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PROF. ROENTGEN'S DISCOVERY.

The now famous Roentgen's discovery has been still further described, the accounts have assumed better shape, and his experiments have been repeated in this country by some of our leading physicists. It was on January 4, at the celebration of the semicentennial of the founding of the Berlin Physical Society, that Prof. Roentgen described his discovery, which had been accomplished only a few days before, detailing his results and presenting proofs of his photographs. The paper covered substantially the ground gone over by us in our last issue. The rays emanating from the cathode of a Crookes tube were used, and in their new role were named "X Strahlen," or "X rays." Prof. Roentgen advanced the theory that the rays are due to the propagation of longitudinal ether waves, analogous in type to sound waves, only differing in their medium or material.

Prof. Philip Lenard, of the University of Bonn, had published two papers in Wiedemann's Annalen, one in January, 1894, and one in October, 1895, showing how the cathode rays could readily pass through aluminum. While the course of the rays passing through aluminum was investigated by him, principally with the aid of fluorescence, he used also sensitized photographic plates. He obtained results closely approximating those of Prof. Roentgen.

Prof. A. W. Wright, of Yale University, occupying the chair of experimental physics and director of the Sloan Physical Laboratory, tried the cathode ray photography with much success. He got prints of various objects through opaque screens. One point brought out is, that while it is distinctly shadow photography, it is so with a difference—it is not merely silhouettes that are imprinted. The effect of the rays upon the photographic plate varies with the nature and thickness of the object through which they pass, so that some representation of its contour and inner structure can be obtained.

One of Prof. Roentgen's exhibits was the photograph of the skeleton of a hand taken from the living hand, the point being that the bones produced a denser "shadow" than did the flesh. This differential action has enabled an aluminum medal to give an image showing its lettering and design. An attempt to take the skeleton of the hand at Yale resulted, it is said, less favorably than with Prof. Roentgen. Prof. Wright's other results were most satisfactory. He found that glass was more opaque to these rays than was ebonite, that aluminum was more transparent than other metals, and his photographs were very interesting and quite numerous.

At Harvard University, Prof. Trowbridge, director of the Jefferson Physical Laboratory, also obtained cathode ray photographs. He is said to have used an exceedingly powerful excitation, enough to give a six inch spark through air; probably a lesser power would answer.

The effects of the new discovery upon medicine and surgery in the diagnosing of disease have been much insisted on, and a recent dispatch from Vienna states that Dr. Neusser, of the Vienna University, has succeeded in detecting calcareous deposits in the internal organs of a patient by the cathode rays.

The rays have been proved incapable of refraction or polarization, and their nature and constitution afford a most difficult problem to deal with—one whose solution may greatly modify our views of radiant energy and of the luminiferous ether, and hence of cosmic questions of the utmost magnitude.

THE PROPORTIONS OF HIGH SPEED ENGINES.

At the meeting of the American Society of Mechanical Engineers held in New York during December, 1895, a valuable paper on the above subject was read by Mr. John H. Barr, of Ithaca, N. Y. The experimental work of which the paper treats, we are told, was carried out by Messrs. F. F. Gaines and H. E. Williams, as the basis of a thesis presented upon graduation at Sibley College, Cornell University.

To secure the data upon which to make the examination, a printed circular was forwarded to the principal makers of high speed engines, with the result that the available data covered about 75 engines by a dozen different builders; the sizes ranging from 25 to 225 rated horse power.

In the subjoined formulas the following notation is used:

D = diameter of piston; A = area of piston; L = length of stroke; S = steam pressure, taken at 100 pounds per square inch above exhaust, as a standard pressure; H P = rated horse power; N = revolutions per minute; C = a constant. All dimensions are given in inches.

In carrying out the investigation, the various dimensions received from the makers for any one given part of an engine were plotted on cross section paper and curves of dimension drawn. A line representing the mean and two lines representing the extremes of these observations were established. "From the equations of these lines formulas are derived which represent the average and extremes of practice." The resulting values for the constant C give the following formulas:

Crank Shaft.—d = diameter of shaft.

$$d = 7.56 \sqrt[3]{HP \div N}$$

(the value of C ranging between 8.76 and 5.98) where 7.56 is the mean value of constant. The diagram gave a maximum of 8.76 and a minimum of 5.98 as the value of C.

Example: If a high speed engine develops 100 horse power at 250 revolutions per minute, we get by using mean value of C:

d (dia. of crankshaft) $= 7.56 \sqrt[3]{100 \div 250} = 5.57$ inches.

Piston Rod.—

$$d = C \sqrt{D^2 L^2}$$
$$= 0.145 \sqrt{D L}$$
$$C = 0.145 \text{ mean value.}$$
$$= 0.177 \text{ max.}$$
$$= 0.119 \text{ min.}$$

Connecting Rods.—In designing these they are calculated as long struts; and then an allowance is made for the flexure stresses due to inertia. The mean constant resulting from this examination is 0.0545, which gives as formula for breadth of rod (b)

$$b = 0.0545 \sqrt{D L^1}$$

L^1 being the length of rod. The height will be made twice the breadth, plus an excess to provide for stresses due to inertia.

The investigation for this ratio of height to breadth of rod gave the mean value h = 2.73b.

Main Journals.—For the projected area of each main bearing, the formula is

dl = C A (d being diameter; l, length of journal) C ranges from 0.367 to 0.739, the mean being 0.489, then d l = 0.489 A.

Crank Pin.—Working upon the formula

$$l = C \frac{HP}{L}$$ the constant was found to vary between 0.192 and 0.417. The mean value gave the following equation:

$$l = 0.333 \left(\frac{HP}{L}\right) + 2.2 \text{ inches.}$$

In noting that these expressions vary in form from the fundamental formula, the author explains that "the two extreme lines of the diagram have been determined upon the proportions of only two makers." The diagram shows a wide variety of practice.

For projected area of crank pin, d l = 0.22 A.

Face of Piston.—The ratio of diameter to face of piston shows a wide variation.

$$f \text{ (width of face)} = 0.437 D \text{ mean.}$$
$$= 0.300 D \text{ minimum.}$$
$$= 0.650 D \text{ maximum.}$$

Crosshead Pin.—The projected area of crosshead pin:

$$d l = 0.105 A \text{ mean.}$$
$$= 0.066 A \text{ minimum.}$$
$$= 0.346 A \text{ maximum.}$$

The mean length of crosshead pin is l = 1.33 d.

Fly Wheel.—The weight of the rim is found from the formula $W = \frac{HP}{D_1^2 N^2}$ (in which D_1 equals diameter of wheel in inches).

The investigation gave

$$W \text{ (weight of rim)} = 833{,}000{,}000 \frac{HP}{D^2N^2} \text{ for the mean}$$
$$= 341{,}000{,}000 \frac{HP}{D^2N^2} \text{ for the minimum}$$
$$= 2{,}780{,}000{,}000 \frac{HP}{D^2N^2} \text{ for the maximum}$$

The average linear velocity of the rim of wheels was found to be 4,200 feet per minute.

Weight of Reciprocating Parts.—For smoothness of running, the weight (W) should be proportional $\frac{D^2}{LN^2}$

The result obtained was $W = 1{,}850{,}000 \frac{D^2}{LN^2}$

Weight of Entire Engine per Horse Power.—The average weight of high speed engines per horse power (W) is given by formula W = 117 (HP) — 820 pounds.

The value of, and the necessity for, such an investigation as this is proved by the wide divergence shown by the various engines from the mean dimensions as ascertained. That two makers of high speed engines of the same H.P. should use two fly wheels with a difference in the weight of rim of 1 to 8 (see above) is one of those anomalies that are continually to be met with when designing is carried out on the "rule of thumb" basis.

ANTWERP is becoming a rival of London for the ivory trade of the world. A report from the British consul general at Antwerp shows the large extent to which ivory is brought to Belgium from the Congo. The ivory industry has of late sprung into new life at Antwerp.

World's Shipping in 1895.

The annual summary of shipbuilding prepared by Lloyd's Register of British and Foreign Shipbuilding has just been issued. It shows, says the New York Sun, that the total output of the world in 1895, not including warships, was about 1,218,000 tons, 104,000 of that being about the total sail tonnage for the year. As far as has been officially recorded, the amount of sea going tonnage totally lost in the twelve months was 700,000 tons, 290,000 steam and 410,000 sail.

From these figures it can be seen that the world's sailing tonnage has been reduced 306,000 tons during the year, and the steam tonnage has increased about 824,000 tons.

Of the new tonnage launched, England has acquired 62·5 per cent. There were launched in England last year 579 vessels, a total of 950,967 tons. Of that number 526 were steam and 53 sailing vessels. In the same period fifty-nine warships were launched in England, including the output from both government and private yards. The total output for the year from British shipyards is about 95,000 tons less than for 1894, but the proportion of steam tonnage to sail has materially increased.

In 1892 sailing tonnage formed about 24 per cent of the output; in 1895 it formed about 5 per cent. These comparisons show the remarkable decline in the sailing tonnage of the world.

The summary also says that 98 per cent of the steam tonnage and 97 per cent of the sailing tonnage was built of steel. The largest steamers launched in the year were the Georgic, 10,077 tons; Victorian, 8.767 tons; and Armenian, 8,765 tons. The largest sailing vessel was the Iranian, 2,958 gross tonnage.

The table which follows shows the number of vessels, merchant and warships, and their tonnage, built in the United States and other countries outside of England. It includes every vessel above 100 tons, and is considered the most complete record ever compiled. It is as follows:

Countries.	Warships. No.	Warships. Tons dis.	Total merchant and warships built in each country. No.	Total merchant and warships built in each country. Tons.
United States	3	12,034	64	96,911
Austria-Hungary	2	11,100	12	18,471
Belgium	—	—	1	1,270
British colonies	—	—	30	10,381
Denmark	—	—	14	10,982
France	7	42,071	34	70,922
Germany	3	6,340	78	94,126
Holland	2	1,155	27	9,447
Italy	2	13,340	12	18,943
Japan	1	2,800	4	5,096
Norway	—	—	21	12,873
Russia	2	2,774	12	5,669
Spain	1	9,000	2	9,910
Sweden	—	—	13	2,767
Total	23	100,614	324	367,807

While the total output from American shipyards for the year is placed at 96,411 tons, the output from yards in the United Kingdom was about 950,000 tons. About 20 per cent of the vessels launched in England were for foreign countries, and of the vessels built 60 per cent were launched in the Greenock district. It is estimated that England sold 386,000 tons to foreign owners, and of this amount more than one-fourth went under the Japanese flag, which shows how the Japs are building up their naval and merchant marine.

The records shows that the largest vessels launched outside of England were the German bark Potosi, 4,027 tons, and the French bark Wulfrau Puget, 3,062 tons. These vessels were built under the supervision of Lloyd's Register.

Torpedo Boat Ericsson.

Secretary Herbert recently decided that he would direct the preliminary acceptance of the torpedo boat Ericsson, subject to another dock trial, the sum of $16,000 to be deducted, however, from the contract price, for failure to complete the vessel within the required time. The Ericsson is now at New London, Connecticut, and the trial will take place there. It is not unlikely that, owing to the unfortunate accidents which caused the delay in completion, Congress will authorize the remission of the $16,000.

The Ericsson has had a number of trying experiences. Accidents to her machinery caused great delay, and on her last attempt at an official trial several men were killed by an explosion and the trial was abandoned. The department is now satisfied that the machinery of the little vessel is in perfect order, and that she can make twenty-five knots an hour, which is a half knot more than required by the contract. The Ericsson was built by the Iowa Iron Works, Dubuque, Iowa.

Kilauea Volcano in Eruption.

After thirteen months of quiescence an eruption of this volcano commenced on January 3, the liquid lava rising the next day to the top of the wide shaft at the bottom of the pit and forming a burning lake 200 feet long by 150 feet wide. The upper rim of the pit is more than 450 feet higher, and the surface of the burning lake, should it reach the top, will then be much greater.

Various Mile Records.

A mile is not a thing requiring such an extraordinary time to cover, provided the coverer of it is properly equipped with a sufficiency of speed-producing powers. Below is given a partial list of some exceedingly speedy milers and their performances, and some slow but sure travelers as well:

Light—0·000005102 of a second, or 196,000 miles in one second.

Electricity—0·00000347 of a second, or 288,000 miles per second.

Earthquake—½s., as calculated by delicate instruments, or around the world in 3½ hours.

Sound in Water—1s., or 4,900 feet in one second.

Cannon Ball—1 6-10s., if it traveled at the muzzle velocity of 3,300 feet per second obtained by some guns.

Sound in Air—5s., or 1,090 feet in one second.

Birds—18s. It is said the frigate bird flies 200 miles an hour; a mile in 24s. by the kestril, or sparrow-hawk, which is said to fly 150 miles an hour; in 1m. 9s. by a pigeon, when flying 200 miles in an actual race; in 1m. 15½s. by a pigeon when flying 400 miles in an actual race.

Railway Train—32s., in May, 1893, the Empire State Express, of the New York Central and Hudson River Road, drawn by engine "999," with Engineer Hogan, near Crittenden, N. Y., or a rate of 112½ miles in an hour.

Duck—40s. or 90 miles an hour.

Electric Railway—59s., on the Baltimore and Ohio Railway, at the Baltimore Tunnel in September, 1895.

Ice Boat—1m., at Newburg Bay, Hudson River.

Tandem Bicycle on Straightaway Road—1m. 17 1-5s., on December 16, 1895, on a straightaway road built for the purpose at Cheyenne, Wyo., with a wind blowing 30 miles an hour, by two riders, John Green and Charles S. Erswell.

Bicycle Straightaway—1m. 25s., John Green, Cheyenne.

Horse Running—1m. 35½s., by Salvator, at Monmouth Park, August 28, 1890.

Bicycle on Track—1m. 40 3-5s., by P. J. Berlo, New Orleans.

Dog.—1m. 43 1-5s., if the greyhound coursed one mile, the usual distance of 200 yards having been run in 11¼s.

Boat—1m. 45s., torpedo boat Sokol, made by Messrs. Yarrow, of England, for Russia, and which developed in October, 1895, a speed of 34 miles an hour. Steamship Lucania in 2m. 13 4-5s.

Bicycle Quadruplet—1m. 47 4-5s., on October 17, 1895, at Denver, Col., unpaced, flying start, Connibear, Dickson, Stone, and Swanbrough.

Bicycle Tandem on Track—1m. 52¾s., on October 27, 1894, at Waltham, Mass., flying start, paced, Haggerty and Williams; on August 17, 1894, at Denver, Col., flying start, unpaced, Titus and Cabanne, in 1m. 55¾s.

Horse Pacing—2m. 1½s., by Robert J., at Terre Haute, Ind., on September 14, 1894, against time.

Bicycle Triplet—2m. 1 4 5s., unpaced, standing start, Kennedy, Murphy and Saunders.

Horse Trotting—2m. 3¾s., by Alix, at Galesburg, Ill., September 13, 1894.

Horse Team Trotting—2m. 12¼s., by Belle Hamlin and Honest George, driven by E. F. Geers, at Providence, R. I., September 23, 1892.

Man Skating—2m. 12 3-5s., by J. F. Donoghue.

Horse Under Saddle—2m. 13s., by Johnson, pacing at Cleveland, O., August 3, 1883, against time; in 2m. 15¾s., by Great Eastern, trotting at Fleetwood Park, September 22, 1877.

Crow—2m. 40s., or 25 miles an hour.

Horseless Carriage—4m., a carriage running 750 miles, from Paris to Bordeaux, in the international race of 1895, or 15 miles an hour throughout.

Man Running—4m. 12¾s., professional, W. G. George; in 4m. 17 4-5s., amateur, T. P. Conneff.

Man Rowing—5m. 1s., by Ellis Ward, on the Savannah River, Florida, April 1, 1872.

Man Walking—6m. 23s., professional, W. Perkins, of England; in 6m. 29 3-5s., amateur, F. P. Murray, of the United States.

Canoe—6m. 40s., July, 1894, by C. E. Archibald, at the fifteenth annual meet of the A. C. A., held at Croton Point, L. I.

Man Swimming—27m. 21 2-5s., J. H. Tyers, Englishman; in 28m. 55 2-5s., G. Whitaker, American; both amateurs; both with seven turns.

Man in Tub—1h. 10m., by Gus Frates, in Oregon, in 1895, paddling in a tub 6 miles in 7 hours.

As will be seen by a study of the above list, in the case where figures are given of speed production wherein man is a factor, the bicycle is beaten only by the railway train, the electric railway, and the ice boat, and its nearest competitor is the running horse, and he is 18 seconds slower. Relatively, it seems as though it were impossible for the bicycle to attain a higher position in the speed world, 17½ seconds separating it from its nearest leader, the ice boat, a lead which looks almost impossible to overcome, if the idea is accepted that anything in the speed line is a cycling impossibility.—The Wheel.

Photography and Chronographic Measurements.

The British Journal of Photography says:

"A note on this subject, from a lecture by Mr. Frederick J. Smith, appears in a recent number of Nature. In order to avoid the error of 'time-lag,' introduced by the use of magnetic and solenoidal arrangements, he has devised a method based entirely on the use of light. Two sources of light at a suitable distance apart throw two beams of light on to a sensitive plate, carried in the carriage of a tram chronograph. By means of lenses the beams of light are caused to form two sharp images on the plate in a vertical line, one above the other, a tuning fork trace is also made on the plate; if the plate traverses when the beams of light are not interrupted, on development two black parallel lines appear on the plate; but if during the passage of the plate the beams of light are cut by any solid object which shuts off the light, then, on development, two gaps are seen to exist. The distance between these markings, when interpreted in terms of the fork trace, gives the velocity of the object which cuts through the beam of light.

"In another method, the projectile cut during its flight through two thin screens, placed in the paths of the beams, and so opened a passage for the light. Two parallel lines are then formed on the plate, one longer than the other; the difference in their lengths duly interpreted gives the velocity of the projectile. This new mode of registering velocities would seem to be very valuable, as the most exact determination of the rapidity of the flight of projectiles at various stages is of great importance in artillery investigations."

Diminution of Risks with Electric Lighting.

The following suggestions are offered by the American National Board of Fire Underwriters to people who are about to employ electric lighting:

1. Have your wiring done by responsible parties, and make contract subject to underwriters' rules. Cheap work and dangerous work usually go hand in hand.

2. Switch bases and cut-out blocks should be non-combustible (procelain or glass).

3. Incandescent lamps get hot; therefore all inflammable material should be kept away from them. Many fires have been caused by inflammable goods being placed in contact with incandescent lamp globes and sockets.

4. The use of flexible cord should be restricted to straight pendent drops and should not be used in show windows.

5. Wires should be supported on glass or porcelain, and never on wooded cleats; or else run in approved conduits.

6. Wires should not approach each other nearer than 8 inches in arc and 2½ inches in incandescent lighting.

7. Wires should not come into contact with metal pipes.

8. Metal staples to fasten wires should not be used.

9. Wires should not come into contact with other substances than their designed insulating supports.

10. All joints and splices should be thoroughly soldered and carefully wrapped with tape.

11. Wires should always be protected with tubes of glass or porcelain where passing through walls, partitions, timbers, etc. Soft rubber tube is especially dangerous.

12. All combination fixtures, such as gas fixtures and electric lamps attached, should have approved insulating joints. The use of soft rubber or any material in such joints that will shrink or crack by variation of temperature is dangerous.

13. Electric gas lighting and electric lights on the same fixture always increase the hazard of fire and should accordingly be avoided.

14. An electric arc light gives off sparks and embers. All arc lamps in vicinity of inflammable material should have wire nets surrounding the globe, and such spark arresters reaching from globe to body of lamp as will prevent the escape of sparks, melted copper and particles of carbon.

15. Arc light wires should never be concealed.

16. Current from street railway wires should never be used for lighting or power in any building, as it is extremely dangerous.

17. When possible, the current should be shut off by a switch where the wires enter the building when the lights or power are not in use.

18. Remember that "resistance boxes," "regulators," "controllers," "rheostats," "reducers" and all such things are sources of heat and should be treated like stoves. Any resistance introduced in an electric circuit transforms electric energy into heat. Electric heaters are constructed on this principle. Do not use wooden cases for these stoves, nor mount them on woodwork.

Locomotive Building, 1895.

All of the thirteen locomotive building companies in the United States, except one, says the Railroad Gazette, turned out more locomotives in the past than in the previous year, the total number having been 1,109, as against 695 in 1894. The freight cars built in 1895 were 31,803, as compared with 17,029 in 1894.