THE BURSTING OF EMERY WHEELS.*

Several years ago the writer was consulted regarding some points of a case in litigation occasioned by the bursting of an emery wheel and the resulting death of a workman. The question to be decided was whether the wheel was unsafe at the speed recommended by the makers, or whether the accident was due to the carelessness of the operator.

As it was just then an "off" year for experiments on fly-wheels there seemed to be no good reason why the same medicine could not be tried on emery wheels. The apparatus already described in former papers read before this Society, with some slight alterations, was adapted to the new requirements, and in the spring of 1902, fifteen wheels of various makes were tested to destruction.

TABLE

No. of Test.	Grade Mark.	No. of Emery.	Working Speed. Revs. per Minute.	Working Speed. Feet per Minute	Bursting Speed. Revs. per Minute	Bursting Speed. Feet per Minute.	Speed Ratio.	Factor of Safety
1	4S	20	1,200	5,030	3,100	13,000	2.58	6.67
2	4S	20	1,200	5,030	3,200	13,400	2.67	7.14
3	4S	20	1,200	5,030	3,350	14,070	2.79	7.73
4	6S	20	1,250	5,230	3,750	15,700	3.00	9.00
5	6S	20	1,250	5,230	2,750	11,500	2.20	4.84
6	8S	25	1,400	5,870	4,550	19,050	3.25	10.56
7	8S	25	1,400	5,870	4,600	19,200	3.28	10.76
8	10S	30	1,250	5,240	4,100	17,100	3.28	10.80
9	10S	30	1,250	5,240	4,150	17,250	3.30	10.82
10	25S	50	1,150	4,810	2,750	11,500	2.39	5.71
11	25S	50	1,150	4,810	2,900	12,100	2.52	6.35
12	M.H.	14	1,200	5,030	3,100	12,970	2.58	6.66
13	M.H.	24	1,200	5,030	3,200	13,400	2.67	7.14
14	H	16-12	1,200	5,030	4,100	17,200	3.42	11.70
15	H	1-12	1,200	5,030	4,150	15,760	3.62	13.10

Tests 6 and 7; wheels made with wire netting, tests 14 and 15, with vulcanized rubber

For the actual details of the work credit is due to Messrs. Chandler and Krueger of the class of 1902, Case School of Applied Science. Most manufacturers of this class of wheels test them for their own information, but the results are not generally given to the public; the writer knows of no published data on this subject. At the Norton Emery Wheel Works, all wheels are tested before leaving the shop at a speed double that allowed in regular service, and occasionally wheels are burst to determine the actual factor of safety.

Emery-wheel accidents are not uncommon, but can usually be traced to the carelessness of the operator. One common cause of failure is allowing a small piece of work to slip or roll between the wheel and the rest. The writer was once present on an occasion of this kind, and although he fortunately was not in the plane of rotation, he has never forgotten his sensations.

The wheels selected for the experiments were all of the same size, being sixteen inches in diameter by one inch thick, and having a hole one and one-quarter inches in diameter.

*Papar read before Saratoga Convention of A. S. M. E., by Prof. C. H. Benjamin.

The object of the experiment being to determine the bursting speed of such wheels as are actually on the market, emery wheels were obtained through various outside parties without indicating to the agents or manufacturers the use to be made of them.

In this way wheels of six different makes were obtained, the label on each wheel showing usually the maker's name, the grade number or letter, the quality of emery, and the speed recommended for use. As shown in the table of results, the working speed varied in the different wheels from 1,150 to 1,400 revolutions per minute, the average being about 1,200 revolutions per minute. For a diameter of sixteen inches this corresponds to a peripheral velocity of about 5,000 feet per minute. The table also shows that the fineness of the emery varied from ten to sixty, the average being about thirty.

The wheels were held between two collars, each six and one-eighth inches in diameter and concaved, so as to bear only on a ring three-fourths of an inch wide at the outer circumference.

The method of testing, and the apparatus used, were precisely similar to those described in the paper on "The Bursting of Small Cast-iron Flywheels," by the author at a previous meeting, to which reference is made for illustrations of the apparatus.

The table shows the results of the experiments in detail, and needs but little explanation. The illustrations, Figs. 1 to 6, show characteristic fractures, and the appearance of various wheels after bursting.

Wheels numbered 1, 2, and 3 were of one make, and show a remarkable uniformity in strength. (Fig. 1.)

Nos. 4, 5, 8, and 9 were all made by one firm; the two latter wheels were of finer grain than the others, and show a correspondingly greater strength. (Fig. 3.)

Nos. 6 and 7 contained a layer of brass wire netting imbedded in the emery, and were about one-third stronger than the average of the ordinary wheels. (Fig. 2.)

The wheels numbered 10 and 11 were the weakest among those tested, but have an apparent factor of safety of between five and six. (Fig. 4.)

Nos. 12 and 13, of still another make, burst at about the average speed. (Fig. 5.) Wheels Nos. 14 and 15 were so-called vulcanized wheels, containing rubber in the bond, and intended for particularly severe service. These showed, as was expected, rather more than the average strength. (Fig. 6.)

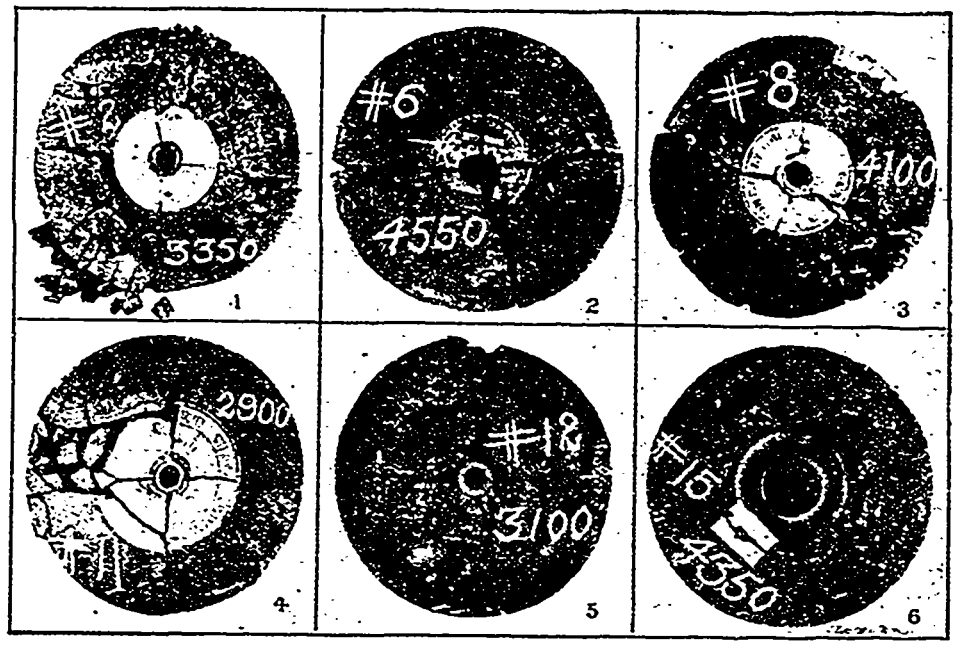
An examination of the last two columns in the table shows that the wheels burst at speeds varying from two and one-quarter to three and three-quarters the working speed, and accordingly had factors of safety varying from five to thirteen.

It is then apparent that any of these wheels were safe at the speed recommended, and would not have burst under ordinary conditions. At the same time, considering the violent nature of the service and the shocks to which they are exposed, it would seem that the factor of safety for emery wheels should be large. In comparison with those generally used in machines, a factor of eight or ten would seem small enough.

It may also be said that such a variation in strength between wheels of the same make and grade, as for instance that between Nos. 4 and 5, indicates a lack of uniformity which causes distrust.

The fractures were in the main radial, as may be seen from the cuts, the wheel splitting in three, four or five sectors as might chance.

It may be assumed that these radial cracks started from the rim where the velocity and stress were greatest, but it is a fact worthy of notice that in nearly every instance the cracks radiated from points where the lead bushing projected into the body of the wheel.



RESULTS OF EXPERIMENTS ON EMERY WHEELS.

Burglars recently made a successful raid upon the office of the Keewatin Lumber Company at Portage la Prairie, Man., breaking open the safe and securing $86 in cash.

Probably the largest stick of oak timber ever cut in the North American continent was manufactured by Messrs. Fowler & Kelsey, of Wallaceburg, Ont., the present season. It is white oak, fifty-one feet eleven inches in length and squaring forty-one by forty inches, making nearly six hundred cubic feet.