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SCIENTIFIC AMERICAN SUPPLEMENT

No. 1049.

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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 semi-centennial 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.

$$d = 7{\cdot}56\sqrt[3]{HP \div N}$$

(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) $= 7{\cdot}56\sqrt[3]{100 \div 250} = 5{\cdot}57$ inches.

Piston Rod.—

$$d = C\sqrt[4]{D^2L^2}$$
$$= 0{\cdot}145\sqrt{DL}$$
$$C = 0{\cdot}145 \text{ mean value.}$$
$$= 0{\cdot}177 \text{ max.}$$
$$= 0{\cdot}119 \text{ min.}$$

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)

$$b = 0{\cdot}0545\sqrt{DL'}$$

L' 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:

$$l = 0{\cdot}333\left(\frac{HP}{L}\right) + 2{\cdot}2 \text{ inches.}$$

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.

$$f \text{ (width of face)} = 0{\cdot}437\,D \text{ mean.}$$
$$= 0{\cdot}300\,D \text{ minimum.}$$
$$= 0{\cdot}650\,D \text{ maximum.}$$

Crosshead Pin.—The projected area of crosshead pin:

$$d\,l = 0{\cdot}105\,A \text{ mean.}$$
$$= 0.066\,A \text{ minimum.}$$
$$= 0{\cdot}346\,A \text{ maximum.}$$

The mean length of crosshead pin is l = 1·33 d.

Fly Wheel.—The weight of the rim is found from the formula $W = \frac{HP}{D_1^2N^2}$ (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.