in the machinery rooms and the pressures and also the travel of the moving cylinder of the machines were automatically recorded.

A rope mat was woven around the central portion of the chain and a similar protection given to the stem of the ship. No damage to the ships occurred as a result of the tests, and the chain was marred only very slightly. Twelve runs were made with the "Allianca" and ten with the "Cristobal," and the vessel was brought to a stop in every case before the chain had paid out to its extreme limit.

The tests with the "Allianca" were not entirely satisfactory, as the resistance valves had not been cleaned for a long time, and there was a slight sticking of the valves which prevented them from closing promptly when the pressure was reduced. All the valves were, therefore, thoroughly cleaned, a new leather placed in one valve, and the other leathers softened up. The tests with the "Cristobal" were made after these changes were made, and proved entirely satisfactory.

The pressure curves have a decided peak at the beginning, which is in every case decidedly above the setting of the resistance valve. Beyond this point, and throughout the greater part of the stroke the pressure remains remarkably uniform, with very few oscillations. The vessel was brought to rest from 51.5 to 62.0 ft. beyond the centre of the fender machines, its speed when striking the chain being from 2.06 to 2.45 miles per hour.

There was little difference between the pressures in the machines on the two lockwalls or in the length of chain paid out from each side. The travel of the cylinders was hardly over 6 ft. out of a total possible stroke of 21.5 ft.

The distance travelled by the ship before being stopped was less than the shortest distance from any of the fenders to the gate it is intended to safeguard, so that there seems to be every assurance that the fenders, if ever called upon, would fulfil their purpose, even in the case of a ship as large as the "Cristobal" and moving at a speed of over 2 miles per hour. As this vessel is about 500 ft. long, and 58 ft. wide, few larger ships are likely to use the canal, nor is the speed of two miles likely to be exceeded in the approaches or the locks.

The distance in which the "Cristobal" was stopped agrees very closely with the theoretical curves which were computed before the designs were completed, but after the working stress of 220,000 lbs. had been adopted for the chain in stopping vessels. These curves are shown in the Annual Report of the Isthmian Canal Commission for 1911. This close agreement with theory is, of course, very satisfactory. Accounts of the various tests are given in the Annual Reports for 1913, 1914 and 1916.

CORRECTION

On page 150 in our issue of February 21st, in the article on "Water Supply and Sewer System for Cap de la Madeleine," by Romeo Morrissette, of Three Rivers, P.Q., it was stated that the sides and bottom of the reservoir were constructed of 1:2:4 concrete, 2 ft. thick, covered by a 3-inch layer of waterproofing grout of the same proportions, "to which," said Mr. Morrissette, "was added 10 per cent. of Toch cement." This should have read "2 per cent. of Toxement," as Toxement is the trade name of the concrete waterproofing made by Toch Bros., and it was found necessary to add only 2 per cent. of it, not 10 per cent., to obtain the desired results.

AVAILABILITY OF ENERGY FOR POWER AND HEAT*

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THE source of all our useful energy is the sun, which continues to supply us with food, fuel, rain, wind, and radiant heat, and has stored up for us in the past vast quantities of vegetable matter since converted into valuable fuels. The forms of energy available for conversion into power and heat are: Water power, wind power, sun power, natural gas, oil, wood, peat, lignite and coal. The cost of converting any one of them as found in nature into a specific quantity of the form of required energy at the particular place required is a measure of its availability. It will depend upon the cost of winning and transportation or harnessing, the cost of conversion, and the cost of transmission.

The cost of winning and transportation applies to the fuels, and is summed up by their price as delivered at the place of conversion. The cost of harnessing refers to expenses, such as those involved in developing a water-power site. The cost of conversion applies to all, and its consideration involves an inquiry into the law of conversion. In its simplest form, this law states that any of the forms of energy may be converted into heat; but that the conversion of heat into work is never the sole result of a natural process. Thus, since the production of work by fuel involves the generation of heat, the best overall efficiencies of coal steam electric generating stations are of the order of only 18 per cent. But the overall efficiency of a hydro-electric station may reach 80 per cent. If, however, a fuel be used to generate thermal energy, as in a steam boiler, it is possible to recover 80 per cent. of its energy. Thus the development of water powers for heating processes which the combustion of fuel will perform with equal efficiency is a degradation of energy. For special electro-thermal processes it is economical to use water power for heating; but they are exceptional, and practically all thermal processes should make use of fuels. For the same reason, wind and water power should not develop heat energy. Unfortunately, wind power is available only for small powers, while the cost of development and situation of water powers make it necessary to use fuels for the generation of most of the world's power supply.

The actual efficiency of conversion of the energy in fuels into mechanical or electrical energy varies considerably. It depends upon the class of fuel and the heat engine. Thus, the best thermal efficiency to be obtained with a steam turbine is about 26 per cent., and with the gas engine about 35 per cent. But the thermal efficiency is not the sole criterion of the cost of conversion, for the costs of the installation are an important factor. And the steam turbine, with its higher heat consumption, is able to compete with and outdistance its competitors for large stations, because of the much lower investment costs.

The energy of a fuel is invariably released eventually in the form of heat. But it is frequently converted into other modifications of fuel. A most important example of this type of conversion is the carbonization of coal, by which not only gaseous liquid and solid fuels are produced but numerous and valuable by-products.

The cost of transmission of energy will depend upon the class of energy transmitted, its price per unit, and the

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