QUICK FREEZING.

In accordance with your directions, I returned from England via America to report, *inter alia*, on the developments in regard to "quick freezing." The following brief report outlines some aspects of the position:—

The present practice in New Zealand is to export frozen lamb almost entirely as carcasses, and it is unusual, even in the case of cattle and sheep, to cut the carcass and export it in the form of joints. The freezing process invariably consists of allowing these to remain at a temperature of about 0° F. for a day or so until frozen. Prior to freezing, the carcasses are usually held on a cooling-floor from twelve to twenty-four hours, and recently numerous works have attempted to eliminate part of the 2 to 3 per cent. of moisture loss (shrinkage) occurring in this stage, by placing the carcasses almost immediately after dressing into the freezing-chamber. This modification of making the treatment a more rapid one should not be confused with that of "quick freezing," in which process the choicest cuts (steaks, fillets, chops, &c.) and edible small-goods (kidneys, livers, sweetbreads, oxtails, &c.), as well as fruit, and especially fish, are moulded, frozen, and wrapped in such a manner that the purchaser may receive them in a condition which is claimed to be almost indistinguishable from the fresh material. The temperatures employed in this "quick-freezing" process are usually of the order of —50° F., and special machinery is necessary. For reasons which will now be explained, the so-called "drip" (on thawing), which is the greatest difficulty and problem found in ordinarily-frozen meat, is largely obviated.

So-called "quick freezing," as applied to fish, meat, and small fruits, has very rapidly developed in America during the last two years; and probably the greatest impetus to its application to meat has been the development of the chain food and grocery store, and the move towards the marketing of foodstuffs in packages or cartons.

The ordinary methods of freezing by placing the product in a "freezer," as in New Zealand, are fairly satisfactory in the cases of lamb and mutton; but beef, when placed in the same freezer, because of its thickness, naturally cools internally much more slowly than does mutton, and the resulting product is neither so palatable nor of as good texture as is the fresh meat. It has been generally understood that this slower freezing of the meat-juices results in the formation of large ice-particles, which fracture the cells, alter the texture, and cause a drip of juices after thawing. For the same reason, fish fillets, because of their higher percentage of water (80 per cent.), suffer the same action on being frozen, although they are smaller and the penetration of cold takes place more rapidly than in the case of beef.

The developments in America were based largely on this theory of formation of ice-particles during freezing; but it is now obvious that there are many more fundamental factors involved in the preservation of the meat proteins in their pristine condition as regards flavour, &c., and that the true explanation of what happens is to be found largely in the province of colloid chemistry rather than in that of mechanics.

The proteins in meat, and the characters giving rise to flavours which one associates therewith, are of extremely complex chemical constitution, and are unstable in that they are liable to undergo changes during storage. Moreover, in the juices there are mineral salts, and the concentration of these mineral salts in the freezing process, due to the removal of water as it freezes out as ice, reacts on the nature of the proteins and their holding-power for "bound" water.

In some respects the problem is analogous to that of the homely custard, which, properly prepared and stored, keeps its moisture and its jelly-like constitution; but under certain conditions the custard is a failure because it parts with its liquids and breaks, or fails to set, and in consequence is less suited for the table. In other words, the holding-power for fluid of the custard is in some way lost.

Considering first the juices in the meat, which we can compare to saline solutions: On freezing, the ice-particles produced are at first of almost pure water, and the slower this freezing process, the more can this water be transmitted through the muscle substance and *accumulate* in large crystals, causing a rupture of the cells.

In quick freezing the juices are more or less frozen *in situ*, and the ice-particles which separate out from the juices are microscopically small, and do not rupture the cells. It must be remembered that the freezing-point of a solution is lower than that of pure water, and consequently the juices are never wholly frozen, because, as ice crystallizes out, the strength of the salt solutions in the remaining juice is concentrated, and the freezing-point successively lowered, and at any given temperature there is a definite ratio between water in the solid state and the water in solution. If during storage, even, of quick-frozen products, any fluctuations of temperature occur, the tendency is to reproduce the big crystals characteristic of the slow-frozen product, because with each slight increase of temperature more ice must go into solution—that is, as temperature rises, the ratio of solution to ice increases. Much of the ice that goes into solution in this condition is that of the smallest of the crystals, which thereby disappear, and when, later, the temperature may fall again, there is a tendency, when this water goes back to the solid state, for it to deposit on the crystals already formed rather than to form new ones. For this reason alone, problems of storage and transportation of quick-frozen meat-products are of paramount importance to New Zealand. Apart from fluctuations of temperature, which are unavoidable, but which can be minimized, there is a far more important factor in the storage of quick-frozen products. As stated above, there is always some of the juice in the liquid state, whatever the temperature. The juice is more concentrated in salts, and the action of this solution on the protein may gradually accelerate changes in the latter, and the subtle alterations of the protein affect mainly their property of acting as gels and holding moisture, and, apparently, the particular chemical constituents of these proteins which give rise to flavour are the things that alter.

This change of the protein is known as an "irreversible" change, because when the meat goes back to normal conditions the protein does not reabsorb its moisture or resume its original chemical composition. When the rate of change is estimated at different temperatures in the