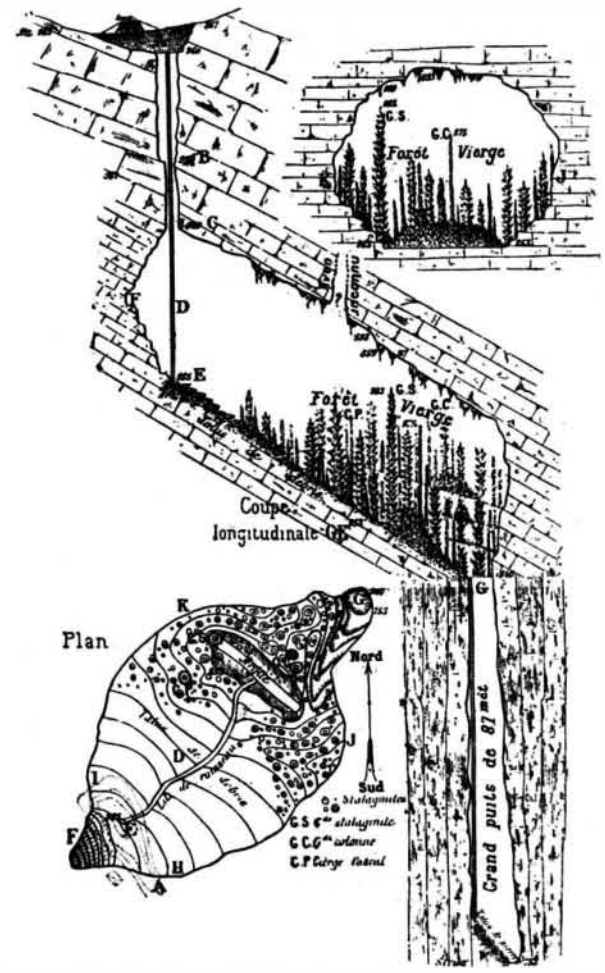
Last September, in company with a party of cave hunters, we went by rail to the quaint old city of Mende, where we took carriages across the Causse, Sauve-Terre, by a magnificent road built at the expense of the province of Lozére. The descent to the hamlet of St. Enimie was by a zigzag series of terraces, leading down from the lofty plateau to the banks of the turbulent river Tarn. Here our party took canoes manned by expert boatmen, shooting some of the rapids, and making portages around others, with occasional pauses to examine venerable castles or interesting grottoes, till, after an exciting voyage of about forty miles, we came to the junction of the Tarn and the Jonté, and made our headquarters at the lovely village of Rozier, whence we made various excursions, only one of which is now to be described, namely, that to the Aven Armand, a singular and terrible pit in the Causse Méjean.

Only four of our party undertook this somewhat perilous exploration, namely, Messrs. Martel, Viré, Armand and myself. We ascended the charming valley of the Jonté to a point almost opposite the celebrated cavern of Dargilan, where we left the state road for a rough and narrow wagon track that wound tediously up the lofty plateau. In doing this we passed many objects of interest. There were tall cliffs, from 500 to 1,000 feet in height, huge monoliths standing like so many obelisks, and majestic archways carved from the purple or vermilion limestone. We saw a number of inhabited cliff dwellings; and saw one that was altogether new, located on the edge of a precipice as abrupt and underneath a crag as inaccessible as those of the similar cliff dwellings of Arizona, but with a winding sheep path leading down to it through a chasm. Geologically speaking, the lower cliffs are of dolomite, above which is a sloping talus of oolitic marl, then another thick mass of Bajocian dolomite, surmounted by thin layers of Oxford limestone, rising like rude stairways to the plateau, where lie broad sheep pastures, with here and there bits of arable land. The only inhabitants are simple peasants, dwelling in moss-grown stone huts, winning a scanty living from their flocks and oat fields.

On the farm of Mr. Bertrand lies an ancient burying ground, the scattered tombs being huge heaps of limestone slabs. One of them we opened, finding human bones and prehistoric implements. In the distance gleamed the Cevennes Mountains, already white with snow, although it was only the 20th of September. Amid the rude dolmens yawned the blackest, ugliest pit that ever entrapped stray animals or unlucky human beings, or that ever tempted reckless cave hunters to fathom its awful depths.

Mr. E. A. Martel, the renowned speleologist, was our leader, and his outfit was complete. It included an ample tent, numerous rope ladders of the most approved pattern and of extra lengths, a folding canvas boat for sailing on subterranean waters, should any be found, a coil of copper wire for our telephone, tools of all kinds needed, together with a fair supply of provisions. No wonder that the peasants took it for the outfit of a traveling circus.

The first thing done was to pitch our tent near the brink of the aven. The next was to gather a quantity of the wild boxwood that grew amid the dolmens, and make a fire by which to warm ourselves and cook our dinner. Preparations followed for descending the aven. Four stout crowbars were fixed firmly in the

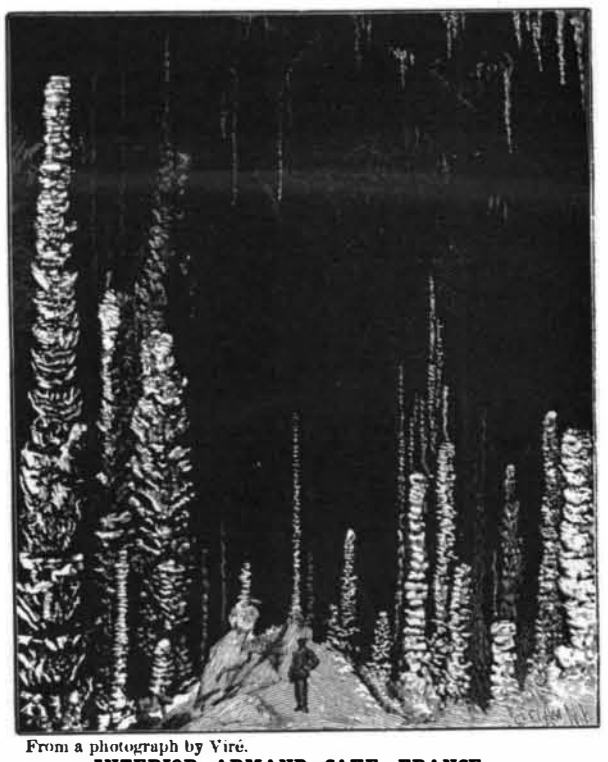


G, C, large column; G, S, large stalagmite; G, P, altar candle; E, bed of cave brook.

THE ARMAND CAVE.

seams of the limestone ledges. The pit was measured and found to be exactly 240 feet in vertical depth. A rope ladder of the required length was fastened to the bars and then hurled down the pit. The copper telephone wire was uncoiled and stretched back from the aven ready for use. It was decided that Mr. Louis Armand was to have the honor of making the first descent, having been the man to call attention to the locality; and it was afterward agreed to give the aven his name, calling it the "Aven Armand," and we are informed that he has since bought the place, with the intention of making it accessible to the traveling public.

Before setting his foot on the first round of the swaying ladder, Mr. Armand fastened a rope around his waist, the end being held by stout peasants. Another rope, held in a similar manner, was attached to a cross bar, on which the explorer sat. These precautions



From a photograph by Viré.

INTERIOR ARMAND CAVE, FRANCE.

were deemed necessary in case some one rope should be cut on the edge of a projecting rock or for some other reason give way. Armand took along a supply of candles and of magnesium ribbon. He carried a pocket telephone, such as is used in the French army, the other end of it being left in the tent. For some time his orders were shouted back long after he had disappeared from sight. But at length his sole reliance was the telephone. It seemed an age before the news was whispered up from the heart of the earth that he had

landed safely amid a forest of stalagmites at the bottom of the shaft and was going to explore his surroundings. After a considerable interval of silence, he telephoned that a sloping way led down to the edge of a second pit deeper than the first, the depth of which was found on measurement to be 300 feet. Then, at Mr. Martel's request, Armand climbed to the surface to make a fuller report than could easily be made over the wire. The excitement of our party was intense. Adding the measurements together, which were afterward verified, we found that the total depth of this enormous abyss was 210 meters, or about 680 feet. Only one cave deeper than this is known in France, and it is one of the most profound caverns in the whole world.

One after another our party climbed down that slender rope ladder, and surveyed the wonders never before seen by mortals. We took several flashlight photographs, only one of them, taken by Mr. Viré, proving very good. It represents what is called "The Virgin Forest," of mighty palmlike stalagmites rising to the lofty height of from 50 to 90 feet, and untouched as yet by the tool of the geologist or dimmed by the explorer's torch.

As the leader of our party, Mr. Martel enjoyed the right to make the official report of this famous discovery, which he did before the French Academy of Sciences, accompanying it by maps and diagrams. Observation of environment suggests that this aven was once the drainageway for an ancient lake, whose contour we were able to trace over the plateau. The excavation, like that of all other limestone caves, was by means of the chemical and mechanical action of running water, although now it is dry, as far as explored, the water having disappeared from numerous fissures below, except as a narrow rivulet winds along the floor of the cave, fed by rains. Henceforth, in counting the wonders of the world, mention must be made of the Aven Armand of the Causse Méjean.

COLUMBIA'S ARTIFICIAL MOON.

Two weeks ago we published an article on the new buildings of Columbia University, and as at that time announced, we publish herewith an account of the system of lighting by reflection as used, we believe for the first time, in the great dome of the library building.

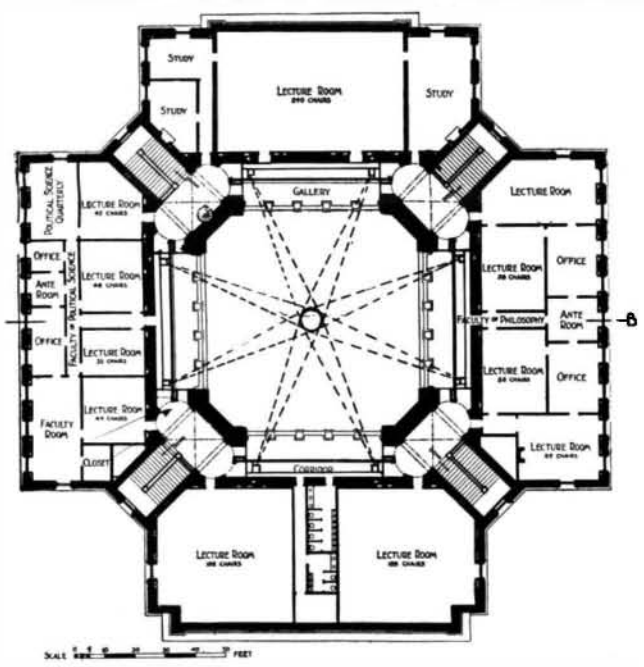
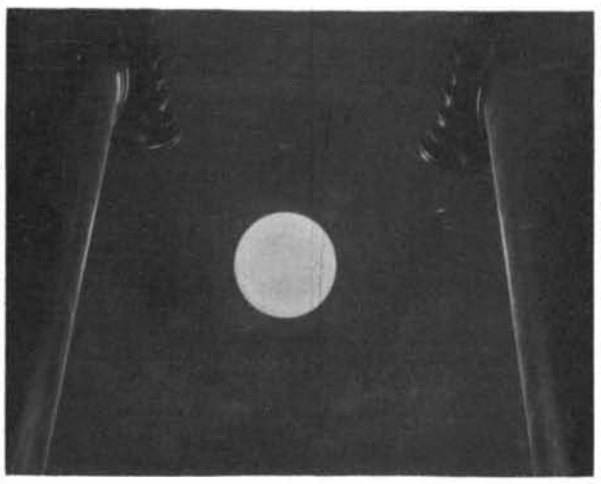


Fig. 1.—SECTION THROUGH GALLERIES IN WHICH PROJECTION LANTERNS ARE LOCATED.

In the design of the new memorial library, donated by President Low to Columbia University, of this city, several illumination problems presented themselves which were difficult of solution and demanded an exercise of considerable originality. It had been decided to light the reading desks in the manner employed at the old library, i. e., by 16 candle power incandescent electric lamps on stands, placed about two feet above the tables and provided with conical shades, green outside and white inside, to direct the light downward. A few lamps were also to be placed behind the columns and on the walls for general illumination below, but no method for lighting up the vast dome, the massive carved stone arches and the architectural features, statuary and books of the upper balcony; these would be left at night in darkness. Again, a bright light source, such as a chandelier, a cluster of arc lamps or even distributed sources of light, would be difficult to get at, cast shadows that would be too dark, dazzle the eye, and destroy the softness in architectural effect striven for. This is the problem that presented itself to Mr. McKim, the architect, and he hit upon the plan of employing a large, luminous light source that would give a steady, pleasant light and one that would produce no sharp shadows. With this idea he went to Prof. Hallock, of the University, and requested that a method be devised to carry out his plans. Experiments were begun, and it was determined to suspend a huge white sphere from the center of the dome and to project upon it the rays of some intense light, such as that from an electric arc. It is well known that a dead white surface will give out 70 to 80 per cent of the light projected normally upon it and that, when the surface has a matt finish, the light will be diffused and lose the glare which accompanies light coming from a polished surface, all of which was as desired. The sphere was built in the summer of 1897, tried once in December, and at the present time is to be seen every Friday evening between the hours of 5 and 7, for the life of the carbons is but 2·5 hours. The large reading room is not used at night, smaller rooms being available, and the "moon" shines but for the accommodation of visitors at the present time. It is as yet in somewhat of an experimental stage of development, but will later on be used regularly.



THE MOON AS IT APPEARS FROM THE MAIN FLOOR OF THE LIBRARY.

General Arrangement.—As will be seen in Figs. 1 and 2, the library is built of cut stone, shown black in section, the external dome being of cut stone and brick. To prevent spreading, there is walled into this dome two steel circular bands, placed at about the height of the top of narrow passage inside the arch. No scaffolding was used in building this arch, but the voussoir stones kept it in place, one layer being finished before the next was added. Inside this stone dome is another dome made of steel and plaster, painted on its interior a dark blue. This color was intended to imitate the deep blue of the clear sky, and consisted of Prussian blue mixed with whiting, the latter being necessary to produce a dead surface without reflecting properties.

Toward the horizon of this sky the tint becomes less dark and shades off so gradually into the still lighter cornice that the effect is more natural than striking. At the level of the lower edge of this dome the sphere or "moon" is placed, receiving the rays of light projection lanterns equally spaced, as shown, and overlapping slightly on the bottom of the sphere. The color of the stonework is a light gray, the columns are a very dark green, with gold capitals, while all woodwork is of oak.

In the semicircular windows the glass is clear translucent and affords sufficient light during the daytime for reading, the electric lights being turned on when it fails on foggy days or toward evening to one-half foot candle. In the galleries behind the columns are hung three 10-inch frosted globes on each side, 12 in all, each containing one 16 candle power lamp—in fact, there are none but 3·5 watt 16 candle power incandescent lamps used in the library. These lamps are not shown in Fig. 2, neither are the book shelves between the columns, nor the 44 lamps they carry, each having a 6-inch spherical frosted globe. The central circular reference shelves also carry 16 such lamps inside and out. Upon the reading desks are placed 152 lamps with conical shades, making a total of 224 16 candle power lamps. But 64 of these are intended for general illumination, and, as they lose about 50 per cent of their light upon passing through ground glass, 32 bare lamps would give the same illumination. Each reading lamp is turned on separately, so that at no time are they all burning, unless all the chairs are occupied at one time. When the lamps are lit, the least illumination received by a page placed horizontally upon the table is about 1·5 foot candles, so that the lighting below may be considered satisfactory. It is, however, the lighting of the upper part of the general reading room with which we are at present concerned.

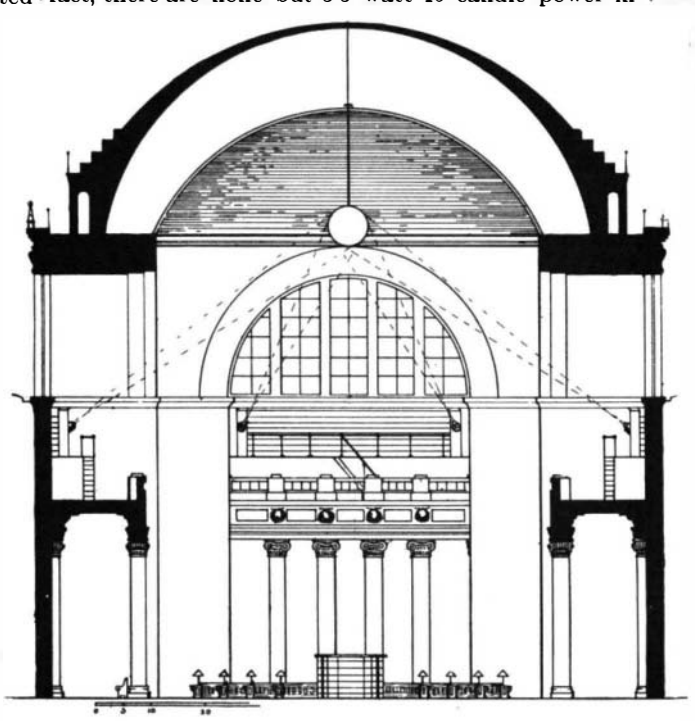


Fig. 2.—SECTION OF LIBRARY SHOWING LOCATION OF MOON AND PROJECTION LANTERNS.

Construction Details.—The "moon" is 7 feet in diameter, having a framework of wood arranged in meridians and parallels. Upon this frame is fastened wood veneering in such a manner as to give a smooth surface to the sphere. It is made in two halves, divided at what corresponds to its equator, and covered by a coat of kalsomine. A quarter inch wire rope suspends this ball, running through its north pole to an iron plate covering externally its south pole, thus making a very secure fastening. This wire rope runs through the dome and over a winch outside, where it is held in place by both a ratchet and grip. If both of these should fail, the ball would be stopped by the rope being not quite long enough to reach the floor. This ball weighs probably 400 to 500 pounds and is seen against a blue background from all parts of the library. The projectors are what is known as the Colt & Company automatic feed type of arc light, the carbons being fed in both directions, so that the arc is always in the center line of the condensing lens. This construction is plainly shown in Fig. 3, along with that of the lenses and the direction of the projected light; the design may be changed, however, as it is not all that could be desired. The objective is so adjusted that the circle of light thrown upon the sphere does not come within about 3 inches of the edge; otherwise, it would form a crescent upon the dome. The carbons are $\frac{7}{16}$ of an inch in diameter, last 2·5 hours, have an arc resistance of 45 volts and an outside current, obtained by resistance boxes, of 125 volts (or 50 volts, if desired). It is supposed that 18 ohms of current are consumed per arc, although this evidently varies, as 25 and 30 ampere fuses have frequently been burned out. No tests of current have yet been made. The position of the arc can be adjusted, as can also that of the projected disk of light. The top carbon is placed slightly to the rear of the lower carbon, causing a crater to form upon the side of the former from which the rays go directly where they are the most needed. This crater is said to emit 80 per cent of the light of the arc, is elliptical in shape, $\frac{1}{4}$ inch wide by $\frac{1}{8}$ inch across, and has an area of about 0·1 square inch. Both the body of the projector tube and the objective tube slide in and out, by which means the circle of light is properly focused, although this focus should not be sharp, as the overlapping rings of light thus become too apparent, and the globe assumes a pieced-up appearance. The projectors are placed in closed blackened closets.

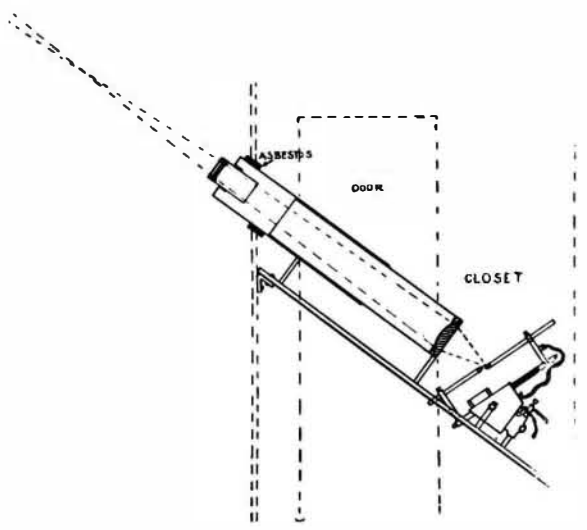


Fig. 3.—SECTION OF PROJECTION APPARATUS.

Operation.—Just before lighting, the several arc lamps are tried separately to see whether they are directed properly and feed well. Then they are turned on and give a light which varies in intensity with the feeding of the carbons. As the circles overlap in some places threefold and in others have but one arc to cover them, and as these arcs may vary from 500 to 5,000 candles, it is very evident that there will be slices of the