posed by Mr. Hilgard, is in the greater part of the type termed "through bridge," which means that the head room above the passing teams is not unlimited. The unobstructed, clear head room varies from 16 feet toward the ends of the bridge, where the arch rises above the roadway, to upward of 25 feet in the center of the span. The arch proper is of the pin-connected type, and has a span of 520 feet from end pin to end pin. The ratio of rise to span is as one to ten. This ratio might easily be changed into a more "economical" one, as 1 : 9 or 1 : 8, without much changing the appearance of the whole structure. The roadway, for the sake of appearance and drainage as well, is shown with a slight camber, amounting to five feet in the center. The steel arch proper is 16 feet high at the ends and 10 feet high in the center. As shown in plan of section, the construction of the floor surface provides for pine block pavement of usual type for teams, and granite between and next adjoining the street car tracks. For the sidewalks cement plates are proposed, the latter, as well as the stone blocks, to be solidly embedded in sand and gravel. A thorough drainage of the whole bridge surface and under the pine blocks in particular is also designed, such as to make the bridge floor first-class and durable in every respect. It is proposed to light the bridge by means of a few chandeliers carrying electric globes.

The advantages claimed for the design are the following:

It dispenses with all and every foundation to be put in the river bed proper (which might or might not involve a great many difficulties and expenses). A bridge of the kind Mr. Hilgard suggests will in no way interfere with the judiciously guarded interests of the Minneapolis water power, as it leaves the conditions of the river exactly as they are at present. It will make a solid and rigid structure, adapted to carrying the heaviest traffic that ever passed over a first-class city bridge. A bridge of any other system than the suspension or cantilever, and yet belonging to the type called deck bridge, while it would, if practical, have the advantage of an unlimited head room above the passing teams, is utterly impracticable, both from an engineering and from an æsthetic point of view, unless at least one pier is put in the river bed proper. A suspension bridge, as well as cantilever, ought to be avoided, from professional and financial reasons. The practically unavoidable necessity, incurred in the adoption of a through bridge, of having two separate roadways, has been emphasized; but this objection is at variance with what has been considered desirable, or even necessary, on the largest bridges in New York, St. Louis, etc., where the traffic in each direction is confined to a separate part of the bridge.

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New Method of Making Water Gas.

The Glasgow *Engineer* says that a new method of making water gas at an extremely low cost was the subject of a recent communication to the French Academy of Science, and that "the matter has caused much anxious attention, not only in France, but all over Europe and in England as well." It is of weighty importance, not only to gas but also to iron makers, if it accomplishes what is predicted of it. A jet of superheated steam is directed into a retort full of incandescent coke. The oxygen unites with carbon to form carbonic acid, and hydrogen is liberated. So far nothing new. The gases are led to a second retort filled with some refractory substance kept red hot, by which a glowing surface is exposed to the gases. At the same time, superheated steam is introduced. This seizes upon the carbonic oxide to form dioxide, and more hydrogen is liberated. A milk of lime bath removes the carbonic dioxide, and the pure hydrogen is led to a reservoir. One ton of coke in this process produces about 69,000 feet of gas, which is about eleven times the quantity usually produced by the expenditure of a ton of coal. This reduces the cost to little, if anything, more than that of natural gas, when the difficulty of controlling the latter is taken into the account. This is for heating purposes. Inventors are at work devising the best methods of carbureting it, and Boulogne-sur-Seine is to be lighted with it next winter.

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The Relative Value of Natural Gas and Coal.

Of Pittsburg coal 55·4 pounds contain the same number of heat units as 1,000 cubic feet of natural gas. With coal at $1.20 per ton, 1,000 feet of natural gas would then be worth 3⅓ cents. But by tests made by the Westinghouse Air Brake Company, 1·18 cubic feet of natural gas evaporated one pound of water from 190° Fah., with the same boiler under which one pound of the best coal evaporated 10·38 pounds of water. That is, one pound coal equals 12·25 cubic feet of gas, or 1,000 feet gas equal $81\frac{32}{49}$ pounds coal. This difference results from the expenditure of heat necessary to raise solid fuel to the gaseous state, which must be done before combustion can take place. In a house grate the loss on this score from using coal would be more than in a large furnace of a factory. Hence, the greater economy in the use of natural gas is in houses and small establishments.

Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.
PUBLISHED WEEKLY AT
No. 361 BROADWAY, NEW YORK.

O. D. MUNN. A. E. BEACH.

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NEW YORK, SATURDAY, OCTOBER 23, 1886.

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(Illustrated articles are marked with an asterisk.)

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TWINE.

Few persons have an idea of the enormous consumption of twine in this country. One of the greatest demands for the article comes from the farmers, who consume thirty-five thousand tons annually upon the self-binding harvesters. Allowing five pounds to the mile, this would be equal to a string long enough to go more than six times round the earth. It takes a length of about three feet of twine to tie a bundle of straw. The farmer sits on his machine, drives alone through his grain field, and without any assistance cuts, bundles, and ties twelve acres of wheat grain per day. To such perfection as this has that unconscionable patent monopolist, the American inventor, reduced mechanism for doing farm labor—monopolist in the judgment of the farmer, because the inventor demands a bonus of perhaps ten dollars a machine as his patent fee. This winter, no doubt, our grateful farmer will, as usual, join the hue and cry for the repeal of the patent laws.

The twine used on the self-binder is generally made either of Sisal or Manila hemp. The Sisal is the cheaper material, but is not so strong or durable as the Manila. In some twines a mixture of the two is employed. For binder purposes, the twine should have sixteen turns to the foot, and a length of three feet would have a breaking strength of not less than seventy pounds. The twine must be carefully made, free from swells or knots, or it will not run smoothly through the knotting device of the binder. The average consumption of twine on a binder harvester is two pounds per acre. About twelve hundred feet of twine per acre are required. It costs the farmer about 25 cents an acre for his twine.

The Manila hemp makes much the better twine, being stronger, smoother, and more durable; the raw material costs more, and its twine sells for more than Sisal hemp, but the Manila twine goes further, and is actually cheaper in use for the farmer; but this fact however is not appreciated by him, and he sticks to the Sisal twine because offered a little less per pound than the better article of Manila. Then, again, the Sisal twine breaks much oftener while running through the binder than the Manila. At every break the farmer must stop his machine, and spend ten or twenty minntes to fix up. He never thinks of charging his lost time against his poor twine. As long as he gets it for a cent or two less than the better article he is perfectly satisfied, no matter if it does bother him.

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Woolen Manufactures in Japan.

Although it appears that there is no probability of wool being grown in Japan, as the only sheep in that country are animals reared with great trouble as curiosities, it is said that woolen manufactures will probably be carried on to advantage there. The Japanese of the upper classes are very generally adopting European clothing; and though this is now principally made by native tailors, all the cloth comes from abroad, especially from Vermont and other New England States. Woolen fabrics are being used very extensively among the rich, and before long the same articles bid fair to become popular with the poorer people. The Japanese government and nation see that there is a fair field for starting woolen manufactures in their country; and, taking into consideration the imitative faculties of this people, and the low rate of wages at which they are content to work, they are likely soon to become proficient in manufacturing too, if they can get the wool, especially as they have shown themselves to be capable of using machinery and other aids to labor which twenty years ago were unknown to them. If wool could be imported, a great industry might be established. The wool of New Zealand and Australia is said to be more suitable than that grown in America for manufacturing cloth for Japan, on account of its greater fineness; and as this latter country has so many products, such as tea, sugar, and rice, all of which are marketable commodities in Australasia, the commercial relations between Japan and those colonies, it is thought, might be developed advantageously by a mutual exchange of produce.

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Piston Area and Heating Surface.

However much change may be effected in the type of a locomotive, certain proportions appear to be incapable of alteration without doing harm; 2½ square feet of heating surface ought to be provided for each square inch of piston area, or, what comes to the same thing, the area of one piston multiplied by 5 will give the proper heating surface. Thus, the area of a 17 inch piston is 227 square inches, and 227×5=1,135 square feet. An 18 inch cylinder has an area of 254·4 inches, and 254·4×5=1,272. In like manner the proper surface for 19 inch cylinders is 1,417 square feet. Of course, this is not to be regarded as a hard and fast rule, but it will be found that it is quite in accord with the best locomotive practice of the day, and that when an attempt has been made to reduce the proportion, the engines have not proved good steamers with heavy trains.