THE JOHNSTOWN DISASTER.

In our last issue we illustrated some of the features of the Johnstown disaster from sketches made on the spot by our special artist. These showed very clearly the general aspect of the scene after the water had done its work. These views we now supplement by reproductions of photographs of characteristic scenes which emphasize the resistless force of the torrent that swept down the Conemaugh valley. It is to be hoped that a tangible theory will be formulated by the committee of the American Society of Civil Engineers appointed to investigate the occurrence. It consists of the following members: J. Max Becker, president; James B. Francis, Wm. E. Worthen, ex-presidents; and A. Fteley. The latter gentleman is at present chief engineer of the new aqueduct. The society has delegated this committee to visit the scene of the disaster and report upon it.

The lesson, after all, seems to be the old one so often taught by engineering disasters, the necessity of allowing a large factor of safety. The late Alexander Holley spoke in his epigrammatic way of the factor of ignorance; this factor in the case of the dam and lake overflow was far too small.

The concurrent force of all the investigations made by engineers, including those specially detailed by our contemporary the *Engineering News*, is as follows: The spillway of the dam for nine years proved adequate for the overflow. On the day of the disaster its capacity was overtaxed. The water rose in the dam far above the level of its bottom. The pipes at the base were closed permanently. Had they been open, it has been calculated that they would not have sufficiently relieved the extra flood to have prevented the water from rising to the top of the dam. Moreover, the spillway was obstructed by a bridge, fish screen, and other obstacles which still further interfered with the outflow. The water began to pour over the crest, probably lowest at the center. The water pouring over the crest cut away the earthwork with greater rapidity, owing to its inferior construction. At every instant gaining strength, the great crevasse was soon made, and the lake emptied itself, with the disastrous results known to all. Had the spillway been of adequate size, the dam would have remained intact, and no life would have been lost.

The dam was originally built under the supervision of Mr. Wm. E. Morris, now deceased, who was principal assistant engineer of the Pennsylvania State canals. He had direct superintendence of the western division. Gen. Jas. N. Moorhead, also deceased, was constructing engineer in charge of the work. It was built of earth well rammed and watered and laid in horizontal layers. The remains of this structural feature are present in the step-like contour of the break. It was covered with rough stone on both faces. The five pipes that passed through its base were used for running off the water when it was required to feed the upper levels of the canal. They were not put in place to be used in an emergency only, but were part of the regular feeding apparatus of the canal system. When opened, the water ran down the South Fork and Little Conemaugh to Johnstown, where it entered the canal. About 1858 the use of the dam was abandoned by the State, and four years later the first break occurred. It was in July, 1862. The culvert through which the iron pipes were carried proved defective, and a quantity of water ran out beneath the dam. Little damage to outside property was done, but the dam was undermined and injured, and a depression was formed in its top. Incidentally, of course, the hard rammed layers were disturbed and disintegrated. After this accident the dam was left to itself with about ten feet of water in it until 1875. In May of this year it was bought by a private individual, who four years later sold it to three gentlemen, the organizers of the South Fork Hunting and Fishing Club. The dam was repaired, most of the work being executed in 1880. The five pipes at the base were permanently closed, and for nine years all went well. Eventually a heavy rainfall overtaxed the structure, and the great disaster occurred.

The dam cost, originally, $240,000. It covered an area of about 500 acres, impounding the water from fifty or sixty square miles of watershed. It was 72 feet high and 900 feet long, and formed a lake that held 480,000,000 cubic feet of water, or about 3,600,000,000 gallons. It has been spoken of as the largest artificial lake in the United States, but it was exceeded in size by the reservoirs formed by the following dams:

Croton dam, in New York—434 feet long, 284 feet being of masonry and the remainder of earth. The height is about 40 feet. The foundation of the dam consists of two lines of stone-filled cribs, with 10 feet of concrete between them. The down-stream face is curved, and faced with granite. A small crib dam 300 feet below forms a basin, which serves as a cushion to break the fall of the water. The back of the dam is filled with earth. Impounds 5,000,000,000 gallons.

Sweet Water dam, in National, Cal.—Rubble masonry in Portland cement; 98½ feet high, 46 feet thick at bottom and 12 feet at top. Of curved type, with radius of 213 feet; 360 feet long on crest. Impounds 6,000,000,000 gallons.

Dam at Oakland, Cal.—Earth, 80 feet high, 300 feet long, and 310 feet wide at base. Impounds 5,000,000,000 gallons.

Dam at Redland, Cal.—Bear Valley dam.—Granite masonry in cement; 64 feet high, 300 feet long, 20 feet thick at base, and 1⅜ feet at top. Curved type, with radius of 335 feet. Impounds 10,000,000,000 gallons.

Dam at San Mateo, Cal.—This is to be 170 feet high, 700 feet long, 176 feet thick at base and 20 feet thick on top. It is to be in Portland cement concrete masonry, and is to have a capacity of 32,000,000,000 gallons. It has only recently been begun.

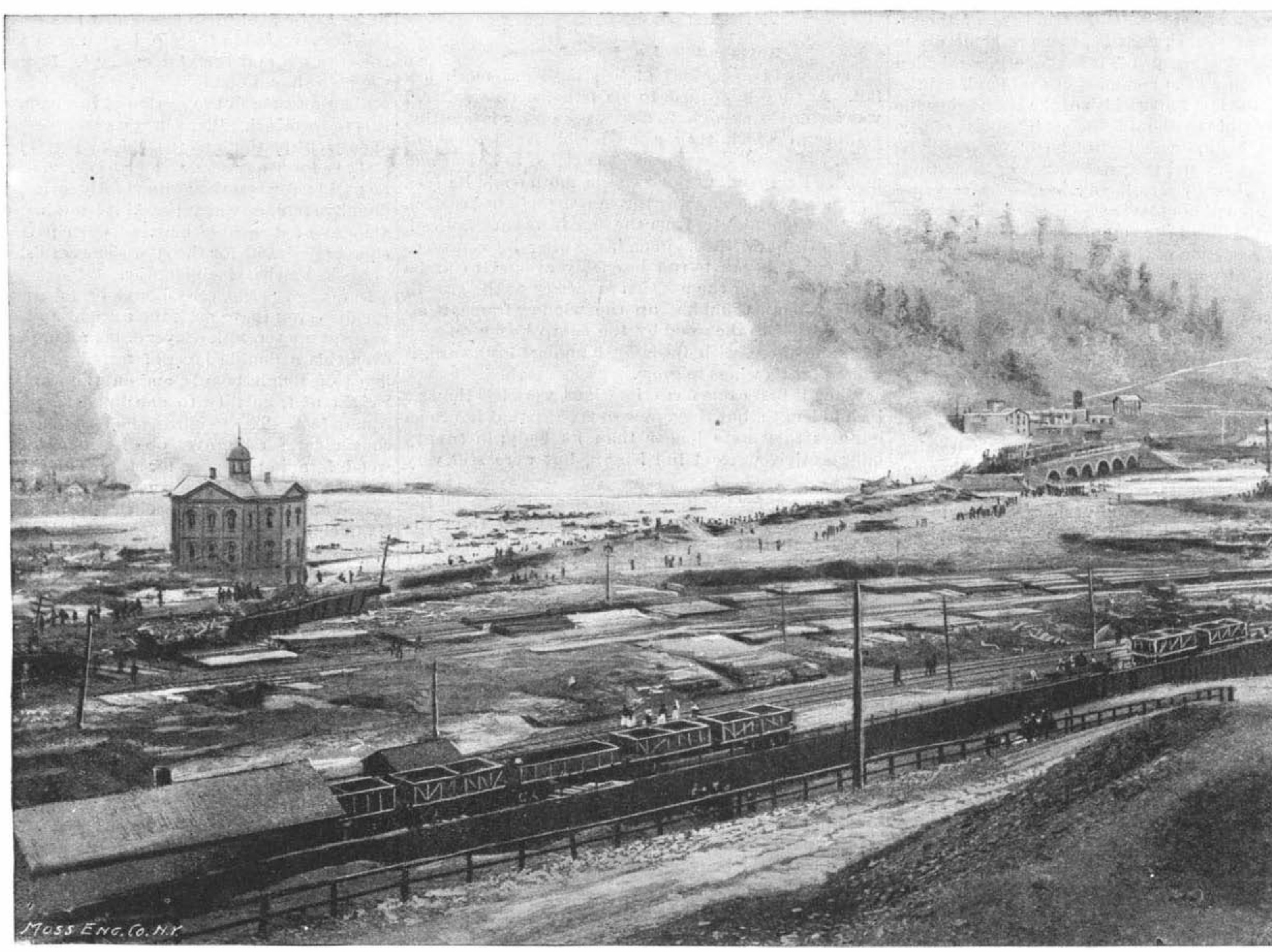
The Quaker Bridge dam will, of course, dwarf all these. It will be 265 feet high from bed rock, with a base 216 feet wide. Ninety-nine feet of its base will be beneath the lake bottom, so that the visible masonry will rise 166 feet. It will impound about 37,500,000,000 gallons of water, forming a lake sixteen miles long.

Apprehensions have been expressed as to the effects of its breaking down. Should such an accident occur, the present Croton dam, which will undoubtedly remain intact and submerged, will lessen, to some extent, the flood. The valley between the Quaker Bridge site and the Hudson River is only two miles long, and has no settlement of any importance in it.

At Johnstown the work of re-establishing the city has been actively carried on. Adjutant-General Hastings remains in charge of the work. A number of soldiers are encamped there for the preservation of order.

Work upon the gorge is still in progress. Stationary engines are in use to draw out the logs and heavier masses, large blasts of dynamite are applied to loosen the debris, and experienced loggers or raftsmen have proved of much help from their skill in handling floating timber. Corpses in an advanced state of decomposition are still found, over thirty having been discovered upon a single day last week. As fast as the remains of animals are extricated, they are burned upon the shores. A number of steam fire engines are on the ground, and have been utilized in pumping out the cellars.

The Pennsylvania railroad had about 3 miles of its roadbed washed away or buried beneath the debris. On the 13th of June, two weeks after the disaster, the line was again open and trains were running through to Pittsburg and the West. The engines carried away in the destruction of the Conemaugh round house were consolidation engines, and very heavy.



THE JOHNSTOWN DISASTER—THE SCHOOL HOUSE, THE ONLY BUILDING LEFT IN THE VICINITY. THE RAILWAY BRIDGE AND BURNING DEBRIS DRIVEN AGAINST IT.—(From a Photograph.)

None were carried less than 100 feet, some were transported 1,200 feet, and perhaps farther. Nearly twenty engines were scattered thus in all directions. Mr. McHenry, of the Cambria Iron Works, states that he saw an engine carried past that for an instant appeared to be floating on the surface of the water thirty feet above the ground. This gives an idea of the power of the water moving down the valley at such high velocity. For the excellent photographs herewith reproduced of the scene of the late disaster, we are indebted to the Dabbs photographic establishment, of Pittsburg, Pa.

The Polariscope as a Thermometer.

The polariscope has recently been applied in France to determining the temperature of incandescent iron and other metals. The color of a glowing mass of metal varies according to its temperature, and a ray of the light when polarized is rotated by a plate of quartz to a degree dependent upon the color. The degree of rotation is measured by the polariscope, and an empirical scale of temperature is thus obtained, which has been found very useful and reliable in metallurgical operations.

THE JOHNSTOWN DISASTER—VIEW ON ELM STREET.—[From a photograph.]

THE JOHNSTOWN DISASTER—VIEW ON MAIN STREET.—[From a photograph.]

Granite.

The essential components of the true granites are quartz and potash feldspar. Although the essential minerals are but two in number, the rocks are rendered complex by the presence of numerous accessories which essentially modify the appearances of the rocks, and those properties render them of importance as building stones. These additional minerals are either present in such amount as to be conspicuous and to exercise an influence upon the appearance and structure of the rock, when they are called characterizing accessories, or they are present in such small amount as to be invisible to the naked eye, when they are called microscopic accessories. If all the minerals which by careful examination have been found in granites should be considered as constituents of the rock, then the latter would appear as very complex. At least two-thirds of all the known elements exist in granitic rocks, and the number of minerals that are liable to be present in special cases is very large.

The following list does not include all of those minerals which have been identified in this rock, for many have been found under circumstances which are so isolated that their occurrence is entirely exceptional. All of the minerals in this list are liable to be found at any time, and may therefore be considered as common constituents of the rock, although the presence of them all together is not to be expected, and some of them may be present in such minute amount as to be of no practical importance. Any one of them, save the two essential constituents mentioned above, may be absent from an individual specimen or from a given locality; and any one may be present in the specimens from a given locality in such amount as to give a character to the rock. Thus almost any one of those minerals which are given as microscopic accessories may assume the character of a characterizing accessory; this is especially true of the iron oxides, which sometimes are present in such amounts as to become characteristic:

Essential:
- Quartz.
- Feldspar.
  - Orthoclase.
  - Microcline.
  - Albite.
  - Oligoclase.
  - Labradorite.

Microscopic accessories:
- Sphene.
- Zircon.
- Garnet.
- Danalite.
- Rutile.
- Apatite.
- Pyrite.
- Pyrrhotite.
- Magnetite.
- Hematite.
- Titanic iron.

Characterizing accessories:
- Mica.
  - Muscovite.
  - Biotite.
  - Phlogopite.
  - Lepidolite.
- Hornblende.
- Pyroxene.
- Epidote.
- Chlorite.
- Tourmaline.
- Acmite.

Decomposition products:
- Chlorite.
- Epidote.
- Uralite.
- Kaolin.
- Iron oxides.
- Calcite.
- Muscovite.

Inclosures in cavities:
- Water.
- Carbon dioxide.
- Sodium chloride (salt).
- Potassium chloride.

—*Prof. G. P. Merrill, in Gov. Report.*

The Elizabeth Thompson Science Fund.

The Elizabeth Thompson science fund, which has been established by Mrs. Elizabeth Thompson, of Stamford, Conn., "for the advancement and prosecution of scientific research in its broadest sense," now amounts to twenty-five thousand dollars. As accumulated income is again available, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from this fund, in order to receive consideration, must be accompanied by full information, especially in regard to the following points:

1. Precise amount required. 2. Exact nature of the investigation proposed. 3. Conditions under which the research is to be prosecuted. 4. Manner in which the appropriation asked for is to be expended. All applications should be forwarded to the secretary of the board of trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U. S. A. It is intended to make new grants at the end of 1889. The trustees are disinclined, for the present, to make any grant exceeding five hundred dollars. Preference will be given to applications for smaller amounts. The following is the list of grants made: $200 to the New England Meteorological Society, for investigation of cyclonic movements in New England; $150 to Samuel Rideal, Esq., of University College, London, England, for investigations on the absorption of heat by odorous gases; $75 to H. M. Howe, Esq., of Boston, Mass., for the investigation of fusible slags of copper and lead smelting; $500 to Professor J. Rosenthal, of Erlangen, Germany, for investigations on animal heat in health and disease; $50 to Joseph Jastrow, Esq., of the Johns Hopkins University, Baltimore, Md., for investigations on the laws of psycho-physics; $200 to the Natural History Society of Montreal for the investigation of underground temperatures; $210 to Messrs. T. Elster and H. Geitel, of Wolfenbuttel, Germany, for researches on the electrization of gases by glowing bodies; $500 to Professor E. D. Cope, of Philadelphia, Pa., to assist in the preparation of his monograph on American fossil vertebrates; $125 to E. E. Prince, Esq., of St. Andrews, Scotland, for researches on the development and morphology of the limbs of teleosts; $250 to Herbert Tomlinson, Esq., of University College, England, for researches on the effects of stress and strain on the physical properties of matter; $200 to Professor Luigi Palmieri, of Naples, Italy, for the construction of an apparatus to be used in researches on atmospheric electricity; $200 to William H. Edwards, Esq., of Coalburg, W. Va., to assist the publication of his work on the butterflies of North America; $150 to the New England Meteorological Society, for the investigation of cyclonic phenomena in New England; $25 to Professor A. F. Marion, for researches on the fauna of brackish waters; $300 to Professor Carl Ludwig, for researches on muscular contraction, to be carried on under his direction by Dr. Paul Starke; $200 to Dr. Paul C. Freer, for the investigation of the chemical constitution of graphitic acid; $300 to Dr. G. Muller, for experiments on the resorption of light by the earth's atmosphere; $300 to Professor Gerhard Kruss, for the investigation of the elementary constitution of erbium and didymium; $50 to Dr. F. L. Hoorweg, for the investigation of the manner and velocity with which magnetism is propagated along an iron bar; $150 to Mr. William H. Edwards, to assist the publication of his work on North American butterflies.

The Forms of Leaves and their Uses.

Even the most cursory observer of vegetable life must have been often struck with the various forms of leaves. Why they should be so variously formed does not, however, often suggest itself, though there is a reason for the special shape and texture of almost every leaf in existence. Plants, such as grasses, daffodils, and others which usually grow in clusters, have generally narrow leaves growing upright, so as not to overshadow one another. Other plants, of isolated habits, have an arrangement of foliage which secures to themselves the space of ground necessary for their development. The daisy, dandelion, or shepherd's purse—which may mostly be seen in pastures—are examples of this. A circle of broad leaves pressed against the ground, forming what is known as a rosette growth, effectually bars the approach of any other plant and keeps clear from all other roots the space of ground necessary to its own nutriment. Floating leaves, and leaves of marsh plants, are usually of simple outline, for, having few competitors, they are not liable to get in one another's light. Submerged plants have mostly leaves of narrow segments—the reason for which is not very well understood, though it is assumed by naturalists that it is for the purpose of exposing as large a surface as possible, in order to extract the minute proportion of carbonic acid dissolved in a vast bulk of water.

Leaves on the boughs of trees are often much divided, so as to fold easily, to prevent their being rent and torn by high winds, while the glossy surface of evergreens is intended to throw off rain and dew, which might freeze on them, and so cause injury to the tissues within. But the hairs on the surface of leaves are perhaps the most interesting study of all. With the aid of a microscope, the beautiful and systematic arrangement of these can be easily discerned, and their uses understood. On many plants there are glandular hairs, to catch or deter small creeping insects; on others there are hairs set so as to act as effectively against young animals as a spike palisade against obtrusive boys; on others, hairs which arrest the drops of moisture and force them down the leaf-stalk, to moisten the earth about the roots; while others are protected by a series of poisoned stings. The ordinary nettle is an example of this, and the beauty and ingenuity of its mechanism is truly wonderful. Each nettle hair is armed with a brittle and pointed siliceous cap, which breaks off in the wound; and the poison is then able to flow out through a tubular hair, from a reservoir at its base. There is scarcely a form of leaf but is specially modified by nature for some particular purpose, and the discovery of this purpose is a source of very pleasant and profitable study to young naturalists.—*Horticultural Times.*

The Manchester Ship Canal.

Some interesting statistics were lately given by Mr. Alderman Bailey, one of the directors, with reference to the progress of this work. He stated that 15½ million tons of earth and rock had been excavated, and that 28 million tons more remained to be removed. It was anticipated that the work would be finished in two years from 1st of January next. There were on the works 183 pumping engines, 82 steam navvies, 5,000 wagons, 158 locomotives, and 116 steam cranes, and in a few months 15,000 men would be employed. He further gave some particulars as to the cost of haulage of one ton, which was stated to be 6d. per mile on the highways, 2d. on the railways, 1-66d. per mile on the Leeds and Liverpool Canal, 1-116d. per mile on the Aire and Calder Navigation, and between New York and Liverpool about 1-300d. per mile.

Natural Gas in the Manufacture of Steel.

The process of James J. McTighe, of Pittsburg, for manufacturing steel is applicable to the production of the various grades thereof, from the soft kinds used for sheets and rails to that employed in the production of tools, needles, surgical instruments, etc.

He describes the process as follows: It has commonly been held that the brittleness of iron or steely irons is due, according as the iron is hot or cold, to the presence of an excess of sulphur or phosphorus. Discarding this theory, and assuming that the "cold-shortness" or "red-shortness" of iron or steel is due principally to an admixture of oxide of iron, I have devised a new method or process of manufacturing carburized iron, according to which, even though both sulphur and phosphorus be in excess in the metal, it is exceedingly ductile when of the soft variety and having the qualities demanded in steel intended for widely different purposes.

Hitherto in the manufacture of ordinary steel of low grades—such, for instance, as is used for rails, boiler plate, etc.—it has been customary to desiliconize and decarburize molten cast iron by blowing air over or through it. It is an acknowledged fact that this air leaves an oxide of iron mixed with the mass.

My invention has for its object to rid the entire mass of iron of all this injurious oxide as well as to recarburize it to the required degree, as also to purify it by the extraction of phosphorus, sulphur, etc.; and to these ends my invention consists in the combination of two processes—the one being the treatment of any kind of molten ferric compound, usually called "cast iron," by air or oxygen for the purpose of desiliconizing, decarburizing, and oxidizing the other being the, treatment of the same after the first step by commercial marsh gas, commonly known as "natural gas."

The first process need not be described, as it is practiced now in a variety of ways, and is well known to commerce as the "Bessemer" or "Siemens-Martin" method.

The second process consists in forcing natural gas through or over the bath of molten iron produced by the first process. The *rationale* of this second process is as follows: The gas disassociates the instant it comes in contact with the molten iron, as it always does in the presence of great heat, the carbon and hydrogen both assuming the nascent state. Carbon having in the presence of heat a great affinity for oxygen, deoxidizes the oxide of iron existing in the mass, thus producing a certain quantity of heat calculated to keep the mass in a molten condition. Hydrogen, on account of a similar affinity, assists in this reaction and result, and the twofold product—carbonic oxide or acid and hydric oxide—passes off as waste, the developed heat effectually preventing the chilling of the mass in the converting vessel. Simultaneously a further quantity of nascent hydrogen combines with portions of the sulphur and phosphorus, and forms, respectively, sulphureted and phosphureted hydrogen, which pass off as vapors, thus further purifying the product. It is also probable that a portion of the nascent carbon will unite with some of the sulphur to form bisulphide of carbon—another vapor that is at once carried off. A certain quantity of the nascent carbon unites with the molten mass of iron to form steel, which will be of high or low grade, according to the duration of the required described reaction.

The special features in the use of natural gas are:

First, its entire freedom from elements which might prove injurious to the steel, especially sulphur and phosphorus. This feature is not found in any gas made from any kind of coal.

Secondly, in the comparatively low amount of carbon it contains, it being almost entirely marsh gas.

All other gases made from petroleums, oils, fat, etc., are very rich in carbon. When such carbons are brought into contact with molten iron, the amount of carbon disassociated by heat is so great as to chill the mass at once or leave flakes of uncombined carbon distributed throughout the mass, which, when the iron is rolled into thin sheets, appear on the surface and effectually prevent its being properly galvanized or tinned. The percentage of nitrogen and free hydrogen shown by some analyses to be in natural gas obviously diminishes the risk of producing such carbon flake.

By the use of natural gas a practical and cheap substitute is obtained in place of the expensive spiegel iron heretofore adopted, and a fine quality of excellent steel of any desired grade is obtained economically and commercially, the same furnace producing, as desired, rails or plate, or sheet or razor, or wire, or cast or malleable steel, a result heretofore never hoped for. These various grades of steel will follow the varying amounts of carbon allowed to combine with the molten iron, and they can be in practice regulated with the scientific precision of chemistry.