expended. Accordingly, the everlasting nature of the action is maintained by the energy being conserved and protected from loss. This is accomplished by supposing reciprocal action to go on using only the same materials, but under different conditions. The different conditions are those which obtain in or near the sun, and those of interplanetary space. In the one we have intense heat, and in the other equally intense cold, and I may here remark that it would be impossible to conceive of matter being placed in positions which afford conditions possessing a greater contrast. Matter is supposed to be subjected at different times to these different conditions, and its behavior under such conditions, produces, in the one case, the heat and light of the sun, and in the other, the materials necessary for maintaining this heat and light. Without further preface, I will endeavor to state Dr. Siemon's theory, in as nearly as possible his own words.

After briefly stating the various theories and offering certain objections to them, he says :- "The true solution of the problem will be furnished by a theory, according to which the radiant energy which is now supposed to be dissipated into space, and irrecoverably lost to our solar system, could be arrested and brought back in another form to the sun itself, there to continue the work of radiation."

(To be concluded in the next number.)

PROCEEDINGS OF SOCIETIES.

The Institution of Civil Engineers, (Eng.)—At the Meeting on the 10th of April, Mr. Brunlees, President, in the Chair, the Paper read was on "The Introduction of Irrigation into New Countries, as illustrated in North-Eastern Colorado," by Mr P. O'Meara, M. Inst. C. E.

The object of the Paper were stated to be three-fold:—first, to give an account of the development of irrigation in North-Eastern Colorado, secondly, to enquire into the principles which should guide the introduction of irrigation into new countries; and thirdly, to examine how far the methods being pursued in North Eastern Colorado were in accord with them. The development alluded to was influenced by most of the defects manifested in older countries, such as—inaccurate measurement of water, growth of ill-defined rights, excessive waste of water, etc., but there was a prospect of improvement through better legislation. The climate of Colorado was described as such, that agriculture was all but impossible without irrigation. Both were begun in 1860. There were 155,000 acres under cultivation in 1880, and it was estimated that in 1883 there would be 465,000 acres, with prospects of still further development. The amount of irrigation possible would be limited by the quantity of water obtainable, and by the area which each unit of it could be made to irrigate. It would amount to 9,750,000 acres under a hypothetical water-duty of 12 inches in depth for one season.

It was laid down that the duty of water in irrigation must vary with (1) the character and condition of the soil, (2) the rainfall, temperature, and evaporation, (3) the method of application, (4) the kind of crop, and, in some cases, (5) the depth of the water-line below the surface of the ground. As regarded (1), the influence of different soils, this must affect the duty of water, because, on the nature of the soil depended the quantity of water it would absorb, and the rate of filtration and of evaporation from within it. The Author gave details of experiments made by him to ascertain the amounts of water, and the times required to moisten two different typical soils in the Cache La Poudre Valley, and he drew some inferences from them. The formation of swampy lands and the prevalence of rust in wheat on some of the older farms were held to indicate, that the quantity of water required for beneficial irrigation became gradually less year by year for a few years after the commencement. (2.) The rainfall of the season should be added to the artificial irrigation, and account should be taken of the surplus water not absorbed by the soil, otherwise all estimates of water-duty must be misleading. The use of ordinary statistics of temperature and evaporation was at present vague and *unsatisfactory, owing to the absence of experiments on the drying of soils.* Nevertheless the question of evaporation was so important, that it was doubtful if any loss of irrigating power occurred in Colorado other than that which was due to it. (3.) Irrigation methods were conducted on two antagonistic principles, viz., to increase to the most profitable extent, in the one case, the quantity of water supplied to a given area, and in the other, the area irrigated by a given volume of water. The "Marcite" cultivation of Italy and the "asbestine sub-irrigation method" of California were cited as instances of these. Methods of irrigation were classed under four heads,—by sprinkling, by flooding, by distributing through furrows, and by distributing through pipes or drains under-ground. Sprinkling had been tried in Scotland on 7 acres of land by the Duke of Sutherland. The methods of flooding with compartments, and of distributing through furrows, were described in detail, as also the method of flooding without compartments, as practised in Colorado. This was characterized as extremely wasteful. It was shown from the experiments on dry soil, before alluded to, that 6 or 8 inches in depth, instead of 42·84 inches as at present expended, ought to suffice for cereals in Colorado. The experience of Professor Blount, of the State Agricultural College, was quoted to show that excellent crops of wheat could be grown with a rainfall of 4¼ inches only, without irrigation. As regarded (4) the water-duty for different crops, it was the degree of moisture required in the soil around its roots, and not the absolute quantity which the plant itself absorbed that had to be considered. The Author furnished, in a tubular form, a list of statistics, derived from various sources, in which he had endeavoured to include the essential elements. He considered it, however, to be nothing more than an approximation, because of the incompleteness of almost every statement of the kind. In the column of "totals," the limits of water-duty appeared much narrower, because of the rainfall being added to the irrigation depth, than they would be otherwise. Countries where good crops were grown without irrigation were included in the Table, being considered to furnish a "natural duty of water," which should be useful for comparison with water-duties in place where irrigation was practised. Some remarks followed with respect to the peculiarities of certain crops—viz., rice, alfalfa, sugar cane, summer meadows, potatoes, cereals, and tea.

The Author then discussed the sources and works of supply, and the legislation of irrigation. The sources were stated to be two, viz., springs and rivers. The supplies were made available for direct irrigation by canals, and for indirect irrigation, after storage, by reservoirs. The works of the "North Poudre Irrigation Canal," of a capacity of about 300 cubic feet per second, which had been carried out under the Author's charge, were described. Those most worthy of remark were a crib dam, 30 feet 6 inches high, some shelf-work, tunnels, and "gulch" bridges. Details were also given of a larger canal, the "Northern Colorado." These works showed a considerable departure from the practice of older countries, owing to the abundance of timber, and to the preference of Americans for economy and rapidity in construction over durability. The principal supplies of water in Colorado came from the snows of the Rocky Mountains. The rivers rose, reached their maximum and fell again, frequently before the end of the irrigation season. Hence measurements of the snow remaining on the mountains were of importance to agriculturists. The construction of reservoirs was dealt with as a means of reducing risk in cultivation in countries where the rivers failed in the crop-season. Reservoirs were distinguished as of three kinds:—"river-bed" reservoirs for equalizing the flow, "main" reservoirs which received the entire volume of a canal, and "detached" reservoirs which received a portion only. A serious error in the construction of some reservoirs in Colorado was pointed out. The gauge first used for measuring water in Colorado was the Max Clark's gauge, and the improved system at present in use, with the formula of Francis:—

$$Q = 3{\cdot}33\,(l - 0{\cdot}1\,n\,h)\,h^{\frac{3}{2}}.$$

were described and commented on. A short account of the legislation affecting irrigation in Colorado followed. The legal definition of an "inch of water" was given in full. Those laws were such, that any holder of land in the State was entitled to take and use the waters of the rivers, and any one could construct reservoirs and store unappropriated water. A fruitful crop of litigation had, as a matter of course, been developed in the State; and some cases were still pending. A series of laws were passed in 1879 to determine the order and priority of existing and future claims, to fix the price of water, and to control its distribution. The Author finally directed attention to the Report of the State Engineer of California on similar laws, concurring generally with the principles advocated therein, and suggesting a free exchange of water-rights, and the condemnation of such reservoir sites as were used for direct irrigation only.

American Society of Civil Engineers.—Mr. F. J. Cisneros, who recently visited the Isthmus of Panama presented an informal statement of the progress of the work upon the Panama Ship Canal. He stated that the purchase of the Panama Railroad by the Canal Company seemed to promise most excellent results, and suggested that proper methods in the management of the railroad, and lower charges for both freight and passengers, would certainly increase its revenue.

In reference to the Canal he said that the line had been completely staked, cross sections taken and the location made and stakes set for definite work for a large portion of the line. The line is entirely cleared and grubbed from kilometre 40 to the mouth of the Rio Grande, and is rapidly advancing at other points. The Valley of the Chagres has been surveyed, and it has been found that the high water lines above the high dam will cover an area of about 6750 acres, and that the volume of water stored will be about 1,000,000,000 cubic metres. Actual work upon the Canal has been commenced at six points.

The contractors, Messrs. Slaven & Co., for dredging the Canal from Colon, have their first herculean dredge in place, and will commence work directly. The Canal Company have been working with two French machines, at the rate of 1000 cubic metres per day for each machine. The Franco-American Trading Co. have contracted for the excavation of about 10 kilom. of the Canal beyond the Bay of Panama. Their machines are being built at Lockport. There are now about 6000 men on the work, chiefly Jamaicans, Carthegenians, and a few Martiniqueans.

Many dwelling houses, machine shops, &c., have been constructed. The machinery is both French and American, and the eleven American excavators are working with great economy. Borings have been made along the whole line, and have extended to the bottom of the Canal giving in a general way the following results. From Colon to kilom. 10. material easily dredge. From Matney to Obispo, mostly clay with occasional seams of rock. From Obispo to Emperador about 7 kilms. of hard trap of Conglomerates. From Emperador to Paraiso, about 8 kilms. clay for about 15 meters, then indurated clay followed by schist and reaching rock near the bottom of the Canal. From Paraiso to Pedro Miguel 10 to 12 metres clay followed by rock. From Pedro Miguel to the sea, mostly clay and mud with the exception of a few seams of rock.

Considerable work has been done at the Port of Colon including the commencement of a break water.