can 'Types of Factory Construction,' in the *Journal of the Association of Engineering Societies*); and lastly, *Figs. 4 to 10*, which show the Goetz-Mitchell Method.

In view of the fact that this is an improvement on former methods, and will tend, if generally introduced, to lessen our enormous annual fire waste (which for years has annually been between \$100,000,000 and \$128,000,000) your committee recommend the award of the John Scott Legacy Medal and Premium to the inventors.

C. JOHN HEXAMER, *Chairman*,
THOMAS P. CONARD,
STACY REEVES.

Adopted, September 2, 1891.

S. LLOYD WIEGAND,

Chairman of the Committee on Science and the Arts.

A COMPARISON OF FIFTEEN AMERICAN VARIETIES OF SOLID EMERY WHEELS.

Among the matter for publication submitted to the Committee in charge of the *Journal of the Franklin Institute*, October 7th, were the advance sheets of a report made to a private manufacturing company on the comparative value of fifteen varieties of solid emery wheels, the comparison having been made by Prof. Coleman Sellers, Prof. J. E. Denton and Mr. Alfred R. Wolff, who were associated in the inquiry at the instance of one of the wheel makers.

In view of the paucity of literature on this subject and as bearing upon a lecture delivered December 9, 1889, by Mr. T. Dunkin Paret, before the Franklin Institute, the committee decided to publish the greater part of this report in the words of its authors.

After stating how the authors became associated in this inquiry the report continues as here follows:

Our first object was to settle the question as to what constitutes a good solid emery wheel.

Our second object was to establish test conditions of such scientific accuracy as to prevent any doubt of the results.

Our third object was to give thorough trial, under uniform test conditions, to the various wheels, and to secure a mass of exact data.

The investigation thus outlined has been of the most painstaking and thorough character, and has lasted about two years.

Having determined on the qualities which constitute a good solid emery wheel, we established our own conditions of test, and submitted to such conditions wheels of our own selection.

The wheels of fifteen different manufacturers were selected. These were:

Celluloid,	Lehigh,	Tanite,
Crystal,	Norton,	Union stone,
Detroit,	Northampton,	Vitrified,
Grant,	Norwich,	Vulcanite,
Hampden,	Sterling,	Waltham.

Among these fifteen varieties only one compared favorably with the Tanite wheel, the latter having easily beaten all competitors save one. The comparative values of the Tanite and its single rival will have to be ascertained by further trials.

After careful study of the literature relating to grinding processes, we witnessed actual grinding by solid emery wheels in various factories; then, in company, twice visited the works of the Tanite Company, and observed a series of trials with Tanite and other wheels, in which the metal was in some cases applied by hand pressure, and in other cases, without such pressure upon machines built expressly for testing purposes. It was unanimously agreed that hand-testing must be done away with and the personal factor eliminated, in order that the results might be unimpeachable. The defect of existing test machines was speedily recognized, and it became necessary to invent a new testing machine. After much study and many trials, with the valuable assistance of Prof. J. Burkitt Webb, we constructed a machine which met the approval of all concerned.

This machine was so constructed that the wheel and work were brought in contact by definite and measurable

pressure without any obstacle being interposed to the free wear of either metal or wheel. The results approximated closely to those obtained by hand-pressure, and yet were independent of all influence from the operators of the machine. The power consumed was measured by a dynamometer attached to the driving shaft and the speed recorded by a tachometer. The resistance between wheel and metal was indicated continually by a standard scale.

After many preliminary trials with this machine its results were compared with those obtained by individual operators under various conditions, and experiments with skilled workmen, expert grinders, were made.

It was agreed, that to constitute a good solid emery wheel, the following qualities should be combined; safety under the widest conditions of use and misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel loss and power consumption; evenness of wear; general staying quality; and reliability under the widest range of circumstances.

We then agreed upon a programme of work—had the test machine erected in the machine shop of the Stevens Institute of Technology at Hoboken—and had the various wheels (bought directly by themselves in the the open market) delivered there. The grinding was done on cast-iron bars supplied directly to us by one founder, special care being taken as to quality of metal and size of bar. The trials reported on were made at the Stevens Institute during 1889 and 1890, the tabulations being too voluminous to admit of detail here.

In preliminary and collateral investigation many trials were made with hand pressure, and some under measured pressures of ten pounds and seventy-five pounds; but our report is based on a long series of trials at three different pressures—forty-two pounds, sixty pounds and 100 pounds. These separate trials numbered several thousand, during each of which exact data were recorded as to speed, power, resistance between wheel and metal, amount of metal ground off, amount of wheel material consumed, and observations made as to the cleanness of cut, amount of heat

generated, amount of glazing or clogging up of wheel with metal, and as to cracks, breaks and defects of wheels.

Of the fifteen varieties six were found too unsafe to warrant their general use, fifty-seven per cent. of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which are included the six unsafe varieties) were found to be such slow cutters that the average metal removal of ten of them was less than the general average of all the wheels. Of the fifteen varieties only four were found to be rapid cutters. Of these one wore so rapidly that the cost of its rapid cut was unreasonable. This left three, safe, effective and satisfactory wheels, one of which, however, was demonstrated to work at a greater cost than the Tanite. The rivalry was thus narrowed to two wheels, and, in the judgment of our board, further trials are necessary before the relative value of these two can be determined.

One striking feature characterized these two. That is, that in every series of trials these wheels increased in productive capacity, the average of the last cuts of all the series being greater than the average of all the first cuts. The thirteen other varieties all decreased in productive capacity, the average of the last cuts being less than the average of the first. Some of these which made a brilliant show at the start, cut scarcely anything at the close.

Our investigation satisfied us that the ordinary user of solid emery wheels is likely to be deceived as to the productive capacity of such wheels and the cost of product if he trusts to mere appearances, and that the real value of any solid wheel can only be fixed by an investigation which gives exact data and covers a wide range of observation.

Such an investigation ours has been, each fact being observed and attested by several independent witnesses trained to scientific observation, and each calculation and measurement being passed through and checked by several hands.

This investigation demonstrates the unquestionable superiority of the Tanite wheel to thirteen out of fourteen competitors.

As nearly all the preliminary and collateral trials were made with Tanite wheels more than three times as many of these were used as of any other make. In all this use, under every degree of measured automatic pressure and under the heavy pressure of long bars used by hand (a test applied to no other wheel) and also at a speed nearly double that of any other wheel save one, *no Tanite wheel burst or broke*. The safety of the Tanite wheel can be considered unquestionable. The cutting power of the Tanite wheel did not deteriorate with use, its average last cuts always exceeding its average first cuts. The Tanite wheel cut well at moderate pressure.

The consumption of power and of wheel material is such that, taking into account the cost of labor and all other items entering the problem, the Tanite wheel does its work at a very low cost.

In the use of all tools and machines, consideration should be given to their regularity and uniformity of action and to their freedom from such stoppages as arise from a variety of undefined and unforeseen causes. From a great variety of causes many of the competing wheels failed to complete their series of trials, and gave rise to frequent incidental stoppages. Such was not the case with the Tanite.

As evidence of these facts, thus summarized and stated in a general manner, we possess an overwhelming mass of exact data in the form of numerical tabulations. These details are reserved for future publication.

COLEMAN SELLERS,
J. E. DENTON,
ALFRED A. WOLFF.