

WEST INDIAN AGRICULTURE

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Much assistance could also be given in the sphere of international relations. Prof. C. E. Merriam, of the University of Chicago, with a team of co-workers, has reviewed the methods adopted in various countries to inculcate patriotism. Quite a deal could be learned from those studies which could be applied to the task of creating as quickly as possible a strong loyalty to a reconstructed League of Nations or whatever other supra-national body there may be set up after this War.

The long-range problems are another matter. With regard to these, the number of men and women who are competent to do effective research is likely to be small, and progress is likely to be slow. But sustained research might in time yield results of quite incalculable value. For example, how little we really know at present about human nature, about its variations, how far it is capable of change, to what extent it is the same always and everywhere. Yet there is a vast amount of material existent in the writings of historians and of anthropologists which, if it were carefully examined, might yield valuable results.

Here let me digress to emphasize the very special case which can be made out for generous support of anthropological research. I am not an anthropologist, but, like all sociologists, I am deep in the debt of the anthropologists. Their special claim derives from urgency; the material upon which they work, the simpler societies, is fast vanishing; investigations which are not made in the next few decades will probably not be made at all; and these investigations throw light on social structure and on human nature which we are scarcely likely to obtain from any other source.

It is, I think, almost essential for effective study of long-range problems, and for that matter it is often desirable for the study of short-range problems, that there should be team-work. A society is a whole, and it needs to be studied as a whole; and that means either the co-operation of many specialists or the work of a man of encyclopædic knowledge. Men of the latter type are rare, are perhaps likely to become rarer. It is to team-work therefore that we must look more and more. But the planning of work by a team, and the intelligent co-operation of team-workers, both demand that knowledge of the interplay of the different factors in social life which is the special subject-matter of sociology. Everyone praises his own leather, and I do so unashamedly; it seems to me deplorable that the persons in Great Britain who have been appointed specifically to teach sociology can be counted on the fingers of one hand.

Whether that be accepted or not, there is at least widespread agreement that we need to take more seriously the scientific study of society. Concretely, that means better provision in the universities, more chairs and and more lectureships, more post-graduate studentships. It means better utilization of the already considerable knowledge of social scientists, and an enlargement among other things of the number of careers open to them. It means better understanding and more team-work among them. There is also a great work of popular education to be done. We need to increase immensely the number of those who have some scientific knowledge of the nature and functioning of society. When such knowledge is greater, and when it is more widely spread, we shall be on our way to a considerable measure of control of social forces; and we shall increase the use and decrease the abuse of the abundant knowledge placed at the disposal of mankind by the natural scientists.

WEST Indian affairs attracted considerable public attention in the period immediately prior to the outbreak of the present hostilities. Severe economic depression and the deplorably low standard of living had indicated that all was not well and general concern was manifested by the Imperial Government. Signs of considerable distress and labour unrest, culminating in disturbances in various Colonies during the late thirties, resulted in the appointment of a West Indian Royal Commission which toured the various Colonies in the Caribbean area during 1938-39, with the object of making specific recommendations. Unfortunately, the report of this Commission has not yet been released, but the main conclusions reached and certain recommendations made were published in February 1940 (Cmd. 6174). Now apart from Trinidad, which has a big petroleum industry, and British Guiana, which has developed bauxite mining and to a less extent gold and diamond diggings, all these Colonies depend entirely on the agricultural industry for their prosperity. The recorded opinion of the 1938-39 Royal Commission that "agriculture is the principal source of sustenance and wealth in the West Indies and the standards of life must largely depend on the intensive use of the soil" therefore accurately portrays conditions.

It is obvious from this that the betterment of agricultural practice underlies the whole problem of social and material progress in this area. The problems involved are intricate and not easy to solve, and it is opportune, therefore, that H.M. Stationery Office should have been able, even in these difficult times, to publish a book entitled "Agriculture in the West Indies" (Colonial No. 182), which gives a very complete and up-to-date description of conditions as they were just prior to the commencement of this War. The book has been compiled by Dr. H. A. Tempany, agricultural adviser to the Secretary of State for the Colonies, from documents supplied to the West Indian Royal Commission, and from other sources. It forms a valuable record of agricultural conditions in each Colony at the present time besides giving historical data which undoubtedly have considerable bearing on the existing state of affairs.

Unlike most other tropical areas, the West Indies have had no tradition of native agricultural practice to build upon, for the native Indian tribes rapidly disappeared under the Spanish rule which was established at the end of the fifteenth century, and the labour required for development was afterwards met by the importation of Africans and later, after the abolition of slavery, by indentured labour from India and to a lesser extent from China and the Portuguese Atlantic Islands.

As is pointed out in the book referred to above, the system of agriculture is really based on the methods in vogue in Great Britain and the European Continent before the great renaissance of the eighteenth century, with its development of rotations and mixed farming, took place. The negro brought few ideas with him, but perhaps insufficient credit has been given to the changes that have been introduced by the immigrants of East Indian origin. For example, it is perhaps not too much to say, that without the help of their traditional art, the development of the rice industry, which shows considerable

progress in British Guiana and could, with a little encouragement, be developed much more in parts of Trinidad and Jamaica, would probably never have taken place so rapidly as it has, for the man of African descent has shown little inclination or aptitude for this type of cultivation.

Throughout the last three hundred years, agriculture has been based on the plantation system, which was first established by the Spanish, and later continued by the French, English and Dutch, when they in their turn began to acquire interests in the islands. Under this system, the land belonged to the planter, who farmed the whole estate with the aid of labourers. The latter owned no land and were not encouraged to cultivate crops for themselves. The crops raised were mainly for export. Sugar-cane has always been the staple plantation crop, and the prosperity of the West Indies may be said to have depended to a large extent, as in fact it does to this day, on the condition of the sugar industry.

Other plantation crops have had their ups and downs. Thus, cotton was cultivated on a large scale at the time of the American Civil War when supplies from the United States to England were interrupted. It ceased to be profitable when peace was declared, and all the memory that is left of it on many of the islands is hillsides covered with poor secondary bush, which are eloquent of the soil erosion that must have taken place during that period. The cacao plantations were started later during one of the periodic depressions in the sugar industry, much of the planting being done at the end of the last century and the beginning of the present one. Cacao is still a major crop in Trinidad, Tobago and Grenada, but is at present in a depressed condition owing to competition from West Africa and Brazil and the ravages of disease.

The cultivation of bananas for export began in a small way in Jamaica during 1868-69. It is somewhat curious that, like sugar-cane, it is not a native of the area, as the Gros Michel banana, which is the commercial variety, undoubtedly originated in the Far East. With the development of better methods of transport, a huge export trade arose and the average exports for the three years previous to this War were in the neighbourhood of twenty-three million stems a year. Now the banana in its turn has become subject to diseases and many growers have had to try to turn to other crops, and, as is the case with cacao, some of the land is going back to cane.

All through their known history, the West Indian territories have been subject to periods of intense depression, which have necessitated the holding of special commissions and inquiries. Prior to the recent commission, probably the most important one was the Royal Commission of 1897 because it did result in certain definite changes for the better. The sugar industry at the time was in the depths of depression; competition with beet sugar, grown under a system of bounties on the continent of Europe, was being severely felt and the Bourbon cane, which was the principal variety, was succumbing to disease. The Commission recommended the thorough overhauling of the sugar industry, the abolition of the sugar bounties, greater diversification of agriculture, the establishment of small holdings, together with the encouragement of peasant agriculture and the placing of scientific research on a proper basis. Many of the proposals were in part at any rate carried into effect. The sugar industry was overhauled and much centralization took place,

leading to the amalgamation of many small estates, the adoption of better methods, and higher extraction in the factory. The sugar bounties were abolished in 1903.

An Imperial Department of Agriculture was established in 1898 and the cost of the operations were paid by the Home Government for ten years. Its headquarters were at Barbados, and it operated chiefly in the Windward and Leeward Colonies, but its influence and the results of its researches were felt throughout the archipelago. Much was done to encourage diversification of crops, one of the outstanding successes being the establishment of the Sea Island cotton industry, which is proving its value for war needs at the present time. New varieties of cane were introduced and cane-breeding operations fostered; chemists began to examine the soils and pathologists to investigate plant diseases and pests. In due course similar departments were organized for Jamaica, Trinidad and British Guiana, and in fact most of the agricultural departments now functioning in our tropical Colonies may be said to have had their inception and to be modelled upon the old Imperial Department of the West Indies.

The 1914-18 war period brought high prices and prosperity to the West Indies. The witchbroom disease had not yet appeared in Trinidad's cacao fields, which were at that time in their prime. Panama disease and the *Cercospora* leaf-spot did not then worry the banana plantations of Jamaica, and the lime producers of Dominica and St. Lucia obtained good crops and good prices, as the wither tip disease only appeared later. But after the short post-war boom, prices fell to a catastrophic extent and in many cases it appeared that the old plantation system was breaking down and would be unable to cope with modern conditions unless considerable modifications and adjustments were made.

The demand of the peasants to own land has been strongly in evidence for years past. It was brought forward at the time of the 1897 Commission, and following its recommendations, some land settlement was actually started in St. Vincent and other islands. These early settlements were comparatively few in number, but their history is interesting and the experience gained should prove most useful at the present time when, as a result of the work of the latest Commission, the need for the development of peasant agriculture has again been stressed. It is not too much to say that the early settlements were not an unqualified success; many of them proved failures due to lack of accurate information and knowledge of the underlying factors involved.

One of the reasons why the demand for land settlement has become so persistent in recent years is the increase in population. Formerly, an appreciable proportion of the labouring population found an outlet for their energies in neighbouring countries. A number emigrated and others found profitable employment for periods of the year in the cane fields of Cuba and other countries. It must be remembered that West Indian labour was largely drawn upon for the construction of the Panama Canal and the opening up of the oil industry in the Central American Republics. These developments offered employment at lucrative rates. The money thus earned enabled the labourer to maintain his family and household in his native island and resulted in the inflow of an appreciable amount of wealth from outside. Within the last ten years or so, this state of affairs has come to an end and immigration laws have curtailed the

activities of the West Indian, who nowadays is forced to try to find his living in the British Colonies.

The difficult problem of finding a livelihood has, therefore, become aggravated. Some of the islands are really densely populated. For example, Barbados, which is about as big as the Isle of Wight, has a population of 1,163 to the square mile; Jamaica, the largest island, had a population of 1,173,600 in 1938, with a density of 263 per square mile, and had increased its population by more than 300,000 in eighteen years. For countries which depend entirely on agriculture and have no industries to speak of, these densities are high. The possibility of relieving the pressure by emigration has exercised the attention of many administrators in recent years. Unfortunately, the other islands are mostly already fully occupied and offer little scope, and the possibilities of the two mainland Colonies of British Guiana and British Honduras have frequently been considered. These two Colonies certainly have the area, and on that basis alone are considerably under-populated. The same might very well be said of Australia.

If one examines the facts, however, it is found that although British Guiana covers an area of about 90,000 square miles, and is, therefore, larger than England, Scotland and Wales put together, eighty-seven per cent is under heavy tropical forest, ten per cent under savannah, and only three per cent on the coast is cultivated. The old idea that land producing heavy rain forest in the tropics must be fertile has been largely exploded, and as a matter of fact the soil underlying these British Guiana forests is singularly poor, and as the few experimental settlements have proved, is incapable of supporting permanent agriculture. The same may be said of the savannah soils. These are also infertile and lacking in essential mineral salts. They at present support a small ranching industry, and it would seem that future developments would lie in the direction of improving the methods of cattle raising. It is possible, even probable, that the forestry industry may be scientifically exploited after the War, even though tropical rain forests are difficult to develop commercially because of the multiplicity of species they contain. Neither the cattle industry nor forestry will, however, be in a position to afford relief to the congested populations of the islands, even if the latter could adapt themselves to work which is specialized and to which they are not accustomed. In British Honduras again, forests predominate, and the evidence is that good agricultural land is strictly limited.

The best means of helping British Guiana at present lies in providing proper irrigation and drainage facilities in the frontal lands, with the view of developing land settlement with paddy as the basic crop, as the conditions are specially suited to this kind of cultivation. The peoples of East Indian origin are skilled in this form of agriculture, but it is more than doubtful whether immigrants from the islands, the majority of whom would be of African descent, would be able to settle down to it. It will be seen, therefore, that the two mainland colonies do not seem to present an easy solution to the over-population problems of the islands, and it is evident that these islands will have to try to find the solution within their own confined boundaries, so long at any rate as the present social and political restrictions affecting emigration continue.

There is no doubt that many of the islands could support a larger population if all the land available for agriculture were properly utilized. As already

indicated, many of the plantations have become derelict and many others are not producing anything approaching their maximum. In many instances the estates are heavily in debt, with the result that considerable capital expenditure would be necessary to make them once more productive. But the owners usually find it impossible to obtain the necessary money to provide for the drainage and replanting and similar operations essential to maintenance of production. The long period of depressed markets has found the owners already mortgaged, and in many cases they continue to use out-of-date methods, so that they are in no condition to tide over bad times. The sugar industry has been able to carry on, though with difficulty, because the smaller estates have combined, the factories have been centralized, modern machinery installed, and scientific inquiries sought and new methods adopted. This was not the case with the cacao, the lime, and, to a less extent, the coco-nut plantations. These crops do not lend themselves so readily to centralization, and as a result many of them have become derelict. It has long been evident that some drastic measure would be needed so that the proper utilization of the available land might be able to meet the situation created by the rising population. Change of ownership and experiments in land settlement with peasant smallholders seem to be the inevitable outcome.

Another matter that has given grave concern is the great dependence of the islands on imports for the food supply. The tradition of the West Indies has been to grow crops for export. In Barbados, for example, the estimated value of the food crops actually home-produced in 1938 was about £135,000, while in the same year the food imports were £516,000 and animal foodstuffs another £78,000. Further, much of the food imported was not of high nutritional value, with the result that the public health authorities were gravely concerned about the malnutrition that was evident. The other Colonies show a similar dependence on imports for their food supplies, although to a less spectacular degree. These islands would be in a serious quandary if anything should happen to upset the smooth working of the shipping lines, as is likely to happen in time of war. A change of policy has, therefore, appeared in the last few years, hastened of course by the advent of the present War, but already seriously considered for some years previously. It is now generally accepted that these Colonies must be more self-supporting in food supplies and should endeavour to produce food of better nutritional value than much of that which is now imported.

The decision to open land settlement was made before the War, and the Governments of the most densely populated islands are taking the steps within their means to acquire suitable estates and settle them with peasants on small holdings. St. Vincent made a start at the beginning of the century. Jamaica has recently done much in this connexion, as in 1938 a sum of £650,000 was raised on loan by the Government to extend settlement further, and a separate Department of Land Settlement was formed. In the Leeward Islands, also, a good start has been made by the purchase of estates in Nevis and Antigua, and the other Colonies have taken similar action. It may be taken, therefore, that a commencement has been made; but it is necessary to sound a word of warning since the technique of successful land settlement in the tropics is not easy, and has many pitfalls. There is the matter of the form of land tenure, for example.

The demand for freehold is great. Naturally, everybody wants to own his bit of land, but Government has definite responsibilities in this direction that cannot be disregarded. It must be remembered that land is precious in the West Indies, and the pressure of population is great. Experience with the older land settlement has shown that there is a tendency to exploit the land. Steep slopes have been deprived of their tree cover for cropping, with the result that much of the soil has been lost and periodic floods have caused destruction lower down. Repeated cropping, without manuring, has impoverished the land, and so on. One could mention some of the older settlements of the islands where the land has been completely ruined in fifteen years and the settlers have then demanded to be placed on fresh land. Instances of this sort can obviously not be repeated on a large scale, because the area of cultivable land is limited and the soil once lost cannot easily be replaced, and so the time might arrive when there would be no worth-while land left for anybody.

In fact, the sooner it is recognized that the soil is the main, and in many cases, the only asset the islands possess, the better it will be for everybody, for once lost it cannot be recovered. The granting of freehold is a matter that needs very serious consideration, therefore, but whatever form of tenure is finally selected, reasonable security must be offered, so as to give the peasant the chance to improve his holding. Without such security, there will be the natural tendency to 'skin' the land. On the other hand, the Government must be in a position to remove anyone who disregards the rules safeguarding the land and adopts methods that result in soil erosion and impoverishment.

The plan is to adopt a system of mixed farming, involving rotational cropping and including the keeping of livestock. The main object of introducing livestock is to provide for a supply of pen-manure and so keep up the humus content of the soil. Under the high temperature and moist conditions of the wet tropics, the soil loses its organic contents far more rapidly than in temperate regions. The details of cropping have yet to be worked out and the size of the holdings will naturally depend on circumstances such as the locality and soil, size of holdings, and availability of irrigation water. It will be necessary that the peasant should be mainly self-supporting so far as food is concerned. On the other hand, he must be able to grow some crops for sale, otherwise he will not have the cash to provide himself with the necessities of life, such as clothing and amenities, nor will he be able to pay his rent and the taxes which are necessary to maintain the governmental and social services.

The class of livestock suited for peasant holdings requires special consideration. The cow is obviously essential, but the type has not yet been finally decided, although a good deal of work has been devoted to livestock in recent years, particularly in Trinidad and Jamaica. In these two Colonies, experiments have been made to grade up local stocks by the use of high-grade dairy breeds of European origin. The Holstein (Friesian) is the breed favoured in Trinidad, and several breeds, including the Channel Island types, in Jamaica. It has been found that the introduction of European breeds has tended to produce a type that is not really suited to the tropics, as, quite apart from the question of resistance to disease, the respiratory organs are not suited to the heat of the tropics. Efforts to improve matters in

these respects are now in progress, using Zebu blood, and undoubtedly considerable progress has been made in producing superior milking cattle. The movement to establish dairies for the production of good milk for supply to the towns has increased of late years and cows bred for this purpose are supplying the gap. Under dairy conditions, however, the cows receive every care and skilled attention and a lot of supplementary and high-grade foodstuffs. Under peasant conditions, such will not be the case, and the cow will have to forage for itself, its food being supplemented with fodder crops and surplus waste from the peasant's holding. The peasant is not likely to be in a position to buy hard grain or cake from outside sources. It is difficult to imagine, therefore, that the large-framed cattle bred for dairy purposes will prove really suitable for the peasant, and one would like to see attempts made to solve the problem by careful selection from the common cows of the countryside.

It is true that there are no indigenous cattle in the country, but they were introduced several hundred years ago by the Spaniards, and running all through the islands one comes across small, shapely beasts, somewhat resembling some of the Channel Island breeds, which are thoroughly hardy and acclimatized and might prove the basis of such a breeding herd as is contemplated. Finally, there is the buffalo. It has been introduced into Trinidad on the sugar estates, but is used solely as a draught beast. Its value as a milch animal is not appreciated, yet in India and the East the buffalo cow is regarded as a fine milking beast and is highly prized as such. In the Colonies with large populations of East Indian descent at any rate, there would appear to be a reasonable prospect for its utilization as a milk-producer.

The details for the consummation of this programme of agricultural reform are now being worked out by the recently appointed Inspector-General of Agriculture, working within the organization set up by the Comptroller for Development and Welfare in the West Indies. The task is immense and one of the difficulties lies in the great variety of climate, soil and conditions that occurs in the various colonies. Each one differs from its neighbours to a remarkable degree, and each has its own peculiar problems. The difficulty of providing staff adequate to tackle the problems involved is enhanced by the number and often the small size of the units concerned. The larger Colonies, such as Jamaica, Trinidad and British Guiana, are in a position to maintain agricultural departments adequately staffed, but the smaller islands cannot afford this, and means will have to be found to pool their resources, and to provide the Inspector General of Agriculture with the necessary staff to carry out essential field experiments, to work out systems of cropping, demonstrate the results of research activities, teach the elements of animal husbandry, and arrange for the orderly marketing of the crops produced.

Many of the problems call for research in the first instance, and up to the present their investigation has not always proved possible. Research work is, in future, to be centralized at the Imperial College of Tropical Agriculture in Trinidad. This institution, after a life of some twenty years only, has already established for itself an enviable reputation and is regarded as the centre for agricultural knowledge, not only by the British Colonies, but also by the Latin American Republics that border the Caribbean Sea, and it has in addition strong cultural ties with

the United States and Canada. Already its hands are full, for in addition to a heavy programme of long-range research, it is the centre at which agricultural cadets receive their training for work in the agricultural departments right through the tropical Colonies of the British Empire. The College also trains men for agricultural work in the West Indian area. If it is to be charged with a number of specific West Indian problems in addition, it will need a good deal more financial support, and will have to be expanded. It is undoubtedly the best place at which to carry out the contemplated researches, and, given adequate funds and the necessary increase in staff, there is no reason to doubt that it will fulfil its task.

The West Indies appear to be on the verge of great new developments. The traditional economic system which depended on the production of export crops and the import of food needs modification. Efforts must be made to render these Colonies far more self-supporting in their food requirements than has been the case in the past, for it is believed that a country which is self-supporting in food is far better able to tide over the periodic trade depressions which inevitably occur, since during such periods the export crops may have to be sold at prices far below cost of production or difficulty may even be felt in disposing of them at all. In either case, there is little enough money available to purchase even the bare necessities of life. So, the next few years may see a radical change in the West Indies in the direction of a more rational system of agriculture, having as its main object the better utilization of the land and the preservation of the all-important soil. The policy of settling people on small holdings will be accelerated with the main object of making these Colonies more self-supporting as regards food. In order to effect this, some of the estates which are redundant, or cannot be worked profitably as plantations under existing economic conditions, will have to be taken over and settled with small holders. This does not necessarily mean that the plantation system as a whole will disappear. Many of those which are favourably situated, such as the sugar estates in the larger islands, must continue, and should benefit because the change should result in a more assured supply of labour from a settled peasantry. In fact, a combination of the two systems, each lending support to the other and with interlocking interests, would seem to be the happiest augury for the future.

CARL VON LINDE

A Pioneer of 'Deep' Refrigeration

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CARL VON LINDE is probably known to most scientific workers as the designer of a liquid-air machine, and nothing else. He contributed, however, to ordinary refrigeration as well, and still more to the problems of gas separation which are now becoming of such technical importance. Thus it is fitting, in this year which sees the centenary of his birth—he was born on June 11, 1842—to survey his work and to realize the debt which we owe to him.

It was in 1876, when he was thirty-four years of age and professor of thermodynamics at Munich, that Linde took out his patent for an ammonia refrigerating machine. Before this, machines using ether

had been used (they are now obsolete), as well as bulky and inefficient cold-air machines; but Linde had the scientific knowledge to calculate the thermodynamic efficiency attainable with different media, and the technical skill to design the plant well—so much so that Ewing, writing in 1908, was able to say: "The design of the Linde machine has been carried out with conspicuous care, and it owes much of its great success to excellence in mechanical detail". From the time of its introduction until recent years, the ammonia machine has been the most widely used refrigerating plant for all purposes except marine work, where carbon dioxide (which also was introduced by Linde, though independently by others) was preferred for various reasons. In recent years, the advent of the turbo-compressor has led to the use of organic refrigerants for air-conditioning work. The wide demand for small domestic plants has also been associated with the use of organic liquids, so that ammonia, though still widely used, is less dominant than formerly.

When he began to work on the production of liquid air, Linde had a clear idea of using it to produce oxygen by fractional distillation, and probably saw this as more important than the attainment of very low temperatures. At the time, air had already been liquefied by various investigators using a number of methods. Linde, in 1893, used a process not unlike that of the ordinary refrigerating plant, but with a heat interchanger to make the cooling cumulative. The air to be liquefied is compressed to a high pressure, cooled by circulating water, and then expanded through a throttle valve. (It is at this point that the process used by Claude differs. In Claude's arrangement, the gas expands in a cylinder and is made to do work so that the process is nearly adiabatic.) Here the temperature falls owing to the unresisted expansion. The cooled air leaving the valve then passes away up the outside of the pipe along which the air flows to the valve; thus the following air starts its expansion at a lower temperature. In this way, the air leaves the valve at continuously lower temperatures, until at last the boiling point is reached, and some of the air liquefies. From this time on, a steady state is approximately reached, in which part of the air leaving the valve flows away in the gaseous form, and may be regarded as the refrigerant, which completes its thermodynamic cycle by warming up to atmospheric temperature, while the remainder is liquefied.

The details of the process have, of course, been modified, but in principle Linde's first apparatus has been closely followed in subsequent design, and has been the basis, not only of liquid-air plants on a large scale, but also of plants for the liquefaction of hydrogen.

One of the two main deviations from the simple process outlined above consists in avoiding the waste which results from the expansion of all the air from high pressure to atmospheric. Actually, it is only that part of the air which is to be drawn off that need be lowered to atmospheric pressure. The remainder, which acts as the refrigerant, can be kept at a much higher pressure, thus greatly reducing the work of compression. To this end, the air at about 200 atmospheres is expanded to 40 atmospheres, and only that part which is to be drawn off is afterwards expanded to atmospheric pressure. It is found in practice that this increases the amount of liquid air obtainable for a given input of energy by about 10 per cent.