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BUREAU OF STANDARDS
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TWELVE EXAMPLES OF WORK ACCOMPLISHED BY THE BUREAU OF STANDARDS

1. Internal Combustion Engine Fuels

When the Inter-Allied Petroleum Conference met in Washington during the war, the adoption of the special aviation gasoline, used and advocated by French engineers, seemed imminent. The adoption of these specifications would have meant the curtailment of gasoline for use in American privately-operated motor vehicles and would have greatly depleted American petroleum resources.

At the outbreak of the war, the Bureau began the construction of a large altitude test chamber, the first one in the world, in which airplane engines could be tested at reduced air pressures corresponding to an altitude of 30 000 feet or over and at reduced temperatures simulating upper air conditions. This altitude chamber was rushed to completion and was in operation in September, 1917. With the data thus obtained on many kinds of fuels, the American representatives went into the Inter-Allied Petroleum Conference and showed definitely that American aviation gasoline was superior to that being demanded by the French. The engineers representing the Allies were convinced of the soundness of our contention. It is no exaggeration to say that this work, besides its great military value, saved tens of millions of dollars to the American petroleum industry and made it unnecessary to impose serious restrictions on privately operated motor cars.

2. Automatic Methods of Recording Gas Analysis

The work done at the Bureau on the development of new automatic methods of recording gas analysis has been of great value, not only in connection with government plants but also in the industries. The methods developed in the Bureau's laboratories for control analysis in the government synthetic ammonia plant at Sheffield, Alabama, have since been very successfully used by the Atmospheric Nitrogen Company in the plant at Syracuse after other methods had failed.

An apparatus installed by the Bureau for recording the sulphur dioxide content of "burner gas" in the sulphuric acid plant of the Naval Proving Ground at Indian Head, Md., has proved especially successful and

is now being copied by the New Jersey Zinc Co., the General Chemical Co., and the DuPont Co. Dr. Lathrop of the DuPont Company expressed the opinion that sulphur dioxide recorders installed in his company's plants will save many thousands of dollars annually in reduced labor costs and more efficient operation. The development of oxygen and hydrogen purity recorders for government electrolytic gas plants has met with great interest on the part of industrial gas manufacturers. Instruments of this type are regarded as invaluable for reducing or eliminating manufacturing hazards.

3. Investigation of Metal Failures

The Bureau has had brought to it, for determination of the cause of failure in service, many metal samples representing widely different types of metals for every class of work. These samples have included iron, steel, and nonferrous metals. The study of these failures often leads to improvements in manufacturing methods, design, and specifications.

As an example mention may be made of the attempt of the New York Water Board to find a suitable engineering material as strong as steel and noncorrodible. During the construction of the New York aqueduct system, many failures of brass bolts, rods, plates, and large castings occurred which could not be satisfactorily explained. The Bureau was called upon to study the problem and soon found that the main contributing factor was the presence of initial stresses in the severely worked material. The presence of these stresses could not be detected by the inspection methods then in vogue nor did the specifications provide for their elimination. A complete study of the problem was made, and methods were devised for measuring the initial stresses and for inspection tests to guard against them. Since that time nearly all specifications for high strength wrought brass have been revised to include methods of determining these stresses as developed by the Bureau with a gratifying reduction in the number of failures.

4. Development of Precision Gage Blocks

Prior to 1918 the United States was entirely dependent upon Sweden for its supply of precision gage blocks. These blocks (precise length standards) are absolutely essential to every machine shop or manufacturing plant in which interchangeable manufacture or "quantity production" is carried on, as, for example, in the production of automobiles, typewriters, sewing machines, electrical equipment, agricultural machinery, etc. During the war the supply of these imported blocks was insufficient to meet the demands, the price became excessive, and sufficient blocks could not be obtained at any price.

An inventor, Mr. William E. Hoke, brought to the Bureau a process by which he believed blocks of the required accuracy could be produced. The proposed method was tried out in a preliminary way so successfully that the Ordnance Department of the Army made an allotment of funds sufficient to cover the development of the process and equipment, and within a few months blocks were being turned out at the Bureau in good numbers which were equal in every respect to the Swedish product. Fifty sets were made for the Ordnance Department of the Army, and later nineteen sets for the Navy Department.

The method developed at the Bureau is now being used commercially and American-made precision gage blocks of high quality can be purchased, and at a price considerably lower than that charged for the Swedish blocks even before the price advance during the war.

5. Standardization of Screw Threads

In cooperation with the National Screw Thread Commission, the Bureau has prepared a report on screw threads (Miscellaneous Publication No. 42, Bureau of Standards), which marks a notable advance in screw thread standardization. The standards set up are being widely adopted in the industries, and the economy effected by the elimination of odd and unnecessary sizes is sufficient to amply justify the time and money expended.

6. Correction of the 100-degree Point of the Saccharimeter Scale

The saccharimeter is used for measuring the quantity of sugar present in a solution. It is the universal instrument used for grading sugars. After a careful investigation by the Bureau's experts, it was decided that the scale of this instrument was not quite correct. Although the correction found was small, this change in the scale has resulted during the past five years in an increase of about $350,000 in customs receipts.

7. Enameled Metals and Optical Glass

The Bureau has been able to show manufacturers of enameled metal ware how to reduce materially the amount of inferior material produced. This is accomplished by a slightly different and more careful method of preparing the sheet metal for enameling. Likewise, glazes have been

adopted very largely and which give less loss. The Bureau's high heat resistance porcelain has largely supplanted foreign material and is now being manufactured by all producers of this ware in this country.

The Bureau's work on optical glass has been of such a nature that it has been of the greatest possible assistance to all the manufacturers of this material in the United States. The output of its experimental glass plant has been consumed entirely by the Navy Department, and, although produced merely in the course of experimental work, the Navy, in requesting a certain amount for the present fiscal year, stated that the glass was of most excellent quality and was improving with each melt.

8. Fire Resistance of Building Columns

The regulations of various cities differ with respect to the fire resisting covering required on structural steel building columns. If the requirements of some cities are safe, the more rigid requirements of others are unnecessarily expensive and wasteful. Practically no sound engineering data have been available. The elaborate series of fire tests of "life size" building columns, carried out by the Bureau in collaboration with other agencies, is one of the most comprehensive and important engineering investigations ever conducted by any laboratory in the world and is destined to have a far-reaching effect on all future fire resistive building construction. This research for the first time makes available to the structural engineer definite information as to the time that structural steel columns, fireproofed in various ways, will maintain the integrity of a building under definite fire conditions. It is obvious that data of this kind have a direct application to hundreds of millions of dollars worth of building construction.

When this investigation was completed, one of the cooperating agencies (The Associated Factory Mutual Fire Insurance Companies) called on Mr. John R. Freeman, one of the leading American consulting engineers, for his opinion as to the value of the work. After a careful study of the report, Mr. Freeman wrote the Bureau stating that in his opinion "The results of this investigation were worth to the American public at least one hundred times and possibly a thousand times what it had cost".

The fire tests on concrete columns, carried out at the Bureau's Pittsburgh laboratories, have produced results of equally far-reaching practical importance, and the same may be said of the work under way on building walls and partitions. Some of the modifications in specifications now under consideration by the National Building Code Committee appointed by Secretary Hoover, which will have a decided tendency to cheapen building construction, are based to a very large extent on test data obtained in the Bureau's laboratories.

9. Inspection and Testing of Electric Lamps

As a result of tests and investigations made in its own laboratories and the collection of information and experience through contact with manufacturers, the Bureau has built up the specifications under which all the electric lamps used by the government are purchased, and it maintains an inspection and testing service which insures that the government shall receive lamps actually fulfilling the specifications.

In buying lamps, quality is far more important than price. Ordinarily, a lamp during its life uses an amount of energy costing from five to ten times as much as the lamp itself, so that a small increase in the energy used for a given candlepower will more than counterbalance a considerable percentage of saving in the cost of the lamp. The quality of electric lamps can be accurately told only by tests.

A few years ago the Bureau had occasion to test for a state government lamps supplied to it at a slightly lower price than that paid by the Federal government, and found that in average life at the specified efficiency these lamps were 40 per cent below those obtained by the Federal government. Repeated comparisons have shown that as a result of its inspection service, the government receives the very best product of the factories, while at the same time manufacturers are stimulated to special efforts in improving their general output to fulfill the government requirements. In other words, by making use of the Bureau's specifications and testing service, instead of buying from the lowest bidder, the government has a beneficial influence on the trade at large and also makes a very important saving in the cost of lighting.

The magnitude of this economy may be judged from the fact that the lamps purchased in the past year totaled over 3 000 000, costing over $950,000. Even if the average quality obtained were only one or two per cent better because of the inspection service, the money invested would be repaid, and there is good reason to believe that the gain is several times this amount.

A secondary advantage is that manufacturers who are trying to improve their product are anxious to have this inspection made as a check on their factory output, and, therefore, desire to compete for the government business when they otherwise would not do so.

10. The Design and Efficiency of Gas Burners

In Technologic Paper No. 193, entitled "Design of Atmospheric Gas Burners," the Bureau of Standards presents the results of the first comprehensive investigation that has ever been made on this subject. The gas pressure, the composition of the gas, and its specific gravity will be different in different cities, and this may vary considerably within each city, depending upon manufacturing and distribution conditions. It is important, therefore, to know how to design and adjust appliances to suit the different conditions and varying needs. The results in this paper will enable the manufacturer and gas appliance expert to design and adjust appliances to give the very best results under each particular condition.

The necessity of conserving natural gas is evident from recent statistics which show that of the 2180 towns in the United States which have natural gas, over 1900 have populations too small to support manufactured gas plants. This will mean that over 1 000 000 consumers will have to go back to solid fuel when the supply of natural gas is exhausted. The recent studies of the Bureau have shown that there is an immense waste in the utilization of natural gas and that with comparatively simple changes in appliances the total aggregate saving would amount to perhaps a million dollars a day.

The suggested changes in natural gas appliances will indirectly bring about a great saving through the reduction in gas leakage, since it will be possible with the improved appliances to use a much lower distribution pressure which will greatly reduce the gas leakage.

The results of the investigation on natural gas burners have been reported in a paper "How Natural Gas Burners Can Be Improved," and given wide publicity among the natural gas companies and manufacturers of gas appliances. The principal conclusions are given in a small pamphlet which has been circulated through the technical press and newspapers in every natural gas using city in the United States. Thousands of copies of this pamphlet have been distributed by gas companies among their customers, the Philadelphia Company of Pittsburgh alone having had 20 000 printed for their own use.

This example in gas engineering is only one instance where the public utility work has represented definite accomplishment. The standards evolved by this Bureau have been adopted by the leading states and cities.

11. The Radio Direction Finder

Radio communication has been advanced through the work of the Bureau of Standards in many ways, a notable example being in the development of the radio direction finder. This has included a study of the fundamental principles of its operation, the improvement of the auxiliary apparatus, and the use of the direction finder in determining the behavior or radio waves during their passage between the transmitting and the receiving stations.

As a result of this work, the Bureau of Standards is called upon for advice regarding the design and use of the radio direction finder, especially in the promotion of safety of navigation both on sea and in the air. Such assistance is furnished to the commercial and private users of radio and to the various government agencies concerned.

As practical applications, there has been developed a direction finder of a type suitable for marine use, and in cooperation with the Bureau of Lighthouses an improved system of radio fog signaling has been installed in New York Harbor. Another application which was developed by the Bureau of Standards is the method of submarine radio communication now used by the Navy Department.

This work on the direction finder is closely related to the other lines of research and fundamental development work of the Radio Laboratory, such as electron tubes and radio transmission.

12. Specifications

The Bureau of Standards has done a great deal of work along the lines of specifications. The greater part of this work has been done in cooperation with:

Government departments,
Cities, Commissions, etc.,
Technical Societies,
In response to private request.

Some of the more important of these specifications are:

Primary batteries,
Secondary batteries,
Incandescent lamps,
Spark plugs for internal combustion engines,
Automobile brake linings,

Automobile tires,
Miscellaneous rubber goods,
Leather belting,
Lubricating oils,
Illuminating oils,
Various paints (14 kinds),
Paint oils (3 kinds),
Varnish (2 kinds),
Portland cement,
Concrete,
Standard sieves,
Lime,
Hollow building tile,
Building brick,
Paving brick,
Paper,
Textiles,
Sewer pipe,
Refractories,
Manila rope,
Fire hose,
Steel,
Bearing metals,
Soap,
Gasoline,
Bronze,
Brass,
Alloy steels.

The results of this work are so far-reaching, often benefiting many not directly concerned with the original research, that it is utterly impossible to estimate their value in dollars and cents.