words "of quotients" Professor Huntington has given my meaning a twist which I never intended. The whole series "of representatives" would sum to 435.

To test how much ground there is in the passage for the misinterpretation I handed copies of my letter to a class of 30 undergraduates, said that there was an ambiguity in one sentence which I identified, and left them to decide what it was, and how they would interpret it. Three fourths of the class thought the meaning was "series of representatives," one fourth thought it was "series of quotients." None of them knew about the interpretation Professor Huntington had put on my words, or why I had asked them the question.

It is hard to understand how a scholar of the position of Professor Huntington could have given my words the meaning he did, and have failed to see that they would bear another meaning which would make them true. It is the harder because after his study of apportionment he must know that in the tables submitted to Congress it has been the practice to print the two series in adjoining columns and to give the sum of the representatives but not of the quotients.

Hitherto I have not answered Professor Huntington's personal attacks but this case is so clear and typical that I have made an exception. *Ab uno disce omnes.*

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QUOTATIONS

INDUSTRIES AND RESEARCH

THERE is one striking and rather disturbing feature of the position in this country with regard to cooperative industrial research. It is specially mentioned in the recently issued report of the Department of Scientific and Industrial Research, and it has been painfully obvious ever since the government scheme for assisting cooperative industrial research came into existence nearly ten years ago. This is the great difficulty of obtaining from the various industries which have set up industrial research associations, with the aid of the government grant, sufficient funds in some cases to earn the government grant and in others even to keep the research association going at all.

The department has hitherto taken a very lenient view of this reluctance on the part of industries to provide funds, but with the approaching completion of ten years of government assistance it is felt that research associations should be self-supporting. Some outspoken comments are made on this matter in the report.

When the scheme was first started cooperative industrial research was an experiment in this country, the result of which no one could accurately foresee, and in the circumstances it was felt that it was justifiable for the state to bear half the cost for a period of five years. When that period came to an end it was agreed that a continuance of state aid was desirable for a further period of five years in view of the special difficulties of British industry. This second period having almost expired, the request has been made to the Department of Scientific and Industrial Research that the state should continue to bear half the cost where industrial research associations have been formed. That proposal has been rejected definitely by the department on the ground that the value of cooperative industrial research has been established, and therefore the industrial research associations, having had ten years' state assistance, should be self-supporting. It is proposed that when the existing contracts come to an end each association shall be considered on its merits and a subscription income fixed which it will be necessary for the association to obtain from other sources before it is eligible for any grant from the department. Only as regards funds obtained in excess of this fixed amount will the department be prepared to make a grant. In other words, this is a clear hint to the industries of the country that they must adequately finance their own research associations, and on general principles it is a sound policy at the present stage of development.

Those who have come in close contact with this work can not but feel sympathy for the manner in which the councils and technical directors of the industrial research associations are always begging the members of their respective industries for additional financial support. At least one such association has gone out of existence because the industry has been unable to raise the necessary funds to earn even the generous grant from the state under the original scheme. The plight of some of the others is such as to cause astonishment. There are at present nineteen such industrial research associations, and it is hard to find a cause why sufficient financial support to enable them to be self-supporting after having had a run of nearly ten years is not forthcoming. Investigation work is having to be curtailed or carried out on a much smaller scale than is desirable for the obtaining of the best results. These associations carry out work of a fundamental character which is inevitably of outstanding financial value to the industries, and in seeking to ascertain the reason for the comparative poverty of our industrial research associations, the reflection is inevitable that all our leading industrial organizations have their own research departments in which a good deal of fundamental, as well as immediately practically valuable, research is being carried out. Whether that is the cause can not be stated definitely; indeed,

offhand, it would appear not to be a reason for failing to support the cooperative research organization.

The difficulties are well shown in the promotion in Parliament of the Rubber Industry Bill, which had for its object the imposition of a statutory levy on all imported (and retained) rubber for the purpose of financing cooperative research. That was opposed by some of the manufacturers, although it was warmly advocated by the majority of the trade. The bill, however, could not be presented for third reading last session owing to lack of time, and it, therefore, failed.

An interesting sidelight on the attitude in some quarters towards cooperative research is given in the report of the department. It is stated that a prominent firm which had been a strong supporter of its research association had a large overdraft at the bank, and the bank, as one condition of arranging the overdraft, insisted that the subscription to the industrial research association should be withdrawn on the ground that it was an unnecessary expenditure.—*Correspondent of the London Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF "DRY ICE" OR SOLID CARBON DIOXIDE AS A LABORATORY REFRIGERANT

"DRY ICE" is a trade name for solid carbon dioxide. Carbon dioxide is a gas at ordinary temperature, but solidifies at a temperature of $-73°$ C. or $-100°$ F. Solid carbon dioxide has been known for a long time, mainly as a laboratory curiosity, being easily prepared from liquid carbon dioxide by tying a piece of cloth over the outlet of a steel tank of the latter and allowing some of the contents to escape. As the liquid evaporates it takes up a large amount of heat and so part of it is cooled down to the solidification point. This forms the CO_2 "snow" as it is called, since it resembles real snow very much.

During the last few years solid CO_2, or Dry Ice, has assumed commercial importance as a refrigerant, particularly for perishable goods in transit, being used in place of ice from water. It is manufactured for this purpose on a large scale, recourse being had to not only cooling but high pressure in making it. Its advantages over "regular" or ordinary ice are easily perceived. It is much colder and thus a given weight will be more effective, it lasts longer, and on melting disappears as a gas into the air, leaving no water, as is the case with ordinary ice.

It is prepared in ten-inch cubes weighing forty pounds each. In lots of forty to two hundred pounds it costs ten cents per pound. In lots of two hundred pounds or more it costs five cents per pound.

During the past year in connection with hardiness studies the writer has had occasion to attempt some freezing tests on apple twigs as a check on other methods of determining hardiness. That is, it was desired to freeze different samples of twigs from different varieties of apples during the dormant period, holding them at varying temperatures from $-5°$ C. down to $-40°$ C., perhaps, and thus to determine their killing point. Liquid CO_2 in steel tanks was first tried. In this case the CO_2 was allowed to expand in a copper expansion coil surrounded by an ether bath. The excised twigs were placed in sealed glass bottles in the ether. This seemed to require too much CO_2 and was therefore abandoned in favor of solid CO_2. This proved very satisfactory, as it was cheaper, the work could be done faster and the method is simple.

Pint-size thermos bottles were used as containers, mainly because they were available. Quart size would perhaps be better, as larger sizes of twigs could then be used. They were about two thirds filled with ether and stoppered loosely with one-hole rubber stoppers, through each of which was thrust a thermometer so that its lower end dipped into the ether. The twigs were cut in about six-inch lengths and placed in sealed test-tubes, and these placed in the thermos bottles, two test-tubes in each. The temperature was lowered gradually by dropping into the ether small pieces of Dry Ice, a little at a time. The fragments sink to the bottom and volatilize rapidly, thus causing a violent bubbling which aids in maintaining the temperature of the bath the same in all parts of the container. After the desired point was reached it could be held by dropping in another small fragment whenever the temperature started to rise slightly. In cases where a large number of samples of twigs were to be frozen, a gallon-size thermos jug, such as used by campers, was used as a container. Thus the results for several varieties would be exactly comparable, all being held at the same temperature for any given series.

Care must be taken in handling the Dry Ice as it burns the hands when held even for an instant. Blocks of a pound or more were cut off with an ordinary wood saw. These in turn could be broken into smaller fragments with a knife or cold chisel. A supply of small pieces for cooling down the ether was kept in a thermos bottle.

After the twigs had been kept at the desired temperature for a given length of time, one hour in these experiments, they were taken out and placed in small, wide-mouthed bottles with their lower ends in water. They were then allowed to bud out at room temperature, those failing to do so being regarded as killed.