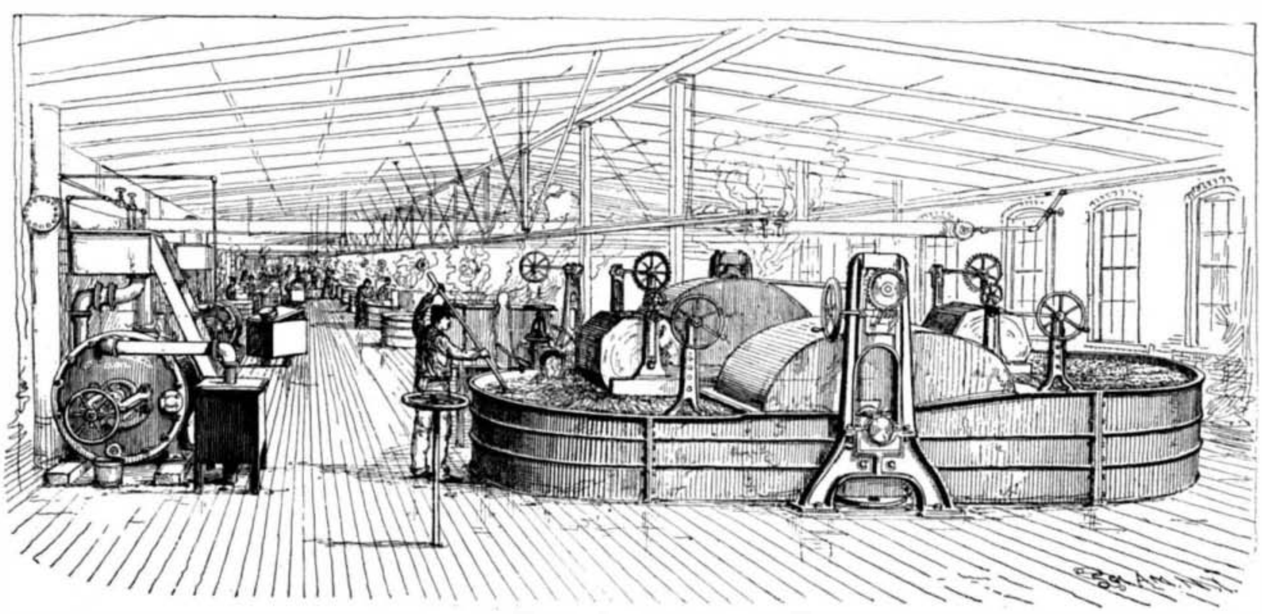
Indians, their chief fear was that it would be necessary to renew the old tribal feuds, but, once on the ground, this idea was soon dispelled, and it is now amusing to see with what formality the tribes exchange civilities. For instance, when the Sioux Indians pay a call to the Arapahoes, the visitors dress with greatcare and march singing to the Arapahoe village. The Arapahoes met them with a song of welcome, and a formal handshaking follows with an exchange of gifts, and peace is declared between the two tribes. Of course, in most cases the Indians are not able to communicate with each other except through the aid of an interpreter, as their languages are different.

Our engraving shows a group of representative Indians of two of the most interesting tribes, the "Flatheads" and the "Assiniboins." The Assiniboins are considered particularly good Indians, and cause little disturbance. They boast that they never fought white men, but with the Cheyennes, Crows, Black Feet, and Nanktons. "Different Cloud," "Kills the Spotted Horse," and "Four Bulls" are three famous chieftains of the Assiniboin tribe. All three were born at the FortPeckAgency, Montana, and have lived there all their lives. "Different Cloud," also known by the name of James Garfield, is thirty-two years of age, and in the famous battle waged between Gen. Miles and Sitting Bull, on Milk River, he did good work for the government, his horse being shot under him. In the course of the fight he scalped six of the Sioux and captured twenty-five horses. "Four Bulls" is also known by the name of James Robert. His career has been a comparatively peaceful one, having only been in one fight against the Crows. He is twenty-nine years of age and speaks English. "Kills the Spotted Horse," whose English name is Allen Clancy, is thirty-three years of age. Five years ago he took part in a fight with the Creeks, and his horse was shot under him and he received two wounds which resulted in his being laid up for three months. When he got well he started out with a party of friends to seek revenge. They stole sixty-five horses from the Creeks and returned home to the agency with this booty. They were promptly arrested for fighting and placed in the guardhouse. The spirit of their forefathers evidently dwelt with them, for they agreed to die by each other's hands. By some means they procured a pair of scissors, with which they stabbed each other. When the jailer arrived, all were dead but "Kills the Spotted Horse," who afterward recovered in the hospital. He is about as striking a type of Indian as any at the Exposition. Antoine Moise and Eneas Michel are from the Flathead agency in Montana. Antoine Moise, though only a little over thirty years of age, has had a very eventful career. Eight years ago he was wounded in battle between the Flatheads and Crow Indians, and the Crow Indian who shot him is on the Indian encampment grounds at Omaha. The other event in his life was his trip to Washington in 1893 to see the "Great Father."

Eneas Michel is twenty-four years of age and has lived all his life on the agency. He speaks English very well and does not call for any special mention.

The scene, particularly at night, is intensely picturesque. Small cooking fires scattered around dimly light up the strange picture, throwing a red glow upon the decorated tepees, while across the trails prance the stalwart braves lavishly decked out with blankets. It is a curious and interesting fact that less than half a century ago the same docile Omaha Indians who peacefully doze by the camp fires within the Exposition gates were waging the war of the tomahawk and arrow on these very grounds, which is a gratifying proof of the triumphal march of civilization.



BEATING AND REFINING ENGINES.

THE MANUFACTURE OF PAPER.

III.—THE PAPER MILL.

In our issues of March 19 and April 30, of this year, we described at considerable length and with the aid of numerous illustrations the processes by which the spruce and poplar logs are manufactured into sulphite and soda fibers. It was shown how the logs are cut into "chips," the length of whose fiber is from one-half to three-quarters of an inch; treated with chemical solutions in huge "digesters," where the "cooking" serves to dissolve out the soluble, incrustating matter of the wood—resin, lignose, cellular matter—leaving only the pure fiber; then washed and screened, and finally bleached, leaving a pure, white, vegetable fiber ready for manufacture into paper in the paper mill proper.

Before describing the final processes, it will be well to mention that there are, broadly speaking, at least six different grades of paper recognized by the manufacturers.

1. The lowest and cheapest of these is *wrapping paper*, such as is used for large parcels and packages. This is made from the screenings and refuse from the different mills.

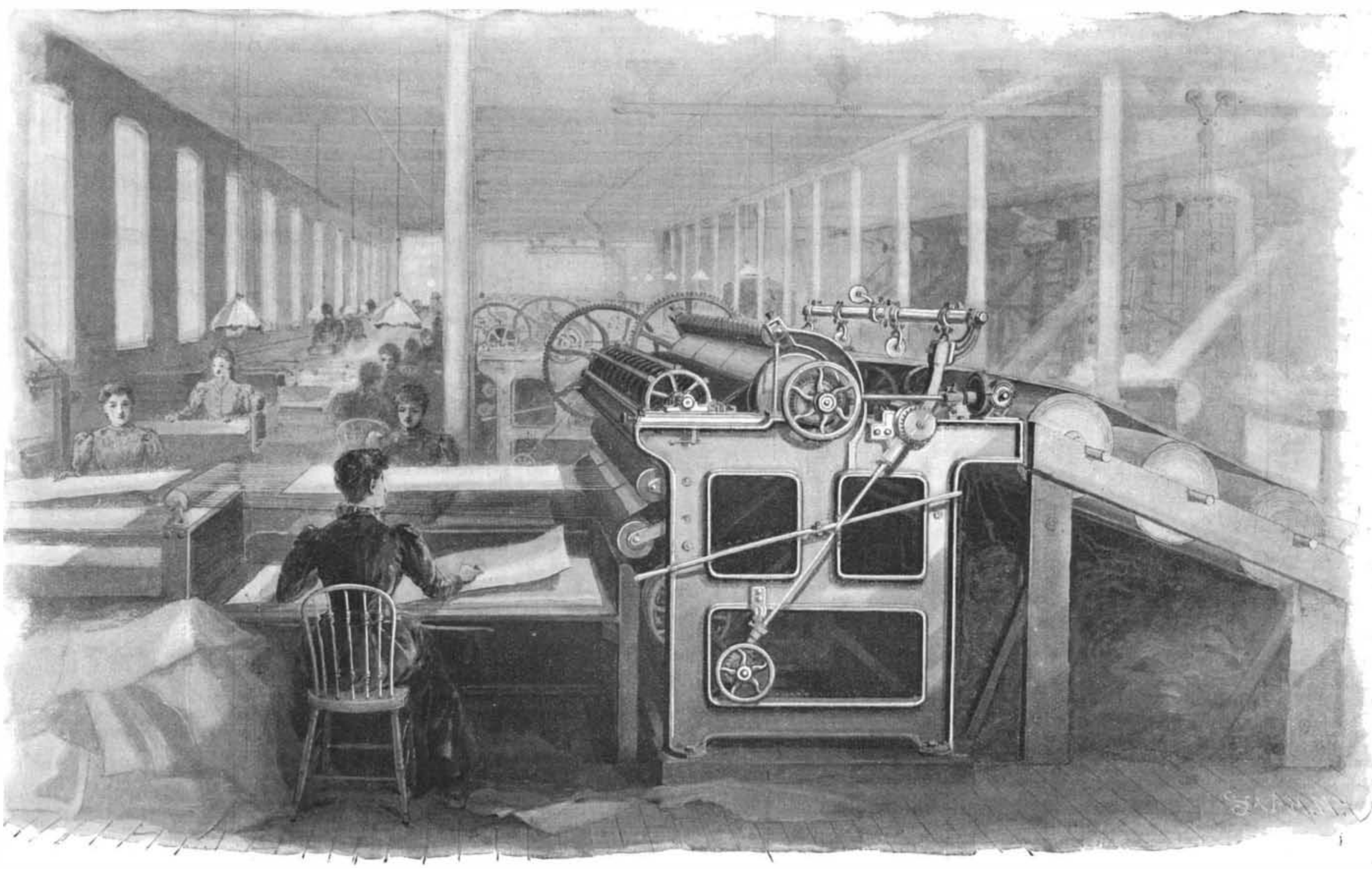
2. *Cheap or "bogus" manila*, made chiefly from ground wood and sulphite fiber, and used for cheap bags, such as are used in retail stores.

3. *Best grade manila*, made from jute and old rope, used for flour sacks and cartridge paper.

4. *News papers and hanging papers*, manufactured from ground wood and sulphite pulp. This grade is practically the same as No. 2, with the difference that the cheap manila is colored. The wood pulp not being chemically treated, the resinous and acid matter remains in the pulp, and in course of time dis colors the paper. It is for this reason that old newspapers become discolored and fade to a yellowish tint.

5. *Book paper*, such as that upon which the SCIENTIFIC AMERICAN is printed, made from bleached sulphite and bleached soda fiber, mixed.

6. *Fine writing papers*, such as note, bond, bank note, tracing, and bank folio paper. This is made from a mixture of rag and wood fibers, and the finest



THE MANUFACTURE OF PAPER—MACHINE FOR CUTTING THE FINISHED PAPER TO SIZE.

grades are manufactured from new cotton and old linen rags.

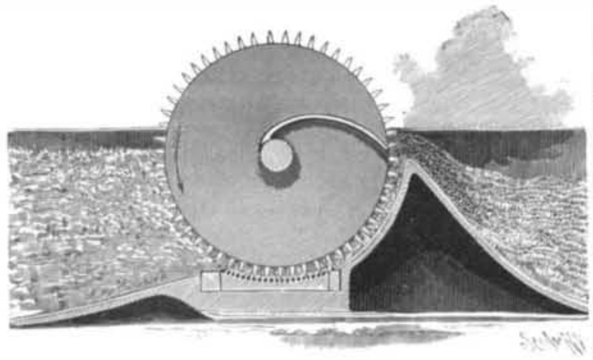
The first step in manufacturing the pulp into paper is to place it in what is known as the beating engine. This consists of a shallow, cast iron tank with semi-circular ends, on one side of which, with its axis at right angles to the longer axis of the tank, is a large revolving roll about four feet in diameter. The surface of the roll is filled with a series of "fly bars," or parallel strips of steel 3/8 inch in thickness and about 5 inches in depth, which extend the full width of the roll and are spaced about 2 inches apart around its periphery. The radius of the roll is slightly greater than the depth of the tank, the bottom of which is curved upward to the rear of the roll, leaving only a narrow passageway for the stream of liquid pulp to pass through. Immediately below the roll a bed-plate, covered with rubbing-strips of 1/4-inch iron, is let into the floor of the tank. The roll is carried in adjustable journals, whereby the space between the face of the roll and the bed-plate may be regulated. The beating engine is 3 1/2 feet deep by 24 feet long, and its capacity is over 1,500 pounds of finished paper. It is loaded with bleached sulphite and soda fiber, brought from the respective mills, and with the proper percentages of clay, starch, sizing, alum, and other materials. The rotation of the roll causes the mixture to flow slowly around the tank. The pulp is drawn in between the roll and the bed-plate, where the action of the iron bars serves to separate and draw out and beat the fiber. By raising or lowering the roll and increasing or reducing the space between the opposing bars on the roll and the bed-plate, the fiber is drawn out to the desired extent. The manipulation of this roll is one of the most important operations in the process of paper-making.

On the opposite side of the engine to the roll are two washers, eight-sided revolving cylinders of wire cloth, with interior scoops which run from the wire cloth face to the interior and serve to catch and drain off the water that passes in through the cloth. The object of the washers is to completely remove all chemicals and other soluble impurities that come over from the sulphite and soda mills. Water flows continuously into the tank on one side and is drawn off by the washers on the opposite side. The process of beating and washing is carried on for about one hour; then the various mixtures, as given above, are added and the engine is run for several hours longer until the process is complete.

The pulp is then allowed to fall down into tanks from which it is pumped to the Jordan refining engines, which are shown to the left of the beating engines in the illustration. This machine consists of a swiftly revolving cone upon the surface of which is a series of knife blades. The cone revolves within a conical drum and the pulp is introduced at the smaller end and driven by centrifugal action to the larger end, at which it is discharged. The purpose of these machines is to make the fiber of an even and suitable length, that which is to be made up into thin papers requiring to be longer than that for thick papers.

After the fiber has been treated in the fining engines, a certain amount of water is added to give it the proper consistency, and it is run through screens located at the head of the Fourdrinier paper machines, two of which are shown in the accompanying illustrations of the Duncan Paper Mills. The Fourdrinier machine, so named after the Frenchman to whom this beautiful invention is due, is one of the most ingenious and perfect devices to be found in the whole range of the industrial arts. The most interesting feature of the machine is the endless traveling wire cloth, herewith illustrated, on which the fiber is interlocked or woven as it were, the water drawn away, and the residue worked into sheet form. The pulp, duly beaten, refined, screened, and diluted with water (as explained above), is piped into the "flow box," a deep rectangular box extending across the full width of the machine, from which it flows out in a thin stream onto an endless 70-mesh wire cloth. The cloth is 118 inches wide and runs over end rollers placed 26 feet apart. To prevent the stream of pulp (which has the appearance and consistency of watered milk) from flowing laterally over the edges of the wire, two endless rubber guides or bands, 2 inches square in section, travel with the wire over the first 20 feet of its length. These guides, known as deckles, run over two pulleys above the wire. The upper half of the wire is supported by and runs over a series of rollers as shown in the illustration. As the pulp passes from the flow-box the particles of fiber float in it just as an innumerable multitude of particles of cotton fiber would float in a stream of water. To unite and interlace the fibers, the wire is given a lateral oscillating or shaking movement, which serves to interlock them much as the warp and woof are interlaced in a textile fabric. Meanwhile the water strains through the cloth, leaving a thin layer of moist interlaced fiber spread in a white sheet over the wire. The separation of the water is further assisted by troughs (suction boxes), which extend across close beneath the wire. Suction pumps connected to these boxes draw the water from the pulp as it passes over them.

The wire with its layer of moist pulp now passes below a roll (known as the "dandy roll") which compresses the fiber, and then below a second and larger roll known as the "conch roll," upon which is a felt jacket shrunk tightly on, which presses out more of the water. The fiber next passes to the "first press," where it is caught up on an endless felt and passed between two rollers, the upper one of wood, the lower of iron covered with rubber, where more water is pressed out of the sheet. Then it passes through the "second press," consisting of an upper roller of brass and a lower roller of iron covered with rubber, where more moisture is pressed out, and finally the sheet commences its long journey up and down over a series of 17 hollow



ROLL AND BED-PLATE OF THE BEATING ENGINE.

revolving iron cylinders, 4 feet in diameter, which are heated by steam. A "drier felt" passes over the rolls with the paper, for the purpose of holding it snugly against the hot surfaces. By the time it has passed over the 17 rolls the sheet is thoroughly dried out.

The surface of the dried sheet is at this stage of the process rough and entirely devoid of the gloss which is indispensable in all "book papers" with the exception of "antique," book paper being the particular grade the manufacture of which we are now describing. The desired finish is secured by passing the sheet through what are called "calender rolls"—a vertical stack of 9 highly polished iron rolls, which "iron" the paper as it passes through them and impart the proper degree of gloss or "finish." The sheet enters at the top and leaves at the bottom of the rolls, whence it is wound onto a wooden reel. There are two stacks of calender rolls to each paper machine.

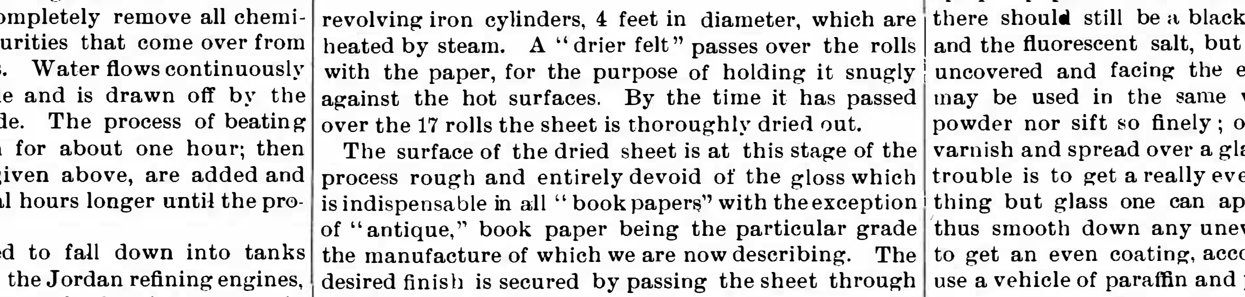
The whole process, from the time the liquid fiber is piped into the "flow box" at one end of the Fourdrinier machines until the dried and calendered sheet is wound onto a reel at the other, is completely automatic and continuous. The weight or thickness of the sheet is determined by the amount of flow of the fiber to the screens. The speed of the paper sheet, when the machine is running on "book paper," such as that on which the SCIENTIFIC AMERICAN is printed, is 140 feet per minute. When the machine is running on "news paper," such as that on which the daily papers are printed, the speed is as high as 500 feet per minute, or nearly 6 miles an hour.

If the paper is to be given a specially high finish, it is run onto wooden rollers and goes to the super-calenders, a series of 9 rolls in which the alternate members consist of chilled refined iron and paper, the paper and iron rolls being of different diameters. The rolls act upon the surface of the paper with a mangling effect, which imparts the desired finish. If a very high finish is desired, the sheet is passed a second or third time through the calenders.

The rolls of paper, which, as they come from the Fourdrinier machine, are from 92 to 112 inches wide, are then carried to the cutting machine (see illustration) and placed in a rack, from which they are drawn over a series of rollers and cut into sheets of the size required for the market. The disk cutters, which are seen arranged on a transverse bar above the first roll, cut the sheet into strips of the desired width, which are then cut to the proper length by a transverse knife.

The paper is then counted, weighed, and either boxed in wooden frames, baled in hydraulic presses, or rolled onto iron or wood cores ready for shipment.

There are few of the arts in which development has been more rapid or the changes more radical and sweeping than in the great industry which has formed the subject of the present series of articles. So true is this, that a first-class mill like that which we have now described, unless it holds itself at all times prepared to make costly changes to keep pace with the improvements of the art, would find itself falling hopelessly behind in less than a decade.



FOURDRINIER MACHINE—DIAGRAM OF THE ENDLESS WIRE CLOTH AND DECKLES ON WHICH THE FIBER IS RUN OUT INTO SHEET FORM.

Fluorescent Screens for Roentgen Ray Work.

A contributor to The British and Colonial Druggist says, from personal experience, that effective fluorescent screens may be made by the amateur, and that a material reduction in cost is thereby effected. Calcium tungstate he regards as a very fair material, and a salt of uranium he thinks very good (the particular salt not being mentioned). The method of making the screen is as follows: Take a plate of glass, say 8 1/2 × 6 1/2 inches; make a mask of stout paper with an opening 7×5; wet this mask with glycerine or mucilage of gum arabic and place it over the plate; cover the plate with collodion, or varnish, or mucilage (with a little glycerine added), and sift the powdered salt quickly and evenly all over the surface. If vellum, parchment, cardboard, or ebonite be used as the support, one may put a coating on both sides, and thus even up any inequalities of deposit; but with a glass support the same advantage will not accrue. Having got a good thick coating of powder, the mask is removed, but this does not matter very much; it has served its purpose to give a clear edge to the coating. The coated side, which must face the tube, if glass is used, is covered with a piece of thin black celluloid, or ebonite, or opaque paper. With vellum, parchment, or paper there should still be a black shield between the tube and the fluorescent salt, but the latter should be left uncovered and facing the eye. The platinocyanides may be used in the same way, though they do not powder nor sift so finely; or they may be mixed with varnish and spread over a glass or vellum surface; the trouble is to get a really even coating, but with anything but glass one can apply a roller pressure and thus smooth down any unevenness. The easiest way to get an even coating, according to the author, is to use a vehicle of paraffin and petrolatum. Equal parts of each are melted together, stirred until cool, and the powdered salt (about two drachms for a 7×5 screen) rubbed on a slab with just enough of the wax mixture to make a workable mass, which is spread by means of a long, straight spatula. An undesirable feature is the liability of the mixture to "run" in a heated atmosphere, but at normal temperature no trouble whatever is encountered. The author mentions that in addition to its value as a means of direct observation, the fluorescent screen reduces the time of exposure in making a skiagraph, being placed beneath the plate when exposed. In conclusion the author remarks: "Of course, it must be understood that even the best and most costly screen will not fluoresce to any extent if the rays are being delivered poorly and intermittently; it will not compensate for a poor and weak electrical discharge and faulty tube. As a gage by which to estimate exposures, I consider a good screen very valuable. With practice one becomes as intimate with the capabilities of his 'tubes' as a photographer with the capacity, as regards covering power and rapidity, of his lens."

Telegraphy Without Wires in Belgium.

Consul Gilbert sends from Liege, under date of July 19, a letter from a professor of a San Francisco school of engineering, who has been investigating inventions in wireless telegraphy. The professor refers to the system of Dr. Della Riccia, connected with the Montefiore Institute of Electricity, at Liege. Dr. Riccia has made improvements on apparatus already in use, simplifying it and increasing its power, and claims that he can confine the oscillations of the transmitter to any special point, to the exclusion of all others. In case of communication between war vessels or forts, the message could be transmitted to one alone; in case of fog at sea, the oscillations would not be limited. Dr. Riccia, it is said, can make the presence of a vessel known to another at a distance of 30 miles and telegraph real messages 7 miles. The full text of the report has been transmitted to the War Department.